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INTRODUCTION

The Kittery quadrangle lies along the coast of southwestern Maine and southeastern New Hampshire in York and Rockingham Counties, and has a land area of about 25 mi^2 (65km^2). The Atlantic Ocean comprises half of the quadrangle. Only areas located in the state of Maine were mapped as part of this study. Physiographically, the quadrangle is dominated by a low-relief, irregular topography that is primarily bedrock-controlled. The bedrock in the Kittery quadrangle consists of metamorphosed sedimentary and igneous rocks (descriptions summarized from Hussey, 1985, are given below). The surficial material is generally thin (less than 30 ft (9 m) thick) and primarily the result of a late Wisconsinan glaciation during which the Laurentide Ice Sheet covered all of New England.

BEDROCK GEOLOGY

The Kittery Formation (Precambrian? to Silurian?) comprises the bulk of the bedrock in the Kittery quadrangle, stretching from Chauncey Creek to the northern edge of the map area. The Kittery Formation consists of three rock units: (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.

The reminder of the Kittery quadrangle is underlain by the Rye Formation (Precambrian?) and an explosion breccia (Cretaceous). Three units compose the Rye Formation: (1) a fine-grained mylonitized dark-brown metapelite; (2) a mylonitized fine-grained brown to greenish-gray gneiss; and (3) a mylonitized fine- to medium-grained gneiss. In addition, all units, and particularly the metapelites, are heavily migmatized and injected by sills of granite to granodiorite gneiss. The contact between the Rye Formation and the Kittery Formation is either a thrust or strike-slip fault. The explosion breccia is located at Sisters Point and Sewards Point and consists of fragments (over 2 in (5 cm) in diameter) of light 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 basic dikes may constitute up to 35% of the rocks exposed in this area.

GLACIAL AND POSTGLACIAL DEPOSITS

The surficial geology of the Kittery 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 formed as a result of glacial retreat and accompanying marine submergence (i.e., the Presumpscot Formation); and (3) a thin mixture of sediments eroded from till and the Presumpscot Formation. Only minor reworking and deposition of surficial materials has taken place since the regression of the sea from southwestern coastal Maine.

The till (Pt) in the Kittery quadrangle is a loose, sandy-matrix diamicton, and is found only in the extreme northwest corner of the quadrangle. The till is generally a thin, nonsorted to poorly sorted, nonstratified mixture of sand, granules, cobbles, and boulders. Erratics in the till include granites, schists, quartzites, 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. The till is found at elevations of 30-80 ft (9-24 m) above sea level (a.s.l.) where it is not overlain by Presumpscot Formation clays and silts, and was also detected beneath Presumpscot Formation clays in test borings along Interstate Route 95.

The Presumpscot Formation (Pp) consists of glaciomarine, marine, and nearshore sediments deposited as the glacier re-

treated 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 green color with prominent manganese stains in weathered exposures. While the Presumpscot Formation may be found anywhere at elevations below the marine limit (locally 180-190 ft; 55-58 m), it occurs in mappable thicknesses only in relatively flat, low-lying areas with elevations of 0-40 ft (0-12 m) a.s.l. along major drainages.

In many places the surficial material is a thin (less than 10 ft; 3 m) mixture of sediments derived from reworking of till and Presumpscot Formation. These marine nearshore deposits are mapped as Pmn. Local bedrock outcrops exist 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 in areas of moderate elevation (20-80 ft (6-24 m) a.s.l.).

Holocene deposits also exist in the Kittery quadrangle. They include wetlands and marine shoreline deposits (Hms). The 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. These deposits are located in relatively small pockets along the eastern coast of the map area.

LATE WISCONSINAN GLACIAL HISTORY

Although southwestern Maine probably has undergone several glaciations, evidence for only one glacial advance is now preserved within the Kittery quadrangle. This event occurred in late Wisconsinan time when the entire Gulf of Maine was covered by the Laurentide Ice Sheet, which at its maximum extended south to Long Island, New York. Regionally, 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 margin reached the southern coast of Maine at approximately 14,000 years B.P. to 13,500 yr B.P. This is supported 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 Kittery 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, generally parallel the present coastline. Locally, however, no ice-marginal positions were found in the Kittery quadrangle.

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 upper 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). Till and Presumpscot 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 northwest. 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.

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