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Trip B-1

TWO-TILL PROBLEM IN NAUGATUCK-TORRINGTON AREA, WESTERN CONNECTICUT *

by

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INTRODUCTION

Two texturally and structurally distinct tills have long been recognized in the crystalline-rock areas of southern New England (for example, Upham, 1878; Flint, 1930, p. 71). More recent references include localities in New Hampshire (Denny, 1958; Koteff, in press), western Massachusetts (Segerstrom, 1955, 1959), eastern Massachusetts (Koteff, 1964; Oldale, 1962, 1964), southern Connecticut (Flint, 1961, 1962, p. 9), and northeastern Connecticut (Pessl, 1966).

Several terms have been used to distinguish the two tills, both in the field and in the literature. "Gray" and "brown", "upper" and "lower" are descriptive terms based on generally acceptable field observations. "New" till and "old" till are less objective terms reflecting an interpretation not acceptable to all geologists.

Although the occurrence of these tills is widely recognized, their origin remains controversial and involves consideration of relative age and mode of deposition. Some geologists regard the tills as contemporaneous deposits laid down by a single ice sheet, one as lodgement till, the other as ablation till. In this hypothesis, physical differences between the tills are considered to reflect differences in mineral composition, mode of deposition, and oxidation by texturally controlled circulation of ground water. Other geologists interpret the two tills as deposits of separate ice sheets, differing in age and possibly also in mode of deposition. The contrast in color and staining of the tills is explained, in this view, as the result of subaerial weathering of the lower till before deposition of the upper till.

DESCRIPTION OF TILLS

Tills in this part of the crystalline-rock uplands of western Connecticut constitute two widespread, discontinuous units. Because of their consistent stratigraphic relationship, we call them the upper and lower tills. Tills in many parts of southern New England are closely comparable to those in the study area (fig. 1), but there are local differences in details. For example, the uppermost few feet of upper till in some exposures in southern Rhode Island is jointed; some drumlins in southeastern Massachusetts are composed of upper till; no lower till is known in large areas of southeastern Massachusetts and southern Rhode Island.

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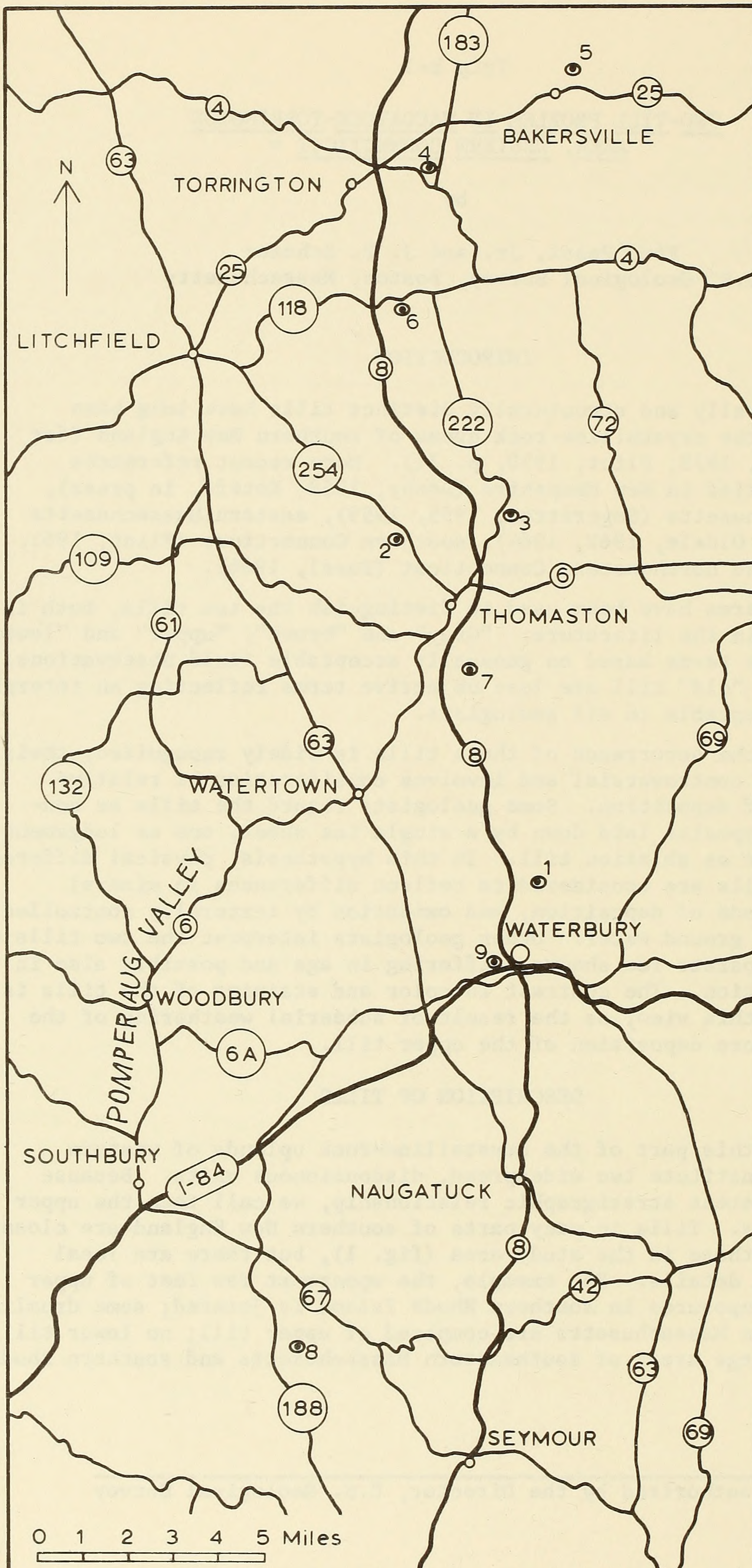

Fig. 1. Sketch map of Naugatuck-Torrington area, Connecticut, showing till localities.

The characteristics of the two tills in the study area are summarized in the table below.

Comparison of upper and lower tills

	Upper till	Lower till
Texture of matrix (finer than ½ in.)	Relatively sandy; contains 60-80% sand and coarser particles, and 20-40% silt and clay. Commonly mottled or streaked with light-colored sandy bodies.	Finer grained; contains 40-75% sand and coarser particles, and 25-60% silt and clay; generally uniform.
Stone content (larger than ½ in.)	Commonly more than 20%.	Commonly less than 20%.
Weathering	Postglacial soil developed in upper 2.5-3.5 ft of late-glacial eolian sandy silt, colluvium, till, etc.; but very little or no yellowish staining deeper in till.	Pervasive oxidation in most exposures; at locality 3, oxidized zone is about 37 ft thick. Dark iron staining occurs on joints and around stones, but generally does not extend as deep as does pervasive oxidation.
Color (of naturally moist material, from Munsell (1954) soil color charts)	Olive-gray to light-olive-gray to olive (5Y 4-5/2-3 to 6/2) in silty matrix. Sandy layers are lighter, or locally stained rusty or yellowish.	Olive to olive-gray to olive-brown (5Y 4-5/2-3 to 2.5Y 4-5/3-5) in oxidized zone (not including stained joints). Dark-gray (5Y 3.5-5/1) in nonoxidized zone beneath.
Compactness	Slight to moderate; almost all collected samples disaggregate during collection or as they dry out.	Moderate to extreme; collected samples dry out as hard coherent fragments.

Comparison of upper and lower tills -- Continued

	Upper till	Lower till
Layering	Textural layering common, generally subparallel to topographic surface. Layering is expressed mostly as lighter colored sandy layers interbedded with darker silty material. Some lenses of well-bedded waterlaid sand or gravel. In deep exposures, layering is generally more abundant in upper than in lower part. At some places, moderate to strong deformation of layering (localities 4,7).	Textural layering and lensing are not common. Exceptional layering at locality 2, and a few deformed lenses at locality 3.
Jointing	None. Preferred subhorizontal direction of breaking, probably caused by fabric of till matrix, noted at only a few localities, in relatively compact and massive, silty phases of till.	Well-developed in most exposures. Subhorizontal joints more closely spaced than subvertical joints; both sets less closely spaced downward. In upper parts of some exsures, subhorizontal joints are so closely spaced as to produce platiness or even fissility. In lower parts of some deep exposures, till lacks jointing. Subhorizontal joints in some places controlled by textural layering. Preferred subhorizontal direction of breaking generally present within joint blocks and in nonjointed till.
Stone fabric (preferred orientations of long axes of elongate stones).	Commonly northeast; ranges from north-northeast to east-northeast.	Commonly north-northwest; ranges from north to northwest.

Comparison of upper and lower tills -- Continued

	Upper till	Lower till
Thickness	Commonly less than 10 ft; rarely 30 ft or more.	Commonly more than 10 ft; more than 100 ft in some drumlins.
Distribution	Lies directly on bedrock in areas of irregular topography controlled by bedrock relief; forms discontinuous and generally thin mantle on lower till.	Constitutes drumlins, and generally underlies smooth hilltops and slopes; almost entirely absent from areas of irregular topography controlled by bedrock relief.

Texture. Both tills have a rather wide range in texture, and cumulative curves overlap considerably (fig. 2, 3). However, textural differences between upper and lower tills are readily apparent in the field, and the curves show the most consistent differences in the silt and clay range. Median-curve values for upper and lower till are, respectively, 27 percent and 37 percent combined silt and clay, and 6 percent and 12 percent clay-size particles alone.

Weathering. The postglacial soil profile seldom is more than 2.5-3.5 feet thick, and in till areas it is developed in colluvium, eolian material, till, or mixtures of these materials. The upper till shows no profile development beneath this soil; however, ground-water oxidation has produced slight iron staining in permeable sandy or gravelly layers at some places. The lower till bears an oxidized zone so thick that only a few exposures in this area (locality 3) reach nonoxidized lower till.

Although Munsell (1954) color designations given in the table are close together on the color charts, the differences between the two tills are conspicuous in the field. The notably gray appearance of the upper till compared to the oxidized lower till is accentuated by the light-colored sandy segregations with which the upper till is generally mottled and streaked. Although the color designations overlap in the area, the differences are systematic at any one locality; the oxidized lower till has higher chroma (more "color"), commonly lower value (darker), and in some places browner hue than does the silty matrix of the upper till. The nonoxidized lower till has even lower chroma than does the upper till.

The oxidized zone of the lower till shows some color differentiation (principally downward decrease in chroma) at some places. In a few large exposures, this color differentiation seems to be partly truncated by the present top of the till; such truncation is indicated also by contrasts in till colors in small exposures. These phemomena do not seem to be related to topgraphic position, or to presence or absence of overlying upper till, and are believed to result from erosion

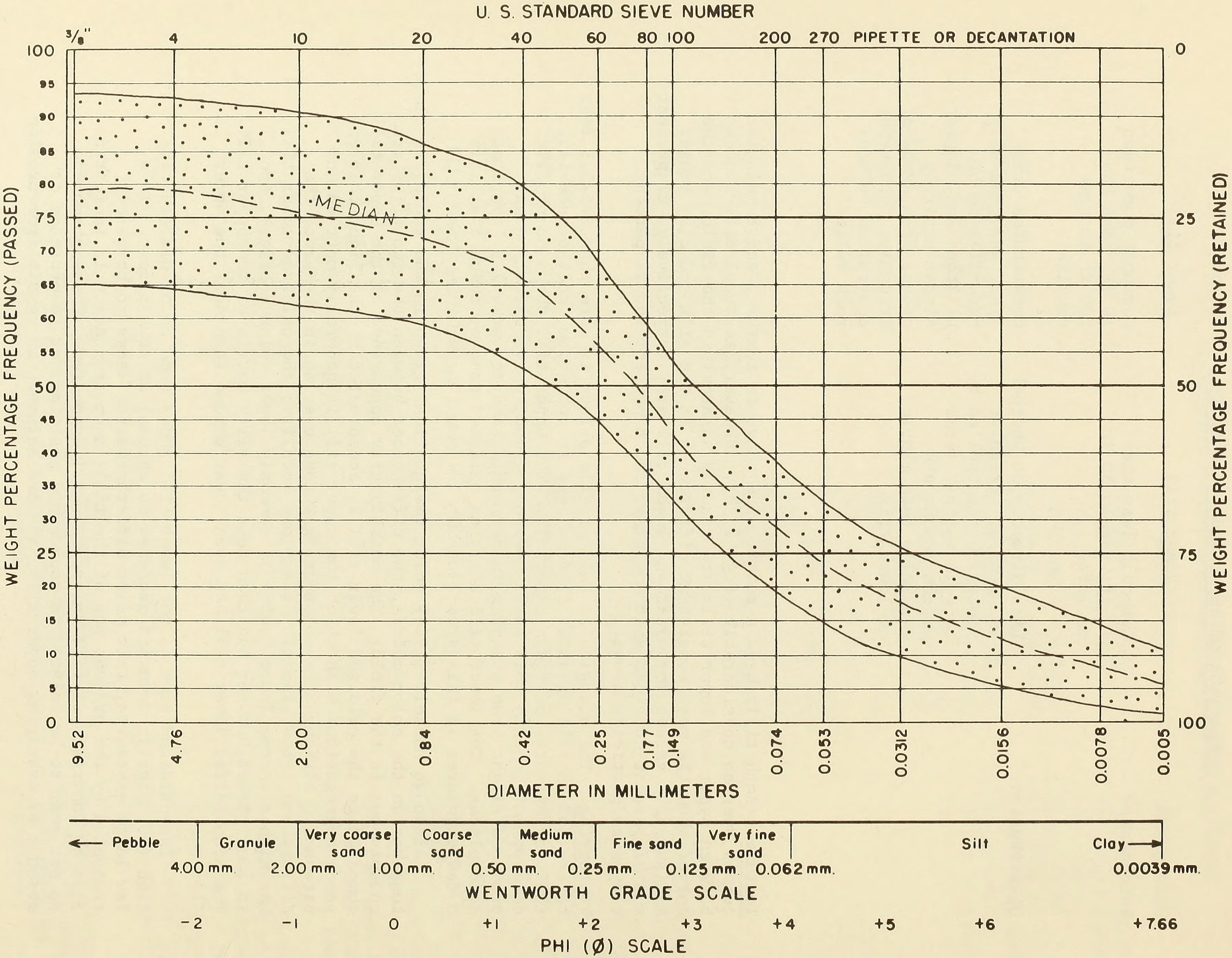

Fig. 2. Range in grain size (cumulative curves, 5 samples) of upper till from the Pomperaug Valley area and vicinity.

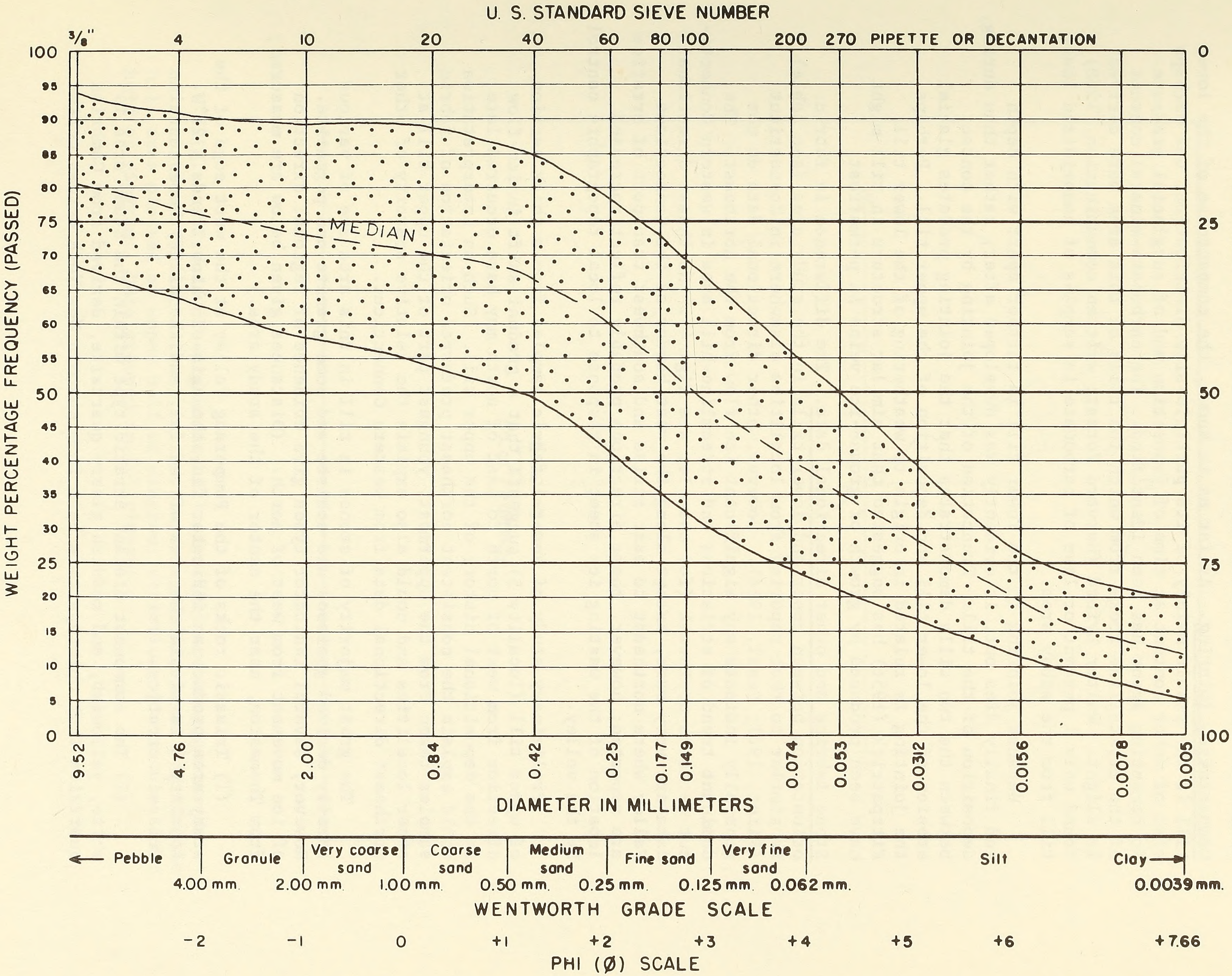

Fig. 3. Range in grain size (cumulative curves, 5 samples) of lower till from the Pomperaug Valley area and vicinity.

of the lower till to variable depth by the ice from which the upper till was deposited. In no exposure in this area did erosion completely remove the oxidized zone of the lower till.

Compactness, jointing. As far as is known, the compactness of the lower till is the result mainly of its particle-size distribution, and perhaps also of water content at time of deposition and of subglacial pressure. No cementing agent has been identified. The carbonate-mineral content of the crystalline rocks from which the tills of this area were derived is slight. Walter Lyford (Harvard Forest; written communication, 1968) found only 1 percent or less of carbonate in samples of nonoxidized lower till from the study area.

Because jointing in the lower till is farther apart with depth and finally dies out, it evidently was developed after, rather than during, deposition of the till. Truncation of the jointing by the contact between the two tills demonstrates that the jointing predates glacial erosion of the lower till and deposition of the upper till. Perhaps the jointing is related in origin to weathering of the lower till. Fitzpatrick (1956) has suggested that similar structure in till might have been produced by growth of ground-ice veins in permafrost.

Stone fabrics and other directional data. The difference in fabric orientation between upper and lower tills in the study area (see table) is similar to that reported from localities elsewhere in Connecticut (Flint, 1961; Pessl, 1966). However, other directional data do not generally indicate any significant ice flow from the northeast. The dominant trend of striations and streamline-hill axes in western Connecticut is north-northwest (for example, see fig. 4). Northeast directional data are very rare, except along the west border of the Connecticut Valley where northeast to east striae and southwest transport of erratics are reported; however, these directions probably reflect increased lobation of the wasting ice sheet in response to local topographic control by the valley.

Preliminary study of several fabric samples from a thick section of upper till (locality 5) suggests that a gradual shift in ice-flow direction from west of north to east of north may have occurred late in the depositional history of the upper till. Such an interpretation could explain the consistent northeast preferred orientation of fabric samples taken from the uppermost, youngest part of the upper till at other localities and could also explain the relative scarcity of other northeast directional data from western Connecticut.

The great majority of stones in till in this area are of various locally derived gneisses and schists and some granite and pegmatite. However, several indicator types give evidence of regional direction of ice movement from west of north. (Distances given below are measured from Thomaston, near the center of the study area.)

(1) Triassic rocks of the Pomperaug Valley at the west edge of the study area produce an indicator fan, the axis of which trends N 25°W. Locality 8 is within the area of the fan, and the tills there contain Triassic erratics.

(2) The commonest distant erratic type within the study area is white, yellowish, and reddish glassy quartzite, derived from Cambrian quartzite that outcrops in a belt from eastern New York across north-

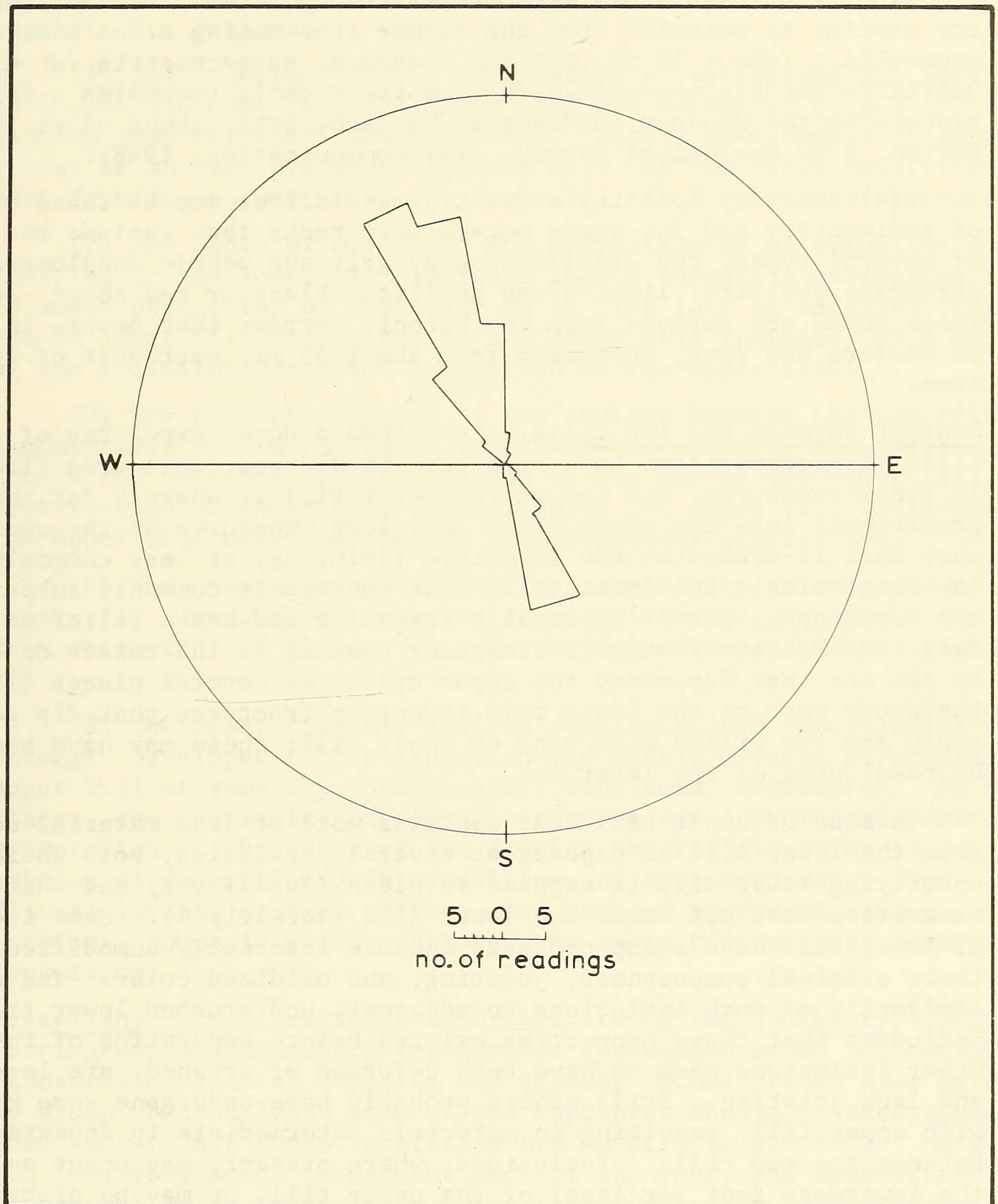

Fig. 4. Trends of streamline-hill axes (91) and average trends of striations (39 localities) in the Pomperaug Valley area. Streamline-hill axes plotted on upper half of diagram; striations plotted on lower half of diagram. Data grouped in 10° classes.

western Connecticut (Poughquag Quartzite), western Massachusetts (Cheshire Quartzite), and western Vermont. The nearest source areas are about 20 mi. NW.

(3) Erratics of hard limonite are rare, but widespread; they are very similar to material from the former iron-mining areas near Salisbury, Connecticut (about 28 mi. NW) and Richmond, Massachusetts (about 50 mi. NNW). Quartzite breccia cemented with limonite closely resembles a fault breccia in the Windsor quadrangle, Massachusetts, about 65 mi. N (Stephen Norton, U.S. Geological Survey, oral communication, 1968).

(4) At every locality a few representatives may be found of a suite of sedimentary and low-grade metamorphic rocks that include red quartzite of several types, red argillite, gray grit and pebble conglomerate, dark-gray phyllite, light-green phyllite, black or red chert, and others. These rocks are derived from the Taconic terrane that occurs in a belt in eastern New York, northward from about 35 mi. northwest of the study area.

Contact between the two tills. More than a dozen exposures of the two tills in superposition have been seen in and near this area (localities 1,2,). In these exposures, the top of the lower till is sharply defined and not gradational into the upper till. All long exposures of the contact show that it truncates the structure (jointing, or less commonly textural layering) within the lower till. The contact is commonly subparallel to the topography, but it is locally irregular and has a relief of a few feet. We believe that this irregular contact is the result of erosion by the ice that deposited the upper till. At several places (localities 1,2) the upper part of the lower till is cut by fractures that dip generally south and are filled with sand or upper till; these may have been produced by basal drag of the later ice.

A zone of upper till that contains more or less material derived from the lower till is exposed at several localities, both where the underlying lower till is exposed in place (locality 1) and where the excavation does not reach the lower till (locality 4). Some inclusions of lower till have sharp contacts and are internally unmodified, retaining their original compactness, jointing, and oxidized color. The close similarity of such inclusions to adjacent, undisturbed lower till indicates that those properties existed before separation of the inclusions. Other inclusions seem to have been deformed or crushed, are less compact, and lack jointing. Still others probably have undergone some mixture with upper till, resulting in materials intermediate in appearance between the two tills. Inclusions, where present, may occur only within the lowermost foot (or less) of the upper till, or may be distributed through a thickness of more than 15 feet.

Where both tills are exposed, the base of the upper till is commonly very sandy, and in many places it is marked by a bed of fairly well sorted sand.

Ages of tills. The upper till was deposited by the last ice sheet to reach southern New England, in Wisconsin time, probably about 20,000-14,000 years ago (Schafer and Hartshorn, 1965, p. 120). We believe that the lower till was deposited during an earlier ice advance; however, the only evidence of the length of the interval between the two advances is the depth of the oxidized zone on the lower till. It has been suggested (Schafer and Hartshorn, 1965, p. 119) that this earlier advance was of early Wisconsin ("pre-classical Wisconsin") and post-Sangamon age, but evidence for this conclusion is not strong.

Summary and conclusions. Observations in the study area lead to the following conclusions which we believe to be applicable elsewhere in southern New England.

(1) Till fabrics and the orientation of striations and streamline-hill axes indicate that the lower till was deposited by glacier ice flowing from the north and northwest. Strong development of fabric lineation and the presence of lower till as the major constituent in most drumlins suggest that the lower till is a subglacial deposit.

(2) The depth of oxidation and pervasiveness of oxidation and staining in the lower till indicate that a subaerial weathering interval followed deposition of the lower till. The lack of marginal staining around lower-till inclusions in the upper till indicates that oxidation of the inclusions predated deposition of the upper till.

(3) The erosional nature of the contact between the two tills as demonstrated by truncation of joints at the contact, the apparent truncation of color differentiation at the top of the lower till, and the distribution of lower till inclusions in the upper till indicates that the upper till was deposited by a readvance of glacier ice.

(4) The upward change in fabric lineation in an exposure of thick upper till (locality 5) suggests a gradual easterly shift in the direction from which the ice flowed, late in the depositional history of the upper till.

(5) The upper till may include subglacial and superglacial facies. Strongly developed fabric lineation and nearly massive structure of upper till at some exposures suggest subglacial deposition. At other places, the continuity of fluvial layering and a preferred fabric orientation in the plane of the fluvial bedding (locality 5) suggest subglacial deposition under conditions of increased water flow. Deformed fluvial layers, coarser texture, and lack of preferred fabric orientation in other, commonly upper, parts of the upper till suggest superglacial deposition.

Miscellany. The localities described are on the Southbury, Thomaston, Torrington, and Waterbury topographic quadrangle maps. Of course, exposures of glacial deposits may quickly become graded over or covered by slump, but at least some of the exposures should be accessible for some years. All these localities are on private property. Many till pits are very muddy throughout much of the year, and appropriate footgear is desirable.

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FIELD LOCALITIES

Locality 1. (27.1N-51.83E) Pit at east side of Willow St. immediately south of its intersection with Waterville St.; 0.6 mi. south of BM 286; Waterbury (Waterbury quadrangle).

Both tills are exposed in this pit. The lower till is mostly covered by slump, and is most easily reached on the west side of the main salient in the middle of the pit. Figure 5 shows contact relations for a length of about 35 ft along this face. Both the layering in the upper till and the dominant subhorizontal jointing in the lower till dip gently westward, approximately parallel to the hillslope. The section is :

7-8 ft upper till, layered; much very stony material; many sand layers.

1-4 ft upper till, more or less mixed with lower till; highly variable and gradational laterally and vertically. Variation in thickness is result of southward rise of contact with lower till. At north end of diagram this material is mostly disturbed lower till; jointing has been lost and compactness decreased, and it is more or less mixed with sandy upper-till material and is cut by irregular lenses of sand. Southward this unit grades into material composed mostly of upper till mixed with a little lower till material; it contains compact jointed inclusions of lower till that have sharp contacts. Near the middle of the diagram, sandy material penetrates at least 3 ft downward into lower till along a south-dipping fracture.

4 ft lower till, compact, jointed, oxidized. Within vertical range of exposure, jointing is more closely spaced upward, approaching fissility. This jointing is distinctly truncated by the upper contact of the lower till.

Locality 2. (31.24N-50.40E). Pit west of relocated State Route 254, about 2 mi. northwest of Thomaston (Thomaston quadrangle), reached by a foot trail that begins on the west side of Route 254 just south of the intersection of Knife Shop Road.

The pit is in the southeast flank of a streamline hill and exposes a section, about 20 feet thick, of olive-brown to olive (2.5Y 4/4 - 4Y 4/3), compact till. Thin platy jointing occurs within thick layers that contain linear concentrations of stones; these structures are subparallel to the topographic slope, but appear to be truncated by it near the north end of the face.

At the north end of the pit, about 3 feet of olive-gray (5Y 4/2.5-3.0) friable till overlies compact olive-brown till. The basal part of the upper till here contains both disaggregated lower-till material and discrete inclusions of lower till. Fillings of upper till penetrate between slabs of lower till that have been displaced, but not entirely detached from the undisturbed lower till below. An iron-stained rind is locally well developed at the contact between the two tills.

Locality 3. (31.51N-51.65E) The pit is on the east side of relocated State Route 222, about 2 mi. north-northeast of Thomaston and 0.3 mi. south of the intersection of Leadmine Road (Thomaston quadrangle). Bedrock is exposed in the pit floor and at the crest of the hill.

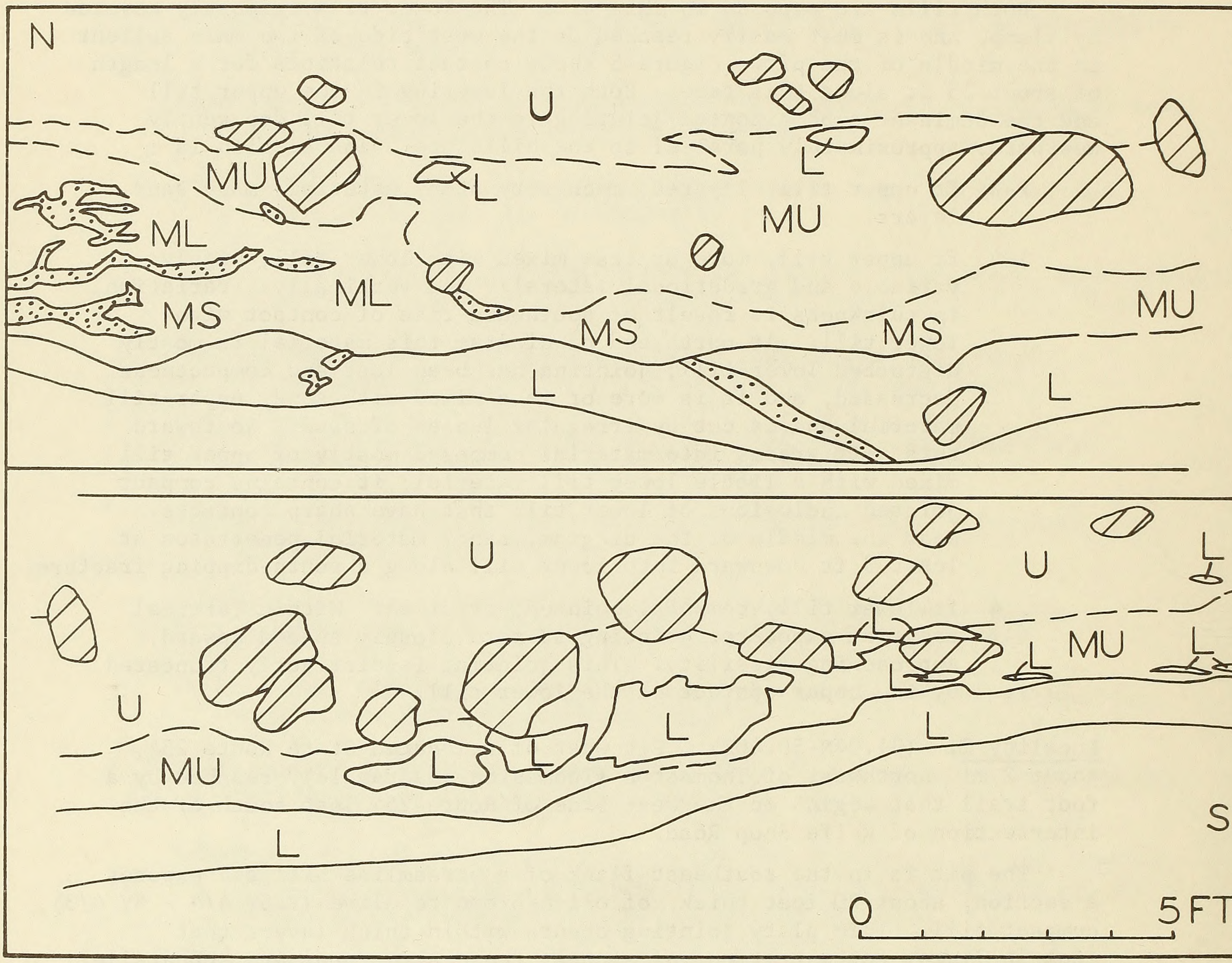

Fig. 5. Section at locality 1, contact between upper and lower tills, Waterbury quadrangle.

L - lower till in place; also inclusions of compact jointed lower till in upper till

M - mixed zone; ML, dominantly lower till; MU, dominantly upper till; MS, much sand mixed with till

U - upper till

Crosslined - boulders

Dotted - sand

Striations on bedrock in the pit floor trend about N 15° W.

The section near the south end of the pit is:

0.5 ft "A" horizon of soil profile.

1.6 ft "B" horizon of soil profile; upper part is dark yellowish brown (10YR 4.5/3.5).

1.3 ft disrupted brown till with iron-stained joint faces.

2.0 ft loose structureless olive (5Y 4.5/3) material; perhaps derived from reworked upper till.

1.5 ft disintegrated rotten bedrock rubble with coarse mica flakes.

8.0 ft blocky compact olive (5Y 4/3) till with closely spaced subvertical and subhorizontal joints; iron staining prominent on joint faces.

8.0 ft blocky compact olive-gray to olive (5Y 4/2.5) till; joints less closely spaced than above.

11.0 ft compact olive-gray (5Y 4/2) till with subhorizontal and subvertical joints; faint iron staining on joint faces increases in intensity upward.

10.0 ft compact olive-gray (5Y 4/2) till with texturally controlled, locally deformed, layering.

21.0 ft compact dark-gray (5Y 3.5/1) till with texturally controlled, subhorizontal layering.

The upper 7 ft of the section is interpreted as colluvium overlying the till. Because of its unusual depth, this exposure demonstrates the gradual disappearance of jointing and the gradual color change from olive to dark gray with depth. These changes are interpreted as the result of prolonged exposure of the till to subaerial weathering.

Locality 4. (35.32N-50.81E). Pit on west side of State Highway 183, about 800 ft north of intersection with State Highway 4 (72 on topographic map), Torrington (Torrington quadrangle).

This pit at the southeast corner of a drumlin shows upper till containing much lower till material; undisturbed lower till is not exposed. The face shown in figure 6 trends northeast, nearly normal to the long axis of the drumlin.

The upper 3-4 ft is upper till, somewhat layered; some is nearly massive, loose, and sandy (olive-gray, 5Y 5/2), and some is much interlensed with sand. A brownish, finer grained lens is interpreted as deformed inclusion of lower till.

The rest of the exposure contains numerous sharp-bordered inclusions of compact, jointed lower till, the largest of which is 8 ft long and 1.5 ft thick (olive, 5Y 4.5/3). There are also numerous bodies of well-bedded sand, some of which are strongly deformed. The remaining material ranges from typical upper till through various intermediate mixtures to lower till that lacks jointing. Some of this lower till constitutes distinct inclusions, but the only ones shown on the diagram are the undeformed ones that retain the original compactness and jointing.

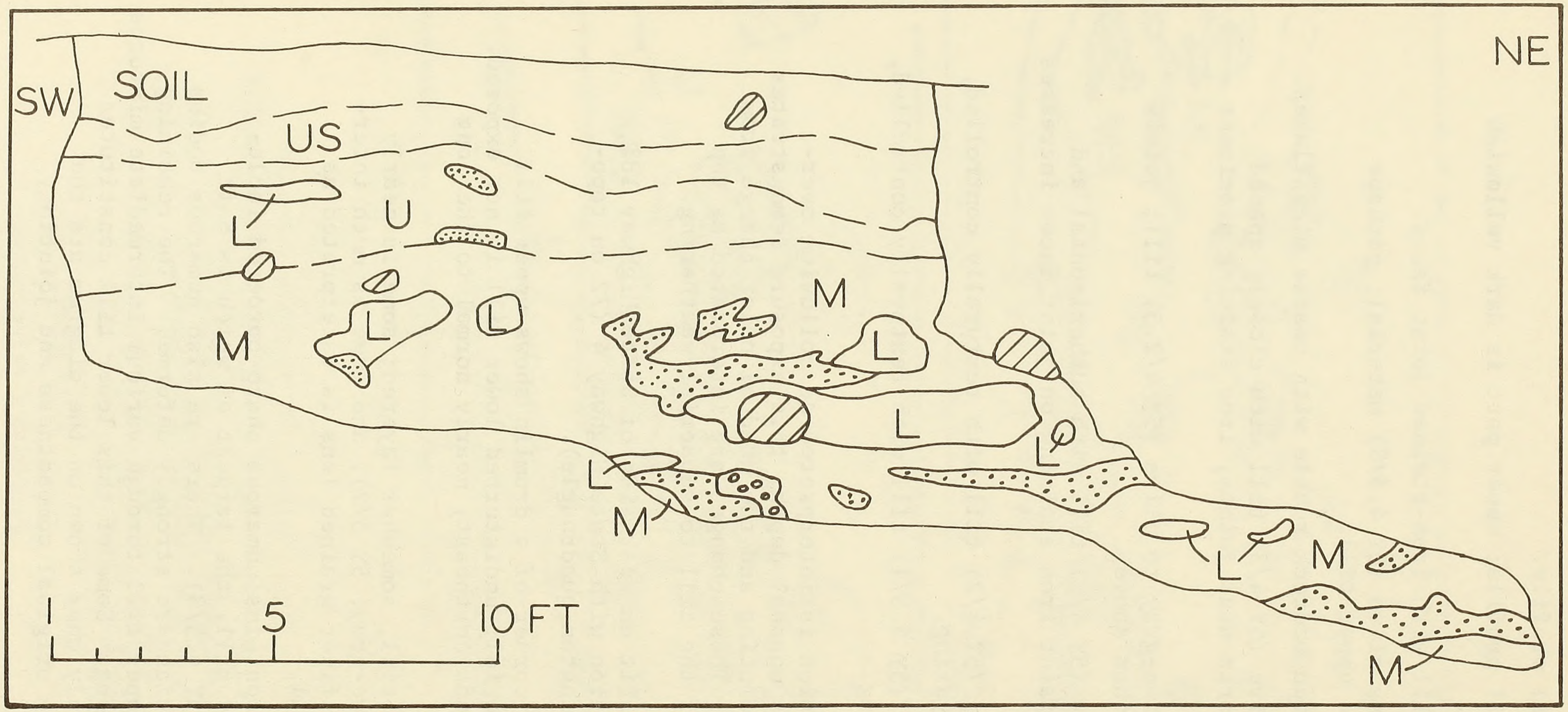

Fig. 6. Section at locality 4, upper till and mixed zone, Torrington quadrangle.

L - inclusions of compact jointed lower till in upper till (uppermost inclusion has lost compactness and jointing)

M - mixed zone; ranges from typical upper till through various intermediate mixtures to lower till that has lost compactness and jointing

U - upper till

US - upper till, much interlensed with sand

Crosslined - boulders

Dotted - sand

Small circles - pebble gravel

A somewhat deformed, smeared inclusion of lower till, 2-7 in. thick and at least 30 ft long, lies 3 ft below the top of the upper till, about 40 ft southwest of the diagrammed exposure. Numerous clasts of pre-glacially weathered rock occur in both tills, and some of these clasts were deformed during or after deposition.

Locality 5. (36.62N-52.38E). The exposure is located in a stream-cut bank on the south side of Bakersville Brook, 0.5 mile north-northeast of Bakersville (Torrington quadrangle). Access is from the south side of Winchester Road which intersects Maple Hollow Road 0.2 mile southwest of Maple Hollow village.

The exposure is 30-35 ft deep and about 200 ft long. In general, the till can be divided into three units:

(1) an upper, discontinuous unit composed of nonlayered, poorly sorted, very stony till. This unit is absent in the western part of the exposure.

(2) a middle unit which is stony and crudely layered, and containing a conspicuous amount of stratified sand and gravel.

(3) a lower unit which is more massive and less stony than the overlying units, and which contains only minor beds of fluvial sediments. The section given below is in the central part of the exposure.

1.0 ft	Eolian sand and silt mixed with till; 1-2-inch-thick organic zone at top.
4.0 ft	Stony nonlayered till (5Y 6.5/2) with lenses of small pebble- to granule-size gravel; some iron staining around isolated pebbles and roots.
4.0 ft	Layered stony till (5Y 6/2) with lenses of well-sorted coarse- to medium-grained sand and granule gravel; iron staining in some sand and gravel lenses.
1.0 ft	Crossbedded medium- to coarse-grained sand and granule gravel with small-scale folds and thrusts.
2.0 ft	Contorted sand layers interbedded with lenses of pebble gravel and stony till-like masses.
1.5 ft	Well-sorted coarse- to medium-grained sand and granule gravel.
11.0 ft	Stony massive till (5Y 6.5/2 to 5.5/3); texturally controlled mottling with light-colored sandy zones and dark-colored silty zones; sandy partings common.
3.0 ft	Covered interval.
0.5 ft	Well-sorted, nonoxidized, crossbedded, medium- to coarse-grained sand.
2.5 ft	Massive stony till similar to the next higher till unit.

Five till-fabric samples were collected in vertical sequence at this locality; three from the lower massive unit, one from the layered middle unit, and one from the upper nonlayered unit (fig. 7). The lower three fabric samples show a well-developed preferred lineation of the pebble

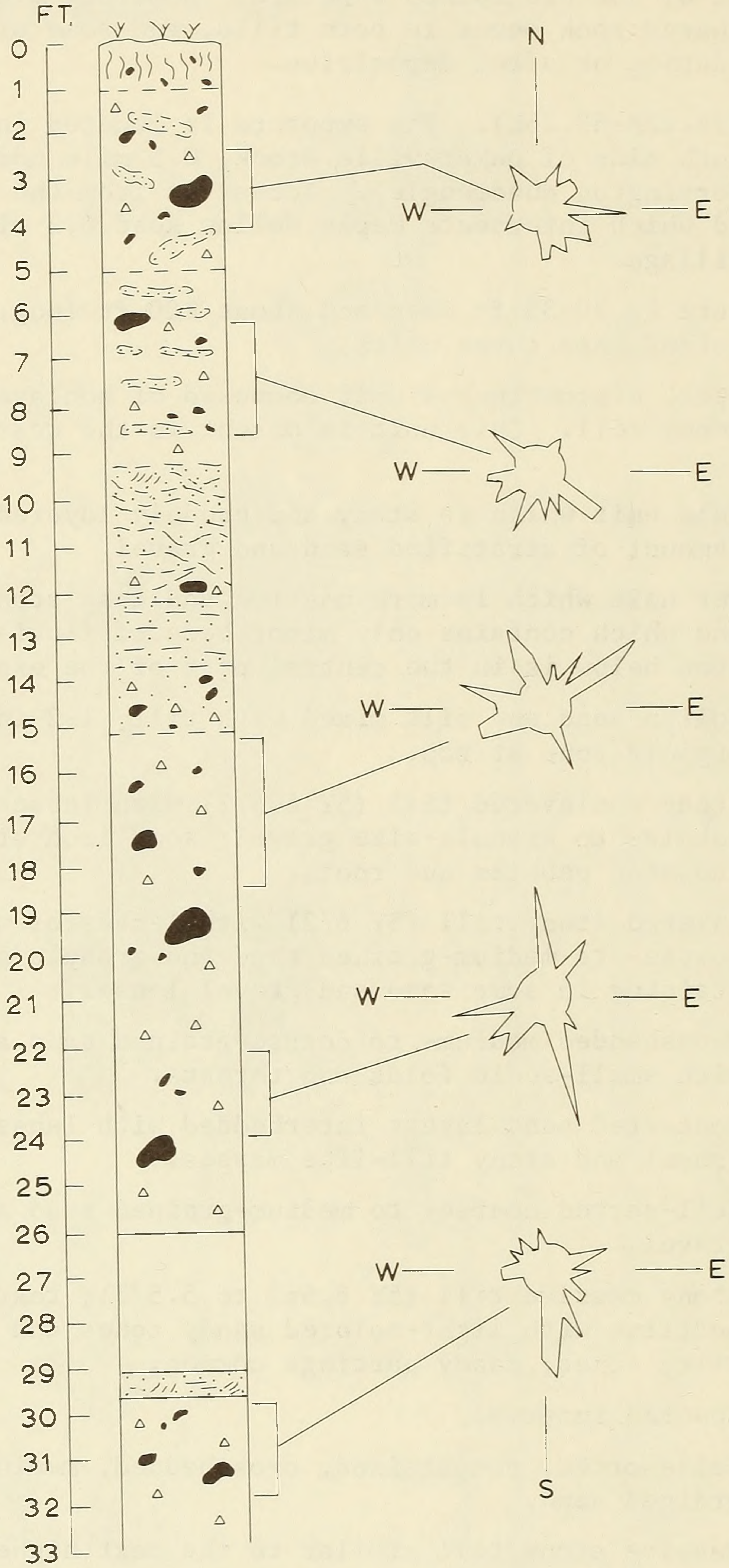

Fig. 7. Generalized stratigraphic column and fabric diagrams from till at locality 5, Torrington quadrangle. Each fabric diagram shows strike of long axes of 50 elongate pebbles measured in the direction of plunge and grouped in 10° classes.

axes. Axes of pebbles from the upper two units show no well-defined preferred lineation, but the axes of pebbles from the middle unit, 6-8 ft deep, have low-angle plunges and appear to lie in the plane of the fluvial bedding in that unit. The lowest sample, 30-31 ft deep, has an A lineation oriented S 10° E and a B lineation oriented about S 80° W. A gradual increase in strength of the southwest lineation at the expense of the southeast lineation occurs in the next two samples at depths of 23 ft and 16 ft. At 16 ft, the A lineation is S 55-65° W and the B lineation is S 25° E.

These data suggest that a gradual shift in ice-flow direction from east of south to west of south may have occurred during deposition of the till. The massiveness and well-defined fabric lineation in the lower unit of the section suggest that this part is subglacial till. The presence of a preferred fabric orientation in the plane of the fluvial bedding and the prominence and continuity of layering in waterlaid sediments in the middle unit suggest that it was deposited as subglacial till at a time of increased water flow at the base of the ice. The absence of a well-defined fabric orientation and the presence of fluvial sediments lacking continuity of stratification in the upper unit suggest that it was deposited as superglacial till.

Locality 6. (33.89N-50.33E). A pit on the northwest slope of Scoville Hill (southwest corner of the Torrington quadrangle), reached via an access road on the south side of State Route 118 (116 on the topographic map), about 0.75 mi. east of State Route 8 at East Litchfield.

The pit shows 30-35 ft of gray stony till, in which the lower 15-20 ft contains thin stringers and smears of olive-brown, compact till.

The upper 12-15 ft of the exposed section is composed of very stony, layered gray till with prominent sand and gravel lenses. Some zones of noticeably browner material occur near the top of the section, but no recognizeable discrete bodies of brown compact till were observed. This brown color may reflect the presence of disaggregated lower-till material mixed with upper-till matrix in this part of the section.

The lower 15-20 ft of the exposure is composed of less stony, less coarsely layered gray till with somewhat finer grained sand and gravel lenses, and interstratified layers of coherent olive-brown till.

Layering in the pit face commonly parallels the topographic surface, except at the southeast corner of the pit where cobble-boulder layers in the upper part of the exposure are truncated by the surface slope. Over-steepening of the topography here, relative to the layering in the till, is the result of erosion of the till surface and formation of a low stream terrace in the drainage channel immediately east of the pit.

Locality 7. (29.66N-51.16E). Pit on south side of West Hill Rd., 1200 ft east of intersection with Waterbury Rd. (State Highway 8 on topographic map), about 0.7 mi. south-southeast of Reynolds Bridge (Thomaston quadrangle).

This pit shows only upper till, with no indication of mixing of lower-till material. The till is more than 13 ft thick, but bedrock is probably not far beneath the base of the exposure. This till has a smaller proportion of stones than is usual in upper till. It is loose and sandy, and the silty finer parts are mostly olive gray (5Y 5.5/2.5).

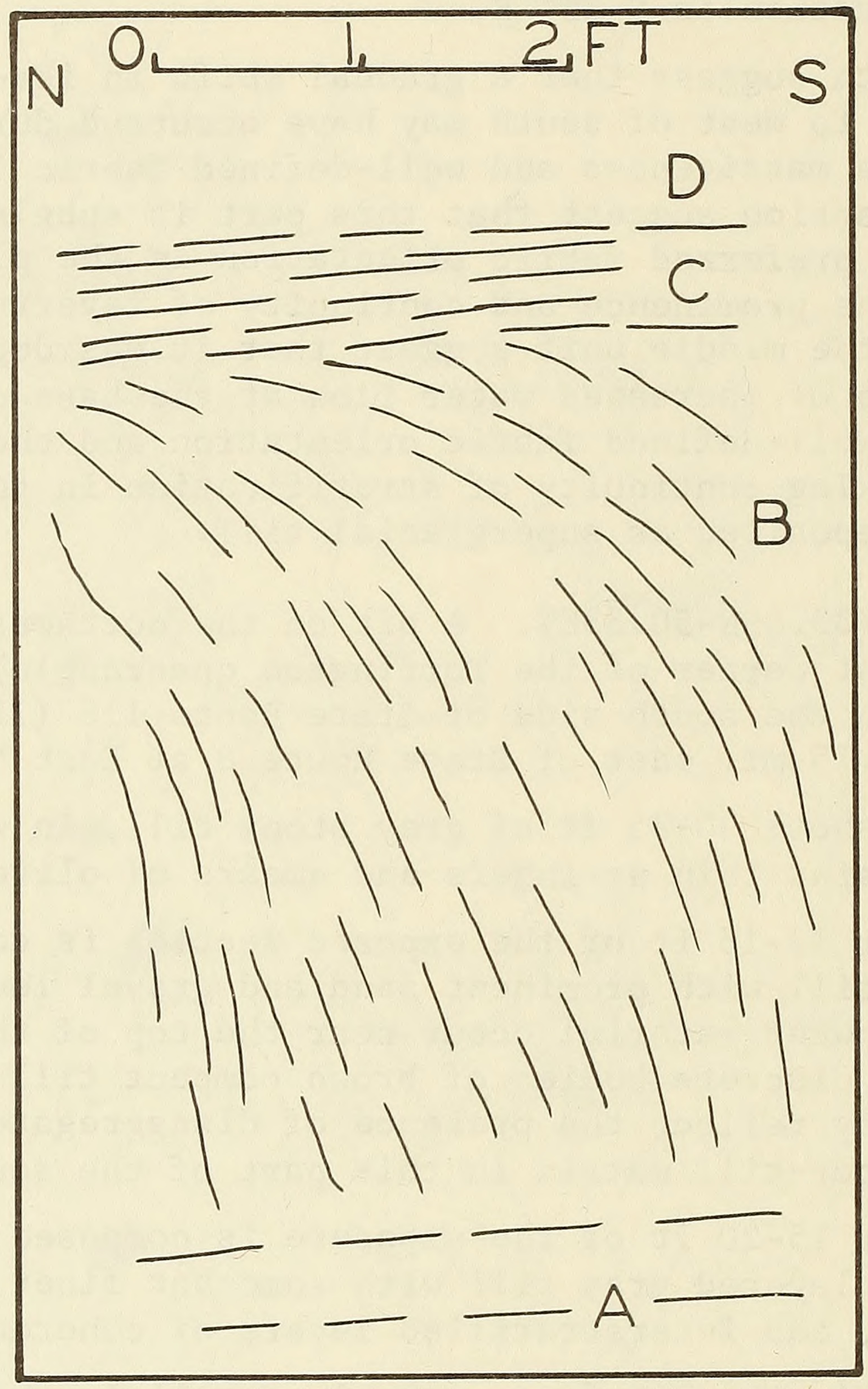

Fig. 8. Section at locality 7, structure of upper till, Thomaston quadrangle.

A and D - massive to slightly layered till

B - till with closely spaced thin sandy layers; strongly deformed

C - mostly layered sand, some sandy till

The major layering of the till dips gently west, subparallel to the hill-slope.

The section shown in figure 8, near the middle of the pit, is:

6.0 ft Subhorizontally layered; ranges from nearly massive till to sandy, fairly well bedded material.

4.5 ft Till with generally closely spaced, light-colored, thin sandy layers. Layering is gently dipping at top of unit, but steepens abruptly downward to steeply dipping SSE or SE. Layering is indistinct at bottom of unit, but probably is truncated by base.

1.5 ft Till, subhorizontally layered.

Except for the lowest unit, which is exposed only at one place, the diagram would serve for the several exposures along the 200-250 ft length of the pit from north to south. The southward steepening of dip of layering in the middle unit is consistent throughout. This structure does not seem to fit closely with hypothesis either of collapse of superglacial drift or of thrust or drag by southward-moving ice. At one place, the inclined layering is cut by several northwest-dipping thrust faults; drag and displacement on these faults shows thrusting southeastward.

One exposure in this pit, shortly south of that in figure 8, shows within the south-dipping till an irregular small body of horizontally bedded, undeformed sand and pebble gravel. This sand and gravel appears to have been deposited by water in an opening formed in the till after its present dip was formed.

Locality 8. (21.74N-49.10E). The exposure is located on the north side of Hogback Road, 0.5 mile east of State Route 188 (east-central part of the Southbury quadrangle).

About 18 ft of sandy friable gray till overlies an exposed thickness of 2-3 ft of compact brown till. The lower 9 ft of the upper till contains thin stringers and lenses of lower till. Concentration of lower-till material within the upper till increases with depth. The main face of the pit strikes approximately north and slopes gently west. The section is:

0.1-0.3 ft Organic-rich "A" horizon of soil profile.

2.0 ft "B" horizon of soil profile; upper part is dark brown (10YR 3.5/3); lower part is dark yellowish brown (10YR 4.5/4).

7.0 ft Sandy, stony, friable, olive to pale-olive (5Y 5.5/3) till with irregular discontinuous iron-stained zones. Mottling is locally well developed with light-colored sandy phases and darker silty phases. A thin lens (4-in. maximum exposed thickness) of iron-stained, granule- to small pebble-size gravel occurs 2 ft above base.

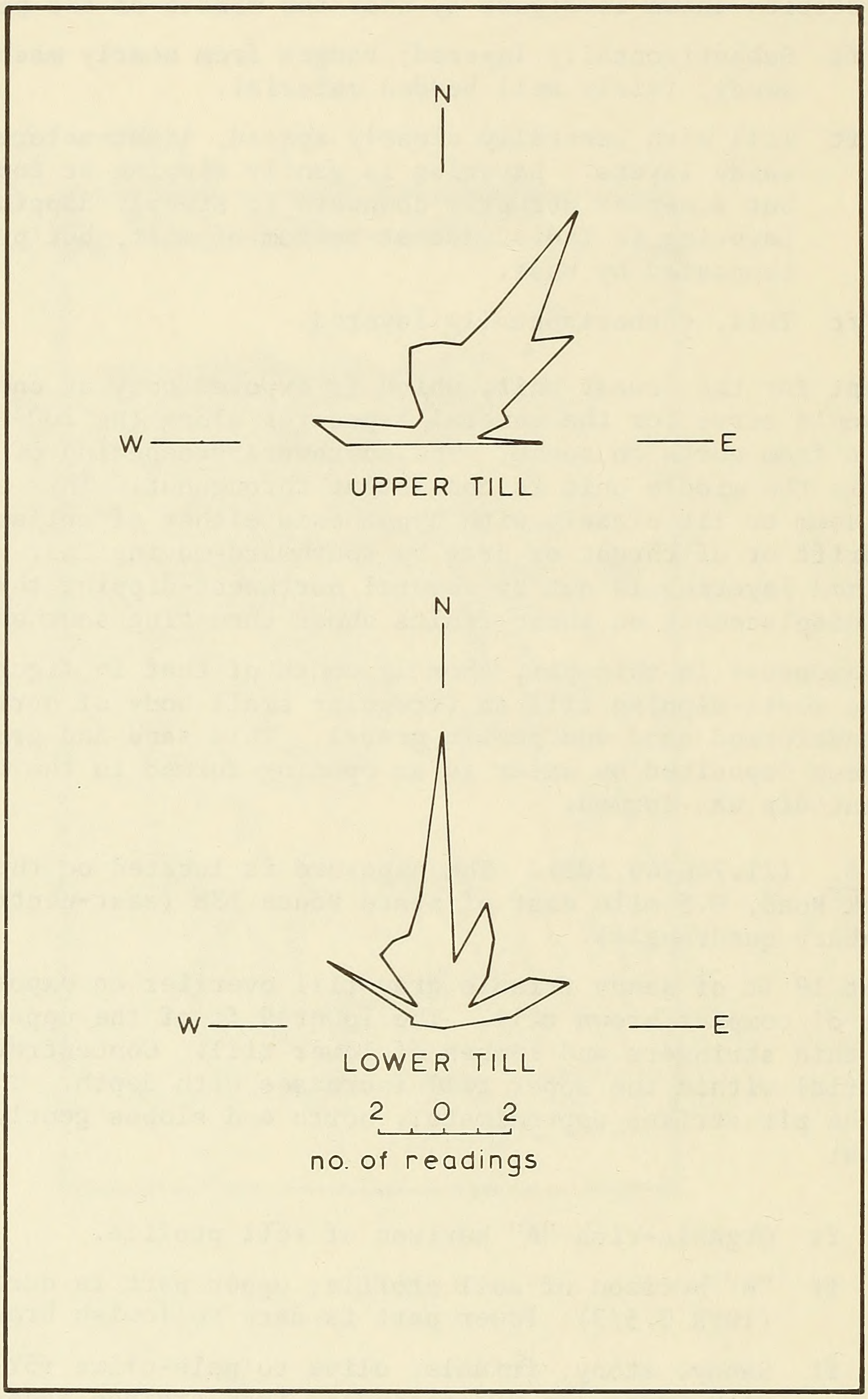

Fig. 9. Till-fabric diagrams from locality 8, Southbury quadrangle. each fabric diagram shows strike of long axes of 50 elongate pebbles grouped in 10° classes.

6.0 ft Sandy stony till similar to that above but with more light-colored sandy material, and mixed with thin (0.5-0.75 in.) irregular-shaped layers of compact olive-brown (2.5Y 4.5/4) till. Spacing of lower-till layers decreases from top (6-10 in. apart) to bottom (2-4 in. apart) of the unit. Upper till becomes somewhat brittle and less friable with admixing of lower till.

3.0 ft Compact light-olive-brown (2.5Y 5/4) till with prominent iron-stained joints; mixed with lenses and pods of gray sandy till. Amount of gray till mixed with brown till decreases with depth.

2.0 ft Compact light-olive-brown (2.5Y 5/4) till with iron-stained joints and irregularly distributed light-yellowish-brown to light-olive-brown (2.5Y 5.5/4) sandy zones.

At the south end of the pit, where the face strikes northeast, about 5 ft of gray sandy till overlies 2-3 ft of compact brown till. The contact between the tills here is more sharply defined than in the section described above, and less mixing of the tills occurs in the base of the upper till. Till-fabric samples were collected from this exposure. The fabric data (fig. 9) indicate an ice-flow direction generally due south during deposition of the lower till, and southwest during deposition of the upper till.

<u>Locality 9</u>. (26.16N-51.57E). Highway cut on the north side of Interstate Highway 84, immediately west of the Highland Avenue overpass, Waterbury (Waterbury quadrangle). This exposure is now grass covered, but during construction it was described as follows:

0.3 ft "A" horizon of soil profile; dark-gray-brown (2.5Y 3.5/4); developed in eolian material mixed with underlying drift.

1.0 ft "B" horizon of soil profile, developed in similar mixed material as above; upper part yellowish-brown (10YR 5/6), lower part light-olive-brown (2.5Y 5.5/6). Yellowish color extends irregularly as much as one foot into the underlying till.

3.6 ft Loose sandy-silty mottled till; silty fines are olive (5Y 4.5/3). Contact is knife-edge sharp and tightly folded, accentuated by a thin oxidation rind. Immediately above the contact is a 4-18-inch-thick zone in which tongues and lenses of lower till extend into the base of the upper till.

7.0 ft Compact olive-brown (2.5Y 4.5/4) till showing some textural variation in which silty phases are more compact (almost platy in places) and darker; sandy phases are less compact and yellower. Light-gray bleached(?) lenses with rusty selvages are present in upper 3 feet.

6.0 ft Compact, olive to olive-gray (5Y 4.5/2.5 near top, 5Y 4.5/2 near bottom), massive till with relatively few stones and no boulders. Includes some strongly deformed, yellowish-brown, layered sand bodies. A 10-12-inch-thick layer of brown compact till occurs at base of section, directly overlying bedrock.

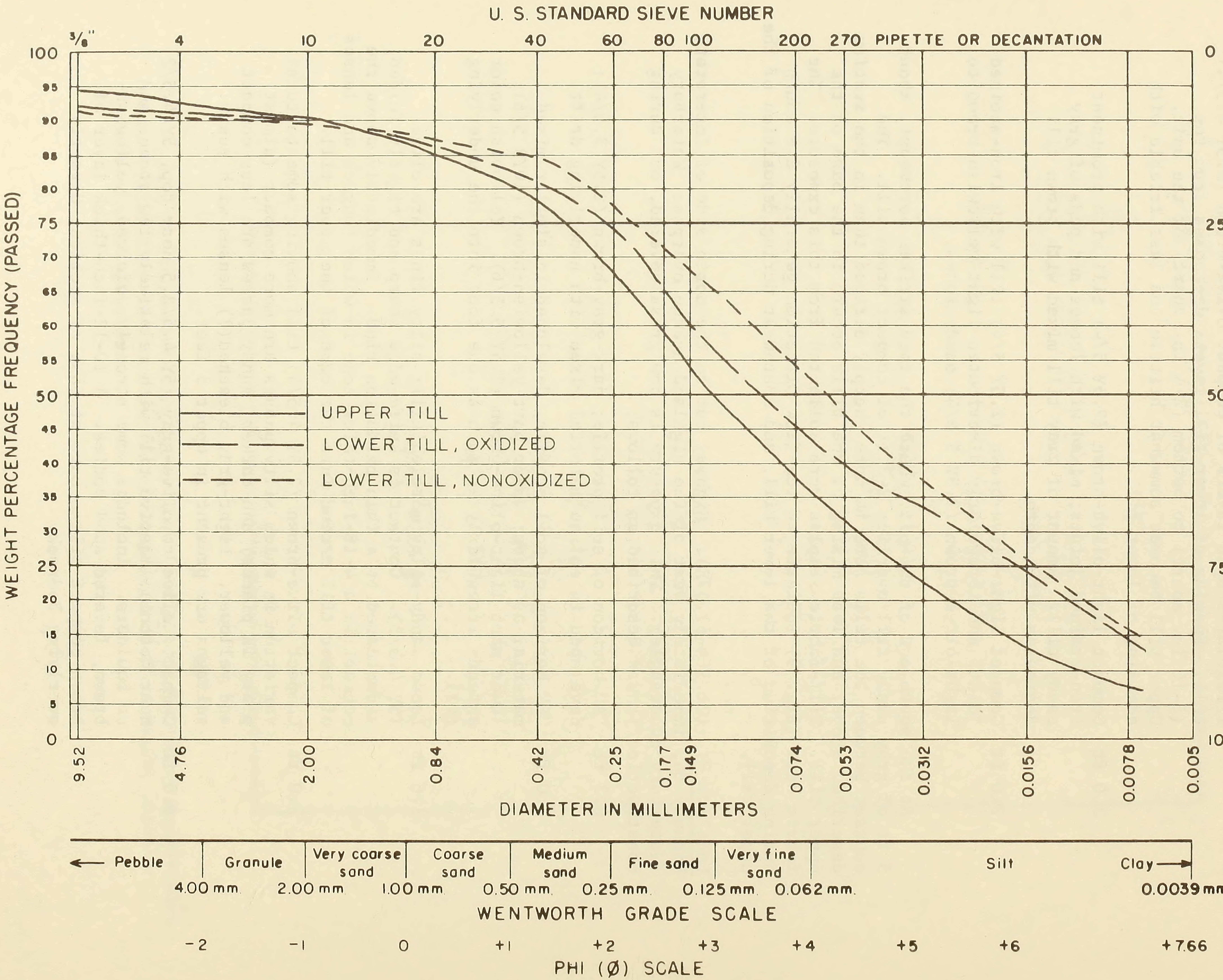

Fig. 10 Cumulative curves from mechanical analysis of tills at

Cumulative curves from mechanical analysis of the upper and lower tills at this locality are shown in figure 10. Differences in grain-size distribution between the two tills are in general agreement with results from similar tills elsewhere in Connecticut.

Till-fabric data from the upper and lower tills at this locality are shown in figure 11. In neither is there a strongly developed fabric lineation, but the generally preferred orientations, northeast in the upper till, northwest in the lower till, are consistent with fabric data from other samples of similar tills.

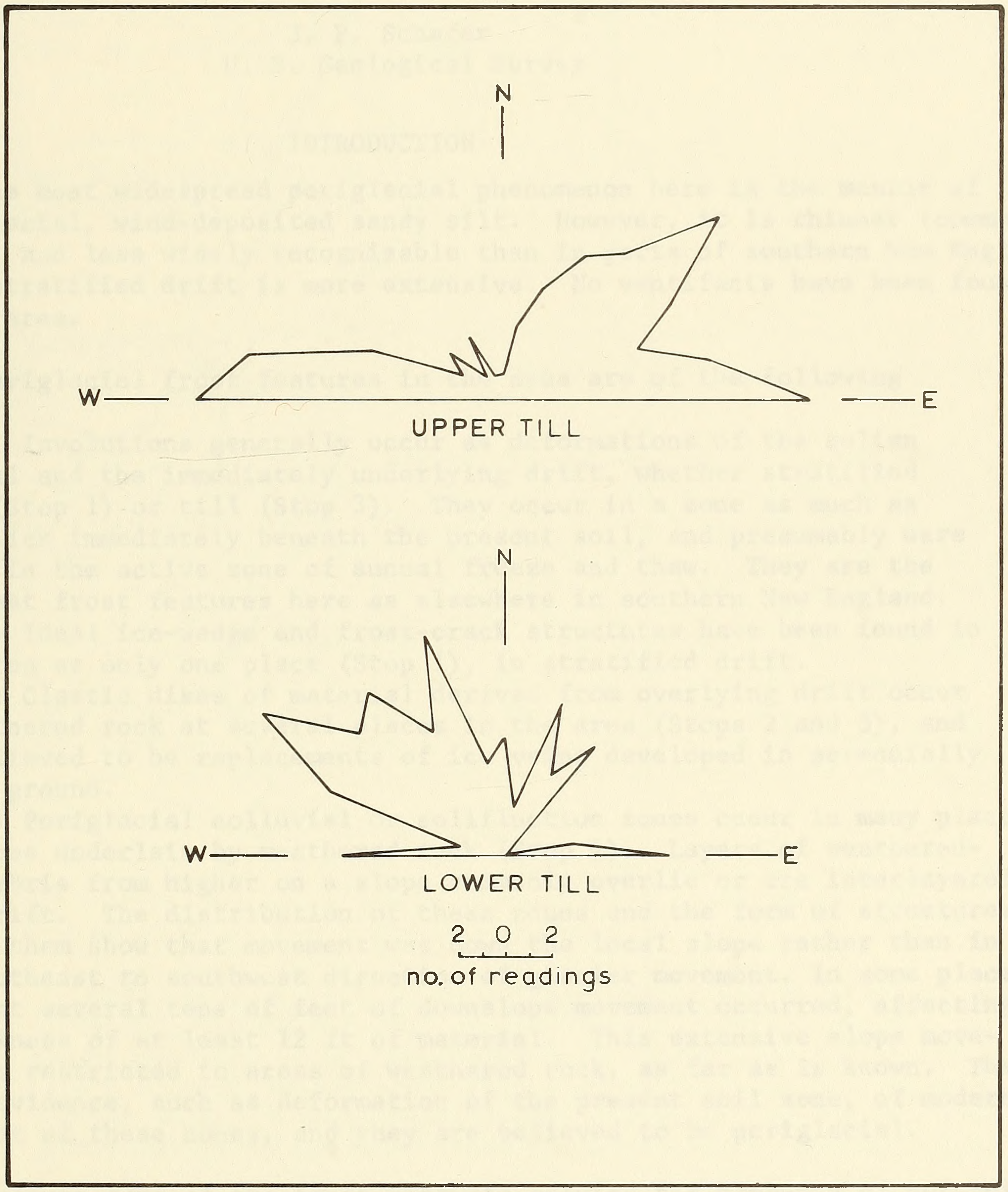

Fig. 11. Till-fabric diagrams from locality 9, Waterbury quadrangle. Each fabric diagram shows strike of long axes of 100 elongate pebbles grouped in 10° classes.