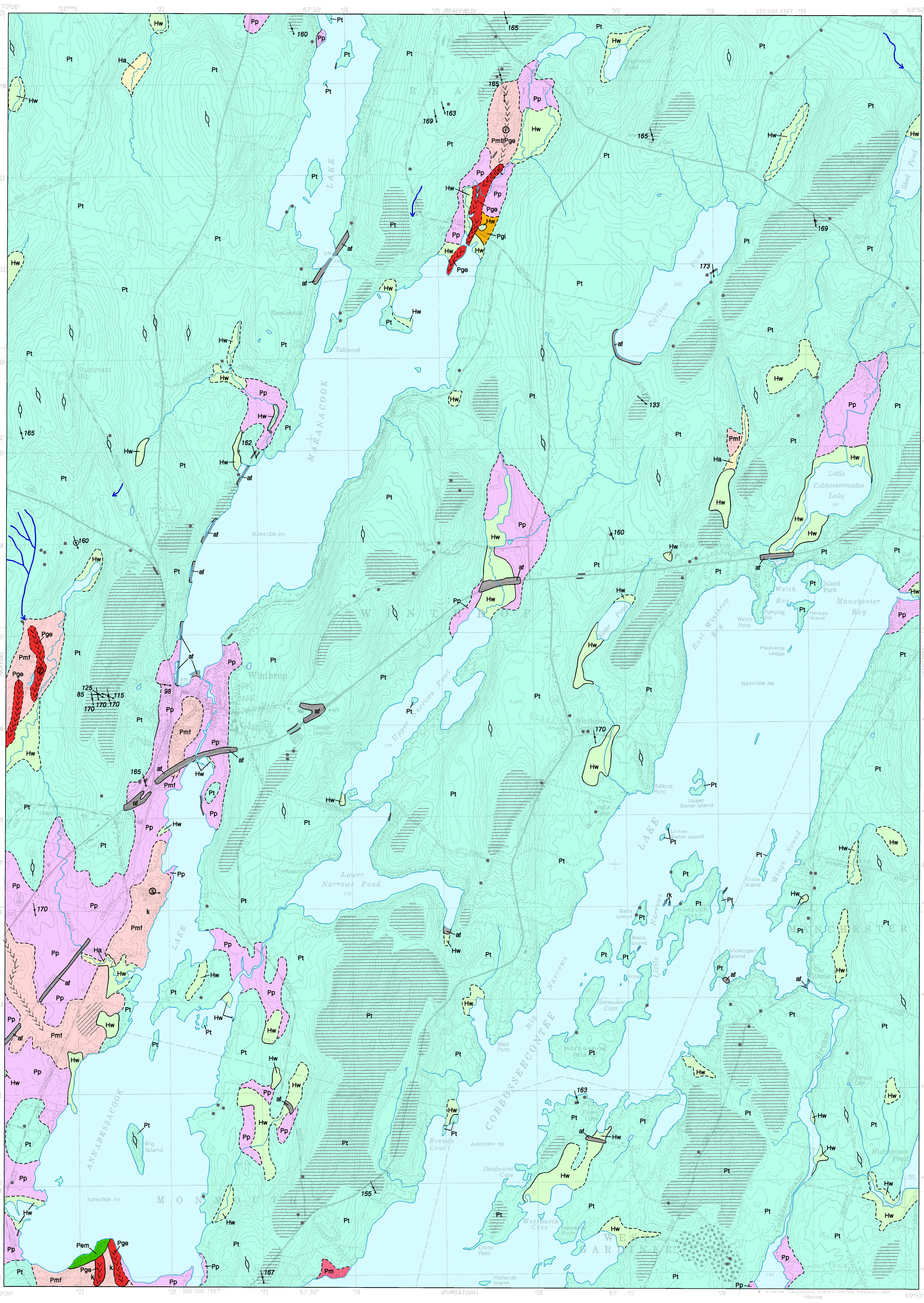
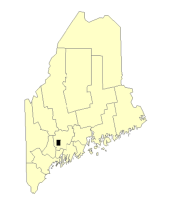
Surficial Geology



SOURCES OF INFORMATION

Modified in 2008 based on field work by Woodrow B. Thompson. Surficial geologic mapping of the Winthrop quadrangle was conducted by Woodrow B. Thompson in 2003-04 for the STATEMAP program. Some of the data included here were collected by W. B. Thompson during reconnaissance surficial mapping of the Augusta 15-minute quadrangle in 1975 and scattered observations during the 1980's and 1990's.



Quadrangle Location

SCALE 1 : 24,000

1 MILE · 7000 FEET · 1 KILOMETER

CONTOUR INTERVAL 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Winthrop 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 streams. May include some wetland deposits.

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

Pm — **Unclassified glaciomarine sediments.** Small deposit of fine sand near south edge of quadrangle. May be part of the Presumpscot Formation.

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

Pmf — **Glaciomarine fans** - Sand and gravel deposited as submarine fans at the glacier margin during recession of the late Wisconsinan ice sheet. Includes patches of Presumpscot clay-silt, which are locally fossiliferous.

Pgi — **Ice-contact deposits** - Glacial sand and gravel formed in contact with remnant ice in the Beaver Brook valley.

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

Pem — **End Moraine** - Ridge of glacial till deposited at the margin of the late Wisconsinan ice sheet when it stood at the south end of Annabessacook Lake.

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. "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, railroads, and the dam at Carlton Pond. Shown only where large enough to affect the contour pattern on the topographic map.

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

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.

135 **Till fabric site** - Arrow shows direction of glacial ice flow indicated by parallel alignment of elongate stones in till.

Dip of cross-bedding - Arrow shows average dip direction of cross-bedding in glaciomarine fan deposits, which indicates direction of fan progradation. Dot marks point of observation.

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

>>>>> **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. May be more extensive than shown.

Area where original topography has been modified or obliterated by excavation.

k **Kettle** - Depression created by melting of buried glacial ice and collapse of overlying sediments.

(F) **Marine fossil locality.**

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., 2004, Surficial materials of the Winthrop quadrangle, Maine: Maine Geological Survey, Open-File Map 04-33.
2. Neil, C. D. and Weddle, Thomas K., 2004, Significant sand and gravel aquifers of the Winthrop quadrangle, Maine: Maine Geological Survey, Open-File Map 04-78.
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.

Winthrop Quadrangle, Maine

Surficial geologic mapping by
Woodrow B. Thompson

Digital cartography by:
Robert A. Johnston

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

Funding for the preparation of this map was provided in part by the U.S. Geological Survey STATEMAP Program, Cooperative Agreement No. 03HQAG0068.

Maine Geological Survey

Address: 22 State House Station, Augusta, Maine 04333
Telephone: 207-287-2801 **E-mail:** mgs@maine.gov
Home page: http://www.maine.gov/doc/nrimc/nrimc.htm

Open-File No. 08-75
2008

This map supersedes Open-File Map 07-83.

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 Winthrop quadrangle.

The most recent "Ice Age" in Maine began about 30,000 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 (Ridge, 2004). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by about 16,000 years ago (Borns and others, 2004). 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 13,000 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 12,000 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

Borns, H. W., Jr., Doner, L. A., Dorion, C. C., Jacobson, G. L., Jr., Kaplan, M. R., Kreutz, K. J., Lowell, T. V., Thompson, W. B., and Weddle, T. K., 2004, The deglaciation of Maine, U.S.A., *in* Ehlers, J., and Gibbard, P. L., eds., Quaternary Glaciations – Extent and Chronology, Part II: North America: Amsterdam, Elsevier, p. 89-109.

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.

Ridge, J. C., 2004, The Quaternary glaciation of western New England with correlations to surrounding areas, *in* Ehlers, J., and Gibbard, P. L., eds., Quaternary Glaciations – Extent and Chronology, Part II: North America: Amsterdam, Elsevier, p. 169-199.

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: Glacially striated boulder in Beaver Brook valley, Readfield. Striations trend parallel to the pen.

Figure 2: Gravel pit showing cross section through an esker, west side of Beaver Brook valley, Readfield. The coarse, poorly sorted gravel is typical of many eskers, which were deposited by meltwater streams in subglacial ice tunnels.

Figure 3: Pit exposure showing succession of glacial sediments in Beaver Brook valley, Readfield. The lowest unit is esker gravel deposited in a subglacial ice tunnel. The middle unit consists of approximately 50 beds, each of which grades upward from fine sand to silt. These beds probably are distal submarine fan deposits formed by a series of sediment flows. They are overlain in turn by silt and clay (Presumpscot Formation) deposited in tranquil marine waters when the glacier margin had retreated from this area.

Figure 4: This pit on the west side of Lake Annabessacook (Winthrop) exposed a submarine fan that formed where sediment discharged into the sea at the mouth of a glacial ice tunnel. The sand and gravel deposits in both this area and the Beaver Brook valley (Readfield) are interpreted as complex associations of eskers and submarine fans which are overlain in places by glacial-marine clay and silt of the Presumpscot Formation. *Hiatella arctica* shells from this pit had a radiocarbon age of 12,445 ± 100 years (Smithsonian Institution lab sample SI-4649; Thompson and Smith, 1988). Other species found here by the author in 1980 included *Macoma* sp., *Mya arenaria* (clams), *Mya truncata* (clams), *Mytilus edulis* (mussels), and some barnacles.

Figure 5: Glacial till exposure southwest of Route 133, Winthrop. The pit face showed a cross section through a bouldery till ridge that may have been deposited as an end moraine at the edge of the last glacial ice sheet. This ridge was draped over an older till that is much less stony. Most of this deposit has been removed since the photo was taken.

Figure 6: Gravel pit in upper Hoyt Brook valley west of Winthrop village, showing well-stratified sand deposited in a marine nearshore environment as the sea withdrew and became shallow. The sand overlies glacial-marine silt and clay (concealed by slump in lower part of section) deposited when the water was deeper.

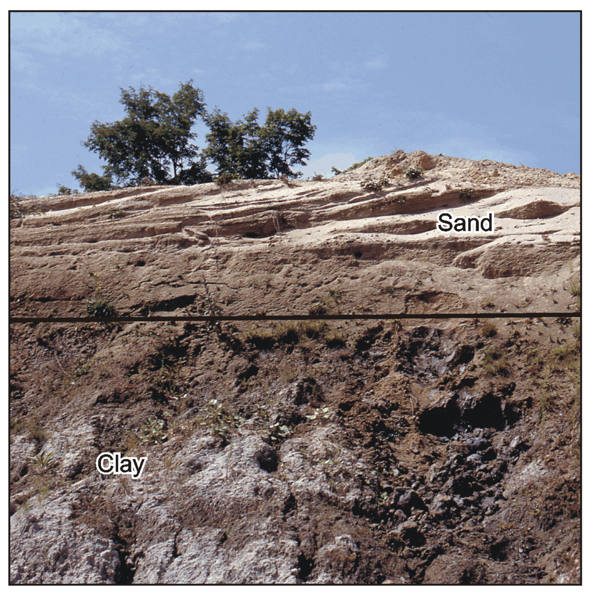


Figure 7: Marine nearshore sand overlying glacial-marine clay in Beaver Brook valley, Readfield. A *Macoma calcarea*(?) shell was collected by the author in 2004, at a depth of 3 ft below the sand/clay contact. This specimen had a radiocarbon age of 13,100 ± 70 years (Geochron Laboratories sample GX-31327-AMS). Sea level was about 300 ft higher than today when the marine fauna lived here.

Figure 8: Shell impressions in marine clay, in the same cluster of Readfield gravel pits as the site shown in Figure 7. Fossil shells of several mollusk species were found here by the author in 1984, including *Hiatella arctica*, *Macoma* sp., *Mya arenaria*, *Mya truncata*, and *Mytilus edulis*.