1-1-1976

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Recommended Citation

Brenninkmeyer, Benno M. S.J., "Dynamics of Sedimentation and Coastal Geology from Boston to Plymouth" (1976). *NEIGC Trips*. 249.
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Trips A-9 & B-9

DYNAMICS OF SEDIMENTATION
AND
COASTAL GEOLOGY FROM BOSTON TO PLYMOUTH

by

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The coastal area south of Boston consists of glacial deposits, bedrock and recent marsh, dune and beach accumulations. In Nantasket Beach and Hull, no bedrock is exposed - only drumlins and prograding beach deposits. Outcrops of Mississippian (?) Mattapan Volcanics and Pennsylvanian or Permian Boston Bay Group are exposed at the south end of Nantasket Beach to the Ponkapoag fault (see Billings, this volume). South of Hingham to North Scituate Beach, Precambrian Dedham Granodiorite and the comagmatic Westwood Granite form many cliffed, irregular headlands. Southeast from North Scituate the coastline is more regular for the ground moraine and drumlins (First through Fourth Cliffs) present there are more easily eroded.

Glacial deposts constitute the principal source of beach material. Rivers contribute only a very minor fraction, except at Fourth Cliff. The exposures of bedrock show only slight erosion, so little material could have been derived from them. The beach sediment is composed of the same type of rock found in the till and gravel exposed in the drumlins such as Allerton and the numbered cliffs. The importance of the drumlins is shown by the presence of shingle near them. This shingle is progressively finer and less angular and smaller in quantity southward from the drumlins. On Nantasket beach shingle extends a little more than 2 km south of Allerton Hill. South of Fourth Cliff shingle is present for more than 3 km. The offshore,eroded drumlins and ground moraine also supply both sand and shingle to the beaches. This is especially noticeable at Nantasket Beach where the sediment becomes progressively finer south of the drumlin and then becomes coarser again.

That boulders can be moved by waves is best seen at the mouth of the North River inside the drumlin at Fourth Cliff. There, boulders 10-30 cm in diameter are spread out in almost a single layer 100-200 m wide on top of the flat surface of a peat bed.

Since the storms of greatest intensity on this coast are North East storms, the prevailing shore drift should be southward on sections of coast trending north south (ie Nantasket and

Scituate) and westward on sections of coasts trending east-west (ie. between Nantasket and Cohasset Harbor) with local reversals around headlands. Available evidence (Chute, 1949) shows that beach material does not migrate to any appreciable amount around promontories. Therefore each beach can be considered as a separate unit when considering supply, movement and disposal of beach sands and shingle.

ROAD LOG

Trip will assemble in the parking lot of Boston University off Bay Street Road and Granby Street. Trip leaves at 8:30 A.M. SHARP!

The bus will take city streets through Boston and Quincy. To the uninitiated, a more relaxing route would be to take Route 128.

Cumulative Milage	Interval Milage	Start at the intersection of the Massachusetts Turnpike and Route 128
19.9	19.9	Route 3 South, bear right.
28.2	8.3	Exit at Route 228, towards Rockland and Nantasket. At end of intersection head towards Nantasket (left). Stay on Route 228 through South Hingham and Hingham.
31.5	3.3	Outcrops of Dedham Granodiorite on left.
37.4	5.9	Nantasket Beach. Follow the boulevard closest to the beach towards Allerton Hill.
38.7	1.3	Phipps Street, left.
39.7	1.0	Adams Street, left. Then right on Nantasket Ave. Straight ahead is Strawberry Hill, one of the six drumlins on Nantasket Beach. The steep bank on the east side of the hill is a wave cut cliff. Three hundred and fifty meters away is the present shoreline.
41.9	2.2	Sharp left, following the bay.
42.7	.6	Nantasket Ave, bear right.
43.0	.3	Harbor View Road, bear right.
43.3	.3	Lillian Jacobs School. Park in parking lot.

STOP ONE - View of Boston Harbor

About 180 drumlins have been recognized in the Boston Area (LaForge, 1932) about 16 of them can be seen from this vantage point. Your are standing on two coalescing drumlins which make up the greater part of Hull. Behind you is Telegraph Hill (with the tower) and Thornbush Hill. In front of you, a fine view of the drumlins of Boston Harbor; from left to right, the three Brewster Islands, Lovell Island, Georges Island (with Fort Warren), Gallops Island (with the docks), Deer Island and Long Island. The long axis of Gallops Island and the drumlin on Deer Island trends S 75° E indicating the approximate direction of movement of the continental glaciation in this locale. The average of all the drumlins in the Boston Area is S 55° E. Some of the drumlins in the harbor contain fragments of marine fossils gouged out from the older marine clay and redeposited in the till of the drumlins.

On Shag Rocks - just to the right of the Boston Lighthouse - Cambridge Argillite is exposed. This uppermost member of the Boston Bay Group (Pennsylvanian or Permian) is composed almost totally of gray argillite with beds ranging in thickness between 0.13 - 7.6 cm,rhythmically alternating between lighter and darker gray. The lighter grays are silty sands and sandy silts, whereas the darker grays are clay and fine silts (Billings, this volume).

Cumulative Milage	Interval Milage	Turn around and retrace the route to Allerton Hill.
43.6	.3	Bear left on Harbor View Road
43.9	.3	Nantasket Ave, bear left.
44.5	.6	Bear right, following the bay.
44.7	.2	Bear left and turn into parking lot. Park here and walk to the beach 200 meters to the east. On the beach turn left and walk to Allerton Hill and Point Allerton.

STOP TWO: Allerton Hill and Point Allerton

Allerton Hill, has been eroding on the average 60 cm per year (Johnson, 1910). The eroded east side has exposed a good cross section of a drumlin. The drumlin is composed of two recognizable units: a upper unit of oxidized yellowish till and a lower unit of unoxidized gray till. The gravels in both of the units are primarily composed of discs and rods of Cambridge Argillite with some Dedham Granodiorite, white quartzite ("Milton" ?) and a small but noticeable fraction of red and purple rhyolites and andesites of the Lynn Volcanics. These Mississippian (?) volcanics are exposed in three areas north of Boston; from Winchester to Saugus, West Medford to Lynn and at Marblehead.

In the sand and clay of the till, eleven species of megafossils have been found: (Source, Crosby, 1893)

	Telegraph Hill	Allerton Hill	Strawberry Hill
Balanus sp	X	X	
Tritia trivettata (Adams)		X	
Ilyanassa obselata (Stump)	X		
Crucibulum striatum (Say)	X		
Buccinum undatum (Linneus)		X	
Maya arenaria (Linneus)	X		
Venus mercenaria (Linneus)	X	X	X
Cyclocardia borealis (Conrad)	X	X	X
Astarte undata (Gould)	X	X	X
Scapharca transversa (Say)		X	X
Cliona sulphurea (Verrill)	X	X	X

At Point Allerton, a well developed cobble berm is present with an imbricated scarp. Wave refraction at the low tide platform refracts the waves such that two sets of waves approach the shore almost at right angles.

The diffraction and refraction of waves at the Point and their constructive and destructive interference with unaffected waves set up a series of cusps in the shingle south of the Point. These cusps are regularly spaced at about 4 m intervals. They gradually die out southwards. The spacing of the cusps will vary depending on the prevailing wave period.

Cumulative Milage	Interval Milage	From the parking lot turn left on Nantasket Ave.
44.9	.2	L Street, turn left. Then right on Beach Ave. Note the armored dunes on the right hand side. Some of the wind gaps have been filled in with shingle by the DPW.
45.5	.6	A Street, right. Then first left on Manumet Ave. At A Street the shingle on the beach is almost absent except at the berm line.
45.9	.4	Coburn Ave, left. First right, Beach Ave. Here the shingle on the beach is completely absent.
46.4	.5	Reverse Street, right. First left onto Manumet Ave.
50.0	.6	At the beginning of the sea wall at the Metropolitan District Commission Reservation, park.

STOP THREE: Nantasket Beach

The beach at Nantasket shows remarkable lack of change since the seventeen hundreds. Johnson (1910) remarks,

> "A chart of Boston Harbor published in the fourth part of the English Pilot in 1709 while not accurate in detail seems to show that no pronounced changes in the shoreline of Nantasket Beach have occured in the last two hundred years."

It was not always that way. Nantasket at one time was a series of drumlins, which gradually, as sea level rose after the Pleistocene, were tied together by tombolos (Johnson, 1967; Figure 1).

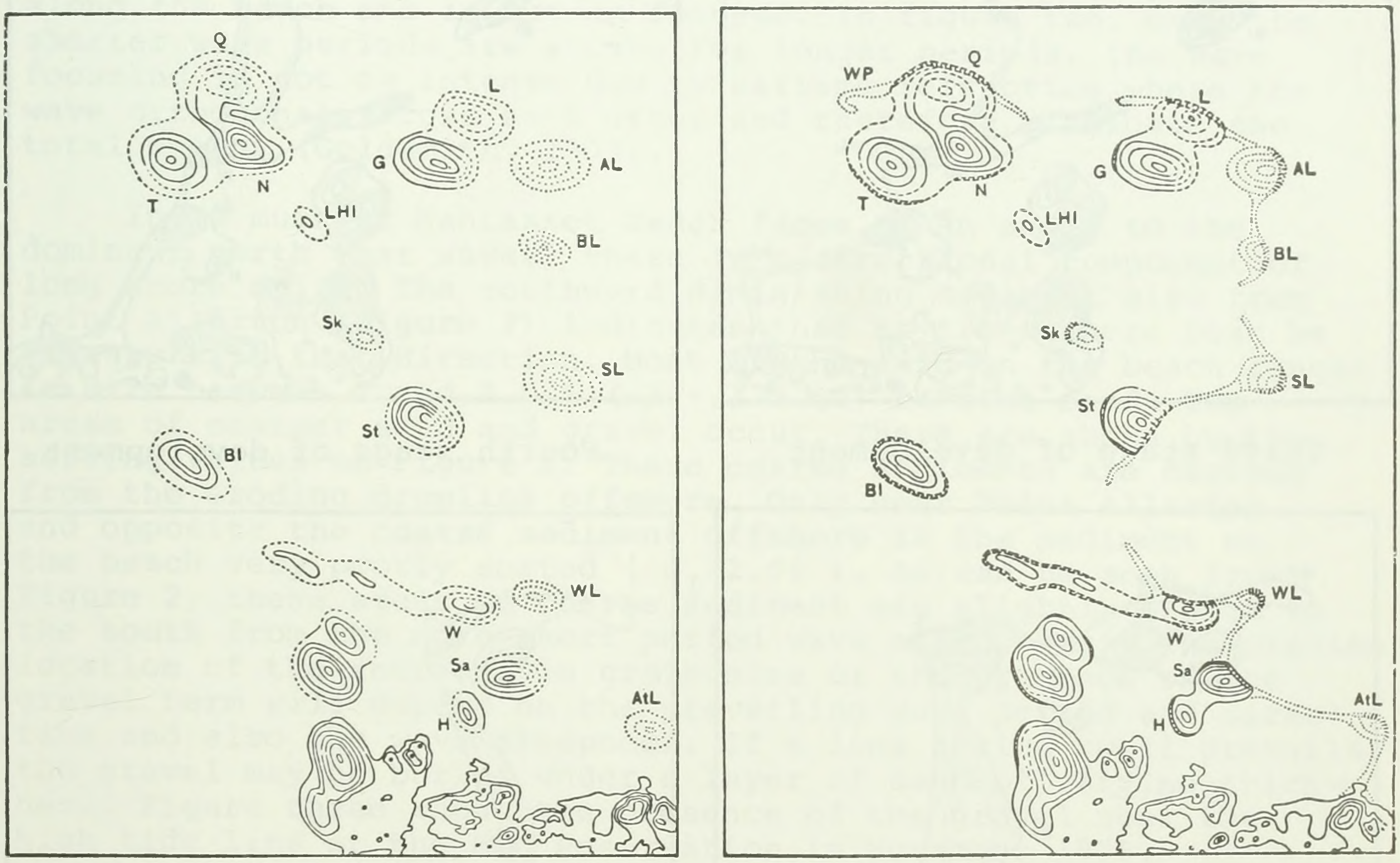
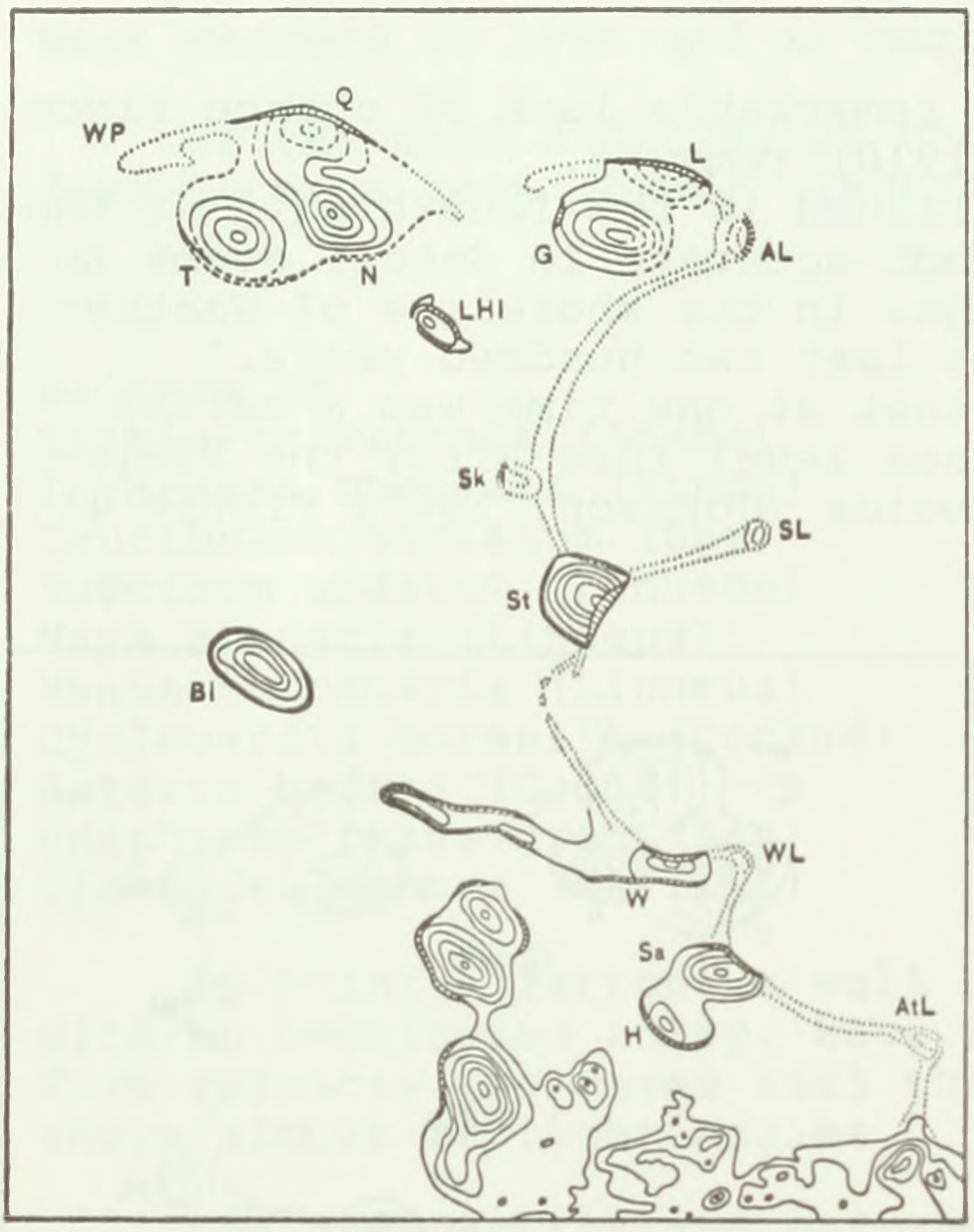


Figure 1 (from Johnson, 1967, p.467-469)

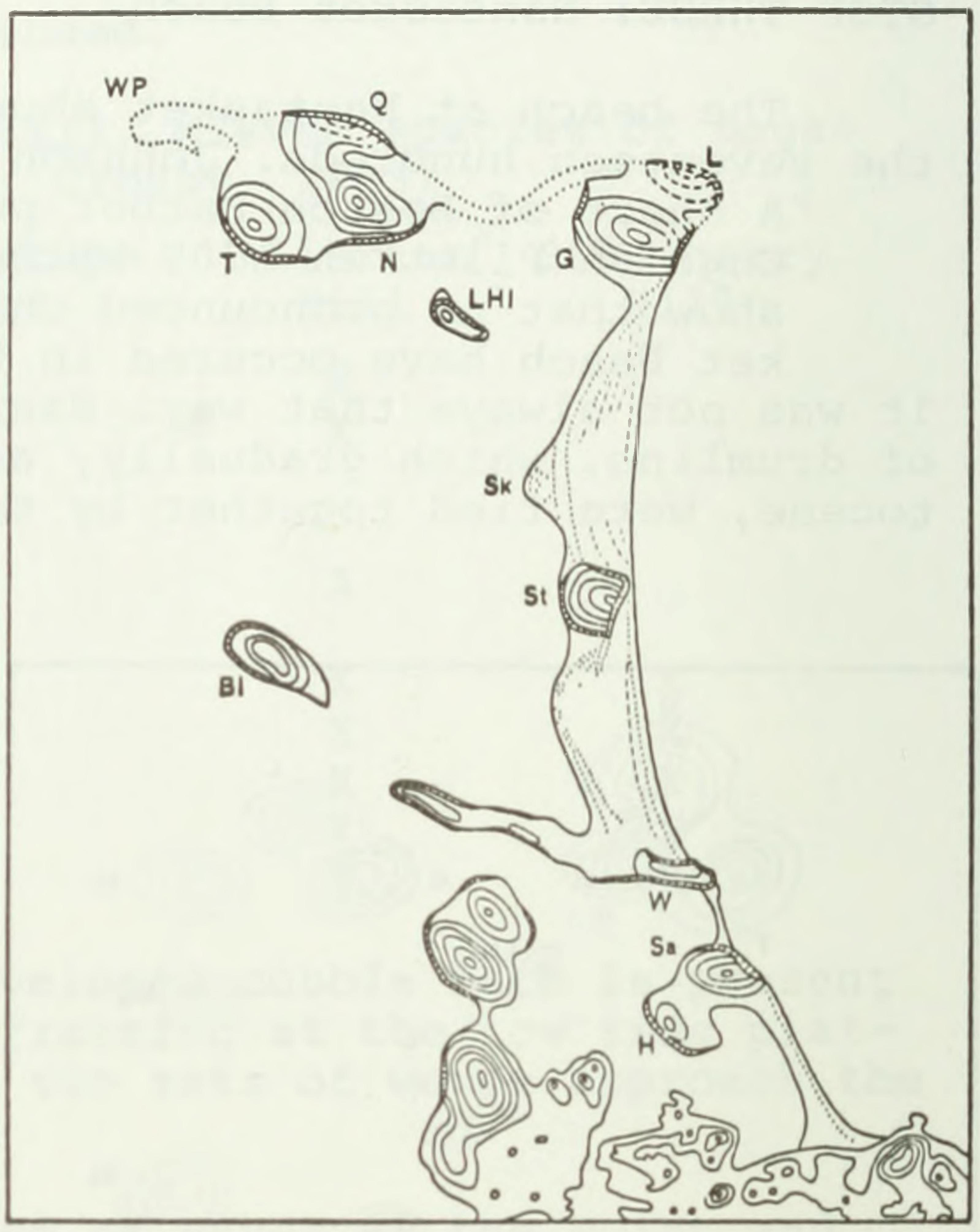
Initial stage of Nantasket Beach complex tombolo.

Second stage in development of Nantasket Beach tombolo.

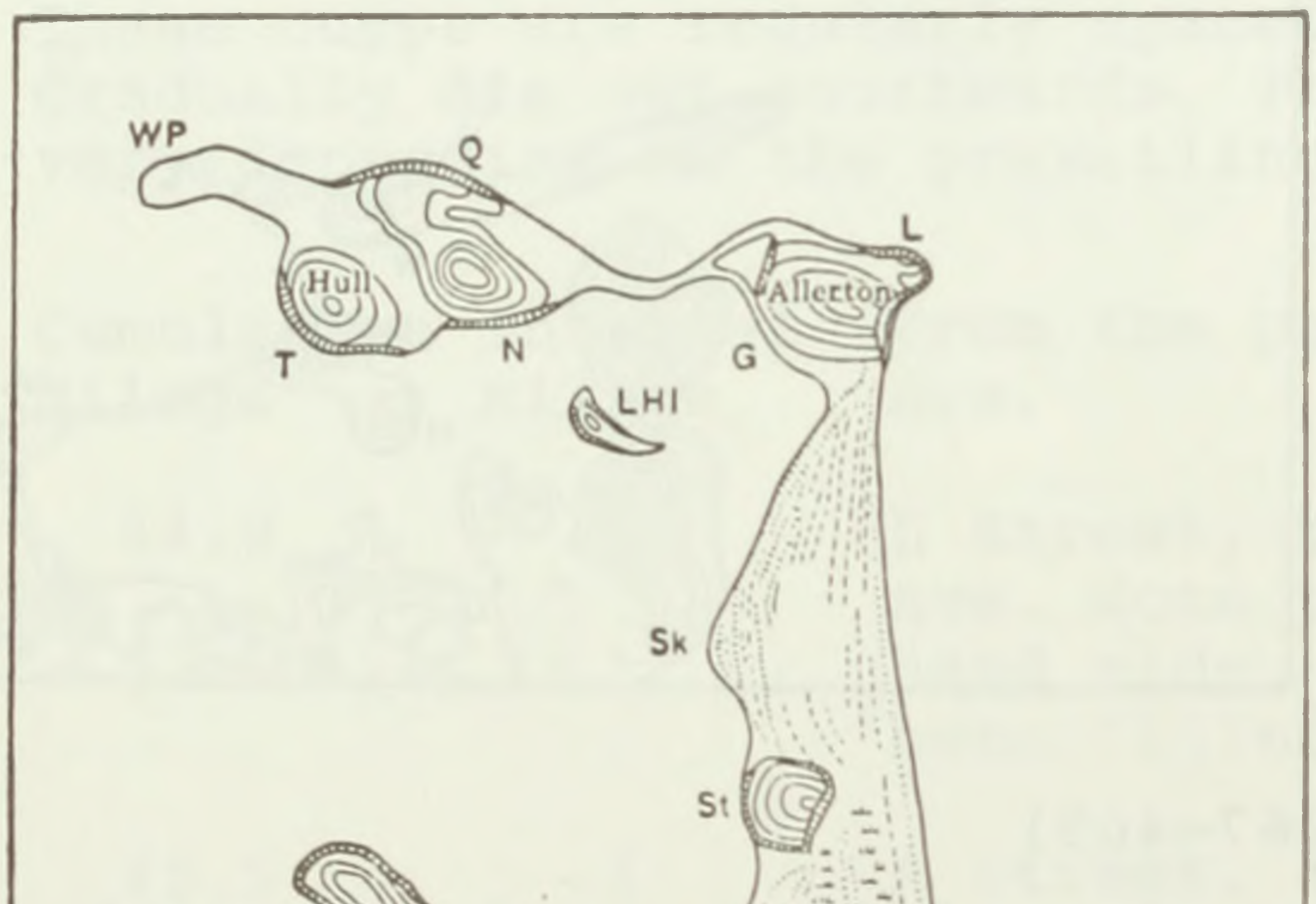
AL	Allerton Lost Drumlin	Sa	Sagamore Hill
Atl	Atlantic Lost Drumlin	Sk	Skull Head Hill
BI	Bumkin Island	SL	Strawberry Lost Drumlin
BL	Bayside Lost Drumlin	St	Strawberry Hill
G	Great Hill	T	Thornbush Hill
H	Hamption Hill	W	White Head Hill
L	Little Hill	WL	White Head Lost Drumlin
LHI	Little Hog Island (Hog Is)	WE	World's End
N	Nantasket Hill (Telegraph)	WP	Wind Mill Point
Q	Quarter Ledge		



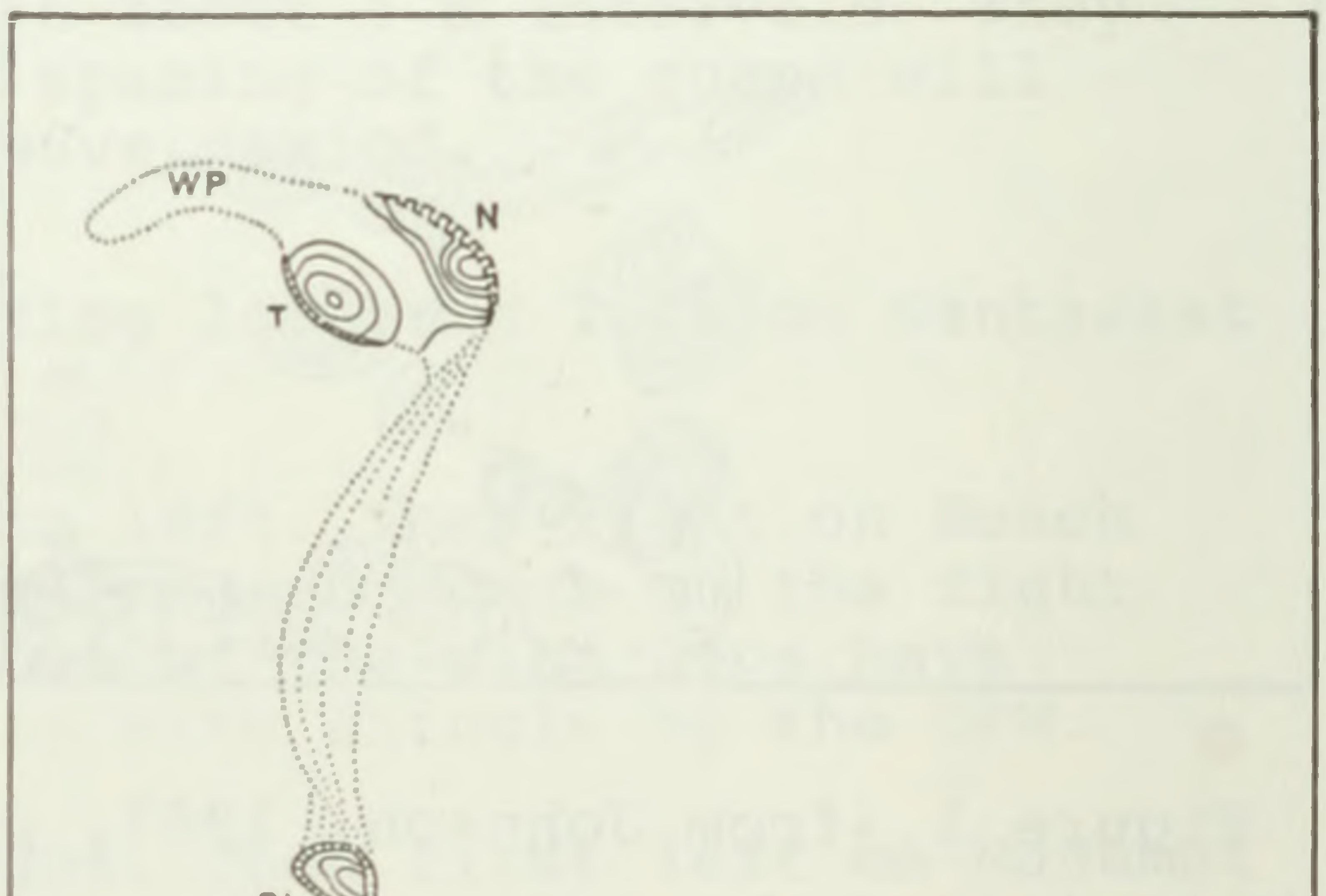
Third stage of development



Fourth stage of development



Present form of Nantasket Beach complex tombolo



Theoretical future of Nantasket

Eventhough, the beach outline is now stable and therefore close to equilibrium, the wave energy is not evenly dispersed across the length of the beach. During periods of high waves, wave energy is focused at two localities, one near the north end of the beach and one south of the center of the beach, in between the eroding drumlins offshore (see figure 2).

The large scale refraction of waves over these obstacles causes a concentration of wave energy at these locations. The southern point shows consistent concentrations of energy for all directions of wave approach and in all tidal stages. The focal point does shift however, between 2.8 and 4.6 km south of Allerton Point. At high tide,the wave energy is more spread out along the beach and is not as focused. In figure two, only the shorter wave periods are shown. For longer periods, the wave focusing is not as intense due to extreme refraction where the wave orthogonals cross each other and therefore dissipate the total energy (Goldsmith, 1973).

In as much as Nantasket Beach faces at an angle to the dominant north east waves, there is a directional component of long shore drift. The southward diminishing sediment size from Point Allerton (Figure 2) indicates that at times there must be transport in that direction. Most of the sand on the beach ranges in size between 2 and 2.5 ϕ (.25-.177 mm) or fine sand. Two areas of coarser sand and gravel occur. These are shown by the sorting values on Figure 2. These coarse sediments are derived from the eroding drumlins offshore. Only near Point Allerton and opposite the coarse sediment offshore is the sediment on the beach very poorly sorted ($\sigma_I > 2.0\phi$). As can be seen from Figure 2, these areas of coarse sediment are slightly offset to the south from the main short period wave energy foci. The precise location of the increase in grain size or the presence of the gravel berm will depend on the prevailing wave period and direction and also the wave steepness. If a long period swell prevails the gravel may be buried under a layer of sand of varying thickness. Figure three shows the presence of the gravel near the high tide line at the MDC Reservation in November 1975.

Cumulative Milage	Interval Milage	
		Turn left on Manumet Avenue.
51.1	1.1	At the Atlantic Aquarium turn left and park.

STOP FOUR: ATLANTIC HILL AND LONG BEACH ROCK

At the south end of Nantasket Beach is Atlantic Hill. Here a good cross section of the basal volcanic units of the Mattapan Volcanics (Mississippian?) and the Pennsylvanian or Permian Boston Bay Group Sediments are exposed. This area is located on the south east margin of the Boston Basin within a north east plunging anticline. These units have been brought to the surface by the Blue Hill Thrust Fault.

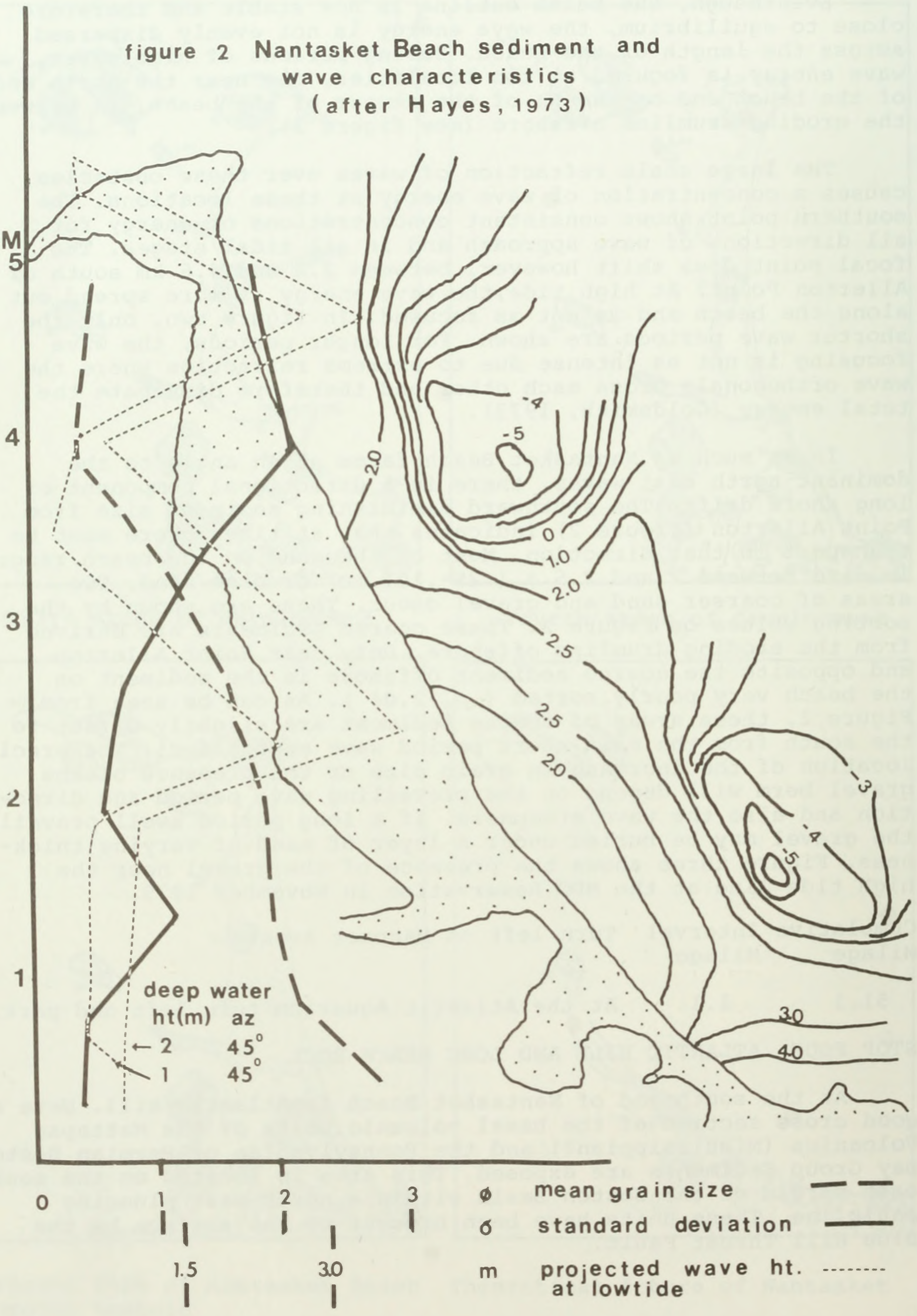


figure 2 Nantasket Beach sediment and wave characteristics (after Hayes, 1973)

Figure 3. Cuspate gravel deposit near the middle of Nantasket Beach, November 1975.

Figure 4. Water lain ash unit and coarser volcanic fragments of the Mattapan Volcanic Complex at Atlantic Hill.

Just left of the restaurant "The Ledges" is a hard, dense greenish gray andesite lava about 18 m thick. These andesites are pillowed, as outlined by the lighter green epidote veins. They also contain bombs. Above the andesite is a 9 m bedded tuff (strike N65°E, dip 25°SE). This layer is a water lain ash deposit (see figure 4). Parts of this layer may be lahars. In the upper part of this unit there are many coarse volcanic fragments. Above this are thin lenticular beds of andesite and tuff. The hill is capped by another greenish gray andesite lava. These andesites are deuterically altered. Plagioclase, chlorite and epidote are the major constituents plus accessory magnetite. There is little primary quartz, but quartz and calcite may be abundant as secondary minerals (Bell, 1964, Skehan, 1975).

Below the andesites and best exposed at low tide on Long Beach Rock is the sedimentary sequence of the Boston Bay Group. The lowest units, to be seen only at low tide on the north side of Long Beach Rock, are tuffaceous conglomerates and agglomerates which include fragments of the underlying Dedham Granodiorite and Lynn Volcanics and also arkose boulders. Above this are 45 cm thick beds of intercalated red sandstone and 15-30 cm layers of banded green porcelaneous shale. These thin beds show brecciation and penecontemporaneous faulting and baking. The contact between the volcanics and the sediments can also be seen at the base of the cliff (around the corner from the restaurant).

The dikes, especially those on Long Beach Rock are parallel to the local faulting and seem to be related to the volcanic activity that produced the andesite flows. The dikes predate the faulting (Crosby, 1893).

Cumulative Milage	Interval Milage	From the parking lot turn left onto Nantasket Ave.
51.2	.1	Atlantic Ave, turn left.

Here is the approximate location of the southernmost of the Boston Basin Faults - Ponkapoag Fault. Although it now dips 80° NW with the Precambrian Dedham Granodiorite on the south and the Boston Bay Group on the north, it is presumed that the fault originally dipped south and was rotated to its present position. In Hingham, the stratigraphic throw is at least 400 meters (Billings and others, 1939).

52.7	1.5	Bear left, staying on Atlantic Avenue.

From here to Cohasset, on both sides of the road three types of acidic intrusives crop out.

Unnamed medium gray, foliated, biotite granite composed of 30-60% plagioclase, much altered to sericite, epidote and albite; 10-35% K spar as orthoclase, microperthite and microcline; 5%

secondary olivine green biotite and accessory magnetite. This granite commonly has sodic plagioclase phenocrysts. It intrudes the Westwood Granite (Chute, 1965).

Westwood Granite is a pinkish gray, fine to medium grained granite with 25-35% quartz, 15-30% albite, 35-50% microperthite, with accessory apatite, sphene and magnetite. It is similar to the Dedham but finer grained. In the Blue Hill, 40 km to the north, the Westwood intrudes the Dedham, but it probably belongs to the same magma series (Chute, 1965).

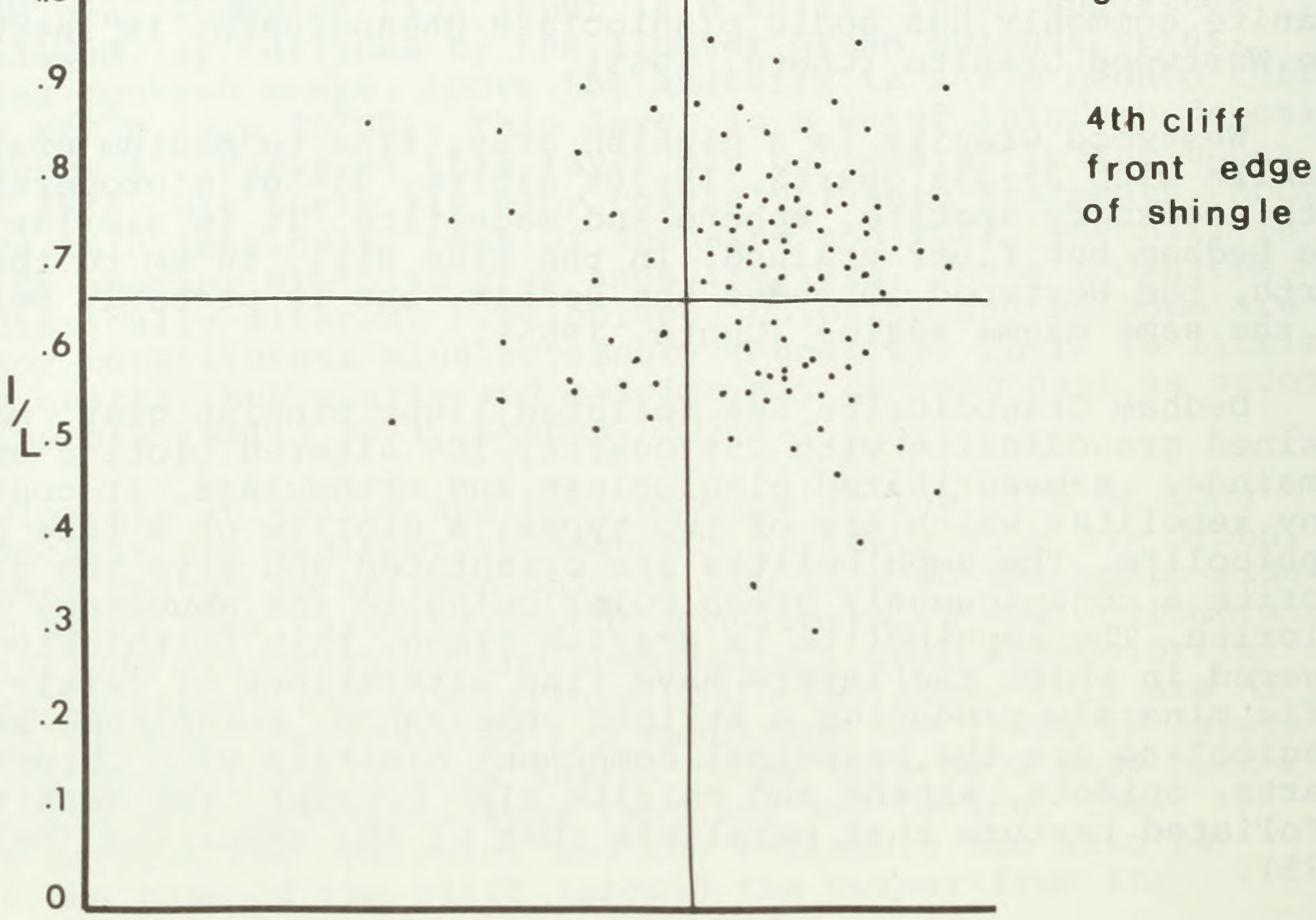
Dedham Granodiorite isa foliated light pinkish gray, medium grained granodiorite with 25% quartz, 10% altered biotite and the remainder saussuritized plagioclase and orthoclase. It contains many xenoliths which are of two types, a diorite or a fine grained amphibolite. The amphibolites are orientated and give the granodiorite a conspicuously green color owing to the abundance of chlorite. The amphibolite is grayish green, thin to thickly layered in which the layers have fine alterations of felsic and mafic minerals producing a striped appearance. Hornblende and plagioclase are the principal component minerals with chlorite, quartz, epidote, sphene and calcite also present. The granite has a foliated texture that parallels that of the xenoliths (Nelson, 1975).

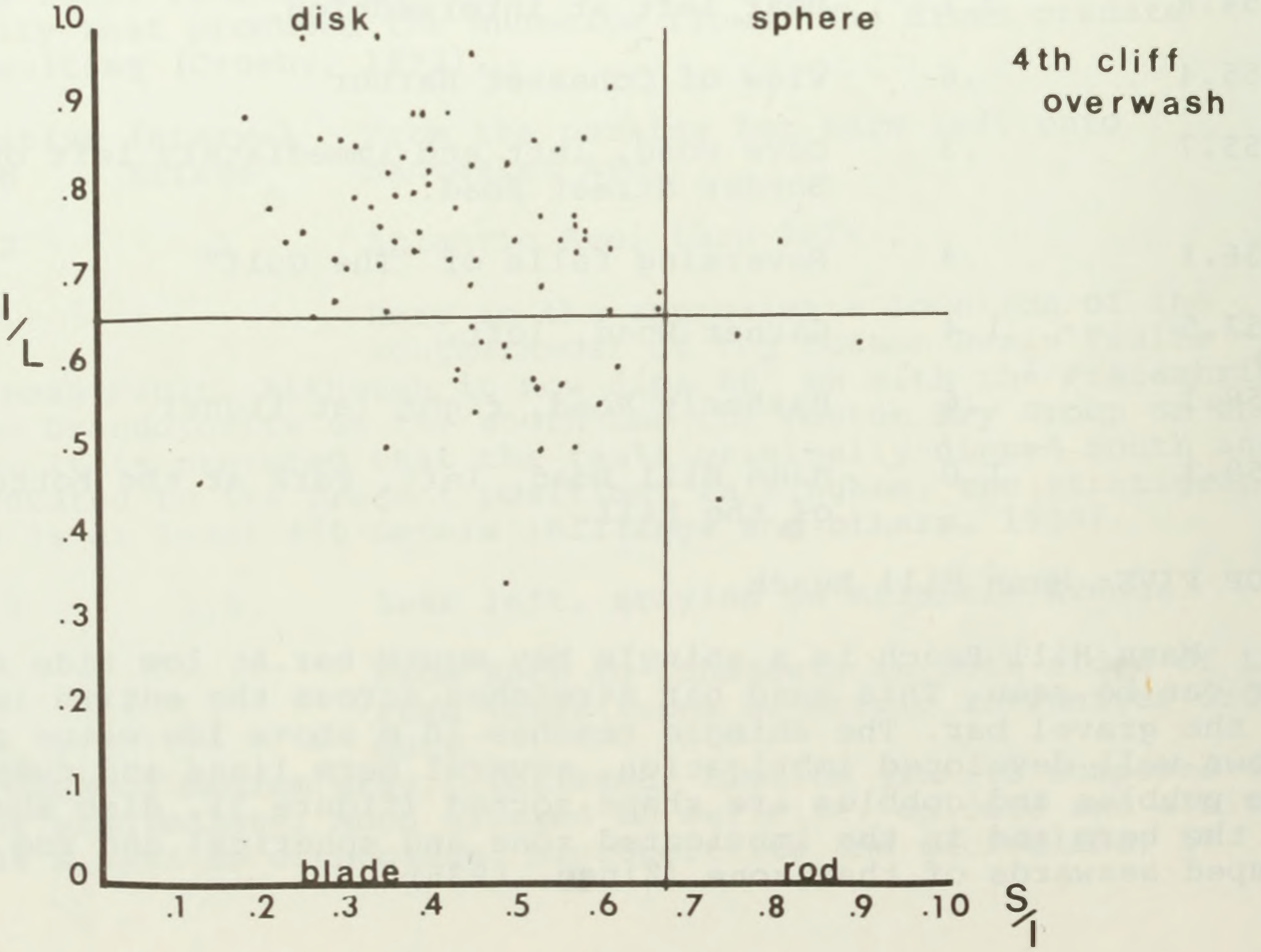
Cumulative Milage	Interval Milage	
54.8	2.1	Bear left at intersection.
55.4	.6	View of Cohasset Harbor
55.7	.3	Cove Road, left and immediately left on Border Street Road.
56.1	.4	Reversing falls of "The Gulf"
57.5	1.4	Garnet Road, left.
58.1	.6	Hatherly Road, right (at light).
59.1	1.0	Mann Hill Road, left. Park at the bottom of the hill.

STOP FIVE: Mann Hill Beach

Mann Hill Beach is a shingle bay mouth bar.At low tide a sand bar can be seen. This sand bar stretches across the entire length of the gravel bar. The shingle reaches 10 m above low water and shows well developed imbrication, several berm lines and cusps. The pebbles and cobbles are shape sorted (figure 5), disc shaped at the berm and in the imbricated zone and spherical and rod shaped seawards of that zone.(Zingg, 1935).

figure 5


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
I/L
4th cliff
front edge
of shingle


disk
sphere
blade
rod
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
I/L
.1
.2
.3
.4
.5
.6
.7
.8
.9
.10
S/I
4th cliff
overwash

Net landward movement of the pebbles during normal sea conditions is small. During storms, pebbles of all shapes are brought in by waves from the offshore tills and ground moraine. Discs, being lighter than a sphere of the same mean diameter and having a lower settling velocity than any other shaped pebble are thrown up higher on the beach (Krumbein, 1939, McNown and Malaika, 1950). Once gravel is high up on the berm, a sorting mechanism takes place. Backwash moving through the gravel, moves the finer sizes seawards (Bluck, 1967). The size and shape of this seaward moving gravel is dependent on the size and geometry of the pore space. Usually a fringe of spherical pebbles is found at the high tide water line. These probably have been moved through the pore spaces. Rods, however, are caught in the intersticies, for they orient themselves with the long axis parallel to the beach.

Seaward movement of the surface particles on the berm scarp takes place under normal conditions. In a traction carpet, spherical and rod shaped particles move faster than discs, for discs have a lower pivotability (Kuenen, 1964). Therefore spheres and rods will be transported further seaward by the backwash. Almost always, there is a fringe of spherical and rod shaped shingle seaward of the gravel bar (see figure 5).

While the discs lag behing, they are not stationary. They become imbricated. Perculation by the backwash produces an imbrication of the pebbles, such that they dip seawards. By means of a caterpillar type action these discs are slowly moved seawards. This movement is irregular, resulting in a wide range of dip values (0-85°).

Diffraction and refraction of waves around Cowen Rocks 0.7 km offshore (the only outcroping of Dedhan Granodiorite in the Scituate Quadrangle) may set up an interference pattern between these waves and unaffected incoming waves such that cusps are usually well developed on Mann Hill Beach. Cusps may also be due to the interaction of transversal waves (edge waves) which are excited by incident waves and the incident waves themselves. Edge waves are surface waves trapped by refraction to the shore and have a maximum amplitude at the shore line. The interaction between these edge waves and incident waves effects the breaker height along the shore and may set up a circulation pattern in the nearshore consisting of an onshore flow towards the breakers,a longshore current and an offshore flow in a strong, narrow rip current. These rip currents are located at the antinodes of the edge waves (Bowen, 1969, 1973).

Once this circulation is set up cusps develop. Cusps on a sandy beach are first noticeable as patches, a few centimeters thick,of gravel, shells or other coarse material. The backwash, instead of returning in dispersed flow, moves away from the patches and returns in a channel. This process is repeated and intensified till the backwash flow attains such momentum that the next swash cannot proceed against it and is projected onto the apices of the developing cusp. There the coarsest particles are deposited while the finer grains stay entrained as the water swings into the adjacent bays without stopping (Bagnold, 1940). These apices become more and more imbricated with each passing high tide. The cusps will be reoriented or eradicated by a change in the sea state.

Cumulative Milage	Interval Milage	Return to Mann Hill Road. Cross Hatherly Road.
59.6	.5	Bear left, staying on Mann Hill Road.
60.3	.7	Bear right, staying on Mann Hill Road.
60.5	.2	Curtis Road, left.
60.9	.4	Shallow left onto Country Way.
		You are now driving over ground moraine deposits, non sorted and unstratified drift with a mixture of sizes ranging from clay to boulders. From test borings, it appears that the moraine is from 30-600 cm thick (Chute, 1965).
63.5	2.6	Left, to join route 3A south towards Marshfield.
64.6	1.1	Cross the North River.

From 1646 to 1871 the North River was known as the cradle of New England Shipbuilding. More than 1,000 vessels were constructed in over 20 shipyards on this river. The most famous of these ships were the Beaver, one of the vessels raided by the Boston Tea Party and the Columbia, the first american ship to circumnavigate the world. There was a plentiful supply of timber, white oak, black walnut and white pine. Demands for larger ships led to two unsuccessful attempts to breach the barrier between Third and Fourth Cliffs, for in the nineteen hundreds the mouth of the North River was 4.8 km south of its present location, flowing for that distance behind a narrow barrier beach. (Spayne, 1975)

64.9	.3	Shore Road, left towards Seaview and Humarock.
65.7	.8	Humarock Street, left.
68.0	2.3	Sea Street, left.
68.4	.4	Cross South River
68.5	.1	Central Avenue, left.

69.9 1.4 Go to the Military Reservation and park. Walk along the beach to the base of the drumlin and then around the drumlin to the spit and bar.

STOP SIX: Fourth Cliff and spit and sand bar in the South River

Fourth Cliff is a 24 m high, 0.8 km long drumlin that consists of 12-30 cm of soil and 9 m of brown oxidized till which grades downwards into incompletely oxidized till. In this lower unit there are remnants of unoxidized gray till that contain some reed like plant remains. These have been dated at 35,000 B.P. (Chute, 1965). The typical amount of silt and clay in the till is 19% with a maximum of 40%. This is an unusually low percentage for eastern Massachusetts drumlins.

On the east side of the drumlin two lenses of sand and gravel 3-4.5 m thick separated by 3 m of till, crop out. These lenses dip 10° to the south and appear to pinch out at the bottom of the cliff (figure 6). The composition of the pebbles and cobbles in the till is primarily Dedham Granodiorite and Westwood Granite and biotite granite and Mattapan Volcanics. The Cambridge Argillite is no longer present in large quantities. The sand is 60% quartz, 20% feldspars and 20% heavy minerals such as biotite, magnetite, garnet and hornblende.

Figure 6. East side of Fourth Cliff, Scituate Massachusetts and the shingle berm in front of the till. Note the layering of the sand and gravel in the drumlin.

On the beach are many boulders and cobbles some of which are so large that even storm waves have difficulty in moving them. As you walk along, make sure you see the large (1.2m) Dedham Granodiorite boulder with the orientated xenoliths of amphibolite. On the north east point there is a boulder pavement. It has an exposed width of 60-100 m at low tide. Of interest is that there seems to be little or no sand movement across this boulder platform below mid-tide level. The boulders below this level show little or no abrasion; instead they are covered with barnacles and seaweed and many show weathered surfaces that would not survive under abrasion. In contrast, the boulders on the upper part of the beach between the base of the wave cut cliff and mid-tide show evidence of abrasion. There are few weathered surfaces or flora and fauna that could survive above the mid-tide level. This scouring is caused by sand and shingle which is washed back and forth at the still stand of the high tide. Above the mid-tide level, the shingle extends about 4 km south of Fourth Cliff. Beyond that, the beach is composed entirely of sand.

Before the nineteen hundreds there existed a barrier between Third and Fourth Cliffs. The mouth of the North River was 4.8 km south of its present location. Then on November 27th, 1898 with a high tide of 4.5 m (1.3 m above normal) and a wind of 120-130 km/h piling up waves even higher, the ocean cut through the beach ridge between the cliffs. In a few hours a channel 45 m wide and 3 m deep had been excavated. Now the channel is 120 m wide and 4.2-4.8 m deep. The average flood tidal velocity through the gap is 24 cm/sec. The ebb tide velocity is 36 cm/sec.

It took three years of longshore drifting to fill the old river entrance. The result is that the South River now flows further north and has developed a sand bar which extends into the North River which recurves it. The bar, now, is almost a reverse mirror image of Cape Cod.

The spit behind Fourth Cliff can be divided into two distinct parts. The first part is adjacent to the drumlin. It is fronted by a low scarp 60 cm high and is composed almost entirely of boulders and cobbles. These cannot have come from the drumlin immediately behind the beach for the sizes there are much smaller. Instead, they must have been carried by storm waves around the north-east point.

About 200 m southwest of the point there is a sudden change in the size of the shingle. The particles become much smaller and sand becomes dominant (see table on the next page). This may demark the boundary of the effect of storm waves. Also there is a scarp of old marsh grass (Spartina patens) there and only the largest storm waves can lift cobbles over this resistant scarp.

From there south westward, sand predominates. The development of the spit has dammed up the sediment coming down the South River. This is now deposted in a sand bar. This bar where it extends into the North River, recurves back to Fourth Cliff. At the north-west corner, the bar has become anchored by extensive beds of mussels. The top of the bar is practically devoid of vegitation or animal life. But sand waves, current ripple marks and rhomboid ripples and rill marks are common.

Table 2. Size analysis of the spit and sand bar at Fourth Cliff (after Spayne, 1975)

ϕ	1	2	3	4	5	6
> -1		42	96	37		
-1-0	<1	<1	1	38		
0-1	12	19	<1	19	28	12
1-2	50	30	1	4	63	56
2-3	38	9	2	2	7	31
3-4	1	1	<1	<1	1	1

1. dune line
2. high water line
3. top of bank at beach front
4. bank at beach front
5. mid bar
6. north-west edge of bar

Cumulative Milage	Interval Milage	
		Return along Central Ave.
71.3	1.4	Sea Street, right.
71.7	.4	After the bridge turn left on Berry Street.
73.0	1.3	Ferry Street, right.
73.6	.6	Bear left staying on Ferry Street.
74.5	.9	Furnace Street, right.
75.9	1.4	Bear right. Merge with Route 139.
76.2	.3	Entrance to Route 3 to Boston via the SouthEast Expressway or Route 128.

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