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Report on Quaternary field mapping in the Waldoboro Area

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Report on Quaternary
field mapping in the
Waldoboro area

From

Bjorn G. Andersen

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Introduction

The Quaternary mapping of the Waldoboro area was done as a reconnaissance mapping. The finished maps therefore don't pretend to show details, but the large trends. Within areas mapped as covered with marine deposits there are patches of till exposed. However, in the description is indicated in which parts the till-patches most likely occur. Some of these areas are shown with hatching on the maps also. The same principles apply to areas covered with till etc.

Emphasis was laid on solving some of the important scientific problems. This part will be discussed with Professor Bonus, and only a few general results will be mentioned in this report.

Professor Bonus introduced me to the geological problems of the area. This introduction was a great help to me.

Although he had done no ~~detailed~~ mapping of the area, he had a rough idea of what was there. The features are parallel to what he has found on the coast of eastern Maine. The work he has done looks very interesting and sound to me, and it is my hope that my work can be a small addition to this.

I would also like to express my gratitude to the Maine Geological Survey and Walter Anderson who has taken much interest in my work and been of great help to me.

- 1) Gør ferdig rapport og alt der skal til Aug.
- 2) Ny dekke, frimerker og bil
- 3) Ny kofert, håndklæde og subs.
- 4) Vask til bil.

Generalized cross-sections

Fig 1

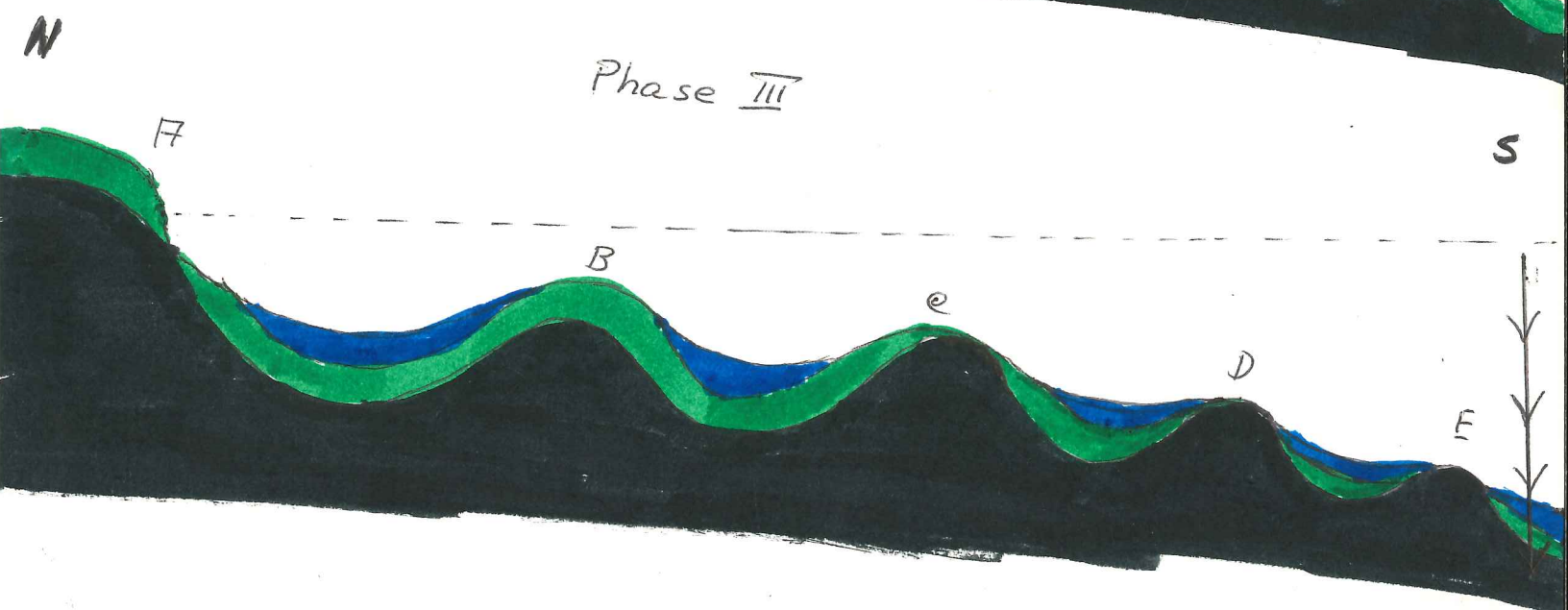
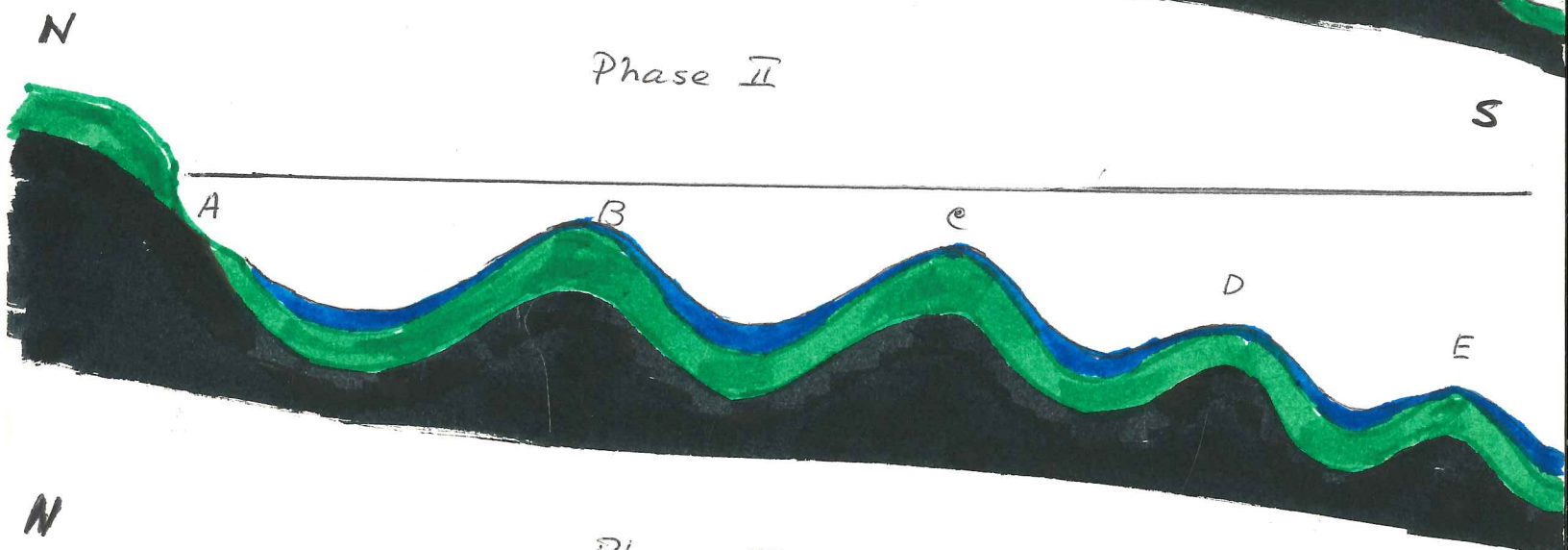
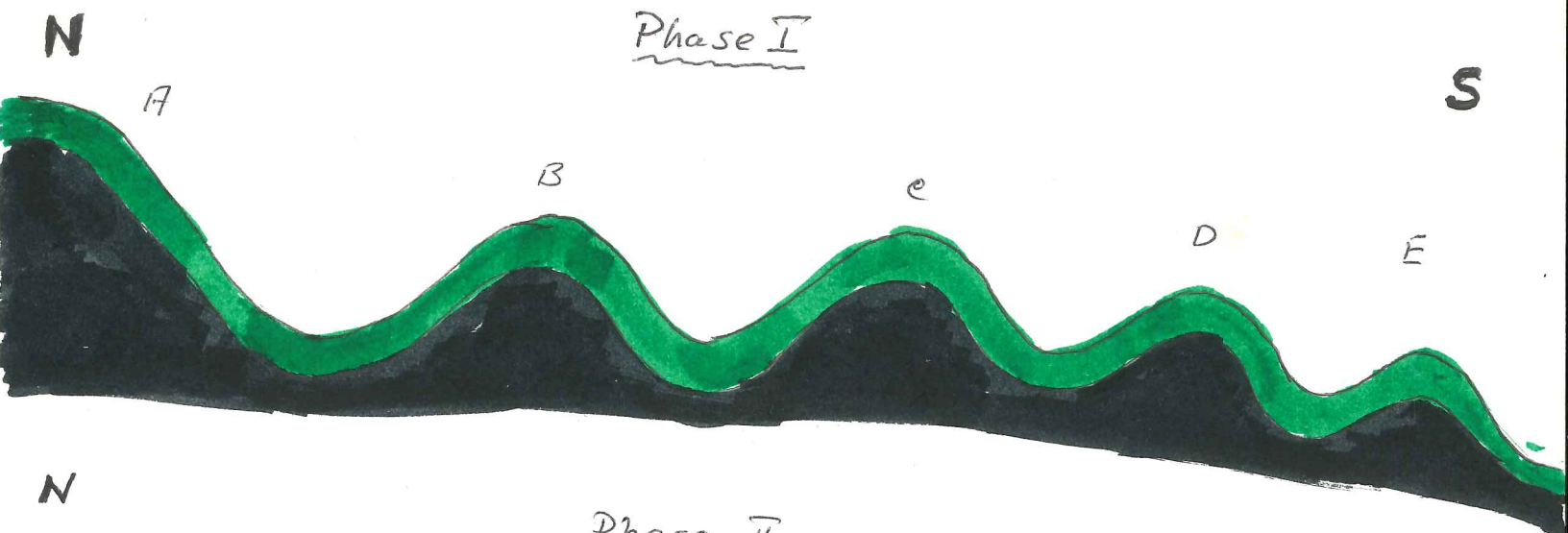
Generalized cross-sections - N-S of the Waldoboro area.

Phase I: The glacier deposited the ground moraine as a more or less continuous sheet. Only in the higher areas, above 400 - 500 feet, north of the Waldoboro sheet ~~did~~ the glacier leave larger areas with exposed bedrock.

Phase II: The sea level when the glacier had retreated to the northernmost part of the area was about 290 feet in the north and 275 feet in the south. A scarp was eroded in the hills at the highest sea level. The fine-grained sediments were washed away from the till leaving a bouldery till at, and ^{immediately} below M_h (the highest coastline).

Phase III: The sea level dropped relatively rapidly, and all areas below M_h were exposed to shore abrasion. The effect of this abrasion was strongest on the projecting hilltops and slopes facing open sea. The fines were gradually washed down to the

lower-lying depressions. Hilltop B lies protected behind hilltop C. Therefore the waves washed away only a part of the thin cover of marine deposits; Hilltop C was more exposed to wave abrasion. There both the marine silt and much of the fines in the till sheet were washed away - leaving a very bouldery till with scattered exposures of bedrock. Hilltops D and E that both lie near the open coast, and ^{were} well exposed to wave-abrasion have ^{no sediment cover,} ~~mainly exposed~~ bedrock, and ~~marine sediments covering~~ the



Bedrock
 Till
 Marine sed.

Phase I: The glacier deposited till

Phase II: The highest sea level following glacial retreat.

Phase III: The sea level dropped to the present level.

Fig 2

Cross-section W-E of a valley where till, eskers and marine deposits exist.

A: Till and two eskers deposited by the glaciers and glacier streams.

B''-B': The same profile after marine abrasion and sedimentation has taken place

B': The profile is located far inland where marine abrasion was relatively weak

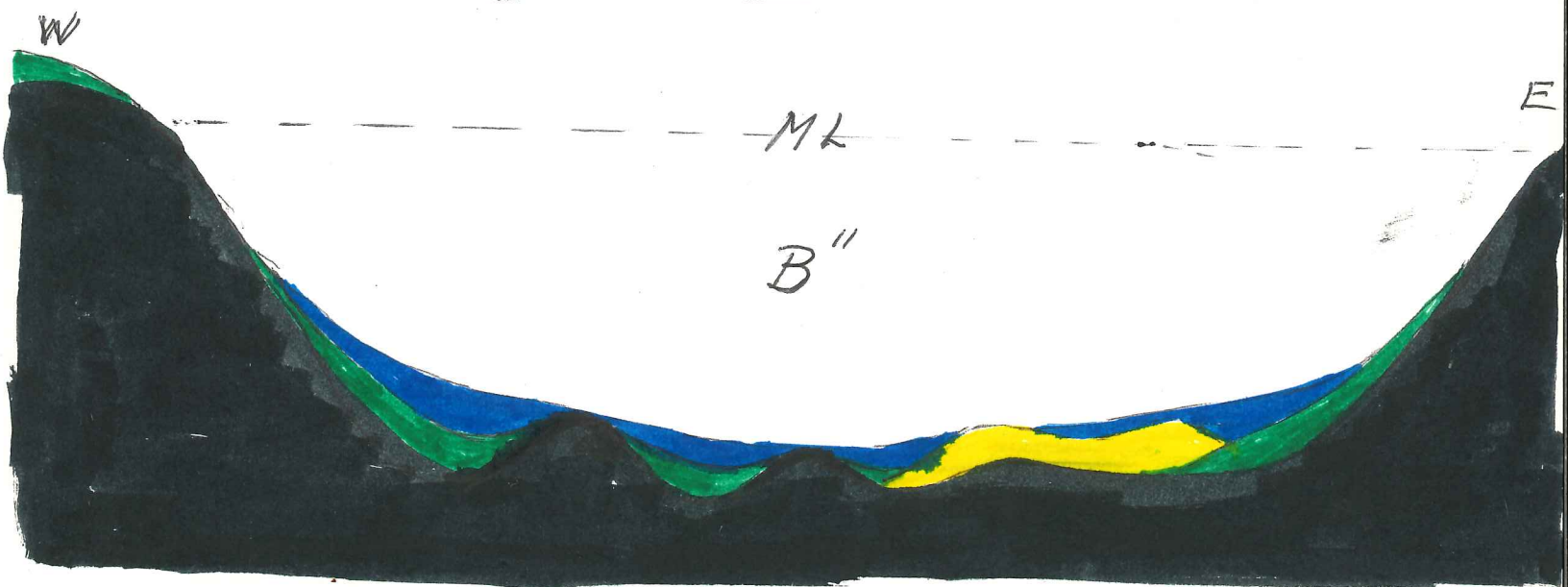
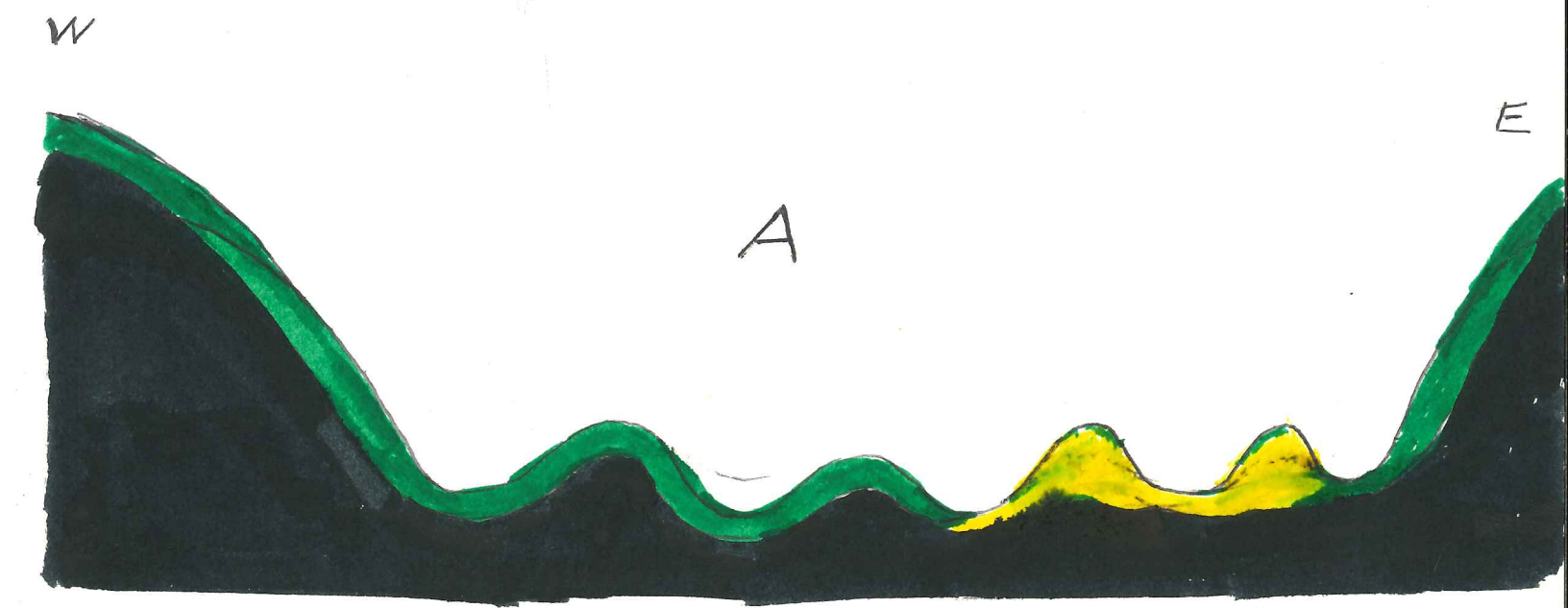
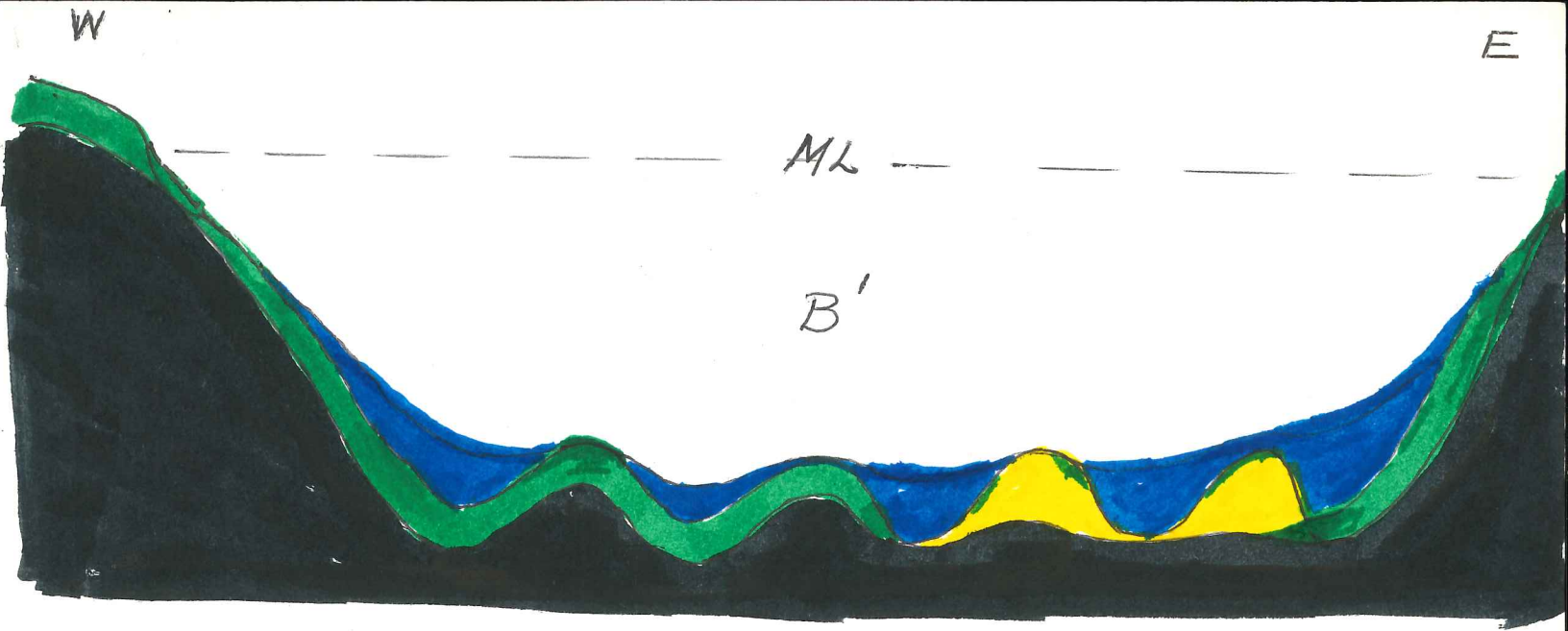
B'': The profile is located close to the present coastline where marine abrasion was stronger.

Black: Bedrock

Green: Till

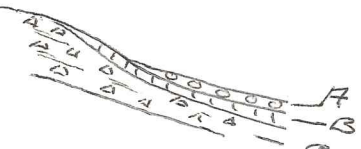
Yellow: Glaciofluvial gravel

Blue: Marine sediments



Description of observed
stations

Stations marked on the maps

- ① SW of Waldoboro, good striation near road $S5^{\circ}E$
- ② SE of Nobleboro, striation near road $S20^{\circ}W$
- ③ E of Nobleboro, 6 feet clay exposed near the road. Scattered erratics on top of the clay.
- ④ S of Nobleboro in small gravel pit. 3-6 feet of silt overlies 6-9 feet of cobble-gravel. Striated bedrock below the gravel, $S10^{\circ}E$.
- ⑤ S of station ④, small gravel-pits.
Pit north of the road:
in moraine ridge :

 - A: 1-2 feet of beach gravel
 - B: 2-3 feet of laminated clay and silt
 - C: 13 feet till, partly striatified.

Pit south of the road:
Good striation on exposed bedrock $S10^{\circ}W$.
- ⑥ SE of station ⑤. Striation $S10^{\circ}E$.
- ⑦ NW of station ⑥. Several pits show 2-4 feet of gravel below 2-3 feet of silt and clay. Striation in several pits, $S5^{\circ}E$.
- ⑧ S of station ⑤. Small pit with 3 feet of gravel below 3 feet silt. Striation $S10^{\circ}E$.

⑨ West of Nobleboro. Rock moraine S.

⑩ Striation $S 5^{\circ} E$.

⑪ and ⑫ North of Nobleboro, striation $S 5^{\circ} E$.

⑬ North of Waldoboro  230 feet

Beach scarp washed into the Waldoboro end moraine ridge. Big boulders on the surface in the washed zone. Fewer boulders above. The scarp probably lies higher than the M.L.

⑭ ~~Beach~~ NW of station ⑬. Weak scarp with washed till below and less bouldery till above the scarp which is here about 275 feet above sea level.

⑮ South of Waldoboro. Good beach scarp with very bouldery till ⁱⁿ below the washed zone.

⑯ NW of Whitney corner. In gravel pit:
1 - 5 feet of till on top of 20 feet sand, gravel and cobbles. The upper beds are ~~folded~~ folded. The till is gravelly and includes stratified material.

⑰ NW of station ⑯. Weak striation $S 20^{\circ} E$.

⑱ E of ⑰. Crossing striation $S 5^{\circ} E$ youngest
 $S 30^{\circ} E$ oldest.

- (19) North of (18). Good striation S 20° E.
- (20) At Union - Good striation near road S 20° E.

(21) SE of Waldoboro:
 Abrasion scarp at 280 feet with unwashed
 till above. Striation S 15 E.

(22) S of (20). Striation S 15 E.

(23) S of (22). 6 - 10 feet of well sorted stratified
 gravel in a broad ridge, Beach ridge?

(24) S of (23). Striation S 20 E.

(25) E of (24). Large gravel pit, probably in beach-
 washed esker.

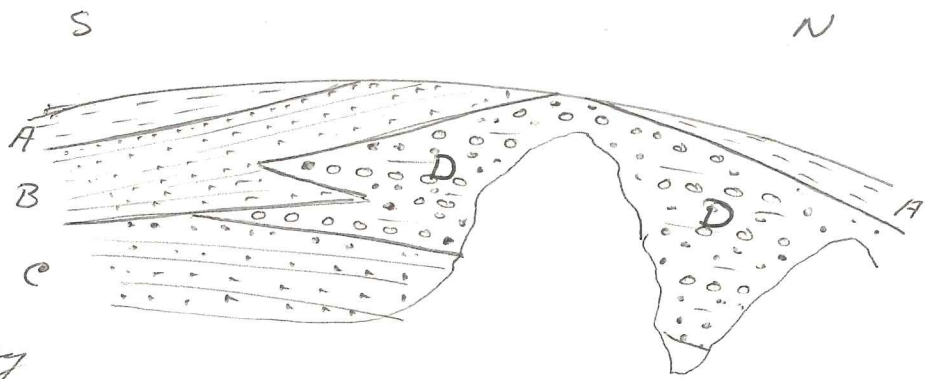
	1-3 feet clay
. . . .	3-6 feet stratified mud and gravel
△ △	9 feet gravel and till with big boulders, crudly stratified.
△ △	
. . . .	6 feet of stratified mud, gravel and cobbles.

(26) N of (21). Cobble beach ridge about 280 feet ^{level} a. sea

(27) and (28) Stations near Station (25).
 Striation S 20° E in small gravel
 pits with 2-6 feet of gravel
 below the silt-clay.

(29) Near Warren. Big gravel pit on ~~the~~ near the
 crest of
 proximal slope of moraine ridge:

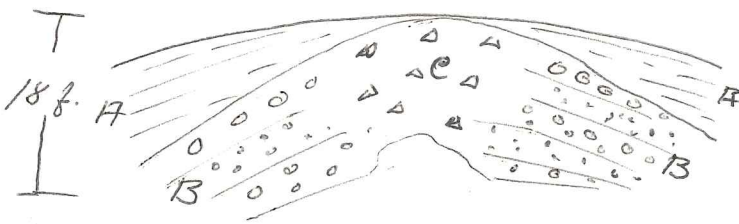
(29) continued:



- A: Brown clay
- B: Laminated sand, mostly finegrained
- C: Stratified coarser sand
- D: Gravel, stratified in some parts, billy in other parts.

(30) Near (29). Abandoned pit. About 18 feet stratified gravel with cobbles underlies clay.

(31) Near (30). In gravel pit:

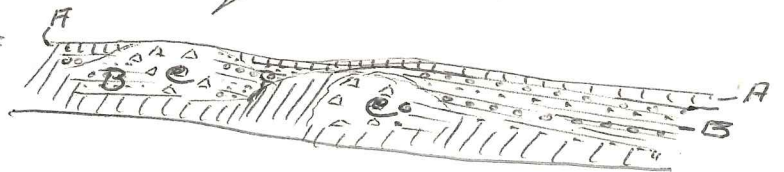


- A: Laminated silt and clay
- B: Stratified gravel
- C: Till ridge with large boulders.

(32) Good straddition near station:
S 70° E youngest and S 25° E oldest.

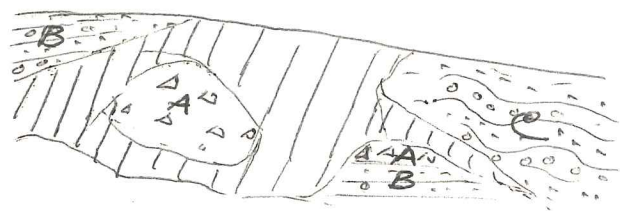
(33) Large gravel pit in ridges and outwash.

East face of pits:



- A: Clay
- B: Stratified gravel
- C: Till and stratified gravel in two moraine ridges.

(34) North of (31). Big gravel pit:



- A: Till and gravel with boulders
- B: Stratified sand and gravel
- C: Same as B, but folded.

The section indicates that there is a buried till ridge which was pushed in place.

(35) out

(36) S of Union. In gravel pit:

	2-6 feet of clay
△ △	3-6 " till
○ ○ ○	8-12 " stratified gravel

(37) N of Union: Weak striation S 5° E.

(38) Striation S 20° E.

(39) NW of Warren Striation S 70° E.

(40) N of (39). Gravel pit:

△ △ △	8-12 feet boulder gravel tilly in places.
○ ○ ○	
○ ○ ○	Stratified sand and gravel.

(41) out.

(42) N of (40). Striation S 30° E.

43-43 out.

(50) Striation S.

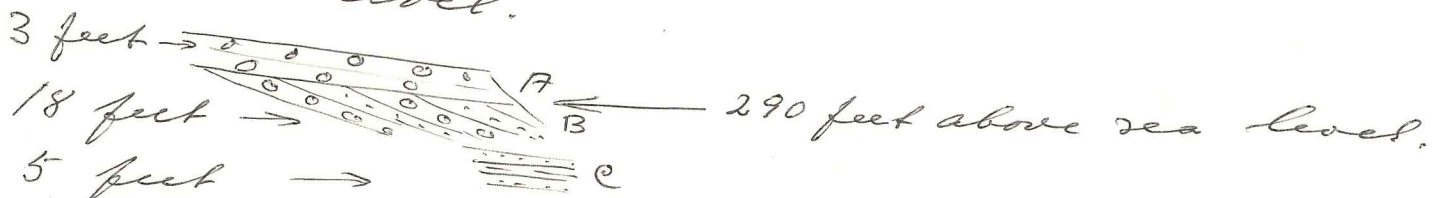
(51) South of locality (1). Striation S.

(52) W of Waldoboro. Striation S 55° E.

(53) North of Damariscotta. Gravel pit with 12 feet gravel on bedrock, striated, S 10° E.

(54) North of Samariscotta lake.

Outwash delta about 290-295 feet above sea level.



A: Topset beds of coarse, poorly sorted gravel with boulders.

B: Foreset beds dipping about 30° south. Beds of sand, gravel and cobbles.

C: Bottomset beds of sand and silt.

The discordance between the topsets and foresets lie about 290 feet above sea level.

The sea level was at least that high when the outwash delta was deposited.

Channels eroded 3-6 feet down into the delta lead NW-ward through a washed moraine which was probably deposited at the ice front.

(55) Gravel pit south of (54). About 10 feet gravel on striated surface, $S 20^\circ E$.

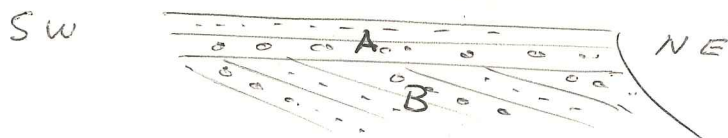
(56) E of (54). Striation $S 25^\circ E$.

(57) SE of (56). Striation $S 20^\circ E$.

(58)

E of (56)

Pit in large outwash delta.



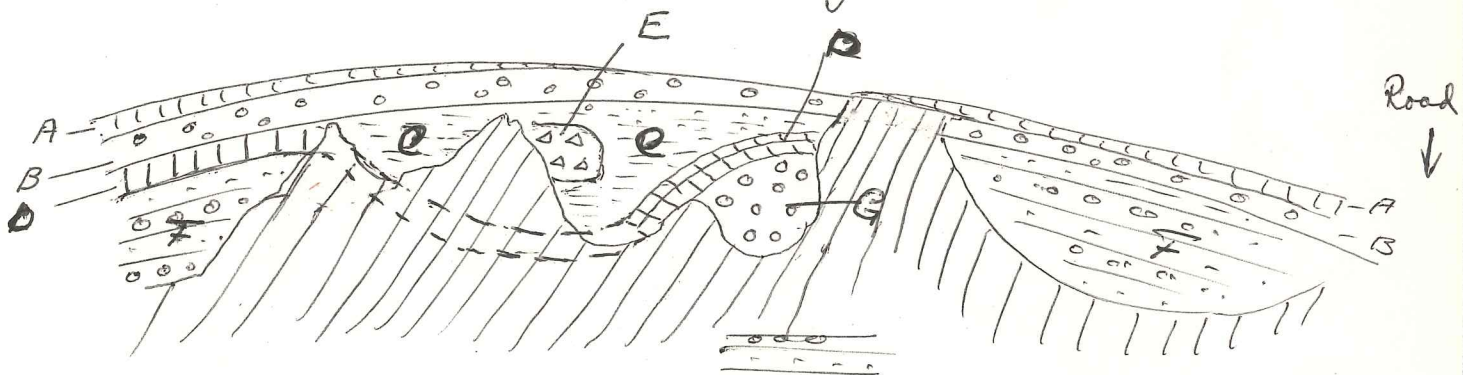
A: 4-6 feet topset gravel beds with cobbles.

B: 18 feet foreset gravel beds

The foreset beds dip steeply towards NE.
 The discordance between topset and foreset section lies about 290 feet above sea level.
 The sea level when the outwash delta was formed therefore was at least 290 feet above sea level - but probably not much higher.

(59)

S of (58). Pit, probably in buried esker.



A: Silt, max 6 feet thick

B: Gravel with cobbles about 6 feet thick

C: Marine blue-clay min. 16 feet thick in central part, laminated silt and clay in upper 2-3 feet

Shells of *Stictella arctica* (many) *Mya truncata*,
Chlamys islandicus, *Macoma calcarea* and
Mytilus edulis lie in the clay. Sample for
 C-14 dating was collected about 6 feet down

(59) continued:

into the clay.

D: Siltbeds, 3-6 feet thick section with large boulders. They underlie the clay.

E: A section of hilllike bouldery gravel

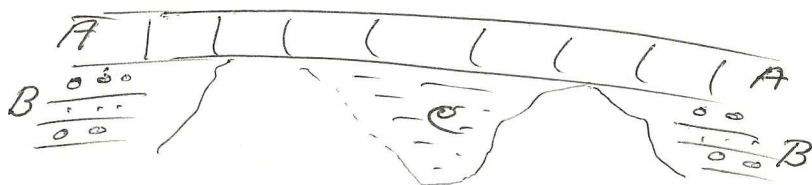
F: Flatlying gravel beds

G: Cobble - boulder gravel, probably a part of the esker-core.

It is not possible to decide whether a collapse or a glacier push has taken place.

A collapse in connection with the formation of a cattle hole is probably most likely.

(60) E of (58). Gravel pit through cattle hole filled with clay, in esker.



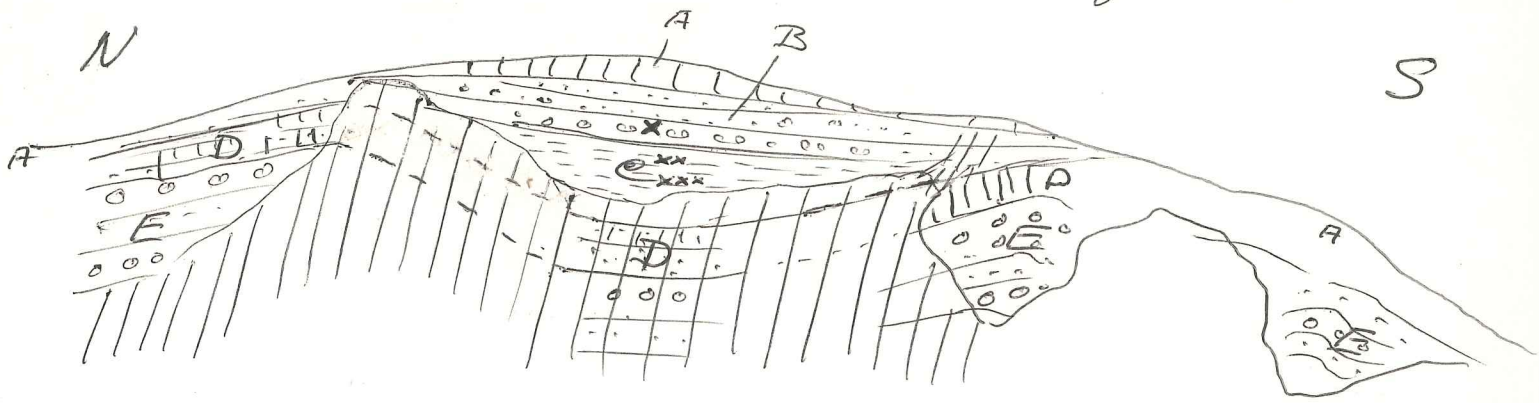
A: Silt B: Sand and gravel

C: Laminated blue-clay. Min. 14 feet.

Shells were found in upper 1/2 yard of the clay. The same species as in (59) were seen, except that *Mytilus* was lacking.

(61)

Gravel pit in esker at Whitney Corner.



A: Silt 2-4 feet

B: Gravel, sand, silt and clay, 2-6 feet
Stratified beds with fossils

Numerous *Mytilus e.* was seen in the lowest-lying gravel bed, about 20 cm thick.

C: Blue clay, sandy in upper part, silty in lower part. - 8-12 feet thick in central part.

D: Stratified silt and sand

E: Stratified gravel, folded and silty in southern part of the pit.

Shell collected at:

x *Mytilus* gravel bed, 20 cm. *the.*, *Stiatella arctica*, *Chlamys islandicus*, *Arctica isl.*, *Mya truncata* and a large snail found in this bed and in beds 2 feet above and below the gravel bed. Sea weed.

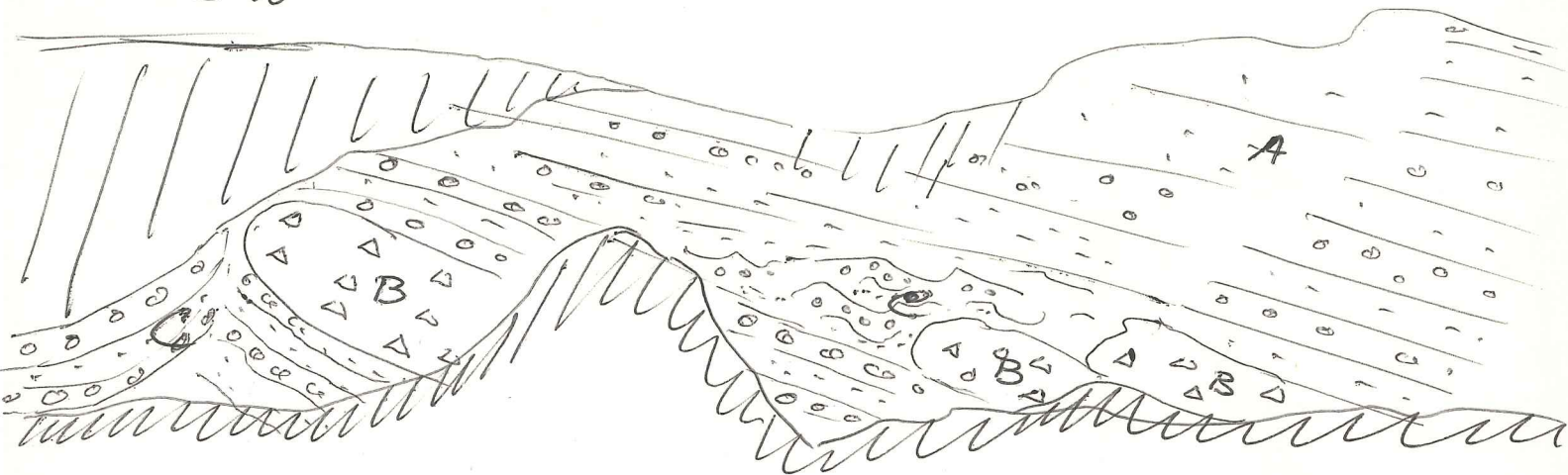
xx large snail collected 2 feet below *Mytilus* gravel

xxx *Stiatella arctica* from clay 3 feet below *Mytilus* gravel. Only H.a. was found in this zone.

(62) E of (61). large gravel pit in
end moraine.

SW

NE



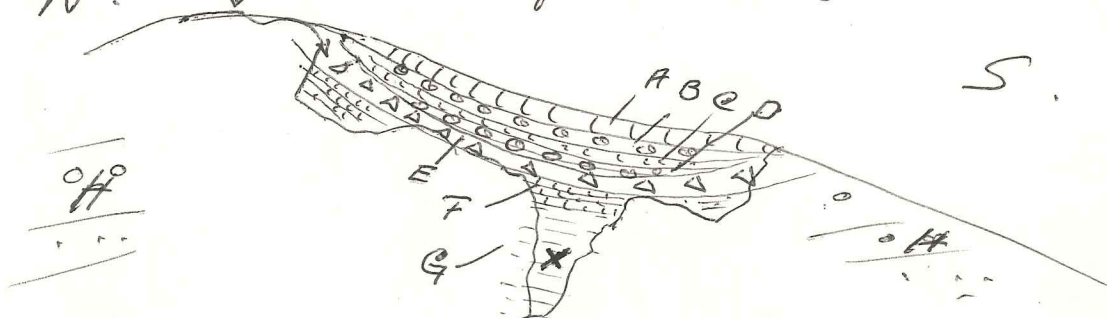
- A: Stratified sand and gravel, 60-80 feet
 B: Till and poorly sorted gravel, evidently pushed in place by the glacier.
 C: Folded sand and gravel

(63) E of (62). large gravel pit in
end moraine ridge.

N.

↓ Crest of ridge

S.



- A: Silt 2-3 feet
 B: Gravel, cobbly 1-2 feet
 C: Silt, 1 foot
 D: Gravel, 1-3 feet, till like cobbly gravel
 E: 2-5 feet silty, clayey cobbly till?
 F: 2 feet laminated silt

(63)

continued.

G: Blue-clay - 4-8 feet exposed.

In upper part of the clay there are *Hiabella arctica*, *Macoma calcarea*, *Arctica islandica*, *Mytilus edulis*, *Mya truncata*, and *Mya arenaria*.

In lower part, where the shell sample was collected (at x) there were only *Hiabella arctica* and few *Macoma calcarea*.

(64)

South of Waldoboro Station S 20° E.

(65)

NW of (64). Station S 10° E.

All of the station directions were corrected (18°) for declination.

Description of
sediments

Description

Bedrock, exposed Most of the mapped area is very well covered with Quaternary sediments. Small exposures of bedrock exist scattered all over the area. More extensive exposures of bedrock were seen in the following districts:

- 1) Some areas lying higher than 400-500 feet on Razorville and Washington Quadrangles. Apparently the glaciers deposited less till on some of the highest projecting hills. Glaciers generally transport and deposit most ground moraine in the lowest-lying portions.
- 2) Areas near the southernmost coast that were well exposed to wave abrasion frequently have no sediment cover. This is particularly true for projecting hilltops and south-facing slopes. In addition a narrow belt along the present shore generally has bedrock exposed.

The ground moraine has been divided
into ground moraine deposited above and
below ~~marine~~ marine limit (Mh).

The ground moraine above Mh
has a considerable silt-clay content
even at the surface. The boulder con-
tent varies, but is considerable less
than in the washed zone immedi-
ately below Mh. Some of the best farm-
land lies on this till, and the
fields frequently stop at the Mh.

The ground moraine below and
at Mh has been washed by the
sea, or it is covered with marine
sediments. Particularly at Mh and
in a zone immediately below Mh
much fines have been washed away
from the till in most places. The
till surface is there generally very
bouldery - and consequently a poor
farm-land. In lower-lying areas
the till was covered with marine
sediments during a deep water-

phase. During a following shallow-water phase much of the finegrained marine sediments were washed away from the till surface. This is particularly true for the ~~most~~ steeper slopes and the projecting hills and ridges that were strongly exposed to marine wave abrasion. In some areas the waves washed away not only the finegrained marine sediments but also the fines from the till surface. In other areas only most of the ^{marine sediments} clay (mainly) along the crest of the ridges were washed away. This is typical for many of the drumlinoid ridges. Many of the best farms lie on such ridges where there is much till exposed or where much of the till has a very thin cover of marine sed. Till is generally not exposed on the valley floors and in the lowest parts of the depressions.

Drumlinoid ridges have been marked on the maps. They are elongated ridges parallel with the ice-flow direction. Most of them probably have a core of bedrock, but rather thick till lie particularly on the stoss-slope (northern) part of the ridges. Much good farm-land lie on these ridges.

Glaciofluvial sediments.

Glaciofluvial sediments, which are the most important source for commercial gravel, were found in ~~outwash~~ outwash deltas, esker-ridges and in some of the larger end moraine ridges, below the 11th. Two very fine outwash deltas lie on the northern part of the Jefferson Quadrangle. Particularly the delta at Globe is very large and a very important gravel source. Good outwash deltas lie on the Rayowille

Quadrangle also. All of these deltas have delta plains lying about 290 feet above sea level. This was the approximate altitude of the sea level at the time when the deltas were deposited in front of the ice.

A rather dominant esker-system ~~goes~~ lies from Sheepscot Pond towards the Muddy Pond delta, and from the Muddy Pond delta to the Globe Delta. Also to the south of the Globe delta there is a ridge which is probably a buried esker. Another large esker lies on the floor of the Medouak River Valley to the east of the Globe delta. South of this ridge there is a strong concentration of gravel pits along a belt with ~~straggle~~ hills and ridges that are buried in marine sediments. They probably represent a buried esker system that can be traced

to the large esker and the end moraine at Whitney Corner. Similar, probably buried esker - systems, can be traced further southward along North Pond and South Pond towards Westworths Corner. Apparently a rather dominant subglacial drainage followed this route.

Some of the largest gravel pits lie in stratified end moraines, where glacier streams terminated at the ice front. This is particularly true for the end - moraine at near Whitney corner. At this place the Waldoboro end moraine has more the character of a large esker or lower deposit.

End moraines

Numerous end moraine-ridges were seen. Some ridges are small, but the ridge immediately north of Waldoboro, the Waldoboro moraine, is rather large and prominent, commonly 15 to 30 feet high - in some areas even higher. Another sharp ridge that can be traced over long distances lies near the south end of South Pond.

The moraine ridges are usually covered with marine sediment - even though this is not indicated on the maps.

The small moraines are numerous, and many more than those marked on the maps probably exist. They are some sort of "annual" moraines, probably deposited during small readvances. The fact that they all lie below Mh, indicate that their origin could be related to marine factors. Could the tide have something

to do with it? A rise in sea level could "lift" the ice-front and cause less friction against the glacier bed. During a following drop in sea level the ice-front could possibly push forward. I will not discuss all possible theories concerning the origin of the small and moraines.

The South Pond moraine, the Waldoboro moraine and the large outwash deltas at Globe-Dyer represent the most dominant and the most important ice-front phases recorded in the studied area.

Marine sediments

Much of the lowest-lying areas is covered with marine sediment. This is particularly true for the floor of the valleys and depressions where the sediments can have a considerable thickness. Marine silt, with some clay is most dominant. Marine sand and gravel

was seen in higher lying areas, immediately below the highest lying stone zone, near the larger bodies of outwash and on the southernmost coast. The finest-grained marine sediments, much clay, underlies the organical sediments that cover the lowest depressions.

Marine fossils were found in some of the marine clays. Only fossils in the oldest clays, the glaciomarine clays, that have interest in connection with the deglaciation history were collected. They were found on the Waldoboro and moraine and outwash deposits near the Globe outwash delta. The shells indicate that *Hiattella arctica* was the first species to enter the districts near Waldoboro and Globe. Professor Bonus found *Portlandia arctica* etc. in still older clays on the coast of eastern Maine. No such shells were seen in the studied area, but they could very well lie in the oldest unexposed clays closer to the coast. Several of the collected shell samples will be

submitted for radiocarbon dating. They should yield dates on course of blue shore levels, and the moraines.

The marine limit, M_h

The marine limit, M_h, is a rather important feature, and much time was used to find the exact altitude of M_h. The outwash deltas near Globe give a rather accurate altitude, 280 feet, of M_h in that area. Flattening deltaic surfaces in some of the valleys on the Quadrangles north of Jefferson and Union indicate that M_h must be close to 300 feet there. No outwash deltas were seen closer to the coast and it is very difficult to find the accurate M_h there. The beach-washed zone frequently extend slightly higher than M_h, which is a complicating factor. Beach ridges about 275 feet above sea level near _____ and _____ were probably deposited near M_h. On relatively protected places the beach-washed zone is no higher than about 275 feet. Therefore the M_h

is probably close to 275 feet on the southernmost coast of the studied area.

A beach-washed zone, generally with a more or less distinctive beach scarp can be traced almost continuously along the green lines (Mh) on the maps. Washed till with numerous erratics ~~to~~ often lie at the surface in this zone. In the southernmost areas, where on slopes that were well exposed to wave abrasion much bare bedrock is exposed in the beach-washed zone at Mh.

Glacial striation. The exposed bedrock is frequently striated. Both the glacial striation and the drumlines show that the ice moved in a south direction, $510^{\circ}\text{W} - 520^{\circ}\text{E}$. This is a direction at right angle towards the end moraines - which it should be.

Good crossing striation was seen in the area near northern end of ~~the~~ South Pond. There the oldest set ^{of} striation is at right

angle to the oldest end moraines.
The youngest set of striation has
a direction at right angle to the
youngest moraines, which intersect
the oldest. This seems to be a
clear evidence of a good glacial
readvance to the youngest moraines.