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Surficial materials of the South Harpswell quadrangle, Open-File 99-40

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Surficial Geology of the South Harpswell 7.5-minute Quadrangle, Cumberland County, Maine

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INTRODUCTION

Detailed surficial mapping of the South Harpswell 7.5-minute quadrangle was conducted by the authors in 1994. Two maps were produced for the Maine Geological Survey (MGS) at a scale of 1:24,000: a surficial geologic map (Bernotavicz and Dubois, 1999a) and a surficial materials map (Bernotavicz and Dubois, 1999b). The geologic map shows the various types of surficial sedimentary deposits formed during the most recent (late Wisconsinan) glaciation, as well as those formed during postglacial (Holocene) time. The materials map shows the locations of sites that were examined in the field, and the recorded thicknesses and composition of deposits. These maps serve to provide the public and State, Federal and municipal agencies with information needed for specific studies. The following report describes the surficial deposits that were found within the quadrangle, as well as the glacial and postglacial history of the area.

Previous Work and Acknowledgments

Reconnaissance surficial mapping and other work was conducted in the study area by Marita Bryant (MGS, unpublished data), W. B. Thompson (MGS, unpublished data), J.M. Clinch (MGS, unpublished data), and Prescott and Thompson (1977). Additional striation measurements were provided by A. M. Hussey (unpublished data). The authors would also like to thank the many landowners that allowed us onto their property.

Location

The South Harpswell 7.5-minute quadrangle is located in southeastern Cumberland County. Approximately 95% of the quadrangle is covered by Casco Bay. The land area consists mostly of islands. The larger islands include a portion of Great Chebeague Island, Jewell Island, Cliff Island, and Haskell Island. There are also many smaller islands within the bay. The other small areas of land include the tips of South Harpswell Peninsula and a small portion of Bailey Island.

The topography within the study area has moderate relief overall, with elevations ranging from sea level to a high point of 160 ft (49 m) on Great Chebeague Island in the northwestern corner of the quadrangle. The other islands all have low relief, ranging from sea level to an average of 60 ft (18 m). The islands are separated by marine troughs including Luckse Sound, Broad Sound, and Merriconeag Sound. Depths in the sounds range from about 40 to 205 ft (12-63 m).

SURFICIAL GEOLOGY

Bedrock and Thin Drift

Bedrock outcrops are abundant along the shorelines of all the islands and South Harpswell Peninsula. There is an obvious structural control on the island topography and trough orientation, resulting from the northeast strike of the underlying bedrock. Individual outcrops are not indicated on the map; instead, they are included in the areas designated by the thin-drift pattern (horizontal lines). This pattern covers much of the study area. It indicates a thin discontinuous veneer (generally less than 10 ft) of surficial sediments over bedrock, with ledge exposed in many places. The surficial materials most often found in the thin-drift areas are nearshore deposits (unit Pmn) that resulted from ma-

rine erosion and reworking of older sediments as the sea regressed in late-glacial time.

Many islands were mapped as a "thin drift, undifferentiated" unit (Ptd). This unit is a thin, discontinuous veneer of till or nearshore sediments overlying bedrock. It is common in areas where marine erosion and redeposition of sediments occurred during the late-glacial marine submergence. Unit Ptdu differs from ordinary "thin drift" in that it is a much thinner veneer in which it is difficult to discern the composition or origin of the sediment due to extensive reworking.

Till

Till (map unit Pt) occurs as a mappable unit at only a few locations within the study area. This unit consists of gray to grayish brown or reddish brown, compact, sandy-silty sediment deposited directly by glacial ice. The unit is stony, with clasts that range from angular to sub-rounded, and has a poorly sorted texture. The best exposures of till were found on Jewell Island, along the northwestern shore, and on Great Chebeague Island in the southeast corner and in various locations in the center portion of the island. Till underlies marine nearshore deposits on the tip of the South Harpswell Peninsula and at Basin Point. The overlying nearshore deposit is approximately 3 ft (1 m) thick at both locations, and the underlying till consists of angular to subrounded fine-grained stones in a grayish clayey matrix.

Presumpscot Formation

The Presumpscot Formation (unit Pp) was first defined by Bloom (1960). It is a glaciomarine mud that occurs over much of southern Maine. This unit consists of silt and clay. It is grayish blue in the unweathered state and weathers to a brownish gray color. The Presumpscot Formation was deposited during the late-glacial marine inundation of the coastal lowlands of Maine during the recession of the Laurentide Ice Sheet.

Exposures of the glaciomarine mud can be found along the northwestern shore of South Harpswell Peninsula, and along the eastern and northern shores of Great Chebeague Island. The thickness of this unit within the study area was hard to determine. An exposure on the eastern shore of Great Chebeague Island showed a thickness of approximately 6 ft (2 m), but the thickness is expected to vary greatly from place to place.

Marine Nearshore and Shoreline 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 (unit Pmn). This unit is the most abundant surficial material within the quadrangle, and is most commonly associated with the thin drift areas. It covers most of the smaller islands and a large portion of Great Chebeague Island and South Harpswell Peninsula.

The marine nearshore unit consists of a reddish brown to grayish brown gravelly sand. It is poorly sorted with local stratification. The clasts are usually angular to subrounded. However, a few exposures exhibit a well-sorted sandy unit with rounded clasts. This type of sediment was well exposed in two gravel pits on the northern part of Great Chebeague Island. The first pit exposed a spit deposit with coarse, well-sorted, rounded gravel overlying dipping sand beds. The latter beds are composed of well-stratified sand and fine gravel and dip to the northwest. The other pit, near the cemetery, shows the typical reddish brown, poorly sorted but well stratified, sand and gravel. The clasts are quite angular within the deposit.

Modern Shoreline Deposits

The Holocene shoreline or beach deposits (unit Hms) are present along much of the coastline on all the islands and in a few places on South Harpswell Peninsula. 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 on the eastern edge of Cliff Island and Great Chebeague. Eagle and Jewel Islands both have large pebbly and cobbly beaches.

Glacial and Post-Glacial History

During glacial advance in southwestern Maine, erosion by the ice produced a distinct northwest-southeast lineation transverse to the northeast-southwest structural grain of the bedrock in the State (Thompson and Borns, 1985). Azimuths of glacial striations within the study area range from 160$ to 190$. The southeast trend of the striations found on the islands cuts the northeast-southwest trend of the bedrock as indicated by the orientation of the islands and troughs within the quadrangle.

The glacial ice margin began to retreat from its terminal position in the Gulf of Maine approximately 17,000 to 15,000 years ago (Tucholke and Hollister, 1973). It was previously thought to have reached the position of the present Maine coastline approximately 13,800 yr B.P. (Smith, 1985). However, new data from radiocarbon dating of Portlandia arctica shells indicates that the ice margin may have been at the Maine coast much earlier, approximately 14,800 yr B.P. in Scarborough (Dorion, unpublished data, 1993) and by about 14,000 yr B.P. in Freeport (Weddle and others, 1993). Therefore, the ice margin probably stood within the South Harpswell quadrangle sometime just prior to 14,000 yr B.P.

During ice retreat, the coastal lowlands of the state became submerged beneath the sea due to lingering isostatic crustal depression caused by the large mass of the ice sheet. The ice remained in contact with the sea and grounded below sea level during its retreat across the coastal lowlands. During this time the older glacial deposits and those associated with ice retreat were draped by marine clay and silt of the Presumpscot Formation (Bloom, 1960). This unit is found in the low areas of the

quadrangle where the depth to bedrock is relatively high. A well situated within the Presumpscot unit on the southeastern shore of Great Chebeague Island has a depth to bedrock of 20 ft (6 m) as indicated by the well casing. A well just to the north, however, shows a depth to bedrock of only 3 ft (1 m). The second well is situated in the nearshore unit (Pmn) that thinly overlies the bedrock of the island, whereas the first well is located in an area were the bedrock is much lower, therefore allowing the marine clay to infill the depression.

The coastal zone remained submerged to depths of more than 300 ft (92 m) (Smith, 1982; Thompson and Borns, 1985; Smith, 1985) until the ice margin had retreated northwest up into the highlands of western Maine and northern New Hampshire. The rate of glacial isostatic uplift became greater than the rise of eustatic sea level, causing a regression of the sea. During this time, the glacial deposits were washed and reworked by the retreating sea, forming the dominant nearshore and beach deposits over the older glacial deposits (Weddle and other, 1993). This thin unit is found throughout the study area. The coastal zone finally emerged by approximately 12,000 B.P. along eastern Maine and by 11,500 B.P. in southern Maine (Smith, 1985). The sea was probably gone from the study area by 12,800 (Weddle, unpublished data, 1994). As the sea reached its present position due to continual rise of eustatic sea level following crustal uplift, the Holocene beach deposits formed in the sheltered inlets and coves along the shorelines of many of the islands, most notably Cliff and Jewell Islands.

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