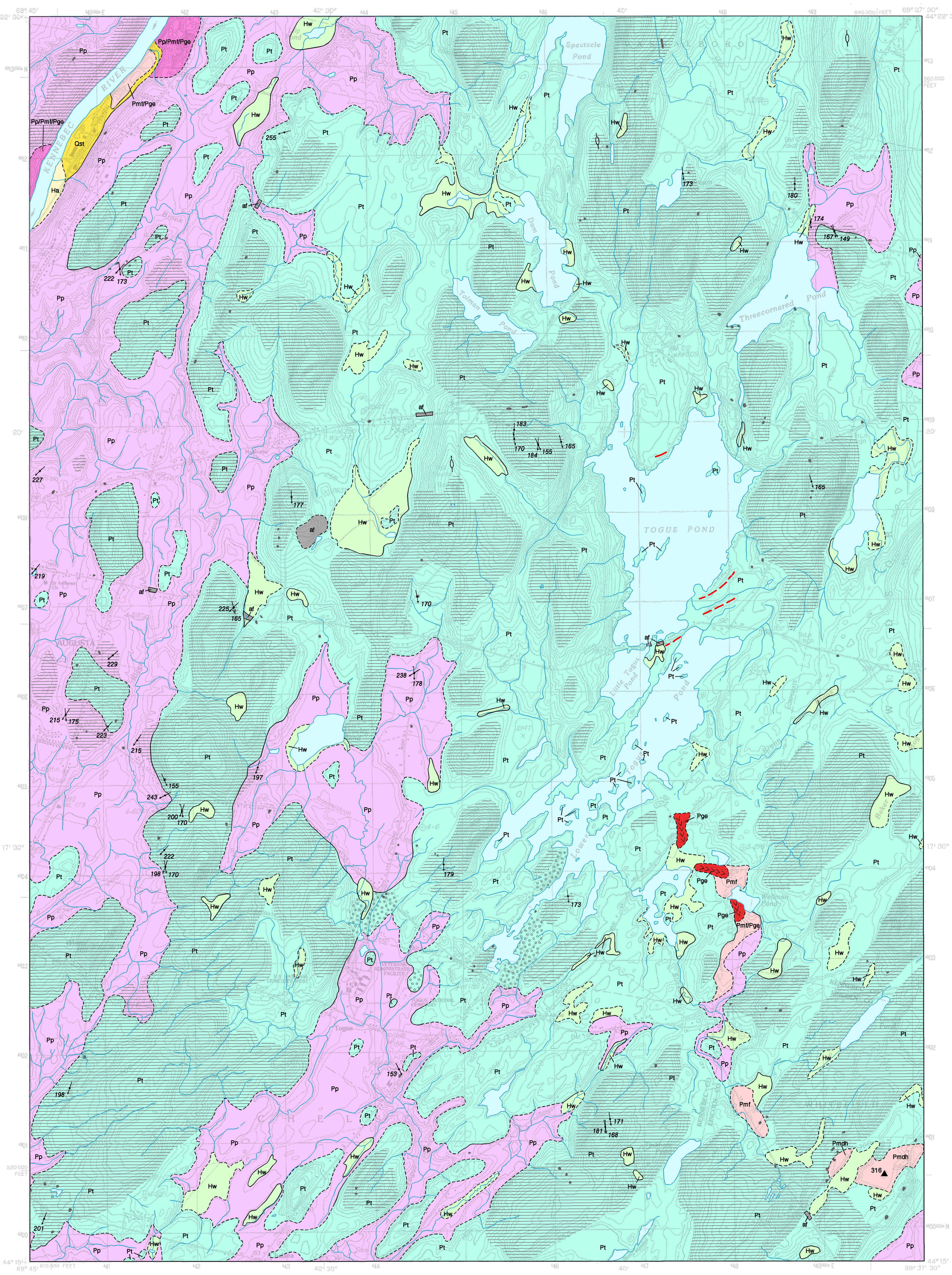
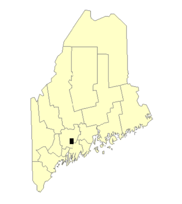
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Togus Pond quadrangle was conducted by Woodrow B. Thompson in 2004-05 for the STATEMAP program. Some of the data included here were collected by W. B. Thompson during reconnaissance surficial mapping of the Vassalboro 15-minute quadrangle in 1975 and scattered observations during the 1980's and 1990's.



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 Togus Pond quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

Ha — **Stream alluvium** - Sand, gravel, and silt deposited on flood plain of the Kennebec River.

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

Qst — **Stream terraces** - Sand and gravel deposited by the Kennebec River at elevations higher than the most recent flood plain.

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

Pmd — **Glaciomarine delta** - 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 (T/F contact) in each delta indicates the position of sea level when the delta was deposited.

Pmdh - Hunts Meadow Road delta. T/F contact at 316 ft (96.4 m).

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

Pp/Pmf/Pge — **Presumpscot Formation overlying glaciomarine fan and esker deposits.** These deposits form a complex assemblage in the Kennebec River valley. A discontinuous ridge of coarse esker gravel (Pge) in the valley bottom is generally buried by submarine fan deposits (Pmf) comprised of stratified sand and gravel. Variable thicknesses of glaciomarine silt, clay, and sand (Pp) overlie the sand and gravel units. These units could not be distinguished accurately at the scale of the map, due to their complex interrelations and limited fresh exposures. Portions of the sand and gravel units have been removed by pit operations.

Pmf/Pge — **Glaciomarine fan deposits overlying esker.** Area where glaciomarine sand, gravel, and silt is known or suspected to have been deposited on top of esker gravel.

Pge — **Esker** - Sand and gravel deposited by glacial meltwater streams in tunnels beneath the ice. Chevron symbols show inferred direction of former stream flow.

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 waterlaid 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. 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 materials in a large landfill.

Contact - Boundary between map units; dashed where location is 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.

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. Flagged trend is older.

135 — **Crescentic fracture locality** - Site where glacial flow direction has been inferred from crescentic fractures on bedrock surface. Dot marks point of observation. Number is azimuth (in degrees) of ice-flow direction.

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

Area of many large boulders, where observed. Large parts of the Togus Pond quadrangle are very bouldery, so only a few of the most conspicuous areas are indicated here.

▲350 — **Glaciomarine delta** - Number indicates elevation (in feet) of contact between delta topset and foreset beds, which marks position of sea level when the delta was deposited (from Thompson and others, 1989, and unpublished survey data).

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. Thompson, W. B., and Locke, D. B., 2005, Surficial materials of the Togus Pond quadrangle, Maine: Maine Geological Survey, Open-File Map 05-3.
2. Neil, C. D., 2005, Significant sand and gravel aquifers of the Togus Pond quadrangle, Maine: Maine Geological Survey, Open-File Map 05-44.
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. Thompson, W. B., Crossen, K. J., Borns, H. W., Jr., and Andersen, B. G., 1989, Glaciomarine deltas of Maine and their relation to late Pleistocene-Holocene crustal movements, *in* Anderson, W. A., and Borns, H. W., Jr. (editors), Neotectonics of Maine: Studies in seismicity, crustal warping, and sea-level changes, Maine Geological Survey, Bulletin 40, p. 43-67.

Togus Pond Quadrangle, Maine

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SURFICIAL GEOLOGY OF MAINE

Continental glaciers like 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. Glacial ice deposited some of these materials, while others washed into the sea or accumulated in meltwater streams and lakes as the ice receded. Earlier stream patterns were disrupted, creating hundreds of ponds and lakes across the state. The map at left shows the pattern of glacial sediments in the Togus Pond quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England (Stone and Borns, 1986). 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 over which the ice flowed. The grooves and fine scratches (striations) resulting from this scraping process are often seen on freshly exposed bedrock, and they are important indicators of the direction of ice movement. Erosion and sediment deposition by the ice sheet combined to give a streamlined shape to many hills, with their long dimension parallel to the direction of ice flow. Some of these hills (drumlins) are composed of dense glacial sediment (till) plastered under great pressure beneath the ice.

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 (Sirkin, 1986). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by 13,800 years ago (Dorion, 1993). 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 420 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. The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine. Age dates on these fossils tell us that 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. Moraine ridges are abundant in the zone of former marine submergence, where they are useful indicators of the pattern of ice retreat.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. Large sand dunes accumulated in late-glacial time as winds picked up outwash sand and blew it onto the east sides of river valleys, such as the Androscoggin and Saco valleys. 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 (Davis and Jacobson, 1985). Geologic processes are by no means dormant today, however, since rivers and wave action modify the land, and worldwide sea level is gradually rising against Maine's coast.

References Cited

Davis, R. B., and Jacobson, G. L., Jr., 1985, Late-glacial and early Holocene landscapes in northern New England and adjacent areas of Canada: Quaternary Research, v. 23, p. 341-368.

Dorion, C. C., 1993, A chronology of deglaciation and accompanying marine transgression in Maine: Geological Society of America, Abstracts with Programs, v. 25, no. 2, p. 12.

Sirkin, L., 1986, Pleistocene stratigraphy of Long Island, New York, *in* Caldwell, D. W. (editor), The Wisconsinan stage of the first geological district, eastern New York: New York State Museum, Bull. 455, p. 6-21.

Stone, B. D., and Borns, H. W., Jr., 1986, Pleistocene glacial and interglacial stratigraphy of New England, Long Island, and adjacent Georges Bank and Gulf of Maine, *in* Sibrava, V., Bowen, D. Q., and Richmond, G. M. (editors), Quaternary glaciations in the northern hemisphere: Quaternary Science Reviews, v. 5, p. 39-52.

Figure 1: Glacial grooves trending 170° (south-southeast, parallel to pen) on granite ledge west of Togus Pond in Augusta. These grooves record the SSE flow of the last ice sheet when it was thickest and overwhelmed the whole region. Other grooves and striations recorded in the quadrangle range from 153° to 238°. Where multiple directions are present, the most recent glacial flow was generally toward the southwest in a zone extending a few miles east from the Kennebec River valley. Conversely, the youngest flow in the area just west of the Kennebec valley was toward the southeast. These variations reveal a late-glacial convergence of ice flow toward the valley axis.

Figure 2: Till exposure on hillside west of Togus Pond in Augusta. This till was deposited by the most recent glacial ice sheet. It contains many large boulders of white granite that were derived from a local rock body called the Togus Pluton.

Figure 3: Till ridge on south side of Route 17 in Whitefield. This is one of many till ridges in the Togus Pond area that have a NNE orientation. They were formerly interpreted as end moraines, but their trend is not consistent with local ice-flow directions. The trend of the ridges most likely results from the NNE strike of the underlying metamorphic rock formations, over which the till is draped.

Figure 4: Gravel pit on east side of Kennebec River in Augusta, showing coarse gravel of the Kennebec valley esker system. The esker was deposited in a subglacial ice tunnel. The gravel beds in center of photo appear to be uncollapsed, yet they show an unusually steep dip of 40° toward the southwest (downvalley).

Figure 5: Southeast side of same pit as Figure 4. Lower level of pit (foreground) shows extremely coarse esker gravel. The back wall of the pit exposes a thick section of well-stratified sand and gravel. The latter unit is a submarine fan deposited over the esker. In places the fan is overlain by glacial-marine clay-silt of the Presumpscot Formation, deposited in tranquil waters when the ice receded from this locality.

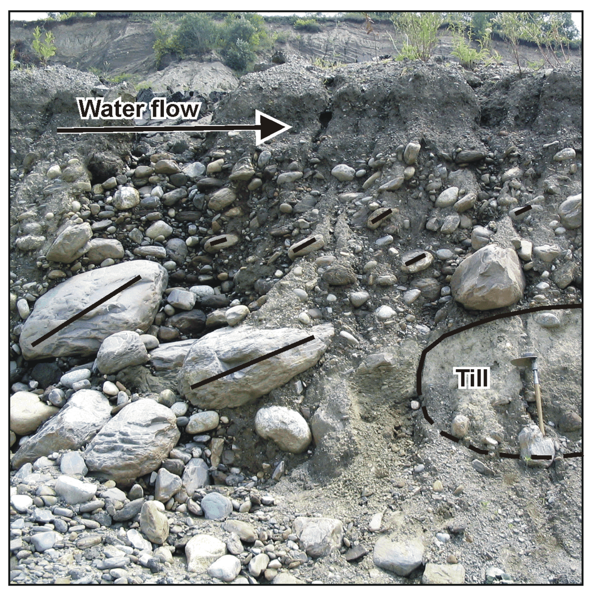

Figure 6: Close-up of the esker gravel seen in Figure 5. Many of the stones, such as the labeled examples, show a preferred orientation that confirms the expected downvalley direction of subglacial meltwater flow (left to right in this view). The photo also shows a large inclusion of till (behind shovel) that was eroded and incorporated in the gravel. Undisturbed till is present just below the pit floor. This is one of the few places in Maine where till can be directly observed beneath an esker.

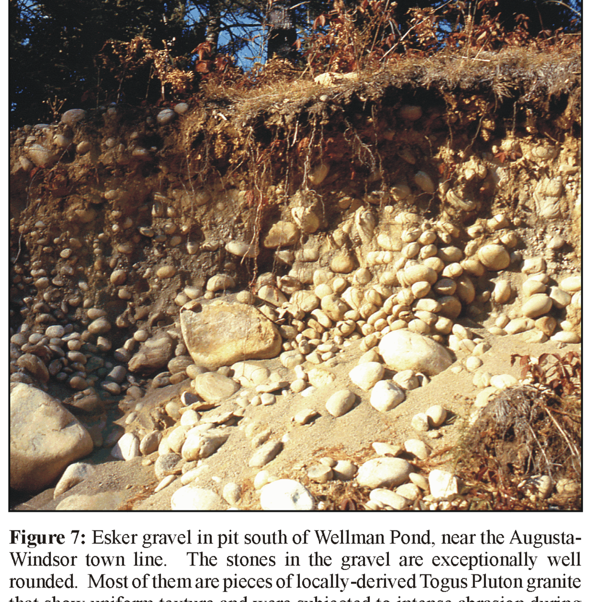

Figure 7: Esker gravel in pit south of Wellman Pond, near the Augusta-Windsor town line. The stones in the gravel are exceptionally well rounded. Most of them are pieces of locally-derived Togus Pluton granite that show uniform texture and were subjected to intense abrasion during transport in a subglacial ice tunnel.

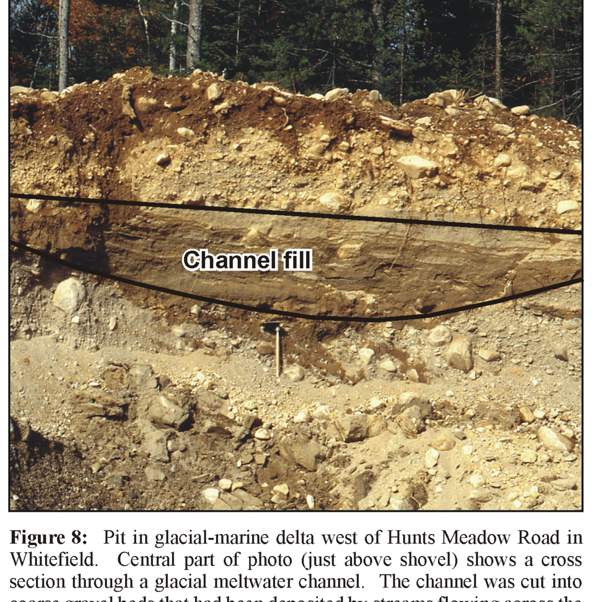

Figure 8: Pit in glacial-marine delta west of Hunts Meadow Road in Whitefield. Central part of photo (just above shovel) shows a cross section through a glacial meltwater channel. The channel was cut into coarse gravel beds that had been deposited by streams flowing across the delta top. It was then filled with silty-sandy sediments deposited under slack-water conditions, and subsequently was covered by more stream gravel.