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Cumberland County, Maine*

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Surficial materials of the Portland East quadrangle, Open-File 99-39

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# *Surficial Geology of the Portland East 7.5-minute quadrangle, Cumberland County, Maine*

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## **INTRODUCTION**

Field work was undertaken in 1994 in order to map the surficial geology of the Portland East 7.5-minute quadrangle for the Maine Geological Survey (MGS). A surficial geologic map (Bernotavicz, 1999a) and a surficial materials map (Bernotavicz, 1999b) were constructed using data obtained in the field and from previous investigations. The geologic map displays the various types of surficial sedimentary deposits formed during the most recent (late Wisconsinan) glaciation, as well as those formed in postglacial (Holocene) time. The materials map shows the locations of sites examined during field investigations and records the composition and thickness of the deposits. Both of these maps provide the public and State, Federal, and municipal agencies with information needed for specific studies. The report that follows describes the surficial deposits that were found within the quadrangle and uses them to interpret the glacial and postglacial history of the area.

### ***Previous Work***

Thompson and Prescott (1977) prepared a reconnaissance-level surficial geologic map of the Portland East quadrangle. Additional work on the surficial geology of the study area has been carried out by J.M. Clinch (MGS, unpublished data).

### ***Location***

The Portland East quadrangle is located in southeastern Cumberland County in southern Maine. It encompasses parts of the towns of Falmouth, Portland, South Portland, Cape Elizabeth, Cumberland, and Yarmouth. Approximately 60% of the quadrangle is covered by Casco Bay and includes several islands such as Great Diamond Island, Cushing Island, Peaks Island, and Long Island. The topography of the quadrangle consists of gentle terrain with a few isolated hills (Fort Hill, Rohrs Hill, and

Munjoy Hill). Elevations range from sea level to a high of 176 ft (54 m) in Falmouth Foreside in the northwestern corner of the quadrangle. The islands are separated by marine troughs including Diamond Island Roads, Hussey Sound, White Head Passage, and Luckse Sound. Depths within these troughs range from about 20 to 115 ft (6-35 m).

## **SURFICIAL GEOLOGY**

Much of the study area is covered by surficial sediments that were deposited during the expansion and retreat of the most recent (late Wisconsinan) glacial ice sheet or during the period of marine submergence that accompanied glacial recession. The general stratigraphic sequence of these deposits on the geologic map consists of: till (map unit Pt), deposited directly by the action of glacial ice; submarine fan deposits (Pmf), which are water-laid sediments deposited where the receding glacier margin stood in the sea; glaciomarine mud of the Presumpscot Formation (Pp), deposited during the time of late-glacial marine transgression; and marine nearshore deposits (Pmn), formed during the regression of the sea. Sediments deposited during postglacial (Holocene) time include swamp (Hws), marsh (Hwm), and alluvial (Ha) deposits. Artificial fill (af) is also present in the quadrangle, and was mapped where feasible at the scale of the quadrangle.

### ***Bedrock and Thin Drift***

Bedrock outcrops are relatively abundant throughout the quadrangle. The shorelines as well as much of the land area on the islands have exposed or near-surface bedrock. The shorelines on the mainland also have a significant amount of exposed bedrock, and a large portion of the land has only a thin cover of surficial sediments. Due to the number of bedrock outcrops in the study area, most individual outcrops are not mapped. Rather,

they are included in areas of “thin drift,” which are indicated by the horizontal ruled pattern. This pattern indicates areas where there are many outcrops or only a thin, discontinuous veneer of sediment overlying the bedrock.

In areas where there are only a few bedrock outcrops, a dot shows the location and, if possible, the shape of individual outcrops. A few larger areas of exposed ledge are shown in gray. The unit **Ptd** indicates areas where it is difficult to identify the overlying sediment composition or origin due to extensive reworking, as well as some islands that were not visited during field work. Areas mapped as Ptd include many of the smaller rocky islands such as Clapboard Island, Cow Island, and Ram Island.

### ***Till***

Till (Pt) is widespread in the Portland East quadrangle. This unit generally consists of gray to grayish-brown or reddish-brown, compact sediment that was deposited directly by the action of glacial ice. The till is a poorly sorted, typically non-stratified mixture of sand, silt, pebbles, cobbles and boulders.

The identification of till was based on observation of natural and artificial exposures, as well as its association with hummocky topography and a large number of boulders. The best exposures of till were found in Falmouth, near the High School, at the Pine Grove School, and along Waites Landing Road. Other exposures were found in Cape Cottage, on Cushing Island, Peaks Island at the Whaleback, and on Great Diamond Island at Echo Point.

### ***Glaciomarine fan deposits***

Two glaciomarine fans (Pmf) were found in the Portland East quadrangle. Both are located in the southwestern part of the quadrangle, in South Portland. These deposits formed where glacial sediments washed into the ocean during brief standstills in ice retreat. During these standstills, meltwater emerging at the glacier margin deposited stratified sand and gravel in a submarine environment. The stratification in these fans dips generally to the south. The southernmost fan was exposed in a gravel pit off of Sawyer Road. The exposure showed interbedded sand and gravel with a thin bed of clay draping the deposit. The northern fan was not well exposed, but it was identified based on the presence of an extensive sand and gravel deposit.

### ***Presumpscot Formation***

The Presumpscot Formation was named and first defined by Bloom (1960). It is the glaciomarine mud (Pp) that occurs over much of southern Maine. This unit consists of silt and clay, with minor fine sand. It usually has a gray or blue-gray color in the unweathered state, and its weathered color is olive-gray to brownish-gray. Marine shells are often found in the mud, and a

shell locality was discovered in the southwestern corner of the quadrangle (near the gravel pit and along the northern edge of the southern glaciomarine fan).

The Presumpscot Formation was deposited during the late-glacial inundation of the sea into the coastal lowlands of Maine during the recession of the Laurentide Ice Sheet. Good exposures of this unit can be found along the shore of Falmouth Foreside and where Mill Creek crosses Route 88 in Falmouth. Other exposures can be seen near Trout Brook in the southwestern corner of the quadrangle, and along the eastern edge of South Portland. The thickness of the unit within the study area was hard to determine. The exposure at Mill Creek showed a thickness of approximately 10 ft (3 m), but considerably greater thicknesses may occur elsewhere.

### ***Marine Nearshore Deposits***

During the regression of the late-glacial sea (due to isostatic uplift of the earth's crust), the glacial deposits were reworked by marine processes as relative sea level fell. This resulted in the deposition of the marine nearshore deposits (Pmn). These deposits formed along former shorelines and commonly consist of a patchy veneer on older deposits.

The marine nearshore unit consists of reddish-brown to grayish-brown sand and gravel. The unit is poorly sorted and is stratified in places. The clasts range from angular to sub-rounded. The marine nearshore unit was found in all parts of the quadrangle. Some areas on the islands, including Peaks and Great Diamond Islands, have deposits of Pmn that are most likely spit deposits formed from the reworking of older sand and gravel or till deposits during marine regression. Other exposures of Pmn consist of a thin veneer of sediment overlying bedrock. These thin-drift areas can be seen in the northwestern part of the quadrangle. Other good examples of the marine nearshore unit occur near the Foreside Church in Falmouth and at a borrow pit near the Underwood School, also in Falmouth.

### ***Modern Shoreline Deposits***

The Holocene shoreline or beach deposits (Hms) are present along much of the coastline of the mainland and islands within the Portland East quadrangle. These deposits often occupy sheltered inlets and coves where wave reworking of older sediments takes place. The unit ranges from pebbly, coarse gravel beaches to fine sandy beaches like those found at Big Beach on Cushing Island and West Shore Sandy Beach on Little Diamond Island.

### ***Holocene Wetland Deposits***

A few areas have postglacial alluvial (Ha), marsh (Hwm), and swamp (Hws) deposits. The alluvial deposits are found along streams and their flood plains, and consist of sand, gravel,

and mud. The marsh and swamp deposits occur in low-lying, poorly drained areas and consist mainly of organic sediments. A large marsh occupies the shoreline of the Presumpscot River near the western margin of the quadrangle. On Peaks Island, a large swamp is located in the northern part of the island.

## **LATE WISCONSINAN GLACIAL AND POSTGLACIAL HISTORY**

In the Portland East quadrangle the glacial sediments record the most recent (late Wisconsinan) glaciation, when the Laurentide Ice Sheet covered the state. The ice advanced across Maine and reached a terminal position in the Gulf of Maine approximately 17,000 yr B.P. (years ago) (Smith, 1985). Regional ice flow at this time was from the northwest to southeast. This can be seen in the glacial striation trends in the quadrangle, which range from approximately 128° to 180°. The advance of the large ice sheet was responsible for the deposition of much of the till found within the quadrangle. Till localities in the quadrangle illustrate the compact, poorly sorted nature of lodgement till formed during ice advance.

As the ice began to retreat, it reached the present southern Maine coastline by 14,800 yr B.P. (Weddle and others, 1993). During ice retreat, the receding glacier margin remained in contact with the sea as marine transgression occurred, due to lingering isostatic crustal depression caused by the large mass of the ice sheet. Ice margin positions can be identified in the southwest part of the quadrangle based on the location of the two glaciomarine fans. Each fan represents a period when the ice front remained at the northwest margin of the fan long enough for the deposit to be built.

During the time of ice retreat, silt, clay and fine sand (the Presumpscot Formation) were deposited as a muddy unit on the floor of the late-glacial sea. This unit drapes the older deposits of till, as well as the glaciomarine fans, and is found in the low-lying areas where the depth to bedrock is relatively high. This relationship can be seen near the southernmost fan in South Portland. At the gravel pit exposure, interbedded sand and gravel is overlain by the Presumpscot Formation. This unit also occurs just north of the fan in an exposure approximately 6 ft (2 m) high. Marine shells were found in the latter exposure, which confirms the marine origin of the sediments.

As the sea began to withdraw from southern Maine, it reworked some the older glacial sediments, creating a regressive facies consisting of shoreline and nearshore sand and gravel (unit Pmn). This marine nearshore unit is found throughout the quadrangle and can be associated with former shorelines of the retreating late-glacial sea. The coastal zone finally emerged by approximately 12,000 yr B.P. in eastern Maine and by 11,500 yr B.P. in southern Maine (Smith, 1985). The land was probably exposed in the Portland East quadrangle earlier than 12,800 yr B.P. (Weddle, unpublished data, 1994). As the sea reached its present position due to continual rise of worldwide sea level following crustal uplift, the Holocene beach deposits formed in sheltered inlets and coves along the shorelines of many of the islands and the mainland. Little modification of the terrain has occurred since the last glaciation except for the development of modern drainage and wetland systems, which has resulted in deposition of the stream alluvium, marshes, and swamps in the quadrangle. However, the most significant modifications have been the human-induced changes to the landscape. Areas of artificial fill can be found in all parts of the quadrangle and represent the removal, transport, and redeposition of surficial materials.

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