"ANATOMY OF THE CHICOPEE READVANCE, MASSACHUSETTS"

by

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The area traversed on this field trip lies in the Easthampton, Mt. Tom, and Springfield North 7.5-minute U.S. Geological Survey topographic quadrangles in the Connecticut Valley Lowland of Western Massachusetts. The terrain is underlain by terrestrial arkosic sedimentary rocks and tholeiitic basalts of Late Triassic and Early Jurassic age (Cornet and others, 1973). The rocks were deposited in a down-faulted half graben produced by the rifting of eastern North America from Africa (Van Houten, 1977). The arkosic sedimentary rocks form two lowlands separated by a hogback held up by the resistant Holyoke Basalt. The Connecticut Valley Lowland is bordered on both the east and west by Paleozoic high-grade metamorphic and igneous rocks of the New England Uplands.

During retreat of the last ice sheet the Connecticut Valley Lowland of Massachusetts was occupied by active ice consisting of two sublobes separated by the Holyoke Basalt ridge (Fig. 1). That the Connecticut Valley was filled with ice while the tributary valleys were free of ice is shown by sets of ice-contact deposits, mainly kame terraces, that step down toward the axis of the main valley. In the Belchertown, Ludlow, Mount Tom, and Easthampton quadrangles, ice-contact slopes associated with these kame terraces trend north-south and are collapsed toward the center of the Connecticut Valley (Fig.2). That the ice was an active lobe as opposed to a stagnant tongue is shown by radial patterns of striations for both sublobes (Fig. 3). In addition, erratics of Jura-Triassic rocks have been pushed onto crystalline rocks to the southeast and southwest of their source area in late-glacial time (Fig. 4).

When the margin of the eastern sublobe was in the southern part of the Springfield North quadrangle, the ice margin readvanced southward 3 to 4km, or underwent a period of oscillatory retreat for several years over the same north-south distance. The main evidence for readvance consists of reddish-brown, compact, lodgement till overlying deformed stratified drift, which in turn overlies till of the main ice advance. Other evidence consists of glaciotectonic features such as thrust faults, shear zones, overturned folds of lacustrine sediment and exotic blocks of deformed sediment.

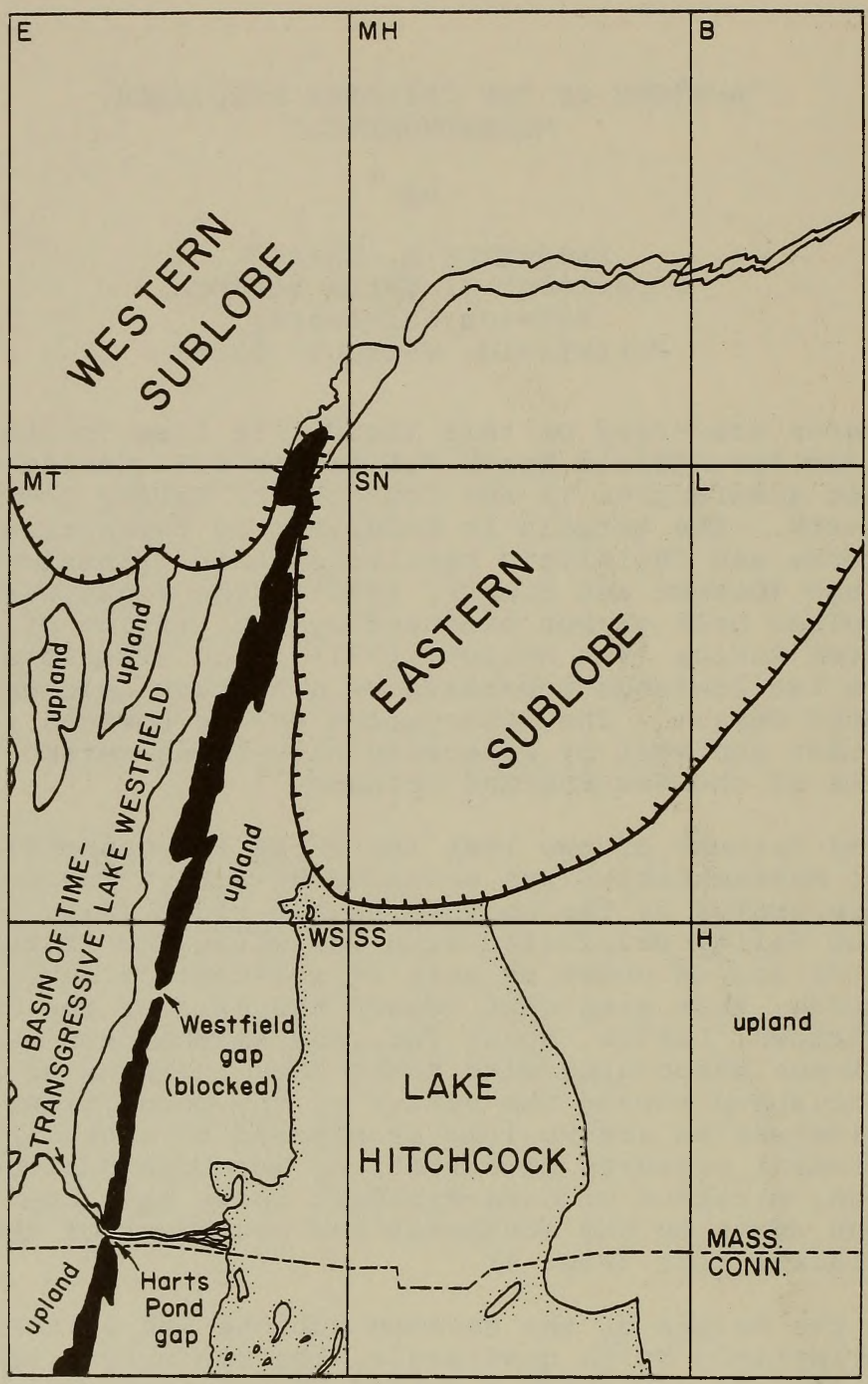

Figure 1. The Connecticut Valley sublobes in late-glacial time. Glacier is outlined by hachured line. Rectangles are U.S.G.S. 7.5-minute quadrangles: E, Easthampton; MH, Mt. Holyoke; B, Belchertown; MT, Mt. Tom; SN, Springfield North; L, Ludlow; WS, West Springfield; SS, Springfield South; H, Hampden. Solid black area is Holyoke Basalt ridge.

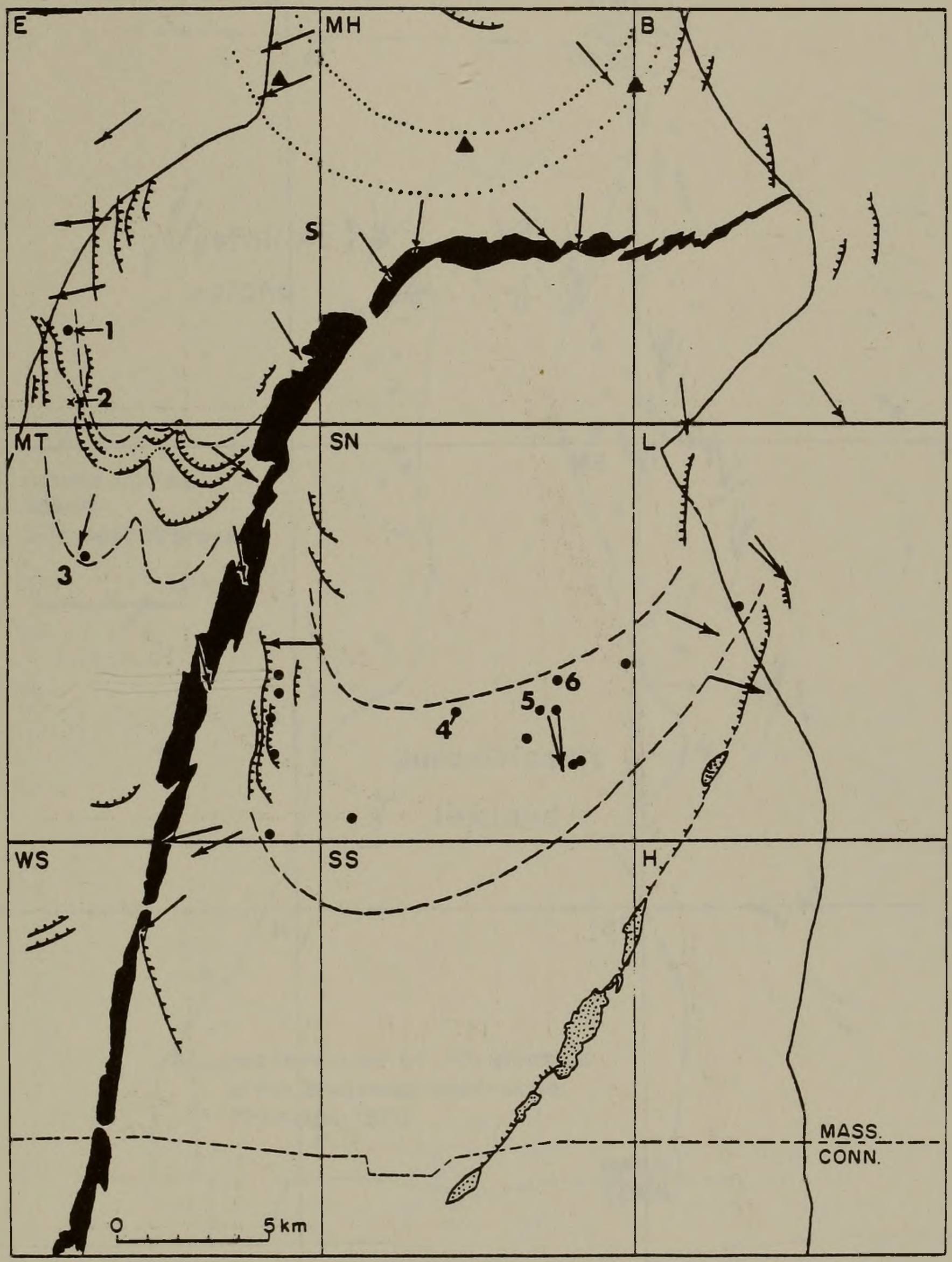

Figure 2. Map of selected striations (arrows), ice-contact slopes (hachured lines; hachures on side of ice), and readvance localities (solid circles, Chicopee readvance; solid triangles, Camp Meeting readvance). Dashed lines enclose area of Chicopee readvance; dotted lines enclose area of Camp Meeting readvance. Ice-contact deposits shown in stippled pattern. Numbers are field trip stops; S, start of trip; see Fig. 1 for quadrangle names.

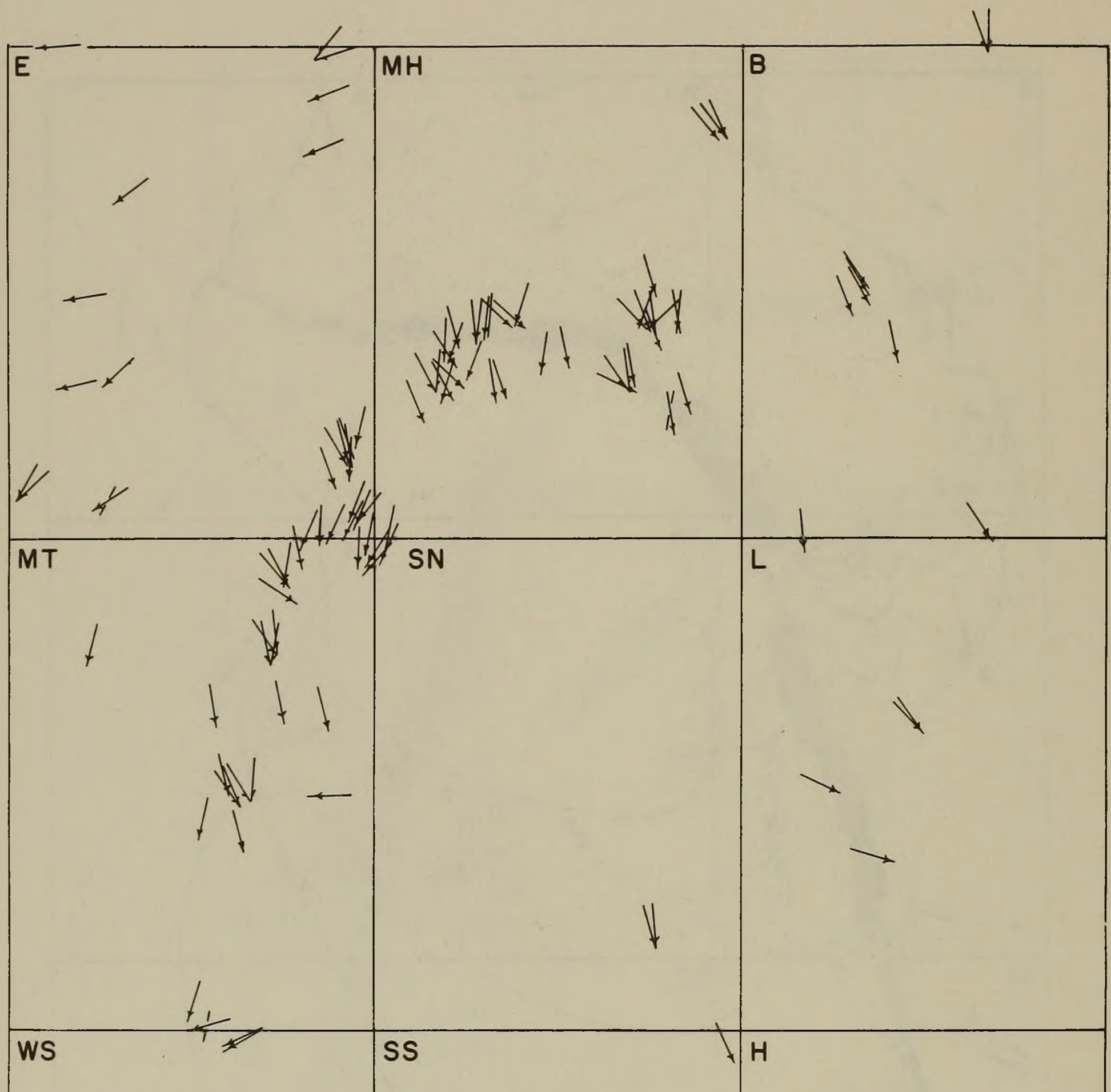

Figure 3. Map of striations in the southern part of the Connecticut Valley of Massachusetts. High concentrations of striations occur on the Holyoke Basalt ridge and on crystalline rocks in the northwest and the east. Location of striations at point of arrow. See Fig. 1 for quadrangle names.

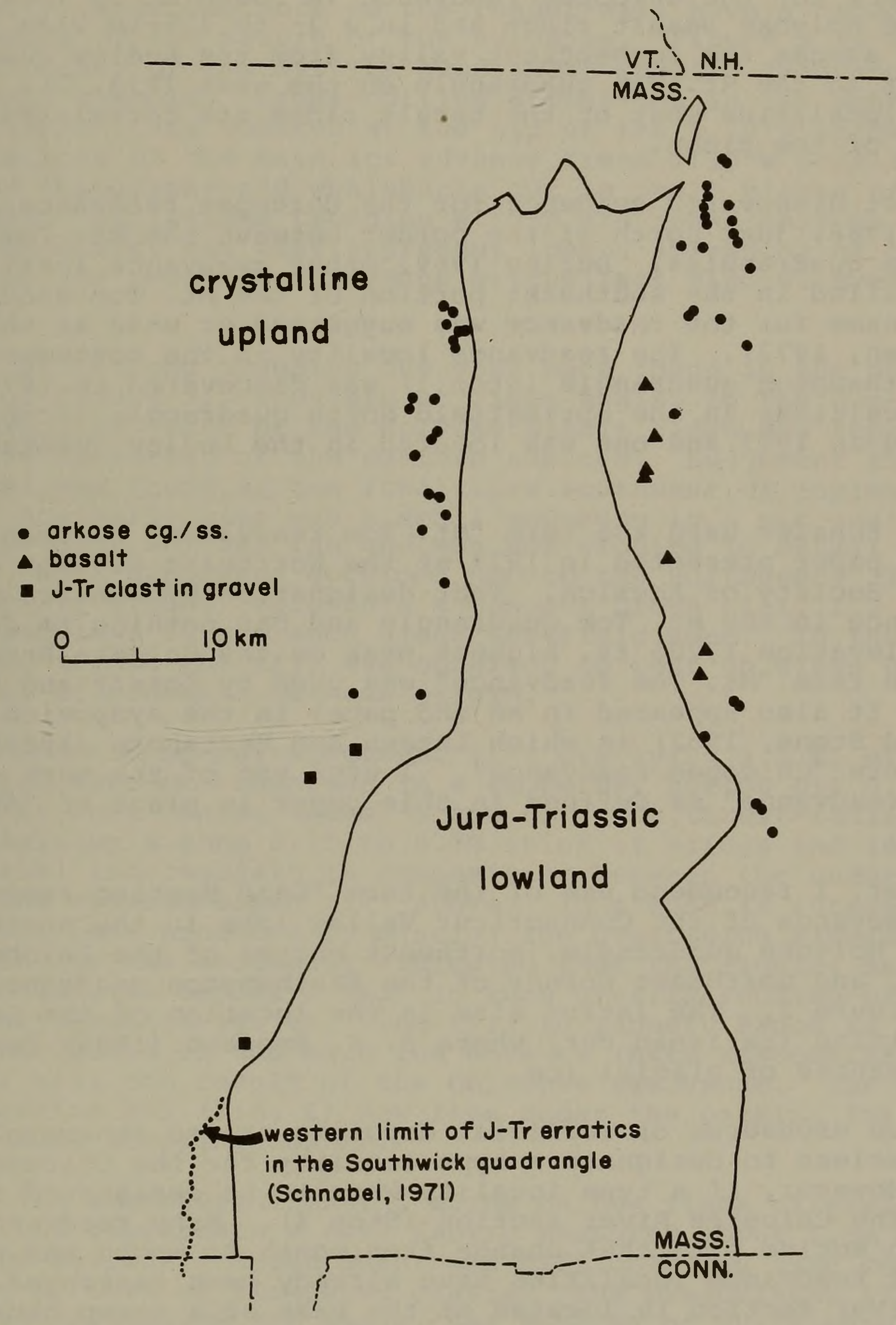

Figure 4. Distribution of erratics of Jura-Triassic rocks overlying crystallines. Erratics were transported east and west from their source area in the Connecticut Valley in late-glacial time.

Evidence for the Chicopee readvance is found at 15 localities east of the Holyoke Basalt ridge and in a 3- to 4.5-km wide zone that loops across the Connecticut Valley from the Ludlow quadrangle on the east to the Mt. Tom quadrangle on the west (Fig. 2). Two readvance localities west of the basalt ridge are correlated with those east of the ridge.

I first discovered evidence for the Chicopee readvance in November, 1968, just north of the border between the Mt. Tom and Easthampton quadrangles. During 1969, other readvance localities were identified in the southeast portion of the Mt. Tom quadrangle. No formal name for the readvance was suggested or used at that time (Larsen, 1972). The readvance locality in the southwest part of the Easthampton quadrangle (Stop 1) was discovered in 1974. Readvance localities in the Springfield North quadrangle (Stops 4,5,6) were mapped in 1977 and one was located in the Ludlow quadrangle in 1978.

J. P. Schafer used the term "Mt. Tom readvance" on drawings used for a paper presented in 1979 at the Northeast Section of the Geological Society of America. That designation by Schafer was for the readvance in the Mt. Tom quadrangle and has nothing to do with Mt. Tom, elevation 1,205 ft. highest peak on the Holyoke Basalt ridge. The term "Mt. Tom readvance" was used by Koteff and Pessl (1981) and it also appeared in an end paper in the symposium volume (Larson and Stone, 1982) in which Larsen and Hartshorn (1982) first used the term "Chicopee readvance". I urge use of the term "Chicopee readvance" as defined in this paper in place of "Mt. Tom readvance".

Further, I recommend use of the term "Camp Meeting readvance" for the readvance of the Connecticut Valley lobe in the north half of the Mt. Holyoke quadrangle, northwest corner of the Belchertown quadrangle, and northeast corner of the Easthampton quadrangle as shown in Figure 2. The latter site is the location of the Camp Meeting cutting (railroad cut) where B. K. Emerson (1898) described three readvances of glacial ice.

Because exposures of surficial deposits are so ephemeral it is probably useless to designate a type locality for the Chicopee readvance. However, if a type locality were to be designated it should be the Chicopee River section (Stop 4). Many readvance localities are in active pits that change from month to month and several of the best readvance localities have already been destroyed. The Chicopee River section is located at the base of a steep bank adjacent to the Chicopee River. Although badly overgrown by vegetation and suffering from mass movements, the site is off the beaten path but is accessible. Chances are good that readvance tills and overlying varved sediments can be excavated at this site for the next decade or two.

The main purpose of this field trip is to observe the various types of evidence for the Chicopee readvance. Those readvance localities that will not be visited or have already been destroyed will be

briefly described here so the reader will have a broader understanding of the nature of the evidence. Figure 5 is the southeast corner of the Mt. Tom quadrangle showing readvance localities as dark symbols. Cross-cutting striations in the southwest corner of Figure 5 are located at the tip of the S 70°W arrow. Here, striations of the main ice advance trend S 10°W parallel to streamlined topography and whalebacks cut in fault blocks of Holyoke Basalt. Striations trending S 70°W are found only on the crests of whalebacks and must represent lobate spreading of the eastern sublobe or possible readvance as the last glacial event at this site.

Striations trending due west were found in the northeast corner of Figure 5. They are at right angles to the due-south trend of drumlins east of the Holyoke Basalt ridge and represent, again, active spreading of the eastern sublobe. Lodgement till over gravel was found at two localities southwest of Ingleside. The more northerly site was a small exposure in a pit just north of the present Holiday Inn and was not studied in detail although similar small exposures occurred just to the northwest. The more southerly symbol represents a compact brown till, 1.2 to 1.8m thick, exposed in a 50-m trench along Westfield Road. In the middle 15m of the trench the till was observed to rest on clean hard-packed gravel of probable outwash origin.

Three meters of lodgement till overlying 3.3 m. of thrust-faulted sand were observed in a temporary borrow pit 0.3 of a mile west of Mont Marie (Figs. 5 and 6). The thrust-faulted sand was overlain by a zone 0.15 to 0.9m thick of slices and lenses of material intermediate in composition between the underlying sand and the reddish-brown till above. This zone is interpreted to be a shear zone produced by glacial ice overriding fluvial sand. Mapping to the southeast indicated that the fluvial sand rested on lacustrine deposits that in turn overlie reddish-brown till in Tannery Brook (Fig. 6). The till in Tannery Brook is believed to be the result of the main ice advance (Late Wisconsinan) and the upper till the result of the Chicopee readvance. The upper portion of section X-Y (Fig. 6) now lies under the parking lot of the Ingleside shopping center.

The southwest-trending arrow on the flank of Bradley Mountain (Fig. 5) represents a till fabric measured about 1.5m below the ground surface. Measurement was difficult and time consuming because of lack of elongated clasts. The predominant lithology was arkosic siltstone and shale, the pebbles of which were usually platy or blocky in shape. The modal direction of the fabric is S 38°W. The possibility of southwest movement of late-glacial ice is reinforced by the obvious east-west asymmetry of Bradley Mountain, Prospect Hill, and several drumlins north of Ingleside.

The boring record for the site 0.4 of a mile east of Bradley Mountain, as based on the number of blows to advance a split spoon a given distance, has at the surface 2.4m of sand (21 and 39 blows), followed by 3.0m of till (89 and 123 blows), 2.4m of sand (39 and

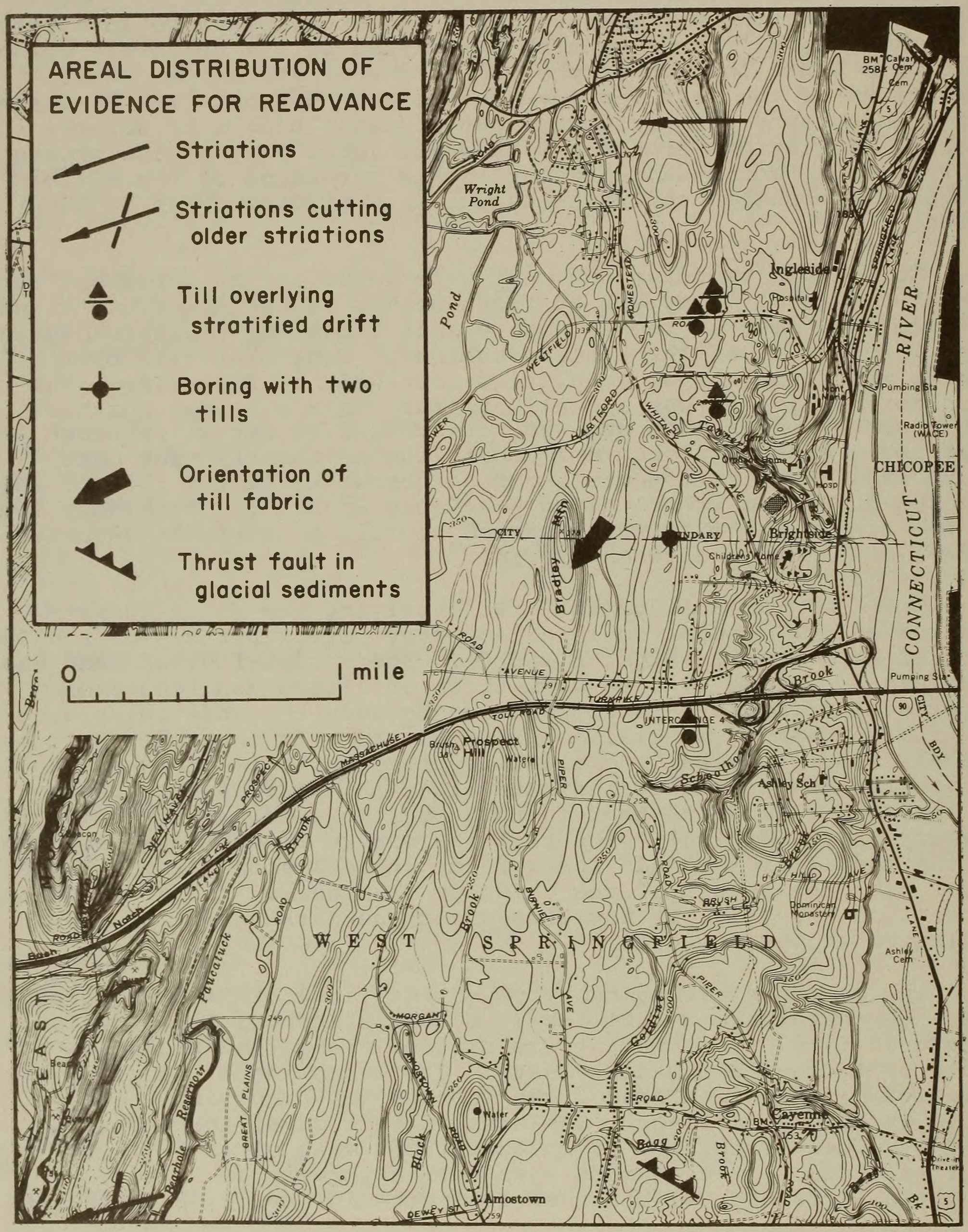

Figure 5. Southeast portion of Mt. Tom 7.5-minute quadrangle showing the areal distribution of evidence for readvance.

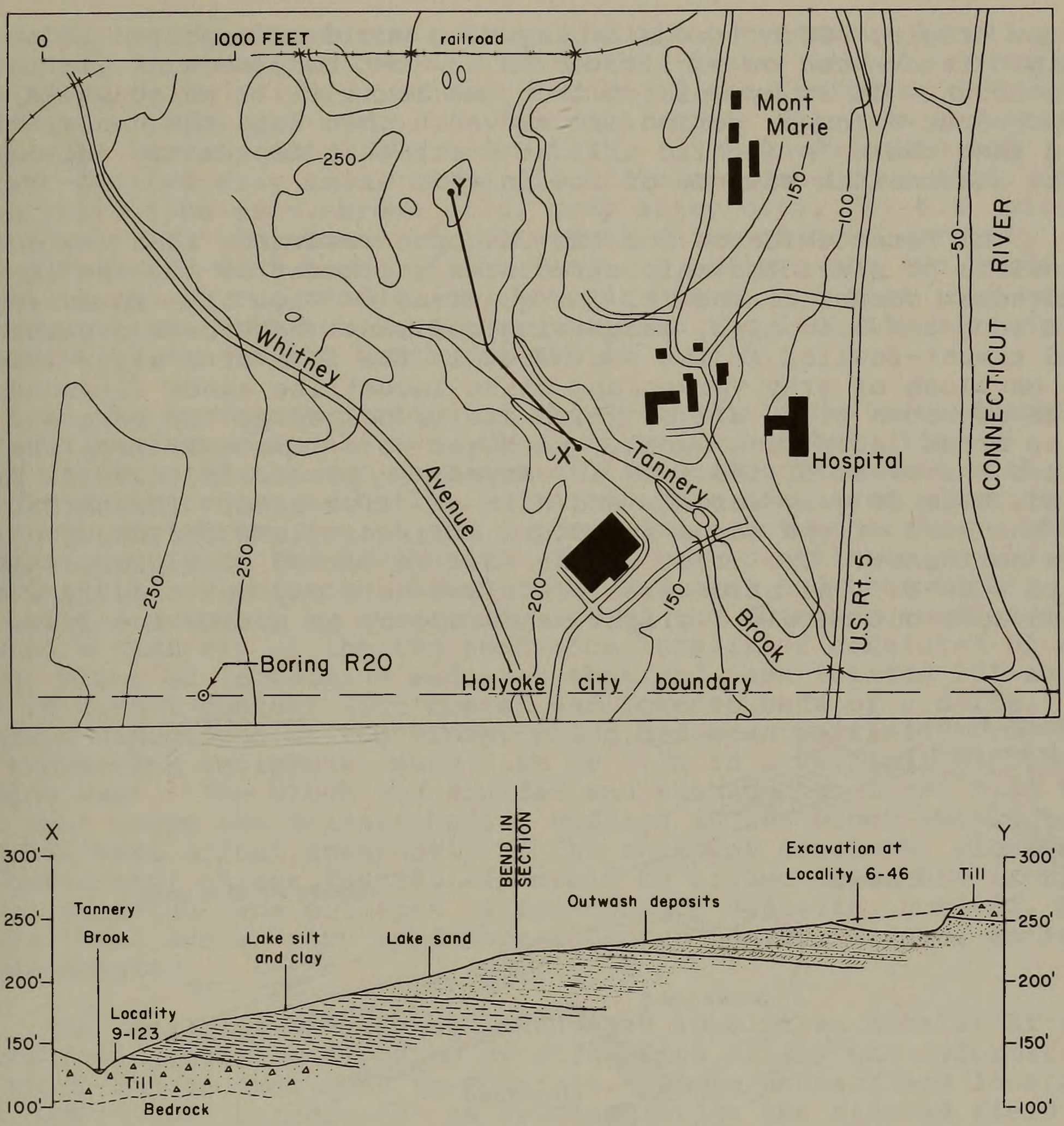

Figure 6. Map and cross section of readvance locality west of Mont Marie.

blows), and at the bottom 2.7m of till (139 and 174 blows). The upper till is believed to be the readvance till of the site west of Mont Marie.

In 1969, two readvance tills were exposed on the west side of a pit just south of the Massachusetts Turnpike at Interchange 4 (Fig. 5). The sequence sand-till-sand-till-sand occurred in a curving exposure 105m long and 2.4 to 3.6m high. Both tills displayed irregular layers of varying composition, which formed by mixing two end members. One end member consists of a brown till, the other of olive-gray clay and dark brownish-red silt of lacus-

trine origin. Such irregular layering would be expected if an ice margin readvanced or oscillated in a water body such as glacial Lake Hitchcock. It is my opinion that the lower till, which is 3m thick, represents a longer period of readvance than does the upper till, and that there is a third till at depth that represents the main, Late Wisconsinan advance of ice in this area.

The first evidence for the Chicopee readvance that was found consists of glaciotectonic structures southwest of Cayenne in the southeast corner of the Mt. Tom quadrangle (Fig. 5). In an exposure 12m long and 3.6m high, lacustrine sediments have been overturned and thrust-faulted to the southwest in the form of a nappe (Fig. 7). An envelope of gray varves and olive lacustrine sands surrounds a core of brown till, all of which are truncated at the base and thrust over brown lacustrine sands. An auger hole 1.5m away from the face under the crest of the fold in varved clay penetrated 0.9m of brown sand, 0.3m of gray varves, and 0.1m of olive sand. The thrust fault at the base of the nappe structure strikes N 70°W and dips 50° to the northeast. The crest of the fold in varved clay plunges 15° toward S 60°E. The structures described here may not signify a major readvance but merely a slight readvance by an active ice lobe.

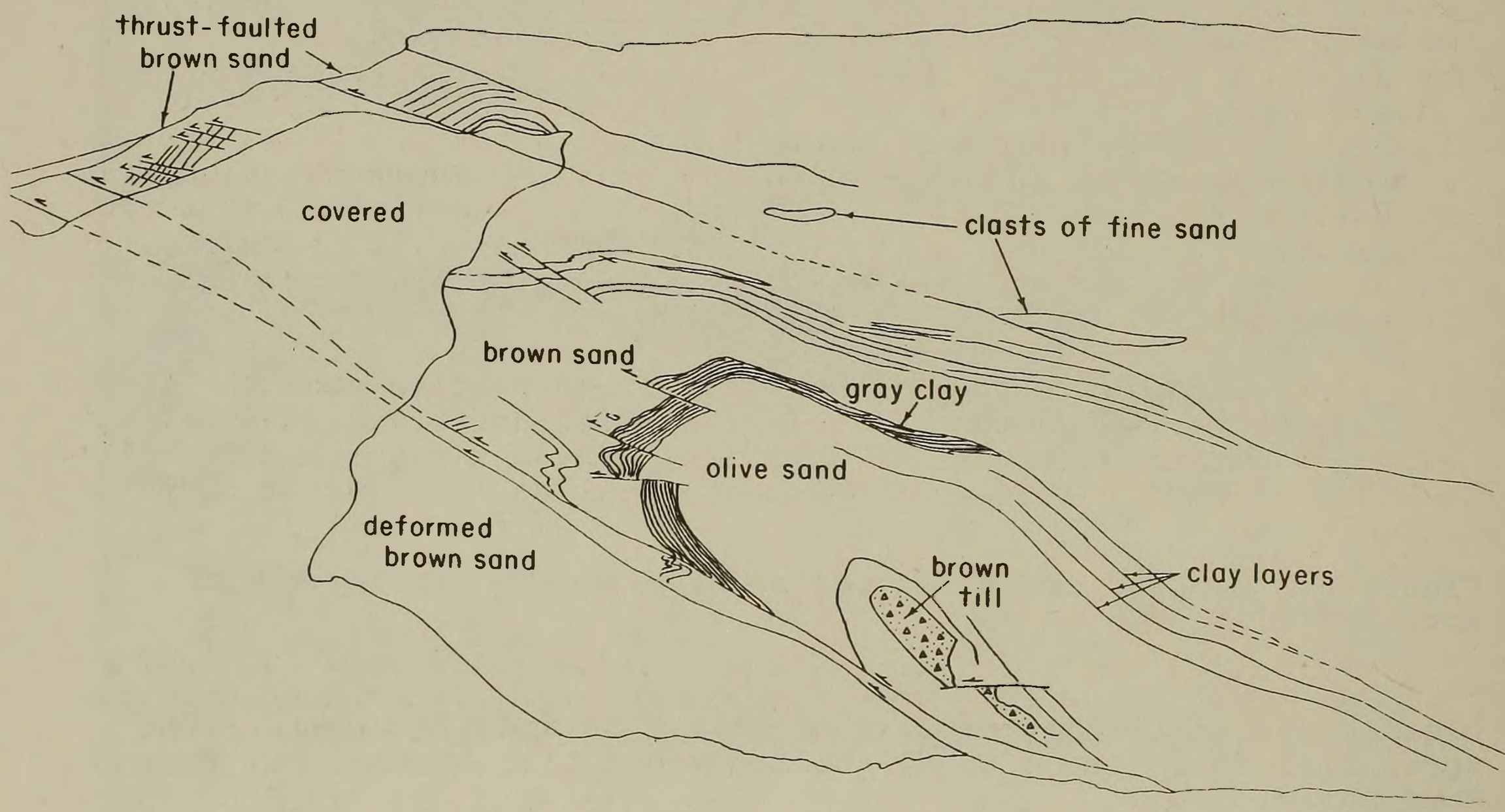

Figure 7. View west-northwest of nappe and associated thrust faults. Exposure slopes toward observer and is 3.6m high at brown till. Traced from a photograph.

East of the Connecticut River the first readvance locality encountered is that at Center Auto Parts, Center Street, Chicopee. The locality is in the southwest corner of the Springfield North quadrangle (Fig. 2). From the top down were: (1) 1.8m undisturbed clay-silt varves, (2) 0.06m brown till, (3) 1.0m deformed and thrust-faulted clay silt varves, (4) 1.5m grayish-brown till, (5) 0.4m brown fine sand, brown silt, gray silty clay, (6) 0.2 (plus) m brown till. Thickness of individual units changed abruptly along the east-west trend of the face. I believe the two upper tills represent two readvances, however minor, and that they may be correlative with two readvance tills at the locality already described 3.4km to the northwest and at Stop 6.

In the southeast portion of the Springfield North quadrangle are two readvance localities adjacent to each other (Fig. 2). The more westerly of the two consists of lacustrine fine sand with ripple-drift cross-lamination. The exposure displayed numerous anastamosing thrust faults and a pervasive fracture cleavage that dipped steeply to the southeast. There was no evidence on the surface of till or erratics, however the sediment had been highly tectonized probably by overriding ice of the Chicopee readvance. The more easterly of the two readvance localities consisted of a large block of lacustrine sediment that had been rotated 90° and was in direct contact with topset and foreset beds of a delta. The minimum dimensions of the block, which had been partially removed by excavating equipment, were 3.6m by 7.2m in a vertical exposure facing west. The block was rounded and extended at least 2.4m to the east under the deltaic beds. Bedding in the block was vertical and had been offset apparently to the south or southeast along two subhorizontal thrust faults. It could be argued that this exotic block resulted from collapse of ice-contact deposits, however, because there are so many readvance features nearby, I favor an ice-shove origin.

The remaining undescribed readvance localities consist of readvance till overlying deposits of stratified drift, the deformation of which ranges from none to moderate. These undescribed localities are significant but are not as spectacular as the planned field trip stops.

ACKNOWLEDGEMENTS

The opportunity to study the surficial geology in the four quadrangles in which evidence for the Chicopee readvance could be found was presented by the U.S. Geological Survey. Much of the above text was taken from Larsen (1972) and Larsen and Hartshorn (1982). Joseph H. Hartshorn suggested the original study on the Mt. Tom quadrangle and many of his ideas are incorporated in this paper. (Figures 1-4 from Larsen and Hartshorn, 1982; figures 5-7 from Larsen, 1972).

Q2-12

Starting point for field trip Q5 is on Conz St. in Northampton, Mass., 0.25 mi. north of Exit 18, Interstate I-91. From Storrs, Route 32 north, 29 mi. to Palmer, Mass., Interchange 8 on Massachusetts Turnpike; west via Mass Pike, 17 mi. to West Springfield, Interchange 4; north via Interstate I-91, 13 mi. to Exit 18, Northampton.

Road Log

Mileage

START: EASTHAMPTON QUADRANGE

0.0 Begin mileage count on Conz St. in front of Towne House Motor Lodge. Proceed NW on Conz St. on former flood plain of Mill River.

0.4 Turn left (SW) at sign with arrow to routes 9 and 10.

0.5 Stop sign, turn left (S) on Route 10, flat for next 0.9 of a mile is underlain by bottom sediments of glacial Lake Hitchcock

1.4 Cross Mill River Diversion

2.3 Hill to right is a drumlin, route follows contact between till (R) and lake-bottom sediments (L)

2.9 Route rises up on till ridge, note boulders.

3.4 Back on lake-bottom sediments

4.1 Turn right (SW) on West St.

4.2 Caution, sharp turn in road, climb back up to lake-bottom sediments

5.2 View left to Mt. Tom Range underlain by Holyoke Basalt

5.3 Stop sign. Turn right (NW) on Loudville Road

6.7 Cross Torrey St. at Lake Hitchcock shoreline. Gravel flat just to W is interpreted to be the top of a small delta built into Lake Hitchcock.

6.9 Top of ice-contact delta built into Lake Manhan.

7.3 Park in field on left side of road. Walk S on W side of field. Turn E at corner, proceed about 50m, follow red-flagged trail southward

<u>STOP 1.</u> North Branch of the Manhan River Section (Fig. 2 and Fig. 8). From the base up, the section consists of: (1) gray till, (2) deformed gray lacustrine sediment and "till equivalent", 2m, (3) reddish-brown compact till, 1.3m, (4) angular clasts blanketed by lake-bottom sands, 0.5m, (5) fine to medium sand with ripple-drift cross-lamination, indicating transport direction to the east, 3m, (6) pebbly coarse sand in delta forests, 2-3m, (7) pebble gravel and coarse sand in delta topsets with some dune bedding, 2-2.5m, (8) eolian fine sand with pebbles. The older gray till was formed by ice moving south-southeast off the crystalline upland just 0.7km northwest of Stop 1. The reddish-brown till and "till equivalent" were formed when the margin of the western sublobe readvanced southwest across lacustrine sediments.

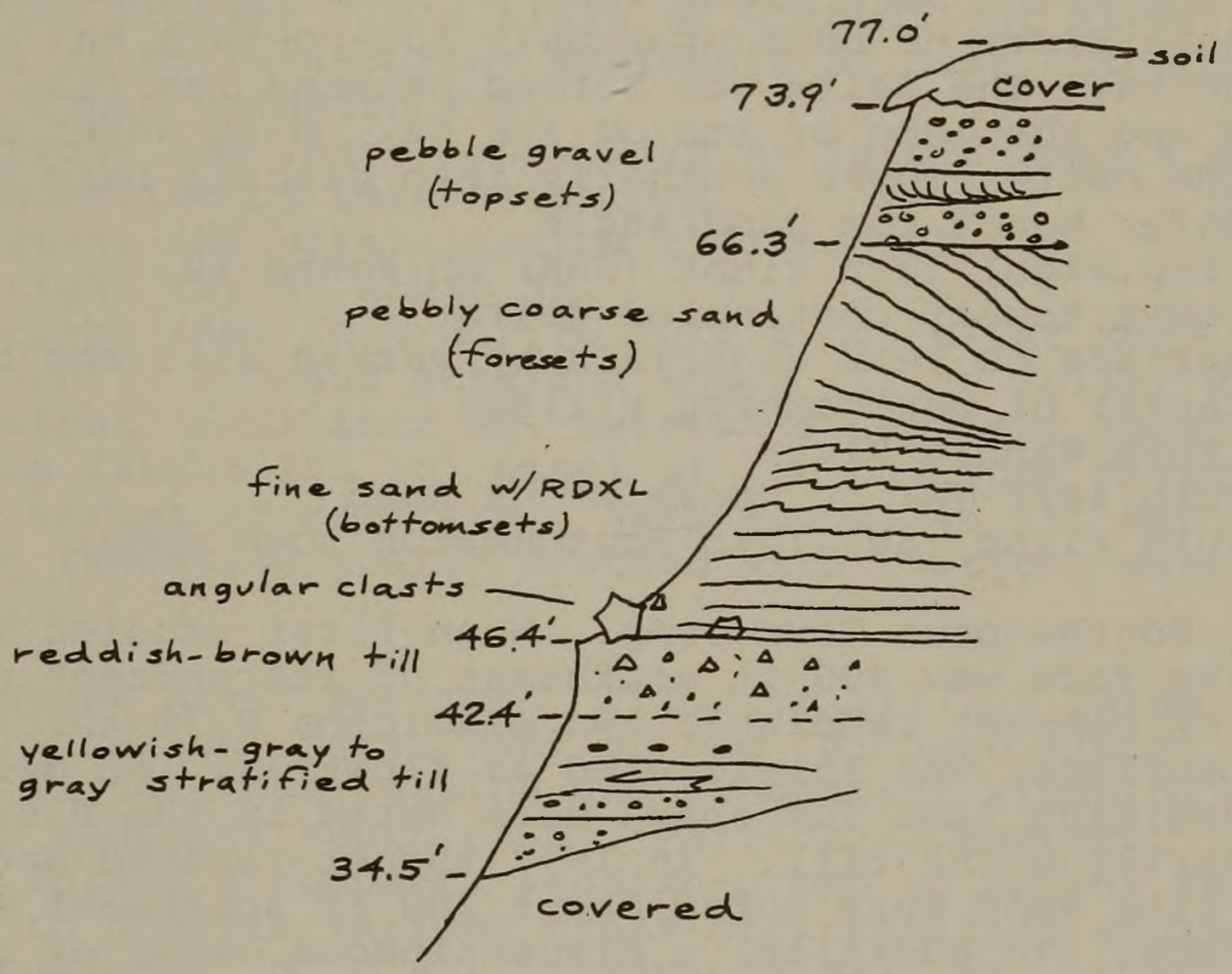

Figure 8. Stratigraphic section of North Branch of the Manhan River measured by hand-leveling, Oct. 28, 1977.

Proceed W on Loudville Road

7.7 Gray gneisses and schists of Paleozoic age exposed on right.

7.9 Turn sharp left (S) on Mineral St just beyond bridge over North Branch

8.4 Mine Road enters from right at town line

8.5 Lead Mine Lodge on left is located 100m north of old south shaft of Loudville lead mine. Lead deposits are believed to be associated with Jura-Triassic mineralization. Most of the lead was mined during the Civil War for Union troops. Route traveled is underlain by till.

9.3 Cross brook, road rises onto gravel flat

9.5 Cold Spring Road enters from right

10.2 Park on right, walk SE on road to pit entrance on L

STOP 2. Striations cut in Triassic arkosic pebbly sandstone. An obscure early set of striations trends S 32°W and is cut by a younger set trending S 52°W. Even if the observer is unwilling to accept the S 32°W - set there is no doubt that the S 52°W - set, taken with other nearby striations, represents active lobation in late-glacial time. The gravel at this site is on a fluvial grade that is slightly lower than that of the Southampton delta, 1.2 mi to the south. This indicates that the gravels at Stop 2 formed slightly after the ice margin melted back from its position on the north side of the Southampton delta.

Proceed SE on Cold Spring Road.

10.4 Turn right (SSW) on Glendale Road.
10.5 Stop sign, turn right (SW) on Pomeroy Meadow Road.
10.7 Road rises up onto proximal, ice-contact end of Southampton delta. The delta was formed between the till ridge on the W and the lobe of ice on the NE. Melt-water streams building the delta flowed southerly into glacial Lake Manhan.
10.0 Enter Mount Tom Quadrangle
12.0 Stop sign, turn right (SSW) on Route 10.
12.2 Leave topset portion of delta
12.4 Terrace on left underlain by varved silt and clay
12.6 Center of Southampton village
13.4 Cross Manhan River
13.5 Turn left (W) on Moose Brook Road
14.2 Turn right (SW) into Southampton town dump.

STOP 3. Southampton Town Dump. When first studied in September, 1968, the active face was 400 ft southeast of its present position. In 1968, a layer of compact reddish-brown diamicton 0.3m thick and 3.3m below the surface, was interpreted as flowtill. No deformational structures resulting from ice shove were noted in the 0.6 to 0.9m of fine sand underlying the till. In 1977 thrust-faulted and overturned beds of fine sand were noted about 200 ft southeast of the present active face. In addition, a discontinuous layer of compact lodgement till was observed near the top of the section. The base of the till truncated beds of light brown medium to coarse sand and dark brown very fine sand that had been sheared and overturned. In July, 1982, the section on the southwest face consisted from the base up of: (1) a covered section, 6.6m, (2) fine to very fine sand, silt and clay in proximal varves, 3.3m, (3) pebbly coarse sand, 0.7m, (4) fine sand with ripples, 0.3m, (5) reddish-brown, hard, compact till with pebbles, 1.3m, (6) pebbly coarse sand, 1m, (7) eolian fine sand with pebbles, 0.6m. The till is believed to represent a minor readvance.

Proceed NW on Moose Brook Rd.
15.0 Turn left (SSE) on Route 10. Route is on till-covered Triassic bedrock for 2.5 mi with views to the E of the Holyoke Basalt ridge.
18.0 Red light, continue due S on Routes 10 and 202.
18.3 Route drops from bedrock ridge onto surface of Barnes outwash delta, a feature formed in time-transgressive glacial Lake Westfield with outlet at Harts Pond gap. (Fig. 1).
20.4 Roaddrops from surface of Barnes outwash delta to surface of terrace cut by the outlet stream from glacial Lake Manhan which drained through Westfield gap.
20.9 Turn right (W) at entrance to Mass Pike, Interchange 3. Proceed E on Mass Pike through sections cut in Barnes delta and onto till-covered bedrock.
24.0 Turnpike passes through Bush Notchformed where faults offset the Holyoke Basalt ridge. Holyoke Basalt outcrops on both sides of Turnpike. (Fig. 5).
25.0 Outcrops of Hampden Basalt.
25.2 Cut in drumlin
25.8 Outcrop of Portland Arkose under I-91 bridge.
26.8 Cross the Connecticut River

27.0 ENTER SPRINGFIELD NORTH QUADRANGLE
Turnpike crosses flood plain of Connecticut River and then climbs up on lake-bottom sediments of Lake Hitchcock with small dunes oriented WNW.

29.4 Turn right and leave Mass. Pike at Interchange 5 which is on the shoreline of Lake Hitchcock.

29.9 Turn right (E) after leaving toll booth.

30.1 Turn right (S) on Route 33.

30.4 Turn right (SW) in order to turn E on Fuller Road

30.7 Red light. Proceed straight ahead (E) on Fuller Road

30.9 Turn right (SSW) into St. Patrick's Cemetery located on a high terrace (about 185 ft. elev) of the Chicopee River. Proceed to SE corner of cemetery. Walk about 345 ft. WSW to top of recent landslide scar. Descend with caution, watch for broken glass.

STOP 4. Chicopee River Section. Prior to 1977, a large sewer line was emplaced along the north bank of the Chicopee River. This activity resulted in the undercutting and subsequent slumping of steep banks of lacustrine sediment south of St. Patrick's Cemetery. In the exposures thus formed a compact, reddish-brown to brown, readvance till was observed to overlie various types of stratified sediment (Fig. 9). As already mentioned (p. Q5-6), readvance till may be available for study at this site for some time in the future.

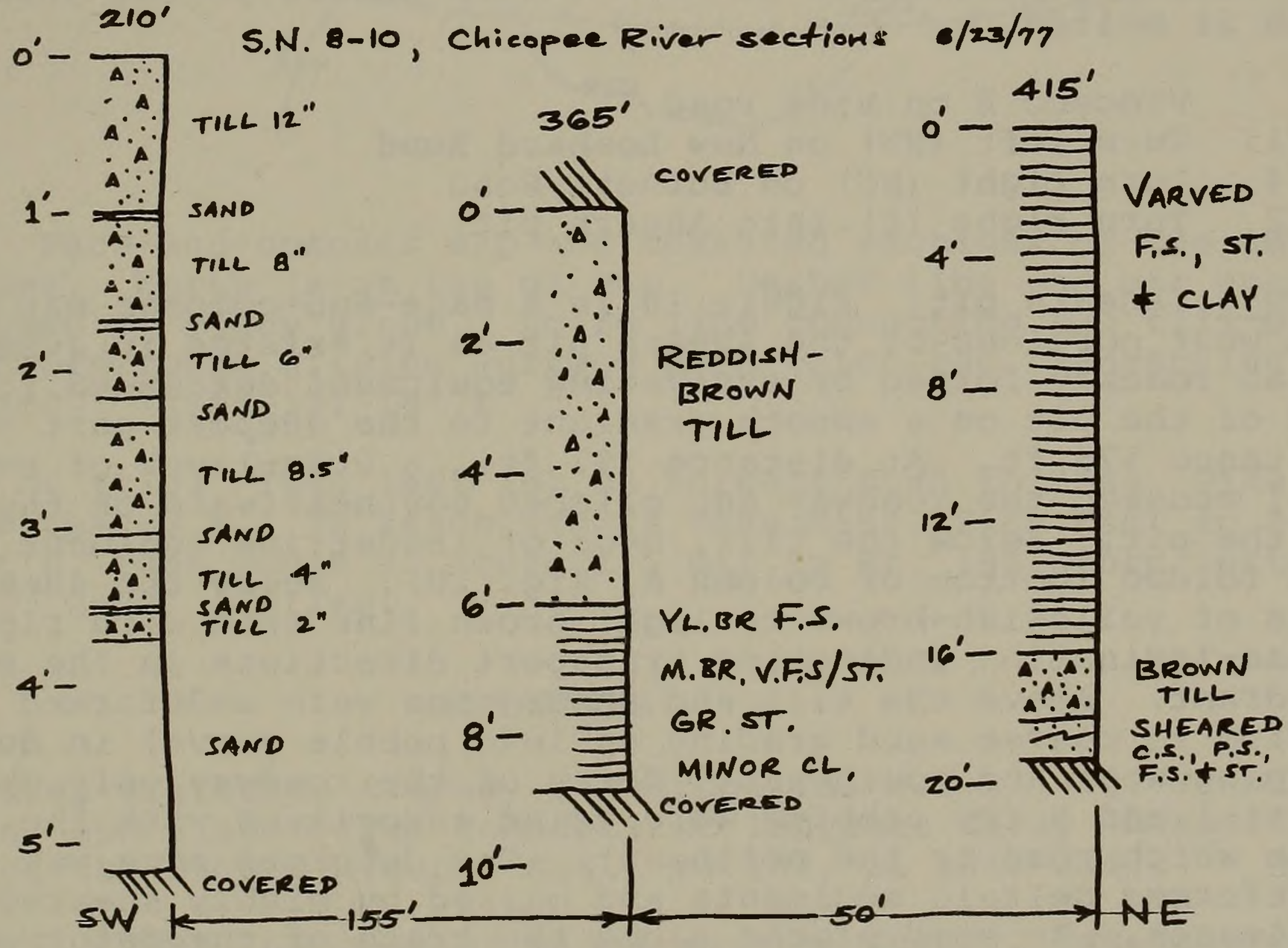

Figure 9. Field sketches of stratigraphic sections south of St. Patricks Cemetery, Fuller Road, Chicopee. Numbers at top of columns are distances northeast of small brook where it enters Chicopee River south of cemetery.

31.3 Proceed E on Fuller Road. Road descends to lower terrace (elev. 175 ft) on right and eventually to the flood plain of the Chicopee River.
32.7 Turn left (N) on access to I-291 northbound
33.0 Red light. Proceed straight ahead (N), I-291 becomes Burnett Road.
33.3 Turn right (E) on New Lombard Road
33.7 Turn sharp right (WSW) on side road adjacent to pit, make U-turn and park

STOP 5 Baskin sand pit. When first observed in 1977 this pit was less than one-half the size of the present pit. Reddish-brown lodgement till was exposed on the southeast side of the pit. A curved exposure with deltaic beds 9m high extended southwest, west, and then northwest from the till. Dune bedding in deltaic topsets indicated transport directions between due west and southwest. No evidence of readvance was noted at that time. By July, 1982, the pit had been expanded nearly to its present size, its growth being limited by powerlines. At the western end of the pit were exposed a series of imbricate thrust faults striking N 70°E and dipping 38°NW. Within the sediments above the thrust faults was a sloping surface marked by pebbles and small lenses of reddish-brown till. I interpret the sloping surface as a gliding plane upon which the margin of the eastern sublobe readvanced a short distance. The readvancing ice was relatively clean as it left little debris on the gliding plane when it melted.

Proceed E on side road.
34.1 Turn left (NW) on New Lombard Road
34.4 Turn right (NE) on Burnett Road
35.2 Turn right (S) into Ahearn pit

STOP 6. Ahearn pit. Figure 10 is a pace-and-compass map of the south and west portions of the Ahearn pit as it existed in June, 1977. A broad roadway formed by excavating equipment descended from the west end of the pit on a smooth gradient to the deepest part of the pit at distance 575 ft. At distance 197 ft., a 0.3m-layer of reddish-brown till crossed the roadway and climbed southeastward on the south face of the pit. Below the till, beds of lacustrine sediment were sheared and folded (bottom of column A, Fig. 10). Below the shear zone were beds of yellowish-brown to light brown fine sand with ripple-drift cross-lamination indicating transport directions in the southwest quadrant. Above the till and shear zone were undeformed beds of medium to coarse sand grading up into pebble gravel in dune crossbeds dipping west and southwest. North of the roadway only small clasts of till and a few pebbles were found associated with the deformed zone which rose to the northeast. The deformed zone was overlain by undeformed deltaic sediments and marked by highly sheared lacustrine sediments. In some places along the trace of the deformed zone, no deformational structures were observed. The zone, a glaciotectonic gliding plane at the base of the ice, was traced around a spur ridge to a small pit at B (Fig. 10). Here, lenses of till and small pebbles separate 2.2m of fine-grained lacustrine from 3.3 of coarser-grained lacustrine from 3.3 of coarser-grained fluvial beds. The

whole aspect is one of a readvance of glacial ice over the front of a delta that is building westward into Lake Hitchcock. By July, 1982, the pit has been extended to the west revealing a second readvance till. The south face has been altered but the first readvance till can be observed to climb over deltaic beds.

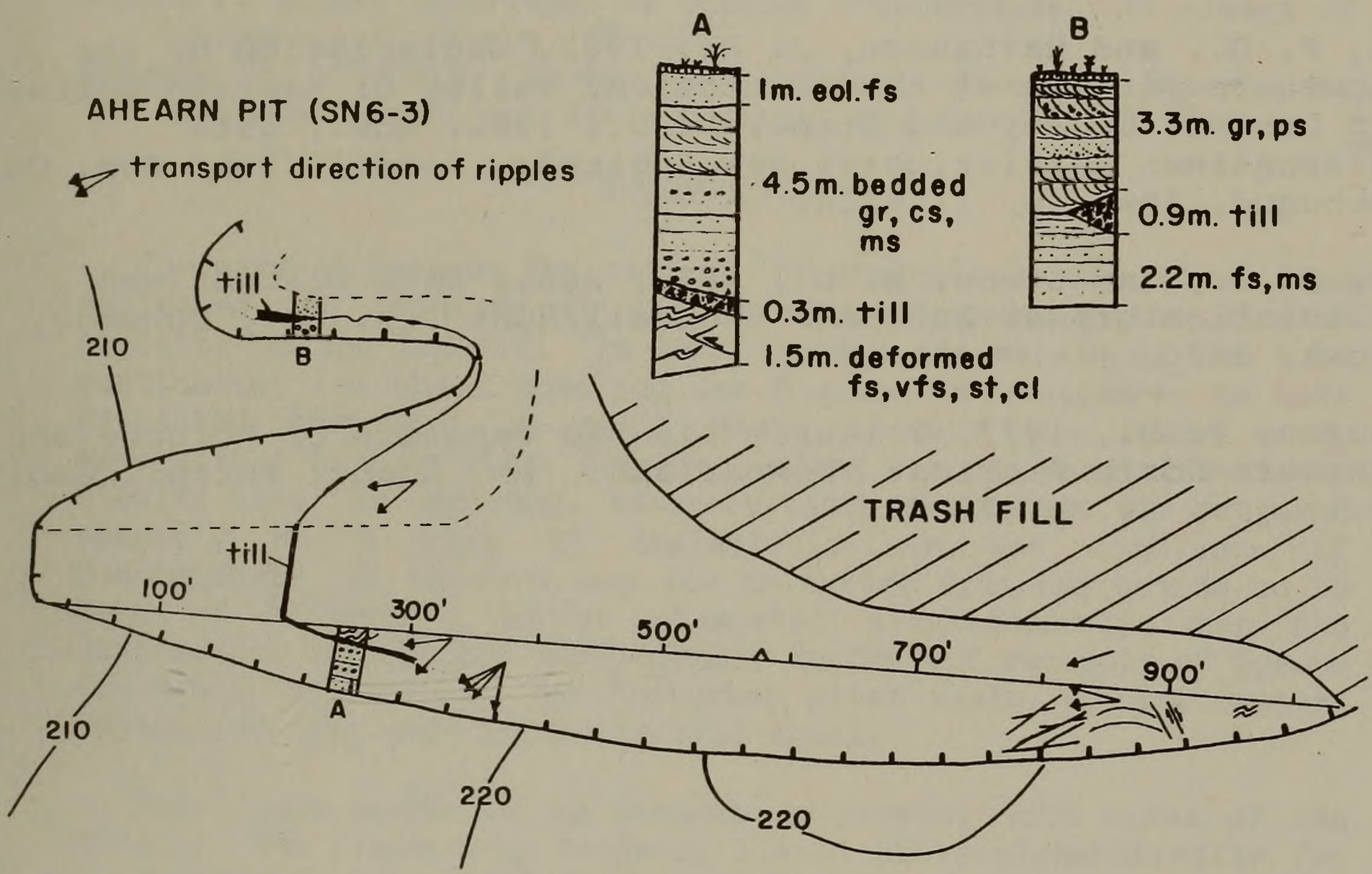

Figure 10. Pace-and-compass map and measured sections of the Ahearn pit, Chicopee. North is at top of map. Dashed line and bar scale represent base of steep slope. Solid line connecting two till bodies is the glaciotectonic gliding surface upon which the readvancing glacier moved. (June 15, 1977)

End of trip. Turn left (W) on Burnett Road to Mass. Pike Interchange 6. To reach Storrs take Mass. Pike east to Palmer, Exit 8, then Route 32 south 2.5 mi. to Rt. 195, turn left (E) to U. Conn. 4 miles.

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