

STRUCTURE AND STRATIGRAPHY OF THE NANTASKET LOCALITY¹

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The field trip to the Nantasket locality will show some structural features of the southeast margin of the Boston Basin and some of the stratigraphic detail of a sequence of interlayered sedimentary and volcanic rocks that is a part of the Boston Bay Group. The sedimentary rocks are composed mainly of volcanic detritus of local origin.

General Features

The terrain in the vicinity of Nantasket is within the Seaboard Lowland section of the New England physiographic province as described by Fenneman (1938). The bedrock surface is a peneplane dissected by narrow, shallow stream valleys; it is rough and hummocky in minor detail but has no conspicuous hills. The land slopes almost imperceptibly toward the coast. Many small islands and submerged reefs and ledges indicate that the gentle slope continues under the ocean. The terrain is characterized by numerous low, almost bare rock knobs and ridges between which is a thin mantle of glacial drift and soil and many small marshes and swamps. Northwest of Nantasket Beach are several drumlins connected by sand plains, bars, and beaches devoid of outcrops.

Structure

The Nantasket locality is on the south margin of the Boston Basin which is a depressed part of the Seaboard Lowland. Here the margin of the basin is a fault zone at least 2 miles wide trending approximately N. 70° E. The major faults strike northeast to east, have displacements of tens of feet to possibly a few hundred feet; the downthrown sides are to the north. Between major faults are multitudes of anastomosing faults having northeast to southeast strikes, steep to vertical dips, and displacements of a few inches to a few tens of feet, with the downthrown sides in most instances on the north.

A few faults trending generally north-south and having nearly vertical dips and displacements of a few feet to possibly a few tens of feet probably formed concurrently with compressional folding of the Boston Basin.

The south part of Hull and the northeast part of Hingham, areas that include all the outcrops of the Boston Bay Group in the Nantasket locality, form

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a northeast-plunging syncline. Complex faulting and lenticular strata preclude precise estimation of plunge, but it is probably between 10° and 20° . Successively younger units of the Boston Bay Group are exposed from west to east along the axis of the syncline.

Bedrock Geology

The rocks in the Nantasket locality are granodiorite and associated aplite that Emerson (1917) included with the Dedham Granodiorite; volcanic and sedimentary rocks of the Boston Bay Group; and several kinds of dikes. All these rocks are nonfossiliferous, and they are not associated with fossiliferous rocks in other localities. In the vicinity of Nantasket, conglomerates within the Boston Bay Group contain felsite boulders that almost certainly came from the Lynn Volcanic Complex. In other localities conglomerates within the Boston Bay Group contain boulders eroded from the Mattapan Volcanic Complex. These volcanic rocks generally are considered to have been erupted during the middle part of the Paleozoic era. The Boston Bay Group seems to have been deposited shortly after eruption of the Lynn and Mattapan volcanic rocks. An erosional unconformity separates the Boston Bay Group and the older granodiorite. Most of the dikes in the Nantasket locality were emplaced during the volcanism that produced the volcanic rocks in the Boston Bay Group. A few dikes seem to be younger and may be among those generally thought to be of Triassic age.

The granodiorite is predominantly a medium- to coarse-grained granitic-textured rock, but in places it is porphyritic. Quartz, microcline, and plagioclase generally constitute at least 90 percent of the rock, though the proportions of the major constituents vary considerably. Aggregates of chlorite, epidote, and hornblende seem to be remnants and products of partial deuteric alteration of original mafic constituents. Plagioclase generally is saussuritized, in places only slightly, and elsewhere so much that twinning features are almost obscured. Pale pink aplite is abundant and in places occurs as large irregular dike-like masses. Xenoliths of older rocks can be seen at several places. Xenoliths in the cliffs along the Cohasset shore, east of Nantasket Beach, are rather fine-grained amphibolites; those in the vicinity of Little Harbor, Cohasset, and Strawberry Point, Scituate, are diorite.

The Boston Bay Group consists of interlayered agglomerates, andesites, tuffs, tuffaceous shales, and conglomerates. These rocks were laid down in quick succession, in part, at least, in a subaqueous environment. The principal source of volcanic material was an explosive volcano east or northeast of the Nantasket locality. The sedimentary rocks are predominantly agglomerates; tuffs and tuffaceous shales generally occur as thin beds, and conglomerates composed of wave-worn cobbles and boulders occur infrequently. The thickness of various units changes considerably within short distances, and some units

are small lenticular deposits. This circumstance, combined with intricate faulting that causes repetition and cutting out of units in several places, makes stratigraphic correlation difficult and uncertain.

The basal unit of the Boston Bay Group in the Nantasket locality is a coarse mixture of agglomerate and conglomerate. It rests upon a rough granodiorite surface and contains considerable arkose and boulders from the underlying rock. Much of the volcanic detritus is more silicic than the local andesites, indicating origin from older flows and from terrain some distance away.

Agglomerates higher in the group are composed mainly of volcanic debris having virtually the same composition as enclosing flows and lesser quantities of the silicic volcanic rocks, and granodiorite.

The Nantasket volcanic rocks are altered andesites. The flows were erupted from local vents, and some of them apparently covered only small parts of the area. The alteration was deuteric and probably was modified by action of sea water upon the lavas. Plagioclase, chlorite, and epidote are the major constituents of these rocks, and magnetite is the principal minor constituent. Most of the rocks contain no primary quartz, but quartz and calcite may be rather abundant secondary constituents. There are four groups of flows: 1) highly-altered, dark-greenish-gray flows that rest upon the basal agglomerate and are exposed only in the western part of the locality; 2) light-greenish-gray to dark-reddish-gray porphyries composed mainly of small plagioclase phenocrysts in a groundmass of plagioclase microlites and iron oxides; these rocks are exposed in cliffs southwest of the amusement park, Green Hill Rock and the larger of the Black Rocks; 3) dark-greenish-gray to reddish-gray, partly amygdaloidal flows that are considerably altered; these flows are exposed between George Washington Boulevard and Straits Pond; and 4) greenish-gray, partly amygdaloidal flows, some having pillow structures and others being highly fragmental, and enclosing beds of greenish-gray tuff and minor dark-red tuffaceous shale; these flows are exposed on Atlantic Hill and along the shore from Long Beach Rock to the west end of Crescent Beach.

There are many dikes in the Nantasket locality. In general the dikes are parallel to the faults, and although minor slips have occurred along one or both walls of some of them, substantial faults occur along only a few dikes. Most of the dikes seem to be related to the volcanic activity that produced the andesite flows; these dikes are older than the faults.

Features of Outcrops to be visited

Stop No. 1 is at a quarry on the east side of George Washington Boulevard and about 0.15 miles south of the bridge over Weir River. This quarry is

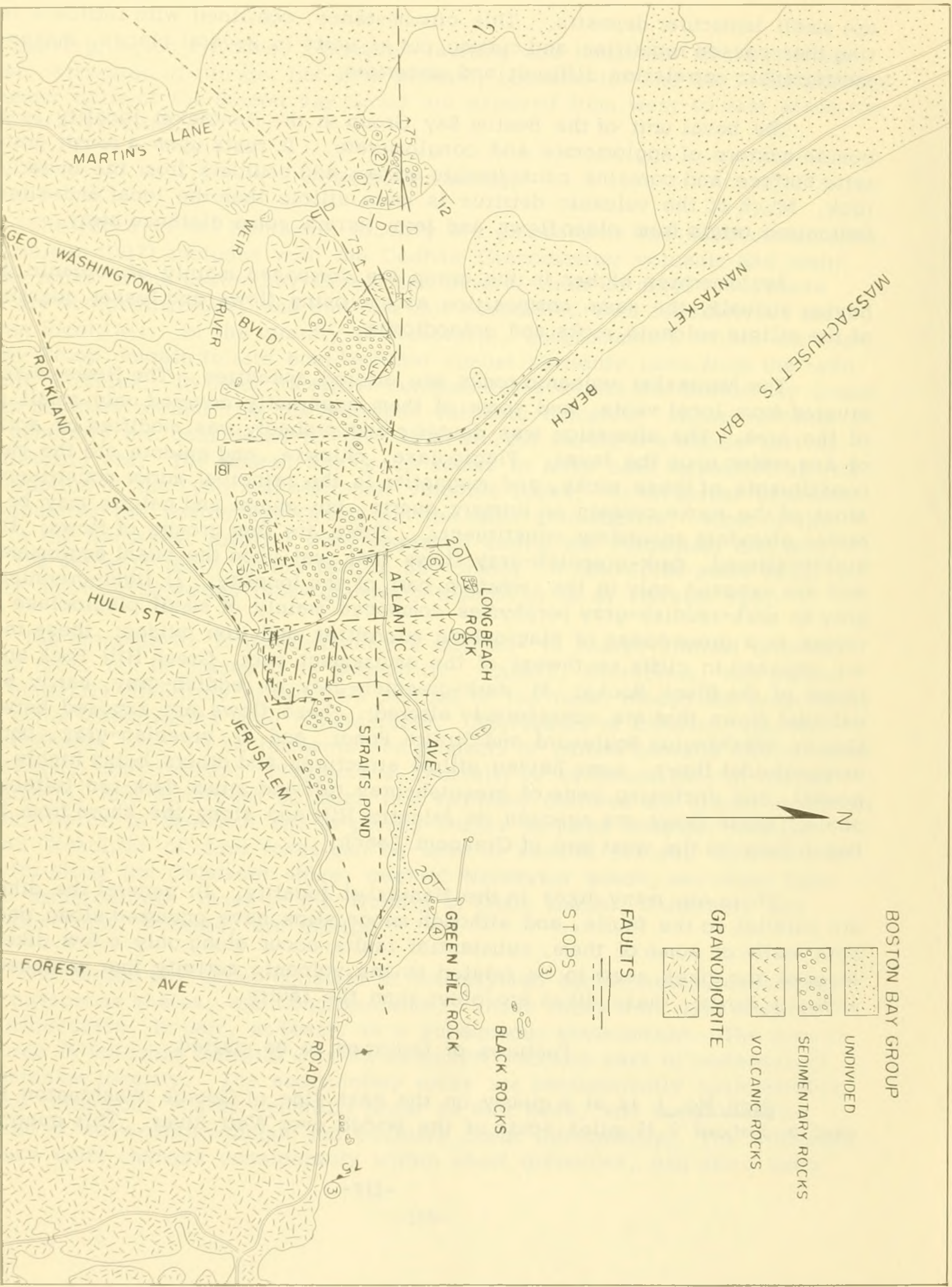


FIG. 1— PRELIMINARY GEOLOGICAL MAP OF THE NANTASKET LOCALITY

SCALE 1 24,000

1/2

1 MILE

in coarse-grained, somewhat porphyritic granodiorite. Much of this rock is composed of irregular pink microcline phenocrysts in a greenish crystalline groundmass. There are zones a few feet wide of purplish-red, finer grained granodiorite that has been partially granulated and then cemented with microcline and quartz; this granulated rock has some of the features of a mylonite, and its color is due to finely dispersed hematite. Some large irregular dikelike masses of light pink aplite are exposed on the quarry walls. A few dark-greenish-gray dikes are associated with the local volcanic rocks; one of these dikes exposed on the west wall of the quarry has been broken and displaced by a small fault.

Stop No. 2 is at a rocky point on Worlds End Estates in the north part of Hingham. This point forms the west shore of Weir River estuary. It is reached by going to the gate of Worlds End Estates at the north end of Martins Lane and then walking about one-half mile northeastward along either one of two trails. Bedrock along Martins Lane and the east side of Worlds End Estates to about 1,000 feet south of the north end of the rocky point is granodiorite. The topography and alignment of outcrops reflect the fault pattern. A northwesterly trending ridge crosses the rocky point about 1,000 feet south of its northern tip. The ridge is bounded on the north and southwest sides by faults; that along the north side is one of the major faults of the Nantasket locality, and its down-thrown side is to the north. Outcrops southwest of the ridge are granodiorite, with a few remnants of reddish arkosic sandstone resting upon it. Granodiorite forms a steep cliff at the west end of the ridge. The unconformable contact between granodiorite and a conglomerate-agglomerate bed that is the local basal unit of the Boston Bay Group can be seen near the west end of the ridge. The sedimentary rocks dip eastward, and eastward along the ridge they are overlain by the highly altered lower volcanic flow of the Nantasket volcanic rocks. Near the east shore of the point the volcanic rock is overlain by an agglomerate bed; at this place the strata have been displaced by some small subsidiary faults, and there is a large dike associated with the Nantasket volcanic rocks. North of the ridge, stratigraphically higher units in the Boston Bay Group are exposed because of the substantial downward displacement of this block along the major fault that bounds the ridge. The fault is seen best at the west shore of the point. The downfaulted block is part of the northwest limb of a northeasterly plunging syncline; consequently the stratigraphically lower units are exposed at the north end of the rocky point. The lower units are amygdaloidal andesites, part of the third group of flows of the Nantasket volcanic rocks; they are overlain by conglomerate and agglomerate units.

Stop No. 3 is at sea cliffs on the Cohasset shore about half a mile east of Black Rock Hotel and Black Rock Beach. The cliffs are composed of granodiorite that contains orientated xenoliths of amphibolite. The granodiorite is conspicuously green owing to an abundance of chlorite and has a foliated texture paralleling that of the amphibolite xenoliths. Several dikes that are

associated with the Nantasket volcanic rocks are exposed in the cliffs.

Stop No. 4 is on the shore near Green Hill Rock. A breakwater connects a large conglomerate outcrop on the shore and Green Hill Rock. The conglomerate is composed mainly of wave-worn cobbles and boulders. Green Hill Rock, which can be reached by walking along the breakwater, is composed of porphyritic andesite of the second group of flows of the Nantasket volcanic rocks.

Stop No. 5 is at sea cliffs on the shore about 750 feet east of Long Beach Rock. These cliffs are composed of andesites and minor interlayered tuffaceous units belonging to the fourth or uppermost group of the Nantasket volcanic rocks. Interesting features at this outcrop are pillow structures, volcanic bombs, and deposition of minor secondary quartz and calcite in the volcanic rocks.

Stop No. 6 is at Long Beach Rock and Atlantic Hill near the southeast end of Nantasket Beach. Rocks at this place are on the northeast limb of the syncline and dip southeastward. The uppermost unit is andesite of the fourth group of flows and is exposed on Atlantic Hill; it is the highest stratigraphic unit of the Nantasket locality. The lowest unit exposed here is tuffaceous conglomerate and agglomerate at the north edge of Long Beach Rock and can be seen only at low tide. In the upper part of these sedimentary rocks is a bed of tuffaceous red sandstone and a bed of banded greenish porcelaneous shale, both about a foot thick; these thin beds display intricate brecciation and miniature faulting that occurred before the sediments were completely lithified. The sedimentary rocks are overlain by rather fine-grained dense andesite, of which a thickness of about 60 feet is exposed. Long Beach Rock is separated from the mainland by a narrow shingle beach. The cliffs at the north base of Atlantic Hill are composed of bedded tuff containing considerable coarse fragmental volcanic material, especially in the upper part of the unit; a thickness of about thirty feet of this unit is exposed. Above this tuff are rather thin lenticular beds of andesite and tuff, and finally a thick layer of andesite that forms most of Atlantic Hill.

TRIP H

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