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**Title:** *Surficial Geology of the Veazie 7.5-Minute Quadrangle, Penobscot County, Maine*

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**Associated Maps:** Surficial geology of the Veazie quadrangle, Open-File 08-39
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# *Surficial Geology of the Veazie 7.5-Minute Quadrangle, Penobscot County, Maine*

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## INTRODUCTION

This report describes the surficial geology and Quaternary history of the Veazie quadrangle in south-central Maine. Surficial earth materials include unconsolidated sediments (sand, gravel, etc.) of glacial and nonglacial origin. Most of these deposits formed during and after the latest episode of glaciation in Maine, called the Wisconsinan glaciation, during the last 25,000 years.

Surficial sediments cover the bedrock over most of the quadrangle and are subject to many uses and environmental considerations. These include sand and gravel extraction, development and protection of ground-water supplies, siting of waste disposal facilities, and agriculture.

The fieldwork for this study was carried out in 2007 for the STATEMAP cooperative between the Maine Geological Survey and the U.S. Geological Survey (USGS). Two maps are associated with this report. The *geologic map* (Hildreth, 2008) shows the distribution of sedimentary units and indicates their age, composition, and known or inferred origin. It also includes information on the geologic history of the quadrangle, such as features indicating the flow direction of glacial ice. This map provides the basis for the following discussion of glacial and postglacial history.

The *materials map* (Hildreth and others, 2008) shows specific data used to help construct the geologic map. These data include observations from gravel pits, shovel and auger holes, construction sites, and natural exposures along stream banks. The materials map also shows boring and well logs.

### *Geographic Setting*

The Veazie 7.5-minute quadrangle has an area of about 52 mi$^2$ (133 km$^2$). It is located in south-central Maine in the Seaboard Lowland physiographic province. It includes parts of the towns of Veazie, Orono, Bradley, Eddington, Holden, Brewer, and Bangor. Altitudes range from sea level in the Penobscot River (tidal up to the hydropower dam in Veazie), to over 470 ft (143 m) on Mann Hill in the southeast part of the quadrangle.

The large-scale topography in the northwestern two-thirds of the study area is controlled by northeast-trending plunging folds in the Silurian-Ordovician Vassalboro Formation metasedimentary rocks on the southeast limb of the Kearsarge-central Maine synclinorium. The southeast one-third consists of a couple of narrow steep dip-slip northeast-striking fault slices of metasedimentary rocks of the Devonian-Ordovician Bucksport Formation (Osberg and others, 1985). Small-scale topography includes moderate-sized to low ridges that were shaped by glacial ice flowing southeast to south, and have been elongated in that direction.

The major stream drainage in the quadrangle is the southwest-flowing Penobscot River, its southeast-flowing northern tributary brooks (Meadow and a few unnamed ones), and its north- to northwest-flowing southern tributaries (Fells, Eaton, and Meadow Brooks and Blackman Stream). In the southeast part of the map area Holbrook Pond and a few large swamps drain eastward into the Chemo Pond quadrangle, thence northward to Blackman Stream and the Penobscot River.

### *Bedrock Geology*

The northwestern two-thirds of the quadrangle is underlain by northeast-trending plunging folds in the Silurian-Ordovician Vassalboro Formation composed of metasedimentary rocks whose protoliths were calcareous sandstone with interbedded sandstone and impure limestone. The Vassalboro Formation, here, lies on the southeast limb of the Kearsarge-central Maine synclinorium. The southeastern one-third consists of a couple of narrow steep dip-slip northeast-striking fault slices of metasedimentary rocks of the Devonian-Ordovician Bucksport Formation, which had similar protoliths to the Vassalboro Formation. The faults are part of the major northeast-striking

Norumbega fault zone that separates the Coastal Lithotectonic Block, which includes the Bucksport Formation, from rocks of inland Maine. All rock units in the quadrangle appear to be of greenshist metamorphic grade (Osberg and others, 1985).

## PREVIOUS AND CURRENT WORK

Early work on the surficial geology in this part of Maine was done generally at a reconnaissance level and at a smaller scale (Prescott, 1966; Thompson and Borns, 1985; Thompson, 1987). A recent surficial materials map (Neil and Williams, 2001) and significant sand and gravel aquifer map (Foster and others, 2001) facilitated fieldwork. Surficial geologic mapping has been completed at the 1:24,000 scale in two adjoining quadrangles - Bangor (Syverson and Thompson, 2008) and Old Town (Kelley, 2008).

## GLACIAL HISTORY AND LATE-GLACIAL HISTORY

Southern Maine probably experienced several episodes of glaciation during the Pleistocene Ice Age, but virtually all evidence of previous glaciations in the Veazie area was obliterated during the last (late Wisconsinan) episode, when the Laurentide ice sheet advanced from the northwest to a terminal position on the continental shelf.

Evidence of glacial erosion within this area is noticeable mainly as southeast- to south- to southwest-trending glacial striations on freshly exposed bedrock surfaces. Several locations contained more than one set of striations. In most cases where it was possible to determine relative ages of the different striation sets, the more easterly of southeast sets was the older. In a couple of locations, two or three sets of striations indicate glacial flow either toward the thalweg of the Penobscot River or parallel to it in the youngest sets of striae. Probably the diversions in glacial flow directions occurred during the waning stages of glaciation, as the ice mass thinned. Further, more detailed, investigations of these striations, in this and adjoining areas, may help in efforts to decipher the changes in glacial flow more precisely during the last stages of glaciation in this part of Maine.

There are probably few true drumlins in the area, but many oval hills composed mostly of till have streamlined slopes elongated parallel to the main southeast to south flow direction of the last continental ice sheet. For example, Coffey Hill in the northeastern quadrant of the map has a characteristic drumlin shape, contains till in its slopes, and has striated bedrock exposed at its crest; the striation direction there parallels the long axis of the hill. In several of the streamlined hills in the area, the long axis curves on the southern end from a southeast trend to a more southerly, even southwesterly trend; this trend tends to follow the pattern of the younger striations in some cases and may also represent the diversion of glacial flow directions during the waning stages of glaciation, as the ice mass thinned. However, this part of Maine was inundated by the late-glacial sea as the glacier receded; it is also possible and likely that the shape of some of the glacially streamlined hills may have been modified by sea wave and current erosion as sea level fell; more detailed study of these features may reveal evidence for such erosion. In addition to oval till hills, some bedrock hills (such as Mann Hill in the southeast part of the map area) exhibit ramp and pluck topography in which the steep rugged southerly slopes represent the plucked lee side of the glacial flow direction and the smooth gentle northerly slopes represent the ramp (stoss) side of the glacial flow direction.

As the waning glacier receded northward, meltwaters flowing southward in a tunnel within or beneath the ice deposited an esker of sand and gravel (Pge) in the northern part of the quadrangle. As the glacier melted and the ice front retreated northward through the area, the sea inundated this area and a variable thickness of glaciomarine silt, clay, and sand (Pp) was deposited like a blanket over the esker. In places, the top 3-5 feet of the esker shows signs of having been reworked by wave or stream action as sea level fell.

After reaching its terminal position on the continental shelf, the late Wisconsinan ice sheet began to recede between 15,000 and 17,000 years ago. Shells collected from glaciomarine sediments deformed by ice shove in the Freeport area (southwest of Veazie) have a radiocarbon age of 14,045 yr. BP (Weddle and others, 1993). The ice sheet terminus is inferred to have reached the Veazie area a short time after that. As the ice sheet melted northward, sea level rose and inundated the entire Maine coastal zone, including perhaps the area in the Veazie quadrangle lying below a current elevation of approximately 440 ft (134 m) above sea level. As summarized by Thompson and Borns (1985), the marine submergence reached its maximum extent at about 13,000 yr B.P., and regressed from the area somewhat before 11,450 yr B.P. (Smith, 1985; Thompson and Borns, 1985), based on shells that indicate the approximate offlap of the late-Wisconsinan sea at Little Falls, Gorham, about 120 mi (190 km) southwest of the Veazie quadrangle.

## GLACIAL AND POSTGLACIAL DEPOSITS

As the ice sheet melted in the Veazie area, it dropped much of the debris incorporated within it in the form of till. At the same time and somewhat later, glacial meltwaters took some of the debris within the glacier, sorted it, carried it some distance and finally deposited it as huge volumes of stratified sediments in various physiographic settings within the quadrangle. These settings are referred to as environments of deposition. Most of the deposits delineated on the map (Pleistocene and Holocene) are characterized on that basis. A few deposits are distinguished by the agent of deposition, such as till (Pt), for which the ice is the agent of deposition and esker deposits (Pge) for which meltwater streams are the agent of deposition. Postglacial deposits include

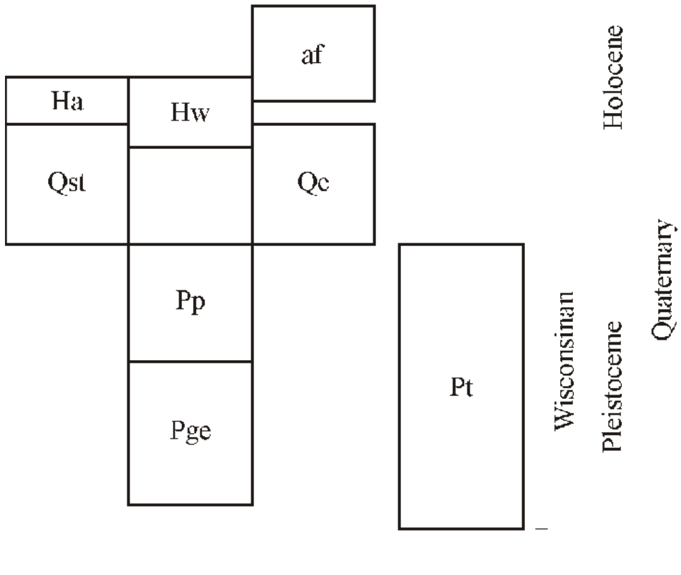


Figure 1. Correlation of Map units, Veazie quadrangle

materials laid down since the glacier melted north of the Veazie area. They include materials mapped as Pleistocene deposits formed during glacial to late-glacial time, prior to 10,000 years B.P. (years before present). Holocene deposits are commonly referred to as recent or modern deposits; they were laid down within the last 10,000 years and most are still in the process of deposition. Quaternary deposits are of uncertain age, but usually are late-glacial and/or postglacial in age. The succession of Pleistocene and Holocene surficial deposits in the New Vineyard area is given in the correlation chart (Figure 1) showing the relative ages of the map units.

***Till (unit Pt)***

Till occurs throughout the Veazie area. Its thickness is variable, as is its composition. The till was deposited from the glacial ice sheet and forms a blanket over the underlying bedrock; it is inferred to underlie younger deposits throughout the area. In most exposures in the quadrangle, this till is light olive-gray, sandy, stony, and moderately compact, showing weathering only in the uppermost few feet. Some drumlins are found in the area, but many hills that are drumlin-shaped (and oriented in the expected direction for drumlins relative to the direction of striations in the area) have bedrock cores that have been plastered with till. Such hills are identified on the geologic map as *glacially streamlined hills*. Though most till is less than 20 ft (6 m) thick in the area, one well in the east-central part of the map (about 1 mi [1.6 km] southeast of Coffey Hill near Route 9) penetrated more than 156 ft (47 m) of probable till. Along the bank of the Penobscot River in Eddington, a well-exposed section of tills and fine-grained water-laid sediments was measured and described by Brady (1982).

***Esker deposits (unit Pge)***

In the north-central part of the map, an esker deposit extends southward along the west side of the Penobscot River. This deposit of sand and gravel was laid down by meltwater streams flowing southward in a tunnel within or at the bottom of the last ice sheet. The exposed part of this esker has been mined in places; it is about 40 ft (12 m) thick. Pits contain mostly sand and gravel, with occasional boulders, overlain in places with a blanket as much as 37 ft (10 m) thick of glaciomarine silt. Also, in places the uppermost sections of borrow pits in these deposits exhibit evidence that at least the top 3-5 feet (1+ m) have been reworked by wave or current action as sea level fell.

***Glaciomarine bottom deposits [Presumpscot Formation] (unit Pp)***

Silty, muddy, fine sandy sediments consisting predominantly of silt and fine sand with local clay and sandy beds and intercalations are interpreted here as late-glacial sea-floor deposits of the Presumpscot Formation (Bloom, 1960). These deposits were derived from glacial meltwaters and laid down at the bottom of the late-glacial sea following the retreat of the ice sheet and prior to uplift of the area above the sea. Pp deposits vary in thickness from less than 3 ft (1 m) in places at the surface to at least 45 ft (13.5 m). In places, Pp materials are draped over older glacial deposits such as Pge and Pt that were inundated by the sea following their deposition. Also, the upper parts of Pp materials have been reworked by wave and current action during regression of the late-Pleistocene sea level through the area, such that much of the surface area of Pp is composed of fine to medium sand. Parts of the Pp unit that lie near the surface are overlain by mapped dune deposits (Qe), and may be coated elsewhere by thin unmapped dune deposits.

***Stream terrace deposits (unit Qst)***

During late-glacial time, when sea level had regressed below the surface of the marine bottom deposits (Pp), the late-glacial Penobscot River was swollen with meltwater carrying abundant sediment; as such it incised a relatively broad channel into these materials and bordering till (Pt), forming braided stream deposits associated with terrace surfaces above the modern flood-plain level of the river. These Qst stream terrace deposits consist of outwash sand, gravel, and silt of varying thickness. In places, some of the area mapped as Qst may consist of a very thin cover on stream terraces carved into underlying glacial deposits. In places the material may consist of postglacial stream terrace deposits. Where the terrace surface is underlain by alluvial material, it may contain as much as 15 ft (5 m) of sand and gravel over the underlying earlier deposits.

### *Eolian deposits (unit Qe)*

When sea level fell and exposed the glaciomarine deposits (Pp), wind erosion was extensive before vegetation was able to take root and anchor the sediments. As a result, relatively thin deposits of windblown sand formed dunes (generally less than 7 ft [2 m] thick) in places and a thin blanket in other places. Only the larger Qe deposits are mapped here, primarily because dune deposits are patchy and not easily recognized except in excavations, which are sparse. Mapped Qe deposits occur near the north-central edge of the map area.

### *Wetland deposits (unit Hw)*

Freshwater swamp deposits characterized by accumulations of fine-grained organic-rich sediments, deposited in low, flat, poorly drained areas are scattered throughout the quadrangle. Little information is available on the thickness of these deposits in the Veazie area, though Cameron and others (1984) report that peat deposits in southwestern Maine generally average less than 20 feet (6 m). In places the unit is indistinguishable from, grades into, or is interbedded with alluvium (Ha). It should be noted that both swamp (Hw) and alluvial deposits (Ha) are coincident along many stretches of flood plains in this area.

### *Stream alluvium (unit Ha)*

Sand, gravel, silt, and organic material deposited by modern streams in their flood plains is mapped as stream alluvium. The extent of alluvium indicates areas that flooded in the past that may be subject to flooding in the future. In places the unit is indistinguishable from, grades into, or is interbedded with wetland deposits (Hw). It should be noted that both swamp (Hw) and alluvial deposits (Ha) are coincident along many stretches of flood plains in this area. Thickness varies from 3-20 feet (1-6 m).

### *Artificial fill (unit af)*

Areas where the original ground surface is covered by a substantial thickness of imported material, both man-made and natural, are mapped as artificial fill (unit af). The material varies from natural sand and gravel to quarry waste to sanitary landfill. The thickness varies, but usually doesn't exceed 20 ft (6 m).

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## REFERENCES

Bloom, A. L., 1960, Late Pleistocene changes of sea level in southwestern Maine: Maine Geological Survey, 143 p.

Brady, K. B. C., 1982, The Quaternary stratigraphy of a multiple-till locality in east-central Maine: M.S. thesis, University of Maine, Orono, 118 p.

Cameron, C. C., Mullen, M. K., Lepage, C. A., and Anderson, W. A., 1984, Peat resources of Maine – Volume 4: southern and western Maine: Maine Geological Survey, Bulletin 31, 123 p.

Foster, L. E., Smith, T. T., Neil, C. D., and Williams, J. S., 2001, Significant sand and gravel aquifers of the Veazie quadrangle, Maine: Maine Geological Survey, Open-File Map 01-262, scale 1:24,000.

Hildreth, C. T., 2008, Surficial geologic map of the Veazie quadrangle, Maine: Maine Geological Survey, Open-File Map 08-39, scale 1:24,000.

Hildreth, C. T., Neil, C. D., and Williams, J. S., 2008, Surficial materials of the Veazie quadrangle, Maine: Maine Geological Survey, Open-File Map 08-40, scale 1:24,000.

Kelley, A., 2008, Surficial geologic map of the Old Town quadrangle, Maine: Maine Geological Survey, Open-File Map 08-47, scale 1:24,000.

Neil, C. D., and Williams, J. S., 2001, Surficial materials of the Veazie quadrangle, Maine: Maine Geological Survey, Open-File Map 01-263, scale 1:24,000.

Osberg, P. H., Hussey, A. M., II, and Boone, G. M., (editors), 1985, Bedrock geologic map of Maine: Maine Geological Survey, scale 1:500,000.

Prescott, G. C., Jr., 1966, Surficial geology and availability of groundwater in part of the lower Penobscot River basin, Maine: U.S. Geological Survey, Hydrologic Atlas HA-225, scale 1:62,500.

Smith, G. W., 1985, Chronology of late Wisconsinan deglaciation of coastal Maine, in Borns, H. W., Jr., Lasalle, P., and Thompson, W. B. (editors), Late Pleistocene history of northeastern New England and adjacent Quebec: Geological Society of America, Special Paper 197, p. 29-44.

Syverson, K. M., and Thompson, A. H., 2008, Surficial geologic map of the Bangor 7.5-minute quadrangle, Maine: Maine Geological Survey, Open-File Map 08-37, scale 1:24,000.

Thompson, W. B., compiler, 1987, Surficial geology of the Bangor 1$^{o}$ x 2$^{o}$ quadrangle, Maine: Maine Geological Survey, Open-File Map 87-9, scale 1:250,000.

Thompson, W. B., and Borns, H. W., Jr. (editors), 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.

Weddle, T. K., Koteff, C., Thompson, W. B., Retelle, M. J., and Marvinney, C. L., 1993, The late-glacial marine invasion of coastal central New England (northeastern Massachusetts-southwestern Maine): Its ups and downs, *in* Cheney, J. T., and Hepburn, J. C. (editors), Field trip guidebook for the northeastern United States: 1993 Boston GSA: University of Massachusetts, Department of Geology and Geography, Amherst, MA, Contribution No. 67, p. I-1 to I-31.