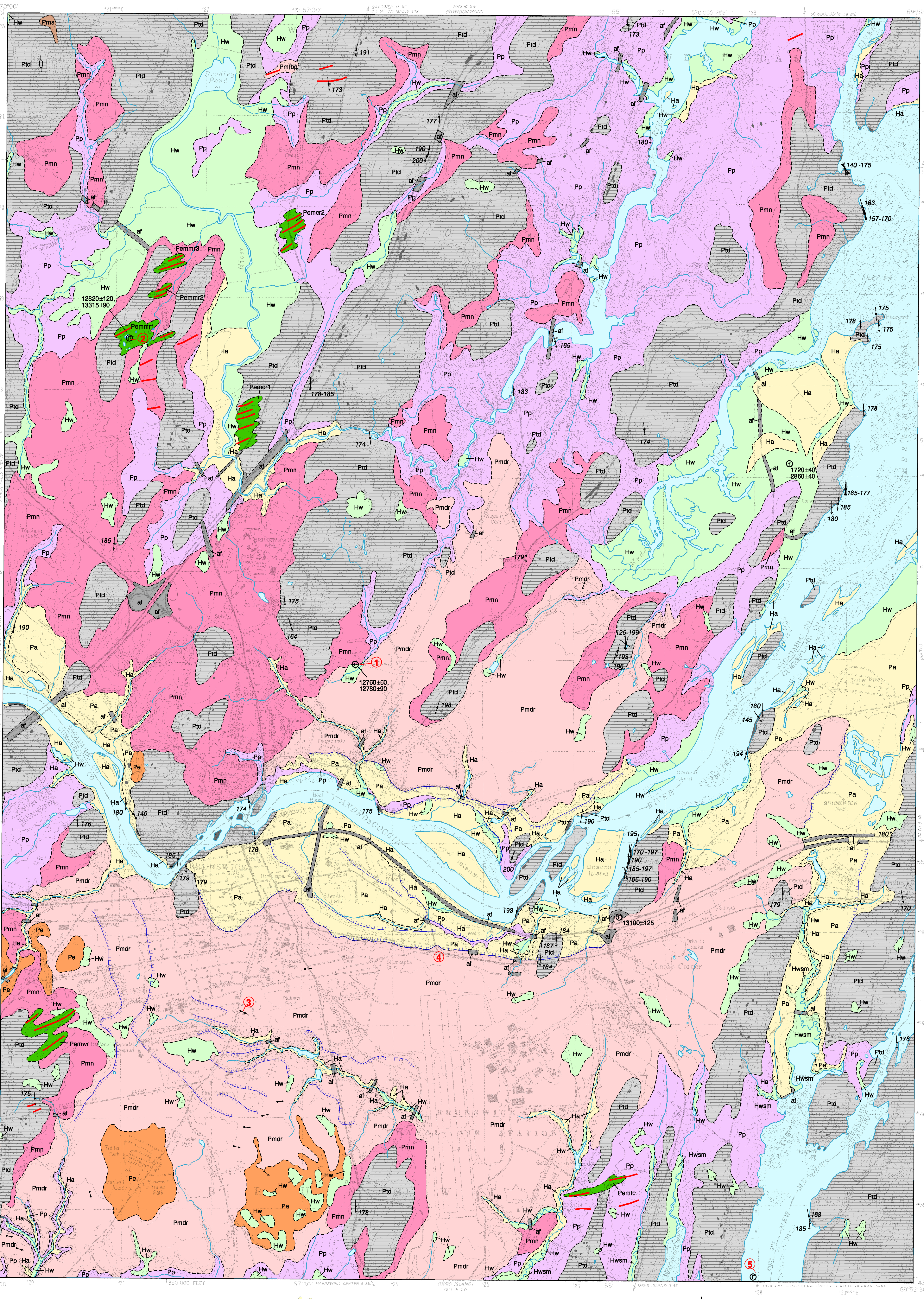
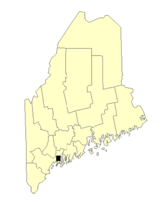
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Thomas K. Weddle completed during the 2000-2001 field seasons; funding for this work provided by the U.S. Geological Survey STATEMAP program.



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 Brunswick 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.

Unit	Description
af	**Artificial fill** - Includes landfills, highway and railroad embankments, and dredge spoil areas. These units are mapped only where they are resolvable using the contour lines on the map, or where they define the limits of wetland units. Minor artificial fill is present in virtually all developed areas of the quadrangle.
Ha	**Stream alluvium** - Gray to brown fine sand and silt with some gravel. Comprises flood plains along present streams and rivers. Extent of alluvium approximates areas of potential flooding.
Hw	**Freshwater wetlands** - Muck, peat, silt, and sand. Poorly drained areas, often with standing water.
Hwsm	**Saltmarsh wetlands** - Peat, muck, silt, and clay. Coastal marsh, subject to tidal flooding. Thin, non-commercial peat layers are present atop a mineral substrate consisting of estuarine sands and muds.
Pe	**Eolian deposits** - Pleistocene eolian deposits comprised of mantle of wind-blown sand and dunes formed following the marine regression. Found often as a blanket deposit, too thin to show on map.
Pa	**Braided-stream alluvium** - Pleistocene alluvium consisting of fluvially deposited sand and gravel; trough-crossbeds with rare mud drapes and intraclasts are representative of braided streams and coastal braid-delta environment formed during the marine regression.
Pmdr	**Regressive marine delta** - Pleistocene marine delta formed during regression of the sea due to isostatic emergence of the land. Very low-angle sand and silt foreset bedding is mantled by trough cross-bedded sand, deposited by braided streams which flowed over the delta top as it prograded seaward. In places, may be mantled with unmapped thin eolian deposits.
Pms	**Marine shoreline** - Pleistocene beach and dune sands deposited during regressive phase of marine submergence. Beach morphology is poorly preserved, but sand and gravel are present along the ridge crest.
Pmn	**Marine nearshore deposits** - Pleistocene gravel, sand, and mud deposited as a result of wave activity in nearshore or shallow-marine environments; not associated with beach morphology.
Pp	**Presumpscot Formation** - Massive to laminated silty clays with rare dropstones and occasional shelly horizons, which overlie rock and till, and are interbedded with and overlie end moraines and marine fan deposits; includes sand deposited as a distal unit of submarine fans.
Pem	**End moraines** - Linear ridges consisting of bedded sand and gravel interbedded with Presumpscot Formation silty clays and overlain by till on the ice-proximal faces of the moraines. Some moraines, or groups of moraines, have been assigned a unique geographic name listed below: Pemcrx - Cathance Road moraines 1 to 2 Pemmrz - Meadow Road moraines 1 to 3 Pemwr - Woodside Road moraines Pemfc - First Church moraine
Pmf	**Submarine outwash fans** - Thick sand and gravel accumulations formed at the mouth of subglacial tunnels along the receding late Pleistocene ice margin. The sand and gravel is interbedded with and overlain by Presumpscot Formation clays at the distal edges of the fans, and interlayered with and overlain by tills at their ice-contact faces. Some fans, or group of fans have been assigned a unique geographic name listed below: Pmfbp - Bradley Pond fan
Ptd	**Thin-drift areas** - Areas with generally less than ten feet of drift covering bedrock. Till overlies bedrock on hillslopes and ridge crests; Presumpscot Formation silty clays are present in depressions; and nearshore deposits overlie till, Presumpscot Formation, and bedrock on hillslopes and at the base of these slopes. Small rock outcrops, and areas of numerous small outcrops are shown as solid gray areas.

Symbol	Explanation
(line)	Contact between units; dashed where inferred
135 135	Striations - observations made at dot. Number indicates azimuth (in degrees) of ice-flow direction. Where two directions are observed in the same outcrop, flags indicate older trends where discerned.
(red line)	End moraine crests.
(hachured line)	Scarps.
(drumlin symbol)	Drumlin.
10,150±450 (F)	Marine fossil locality (may be from natural exposure or subsurface core). Numbers are radiocarbon-age estimates.
10,150±450 (f)	Non-marine fossil locality (may be from natural exposure or subsurface core). Numbers are radiocarbon-age estimates.
(arrow)	Dip direction of fluvial cross-bedding
4	Photo or other image locality - Location of site shown and described in map legend.

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. Locke, D. B., and Weddle, T. K., 2001, Surficial materials of the Brunswick quadrangle, Maine: Maine Geological Survey, Open-File Map 01-485.
2. Neil, C. D., 1999, Significant sand and gravel aquifers of the Brunswick quadrangle, Maine: Maine Geological Survey, Open-File Map 99-18.
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. (eds.), Neotectonics of Maine: Maine Geological Survey, Bulletin 40, p. 43-67.

Brunswick Quadrangle, Maine

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SURFICIAL GEOLOGY OF THE BRUNSWICK QUADRANGLE

The surficial geology in the Brunswick quadrangle records the advance and retreat of the last great glacier in the region, the Laurentide ice sheet, and subsequent Holocene events and deposits. Of the deposits associated with this record, the Brunswick sand plain is the most prominent in the quadrangle. Radiocarbon age analyses of marine fossils from deposits have provided an estimate of the time when the sand plain was formed, and also a basis for hypothesizing that it formed during a worldwide rapid rise in sea level.

By the end of the last great ice age, as the glaciers were melting and the retreating ice margin had reached the present-day coast of Maine, the ocean had flooded the Gulf of Maine and was in contact with the ice front. This flooding was in response to downwarping of the earth's crust due to the weight of the massive ice sheet. As the ice melted, the depressed crust did not respond immediately to the release of weight from the ice, and as a result the sea was able to flood inland, up river valleys and in lowlands. In the Brunswick quadrangle, the highest elevation that the sea reached is about 275 feet above sea level. During the retreat of the ice and the relative rise of sea level, discharging meltwater from the ice carried sediment to the sea where it was deposited. Later, when the earth's crust began to respond to the released weight of the ice, emergence of the land from the sea resulted in a relative fall of sea level, and nearshore deposits associated with the lowering sea were laid down in the shallow water.

The elevation of the sand plain is well below the highest elevation of older marine deposits, by as much as 175 feet. Clearly it is a younger feature than the high elevation marine sediments. Exposures in the surface of the plain show trough cross-bedded sand, representative of a braided stream fluvial system. Test-boring logs and geophysical data indicate the shallow geologic sequence records the transition by late-glacial isostatic emergence from marine to near-shore conditions and the deposition of the Brunswick sand plain. Surficial sand of the plain overlies a sandy silt zone that includes discrete, correlated sand units, which gently dip eastward. Beneath the sandy deposits, thick glaciomarine mud overlies sand and till lying on top of bedrock.

Age analyses on marine fossils from the section shown in Location 1 found at an elevation just above the highest surface of the sand plain yielded 12.8 ka ages. Samples from a seismically identified sequence (Location 5), probably very much like the sequence shown at Location 1, provide the youngest ages from marine fossils (12.2 ka). The seismically identified units are likely the distal equivalent of the sand plain.

Marine fossil radiocarbon ages must be corrected for "old" carbon derived from sea water. For the Pleistocene Gulf of Maine the correction is estimated at ~600 years (Dorion and others, 2001). Thus, using 12.2 and 11.6 as corrected bracketing ages for the time of formation of the Brunswick sand plain, the time overlaps the period of rapid worldwide sea level rise during MWP-1A, which occurred between 12.6 and 11.7 kyr BP (Bard et al., 1990; Adkins et al., 1998). The data support the interpretation that the sand plain is a coastal braid-plain delta formed as emergence continued, but during a period of relative sea-level stability as a result of MWP-1A.

References Cited

Adkins, J. F., Cheng, H., Boyle, E. A., Druffel, E. R. M., and Edwards, R. L., 1998, Deep-sea coral evidence for rapid change in ventilation of the deep North Atlantic 15,400 years ago: Science, v. 280, p. 725-728.

Bard, E., Hamelin, B., and Fairbanks, R. G., 1990, U-Th ages obtained by mass spectrometry in corals from Barbados: Sea level during the past 130,000 years: Nature, v. 346, p. 456-458.

Crider, H. B., 1998, Late Pleistocene development of the Brunswick sand plain and adjacent paleochannel (unpublished M.S. thesis): Boston University, Boston, Massachusetts, 219 p.

Dorion, C. C., Balco, G. A., Kaplan, M. R., Kreutz, K. J., Wright, J. D., and Borns, H. W. Jr., 2001, Stratigraphy, paleoceanography, chronology, and environment during deglaciation of eastern Maine, *in*: Weddle, T. K., and Retelle, M. J., (eds.), Deglacial History and Relative Sea-Level Changes, Northern New England and Adjacent Canada: Boulder, Colorado, Geological Society of America Special Paper 351, p. 215-242.

Oakley, A. J., 2001, The seismic and sedimentological characteristics of the upper New Meadows River, mid-coast Maine (unpublished Senior thesis): Bowdoin College, Brunswick, Maine, 29 p.

Location 1. Light gray massive-appearing glaciomarine mud at base of section, overlain by layered mud that changes color from dark gray and brown up section, and capped by tan silty sandy and sand at top of section (this site is now covered).

Location 1. Rock outcrop overlain by stony till, draped by Presumpscot Formation at location 1, Brunswick-Topsham Route 196 Bypass.

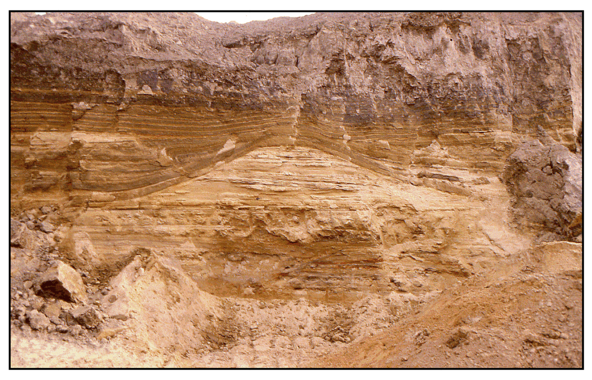
Location 1. West end of section. Note abrupt contact between gray and brown layered mud at mid-section of road cut. Unconformity between dipping beds and overlying horizontal beds at top of section marks transition between coarsening upward marine regressive sequence and tan shoreline sand. A thin veneer of wind-blown sand (darker tan material at very top of section).

Location 1. Presumpscot Formation; shovel is at contact between layered mud and underlying massive-appearing mud. Note convoluted layers along horizons above shovel head. Slumping of the layers after they were deposited on the ocean floor disrupted the beds. Later, deposition continued with no slumping, evident by the undisturbed layers up section.

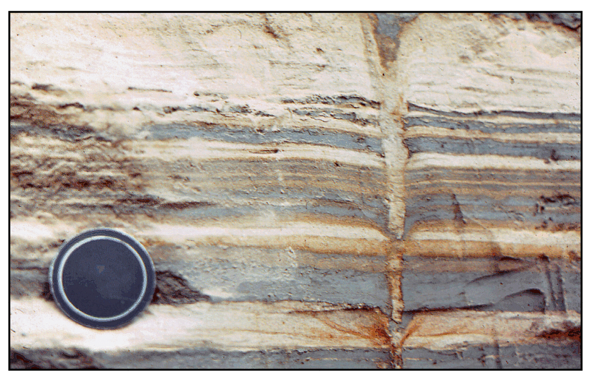
Location 1. Barnacle basal plates attached to rock outcrop. Radiocarbon age analyses from these and other marine fossils are approximately 12,800 years before present.

Location 1. Assemblage of fossils from section: left to right, dropstone with barnacles attached; juvenile whelk; juvenile snail (*Natica clausa*); two scallops (*Pecten irradians*); three clamshells in front of small scallop (left to right) *Macoma baltica*, and two valves from *Serripes groenlandicus*.

Location 2. Laminated sand and mud containing a lense of coarse-grained debris, which melted out from an iceberg onto the sea floor or slumped off the ice, and was later overlain by undeformed sediment. Webber Pit; photo by M. J. Retelle.

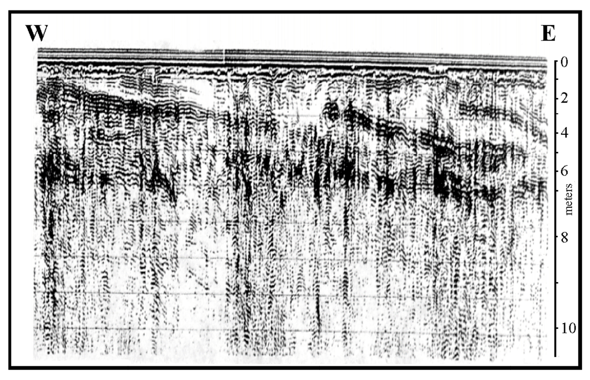


Location 2. Lobe of bedded sand in a glaciomarine fan at bottom of section, truncated and draped by rhythmically bedded sand and mud of younger overlying fan lobe; photo by M. J. Retelle.

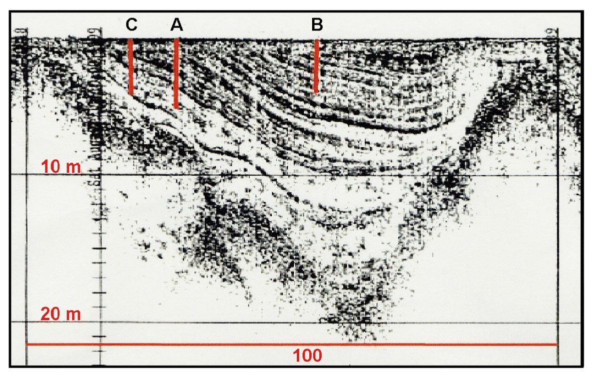


Location 2. Nearshore deposits with vertical burrow by mollusk (?) cutting through laminated sand and mud (photo M. J. Retelle).

Location 3. Fluvial trough cross-bedded gravelly sand interpreted to be delta topset beds at surface exposure of Brunswick sand plain. Bedding is characteristic of shallow-water braided streams, which flowed on the surface of the plain then into ocean to form a coastal braid-plain delta. View is to west, flow direction is to the east toward observer.



Location 4. Ground-penetrating radar image from Brunswick sand plain, showing eastward-directed shallow-dipping forms interpreted to be low-angle delta foreset beds of the Brunswick sand plain (Crider, 1998).



Location 5. Seismic section from New Meadows River. Layering in seismic image represents layering in glaciomarine deposits similar to that seen at Location 1. Location and length of cores taken from sediment are represented by the capital letters A, B, and C. The upper part of the seismic sequence is likely the distal equivalent of the sand plain. Radiocarbon-dated fossil shells from core C and core B are respectively 13,300 and 12,300 years before present (Oakley, 2001).