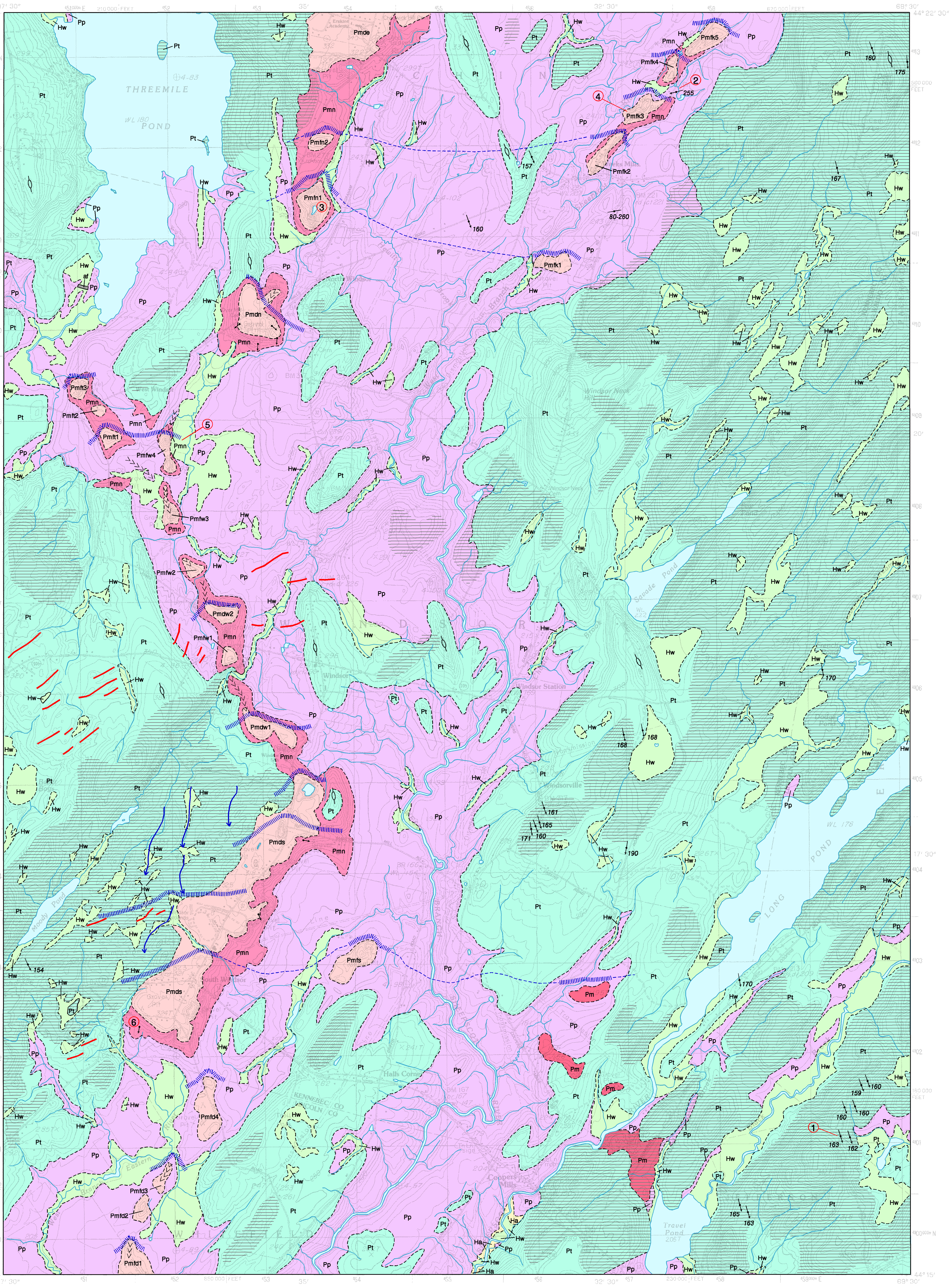
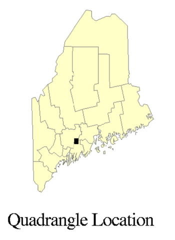
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Thomas K. Weddle completed during the 2004 field season; funding for this work provided by the U.S. Geological Survey STATEMAP program and modified by 2008 and 2009 field data.



Quadrangle Location

SCALE 1 : 24,000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Weeks Mills quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

The use of industry, firm, or local government names on this map is for location purposes only and does not impute responsibility for any present or potential effects on the natural resources.

Ha — **Stream alluvium** - Sand, gravel, and silt deposited on flood plains of the Kennebec River and other streams. May include some wetland deposits.

Hw — **Wetland deposits** - Peat, muck, silt, and clay in poorly drained areas.

Pmn — **Marine nearshore deposits** - Small area of gravelly sediments in the Kennebec Valley. Inferred to have formed when marine processes reworked older glacial deposits during regression of the sea.

Pp — **Presumpscot Formation** - Glaciomarine silt, clay, and sand deposited on the late-glacial sea floor.

Pmd — **Glaciomarine deltas** - Sand and gravel deposited into the sea and built up to the ocean surface. Formed at the glacier margin during recession of the late Wisconsinan ice sheet. Elevation of boundary between topset and foreset beds in each delta indicates the position of sea level when the delta was deposited.

- Pmde - Erskine Academy delta. Topset/foreset contact at 321 ft (97.8 m).
- Pmdn - North Windsor delta.
- Pmds - South Windsor delta. Topset/foreset contact at 309 ft (94.2 m).
- $Pmdw_x$ - Windsor deltas.

Pmf — **Glaciomarine fans** - Sand and gravel deposited as submarine fans at the glacier margin during recession of the late Wisconsinan ice sheet

- $Pmfd_x$ - Doyle Road glaciomarine fans.
- $Pmfk_x$ - Weeks Mills glaciomarine fans.
- $Pmfn_x$ - North Windsor glaciomarine fans.
- Pmfs - South Windsor glaciomarine fans.
- $Pmft_x$ - Three Mile Pond glaciomarine fans.
- $Pmfw_x$ - Windsor glaciomarine fans.

Pm — **Pleistocene glaciomarine deposit** - undifferentiated.

Pt — **Till** - Loose to very compact, poorly sorted, massive to weakly stratified mixture of sand, silt, and gravel-size rock debris deposited by glacial ice. Locally includes lenses of water-laid sand and gravel. Boulders commonly present on ground surface.

Bedrock outcrops/thin-drift areas - Ruled pattern indicates areas where bedrock outcrops are common and/or surficial sediments are generally less than 10 ft thick. Mapped from air photos and ground observations. Actual thin-drift areas probably are more extensive than shown. "rk" indicates large area of bedrock exposure. Dots mark locations of small individual outcrops.

af — **Artificial fill** - Variable mixtures of earth, rock, and/or man-made materials used as fill for roads. Also includes waste heaps from rock quarries. Shown only where large enough to affect the contour pattern on the topographic map.

Contact - Boundary between map units, dashed where approximate.

Moraine ridge - Line shows inferred crest of moraine ridge deposited along the retreating margin of the most recent (late Wisconsinan) glacial ice sheet. Dashed where identification is uncertain. Moraines in this area usually are composed of till, but many till-mantled ridges in the quadrangle are actually cored by bedrock and parallel the north-northeast trend of local metamorphic rock formations.

Ice-margin position - Shows an approximate position of the glacier margin during ice retreat, based on meltwater deposits, moraines, and/or positions of meltwater channels. Dashed blue line between ice-margin positions represents correlative position of the ice margin.

Glacially streamlined hill - Symbol shows long axis of hill or ridge shaped by flow of glacial ice, and which is parallel to former ice-flow direction.

135 **Glacial striation locality** - Arrow shows ice-flow direction inferred from striations on bedrock. Dot marks point of observation. Number is azimuth (in degrees) of flow direction. Symbol with no arrow indicates unknown flow direction.

Dip of cross-bedding - Arrow shows average dip direction of cross-bedding in fluvial or deltaic deposits, which indicates direction of stream flow or delta progradation. Dot marks point of observation.

>>>>> **Crest of esker** - Alignment of symbols shows trend of esker ridge. Chevrons point in direction of meltwater flow.

Meltwater channel - Channel eroded by glacial meltwater stream. Arrow shows inferred direction of former stream flow.

(4) **Photo location**

USES OF SURFICIAL GEOLOGY MAPS

A surficial geology map shows all the loose materials such as till (commonly called hardpan), sand and gravel, or clay, which overlie solid ledge (bedrock). Bedrock outcrops and areas of abundant bedrock outcrops are shown on the map, but varieties of the bedrock are not distinguished (refer to bedrock geology map). Most of the surficial materials are deposits formed by glacial and deglacial processes during the last stage of continental glaciation, which began about 25,000 years ago. The remainder of the surficial deposits are the products of postglacial geologic processes, such as river floodplains, or are attributed to human activity, such as fill or other land-modifying features.

The map shows the areal distribution of the different types of glacial features, deposits, and landforms as described in the map explanation. Features such as striations and moraines can be used to reconstruct the movement and position of the glacier and its margin, especially as the ice sheet melted. Other ancient features include shorelines and deposits of glacial lakes or the glacial sea, now long gone from the state. This glacial geologic history of the quadrangle is useful to the larger understanding of past earth climate, and how our region of the world underwent recent geologically significant climatic and environmental changes. We may then be able to use this knowledge in anticipation of future similar changes for long-term planning efforts, such as coastal development or waste disposal.

Surficial geology maps are often best used in conjunction with related maps such as surficial materials maps or significant sand and gravel aquifer maps for anyone wanting to know what lies beneath the land surface. For example, these maps may aid in the search for water supplies, or economically important deposits such as sand and gravel for aggregate or clay for bricks or pottery. Environmental issues such as the location of a suitable landfill site or the possible spread of contaminants are directly related to surficial geology. Construction projects such as locating new roads, excavating foundations, or siting new homes may be better planned with a good knowledge of the surficial geology of the site. Refer to the list of related publications below.

OTHER SOURCES OF INFORMATION

1. Weddle, T. K., and Locke, D. B., 2005, Surficial materials of the Weeks Mills quadrangle, Maine: Maine Geological Survey, Open-File Map 05-11.
2. Neil, C. D., 2000, Significant sand and gravel aquifers of the Weeks Mills quadrangle, Maine: Maine Geological Survey, Open-File Map 00-4.
3. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print).
4. Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.
5. Grover, T. W., and Fernandes, L. C., 2003, Bedrock geology of the Weeks Mills quadrangle, Maine: Maine Geological Survey, Open-File Map 03-49.

Weeks Mills Quadrangle, Maine

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SURFICIAL GEOLOGY OF MAINE

Continental glaciers as large as the ice sheet now covering Antarctica probably extended across Maine several times during the Pleistocene Epoch, between about 1.5 million and 10,000 years ago. The slow-moving ice superficially changed the landscape as it scraped over mountains and valleys, eroding and transporting boulders and other rock debris for miles. The sediments that cover much of Maine are largely the product of glaciation. The map at left shows the pattern of glacial sediments in the Weeks Mills quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England. During its peak, the ice was several thousand feet thick and covered the highest mountains in the state. The weight of this huge glacier actually caused the land surface to sink hundreds of feet. Rock debris frozen into the base of the glacier abraded the bedrock surface creating grooves and fine scratches (striations). Erosion and sediment deposition by the ice sheet streamlined many hills, with their long dimension parallel to the direction of ice flow.

A warming climate forced the ice sheet to start receding as early as 21,000 years ago, soon after it reached its southernmost position on Long Island. The edge of the glacier reached the present position of the Maine coast by 13,800 years ago. Even though the weight of the ice was removed from the land surface, the Earth's crust did not immediately spring back to its normal level. As a result, the sea flooded much of southern Maine as the glacier retreated to the northwest. Ocean waters extended far up the Kennebec and Penobscot valleys, reaching present elevations of up to 465 feet in the central part of the state.

Great quantities of sediment washed out of the melting ice and into the sea, which was in contact with the receding glacier margin. Sand and gravel accumulated as deltas and submarine fans where streams discharged along the ice front, while the finer silt and clay dispersed across the ocean floor. Ocean waters covered parts of Maine until about 11,000 years ago, when the land surface rebounded as the weight of the ice sheet was removed.

Meltwater streams deposited sand and gravel in tunnels within the ice. These deposits remained as ridges (eskers) when the surrounding ice disappeared. Maine's esker systems can be traced for up to 100 miles, and are among the longest in the country.

Other sand and gravel deposits formed as mounds (kames) and terraces adjacent to melting ice, or as outwash in valleys in front of the glacier. Many of these water-laid deposits are well layered, in contrast to the chaotic mixture of boulders and sediment of all sizes (till) that was released from dirty ice without subsequent reworking. Ridges consisting of till or washed sediments (moraines) were constructed along the ice margin in places where the glacier was still actively flowing and conveying rock debris to its terminus.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. The modern stream network became established soon after deglaciation, and organic deposits began to form in peat bogs, marshes, and swamps. Tundra vegetation bordering the ice sheet was replaced by changing forest communities as the climate warmed. Geologic processes are by no means dormant today, however, as rivers continue to modify the land surface.

Figure 1. Glacial striations and grooves trend 163° on bedrock surface (gray and black schist, Scarboro Formation); ice-flow direction is toward the viewer. The striations formed during the advance of the ice sheet and are consistent with the regional southeast trend in the quadrangle and adjacent areas.

Figure 2. Glacial striations trend 255° on bedrock surface (rusty-weathering schist, Hutchins Corner Formation); ice-flow direction is away from viewer. These striations formed during the deglacial phase when ice thickness was less than during the maximum phase and ice flow was controlled by drawdown into a marine embayment in the southwest-trending West Branch Sheepscot River valley.

Figure 3A. Deformed stratified-drift deposits found in excavation of a glaciomarine fan in China; low-angle thrust faults can be traced to the right near the shovel (strike 80°, dip 11°). Above the shovel are blocks of till and angular boulders; this deformation is from local ice-readvance. Higher in the section above the shovel, sand with swallow burrows is overlain by coarse cobble gravel; the sand, seen in the photo as discontinuous light and dark-colored segments, has been deformed due to loading by the deposition of the gravel.

Figure 3 B. Close up of the thrust fault and drag folds associated with the ice-readvance thrusting. Striations found on three separate bedrock surfaces in the pit do not appear to be related to the readvance. Striations with a southeast- trend range from 140° -160°, representative of the regional ice-flow; a second set has a bearing of 115° - 295°; a third set has a bearing of 125° – 305°.

Figure 3C. Coarse cobble gravel found in same glaciomarine fan as in upper part of section in Figure 3A, western part of pit. Flow direction of deposits is away from viewer.

Figure 3D. Close up of gravel deposit; note sharp contacts and grain-size variation within the unit, representative of changing flow conditions during deposition.

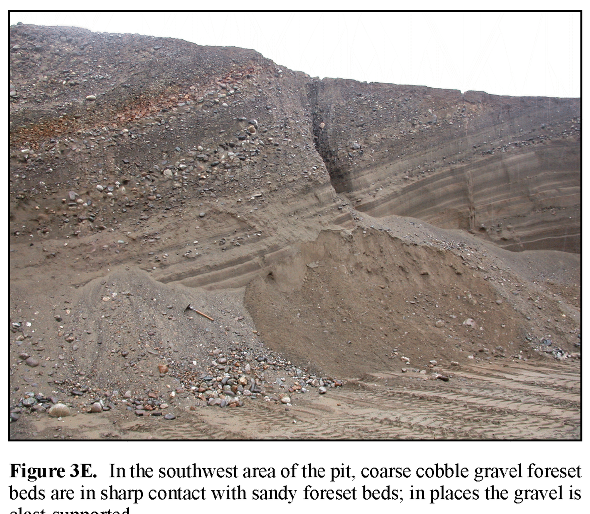

Figure 3E. In the southwest area of the pit, coarse cobble gravel foreset beds are in sharp contact with sandy foreset beds; in places the gravel is clast-supported.

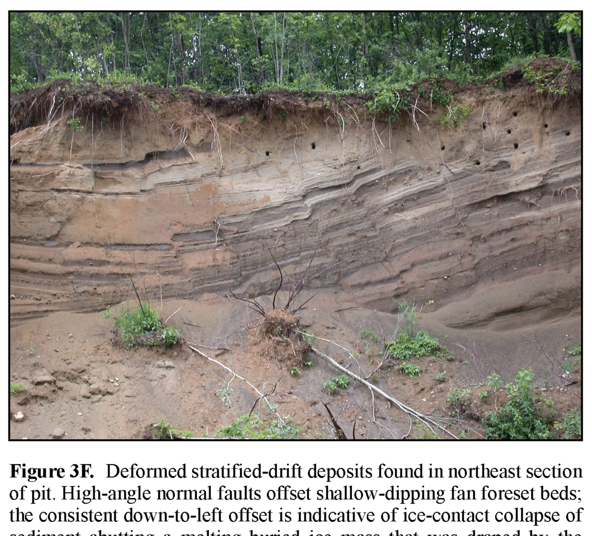

Figure 3F. Deformed stratified-drift deposits found in northeast section of pit. High-angle normal faults offset shallow-dipping fan foreset beds; the consistent down-to-left offset is indicative of ice-contact collapse of sediment abutting a melting buried ice mass that was draped by the foresets.

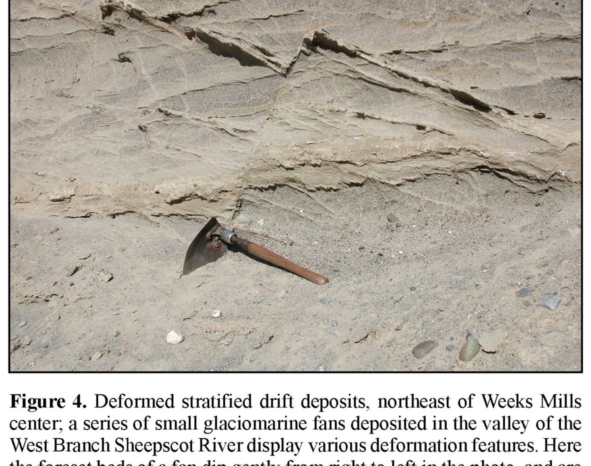

Figure 4. Deformed stratified drift deposits, northeast of Weeks Mills center; a series of small glaciomarine fans deposited in the valley of the West Branch Sheepscot River display various deformation features. Here the foreset beds of a fan dip gently from right to left in the photo, and are offset by normal faults along which fine-grained sand injection dikes and dewatering structures are found. The deformation features are formed by collapse of ice-contact deposits and sediment instability, causing the slumping and dewatering.

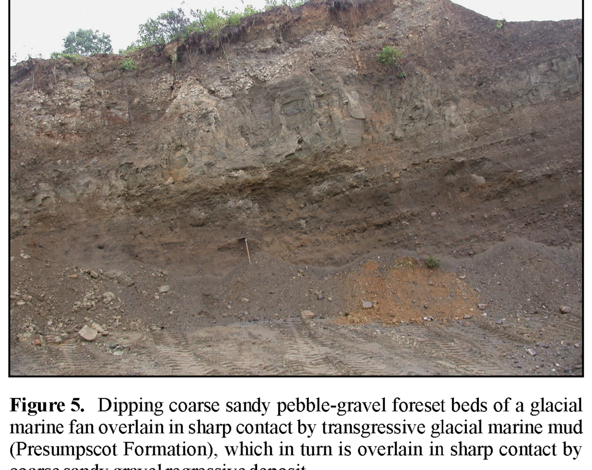

Figure 5. Dipping coarse sandy pebble-gravel foreset beds of a glacial marine fan overlain in sharp contact by transgressive glacial marine mud (Presumpscot Formation), which in turn is overlain in sharp contact by coarse sandy gravel regressive deposit.

Figure 6A. Low-angle foreset beds in South Windsor glacial marine delta; the paleoflow direction of the foreset beds is 190 degrees, approximately toward the viewer in the photo.

Figure 6B. Close of left side of Figure 6A showing incised channel in foreset bedding to left of gravel operation equipment.