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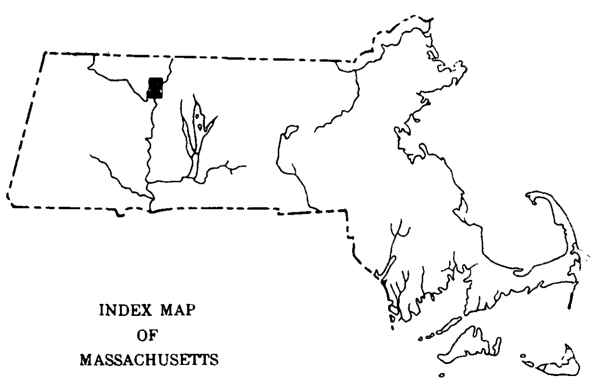
GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

SURFICIAL GEOLOGIC MAP OF THE GREENFIELD QUADRANGLE FRANKLIN COUNTY, MASSACHUSETTS

By
Richard H. Jahns



INDEX MAP
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By Richard H. Jahns

The Greenfield quadrangle, lies mainly within the Connecticut Valley province of western Massachusetts. It is drained by the Connecticut River and by the lower courses of five major tributary rivers. The valley floor, is interrupted by a long bedrock ridge on the west side of the Connecticut River and by several isolated bedrock hills on the east side. Prominent ridges and hills in the southeastern part of the quadrangle represent the western edge of the Worcester County plateau or central uplands province.

Schist and gneiss of Paleozoic age form the highlands in the southeastern part of the quadrangle; the remainder of the area is underlain by medium- to coarse-grained sedimentary rocks and by diabase, all of Triassic age. These two contrasting terranes and their complex relationships in the Greenfield quadrangle have been described elsewhere (notably, Emerson, 1898, 1917; and Willard, 1952).

Overlying much of the bedrock are unconsolidated sediments of Quaternary age that include ice-laid, glaciofluvial, and glaciolacustrine deposits, along with younger stream, pond, swamp, and eolian deposits. The nature and distribution of these materials were determined from numerous exposures, from hundreds of hand-dug test holes, and in part from morphology and interpretations of origin. Closely related assemblages of surficial deposits have been described from adjacent areas (Emerson, 1898; Jahns and Willard, 1942; Jahns, 1947, 1951; Segerstrom, 1955a, 1955b, 1959), and reference should be made to these earlier publications for more detailed discussions of glacial and postglacial history of this part of the Connecticut Valley.

Bedrock exposures

The distribution of bedrock exposures is closely controlled by glacial erosion and deposition that ceased only about 10,000 years ago. The directions of glacial grooves and striae on numerous ledges indicate a general southerly to south-southwesterly advance of the last ice sheet over the quadrangle area; the many local variations are due in part to the influence of gross irregularities of the pre-existing bedrock surface. Glacial erosion evidently was most vigorous where this surface was roughest and was especially effective on south-facing slopes, where large blocks of solid rock were removed by plucking. Deposition from the ice was greatest on the lower parts of major slopes, so that the largest and most abundant bedrock exposures appear on the tops and high on the flanks and northerly slopes of hills and ridges.

Unconsolidated glacial and postglacial deposits mask most of the bedrock in the valley areas, especially below the 350-foot contour.

Surficial deposits

Glacial ice deposits

Drumlins, none of which is known to enclose a sizeable bedrock core, constitute the thickest deposits of till in the quadrangle. The largest group of drumlins lies in the northern part of the Pocumtuck Range.

A discontinuous but widespread blanket of ground moraine overlies the bedrock and in turn is covered by younger surficial deposits in most of the valleys. This ground moraine (Qgm) is not more than 10 feet in average thickness, though much thicker accumulations, shown separately on the map (Qgt), are present on the lower slopes of several hills. No end moraines have been identified in the quadrangle or adjacent areas, and their absence is compatible with outwash features indicating that recession of the last ice sheet was characterized by a marginal zone comprising many individual, essentially stagnant masses of ice.

Three lithologically contrasting types of till are distributed throughout the quadrangle. Both lateral and vertical changes are common. In most places these tills have been intimately mixed to yield various compositional hybrids. In some places only one of these tills is present; in others two or all three of them occur as irregular layers, lenses, and pods to form grossly heterogenous sections.

Grayish-orange to reddish-brown till, derived mainly from the Triassic rocks, is most common in the Connecticut Valley area and on hills and ridges that rise within this area. A much finer grained, medium- to dark-gray and olive-gray till also occurs here but increases in abundance toward source areas of dark-colored slate and schist farther west and north. Much of the finer grained till along the western edge of the quadrangle is markedly calcareous. Coarser grained, gray, olive-gray, grayish-yellow, and light-brownish till, evidently derived from lighter colored crystalline rocks, is dominant in the southeastern part of the quadrangle and is locally abundant in the western and northern parts.

Two groups of tills are distinguishable in a stratigraphic sense; each includes all three compositional types noted above. The lower group comprises tills that contain relatively high percentages of silt- and clay-size particles, are compact and well indurated, and are characterized by a closely spaced parting roughly parallel with the ground surface. They constitute the major part of all drumlins and thick sections of ground moraine. The upper group, in contrast, is nowhere more than 15 feet thick and in most places is less than 8 feet thick. Its tills are relatively loose and uncompacted, and are better sorted and contain less fine-grained material than is found in those of the lower group. Parting is poorly developed or absent altogether in till of the upper group, but irregular layers and lenses of sandy to gravelly debris, evidently formed through reworking by melt waters, are locally abundant.

The upper and lower tills may have been formed by ice sheets of different glaciations, but no exposures of undoubted interglacial deposits between them have yet been found. Alternatively, they might record the complex history of a single glaciation; for example, the lower tills could have been laid down beneath the latest ice sheet, and the upper tills subsequently deposited over them during wastage of the ice. The general question of stadial assignment, which has been raised for similar two-fold sequences of tills in many other parts of New England, is yet to be resolved.

Glacial stream and pond deposits

As the last ice sheet melted and receded northward during deglaciation of the Greenfield quadrangle, its irregular margin evidently was characterized by a zone of pitted and broken blocks that had become stagnant.

At first, the melt-water paths must have been complex, as they wound their way around the broken blocks and through the many interconnected openings in the wasting ice. As these blocks became smaller and further separated during deglaciation, their influence on drainage diminished and the melt waters became controlled by irregularities of the land surface. In general, this marginal zone extended farther southward in valley areas than on adjacent higher ground, but some masses of ice also must have lingered in small, high-level basins. Relatively high-level deposits from melt waters are widespread, especially in the southeastern part of the quadrangle where their average thickness is on the order of 50 feet.

Ice-channel fillings (Qic), comprising eskers and crevasse fillings, appear both as isolated, narrow, steep-sided ridges and as groups of branching and merging ridges. Some were developed in tunnels in the wasting ice, others in various kinds of open channels. Most consist of coarse, poorly sorted, and crudely stratified gravel. Included boulders and blocks are common, and irregular masses of till are present locally.

Kame deposits (Qk), formed within and over groups of ice blocks, are abundant in several areas of typical knob-and-kettle topography. They also are dominantly coarse grained, but in general are somewhat better sorted and more regularly bedded than the ice-channel fillings.

Kame-terrace deposits (Qkt), laid down in relatively narrow openings between glacial ice on one side and a hillslope or valley wall on the other, consist mainly of coarse, well-bedded sand and gravel. The inner margins of these benchlike accumulations abut against bedrock, till, or older outwash deposits, and their outer, or valleyward, margins generally are ice-contact slopes.

Kame-plain deposits (Qkp) were formed in large openings between ice blocks, rather than between the ice and adjoining higher ground. Like the kame terraces, these accumulations are flat topped and consist chiefly of coarse sand and gravel. Some are bordered wholly by ice-contact slopes, against the lower parts of which younger outwash deposits commonly are banked. Others, such as the plain 1-1/4 miles south of Montague, represent incomplete filling of temporary ice-locked ponds; these accumulations are deltaic and generally contain high percentages of sand.

Many local thin deposits of outwash (Qsg) were laid down from wasting ice masses not directly associated with any extensive system of melt-water drainage. They are younger and topographically lower than adjacent outwash deposits, and occur typically on the bottoms of some kettles and most larger ice-block depressions, as well as beneath many of the post-glacial swamp and lake deposits in the quadrangle. They range from poorly sorted, irregularly bedded rubbly gravel to well-sorted and thinly bedded sand.

The various kinds of outwash deposits noted above are intimately associated with one another in most places, and they commonly form groups at two or more different levels in the same valley or basin. The glacial melt waters clearly were controlled by a succession of temporary spillways or outlets, some in bedrock, some in older glacial deposits, and others in the wasting ice itself. The levels of the outwash deposits, especially the kame terraces and kame plains, indicate that successively lower escape routes became available to the melt waters during deglaciation of a given valley or basin, and that occupation of each route marked abandonment of an immediately preceding higher route.

Outwash deposits at different levels are distinquished throughout the quadrangle, and individual outwash sequences are identified in its southeastern part. Features bearing the same subscript number on the map belong to the same sequence or melt-water profile. These sequences in the Greenfield quadrangle are correlated directly with those in the adjoining Mount Toby quadrangle (Jahns and Willard, 1942, p. 170-178; Jahns, 1951). The earlier sequences in this area represent melt-water paths extending southward between Mt. Toby and Stoddard Hill, the younger ones paths extending southwestward in the area north of Mt. Toby. The altitude and coarseness of deposits and the percentage of kame and esker materials within them decrease progressively toward the distal (southerly) end of each sequence.

Deposits of glacial Lake Hitchcock

The ultimate base level of melt-water drainage within the quadrangle was the water plane of Lake Hitchcock, a long-lived proglacial lake that occupied the main lowland area. This large body of water was dammed by glacial deposits at Rocky Hill, Conn., to the south, and its nearly constant level was controlled by a bedrock spillway near New Britain. Over a period of many centuries the lake gradually expanded northward as the ice melted from the Connecticut Valley area, until it reached well into New Hampshire (Loughlin, 1905, p. 24-25; Flint, 1933, p. 975-981; Lougee, 1939).

Melt-water deposits associated with Lake Hitchcock represent the youngest outwash sequence in the Greenfield quadrangle. Most prominent among them are deltaic accumulations of sand and gravel (Qhd) that can be traced sourceward into kettled outwash-plain deposits (also shown as Qhd) and kame deposits (Qhk) of the same sequences. Montague Plain and other plains to the north and northwest, all at present altitudes of 300 to 350 feet, represent a great composite delta that was nourished by melt waters entering the lake from the north and east (Emerson, 1898, p. 626-629; Jahns and Willard, 1942, p. 179-188). Several smaller deltas are present elsewhere. Wherever the moderately sloping delta fronts have been preserved, as in the areas immediately south of Turners Falls, north of Montague, and south of The Bars on the Deerfield River, they grade into the nearly flat lake-bottom plain.

The principal bottom sediments of Lake Hitchcock (Qhl) are varved clay, silt, and fine sand, at least 300 feet in maximum thickness, that are overlain by a continuous blanket of sand 2 to 25 feet thick. The varved deposits have yielded valuable data concerning the chronology of glacial retreat in the Connecticut Valley area (Antevs, 1928). Thinner and much coarser grained shoreward deposits (Qhs) are in part older and in part younger than the varved section. The older of these sands and gravels, which rest upon till or bedrock, were derived from valley-margin kames and other ice-contact deposits through reworking by waves and currents; the younger accumulations, which rest upon finer grained varved sediments, represent comparable reworking of adjacent deltas and other deposits that had been laid down along the lakeshore.

Numerous depressions on parts of the old lake-bottom plain mark the sites of sediment-buried ice blocks that were preserved for long periods of time, some of them outlasting the lake itself. The kettles commonly are associated with subdued scarps, some as much as 20 feet high, that reflect ice-contact slopes buried beneath younger parts of the lake-bottom section. Both kinds of surface irregularities are especially abundant near the southwestern corner of the quadrangle.

Sandy to gravelly beach and bar deposits of Lake Hitchcock (Qhb) appear as fringes, a few feet to 2,000 feet wide, along the outer parts of many deltas. They veneer the deltaic sediments and terminate shoreward against low wave-cut scarps. Wave-cut benches, with or without narrow beach deposits, are recognizable at altitudes of 300 to 330 feet on numerous other slopes that are underlain by till or by prelake outwash deposits. These shoreline features are especially well preserved along the sides of Taylor Hill and the Pocumtuck Range.

Younger surficial deposits

The level of Lake Hitchcock dropped suddenly when the barrier at Rocky Hill, Conn., was breached, but complete draining of the water body in the Greenfield quadrangle was not accomplished until the postlake Connecticut River worked its way headward through intervening glacial deposits that lay at relatively high levels. During this fairly short period of time the deltas in the quadrangle were trenched, and the removed materials were deposited on lower ground as smaller deltas and fans (Qhf). Where the flow of water was large, broad swales were cut into the older deltaic sediments; these now appear as erosional terraces thinly veneered with fluvial sand and gravel (Qhdx).

With progressive shrinking and separation of the lake into various shallow and short-lived water bodies, the Connecticut River and other streams began to form an integrated pattern of fluvial drainage. They first cut broadly into the higher parts of the old lake bottom, leaving only thin, discontinuous sheets of stream-laid sediment (Qhlx and Qhsx) upon the newly stripped surfaces of varved clays and other lake deposits. Most of the streams adopted courses little different from those held in preglacial times, but the Connecticut River was a notable exception. With its preglacial path blocked by the outwash deposits underlying Montague Plain (Emerson, 1898, p. 625-629; Jefferson, 1898, p. 463-467), the reestablished river now detoured westward past Turners Falls, thence in a broad swing southward through Greenfield, and finally eastward through the deep gap between Temple Woods Mountain and the Pocumtuck Range to rejoin its former course west of Taylor Hill. Later, it established its present route southwestward from Turners Falls along the east side of Temple Woods. An accompanying westward path through Greenfield, now expressed by Whiteash Swamp, Cherry Rum Brook, and the valley of Green River, ultimately was abandoned.

As the Connecticut River cut downward through glacial deposits in the Turners Falls area, it became superimposed across the Lily Pond barrier, a narrow ridge of Triassic sandstone and shale that now forms the southern wall of Barton Cove (Emerson, 1898, p. 724-725; Jefferson, 1898, p. 463-472; Jahns and Willard, 1942, p. 189-190). Here the river temporarily formed a large waterfall. Extending upstream from the lip of this waterfall is a series of cut terraces with veneers of fluvial silt and sand (Qlpu). A similar series of younger and lower terrace deposits (Qlpl) is graded to the lip of a second temporary waterfall in the same barrier. Both sets of Lily Pond terraces are at least in part time equivalents of glacial Lake Upham (Lougee, 1939, p. 139) in New Hampshire.

The Connecticut River and other major streams in the quadrangle continued to cut downward during latest glacial and postglacial times, forming terraces at successively lower levels. Sediments were deposited on these erosion surfaces in much greater quantities than on the earlier river benches formed during the draining of Lake Hitchcock. Flood-plain, bar, and bottom deposits (Qrt) of silt, sand, and gravel form terrace covers 5 to 35 feet thick, and the terrace surfaces typically are marked by numerous scarps, channels, and by subdued ridges in groups with scroll-like patterns (Jahns, 1947, p. 34-51). River erosion and deposition have continued to the present time, and no distinction has been made on the geologic map between the modern river deposits and their earlier homologues.

The courses of most smaller tributary streams also are marked by deposits of silt, sand, and gravel (Qst), some of which occur along narrow terraces above the present flood plains. In many places these materials grade laterally or upstream into aprons or cones of colluvium or alluvial-fan detritus (Qf).

Windblown silt and fine sand form a discontinuous but widespread blanket, about 5 feet in maximum thickness, over bedrock and glacial deposits. These deposits, not shown separately on the geologic map, contain abundant rock fragments derived from underlying glacial drift by frost heaving. Topographically more prominent are numerous irregular accumulations of dune sand (Qd) that are scattered over the valley floor and piled against many slopes; they are most abundant on the surfaces of the Lake Hitchcock deltas and the oldest of the Connecticut River terraces. Most of the eolian deposits in the quadrangle are due to extremely strong winds, chiefly from the west and southwest, that followed draining of the valley lake.

Small masses of landslide debris (Qls) are present along the high scarp cut into the old lake-bottom plain south of Turners Falls, where fine-grained varved sediments have slid into the headward parts of short, deep ravines. The slides appear to be currently active. Accumulations of talus (Qta) occur along the bases of numerous cliffs and other steep slopes and are especially abundant in the Pocumtuck Range and along the flanks of Temple Woods Mountain.

Swamp deposits (Qs), most of which occupy depressions of glacial origin, are present in nearly all parts of the quadrangle. They typically consist of a few feet of peat and dark-brown to gray muck that is rich in vegetable matter, and generally lie upon glacial till, outwash deposits, or fluvial sediments.

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