DEPARTMENT OF CONSERVATION
Maine Geological Survey

Robert G. Marvinney, State Geologist

OPEN-FILE NO. 99-137

Title: *Surficial Geology of the York Beach 7.5-minute quadrangle, York County, Maine*

Author: *Patrick B. O'Toole and J. Michael Clinch*

Date: *1999*

Financial Support: Funding for the preparation of this report was provided in part by the U.S. Geological Survey Cooperative Geological Mapping (COGEOMAP) Program, Cooperative Agreement No. 14-08-0001-A0381.

Associated Maps: Surficial geology of the York Beach quadrangle, Open-File 99-106
Surficial materials of the York Beach quadrangle, Open-File 98-167

Contents: 3 p. report

Maine Geological Survey
Open-File 99-137

Surficial Geology of the York Beach 7.5-minute Quadrangle, York County, Maine

Patrick B. O'Toole
J. Michael Clinch

INTRODUCTION

The York Beach quadrangle lies along the coast of southwestern Maine in York County, and has a land area of about 10 mi^2 (26 km^2). Altitudes in the quadrangle range from sea level to 224 ft (68 m) above sea level (a.s.l.), but are generally less than 100 ft (30 m). The underlying bedrock consists of metamorphosed igneous and sedimentary rocks which are exposed at numerous small outcrops (bedrock descriptions below are summarized from Hussey, 1985). The surficial material is primarily the result of a late Wisconsinan glaciation during which the Laurentide Ice Sheet covered all of New England.

BEDROCK GEOLOGY

The Kittery Formation of the Merrimac Group is exposed in a narrow strip along the coast. The absolute age of this formation is uncertain, with estimates ranging from Precambrian to Silurian. The Kittery Formation consists of three rock types: (1) a thinly laminated calcareous and feldspathic quartzite; (2) a gray feldspathic, micaceous calcareous quartzite with a dark-brown color and fine texture; and (3) a dark or brownish-gray chlorite or biotite phyllite. It is thought that the Kittery Formation accumulated mostly as turbidites in a deep-sea submarine fan environment.

Most of the York Beach quadrangle is underlain by plutonic rocks of the Agamenticus Complex (Early Triassic age). Although four plutonic phases exist in this complex, only three are present in the map area. The age relationships of the phases are uncertain, but the oldest is presumed to be a medium-grained, brown to olive-green syenite located in the Wander Hill vicinity. The presumed next youngest is an alkaline quartz syenite which surrounds the older syenite stretching from the town of Cape Neddick around to Gulf Hill. The mineralogy of the two syenites is similar except that the younger body has much more quartz (10-15%). The youngest member of the Agamenticus Complex in the quadrangle is an alkaline granite characterized as a fine-grained, buff to slightly salmon colored intrusive. This unit is located in the Simpson Hill area.

A relatively small composite basic pluton, referred to as the Cape Neddick Complex, is exposed on the Cape Neddick peninsula. The complex is of Cretaceous age and consists of two bodies: a central funnel of dark gray anorthosite gabbro which is intruded by two partial cone sheets. The cone sheets and the marginal parts of the funnel are composed of a dark-gray poikilophitic cortlandtitic gabbro. The older intrusion consists of augite, hornblende, biotite, altered olivine, magnetite, and labradorite. The younger gabbro is mineralogically similar except it contains hypersthene and unaltered olivine.

A small body of explosion breccia rims the eastern edge of Cape Neddick. According to Hussey (1985) the breccia is composed of fragments (up to 2 in (5 cm) in diameter) of the Kittery Formation and dark colored, aphanitic volcanic or shallow hypabyssal rocks.

Dispersed throughout the quadrangle are north-northeast trending basic dikes. The dikes are composed mostly of basalt or diabase and range in age from Early Triassic to Early Cretaceous. They are non-metamorphosed, but frequently show a wide variety of deuteric alteration effects. It has been reported that the dikes may constitute up to 35% of the rocks exposed in this area.

GLACIAL AND POSTGLACIAL DEPOSITS

The surficial geology of the York Beach quadrangle is primarily the result of glacial activity which took place during late Wisconsinan time. The late Wisconsinan deposits can be divided into three types: (1) materials deposited directly by the glacial ice (i.e., till); (2) deposits related to deglacial processes associated with the late-glacial marine submergence (i.e., the Presumpscot Formation); and (3) a thin mixture of sediments eroded from till and the Presumpscot Formation. Only minor re-

working and deposition has taken place since regression of the sea from southwestern coastal Maine.

Till (Pt) in the York Beach quadrangle is a loose, sandy-matrix diamicton which blankets much of the map area. The till is generally a thin, nonsorted to poorly sorted, nonstratified mixture of sand, granules, cobbles, and boulders. However, a thick (50 ft; 15 m) exposure of till is present at Dove Bluff on Cape Neddick. Erratics In the surface till include granites, phyllites, quartzites, schists, and basalts that appear to have been derived from the northwest. Field identification of the till was made on the basis of hummocky topography and abundance of erratics, supplemented by auger-hole subsurface data. This till is generally found at elevations above 60 ft (18 m) a.s.l., where it is not overlain by Presumpscot Formation clays and silts. The till is very thin (commonly less than 10 ft (3 m) thick) over the northern half of the quadrangle, as shown by the ruled pattern on the geologic map. The distribution of thicker till suggests that much of the till has colluviated downslope.

The Presumpscot Formation (Pp) and sandy regressive marine deposits (Pmrs) are glaciomarine, marine, and nearshore sediments deposited as the glacier retreated in contact with ocean waters. The Presumpscot Formation consists of silts and clays derived from glacial rock flour. It typically is bluish gray in fresh exposures, and is oxidized to an olive-gray to greenish color with prominent manganese stains in weathered exposures. While the Presumpscot Formation may be found anywhere at elevations below the marine limit (180-190 ft; 55-58 m), it occurs in mappable thicknesses only in flat, low-lying areas from 5 to 30 ft (2-9 m) above sea level along major drainages, and is characterized by low relief. The sandy marine sediments (Pmrs) may include ice-proximal deposits, beach or nearshore deposits, and wave-reworked deposits formed during the marine recession. Locally the sands are medium to coarse grained, oxidized, and yellow to rust-colored. This unit was found at only one locality in the quadrangle, just north of Simpson Hill.

In many places the surficial material is a thin mixture of sediments derived from reworking of till and Presumpscot Formation. These marine nearshore deposits are mapped as Pmn. Bedrock outcrops are common in these areas, but are too small to map individually. Pmn is the result of marine erosion and redeposition of Pleistocene sediments during the marine offlap. Identification in the field was based on the presence of bedrock outcrops, erratic boulders, and Presumpscot Formation silts and clays in close proximity. Contacts between Pmn and Pt, and Pmn and Pp are gradational, and many of the mapped boundaries are approximately located. Pmn is generally found near the coast in areas of moderate elevation (20-80 ft (6-24 m) a.s.l.).

Holocene deposits also exist in the York Beach quadrangle. They include wetlands, salt marshes (Hwsm), and marine shoreline deposits (Hms). Wetlands are classified according to whether they are freshwater marshes (Hwfm), salt-water marshes (Hwsm), or swamps (Hws). Some of the wetlands are underlain by peat and are further classified according to thickness and ash content of the peat (see map explanation [O'Toole and Clinch, 1999]). Swamps are primarily muck, peat, and silt, and are found in areas of low relief underlain by either Pp or bedrock. The salt marshes generally have less than 5 ft (1.5 m) of fibrous peat, which is interlayered with silt. Marine shoreline deposits include beaches and zones of wave-reworked sediments, and are located along the coast.

LATE WISCONSINAN GLACIAL HISTORY

Although southwestern Maine has probably undergone several glaciations, evidence for only the late Wisconsinan glaciation is preserved in the York Beach quadrangle. During this time the Laurentide Ice Sheet covered the entire Gulf of Maine, and at its maximum extended south to Long Island, New York. Regional ice flow directions were from the northwest to the southeast (Thompson, 1982; Smith, 1985); however, no evidence was found in the quadrangle to confirm this. In addition, because of the complete lack of ice-marginal deposits, the chronology of ice retreat in this area is difficult to discern.

Recession of the late Wisconsinan glacier reached the southern coast of Maine at approximately 14,000 years B.P. to 13.500 yr B.P., as shown by radiocarbon dates of 13,800 ± 100 yr B.P. and 13,200 ± 120 yr B.P., both of which were obtained from Kennebunk, located a few miles to the northeast (Smith, 1985; Thompson and Borns, 1985). No radiocarbon dates are available from the York Beach quadrangle itself. Recession was caused by calving into marine waters, and was accompanied by marginal thinning and drawdown of the ice. By analogy with modern glaciers, the configuration of the ice margin probably was controlled by local topography. Regionally, the glacier retreated to the northwest; and successive ice marginal positions, reconstructed from grounding line moraines and radiocarbon dates, parallel the coastline. Locally, however, no ice-marginal positions were found.

Contemporaneous with the deglaciation of southwestern Maine was the inundation of the coastal region, including much of the map area, by the transgressing sea, the result of isostatic depression caused by the weight of the ice. At its maximum extent (approximately 13,000 years B.P.) The marine submergence extended inland about 15 mi (24 km) in this part of Maine . The marine limit in the quadrangle is estimated at 190 ft (58 m) a.s.l. (Thompson and others, 1983). The Presumpscot Formation (Pp) was deposited at this time as a blanket on small hills and in valleys.

The marine recession is thought to have started shortly after the ice margin had retreated beyond the inland limit of marine submergence (Thompson and Borns, 1985). During the marine recession, sediments that had been deposited on the steeper slopes were reworked to form sandy sediments. Till and Pre-

sumpscot Formation silts and clays that covered bedrock in the southeast portion of the quadrangle were extensively reworked and eroded, leaving only a thin layer of erratics and clay over bedrock. The marine recession continued until sea level was considerably lower than modern sea level. The only local evidence for this recession is in test borings along the Bragdon Bridge, located in the York Harbor quadrangle to the west. There, the Presumpscot Formation clays have been truncated by postglacial erosion to a depth of 55 ft (17 m). Since that time, sea level has risen to its modern height, accompanied by the deposition of modern beach deposits and the development of salt marshes and other wetlands. The only evidence for large scale erosion and redeposition is found at Dover Bluff, on the south side of Cape Neddick, where wave erosion has cut a cliff into a thick till deposit, leaving a cobble to boulder beach at the foot of the bluff. Sands eroded from this till exposure have been redistributed southward to form Long Sands Beach.

REFERENCES

Hussey, A. M., II, 1985, The bedrock geology of the Bath and Portland 2-degree map sheets: Maine Geological Survey, Open-File Report 85-87, 82 p.

O'Toole, P. B., and Clinch, J. M., 1999, Surficial geology of the Kittery quadrangle, Maine: Maine Geological Survey, Open-File Map 99-88.

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

Thompson, W. B., 1982, Recession of the Late Wisconsinan ice sheet in coastal Maine, *in* Larson, G. J., and Stone, B. D. (eds.), Late Wisconsinan glaciation of New England: Kendall/Hunt, Dubuque, Iowa, p. 211-228.

Thompson, W. B., and Borns, H. W., Jr., 1985, Till stratigraphy and Late Wisconsinan deglaciation of southern Maine: A review: Geographie Physique et Quaternaire, v. 39, no. 2, p. 199-241.

Thompson, W. B., Crossen, K. J., and Borns, H. W., Jr., and Andersen, B. G., 1983, Glacial-marine deltas and late Pleistocene-Holocene crustal movements in southern Maine: Maine Geological Survey, Open-File Report 83-3, 18 p.