State Geological
and
Natural History Survey
of
Connecticut

THE SURFICIAL GEOLOGY
OF THE
WALLINGFORD QUADRANGLE
With Map

Open Map
Open Figure II

By

Stephen C. Porter

QUADRANGLE REPORT NO. 10

1960

STATE GEOLOGICAL AND NATURAL HISTORY SURVEY
OF CONNECTICUT

QUADRANGLE REPORT NO. 10

THE SURFICIAL GEOLOGY OF THE WALLINGFORD QUADRANGLE

With Map

BY

STEPHEN C. PORTER

Middletown

Printed by the State Geological and Natural History Survey

1960

State Geological and Natural History Survey of Connecticut

COMMISSIONERS

Hon. Abraham A. Ribicoff, *Governor of Connecticut*
J. Wendell Burger, Ph.D., *Professor of Biology, Trinity College*
Richard H. Goodwin, Ph.D., *Professor of Botany, Connecticut College*
G. Evelyn Hutchinson, Ph.D., *Professor of Biology, Yale University*
John B. Lucke, Ph.D., *Professor of Geology, University of Connecticut*
Joe Webb Peoples, Ph.D., *Professor of Geology, Wesleyan University*

DIRECTOR
Joe Webb Peoples, Ph.D.
Wesleyan University, Middletown, Connecticut

EDITOR
Elizabeth G. Weinman

DISTRIBUTION AND EXCHANGE AGENT
Robert C. Sale, *Librarian*
State Library, Hartford

TABLE OF CONTENTS

ILLUSTRATIONS

The Surficial Geology of the Wallingford Quadrangle

by

Stephen C. Porter

INTRODUCTION

LOCATION

The Wallingford 7½-minute quadrangle is located in south-central Connecticut in the middle of the Connecticut Valley Lowland and lies within New Haven County (fig. 1). The principal towns in the area are North Haven and Wallingford, both lying on the east side of the Quinnipiac River, which flows south through the western half of the quadrangle.

METHOD OF STUDY

The areal distribution and physical characteristics of surficial deposits were determined from observations in sand and gravel pits, stream cuts, and other artificial exposures; from numerous test holes made with shovel or soil auger; and from study of surface forms. Subsurface information was acquired from the Connecticut State Water Resources Commission, the Ground Water Division of the U.S. Geological Survey, the Pratt and Whitney Corporation, the American Cyanamid Company, and from individual well drillers. Mapping was done on a topographic base at a scale of 1:24,000, supplemented by aerial photographs. The northwest corner of the quadrangle, west of the Quinnipiac River and north of Pine Brook, was mapped by R. F. Flint.

ACKNOWLEDGMENTS

The financial support of the Connecticut Geological and Natural History Survey, under the direction of Dr. John B. Lucke, during the 1958 summer field season is gratefully acknowledged. The project was undertaken at the suggestion of Dr. R. F. Flint of Yale University, to whom the writer is indebted for many helpful suggestions during the work and for his critical review of the manuscript. Informal discussions and field examination of numerous aspects of the surficial geology of the quadrangle with Joseph B. Hartshorn and (Mrs.) Penelope M. Hanshaw have been most helpful.

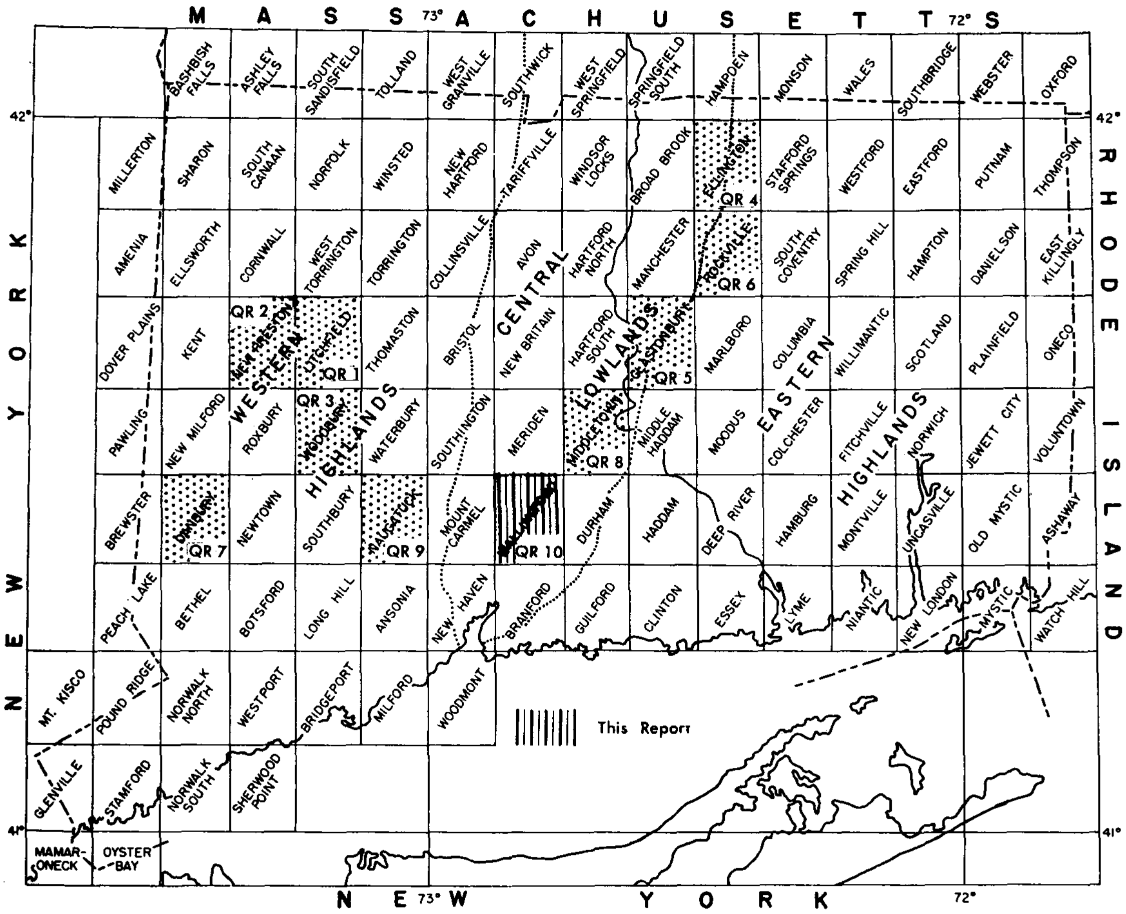


Figure 1. Index map of Connecticut showing location of Wallingford quadrangle.

Previous Work

Dana (1870, 1871) first showed conclusively that glacier ice invaded southern Connecticut during the Pleistocene Epoch. His subsequent studies (1875-1876, 1883, 1883-1884) over the next decade and a half resulted in the accumulation of a large amount of observational data and new ideas about the glacial history of southern New England. His studies were concerned mainly with the Connecticut Valley Lowland and, in particular, the region about New Haven. Many of his observations were made in the Wallingford quadrangle. The first detailed report on the glacial geology of the New Haven region was published by the Connecticut Geological and Natural History Survey in 1920 (Ward, 1920). The Wallingford quadrangle was included in this report as part of the area described. On the glacial map of the state, published as part of *The Glacial Geology of Connecticut* (Flint, 1930), the general distribution of the larger units of glacial drift in the Wallingford quadrangle is shown. A further study of late-glacial features in the Quinnipiac-Farmington Lowland (Flint, 1934) added to knowledge of the late-glacial history of the Wallingford area. Included in this paper is a map showing the distribution of glacial deposits in the Quinnipiac Valley in greater detail than had previously been shown. Krynine (1937) subsequently undertook a petrologic study of the glacial deposits in the Quinnipiac Valley and contributed a great deal of data on the composition, characteristics, and provenance of the stratified sediments. Olmsted's (1937) study of the vegetation growing on the Quinnipiac Valley outwash plain included a discussion of the character and distribution of the soils within this sector of the quadrangle.

GENERAL FEATURES

The quadrangle lies within the major physiographic feature known as the Connecticut Valley Lowland, in which glacial and postglacial sediments irregularly mantle sedimentary and igneous bedrock of Triassic age.

Altitudes within the quadrangle range from approximately sealevel along the Quinnipiac River in the southwest corner of the quadrangle to 610 feet in the upland region in the northeast corner. The low, nearly flat floor of the Quinnipiac Valley contrasts sharply with the higher, irregular topography to the east and west.

Topography is controlled in part by the distribution of various bedrock units, especially in the upland regions, and in part by glacial deposits. In the upland regions, glacial sediments tend to be thin and their surface conforms generally to the underlying bedrock topography. In valleys thick deposits of stratified drift form topographic features that include kames, kame terraces, ice-channel fillings, kettles, and in the Quinnipiac Valley, an outwash valley train. Most of the high hills, such as Totoket Mountain, the eastern part of Mount Carmel (the "Sleeping Giant"), and several discontinuous ridges bordering Muddy River, owe their height to resistant basaltic bedrock. In this quadrangle sedimentary rocks generally underlie subdued topographic forms.

The western half of the quadrangle is drained by the Quinnipiac River, which enters Long Island Sound in the New Haven quadrangle. It is a slow-flowing, meandering stream with a gradient of 5.9 feet per mile through the quadrangle. Minor tributaries, including Pine Brook, Waterman's Brook, Wharton Brook, Allen Brook, Catlin Brook, and Glen Brook, drain the adjacent uplands. Broad Brook, which has been dammed to form Broad Brook Reservoir, drains the northeast corner of the quadrangle and flows into the Quinnipiac River in the Meriden quadrangle. The eastern part of the quadrangle is drained by Muddy River, which flows south to join the Quinnipiac River in the Branford quadrangle, and Farm River, a small stream that joins the East Haven River in the Branford quadrangle. Swamps are present where subsurface drainage is poor, notably in upland areas where nearly impermeable till mantles the surface, or along channels of flood plains of sluggish streams. Swampy areas occur in several abandoned meander cutoffs of the Quinnipiac River. Most of the small ponds and lakes in the quadrangle are man-made features.

BEDROCK GEOLOGY

Triassic redbeds consisting of conglomerate, arkose, siltstone, and shale constitute the sedimentary bedrock of the quadrangle. Interstratified with the sedimentary rocks are three basaltic lava flows which, with related basaltic dikes and sills, constitute the igneous bedrock units of the quadrangle. Included in the map area are upper beds of the New Haven arkose, the Talcott basalt, the Shuttle Meadow formation, the Holyoke basalt, and the East Berlin formation (Krynine, 1950; Lehmann, 1959). Most of the quadrangle is underlain by pinkish-gray arkose of the Upper Division of the New Haven arkose. The Talcott basalt may be present in the extreme northeast corner of the quadrangle east of Hog Hill Road. Totoket Mountain is formed by the Holyoke basalt which overlies the Shuttle Meadow formation. The East Berlin formation, though not exposed, is probably present in the extreme southeast corner of the quadrangle, overlying the Holyoke basalt. The eastern end of Mount Carmel, a large intrusive igneous body, is included in the western part of the map area. Several prominent dikes, which form long linear ridges striking approximately N30E, are present east of the Quinnipiac River. A long basalt dike lies in the northwest corner of the quadrangle along Copper Valley. Small disconnected exposures of basalt in the uplands west of the Quinnipiac River belong to dikes or intrusive igneous bodies of unknown relationships.

Structurally, the intercalated sedimentary rocks and basalt flows form an eastward-dipping homocline. The attitude of the sedimentary units within the quadrangle is variable, with strikes ranging from N17E to N67E, and dips ranging from 8 to 20 degrees SE.

PREGLACIAL HISTORY

During late Triassic time, this area was the site of extensive deposition of continental sediments in an actively subsiding fault trough bounded by highlands to the east. According to Krynine (1950, p. 196), a hot and seasonally very humid climate prevailed. At three times during deposition of the sediments, volcanics poured out on the surface as lava flows and were subsequently buried by more sediments derived from crystalline highlands to the east. Dikes and various intrusive bodies such as Mount Carmel were also emplaced at this time. The Triassic Period was climaxed by uplift in western Connecticut, which tilted the sedimentary trough to the east, and by normal faulting, which displaced the sedimentary and igneous units, probably producing a system of block mountains and intermont basins similar to those currently found in Nevada and adjacent states. A long period of quiescence followed, during which the land was reduced to a surface of low relief. During the Cenozoic Period, slow renewed uplifts caused streams to erode the bedrock differentially. Degrading streams became adjusted to the bedrock structure and developed valleys in the more erodible sedimentary rocks. By the beginning of the Pleistocene Epoch, surface feature and drainage patterns had assumed the general form they have today.

SURFICIAL GEOLOGY

Evidence of Pleistocene glaciation, in the form of erosional features and glacial sediments, is abundant in the Wallingford quadrangle. Virtually the entire land surface is mantled by stratified and nonstratified sediments that are generally well exposed for study. Linear topography in the quadrangle is attributable in part to glacial erosion; minor erosional features likewise attest to the erosive capability of the glacier.

Glacial Erosion

Evidence of glacial erosion on bedrock outcrops is present at many places in the quadrangle but is never exposed extensively. Glacially polished bedrock is seldom seen, except where recently denuded of surficial sediment. Both arkose and basalt weather rapidly, with the result that polished surfaces are destroyed soon after they are uncovered.

Wherever glacial polish occurs, striations are normally present on the polished faces. Etched by rock fragments carried in the basal part of the glacier, striations afford an accurate visual record of the latest movement of the ice at the place where they occur. They tend to be deeper and greater in number on the more readily erodible Triassic sandstones and shales than on the more resistant basalts (fig. 2). In the upland region north of East Wallingford, several sets of striations occur, with strikes ranging from S5W to S10E. Directions of striations recorded in the Quinnipiac Valley and on the adjacent Mount Tom range from S27W to S35W. The range in strikes suggests that pre-existing bedrock topography locally influenced ice movement. The preglacial Quinnipiac Valley formed a trough, down which the advancing ice moved as it reached the Wallingford area. The movement of the glacier through the valley was undoubtedly favored by low relief of the valley floor, a southward slope, and absence of transverse topographic barriers.

Accumulated subsurface information has shown that the bedrock floors of many Connecticut rivers lie below present sealevel in their lower portions. Fluvial erosion, at a time when sealevel stood lower relative to the land and when southern Connecticut was ice-free, may have contributed appreciably to the deepening of the valley floors. It is likely, though, that their present depths are due at least in part to glacial erosion.

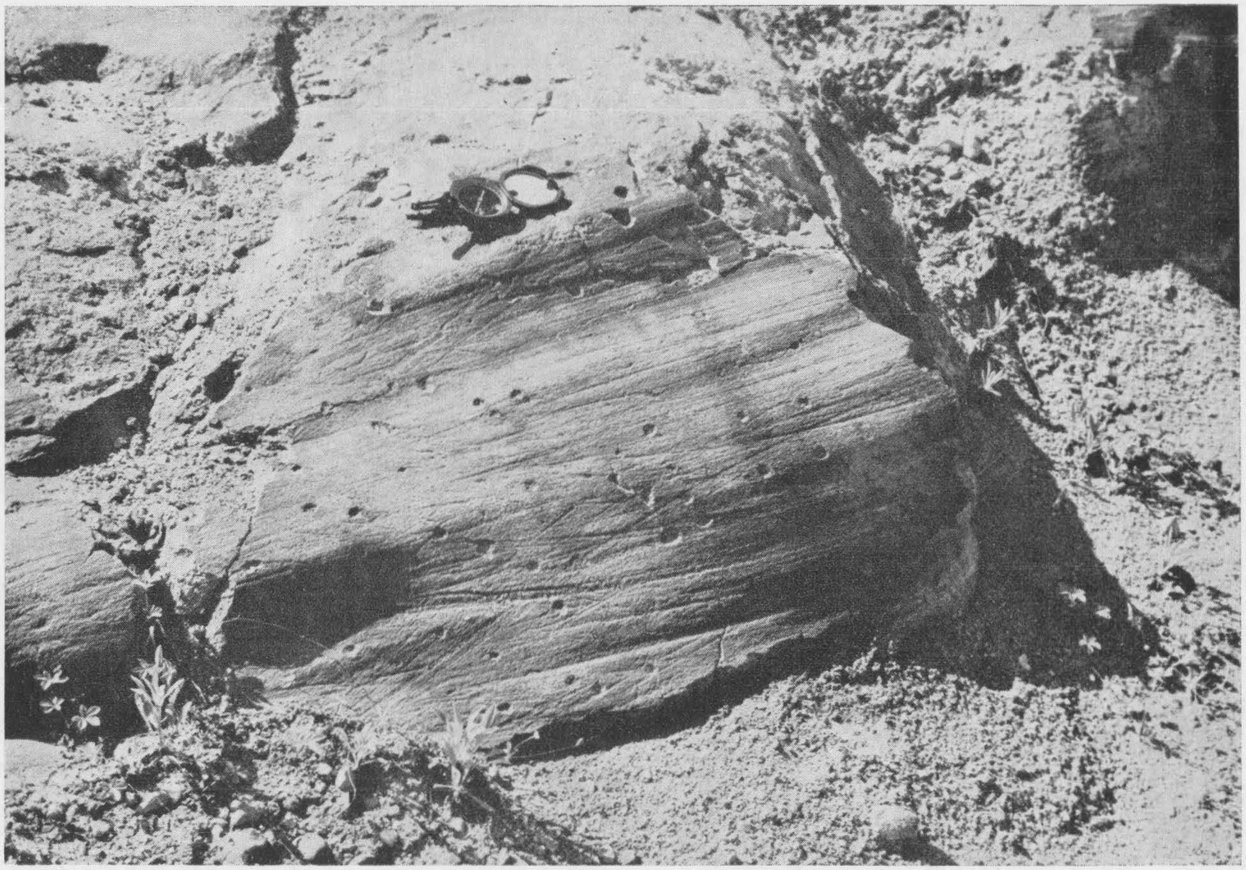


Figure 2. Outcrop of arkose showing glacial grooves and striations. Quinnipiac Valley, one mile north of North Haven. Round pits on surface of outcrop caused by rifle bullets.

Well records show that the bedrock floor of the Quinnipiac Valley lies well below sealevel and that in places, the thickness of glacial drift exceeds 200 feet. There are few wells in the valley, but enough borings and seismic traverses have been made to show that the buried valley is probably a continuous feature from the northern border to the southern border of the quadrangle. The data show that the buried valley does not have a uniform gradient but is a shallow trough containing several deeper basins. One of the basins lies adjacent to the town of Wallingford, where a well was drilled to a depth of 250 feet in unconsolidated sediments without reaching bedrock. The bedrock floor lies at least 200 feet below sealevel in another deep basin west of Wharton Brook State Park. In the northern half of the quadrangle, the bedrock trough lies near the center of the present valley, but in the southern half it appears to follow the eastern side of the valley, east of North Haven (fig. 3). A secondary valley, buried by drift, lies beneath the present river channel west of North Haven. The very irregular gradient of the bedrock valley floor through the Wallingford quadrangle suggests that glacial erosion played an active role in valley deepening.

Major and minor topographic features in the quadrangle normally display marked linearity, probably due largely to differential erosion of the dipping bedrock formations in preglacial time, but also due in part to glacial erosion. The mode of the long axes of 130 linear topographic features trends N25E, nearly paralleling the trend of the Quinnipiac Valley, the strike of the sedimentary bedrock formations, and the average direction of the glacial striations. The preglacial valley and the preglacial bedrock ridges probably played a significant role in determining local direction of ice movement within the quadrangle.

There are several well developed drumloid hills in the quadrangle, but, owing to the lack of adequate deep exposures or wells, it is uncertain whether they are true drumlins (streamlined lens-shaped mounds of till with oval ground plan), or rock drumlins (identical in form with true drumlins but possessing a rock core mantled with till). Among such features are two elliptical hills in North Haven. The largest of these, in the center of the town, is surrounded by glacial outwash sand and gravel. The second hill lies half a mile south of the first and is also surrounded by glacial outwash. On the north side of this hill bedrock is exposed, but on the south side of the hill reddish sand and gravel underlie the surface. Till mantles the top of the hill, in places overlying the reddish sand and gravel. The hill is probably a small rock drumlin with tail of stratified drift extending to the south.

GLACIAL DEPOSITS

Sediments of glacial origin can be grouped broadly into two categories: ice-laid sediment and water-laid sediments. Ice-laid sediment consists of till, a nonsorted, nonstratified sediment carried or deposited by glacier ice. Water-laid sediments consist of stratified material that was deposited by streams of glacial meltwater during deglaciation. Also included are sediments deposited in glacial lakes that were fed by meltwater streams.

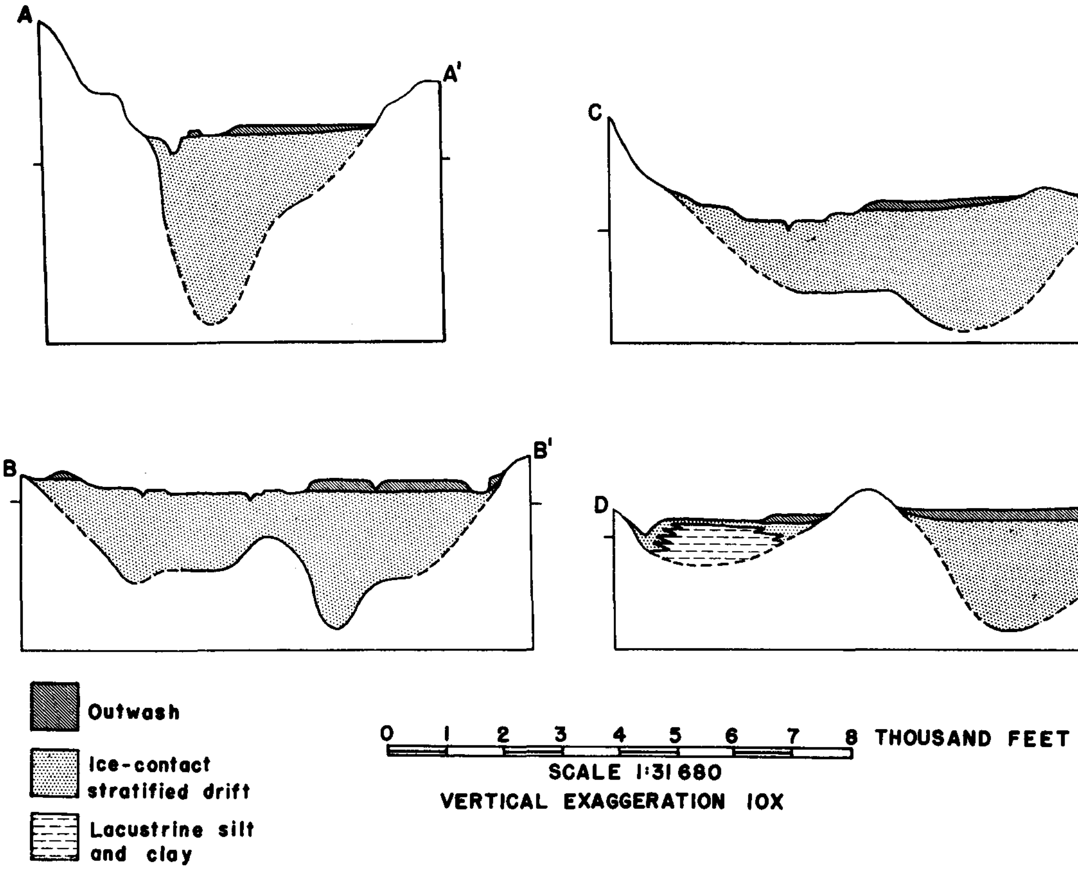


Figure 3. Geologic cross sections of the Quinnipiac Valley showing inferred configuration of the bedrock floor and the relative thicknesses of sediments comprising the valley fill.

Till

A fairly continuous blanket of till of variable thickness mantles the bedrock surface of the quadrangle. On most upland surfaces till forms an almost continuous cover, but on valley floors it is commonly buried beneath stratified glacial sediments. In only a few places is bedrock exposed directly under stratified sediment. In the valleys till has been recorded in many deep borings that pass through the drift and reach bedrock. It is likely, therefore, that till covers much or most of the bedrock floors of the valleys, though presently obscured from view.

Till in the Wallingford quadrangle, like most till in New England, is notably stony. The bulk of the coarse fractions of the till consists of pebbles, cobbles, and boulders that were derived from prominent basalt ridges lying in the path of the advancing glacier. The matrix, consisting of sand, silt, and clay, normally has about the same grain-size distribution as the underlying bedrock. The sedimentary rocks of the quadrangle consist mostly of sandstone with some siltstone and shale and a little conglomerate. It is not surprising, therefore, to find that the till matrix is very sandy, with varying minor amounts of silt and clay (fig. 4). In general, the till matrix contains more silt and clay than does the source bedrock; probably this fact reflects diminution of grain size through the grinding action of rock debris carried in the basal ice.

Rock fragments in the till are generally angular to subangular, although in some places well-rounded stones are plentiful. Sand-size particles are predominantly angular, and consist of small rock fragments or of mineral grains. Pebble- and cobble-size fragments are rounded to angular. Angular stones normally are plentiful in till lying south of prominent bedrock ridges. In many places, subrounded and rounded stones occur in till that mantles valley floors; probably they represent stream gravel incorporated in the basal till. Many large stones have scratched and faceted surfaces, the result of abrasion as the stones were transported in the basal part of the glacier.

The mineral composition of the till matrix compares closely with that of the Triassic country rock from which it was largely derived. Quartz, feldspar, hematite, muscovite, and kaolin constitute the chief minerals present in till, but small fragments of bedrock are also included in the coarser sand sizes. Small pieces of basalt and its mineral constituents also comprise a small fraction of the particle assemblage.

The stones present in till are also largely derived from nearby bedrock. Till in which most of the stones are basalt is found on the hill south of Sleeping Giant State Park and along the eastern border of the map area, immediately west and south of Beseck Mountain, Fowler Mountain, and Pistapaug Mountain, which lie in the adjoining Durham quadrangle and are composed of resistant Holyoke basalt. Sandstone blocks are common constituents of till mantling hills of Triassic sandstone. Fragments of crystalline rock are present in the till also but they are rare and form an almost negligible percentage of the total number. Their scarcity is largely attributable to the fact that the Wallingford quadrangle lies in the middle of the Connecticut Valley Lowland. The direction of glacier

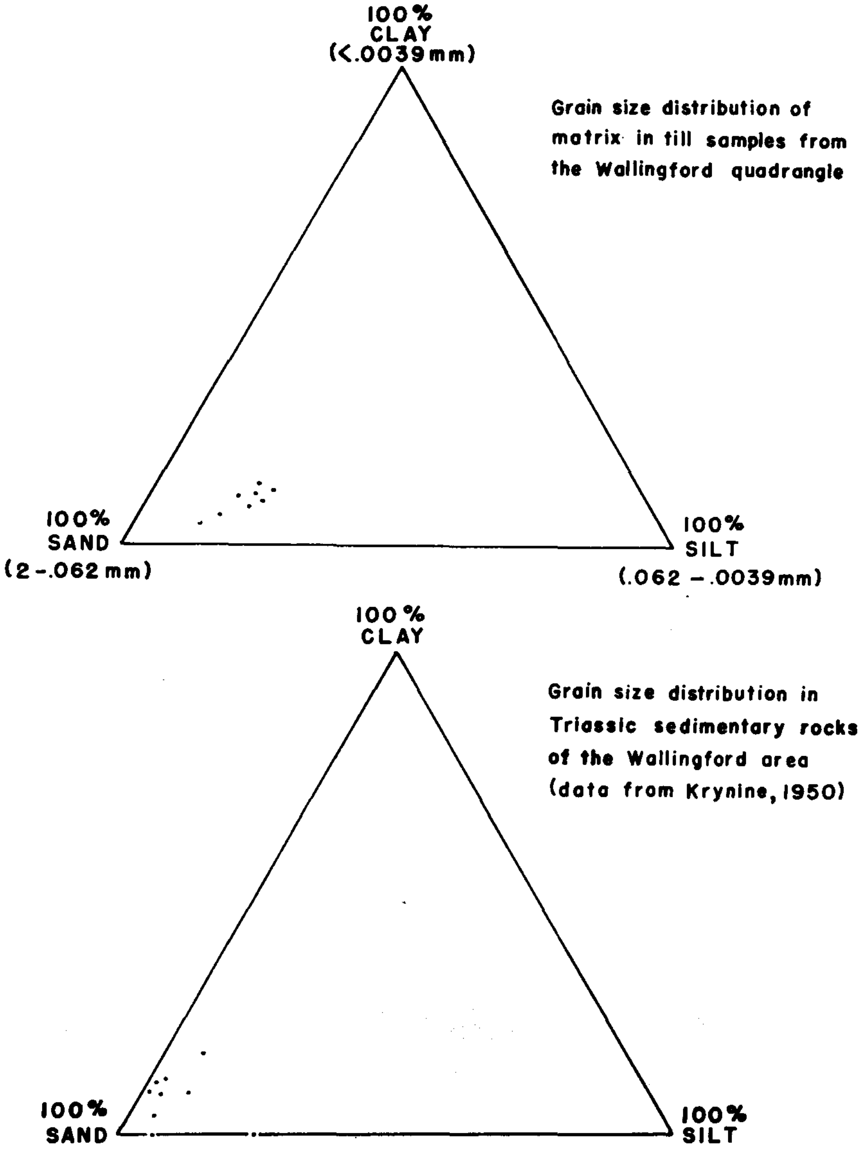


Figure 4. Grain-size distribution in till and Triassic sedimentary rocks.

movement roughly paralleled the lowland, so that few rocks from the crystalline uplands were carried out into the middle of the Triassic belt.

The thickness of till is variable. Generally it is thin along the tops of hills but thickens downslope. Drilling records of wells throughout the quadrangle show that till ranges in thickness from 0 to as much as 40 feet. The average figure for till thickness in 98 wells is 16 feet. In the latitude of North Haven the drilling records show that till ranges in thickness from 0 to 30 feet, but in more than half the wells till is between 5 and 10 feet thick. In the region of Wallingford, the till in wells ranges from 0 to 40 feet in thickness. In 32% of the wells in this area, till is from 5 to 15 feet thick and in 45% of the wells it is 20 to 30 feet thick. Till is less commonly exposed in valleys than on hillsides but is sometimes visible in stream cuts and gravel pits. In only five such exposures was till seen lying directly on bedrock, and in none of these was the till more than 5 feet thick. The thickest section of till seen in the quadrangle lies on the south side of Airline Road, one mile southwest of East Wallingford, where till on the north side of a hill reaches an exposed thickness of about 15 feet.

In the Wallingford quadrangle, till is characteristically reddish or brownish in color, reflecting the color of the Triassic sedimentary source rocks. Common colors of the till are moderate reddish brown (10 R 5/4)[1], pale grayish red (10R 5/2), and light brown (5YR 6/4). The surface color of basalt stones in the till is generally light brown (5 YR 6/4) to grayish orange (10YR 7/4) because of oxidation. When conditions have prevented oxidation of the iron-rich minerals in the basalt, stones may retain the dark-gray (N3) color of the fresh rock.

Stratification is lacking in the heterogeneous till, but pronounced fissility parallel to the ground surface is common. The fissility, which at first sight resembles stratification, is a structural feature, the cause of which is not known with certainty. Some exposures of stony till, when analyzed statistically, show a preferred orientation of stones that imparts a characteristic fabric to the till. Holmes (1941) showed that in some tills a large number of stones lie with their long axes oriented parallel with the direction of flow of the ice that deposited them. Three samples of till from the Wallingford quadrangle were analyzed and a strong preferred orientation of stones was noted. The sections studied lie: (1) immediately west of Old Hartford Turnpike, half a mile north of the point where it leaves the southwest corner of the quadrangle, (2) at the junction of Cheshire Road and Schoolhouse Road, and (3) on the top of an elliptical hill half a mile south of North Haven. Each of the fabrics showed a preferred orientation of stones in a direction of N30-40W.

Owing to the normally slight thickness of the till, its topographic expression generally reproduces the topographic expression of the underlying bedrock. The till cannot properly be termed moraine because it is not characterized by recognizable topography of its own. In the Wallingford quadrangle, therefore, till is considered to be a stratigraphic unit but not a topographic entity.

---

[1] Rock and sediment colors in this report are described according to the Munsel Rock Color System (Goddard, 1948).

Erratic boulders are common features in certain parts of the quadrangle; several large ones occur in the uplands west of the Quinnipiac Valley. All large erratics seen consist of basalt and are most abundant in areas south of prominent basalt hills or ridges. One large erratic, on the south side of Cheshire Road northeast of Fresh Meadows, is particularly noteworthy, for it measures 21 feet in diameter (fig. 5).

ICE-CONTACT STRATIFIED DRIFT

Stratified sediments of ice-contact origin are highly variable internally and are characterized by relatively poor sorting, abrupt changes in grain size both vertically and horizontally, included lenses of till, and collapse features. In any exposure, grain-size distribution is normally large (fig. 6). Pebble and cobble layers are commonly interstratified with beds of sand and silt. Many beds of sediment are characterized by extreme variation in grain size and consist of particules ranging in size from silt to cobbles. Large erratic boulders are sometimes found within bodies of stratified drift; small erratics are common features. Degree of rounding varies greatly, but is in general poor; this suggests that the sediment has not traveled far from its source. Fluvial cross-bedding is the dominant depositional structure, but deltaic stratification and horizontal lamination occur also. The current directions inferred from these structures vary greatly, but a general southward movement appears to have predominated. Some exposures show evidence of sediment collapse, the beds being folded or displaced by small faults. Such features probably formed when marginal blocks of ice melted away, removing the support they afforded during deposition of the stratified sediments.

Ice-contact stratified drift is invariably reddish in color, ranging from pale red (5R 6/2) or grayish red (5R 4/2) to moderate reddish brown (10R 4/4). Some cobbles and pebbles characteristically have a weathering coat of maganese oxide that gives them a shiny very-dusky-purple (5P 2/1) color. The reddish color of the ice-contact sediments is attributed to the fact that the sediments are composed largely of locally derived Triassic redbed detritus, with a similar range in color.

Petrologic study of the sand-size fraction has shown that the provenance of the sediments is composite. Krynine (1937) showed that more than two-thirds of the sand-size particles consist of reworked local bedrock, that ice-transported material constitutes about one-third of the total, and that very subordinate amounts consist of remnants of an alluvial cover formed prior to the advance of the glacier. The bulk of the pebble- and cobble-size fraction is also locally derived arkose, siltstone, or basalt. The crystalline component is present in this size fraction but constitutes only a small part of the total. The widespread occurrence in ice-contact stratified drift of cut-and-fill stratification and of even-bedded sand, silt, and clay indicate that the sediments were deposited both in streams and in small lakes dammed by wasting residual ice. Inasmuch as the directions of flow of the meltwater streams were determined by the distribution of melting ice blocks, stream positions were temporary and shifted suddenly as new avenues were opened to them. Similarly, ice-dammed ponds filled and then drained as ice melted and as outlets opened. Because of constantly shifting and coalescing stream channels,

Figure 5. Large erratic of basalt on Cheshire Road, 300 yards west of junction with Schoolhouse Road.

Figure 6. Typical exposure of ice-contact stratified drift showing poor sorting and rapid changes in grain size. Hand lens indicates scale.

discharge varied greatly, so that at times a stream was able to transport a coarse bedload, whereas at other times it was able to carry only a fine suspended load.

With the exception of several small localized deposits at high altitudes, ice-contact stratified drift is confined mainly to valley floors of the present drainage system, where it is exposed in stream cuts and in gravel pits. It is exposed discontinuously along the margins of the Quinnipiac Valley, where it lies higher than the nearly uniform upper surface of an outwash valley train. Half a mile south of Wharton Brook State Park it locally rises above the valley train in three isolated kames. Ice-contact sand and gravel lie above the outwash plain on the south side of a hill, half a mile south of North Haven. Reddish ice-contact sands are exposed also in the faces of low terraces cut by the Quinnipiac River and in many commercial sand and gravel pits distributed throughout the valley.

The upper surface of the ice-contact sediments in the Quinnipiac Valley is highly irregular, having a maximum relief of 40 to 50 feet in several cross profiles of the valley. In many exposures in the Wallingford quadrangle, a lag concentrate of pebble and cobble gravel lies at the contact between the reddish sands of ice-contact origin and the yellowish-gray outwash sands (fig. 7). The gravel layer is known to occur only south of South Meriden in the Meriden quadrangle. The lag is probably a result of the winnowing-out of fine sediment during a period of fluvial erosion prior to outwash sedimentation. Much of the original depositional surface of the ice-contact stratified drift appears to have been reworked and channeled by the stream that formed the lag gravel. However, the original surface of deposition is probably preserved on kame terraces along the valley sides and on kames that rise above the upper surface of the outwash.

Well-log information in the Quinnipiac Valley indicates a maximum thickness of ice-contact stratified drift of more than 250 feet. The scattered wells suggest an average maximum thickness along cross profiles perpendicular to the axis of the buried bedrock valley of about 200 to 225 feet (fig. 3).

Ice-contact stratified drift forms a nearly continuous mantle along the valley of Muddy River where kame terraces occur discontinuously along the valley sides. Kames are found one mile south of Clintonville, near the river west of Tyler Mill Pond, half a mile south of Spring Lake, and in the area of ice-contact stratified drift near the northeast corner of the quadrangle. Three large kettles occur in a kame terrace north of Dayton Pond, near the southern edge of Pine River Reservoir (fig. 8).

Similar features are abundant in the Farm River Valley where well-developed kames are numerous and where three large kettles are located immediately south of Tommy's Path.

Scattered well logs show that the ice-contact deposits are about 80 feet thick in the vicinity of Clintonville, at least 15 feet thick near Pine River Reservoir, and up to 40 feet thick around Spring Lake.

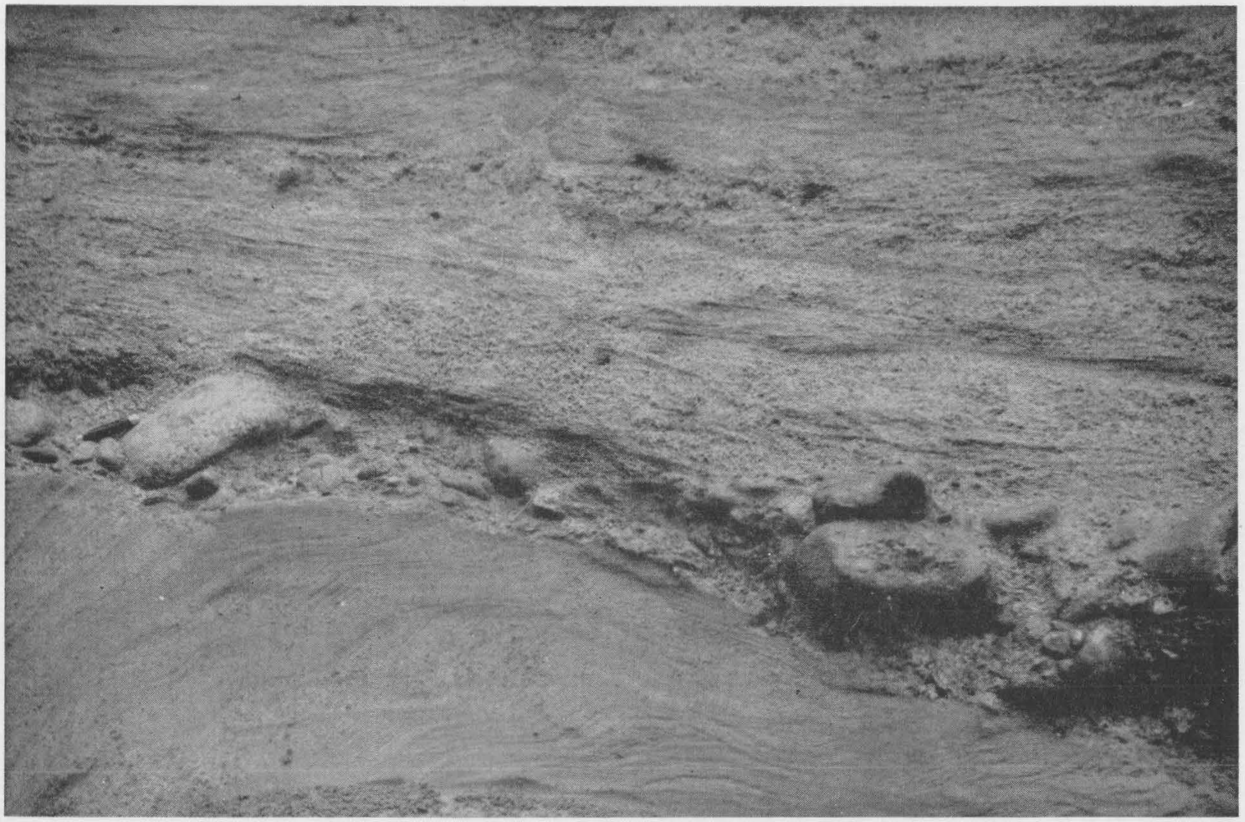


Figure 7. Gravel layer separating yellowish-gray outwash from underlying reddish ice-contact stratified drift in the Quinnipiac Valley. Pocket knife indicates scale.

Figure 8. Pond-filled kettle in kame terrace east of Pine River Reservoir.

Lake Sediments

Laminated and nonlaminated clay and silt occur at several localities in the Quinnipiac Valley and in the upland regions. At the Stiles Corporation pit, near the southwest corner of the quadrangle, Ward (1920) reported 60 feet of reddish, rhythmically laminated clay and silt resting on bedrock. This deposit is believed to be co-extensive with similar laminated clay and silt farther down the valley in the New Haven quadrangle, where it is known as the New Haven clay. The Stiles pit is inoperative at present and the laminated silt and clay are not exposed, but they can be seen a short distance south at Bruces Ice Pond in the Branford quadrangle. The individual laminae are remarkably uniform in texture and color. There are, on the average, about 12 couplets per vertical foot. Coarse-textured laminae are light brown (5 YR 5/5) in color, grade upward from fine sand or silt into clayey silt or silty clay, and are overlain by layers of dusky-red (10 R 3/3) clay. Concretions are common at several horizons and occur in the silt layers. They vary greatly in size, shape, and symmetry. The shapes range from spheroidal or subspheroidal to linear flattened forms (fig. 9). They are composed mainly of silt with some clay, cemented by calcium carbonate. Some erratic pebbles are also found within the laminated sediments and were probably ice-rafted and dropped to their present positions. Krynine (1937) concluded that the only adequate source of the sediment is the Upper Division of the New Haven arkose, the dominant sedimentary rock type in the Wallingford quadrangle. By analogy with similar deposits, the sediments are believed to be lacustrine in origin and to represent deposition in a large proglacial lake that probably extended from the narrows at East Rock in the New Haven quadrangle into the southern part of the Wallingford quadrangle, a distance of about 5 miles. The exact stratigraphic position of the sediments in the Wallingford quadrangle is not known. In the New Haven quadrangle the lacustrine sediments have a channeled upper surface and are unconformably overlain by yellowish-gray outwash sand. Outwash also overlies lacustrine sediment in some exposures at Bruces Ice Pond. In several places, however, reddish sand overlies the laminated silt and clay with apparent conformity, and at other places is interstratified with them. These relations suggest that the laminated lacustrine sediments are contemporaneous with reddish sands of ice-contact origin and represent a lacustrine facies of these deposits.

One mile east of the Stiles pit, on Clintonville Road, several wells have penetrated 130 to 160 feet of red "clay" that overlies red sand and is overlain by yellowish-gray sand. A well at the Pratt and Whitney factory encountered 41 feet of red clay, and test borings on American Cyanamid Company land disclosed 16 to 90 feet of red clay. Ward (1920) noted clay in the bed of Wharton Brook and on the banks of the Quinnipiac River at the east end of Sleeping Giant State Park that are not currently exposed to view. He also reported 150 feet of clay in a well at Wallingford. Red nonlaminated silt was observed underlying red ice-contact gravel and yellowish-gray outwash in an excavation at the filtration plant in Wallingford. Red "clay" is also known to occur under the Meriden-Wallingford Washed Sand and Stone Company pit, one mile north of Community Lake in Wallingford. More subsurface infor-

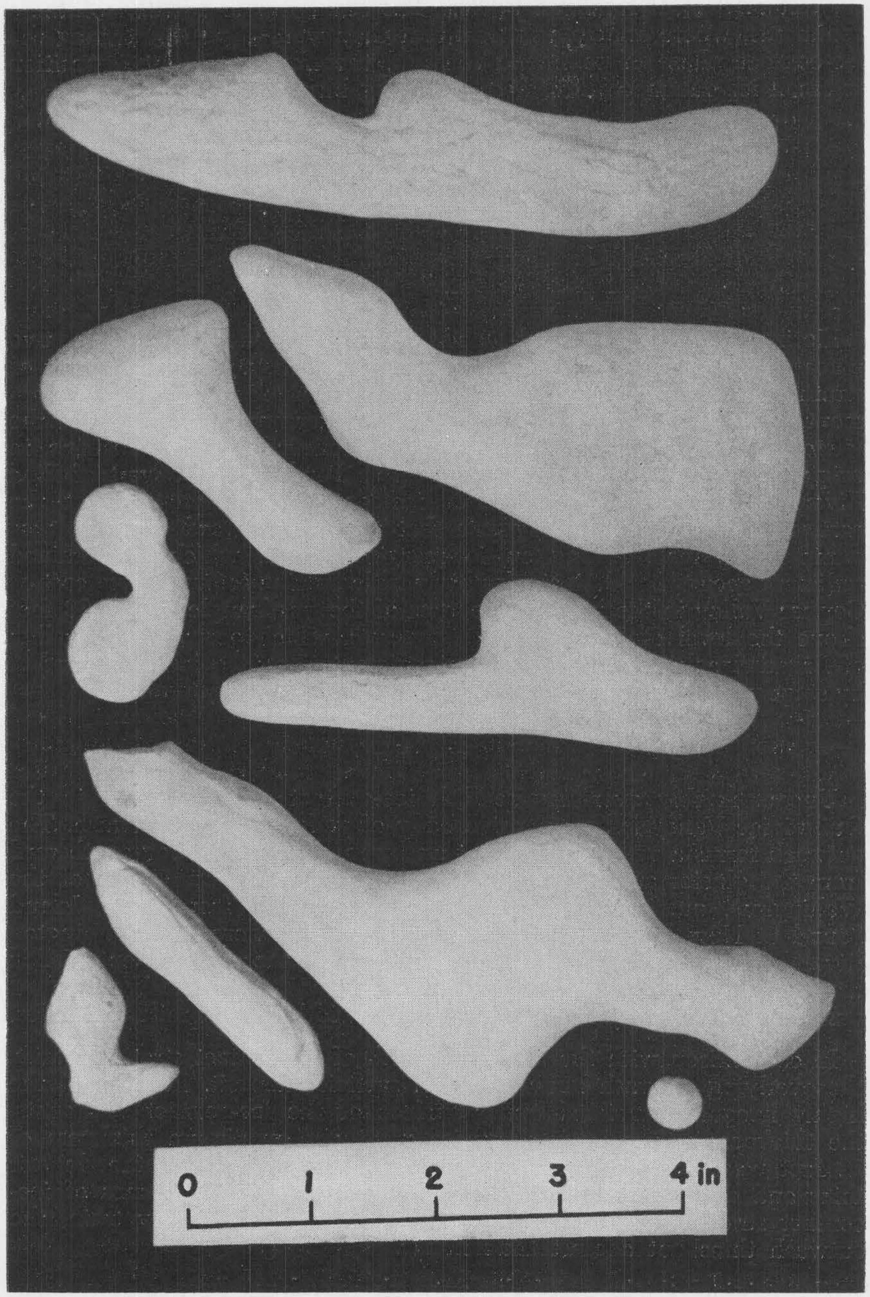


Figure 9. Concretions from New Haven clay.

mation is necessary before it can be determined whether these scattered occurrences in the Quinnipiac Valley represent a continuous lacustrine deposit or several localized bodies. The stratigraphic position of these sediments, where known, suggests that they were deposited during the ice-contact phase of sedimentation and therefore represent deposition in small ice-dammed lakes among melting blocks of glacier ice.

Small exposures of deformed, rhythmically laminated silt and clay occur in the banks of two minor tributaries of the Quinnipiac River, one near the junction of Mansion Road and Old Hartford Turnpike, and the other near the point where the Wilbur Cross Parkway leaves the southwest corner of the quadrangle. These deposits represent deposition in small ice-margin ponds or lakes. The sediments were tilted when supporting ice masses melted away.

Horizontally bedded sand-, and clay-size sediments occur in two places in the uplands east of the Quinnipiac Valley. A small deposit of stratified sand and silt, exposed during excavations for a housing development, lies on a hillside above Wharton Brook, immediately west of the village of Quinnipiac. A larger deposit, believed to be lacustrine in origin, lies in a basin at the north end of Pond Hill just west of Pine River Reservoir. The presence of ice-contact stratified drift at the eastern end of the basin suggests that normal eastward drainage was dammed by ice, forming an ice-margin lake in which fine-grained sediment accumulated. A similar body of lacustrine sediment lies east of Copper Valley in the northwest corner of the quadrangle. It lies 80 feet above the level of Broad Brook Reservoir, which occupies the valley of Broad Brook, and resulted from sedimentation in a lake impounded by stagnant ice in Copper Valley.

Outwash

Unconformably overlying reddish ice-contact stratified drift in the Quinnipiac Valley is an extensive body of yellowish-gray outwash. The outwash forms a valley train, built up by meltwater draining southward from the glacier at a time when the ice margin lay well north of the Wallingford quadrangle. The valley train extends from Long Island Sound at New Haven, northward to the point where the Farmington River leaves the Western Upland, and enters the Connecticut Valley west of Farmington, a distance of about 36 miles. In the Wallingford quadrangle it is a major feature, varying in width from ¾ mile to 2 miles.

In comparison with the thick valley fill of ice-contact stratified drift, the overlying outwash body is a thin surficial deposit. Because of the highly irregular erosional upper surface of the ice-contact sediments, the thickness of the outwash varies greatly. A maximum thickness of 32 feet was measured near the center of the valley, but the deposit thins and disappears toward the valley margins. Where kames of ice-contact stratified drift rise above the surface of the valley train, the outwash thins out against their flanks.

The original thickness of the outwash may have been greater than that seen today. Differential compaction of the sediment and recent erosion by the Quinnipiac River could have reduced the original depositional surface by an appreciable amount.

The outwash displays fluvial cross-bedding and cut-and-fill stratification; it is stratified in thin foreset courses a few inches to a few feet in length (fig. 10). Changes in grain size are normally abrupt, both horizontally and vertically, though the changes are much less extreme than in ice-contact stratified drift. A wide range in grain size normally is found in any single exposure, but the average grain-size distribution for several exposures at a given latitude is generally about the same. Textural analysis has shown, however, that the average grain-size distribution of the outwash decreases in a downstream direction within the quadrangle (fig. 11). In the northern part of the quadrangle, there is a marked bimodal grain-size distribution in the outwash with one mode consisting of fine pebble-size and larger ($>$ 4mm) and a second mode lying in the range of coarse sand (0.5 to .71 mm). Downstream the first mode diminishes in value and disappears while the second mode increases in value and shifts toward the smaller grain sizes. At the southern boundary of the quadrangle the mode lies in the medium sand range (.25 to .35 mm).

In the pebble-size fractions, the particles are normally subrounded to rounded, whereas in the coarse sand size they are subangular to subrounded. In the finer size grades, particles tend to be predominantly angular to subangular.

Lacustrine silts and clays are present locally, indicating that parts of the outwash surface held ponds of quiet water for a time before the aggrading streams moved over them to resume fluvial deposition. In an exposure at the Meriden-Wallingford Washed Sand and Stone Company pit, north of Wallingford, a thin but extensive lens of fine silt displays remarkable distorted and deformed laminae that must have resulted from slumping of the unconsolidated sediments after deposition in a small pond (fig. 12).

Current directions, as shown by orientation of foreset courses, are variable in any one exposure, suggesting deposition by a braided stream with constantly shifting channels. The average direction of foresets, however, is downvalley. The currents were controlled by laterally shifting stream channels, rather than by residual ice masses, as was the case with the underlying ice-contact sand and gravel.

According to Krynine (1937), the outwash was derived chiefly from crystalline rocks in the drainage areas of the Farmington and Pequabuck Rivers. In the Wallingford quadrangle, the outwash has a variable amount of locally derived Triassic admixture, probably derived from the reddish ice-contact sediments below the outwash. Krynine showed that the amount of Triassic admixture may be as high as 85 percent, but usually ranges from 10 to 50 percent and averages 20 to 30 percent.

Where the amount of incorporated Triassic admixture is small, the outwash is normally yellowish gray (5Y 7/2) in color, but where the reddish Triassic admixture forms 50 percent or more of the sediment,

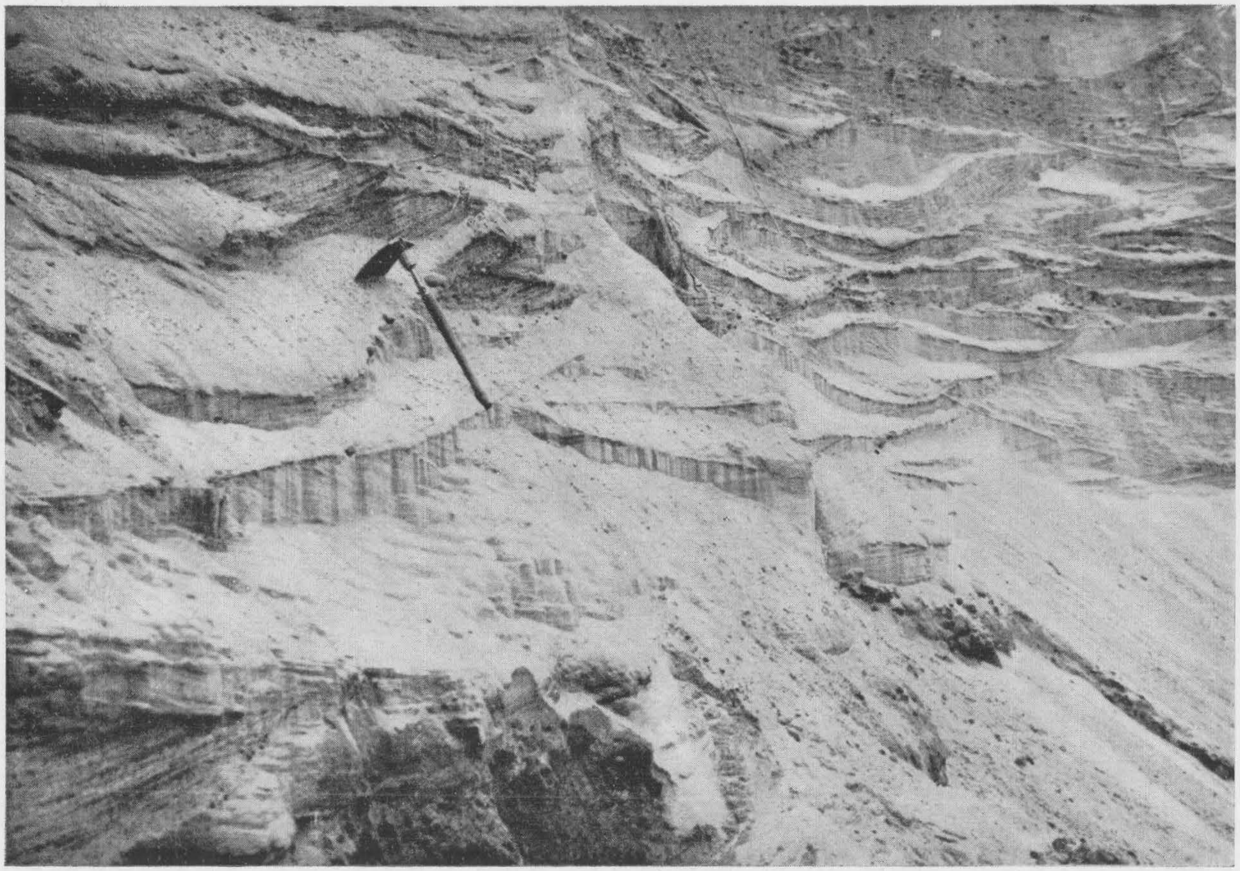


Figure 10. Exposure of yellowish-gray outwash showing cut-and-fill stratification. Wallingford-Meriden Washed Sand and Stone Company pit, Wallingford.

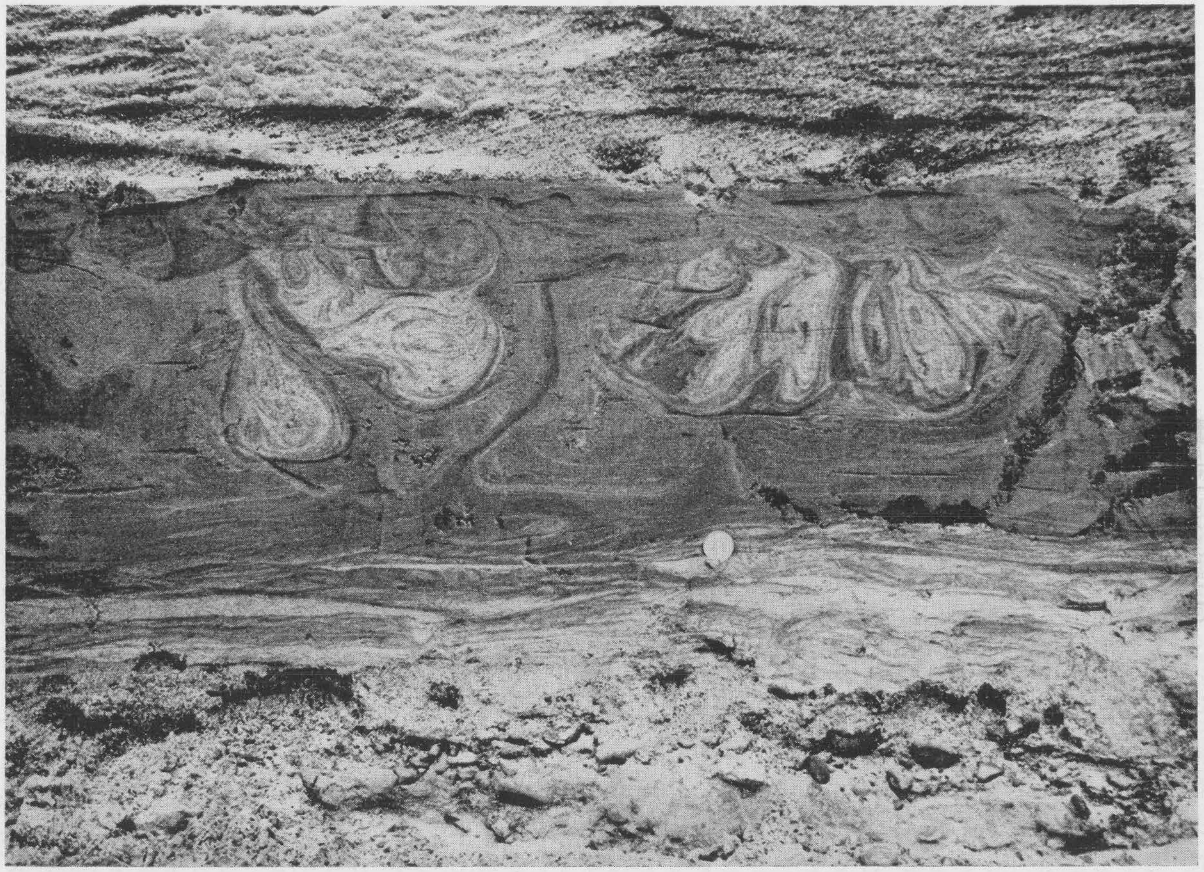


Figure 12. Distorted laminae in lens of silt within outwash body of the Quinnipiac Valley. Wallingford-Meriden Washed Sand and Stone Company pit, Wallingford. Nickle indicates scale.

the color approaches reddish gray (7R 4/2). When fresh and not greatly contaminated, the outwash can be readily distinguished from ice-contact stratified drift on the basis of color. The color of the weathered surface zone of the outwash normally ranges from light brown (5YR 5/6) to dark yellowish orange (10YR 6/6).

Although the valley train originally extended virtually unbroken across the Quinnipiac Valley lowland, postglacial erosion by the Quinnipiac River has dissected it and produced a series of non-paired terraces (fig. 13). In the Wallingford quadrangle the river has intrenched itself west of the centerline of the valley, resulting in an asymmetric distribution of outwash on the geologic map. A broad expanse of outwash extends along the eastern side of the valley, ranging in width from 0.2 to 1.3 miles. West of the river only scattered remnants lie along the valley side, in many cases having been protected from erosion by resistant bedrock defenses upstream.

On the eastern side of the valley, the upper surface of the outwash body is not a flat plain but has distinct and irregular microrelief. The surface generally slopes gently away from the valley side, toward the river. In places, old stream channels appear to be present on this gently sloping surface. If the present surface of the valley train is the original surface to which outwash sediments were built up, before erosion by the Quinnipiac River, the slight relief that does exist may represent channels of the braided stream that deposited the sediment. Differential compaction of the outwash after deposition may also have contributed appreciably to the configuration of the present surface. The original porosity of the outwash may have been as high as 25 to 50 percent, in which case compaction could have differentially lowered the upper surface, especially near the center of the valley where the deposit is thickest. If, however, the present surface is erosional, the observable relief is due to degradation by the postglacial Quinnipiac River and its tributaries. Probably each of these factors contributed to the formation of the present surface relief.

The outwash plain lies at an altitude of about 95 feet at the northern boundary of the quadrangle and declines to an altitude of about 50 feet at the southern boundary. The gradient, based on the highest altitudes of the deposit, is 6 feet per mile (fig. 14). This inclined surface may be the result of one or several processes. It could be: (1) the surface of initial deposition, (2) an erosional terrace or series of them, (3) a surface that has been warped by differential uplift of the land after disappearance of the glacier, or (4) a combination of the above. Field relations suggest a combination of the first two processes. Postglacial uplift may be a contributing factor, even though no evidence of it was found within the Wallingford quadrangle.

The stratigraphic relations and sedimentary structures of the outwash body show that it was deposited during deglaciation by meltwater originating from the wasting glacier, which by this time lay north of the Wallingford quadrangle. The cut-and-fill stratification is the result of the alternately degrading and aggrading activity of high-velocity streams in rapidly shifting channels. The sedimentary features of the

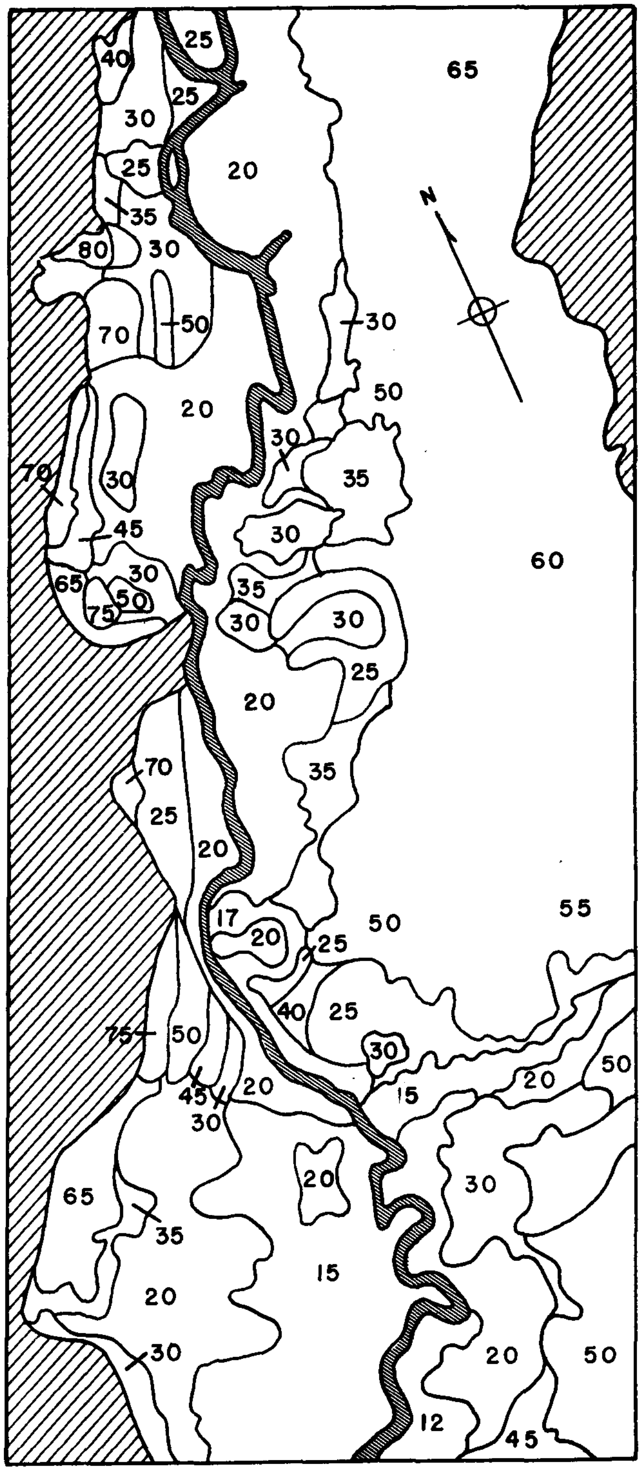


Figure 13. Postglacial terracing in the Quinnipiac Valley. Numbers are altitudes of terrace remnants above sea level.

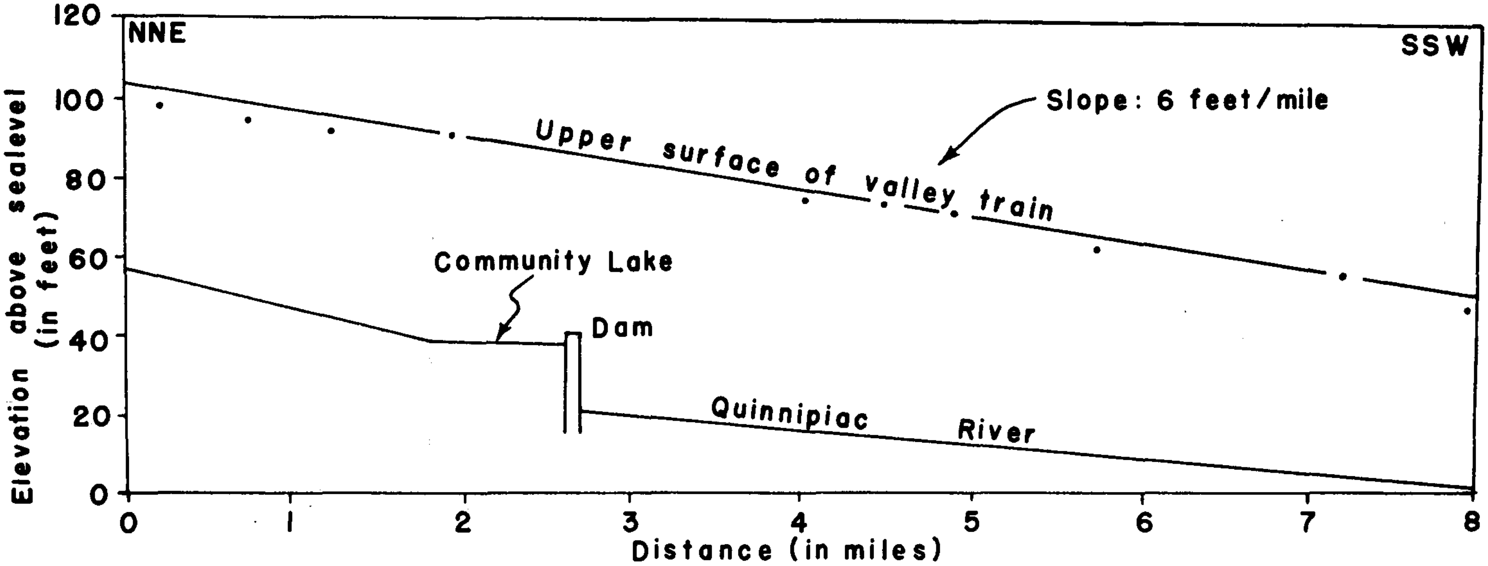


Figure 14. Long profile of upper surface of outwash valley train in the Quinnipiac Valley.

deposit suggest sedimentation by a braided stream that shifted back and forth across the valley, eroding, reworking, and depositing sediment.

POSTGLACIAL DEPOSITS

The period that has elapsed since the ice sheet disappeared from the Wallingford quadrangle constitutes postglacial time. During this interval, the glacial land surface has been modified by the natural processes of weathering, erosion, and biological activity and by the activities of man.

Terrace Alluvium

Alluvium composed of reworked outwash and ice-contact sand and gravel lies at the surface of river-cut terraces in the Quinnipiac Valley, and is mapped as terrace alluvium. This body of sediment is limited to a belt adjacent to the Quinnipiac River and covers the surfaces of terraces that lie lower than the upper surface of the outwash valley train. The sediment is rarely more than 1 or 2 feet in thickness, but sometimes reaches a thickness of 4 or 5 feet. Particle size ranges from silt to pebbles, but sand forms the bulk of the deposits. The sediment is normally poorly to moderately well sorted. The coarser fractions are subrounded to well rounded, having gone through as many as three cycles of erosion and deposition: (1) Triassic erosion and sedimentation, (2) glacial erosion and deposition, and (3) postglacial erosion and deposition by the Quinnipiac River. The sediment consists of a variable mixture of minerals and rock fragments originally derived from Triassic sedimentary and igneous rocks and from crystalline rocks of the Western Upland. On the higher terraces, the sediment consists mostly of crystalline material derived from the outwash. On terraces lying lower than the contact between the outwash and the ice-contact stratified drift, the alluvial veneer consists mostly of reddish sediment, with a much smaller percentage of crystalline admixture.

The color of the terrace alluvium is variable, depending on the relative amounts of outwash and ice-contact stratified drift contained. It normally ranges from light brown (5YR 6/6) to dark yellowish orange (10YR 6/6). The distribution, physical characteristics, and stratigraphic position of the sediment suggest that it was derived locally and was deposited by the Quinnipiac River as it meandered on the valley floor during postglacial degradation.

Alluvium

Alluvial sediments, ranging in size from silt to cobble gravel, occur in the beds of streams and on valley floors in the quadrangle. Along the Quinnipiac River, the bulk of the alluvium consists of well-sorted moderate brown (5YR 3/4) to dark reddish-brown (10R 3/5) sand and silt, confined to the river and to the narrow floodplain. A bedload of pebble- and cobble gravel occurs in the river channel. The river has entrenched itself to a position below the yellowish-gray outwash and derives most of its sedimentary load from reddish ice-contact stratified drift, through which it currently flows. Generally the alluvium is poorly exposed and the thickness is known at only a few places, where well logs and auger holes indicate that it is 4 to 10 feet thick. The modern alluvium differs from terrace alluvium in containing a very small percentage of crystalline minerals derived from yellowish-gray outwash, in having a reddish color rather than a yellowish-orange color, and in being distributed in the channel and on the floodplain of the present river, unlike the terrace alluvium which is confined to higher river terraces.

Alluvium found in the channels and adjacent alluvial flats of Wharton Brook (east of the Quinnipiac Valley), Muddy River, Broad Brook, Pine Brook, and Allen Brook, tends to be coarser than alluvium in the Quinnipiac Valley, probably because these streams drain areas underlain by bedrock, stony till, and ice-contact stratified drift of variable coarseness. Most of the tributaries to these streams have steep gradients and normally have narrow channels, within which the alluvium is confined.

In several streams that drain ridges of basalt, the bulk of the alluvium consists of pebble- and cobble gravel. The channel of Gulf Brook, on the northwest side of Totoket Mountain, has so steep a gradient in its upper portion, and its competence during floods is so great, that cobble-size fragments of basalt constitute the bulk of the channel deposit. From the point where Gulf Brook enters the Farm River Valley at the east end of Tommy's Path to the point where it enters Farm River itself, the stream load consists mainly of pebble-, sand-, and silt-size particles, a condition which results from abrupt decrease in gradient and loss of competence.

Swamp Deposits

Swamps are common features of the Wallingford quadrangle. They are found both in the Quinnipiac Valley and on the drift-mantled uplands. Most of the swamps in the upland regions lie in poorly drained basins floored with till. The swamp deposits, underlying living swamp vegetation, are mainly dark-brown to black muck, a sediment consisting chiefly of fine sand, silt, and clay, with a high percentage of decayed, finely comminuted organic matter composed of residues from woody and herbaceous plants, rushes, and sedges. In the smaller swamps the deposits are seldom more than a few feet thick. In some of the larger swamps, such as Fresh Meadows and Tamarack Swamp, their thickness may be greater but is not known. Many of the swamps in the uplands have been drained and the land converted to pastureland or farmland.

Swamps also occur along the floor of the Quinnipiac Valley. Most of these lie in abandoned channels and cut-off meanders of the river where muck overlies alluvium or ice-contact stratified drift. At Wallingford the river has been dammed to form Community Lake, resulting in the growth of fresh-water swamp vegetation along the upstream end of the lake (fig. 15). The vegetation consists mostly of tall swamp grasses which grow on alluvium deposited by the river at the point where it meets the still-standing lake water.

Similar swamp grasses grow in areas adjacent to the river in the southwest corner of the quadrangle. Although the swampy areas appear

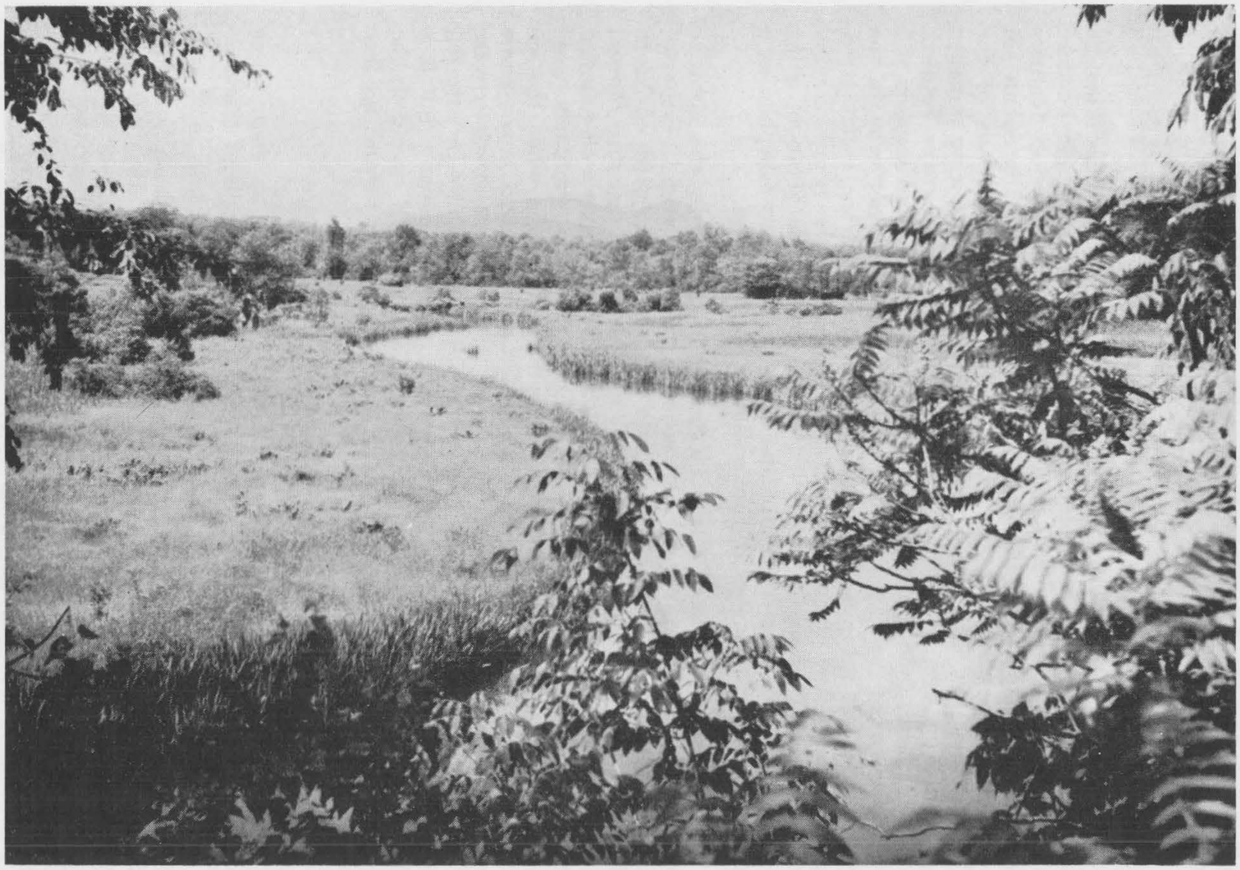


Figure 15. Swamp grasses on floodplain of the Quinnipiac River near Wallingford.

to be continuous with tidal marsh in the Branford and New Haven quadrangles, the vegetation is composed of fresh-water types and the swamps lie above high-tide level. Probably these swamps are underlain by impermeable interbedded silt and clay, which is exposed nearby, and have formed on the river floodplain where drainage is poor.

Eolian Sediment

Wind-transported silt forms a discontinuous part of the surficial mantle in the quadrangle. It is generally thin and difficult to recognize because it is included in the modern soil profile, where its physical features have been changed by soil-forming processes. Probably the eolian silt was derived largely from the outwash valley-train sediments of the Quinnipiac Valley which were subject to wind action during outwash sedimentation and until the time when a vegetation cover formed. Much of the surface sand of the valley train has been, and some is still being, reworked by the wind. Well-formed dunes do not exist in the quadrangle, but some of the minor relief features on the valley train, in the form of low elongate ridges of sand, may be the result of wind transport. In all areas that currently lack a cover of vegetation, a lag deposit of pebbles has formed on the surface of the outwash plain as a result of winnowing away of fine sediment by the wind.

Well-formed ventifacts (stones faceted and polished by the abrasive action of wind-blown sand and silt) occur in the uppermost 12 inches of plowed soil on the till-mantled elongate hill half a mile south of North Haven. These stones, consist of basalt and have one or more faceted faces. The faces, commonly pitted, truncate the otherwise well-rounded stones, forming sharp edges or keels (fig. 16). The ventifacts were formed in the interval, probably short, between the time when the ice left the site and the time when a substantial vegetation cover came into existence. Probably during this interval strong persistent winds were blowing off the glacier. The effective wind direction cannot be inferred from the ventifacts, for they have been disturbed by plowing, but it is likely that the winds were blowing generally southward owing to the pressure gradient between ice-covered land to the north and ice-free land to the south.

Artificial Fill

Artificial fill consists of deposits artificially produced by man. These include highway and building fills and large accumulations of trash.

The Wilbur Cross Parkway is a prominent man-made feature that follows the Quinnipiac Valley from the center of the northern boundary of the quadrangle to the southwest corner. Most of the artificial fill used in its construction was obtained from outwash and ice-contact stratified drift adjacent to the parkway. Artificial fill also occurs near the Stiles clay-pits in the southwest corner of the quadrangle, and represents overburden removed to facilitate excavation of silt and clay.

Much earth- and gravel fill is found along roads and railroads and was probably obtained largely from nearby deposits of gravel, sand, or till.

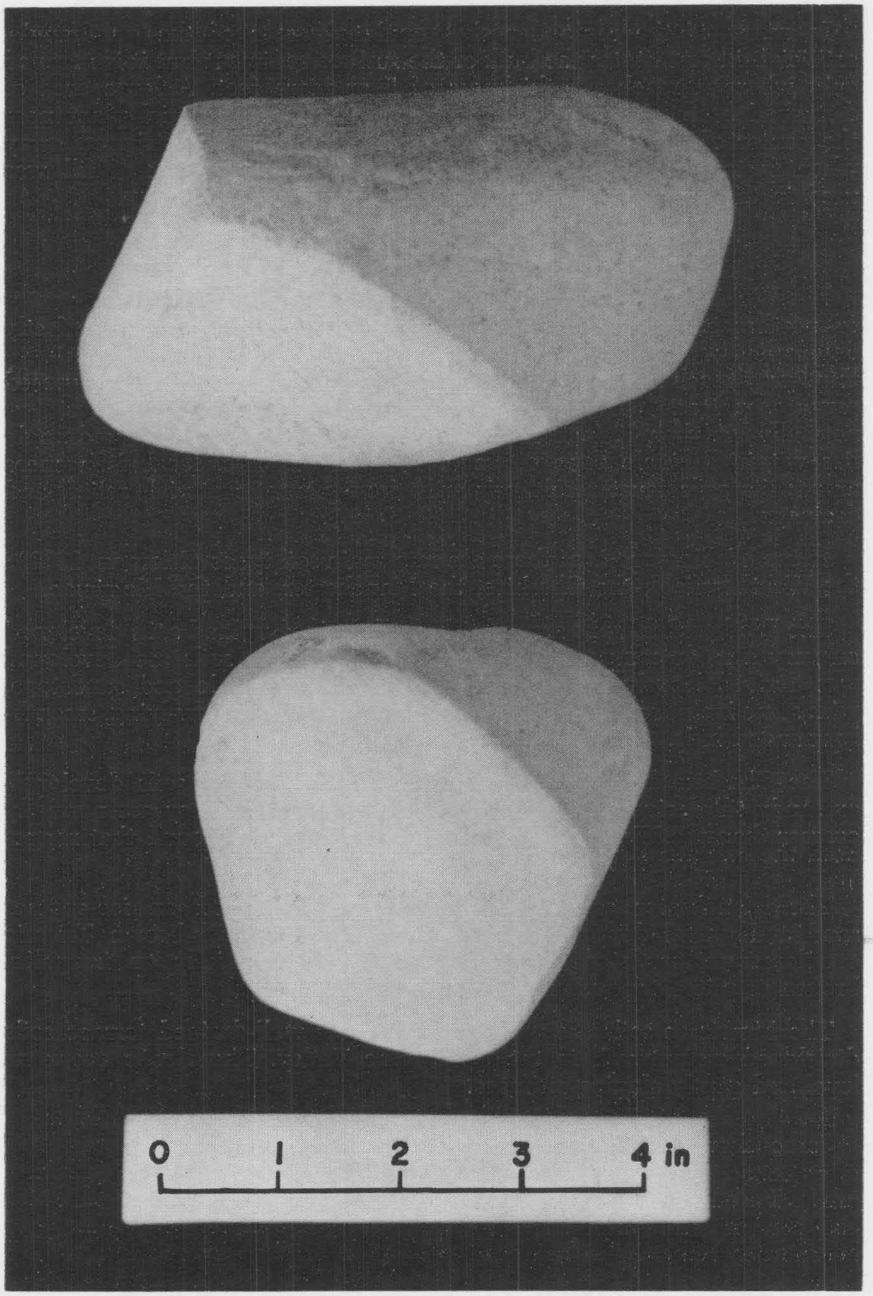


Figure 16. Ventifacts collected from the top of a hill half a mile south of North Haven.

Crushed basalt, obtained from quarries in the Holyoke basalt in adjacent quadrangles, is commonly used for railroad foundation material.

In many of the more densely populated areas of the quadrangle, artificial fill constitutes the bulk of the surface sediment but it is mapped only where it reaches a thickness of 5 or more feet. A large area of disturbed earth occurs at the Pratt and Whitney industrial plant near the center of the quadrangle. At this site outwash was stripped away when factory foundations were laid, and a large amount of fill was used in the construction of an approach ramp.

SOILS

The Wallingford quadrangle lies within the Brown Podzolic soils region of northeastern United States. Brown Podzolic soils are imperfectly developed podzols that are characterized, in forested areas, by a very thin, gray leached zone underlying a thin mat of partially decomposed organic matter. These soils, having weakly developed profiles, are normally less than 30 inches in thickness. As the Wallingford quadrangle lies within a single zone of vegetation and climate, local differences among its soils must result primarily from parent material, relief, and drainage.

In the Wallingford area there are four main soil types (Morgan, 1939): the Weathersfield, the Cheshire, the Manchester, and the Merrimac.

The Wethersfield soils are reddish, well-drained upland soils developed on very firm or compact till. The till on which the soils are developed was derived largely from reddish-brown Triassic shale and sandstone, with some included basalt. The soils normally occur on low-lying, smoothly rounded hills.

The Cheshire soils are reddish, well-drained upland soils developed on sandy till derived mainly from reddish sandstone. They are normally coarser than the Wethersfield soils and are found on ground that ranges from nearly level to hilly.

The Manchester soils are thin and are developed on ice-contact sand and gravel deposits derived mostly from reddish-brown Triassic conglomerate, sandstone, and shale. They occur chiefly on irregular, broken or pitted topography having gentle to steep slopes.

The Merrimac soils are well- to excessively well-drained terrace soils developed on outwash in the Quinnipiac Valley. These soils occur on level and gently sloping surfaces.

Some characteristics of these soils are listed in table 1.

Table 1. Characteristics of Soils in the Wallingford quadrangle.
Data from Morgan (1939), Lunt (1948), and Shearin, et al.(1956).

		Wethersfield soils	Cheshire soils	Manchester soils	Merrimac soils
Parent material		Compact till derived mainly from Triassic sedimentary rocks	Sandy, loose to firm till derived mainly from Triassic sedimentary rocks	Ice-contact stratified drift derived mainly from Triassic sedimentary rocks	Stratified outwash derived mainly from crystalline rocks of the Western Uplands
Profiles	A horizon	Reddish-brown to dark reddish-brown loam	Reddish-brown fine sandy loam or light loam	Dark reddish-brown gravelly sandy loam	Dark yellowish-brown sandy loam or coarse sandy loam
	B horizon	Reddish loam or silt loam	Yellowish-brown sandy loam or loam	Yellowish-orange gravelly sandy loam or fine sandy loam	Yellowish-brown sandy loam or coarse sandy loam
	C horizon	Reddish very firm compact till	Reddish-brown sandy loam or loamy sand and gravelly till	Reddish sand or gravel	Yellowish-gray stratified sand and gravel
Thickness	A horizon	8″	8″	1 - 1½″	6 - 10″
	B horizon	10 - 16″	10 - 16″	8 - 12″	12 - 18″
Drainage		Well drained	Well drained	Well to excessively well drained	Well to excessively well drained

The soil developed on the outwash in the Quinnipiac Valley was described by Olmsted (1937) in connection with his studies on the plant ecology of the North Haven sand plain. He stated that a well-developed profile is not possible here because of the very sandy character of the parent material and the virtual absence of silt and clay. A typical profile shows a dark-brown to very dark grayish-brown A horizon, which has a sharp, even lower boundary at approximately 8 inches (fig. 17). This distinctive boundary is probably the result of plowing in the early colonial period when the outwash plain was used as farmland.

GLACIAL AND POSTGLACIAL HISTORY

Prior to Pleistocene continental glaciation, the landscape in the Wallingford area was, in terms of gross topographic features, essentially as it is today. Probably relief was slightly higher and topography less streamlined, but drainage, though better integrated, followed much the same routes as it does at present. The valley of the modern Quinnipiac River was occupied by a preglacial stream, probably of about the same size as the present Quinnipiac, flowing south to tidewater. Lowland belts, such as the valleys of Farm River, Muddy River, and Broad Brook, also probably contained preglacial streams. A long pre-Pleistocene period, during which chemical and biological agencies weathered the bedrock, probably resulted in a deep residual soil mantling the land surface.

The several continental glaciations that have been recognized in central United States are not discernible in the Wallingford quadrangle. If more than one major glaciation affected the area, evidence of it is not present in the stratigraphic sequence. All the glacial deposits and erosional features described in this report are probably attributable to the most recent continental ice sheet, and as such are correlative with the classical Wisconsin drift of the Great Lakes region.

The advancing glacier stripped away the soil cover, quarried rock from prominent ridges, smoothed topographic profiles, gouged and polished the bedrock surface over which it passed, and deposited a thin, uneven mantle of till over the land surface. The preglacial drainage pattern was disrupted as the ice advanced and filled the stream valleys. When the ice sheet was at its maximum extent, the quadrangle was completely buried under ice. In the upland areas, where the total relief is about 400 feet, the ice sheet covered the highest ridges. At Wallingford, the base of the ice in the Quinnipiac Valley was at least 200 feet below sealevel. Striations on the top of nearby Mount Tom (402 feet above sealevel) show that the ice overrode this hill. The ice, therefore, was at least 600 feet thick over the valley, although the total thickness of the glacier was probably far greater than this minimum figure.

The orientation of striations and grooves suggests that, in general, the ice sheet advanced in a southward to southwestward direction. Apparently movement was controlled to a large degree by preglacial topography, especially the Quinnipiac Valley. The directions of ice flow inferred from till-fabric measurements are not in accord with the evidence from striations, however. Further study may show that these fabrics represent local deviations from the general trend or that they reflect a local

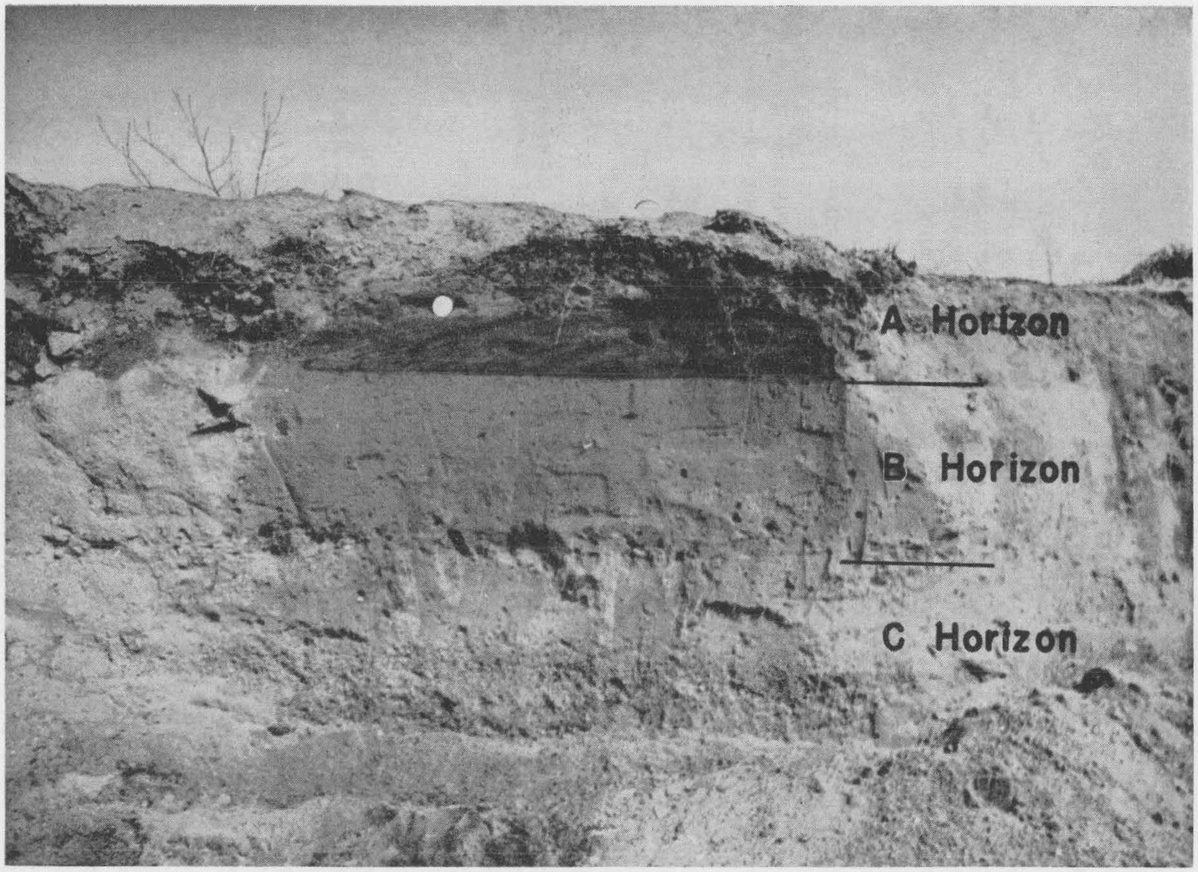


Figure 17. Soil profile developed in the upper part of the Quinnipiac Valley outwash body. Lens cap (1½″ diameter) indicates scale.

readvance of the ice in a southeastward direction.

The presence of large areas of ice-contact stratified drift, confined mainly to lowland areas, suggests that after the glacier had advanced to a position well south of the Wallingford quadrangle, its marginal part ceased to flow and melted away in place. The ice probably disappeared first from the uplands, where the highest hills were the first land areas to be uncovered as the ice sheet melted down. Further melting left residual tongues and isolated masses of ice in the lowlands and valleys.

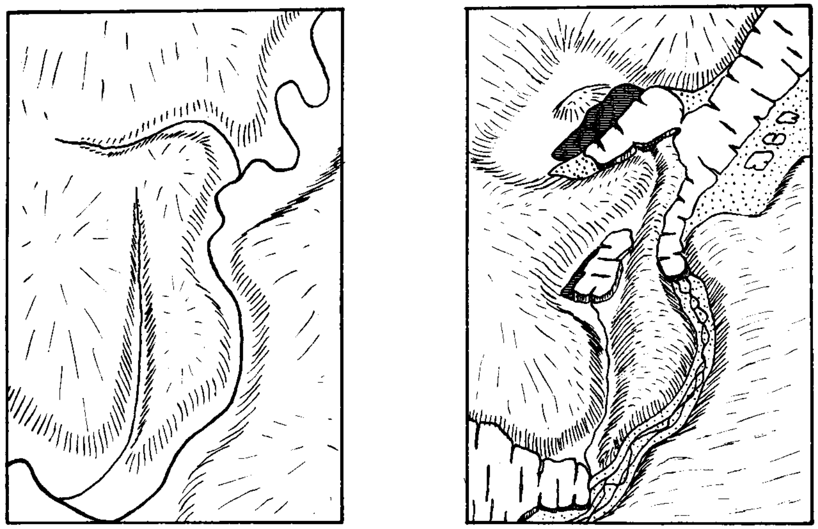
The wasting of the glacier resulted in streams of meltwater that flowed down, along, and between the masses of ice, following the lowest open avenues toward the sea. Owing to the irregular distribution of the ice masses and fluctuations in the amount of melting, the volumes, gradients, and velocities of the streams varied greatly, as did their competence. The character of the sediments they deposited reflects the wide range of variation.

In the early stages of deglaciation, drainage was probably confined mainly to valley sides, where ice melting was greatest, as evidenced by a series of discontinuous kame terraces along the Quinnipiac, Farm, and Muddy River Valleys. As further melting took place, streams gained access to valley floors and deposited sediment between isolated bodies of ice. Some ice masses were competely buried by sediment. As the ice melted, the overlying sediments collapsed, forming depressions, or kettles, in the valley floor topography. Hills, or kames, composed of stratified drift were left standing above the valley floors as surrounding ice supports melted away.

Numerous ponds and ice-margin lakes formed where streams encountered ice or drift dams. Many of these were small and short-lived, and survived only long enough to accumulate a thin layer of stratified silt or clay. Others were large bodies of water and apparently existed longer.

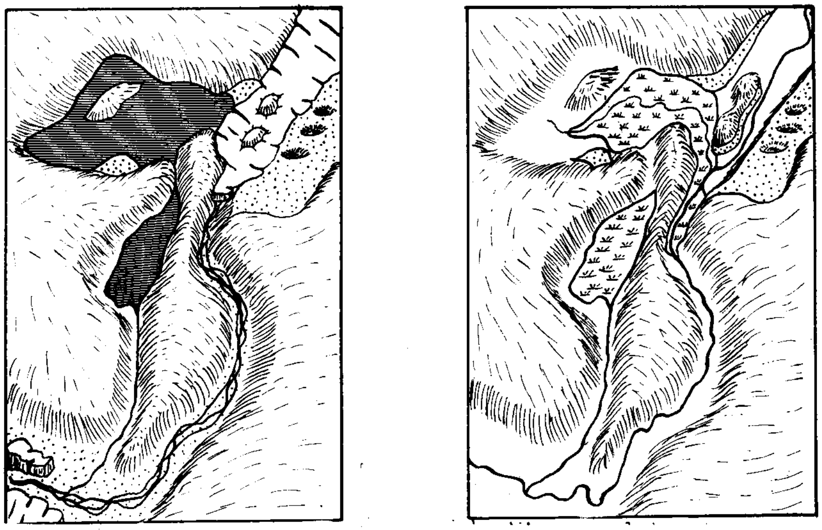
During deglaciation normal eastward drainage of the small valley lying north of Pond Hill was dammed by ice in the region of Pine River Reservoir, so that an ice-margin lake formed (fig. 18). A natural outlet for the impounded waters lay at the southern margin of the valley, where a deep gap in a basalt ridge apparently constituted a spillway. When the lake waters rose to the level of this spillway they overflowed into the basin now occupied by Tamarack Swamp. A second lake formed in this basin. It, in turn, maintained a constant level as a result of another spillway which led the water to the Muddy River, immediately west of Tyler Mill Pond. Once the ice in the valley of the Muddy River became sufficiently broken up, the drainage was re-established in an easterly direction. This caused the upper lake to drain, and the spillway was abandoned. Swamp vegetation subsequently began to grow in the drained lake bed. The water in the lower basin continued to drain toward the south, the direction of present drainage, and a swamp ultimately replaced the lake.

A similar history probably accounts for the presence of lacustrine deposits east of Copper Valley. These sediments occupy the site of



1. Probable preglacial drainage in the Pine River Reservoir area.

2. Drainage pattern after ice had melted from upland areas.



3. Level of ice-margin lake is controlled by spillway to south which carries water to second lake.

4. With complete disappearance of ice, present drainage pattern is established, lakes drain, and swamp conditions prevail.

Figure 18. Reconstructed sequence of events during deglaciation of the Pine River Reservoir-Tamarack Swamp area in the Muddy River Valley.

a late-glacial lake that existed on the higher ground near the edge of the valley. Deposits of ice-contact stratified drift on the valley side of the lake bed suggest that ice in the valley probably formed a dam behind which the meltwater was impounded. Fine-grained sediments accumulated in the lake until enough ice had melted to allow the lake water to spill out and enter the adjacent valley.

The rhythmically laminated silt and clay that underlie the southern part of the Quinnipiac Valley probably were deposited in a large lake that was dammed by deposits of stratified drift across the downstream part of the valley in the New Haven quadrangle. This lake, fed by glacial meltwater, was evidently long lived, for in it was deposited a considerable thickness of cyclic sediments. The presence of ice-rafted erratic stones in the silt and clay suggests that during at least part of the lake's history remnants of the glacier were nearby.

As streams coalesced, as water volume increased with melting of the ice, and as drift dams were breached and eroded in the Farm and Muddy River Valleys, present drainage lines were gradually established. Most of the preglacial stream courses had been greatly altered by glacial erosion and deposition so that over much of their lengths the streams followed new courses determined largely by the configuration of the mantle of ice-contact stratified drift.

As deglaciation continued in the Quinnipiac Valley, meltwater streams coalesced and drained southward toward New Haven Harbor. The presence of ice and drift in the bottom of a preglacial gorge west of South Meriden in the Meriden quadrangle probably caused meltwater draining from the north to be ponded at the west end of the gorge. When the ponded water reached the altitude of the lowest open course through the gorge, it flowed east into the lower Quinnipiac Valley. Owing to rapid erosion by the escaping meltwater, the fill was probably quickly removed from the gorge. The impounded water drained eastward through the new outlet and then flowed south into the Wallingford guadrangle. The stream was apparently underloaded, for in many places it reworked the upper surface of the ice-contact stratified drift, removing the fine sediment and leaving a coarse pebble- and cobble-gravel lag blanketing the ice-contact deposits. If this hypothesis regarding the origin of the lag is correct, outwash deposition must have begun shortly after the lag formed, for wherever the lag occurs, it is directly overlain by yellowish-gray outwash.

Deglaciation in the upper Quinnipiac Valley, near the present great bend in the Farmington River, permitted the Farmington and Pequabuck Rivers to leave the Western Upland and flow south along the valley of the Quinnipiac River (Flint, 1934). The ice-contact sediments that formed the valley floor were quickly blanketed by detrital sand and gravel of crystalline-rock origin, derived from the Farmington and Pequabuck drainages, that was carried into the Quinnipiac Valley as outwash. The outwash was deposited by an actively eroding and aggrading system of braided stream channels that shifted back and forth across the floor of the valley. The outwash sediments, initially pure crystalline-rock detritus where they entered the Quinnipiac Valley from the Western Upland, became contaminated with sediments of Triassic-rock origin as the meltwater cut into deposits of ice-contact stratified drift and incorporated them into its sedimentary load. As aggradation continued, the valley floor became a nearly flat outwash plain with only a few of the higher kames and bedrock hills protruding above the surface.

Subsequent diversion of the Farmington and Pequabuck Rivers to the north and east to join the Connecticut River via a gorge at Tariffville, probably as a result of further deglaciation, brought an abrupt end to outwash deposition. The modern Quinnipiac River was then established on the outwash and flowed south along the valley train to Long Island Sound. As it meandered across the valley floor, the underloaded river cut down into the outwash sediments producing non-paired terraces, the upper surfaces of which were thinly veneered with a layer of mixed sediment consisting of reworked outwash and ice-contact stratified drift.

With the establishment of postglacial drainage lines in the Farm and Muddy River Valleys, the deposits of drift in those lowland areas were reworked and terraced by streams. The degree of adjustment of these streams to the postglacial topography is varied. In places the streams flow sluggishly across wide valley flats; in others they flow swiftly through steepwalled bedrock gorges.

The surface sediments of the open, nonforested valleys and slopes and of the broad outwash plain were exposed to periglacial and postglacial winds that locally developed a few ventifacts and deposited a thin, discontinuous layer of eolian silt. The thinness of the eolian mantle and the scarcity of ventifacts suggests that the period of strong wind action was short. Probably a cover of vegetation was established soon after the ice disappeared, and the environment had again become favorable for plant growth.

As the ice sheet disappeared from southern New England, the climate became milder, and normal soil-forming processes resumed. The first soils to form were probably those developed on the till-mantled uplands. As the ice melted and finally disappeared in the valleys, soils formed on ice-contact stratified drift and on outwash. In some places, where sediments were freed of ice concurrently, the soils are undoubtedly of the same age. The youngest soils occur on postglacial terraces and on alluvium bordering the major streams.

Postglacial erosion has had little effect in altering the major topographic features of the quadrangle. Stream action has been directed mainly toward the modification and adjustment of new drainage routes and the degradation, terracing, and alluviation of stream valleys. The growth of swamps in poorly drained basins and the return of forest vegetation have altered the landscape appreciably, but the most notable changes have been those brought about by man.

ECONOMIC GEOLOGY

SAND AND GRAVEL

The large body of sand-and-gravel outwash in the Quinnipiac Valley is a source of material suitable for concrete aggregate, sedimentary fill, road surfacing, and water filtration. In some places the sediment is so well sorted that supplementary washing is not necessary. Normally, however, the outwash must be screened to separate the gravel component from the sand. The amount of gravel in the outwash decreases in the downstream direction (fig. 14), ranging from about 38% in the northern part of the quadrangle to as little as 2.5% in the southern part. The amount of silt and clay in the outwash is negligible, never being more than 0.5%.

The average thickness of the sediments is probably about 15 feet, which means that an estimated 90 to 100 million cubic yards of outwash are present in the Wallingford quadrangle. About 3 to 4 million cubic yards had been removed for commercial uses before 1960. Future supplies will be limited mainly by the extent of urban and suburban development, for much of the surface of the valley train is covered with buildings and roads.

The extensive deposits of reddish ice-contact sand and gravel are in little demand as building materials because they are structurally weaker than the outwash sediments. Their main use is as fill in the construction of buildings and roads, because their high permeability permits good drainage. This type of fill is obtained mainly in the Muddy River and Farm River Valleys, where pits have been opened in kames and kame terraces. Much of the reddish ice-contact sediment underlying the outwash in the Quinnipiac Valley consists of moderately well-sorted gravel, sand, and silt. However, it is not being excavated because the bulk of it lies below the water table.

BASALT

Totoket Mountain and several dikes are potential sources of basalt ("traprock") which, when crushed, is excellent for aggregate, fill, and surfacing material. However, the presence of operating traprock quarries in the Branford and Durham quadrangles does not warrant the development of similar quarries in the Wallingford quadrangle in the foreseeable future.

SILT AND CLAY

Laminated silt and clay have been excavated along the floor of the Quinnipiac Valley in the southwest corner of the quadrangle for use in brick-making. Similar sediments are currently being excavated farther south, in the New Haven quadrangle. The lateral extent of these sediments in the Wallingford quadrangle is not known with certainty, but it is probable that they are present in the Quinnipiac Valley as far north as North Haven. Reddish silts and clays appear in well logs at several places in the Quinnipiac Valley north of North Haven but owing to their depth below the surface and the water table, their recovery is not economically feasible at present.

SWAMP DEPOSITS

Organic swamp deposits in the quadrangle are potential sources of fertilizer for horticultural use; small-scale production of these deposits may be economically feasible. Many swamps have been drained and their rich organic deposits utilized in developing truck farms and pasture land.

GROUND WATER

The thick sedimentary fills occupying the main stream valleys in the quadrangle constitute likely sources of useable ground water. The yellowish-gray outwash of the Quinnipiac Valley is thin relative to the total valley fill, so it may not be a source of abundant ground water. The underlying reddish gravels, sands, and silts, in places reaching a thickness of a least 200 feet, offer the best potential source of ground water in this valley. Several industrial plants near Wallingford are currently obtaining water from water-bearing gravels in the ice-contact deposits.

The thick fills of stratified drift in the Farm and Muddy River Valleys, where depth to bedrock locally reaches 80 feet, are also potential sources of water. Suitable water-bearing bodies occur also in the Triassic sedimentary rocks, from which many wells are currently producing water. According to Brown (1928, p. 175), however, the quality of the water in the sandstone is not generally as high as that in the overlying stratified drift.

SOILS

Soils in the Wallingford quadrangle bear a close relationship to parent material and can be broadly divided into two main types: till soils and stratified-drift soils. Till soils are often stony and generally poor for farming. Non-stony areas on which Cheshire and Wethersfield soils are developed are used mainly for hay, pastureland, corn, dairy farming, and orchards. Stony areas are largely forested. Areas underlain by Manchester soil are largely cut-over forest or idle. Corn, hay, vegetables, and pasture crops are grown locally, but because of rapid internal drainage in many areas, the Manchester soil is generally poor for cultivated crops unless it is irrigated. Crop yields are often low and uncertain. Much of the surface of the outwash valley train is idle or covered by buildings and commercial sites. In the Wallingford quadrangle the Merrimac soil is used mostly for garden crops and orchards. This soil is easy to work but is generally poor for the support of vegetation because of low moisture-holding ability and the lack of abundant nutrient material. Crops suffer in dry seasons unless properly irrigated. Nurseries currently constitute one of the major economic uses of Connecticut soils because nursery crops, when properly cared for, grow well on both till soils and stratified-drift soils.

REFERENCES

Brown, J. S., 1928, Ground water in the New Haven area, Connecticut: U. S. Geol. Survey Water-Supply Paper 540, 206 p.

Dana, J. D., 1870, On the geology of the New Haven region, with special reference to the origin of some of its topographic features: Connecticut Acad. Arts and Sci. Trans., v. 2, p. 45-112.

——— 1871, On the Quaternary, or post-Tertiary of the New Haven region: Am. Jour. Sci., 3rd ser., v. 1, p. 1-5, 125-126.

——— 1875-1876, On southern New England during the melting of the great glacier: Am. Jour. Sci., 3rd ser., v. 10, p. 168-183, 280-282, 353-357, 409-438, 497-508; v. 11, p. 151; v. 12, p. 125-128.

——— 1883, On the western discharge of the flooded Connecticut, or that through the Farmington Valley to New Haven Bay: Am. Jour. Sci., 3rd ser., v. 25, p. 440-448.

——— 1883-1884, Phenomena of the glacial and Champlain periods about the mouth of the Connecticut Valley – that is, in the New Haven region: Am. Jour. Sci., 3rd ser., v. 26, p. 341-361; v. 27, p. 113-130.

Flint, R. F., 1930, The glacial geology of Connecticut: Connecticut Geol. Nat. History Survey Bull. 47, 294 p.

——— 1934, Late-glacial features of the Quinnipiac-Farmington lowland in Connecticut: Am. Jour. Sci., v. 227, p. 81-91.

Goddard, E. N., and others, 1948, Rock color chart: National Research Council, Washington, D. C., 6 p.

Holmes, C. D., 1941, Till fabric: Geol. Soc. America Bull., v. 52, p. 1299-1354.

Krynine, P. D., 1937, Glacial sedimentology of the Quinnipiac-Pequabuck lowland in southern Connecticut: Am. Jour. Sci., v. 233, p. 111-139.

——— 1950, Petrology, stratigraphy, and origin of the Triassic sedimentary rocks of Connecticut: Connecticut Geol. Nat. History Survey Bull. 73, 247 p.

Lehmann, E. P., 1959, The bedrock geology of the Middletown quadrangle: Connecticut Geol. Nat. History Survey Quad. Rept. 8, 40 p.

Lunt, H. A., 1948, The forest soils of Connecticut: Connecticut Agr. Expt. Sta. Bull. 523, 93 p.

Morgan, M. F., 1939, The soil characteristics of Connecticut land types: Connecticut Agr. Expt. Sta. Bull. 423, 64 p.

Olmsted, C. E., 1937, Vegetation of certain sand plains of Connecticut: Bot. Gaz., v. 99, p. 209-300.

Shearin, A. E., Swanson, C. L. W., and Brown, B. A., 1956, Preliminary report on the soils of Hartford County, Connecticut: Connecticut Agr. Expt. Sta., New Haven, 68 p.

Ward, Freeman, 1920, The Quaternary geology of the New Haven region: Connecticut Geol. Nat. History Survey Bull. 29, 78 p.