Report on Surficial Geologic Mapping in the Peacham Quadrangle and the Eastern Portion of the Mount Worcester Quadrangle, Vermont

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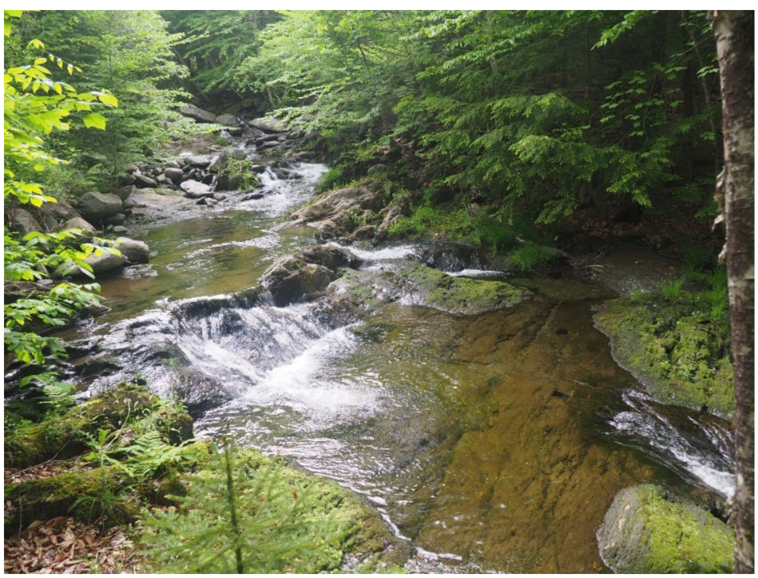

Report Prepared for the Vermont Geological Survey to accompany
Open File Maps VG2023-4 and VG2023-5
December, 2023

On the cover:

Upper photo: View looking southeast across the rolling Vermont Piedmont terrain of the Peacham quadrangle from Mack Mountain Road in Peacham. Harvey Mountain on right. Photo taken on 11/10/2021.

Lower photo: Bedrock grade control on Hancock Brook at Station 1814, Mt. Worcester quadrangle, 6/16/2023.

Introduction

The surficial geologic maps of the Peacham quadrangle and the eastern portion of the Mount Worcester quadrangle are the last pieces needed for the compilation of the surficial geology of the entire Vermont portion of the Montpelier One Degree sheet. The Montpelier One Degree sheet is shown in Figure 1. The Peacham and Mount Worcester quadrangles are outlined on Figure one and are shown in more detail in Figures 2 and 3, respectively.

This report is intended as a brief update on significant findings in the two study areas. For each study area a set of significant findings is followed by a photo essay showing representative geologic and landscape features.

The Pleistocene and Holocene history of the region is described in much more detail in Larsen and others (2003), Dunn and others (2011), and Dunn and Springston (2019). Ice movement indicators and their relationships with late Wisconsinan ice dynamics are discussed in Ackerley and Larsen (1987) and Wright (2015). Glacial lakes in the area are illustrated in Springston and others (2020) and described in more detail at the Vermont Geological Survey website: https://dec.vermont.gov/geological-survey/vermont-geology/glaciallake .

For the eastern portion of the Mount Worcester quadrangle, the most relevant 1:24,000 surficial mapping is that by Larsen (1999a and b) in the Montpelier quadrangle (immediately south of the study area.

For the Peacham quadrangle, the most relevant reports are Springston and Kim (2008) in the Knox Mountain study area (parts of the Marshfield and Plainfield quadrangles), Springston (2017) in the Joes Pond quadrangle, and Springston (2020) in the Groton quadrangle.

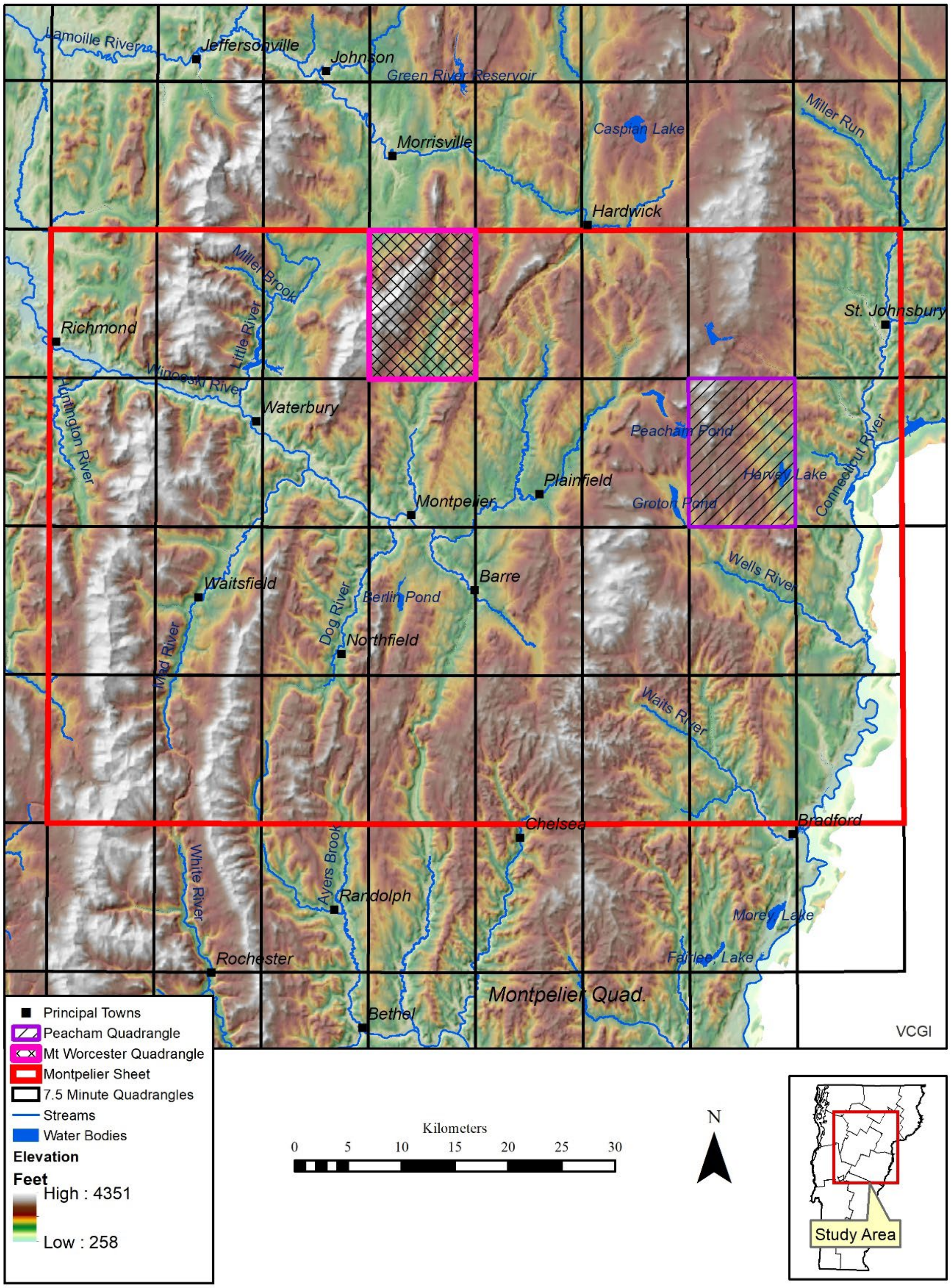

Figure 1. Location map for the Montpelier One Degree sheet. The Peacham and Mount Worcester quadrangles are outlined.

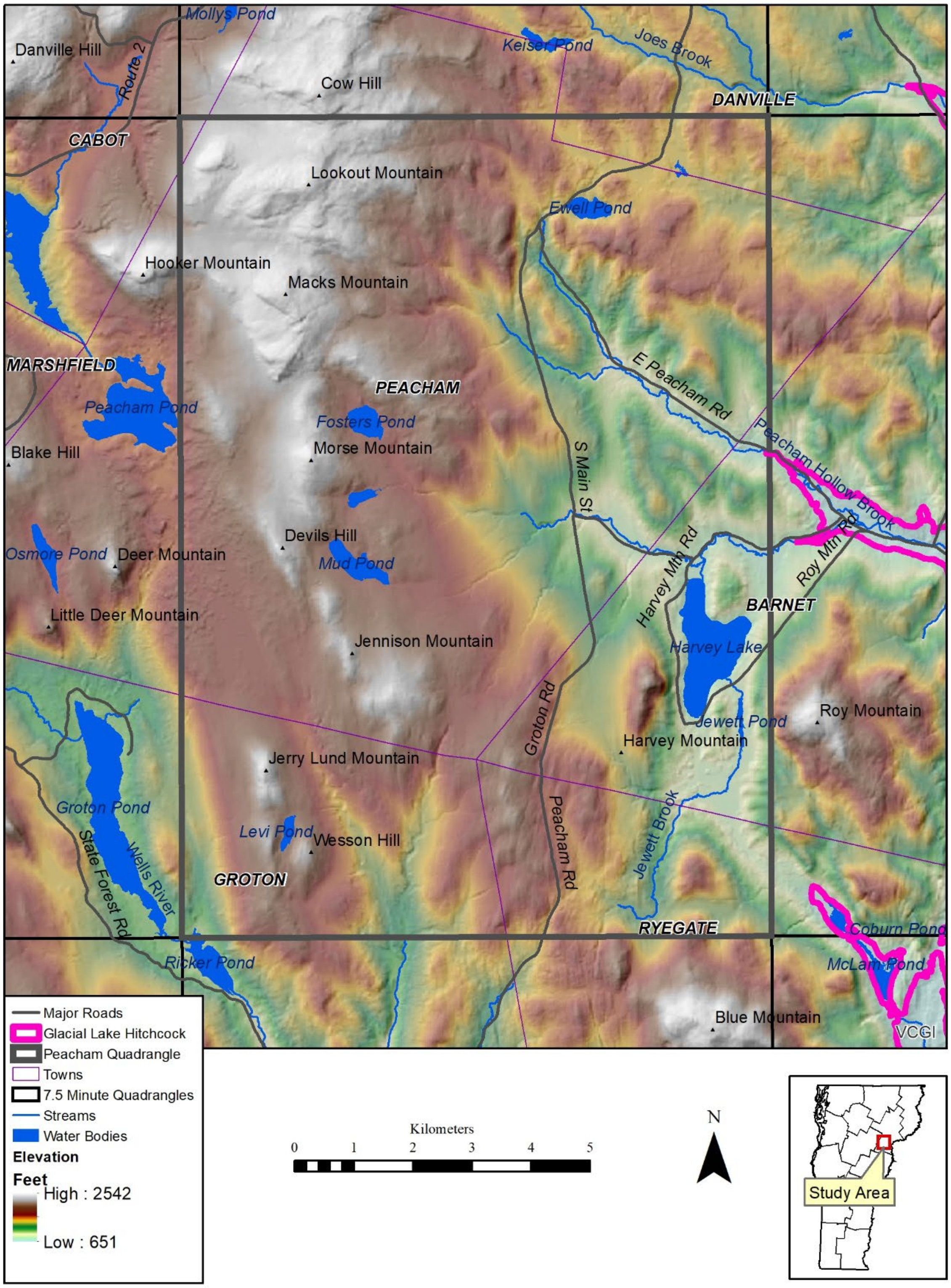

Figure 2. Location map for the Peacham 7.5 minute quadrangle.

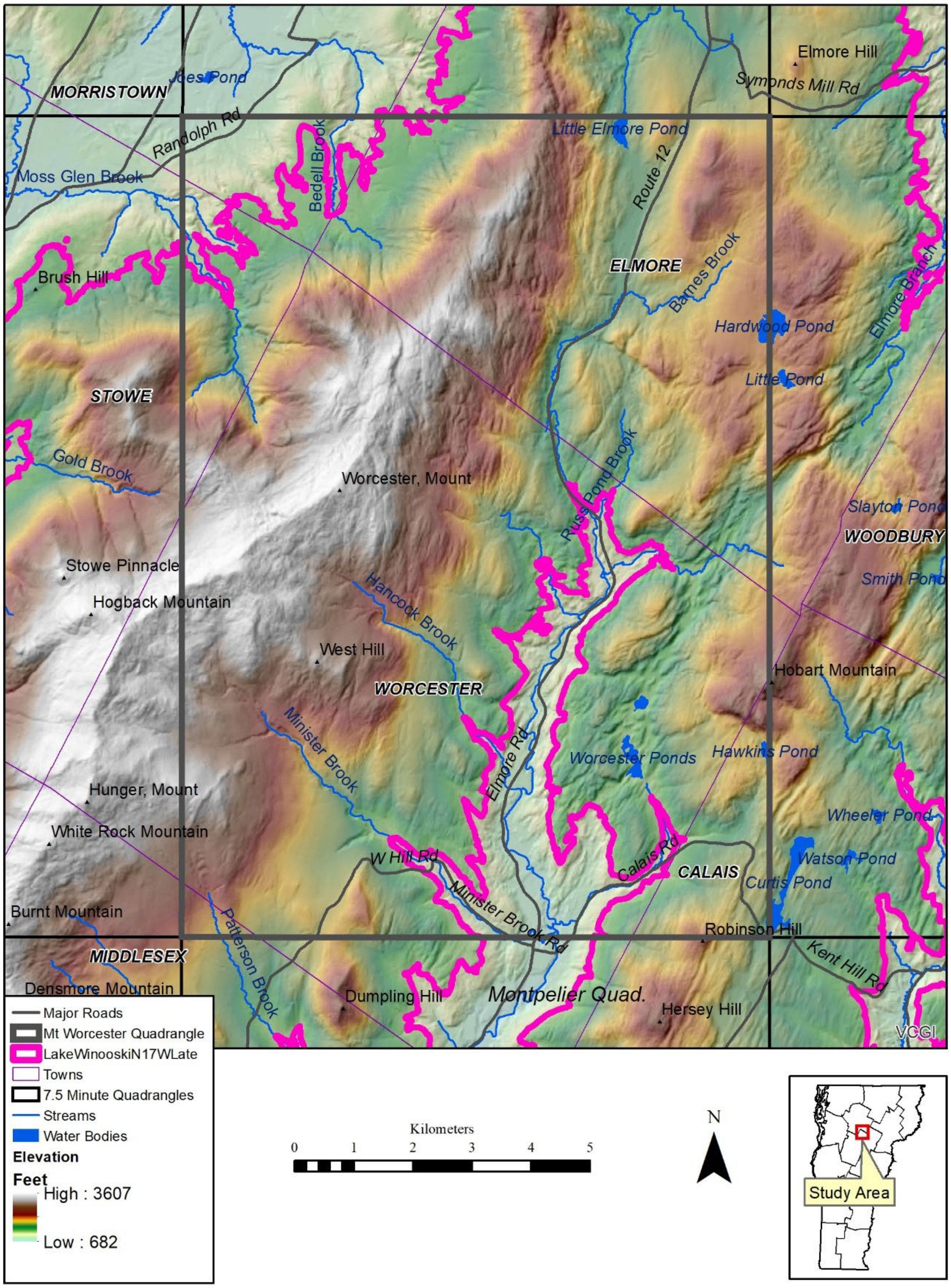

Figure 3. Location map for the Mount Worcester quadrangle.

Peacham 7.5 Minute Quadrangle

Significant Findings, Peacham Quadrangle

Bedrock outcrops are abundant over most of the Peacham quadrangle. The major exceptions are the lowlands in the Peacham Pond basin on the western edge of the quadrangle, where bedrock outcrops are quite scarce. This area is underlain by thick till.

In addition to the bedrock outcrops visited as part of this and other geologic mapping projects, Plate 1 also shows points where interpretation of lidar topographic data can be used to infer shallow bedrock. These will be used as an aid to construction of a bedrock surface elevation map and a depth to bedrock map for the Montpelier One Degree Sheet project.

Glacial till is the most widespread surficial material in the Peacham quadrangle. Three till facies are found in the quadrangle: A loose, tan, fine-sand matrix till with abundant granitic clasts and often abundant large granitic surface boulders; a loose, brown-weathering, fine-sand matrix till with abundant weathered clasts of the Waits River and Gile Mountain Formations; and a dense to very dense, olive to dark gray, silty fine sand-matrix till. Although each of these facies in distinct in appearance, it has so far proved impractical to distinguish them as mappable units. The distribution of these three facies in the Peacham quadrangle and surrounding quadrangles is currently under investigation.

Two broad classes of ice movement indicators are seen in the Peacham quadrangle: Glacial striations and crag and tail features. Striations in bedrock are quite scarce in the quadrangle. Only two sites were identified, with striations oriented 142° and 167°. The 142° striations are probably due to southeast-directed ice flow during the peak of the late Wisconsinan glaciation while the 167° striations are more in line with late ice movement when the ice was thinner and more controlled by the underlying topography (Ackerley and Larsen, 1987; Wright, 2015). Crag and tail landforms, by contrast, are common in the central and southwestern portions of the quadrangle. On the lidar-derived topography they each show indications of a bedrock knob at the northerly end and a tail of thick till extending approximately 165 to 175°. The southerly orientation is due to the later ice movement.

Numerous short till ridges that are interpreted as moraines were identified in the western portion of the Peacham quadrangle. The most extensive set is found on the western and northern edges of Peacham Bog. Three similar till ridges are found southeast of Peacham Pond on the western edge of the quadrangle. These western till ridges are similar to features interpreted as Rögen moraines in the Knox Mountains study area to the west (Springston and Kim, 2008). A third area of moraines is located to the south of Harvey's Lake. If these generally east-west till ridges are recessional moraines, they record the south-to north retreat of an ice margin into the Harvey Lake basin.

Large granitic glacial boulders derived from the Knox Mountain pluton are very abundant in the western portions of the Peacham quadrangle, especially in the Peacham Pond basin. Many of these were probably plucked from the south face of Hooker Mountain as the ice rode over it. As most or all of the boulders mapped were probably still within the boundaries of the Knox

Mountain pluton they are identified as glacial boulders rather than erratic boulders. The pattern of concentrations of granitic boulders and possible Rögen moraines in the lowlands south of granitic peaks is seen in in several locations in the Knox Mountain study area to the east (Springston and Kim, 2008).

The only ice-contact deposit identified in the Peacham quadrangle is a short esker located in the hills west of Jewett Brook in the southeast corner of the map.

Meltwater channels are widespread in the western and southern portions of the Peacham quadrangle. Where present on hillsides as sets of channels that roughly parallel the contours, they are interpreted to have formed at or under an ice-margin that was down-wasting off the hillside. Others are located in low spots in east-west drainage divides. These channels appear to have formed when meltwater flowed out from a glacial remnant to the north into an ice-free area to the south of the ridge.

No glacial lake deposits were identified in the Peacham quadrangle. The closest arm of glacial Lake Hitchcock is in the western part of the Barnet quadrangle along Peacham Hollow Brook.

Three extensive wetland areas are found withing the study area, as well as numerous smaller ones. Peacham Bog is a large peatland on the western edge of the study area. Peat there is in excess of one meter thick. A string of wetlands extends up the valley of Rake Factory Brook, crossing the northeastern corner of the study area. A large wetland complex fills the Jewett Brook valley south of Harvey Lake in the southeastern part of the study area.

Description of Map Units

Holocene Deposits

Artificial Fill. Artificially-emplaced material along road beds, embankments and in developed areas. Material varies from natural sand, gravel, or till to various artificial waste materials. Thickness varies.

Alluvium. Silt, sand, and gravel deposited by modern streams. Includes stream channel, bar, and floodplain deposits. Wetland deposits are common within these areas and are not distinguished. Thickness in tributary valleys is typically less than 3 meters, although the depth may be much greater in the valleys of the larger streams.

Alluvial Terrace Deposits. Silt, sand, and gravel deposited on terraces above the modern floodplains of streams. They are composed of a variety of channel, bar, and floodplain deposits. Generally less than 5 meters thick.

Talus. Fans or aprons of fallen blocks of angular rock at the bases of bedrock cliffs. May contain colluvial (slope-wash) deposits as well. Of variable thickness.

Wetland Deposits. Accumulations of organic matter and/or clastic sediment in low-lying areas. Includes a wide variety of wetland types. Commonly overlaying other deposits such as alluvium, lacustrine sediment, or till. Only larger deposits are shown.

Pleistocene Deposits

Esker Deposits. Elongate ridge of ice-contact stratified sand and gravel deposited by glacial meltwater streams in tunnels within or beneath the glacial ice. A short esker is located in the hills west of Jewett Brook in the southeast corner of the map.

Moraine Deposits. Composed primarily of till with variable amounts of stratified sand and gravel. Deposited in the vicinity of an ice margin, primarily from the direct melting of glacial ice.

Till. Very dense to loose, unsorted to very poorly sorted material deposited directly from glacial ice. Contains a wide range of grain sizes, from clay or silt up to large boulders. The till matrix texture ranges from fine sand to clayey silt. Three till facies are found in the Peacham quadrangle: A loose, tan, fine-sand matrix till with abundant granitic clasts and often abundant large granitic surface boulders; a loose, brown-weathering, fine-sand matrix till with abundant weathered clasts of the Waits River and Gile Mountain Formations; and a dense to very dense, olive to dark gray, silty fine sand-matrix till. Thickness is highly variable, from less than 1 meter to greater than 30 meters. Boulders are common throughout, but are especially abundant in the westernmost portion of the quadrangle in areas south and south-southeast of hills underlain by granitic rocks. Areas at the bases of steep slopes may include colluvium and talus deposits. On the upper slopes of hills, the till deposits are commonly very thin (less than one meter).

Photographic Essay: Geologic Features of the Peacham Quadrangle

Boulder bed stream (probable lag deposit) at Station 1333, Groton State Forest, Peacham quadrangle, 9/1/2022.

One of the many large granitic glacial boulders in the western part of the Peacham quadrangle. Station 1323, southeast of Peacham Pond in Groton State Forest, 9/3/2022.

Abundant scattered granitic surface boulders at Station 1378, Groton State Forest, Peacham quadrangle, 9/3/2022.

Large granitic boulder in conifer stand. Station 1408, Groton State Forest, Peacham quadrangle, 9/8/2022.

Typical granitic boulder stone wall in the westernmost part of the area. Northwest of Fosters Pond at Station 1741, Peacham quadrangle, 5/26/2023.

View looking southeast across the rolling Vermont Piedmont terrain of the Peacham quadrangle from Mack Mountain Road in Peacham. Harvey Mountain on right. Photo taken on 11/10/2021.

Typical rolling landscape of central and eastern parts of area. Looking south towards East Peacham from Station 1259 on Old County Road, Peacham quadrangle, 4/28/2022.

Sandy till at Station 1259 on Old County Road north of East Peacham, Peacham quadrangle, 4/28/2022.

Tree throw in bouldery fine-sandy till southeast of Levi Pond at Station 1837, Peacham quadrangle, 6/20/2023.

Looking north up the western arm of Peacham Bog from Station 100. This extensive wetland complex is underlain by a thick peat deposit.

Out on surface of Peacham Bog, Groton State Forest. Station 1441 in the Peacham quadrangle, 9/9/2022.

Soil auger plunged to handle in thick peat deposit at Peacham Bog, Groton State Forest. Station 1441 in the Peacham quadrangle, 9/9/2022.

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Large beaver-influenced wetland complex at Jewett Pond, looking south from Station 1609, Peacham quadrangle, 10/27/22.

Levi Pond looking north from south end. Near Station 1832, Roy Mountain Wildlife Management Area, Peacham quadrangle, 6/20/2023.

Mt. Worcester 7.5 Minute Quadrangle

Significant Findings, Eastern Portion of the Mt. Worcester Quadrangle

Bedrock outcrops are extremely abundant over most of the eastern Mt. Worcester quadrangle. Several of the field traverses on either side of the North Branch revealed a landscape of nearly continuous bedrock ribs separated only by thin glacial till and colluvium.

In addition to the bedrock outcrops visited as part of this and other geologic mapping projects, Plate 1 also shows points where interpretation of lidar topographic data can be used to infer shallow bedrock. These will be used as an aid to construction of a bedrock surface elevation map and a depth to bedrock map for the Montpelier One Degree Sheet project.

Glacial till is the most widespread surficial material in the eastern Mt. Worcester quadrangle. The till ranges from dense fine sandy silt matrix till to very dense very fine sandy silt matrix till. The variations in texture and geochemistry of the till in this and other parts of the Montpelier One Degree Sheet are currently under investigation.

Glacial boulders are of course encountered in the eastern Mt. Worcester quadrangle--the stone walls alone provide plenty of evidence for them. However, large boulders in excess of one meter in diameter are far less abundant that in the Peacham quadrangle and indeed many areas in central Vermont. The reason for this relative scarcity of large blocks is unclear, but perhaps the spacing of bedrock joints is more conducive to the production of smaller blocks during glacial erosion.

Glacial striations and grooves are common on the hard metamorphic rocks of the eastern Mt. Worcester quadrangle. Striations and grooves range in orientation from 135° to 198°. The southeasterly striations are probably due to southeast-directed ice flow during the peak of the late Wisconsinan glaciation while the southerly striations are probably the result of late ice movement when the ice was thinner and more controlled by the underlying topography (Ackerley and Larsen, 1987; Wright, 2015). An example of this pattern is shown at Site 169 where striations oriented 155° are cross-cut by younger 189° striae. Crag and tail landforms, which were so common in parts of the Peacham quadrangle, were not seen in the Mt. Worcester quadrangle, or indeed any of the area west of the RMC.

Thirteen of the striation locations on the crest of the Mount Worcester range were digitized from a 1:62,500 scale manuscript map (no date) by Stewarrt Clark (U. S. Geological Survey, retired).

A short esker segment is located on the east side of Russ Pond Brook in the northeast corner of the map. This, combined with the meltwater channels and outwash deposits described below, appears to be the only direct evidence of the glacial drainage system that must surely have existed in the study area.

Only a few meltwater channels were identified in the study area. Except for a set of three arcuate channels in the upper reaches of Patterson Brook and a single arcuate channel southwest of Little Elmore Pond in the northeast corner of the quadrangle, they are all bedrock-controlled channels oriented roughly north-north-east to south-southwest (parallel to dominant foliation). Limited sand and gravel deposits are found at the south end of a pair of channels on the north side of Hancock Brook and a small pit exposes bedded sand and gravel at the south end of a meltwater channel just to the south of the study area in the Montpelier quadrangle (Station 131).

Glacial Lake Winooski extended up the North Branch valley and tributaries in the study area. Lake deposits were encountered in the North Branch valley as far north as the mouth of Hancock Brook, where two delta remnants are found on either side of the brook where it empties out into the North Branch valley.

Holocene alluvial fans are found in several locations where steep streams come down onto valley bottoms. The largest fan is at the mouth of Hancock Brook.

Description of Map Units

Holocene Deposits

Artificial Fill. Artificially-emplaced material along road beds, embankments and in developed areas. Material varies from natural sand, gravel, or till to various artificial waste materials. Thickness varies.

Alluvium. Silt, sand, and gravel deposited by modern streams. Includes stream channel, bar, and floodplain deposits. Wetland deposits are common within these areas and are not distinguished. Thickness in tributary valleys is typically less than 3 meters, although the depth may be much greater in the valleys of the larger streams.

Alluvial Terrace Deposits. Silt, sand, and gravel deposited on terraces above the modern floodplains of streams. They are composed of a variety of channel, bar, and floodplain deposits. Generally less than 5 meters thick.

Alluvial Fan Deposits. Boulder, pebble, and cobble gravel and pebbly sand deposited at sites where steep, stream gradients are sharply reduced. Common at the mouths of steep tributaries where they meet the main stream. Generally less than 5 meters thick.

Talus. Fans or aprons of fallen blocks of angular rock at the bases of bedrock cliffs. May contain colluvial (slope-wash) deposits as well. Of variable thickness.

Wetland Deposits. Accumulations of organic matter and/or clastic sediment in low-lying areas. Includes a wide variety of wetland types. Commonly overlaying other deposits such as alluvium, lacustrine sediment, or till. Only larger deposits are shown.

Pleistocene Deposits

Older Alluvial Fan Deposits. Remnants of late Pleistocene alluvial fans can sometimes be found at sites where alluvial material built out onto glacial lake deposits. Subsequent downcutting by the main stream and tributaries may leave the late Pleistocene alluvial fan deposit stranded at the back edge of a lake-bottom terrace.

Lacustrine Deposits, Undifferentiated. Coarse- to fine-grained sediment deposited in a proglacial lake.

Lacustrine Deposits, Coarse-grained. Well-sorted sand, pebbly sand and/or sandy gravel deposited in shoreline, shallow water, or lake bottom environments of a glacial lake.

Lacustrine Deposits, Fine-grained. Clay, silt, and very fine to fine sand deposited in deeper waters. Commonly laminated. Plfv (varved) where clear indications of annual layers are present. Deposited in distal lake bottom environment of a glacial lake.

Lacustrine Deposits, Delta. Well-sorted sand and gravel deposited in glacial Lake Winooski at the mouth of a tributary stream. Includes topset and foreset beds. Delta remnants are found on the slopes west of the mouth of Hancock Brook and on two small streams in the southeast corner of the quadrangle.

Outwash Deposits. Glacial meltwater deposits composed of stratified sand and gravel deposited in streams in locations out beyond the glacial margin. Includes relatively narrow valley train deposits in confined mountain valleys and broad sheets of outwash deposited in the broad lowlands.

Ice-contact Deposits, Undifferentiated. Unsorted to poorly-sorted stratified sand, gravel, and silt deposited in contact with glacial ice. Surface may contain scattered kettle holes formed by melting of buried ice blocks or be a highly complex kame and kettle.

Esker Deposits. Elongate ridge of ice-contact stratified sand and gravel deposited by glacial meltwater streams in tunnels within or beneath the glacial ice. A short esker is located on the east side of Russ Pond Brook in the northeast corner of the map.

Till. Very dense to moderately dense, unsorted to very poorly sorted material deposited directly from glacial ice. Contains a wide range of grain sizes, from clay or silt up to large boulders. The till matrix texture ranges from fine sand to clayey silt. Boulders are common throughout the study area, but in contrast to the Woodbury quadrangle to the east there are relatively few large (> 1 meter) surface boulders. Thickness is highly variable, from less than 1 meter to greater than 30 meters. Over large portions of this study area the till deposits are very thin (commonly less than one meter). Areas at the bases of steep slopes may include colluvium and talus deposits.

Quaternary Deposits

Sand and Gravel, Undifferentiated. Encompasses a wide variety of coarse-grained surficial materials in cases where information is inadequate to determine age and environment of deposition. The deposit in the east-central part of the study area near the mouth of Hardwood Brook may be glacial outwash.

Older Deposits

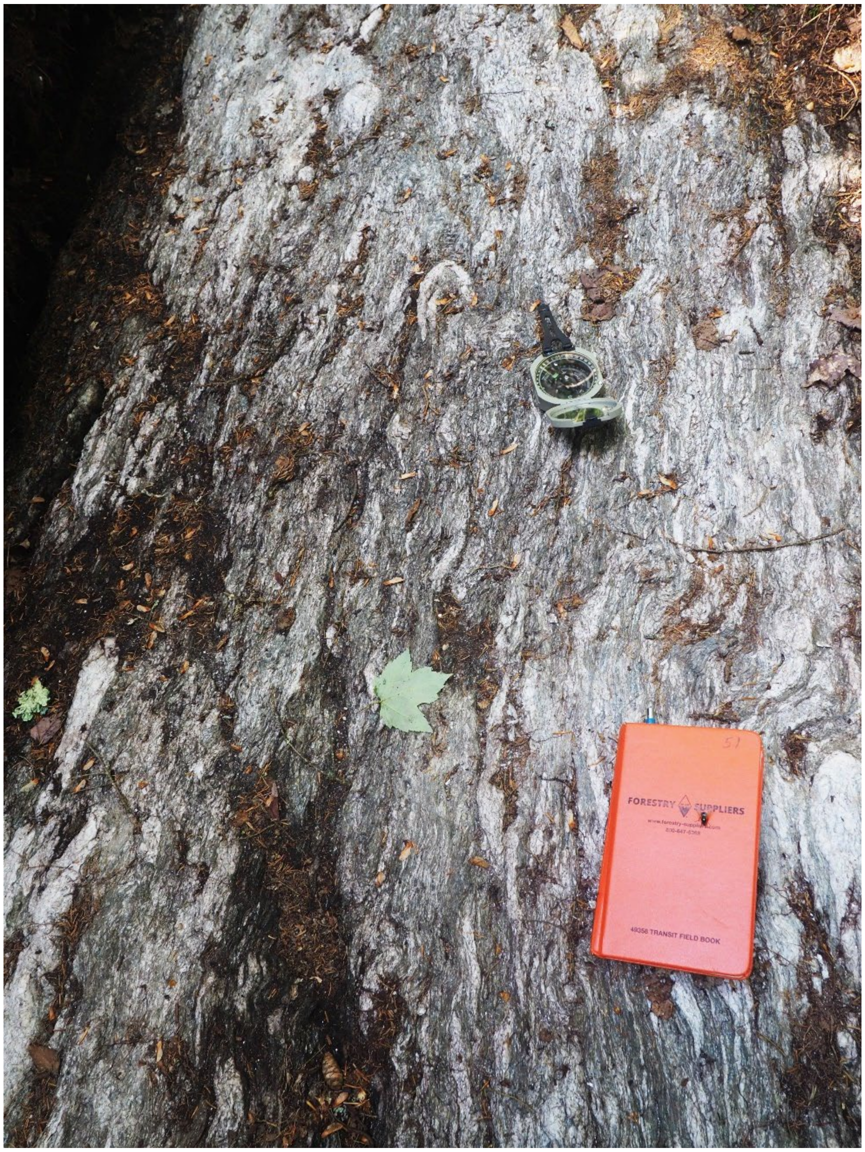
Area of extensive bedrock exposures.

Photographic Essay: Geologic Features of the Eastern Portion of the Mount Worcester Quadrangle

Bedrock grade control on Hancock Brook at Station 1814, Mt. Worcester quadrangle, 6/16/2023.

Falls on Hancock Brook at Station 1823, Mt. Worcester quadrangle, 6/16/2023.

Typical outcrop of “pinstripe” Moretown Formation at Station 1888 at Worcester Cemetery east of VT Rt. 12, north of Worcester Village, Mt. Worcester quadrangle, 6/23/2023.



Outcrop of gray muscovite schist (Stowe Formation?) at Station 1903 in Putnam State Forest, west of VT Rt. 12, Mount Worcester quadrangle, 6/23/2023.

Striations of two ages on bedrock at Station 169, Mount Worcester quadrangle, 10/4/2023. The older striations , which are parallel to the compass, are oriented 155° and the younger ones, which are parallel to the pencil, are oriented 189°. This pattern of older southeast-directed striations crosscut by south-directed striations is common in central Vermont. The pattern is probably due to southeast-directed ice flow during the peak of the late Wisconsinan glaciation, followed by later, more topographically-influenced southerly ice flow.

Dense, fine sandy silt matrix till at Station 1810 on ___Road, Mt. Worcester quadrangle, 6/16/2023. Shovel has been used to expose fresh till (to left of shovel). Surrounding material is typical weathered appearance of the till.

Moderately dense fine sand matrix till at Station 138 on West Hill Road, Mt. Worcester quadrangle, 9/22/2023. Till sample site.

Close-up of moderately dense fine sand matrix till at Station 138 on West Hill Road, Mt. Worcester quadrangle, 9/22/2023. Till sample site.

Dense silty fine sand matrix till on Calais Road at Station 146, Mt. Worcester quadrangle, 10/2/2023. Till sample site.

Close-up of dense silty fine sand matrix till on Calais Road at Station 146, Mt. Worcester quadrangle, 10/2/2023. Till sample site.

Sand and gravel deposit east of MacKenzie Drive at Station 131, just to the south of the study area in the Montpelier quadrangle, 9/22/2023. Beds may be tilted due to post-depositional collapse. This deposit is located at the south end of a prominent north-south bedrock-sided meltwater channel and appears to be outwash deposited in a temporary water body.

Panorama taken on the Wrightsville Dam looking north (upstream) at the reservoir. Although the reservoir is south of the Montpelier quadrangle to the south of the study area, it provides a good view of typical terrain in the study area. Photos taken on 10/2/2023. Note delta on of a small stream on the left. Note wood and wrack line on upstream face of the dam in the foreground. This resulted from water impounded after the intense rains on July 9-11, 2023.

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