MAP GQ-469

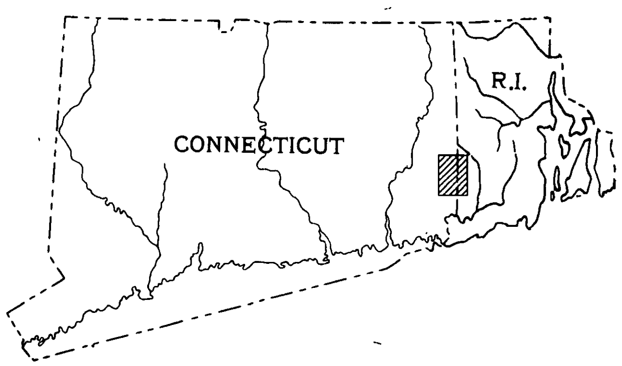
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE STATE OF CONNECTICUT
GEOLOGICAL AND NATURAL HISTORY SURVEY
AND
THE STATE OF RHODE ISLAND
DEVELOPMENT COUNCIL

GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

SURFICIAL GEOLOGIC MAP OF THE VOLUNTOWN QUADRANGLE CONNECTICUT–RHODE ISLAND

By
Tomas Feininger



QUADRANGLE LOCATION

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.
1965

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Introduction

The surficial deposits of the Voluntown quadrangle are all unconsolidated and lie on an irregular bedrock floor. Nearly all are of Pleistocene age and of glacial origin. They include: 1) ground moraine, a nearly continuous layer of till that probably also underlies most of the other surficial deposits, 2) ice-contact stratified deposits, predominantly of sand but having some silt and gravel, generally confined to the major valleys, and 3) lake deposits, predominantly clay, deposited in a proglacial lake south of Hodge Pond. The freshness of the materials in these deposits and the negligible amount of postglacial erosion suggest that the deposits are of Wisconsin age. Postglacial surficial deposits are limited to scattered thin deposits in swamps.

The deposits were mapped on the basis of both artificial and natural exposures, supplemented by several hundred test holes from 1 to 4 feet deep and 18 deep auger test borings made by the U.S. Geological Survey in cooperation with the Connecticut Water Resources Commission.

Preglacial and early glacial history and deposits

The bedrock of the Voluntown quadrangle is entirely plutonic, predominantly a suite of Mississippian(?) or older granitic intrusive rocks. (Feininger, 1964). Most outcrops expose fresh rock. Granite gneiss in the northeast corner of the quadrangle, however, is stained and disaggregated to a granular grus, in places to depths greater than 18 feet. This grus, known locally as rottenstone, is not extensive elsewhere in the quadrangle, but does occur sporadically, as in the small pit 2 miles east of Voluntown. The rottenstone is older than the last glaciation, as it is overlain by ground moraine in several places.

The Wisconsin ice sheet advanced across the quadrangle from the north-northwest. Striations on bedrock show that at least the last ice movement was between S. 16° E. and S. 21° E. Crescentic gouges and crescentic fractures with tip-to-tip axes perpendicular to the trend of striations locally are plentiful. Gouges as much as 3 feet tip-to-tip and 2.5 inches deep occur 0.62 mile N. 69° E. of where Ten Rod Road crosses the State boundary. The ice sheet removed any earlier soils and surficial deposits, and, except where rottenstone is preserved, eroded fresh bedrock as well. The materials thus eroded were spread beneath the ice as a nearly continuous layer of nonstratified and nonsorted till here mapped as ground moraine. Erosion of bedrock and deposition of till by the southward flow of the ice conspicuously shaped the topography. Most north slopes of hills are smooth, gentle, and continuously veneered with till, whereas most south slopes are uneven, steep, and studded with bedrock outcrops.

The surface of the ground moraine is smooth, and surface boulders are common. Nearly all these boulders, as well as most of those within the till, are of the same rock type as the bedrock which underlies the locality or occurs no more than a few miles to the north.

Two small areas, one south of Voluntown and the other south-southwest of Yawgoog Pond, have a continuous cover of boulders. These areas may mark a temporary halt of the ice front during deglaciation, or they may be sites where the fine-grained materials were flushed from the till by melt water during deglaciation.

Late-glacial and postglacial history and deposits

Deglaciation began when the rate of ablation exceeded the rate of nourishment, which caused the ice sheet to thin. Eventually a peripheral zone of the ice sheet at most a few miles wide became stagnant and essentially motionless, probably when the highest hills were bared as nunataks. Further thinning of the ice exposed progressively lower land and produced a northward migration of the peripheral stagnant zone. The last glacial ice lay as tongues and isolated masses of dead ice on the floors of the broad low valleys.

Enormous quantities of melt water issued as streams from the dissipating ice sheet. The streams carried sediment that was derived from debris within, and till around and under the ice. The ice-contact glaciofluvial sediments, were laid down chiefly among and on the stagnant ice masses that remained on the valley floors in the peripheral stagnant zone.

The history of deglaciation may be traced from the locations and elevations of the glaciofluvial deposits. Similarly, the sizes and shapes of stagnant ice masses that were present at sites of glaciofluvial deposition are reflected by the morphology of the deposits.

Early glaciofluvial deposits were laid down at relatively high elevations when ice still filled the low valleys. The low valleys were in turn the sites of later glaciofluvial deposition when further thinning of the ice allowed drainage through them. Immediately at the close of their deposition, the glaciofluvial sediments had a smooth graded surface, broken only by the projecting tops of the largest stagnant ice masses. The melting of those stagnant ice masses that were buried or surrounded by glaciofluvial sediments caused differential collapse of the deposits and produced a hummocky topography. The sites of the melted stagnant ice masses are now topographic lows, commonly floored with swamp deposits, and are wholly or partly bounded by collapse slopes. The kame plains and kame terraces and many of the kames and ice-channel fillings indicated on the geologic map are high-standing uncollapsed remnants of the initially smooth surface of the glaciofluvial deposits. Some of the kames, however, may have been deposited in depressions on the stagnant ice surface, and some of the ice-channel fillings may have been deposited in tunnels within the stagnant ice.

Much of the ground moraine of the uplands is veneered with a layer of eolian silt and very fine sand 3 feet thick or less. This material was derived from the glacial deposits before they became covered with vegetation.

Ice-contact glaciofluvial and glacial-lake deposits

The bulk of the ice-contact glaciofluvial deposits and the fine-grained sediments deposited in a proglacial lake belong to four depositional episodes. The deposits of these episodes constitute, from oldest to youngest, groups 1 through 4. The change from one depositional episode to the next generally was distinct. In places, however, the change was gradual and the deposition of one group was not completed before the beginning of deposition of the next.

Deposits of group 1

The glaciofluvial deposits of group 1 are the oldest correlated deposits in the quadrangle. They are irregularly and discontinuously distributed on the east slope of Myron Kinney Brook valley, in the Green Fall River valley south of Green Fall Pond, in and around the head of the valley of Denison Brook, and southwest of the outlet of Beach Pond. The patchy distribution of most of the deposits and the protrusion of bedrock through them in many places suggests that they are thin.

During the deposition the ice front stood in a north-northeast line against the west scarp of the deposits in Myron Kinney Brook valley and against the head of the deposits in Denison Brook valley. Most of these deposits and probably all the deposits southwest of the outlet of Beach Pond and in the swamp-floored valley to the south were laid down on stagnant ice. Subsequent melting of this ice caused the deposits to collapse onto the ground moraine as an irregular mantle. The topography and position of the deposits suggest that melt-water drainage was through three outlets. Two were from the deposits in Myron Kinney Brook valley; one across the 360-foot saddle west of Pendleton Hill, and the other through the 400-foot upland valley immediately west of Wheeler Road. The third outlet, from the deposits in Denison Brook valley, was through the narrow valley immediately northwest of Green Fall Pond and thence down the Green Fall River valley.

Large exposures in the deposits are limited to two active pits a mile north-northeast of Pendleton Hill. Here the texture ranges from medium sand to pebble and cobble gravel. Similar materials are exposed in the abandoned pits 0.6 and 0.9 mile northwest of the outlet of Green Fall Pond. Elsewhere medium sand predominates, although at least the uppermost few feet of the western fringe of the deposit in Myron Kinney Brook valley is chiefly very fine to fine sand.

Deposits of group 2

The glaciofluvial deposits of group 2 lie south of Pachaug River in the west-central part of the quadrangle. The topography of these deposits is very irregular. Ice-contact collapse slopes and kettleholes are common throughout and show that the bulk of the deposits, like those of group 1, were laid down on or among stagnant ice masses. Only the kame plain 1.5 miles southeast of Voluntown preserves a relatively flat, uncollapsed surface. Some low areas, such as that now partly occupied by Doaneville Pond, were the sites of large blocks or tongues of stagnant ice that persisted throughout the glaciofluvial deposition.

The deposits head at a locally prominent ice-contact collapse slope that trends northeasterly from Voluntown and constitutes the boundary with the younger and lower deposits of group 4. The boundary marks the position of the glacier front during the deposition of group 2, and shows that this front had retreated north-northwestward a little more than 2 miles from its position during the deposition of group 1.

Melt-water drainage from the area of deposition was through three widely separated outlets. One outlet, also used during the deposition of group 1, was across the 360-foot saddle west of Pendleton Hill. Another outlet was to the west and out of the quadrangle south of Voluntown. The third was through the narrow valley northwest of Green Fall Pond. Melt water that passed through this valley probably eroded a channel through the earlier deposits of group 1 along the present course of Denison Brook. The presence of this outlet implies that glaciofluvial deposition in the Green Fall River valley to the south may have taken place during the deposition of both groups 1 and 2, and that the small discontinuous deposits in the valley mapped as contemporaneous with the deposits of group 1 may in part have been laid down during the deposition of group 2.

Surface exposures and logs of auger test borings (Nos. VO-133 through VO-140, and GS-162, Fig. 1) show that more than half the glaciofluvial sediment of group 2 is medium sand or finer. Less than 15 percent is gravel, the bulk of which is in a discontinuous surface cap nowhere more than 20 feet thick. The fine texture of the glaciofluvial sediments of group 2 shows that the melt-water streams had low competency and that temporary ponding may have been widespread.

Two small patches of till, each less than 300 feet in diameter, are surrounded by glaciofluvial deposits of group 2 one mile southeast of Voluntown. It is not known whether these patches are the protruding summits of ground moraine hillocks, or whether they are sheets of flowtill (Hartshorn, 1958) that slid from adjacent stagnant ice masses during or after glaciofluvial deposition.

Glacial-lake deposits contemporaneous with the glaciofluvial deposits of group 2 lie in the valley of Myron Kinney Brook. This portion of the valley, where little or no stagnant ice remained during group 2 glaciofluvial deposition, was the site of a proglacial lake that was enclosed on the east, south, and west by bedrock hills, and was dammed on the north by stagnant ice masses in the vicinity of the site of Hodge Pond.

The lake was fed by sediment-laden melt-water streams that flowed in from the north. The south part of the glaciofluvial deposits of group 2, where these streams entered the lake, probably consists of an extensive kame delta, although delta structure is not exposed. The melting of the subjacent stagnant ice caused general collapse of the delta, whose remnants constitute the hills immediately south and southeast of Hodge Pond. Pits, small test holes, and an auger test boring (VO-140, Fig. 1) show that the bulk of the delta is very fine to fine sand.

The highest point on the delta, probably an uncollapsed remnant of the original surface, is 370 feet. This suggests that the 360-foot spillway west of Pendleton Hill controlled the lake level, and that a potential lower outlet to the west through an upland valley at 330 feet, midway between Hodge Pond and Billings Lake, was dammed by stagnant ice. The approximate shoreline of the lake, based solely on the elevation data given above, is shown on the geologic map. This shoreline is not shown on the earlier deposits of group 1 as these probably lay on stagnant ice and stood above their present position during the existence of the lake. The increase of elevation of the reconstructed shoreline from south to north (about 5 feet per mile) is based on evidence of postglacial crustal tilting elsewhere. When the stagnant ice dam melted, the lake drained northward on the present course of Myron Kinney Brook.

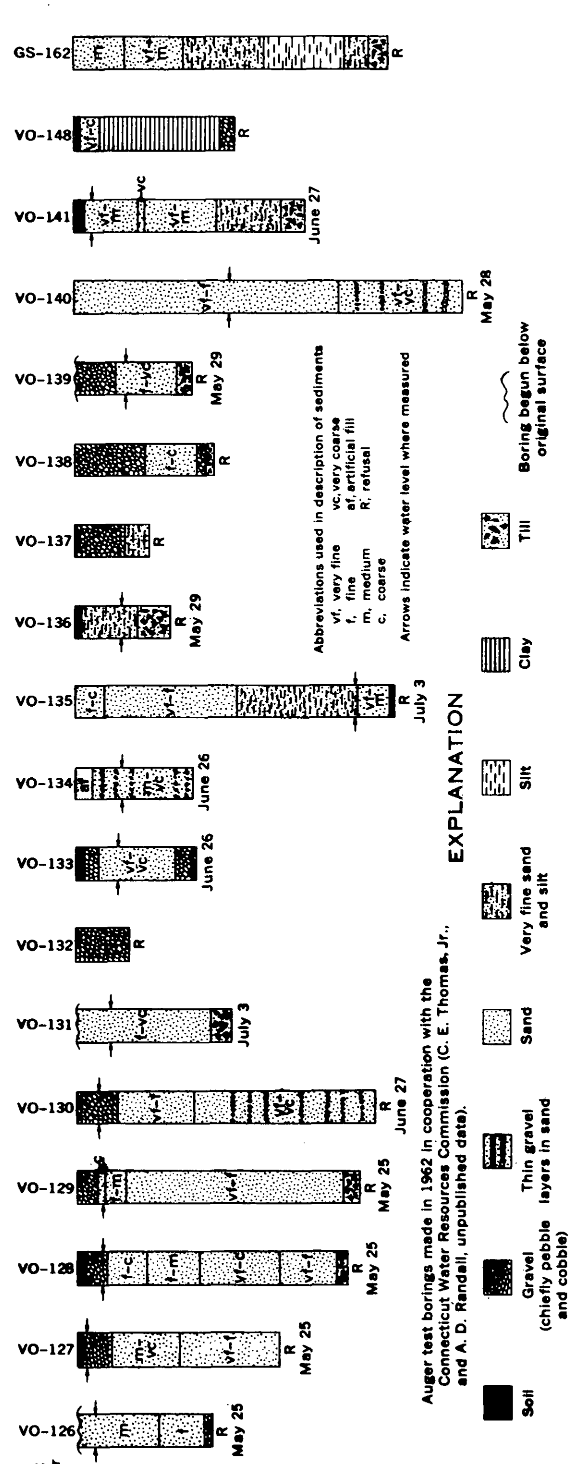

Figure 1.—Generalized logs of U.S. Geological Survey auger test borings

An auger test boring was made in the glacial-lake deposits. The log (No. VO-148, Fig. 1) shows that the bottom deposits are chiefly clay, and at the site of the boring are 35 feet thick.

Deposits of group 3

The glaciofluvial deposits of group 3, in the Pachaug River-Beach Pond valley, are chiefly small, high-standing, discontinuous kame terraces with tops 70 feet or more above the valley floor.

The ice front probably lay approximately east-west on the hills between half a mile and one mile north of Beach Pond during the deposition of group 3. The concentration of the group 3 deposits at the south ends of three north-trending valleys, one immediately east of the state line, and two a little more than a mile to the west, indicates that the sediment-laden melt-water streams from the melting ice flowed through these valleys to the sites of deposition. The restricted distribution of the deposits and their prominent ice-contact slopes which face the valley show that they were laid down when stagnant ice still largely filled the Pachaug River-Beach Pond valley. The melt-water streams that laid down the group 3 deposits around the east half of Beach Pond may have drained southeastward into the valley of Brushy Brook through a 360-foot saddle a quarter of a mile south of the east end of Beach Pond. No definite correlation can be made, however, between the group 3 deposits and the deposits in Brushy Brook valley. The melt-water streams that laid down the group 3 deposits around the west end of Beach Pond probably drained to the west, approximately along the course of the modern Pachaug River.

The bulk of the deposits of group 3 is sand, mostly medium grained or finer; gravel is rare. Deltaic bedding of some sand in the large pit northwest of the outlet of Beach Pond shows that ponding developed locally.

Deposits of group 4

The glaciofluvial deposits of group 4 lie in the valleys of Mount Misery and Great Meadow Brooks and on the periphery of the large swamp at the confluence of Pachaug River and Great Meadow Brook.

The ice front stood somewhere in the Oneco quadrangle during glaciofluvial deposition of group 4, more than 2 miles north of its position during the previous depositional episode. The low relief of ice-contact collapse landforms shows that stagnant ice present during deposition was in relatively thin sheets and not in blocks and tongues characteristic of the other groups. Only at Voluntown and at the confluence of Lowden and Mount Misery Brooks does the local relief of ice-contact topography exceed 30 feet. Melt-water drainage from the entire area of deposition was through the bedrock gorge at Voluntown now occupied by Pachaug River.

Logs of auger test borings (Nos. VO-126 through VO-132, and VO-141, Fig. 1) show that very fine to medium sand constitutes the bulk of the deposits. Gravel is rare and is chiefly confined to a surface cap generally 10 feet or less thick.

Isolated ice-contact glaciofluvial and glacial-lake deposits

Ice-contact glaciofluvial deposits not correlative with one another or with similar deposits of known relative age have been mapped separately from those that can be assigned to a depositional episode. These uncorrelated deposits are small and generally thin and lie on the uplands or in isolated valleys.

The largest uncorrelated deposit is at Dawley Pond in the north-central part of the quadrangle. Small exposures show that the uppermost 10 feet is predominantly medium sand with some pebble and cobble gravel. The deposit was laid down, probably contemporaneously with the smaller deposit half a mile north of the pond, when stagnant ice still filled the valley of Great Meadow Brook.

Other large uncorrelated deposits are in Brushy Brook valley 2 miles northeast of Yawgoog Pond, and on the hills a mile south of Beach Pond. The deposits in Brushy Brook valley were laid down by southeastward-flowing melt-water streams, and are chiefly in a kame terrace along the southwest wall of the valley. The deposit is poorly exposed, and its texture is unknown. The deposit south of Beach Pond, on the other hand, is well exposed. It is composed entirely of fine and medium sand. The high elevation of this deposit shows that it was formed early during deglaciation.

Uncorrelated deposits elsewhere in the quadrangle are small. Probably none is more than 30 feet thick.

Two deposits--those in the valleys of Kelley Brook and Falls River in the northeast corner of the quadrangle, and a small part of those in Brushy Brook valley 5 miles to the south--are contemporaneous with one another, as both are continuous with glaciofluvial deposits of a single age in the Hope Valley quadrangle (Feininger, 1962).

Swamp deposits

Swamp deposits locally overlie and are therefore younger than all the glacial deposits. They are restricted to topographic depressions and poorly drained areas, and are nowhere well exposed. Small test holes show that the swamp deposits are composed chiefly of silt and fine sand rich in organic matter and interbedded thin peaty layers. Peat layers several feet thick probably underlie some of the large swamps.

Economic depisits and engineering geology

The surficial deposits have a broad range of mechanical properties that affect their usefulness. Paramount among these properties are porosity and permeability, ease of excavation, compaction, and ability to stand in cuts.

Rottenstone

Rottenstone is an excellent road metal because the angular fragments give good traction and do not scatter. Locally it has been used as chicken grit. The great permeability of rottenstone, probably greater than that of any of the other surficial materials in the quadrangle, makes it wholly unfit for dam foundations. Rottenstone is easily excavated even with hand tools, although it grades into progressively fresher and harder rock with depth.

Till

Till is well suited for use as fill and in earth dams. It compacts moderately well. The low permeability of the till makes it a poor aquifer. Large-diameter dug wells yield no more than 5 gallons per minute. Seasonal fluctuation of the water table is considerable, and many shallow wells are dry during summers (Randall and others, 1960). The till is sufficiently impermeable to be a suitable foundation for small dams.

The cohesiveness and boulder content of the till make it moderately difficult to excavate, even with power tools. The floors of most pits in till are strewn with boulders from 3 to 10 feet in diameter left behind during excavation. The till will stand in vertical cuts for several months or longer.

Glaciofluvial deposits

Only a small part of the glaciofluvial deposits is sufficiently coarse grained to be suitable as fill or aggregate. These materials, chiefly pebble and cobble gravel, form a discontinuous cap on the glaciofluvial deposits of groups 2 and 4. Between half and three quarters of the glaciofluvial material is medium sand or finer and is suitable only as fill in small structures or as plaster sand.

All the glaciofluvial sediment coarser than very fine sand is very permeable and an excellent aquifer that constitutes the largest potential ground-water source in the quadrangle. Wells in the large deposits produce as much as 50 gallons per minute (Randall and others, 1960). Although the water table is within 10 feet of the surface in most places, it is considerably deeper under high-standing deposits (see log VO-135, Fig. 1). Seasonal fluctuation of the water table is generally less than 5 feet.

The glaciofluvial deposits are nearly all too permeable to be suitable for large dam foundations.

All the glaciofluvial deposits are easily excavated and boulders are rare. The materials stand in vertical cuts generally no more than a few hours or days.

Glacial-lake deposits

All data on these deposits are from a single boring (VO-148, Fig. 1). Geologic extrapolation from this boring suggests that the deposit contains more than 1 million, and possibly as much as 6 million cubic yards of clay probably suitable for brick manufacture.

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