Notes on Coastal Processes and Geomorphology

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Brouillet MV Geomorphology

The highly unstable geologic structure of the south side of the Vineyard enables it to erode at a much faster rate than that predicted by the Bruun rule (Table 17)

From 1933 to 2003, trend analyses indicated that sea level was rising at 2.56 mm/yr in Woods Hole (Figure 57A). Similar analyses for Nantucket, from1965 to 2003, indicated a rate of 3.08 mm/year.

the IPCC's projection of 0.59 m by the year 2100,

Massachusetts Coastal Zone Management and Thieler *et al*., (2001) indicated that, from 1851 to 1994A closer look at the individual study sites showed that the south side of Martha's Vineyard had the highest linear rate of shoreline change per year (-1.71 m/yr) (Table 15), with 90% of the shoreline eroded and 2.6 km2 of land lost to the sea.

Clearly, sea levels are rising and Martha's Vineyard is eroding at a much faster rate on the south side of the island than at the other two study sites with predominantly northeastern and northwestern exposure. The northwest coast takes the brunt of winter winds and the northeastern side of the Vineyard has direct exposure to Northeasters, but both of these study sites appear to be on the low end of the coastal erosion spectrum for this island. In fact, the NE and NWareas are manifesting accretion in some spots.

The culmination of these analyses led me to five key conclusions, namely that: 1) the three sites manifested different rates of erosion and accretion, from a loss of approximately 0.1 m/yr at the NE and NW sites to over 1.7 m/yr at the SS site; 2) the NE and NW sites fit the ratio predicted by Bruun for the rate of erosion vs. SLR, but the SS site exceeded that ratio more than fivefold; 3) the shoreline erosion patterns for all three sites are dominated by short-range effects, not long-range stable effects; 4) geological components play key roles in erosion on MV, a possibility consistent with the island's paraglacial nature; and 5) the south side of MV is the segment of the coastline that is particularly vulnerable to significant erosion over the next 100 years

. Longshore sediment movement to the vicinity of Martha's Vineyard originates from the coastal waters of Connecticut and Rhode Island and moves northeast, splitting its path when it reaches the waters near Aquinnah. The shorelines of the SS site are fed with this sediment while some of it continues to move northeasterly (van Gaalen, 2004). How much of this sediment feeds the south coast is unclear, but the main source of surficial sediments in this area are primarily derived from the reworking of Holocene glacial debris (Poag, 1978; Townsend *et al*., 2004)

Buynevich 2006 ACK paraglacial coastline
Ground-penetrating radar - GPR – shows recent coastal dynamics interacting with glacial formations.

Barrier and mainland beaches influenced by: recent accelerated sea-level rise that exacerbates erosion and flooding in intense storms; natural and anthro reductions in sediment supply; increasing development.

ACK recently eroding at rates locally > 3m/yr. Need to ground in history and extend into prehistory.

ACK – unlimited fetch to E and S. Graph of shoreline changes for different time perdios: 1846-1887; 1887-1955; 1955-1978; 1978-1994.

Haulover Beach – 2 km long strip connects island to Coskata upland. Haulover for whaling ships and boats, retreats 2m/yr. Breached by northeast storm December 1896, channel migrated and closed near Coskata in 1908.

Low Beach – aggrades on northern half north of Coast Guard Station; retreats south of station

Surfside Beach – W end undergoes severe erosional episodes

Miacomet Pond – occupies proglacial spring-sapping valley; GPR shows U-shaped reflector down to about 6 m – old spring-sap valley. Filled by longshore transport. Similar structures in valley fill in on and off-shore of MV. Sapping valleys cut into the outwash.

Smith 1969 Geomorphology of Middle Ground
Sand waves on MG of up to 2 m completely rebuilt in tidal cycle. MG is a body of sand whereas its Sw extension – Lucas Shoal – composed of glacial drift from a small recessional moraine and then sea level rise in which wave erosion and longshore drift created an elongate submarine ridge that then submerged and left relic moraine. Large-scale morphological changes occur in only a few years but now shoal is in dynamic equilibrium.

Uses 1887, 1906-08, 1942 charts. Analyzed sediments. Lucas Shoal = glacial drift. MG sand with surrounding area glacial drift. Sand also in troughs of sand waves so entire MG appears to be sand. So assume that the flattish bottom is gravel from drift and sandy MG shoal is sand.

Counterclockwise circulation of tidal flow around shoal.

Since Lucas is till and parallel to Elizabeth Island moraine speculate that it is a small moraine. SO 12000 yrs BP the Vineyard Sound was broad valley sloping from NE to SW with a single large hill – Lucas Moraine where Lucas Shoal now is. Significant wave action began around 8000 BP when seal level 20.2 m. By 6000 Lucas Shoal was likely an island as drift at 6.4 m depth so definitely an island at 3500 BP. Assume that 3 M lost as sea passed over area (conservative) submergence was at 3000 BP. SO wave attacked for 5000 BP.

Limited depth and fetch to all but SW and SW prevailing winds – suggest largest wind waves from SW or W so strong long-shore drift of sediment to NE, depositing spit out of E end of ridge. Blunt SW end of Lucas Shoal – typical of upwind side of eroding island, with spit to E and NE. Similar to Danish Island of Anholt. When channel S of MG closed to NE longshore drift from LS and MV produced midbay bars that then added to spit once the northeast channel was open. Map of position of shoal in 1886, 1906, 1962.

Currently shoal cannot cannot extend much further to NE – sand lost off W Chop end is recircluated down N side to the west.

Based on erosion at Norton Pt (o.3 m/yr) as indicative of Lucas Moraine – 1m/yr eroded off SW end of shoal. Adequate erosion of material from Lucas Moraine to form MG. No way for MV beach sand to move to MG for 6000 yrs.

Oldale and O'Hara 1984 Get figures 12 and 13
End moraines on Cape Islands - glaciotectonic – analogy Thompson Glacier end moraine in Canadian Arctic Archipelago – glacier is overriding its outwash plain displacing outwash deposits forward and upward. New sheets added to base of moraine and till is deposited on moraine as ice overrides it. Formed during readvances of late Wisconsinan ice over preglacial, interglacial and glacial deposits. Moraines formed as ice advanced upward and over the coastal plain cuesta or ice-contact margins of outwash plains, shearing off sheets of material and transporting them forward and upward beyond ice front. Thrusting facilitated by clay and silt beds; permafrost could have strengthened loose gravel and sand.

Coastal end moraines = till over stratified drift and layers of basal till indicate fluctuations. Episodes of stagnation zone retreat when outwash plains formed alternated with episodes of ice-front readvance when end moraines formed . By as much as 25 km readvance. Similar to L Michigan up to 12 end moraine building readvances. Up to 460 km/1000 yrs.

Ice SE Mass retreated 150 km from outermost end moraine to N of Boston in 2500 yrs – during this time many opportunities for readvances.

Recession = alternating episodes of ice-front retreat when outwash formed and ice-front advance when moraines built. May be similar to L Michigan where >12 moraine-building episodes caused by readvancing ice during overall retreat.

Not stillstands in which advance balanced by ablation. As ice margin advanced detachable sheets of drift and preglacial strata up to 1x0.5x30m displaced beneath and beyond ice margin to form moraine. Outwash plains on Cape deposited atop and beyond downwasting stagnant ice.

End moraine structure from exposures and gravel pits.

Preglacial Cape – broad lowland underlain by consolidated PreCambrian to Mesozoic age. About Elizabeth Islands and S Shore Cape – cuesta underlain by unconsolidated Cretaceous to Pleistocene age. N face scarp of cuesta – narrow, steep-walled N-sloping valleys.

ACK moraine include deformed Sangamon an age beds; MV includes deformed Montauk tills of early Wisconsinan formations. Can relate Buzz Bay and Sandwich Moraines to marine beds N of Boston.

Overall drift 20-30,000 yrs BP. C.A. Kaye – willow leaves 15000 BP also peat 12,700 BP

Woodworth and Wigglesworth – recognize ice-thrust nature of moraines with Gay Head thrusting and folding of Tertiary and Cretaceous strata within moraine.

Kaye 1964 a,b proposed two Illinoian age moraines and third of early Wisconsinan age. Thrust folding and faulting of old drift, pre-Pleistocene strata and interglacial deposits. Proposed imbrications of permafrost slabs 30 m thick.

O + O – glaciotectonic end moraines. Formed as advancing ice thrust sheets of drift and preglacial strata beneath and beyond ice front. Contrary to general belief that Mass end moraines are primarily sedimentary and formed by stationary glacier terminus when advance balanced by ablation.

Compared with characteristics in literature on thrust moraines. “Ice thrust” “Ice-push Moraines” Ice-thrust –ridge” etc. Flint – excluded ice-thrust from his discussions of end moraines – restricted to small ridges.

O+O thrust ridge=single ridge; thrust moraine=larger feature comprised of many ridges. Both characterized by:

- Largely stratified drift or preglacial strata veneered in places by till.
- Dislocation of strata
- Repetition of stratigraphic units
- Interlayering of glacial drift and preglacial strata
- Deformed strata underlain by undisturbed strata. Large-scale deformation
- Tilted strata with dip direction opposite or different from regional or original dip
- Large deformation structures – thrust faults displaced 1 km+; thrust sheets 100m x 1 km; folds of 10s to 100s of meters
- Morphology – positive relief relative to adjacent drift; morphologic grain roughly parallel to ice front; topographic low adjacent to proximal side of moraine; surface slope towards ice; valley slope towards ice as in valleys cut towards escarpment.

Dominant characteristic of the coastal end moraine – composed largely of stratified deposits veneered in many places by till. E.g., older stratified material capped by till. Much of ACK moraine capped by gravelly sand.

MV – exposures show moraine composed of essentially Cretaceous and Tertiary Strata including pre-late Wisconsinan till and sorted.

Elizabeths and Cape – moraines composed largely of glaciofluvial and glaciolacustrine deposits veneered by till.

Stratified drift difficult to recognize as glaciotectonic – but thick accumulations of boulder-gree, well-sorted material glaciofluvial and glaciolacustrine unlikely to be deposited against or beneath ice.

Dislocations – MV Cretaceous strata are 80 m and Tertiary are 30 m above undisturbed positions beneath central outwash plain. Similar phenomena on Elizabeths and ACK. Cape – find glaciolacustrine deposits at moraine front where couldn't have been a lake.

MV – intercalation of Cretaceous and Tertiary age strata. Also interlayering of preglacial and drift materials.

Deformation is superficial – underlain by undeformed strata. No tectonic activity in NE since Paleozoic.

Tilted beds in all of the end moraines. MV – Cretaceous and Tertiary beds tilt steeply N whereas intact beds slight tilt to S.

Large folds and faults seen at Gay Head. Many small features at Nashawena and Cuttyhunk.

End moraines generally stand well above adjacent stratified drift. Grain = individual ranks of ridges trending approximately parallel to ice front. Esp in Sandwich moraine. Ridges approx. rectangular in plan. E.g., very small ridges south of larger ridges. Each ridge in moraine may represent a single thrust.

Canada – ridges often bordered up-ice by a low where the material came from. True in general of moraines on Cape and islands – bordered to N by major topo lows. Partly due to removal of material by ice thrust.

Cuesta escarpment pre-glacial sloped towards ice. To advance to MV ice moved up valleys deeply incised in cuesta of Cretaceous and Tertiary age. Same in ACK and Elizabeths.

If thrust need moraine-outwash contact that dips beneath the moraine. No sites show moraine below outwash so contact dips Nward beneath moraine.

Sandwich moraine can see outwash deposits in moraine – thrust up by advance.

Hypothesis need fluctuating ice front. Direct evidence in moraines and till that veneers moraines in many places. Readvance by up to 25 km. So, formed during over-all retreat as ice front fluctuated. During stagnation-zone retreat outwash plain and ice-contact deposits formed. Alternated with ice advance when end moraines formed.

Where did thrusting take place? Subglacially right behind ice-front; englacially near front; or beyond ice front. O+O favor first and last because most of ACK moraine not overridden by ice. Force was result of forward glacier movement and load of glacier on drift. Easiest relief to this force was towards ice front – in form of thrust faults and shear zones, arcuate in profile that originated beneath ice and terminated beyond it.

So outwash laid down as ice stagnates and melts; ice then readvances thrusting it up in folds; ice can override the ridges and lay down thin till; stagnates and lays down new outwash to N.

Permafrost may play a role in the formation of thrust moraines – hydrologically and structurally. Or intercalated clay and silt as provide zones with high pore pressures that facilitate shearing. Lots of clay and silt. Permafrost evidence equivocal.
O+O do favor permafrost as mechanism to consolidate sand and gravel and means of freezing glacier to sediments below and transmitting shear forces.

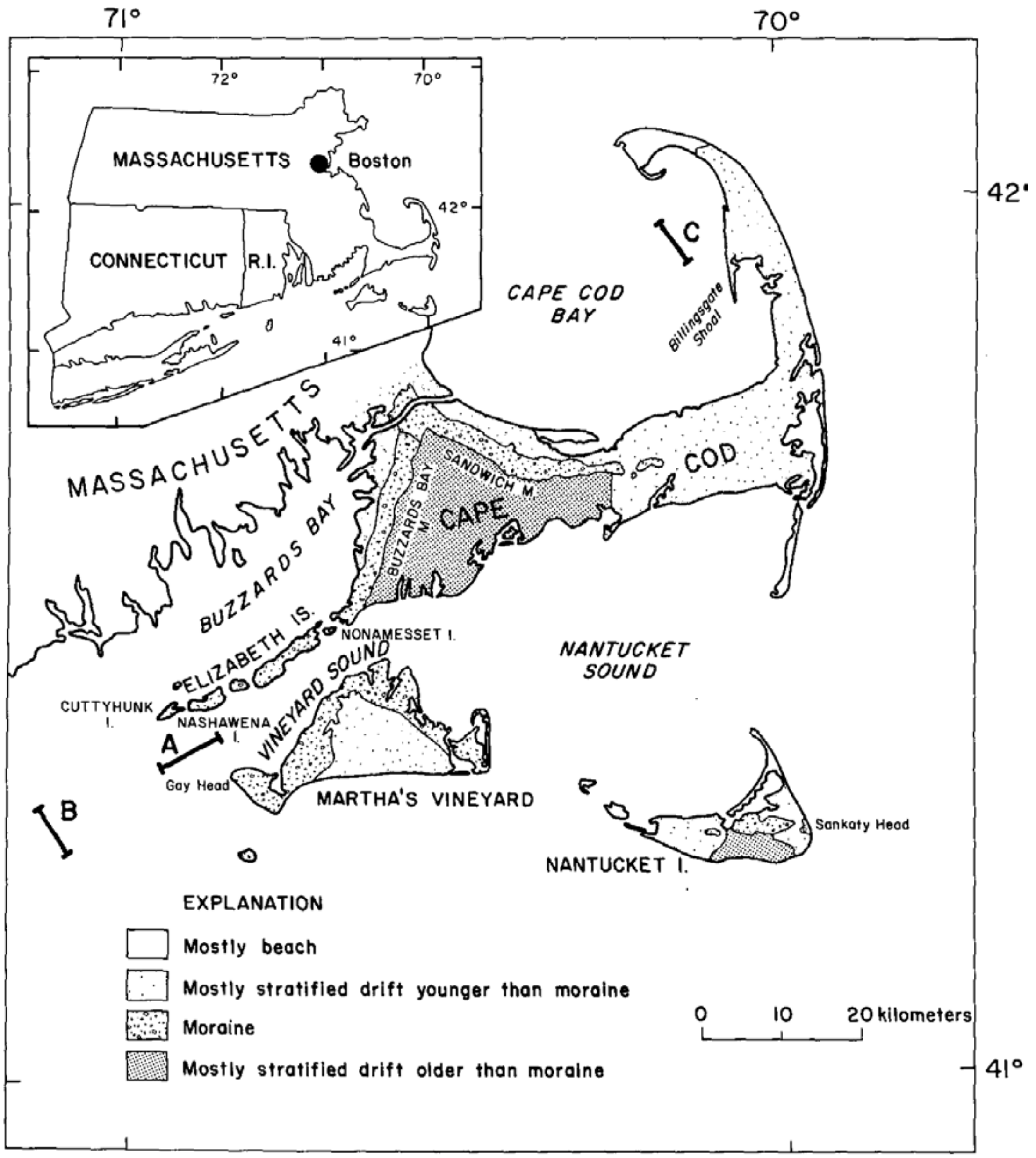
As moraines formed – younger thrust sheets added to base of moraine. Small ridges formed in outwash beyond main moraine front – represent first stage in deformation. Older ridges overridden by ice. Some erosion of ridges and deposition of basal till – obscured some thrust morphology, as did ablation till, flowtill and outwash. In most places except ACK overriding was extensive and covered most of moraine.

Mills and Wells 1974 – similar explanation for western Long Island. Thrust Cretaceous sediments as much as 1.6 km up and beyond ice front. Then ice overran emplaced thrust sheets.

Similar elsewhere in LI and Block Island. So, most major end moraines in northeastern US have glaciotectonic origin.

Thompson Glacier NWT – Axel Heiberg Glacier:

- Active thrust sheets in distal part of moraine; inactive thrust sheet s in middle become increasing obscured by erosion and deposition of stratified drift; inactive in proximity to ice become obscured by drift deposited directly in front of ice
- Moraine being overridden by glacier; saw near complete overriding nearby
- Youngest part of moraine furthest from the ice front; moraine constructed by adding thrust sheets to base
- - youngest thrust sheet = 1 yr, small ridge in outwash at front of moraine. Analogous to small ridges out in front of Sandwich moraine.


71°
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MASSACHUSETTS
Boston
CONNECTICUT
R.I.
CAPE COD BAY
Billingsgate Shoal
C
MASSACHUSETTS
BUZZARDS BAY
SANDWICH M.
BUZZARDS BAY M.
CAPE
COD
ELIZABETH IS.
NONAMESSET I.
VINEYARD SOUND
NANTUCKET SOUND
CUTTYHUNK I.
NASHAWENA I.
A
Gay Head
MARTHA'S VINEYARD
B
Sankaty Head
NANTUCKET I.
EXPLANATION
Mostly beach
Mostly stratified drift younger than moraine
Moraine
Mostly stratified drift older than moraine
0
10
20 kilometers

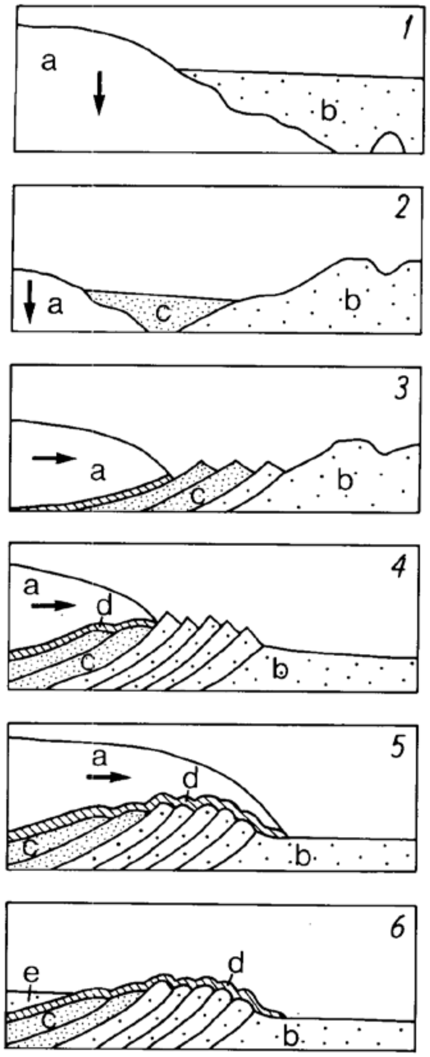
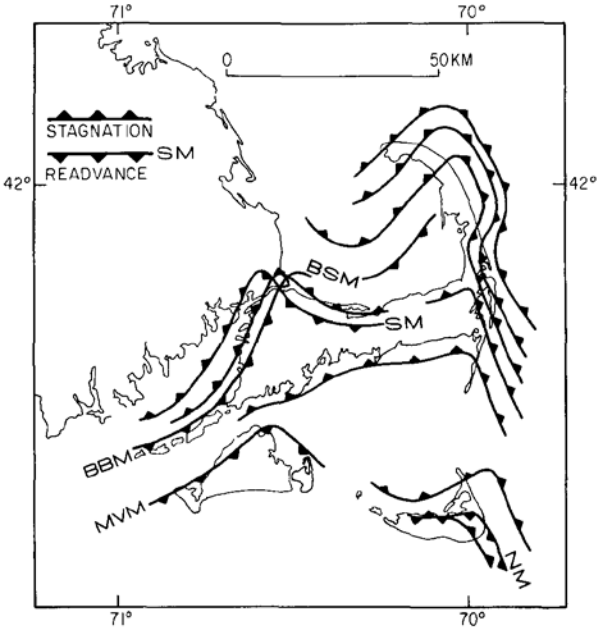


Figure 12. Inferred sequence in the formation of the coastal end moraines. In this example, the moraine is composed largely of stratified drift. Designations are: (a) ice; downward-pointing arrow is downwasting stagnant ice, right-pointing arrow is advancing ice and ice front; (b) older outwash deposited during stagnation-zone retreat; (c) younger outwash deposited during stagnation-zone retreat; (d) basal till (discontinuous in many places) deposited by overriding ice; (e) outwash younger than the moraine deposited during stagnation-zone retreat. Stages 1 and 2, outwash-plain formation beyond stagnant downwasting ice. Stages 3 and 4, formation of the thrust moraine beyond an advancing ice front; thrust sheets increase in age from right to left. Stage 5, complete or partial overriding of the moraine and deposition of a till veneer. Stage 6, retreat of the ice and deposition of younger outwash.

Figure 13. Major ice-front positions during the retreat of the late Wisconsinan ice from Cape Cod and the islands. Stagnation positions represent episodes of outwash-plain building. Advance positions represent episodes of moraine-building. NM, Nantucket moraine; MVM, Martha's Vineyard moraine; BBM, Buzzards Bay moraine; SM, Sandwich moraine; BSM, Billingsgate Shoal moraine.



Person et al. Pleistocene hydrogeology
Pleistocene sea level 120 m low for 100-40 KY Average 40 m.

High recharge associated with ice-sheet aquifer interactions. Glacial recharge reorganized subsurface flow. Hydrologic heads up to 90% of ice thickness. Subglacial melting occurs in outer few hundred km. Permafrost could reach 100 m thick and extend 100 km upstream and downstream of ice front.
Glaciomarine unit

Extensive eskers in ME – ice wet-based with extensive subglacial drainage network.

Recharge from last two glacial maximums due to high subglacial meltwater. High meltwater heads beneath glacier. Plus drop sea level.

Max S extent 21 ka; retreated to mainland by 16 ka. Ice 600-1000 m near toe of ice. Thrust structures – suggest permafrost and high pore-fluid pressures.

120 m sea level lowering 15 ka, but significant variation along shore due to ice-sheet loading.

Mass - Oldale – sea level 33m higher than present shoreline at 14 ka – deposited thick. Peat on top at 12.3 ka indicate rapid sea-level lowstand as forebulge moved rapidly through. By 11 ka sea level 60m below in S ME and 65 in MA as ice retreated N and ice-sheet forebulge migrated N.

ACK hydrology – 40% of precip recharges GW aquifer. Similar on LI, Cape, MV. GW is shallow – water from Pleistocene unconsolidated outwash. Sands.. LI also use Cretaceous aquifers as shallow water is contaminated.

ACK max water table elevation is 3.6 m above sea level. LI up to 24 M.

Can get freshwater lens pushed 80 km beyond W end of continental shelf and 30 km beyond mean sealevel. Can get out 150 km beyond coastline if confining layer etc. Not simply meteoric recharge. Thrusting due to ice may have opened deep confining beds (Oldale and OHara).

Cannot infer FW resources form modern sealevel. ACK – modern GW table at 2 m in center of island. Would expect fresh-sea interface at 80m. Actually not found in wells 100-120 m deep.

Below ice drainage would deliver water form very far away – due to bedrock.

Bothner et al. 1981 Modern sediment accumulation on Continental Shelf
“Mud patch” – are of fine-grained sediment 170x74 km in 60-150 m depth S of MV. Site of modern sediment deposition – only known site of present-day deposition on Continental Shelf of EE US exclusive of Gulf of Maine. Net current flow from NE to SW so fine-grained material from ACK Shoals and Georges Bank. Huge area due south of MV, extends in width from LI to ACK. Source is now sandy but originally more silt and clay – gradual winnowing out of fines left a protective lag deposit of sand and

gravel. Material suspended during storms. Relatively low energy in bottom area versus shoals and so deposits out. Lower tidal current velocities and greater depth so less surface turbulence.

Known to whalers as guide – dropped lead weight with wax on it to take a sample in foggy weather approaching ACK and New Bedford. Rest of region sandy so unique position.

Determined with C-14 an dPb-210. Sink of pollutants associated with fine-grained.

Sediment deposition rate decreasing to top. Bottom about 8630 BP – so shortly after sea transgressed area. Surface is about 2000 yrs BP – due to old C and sediment mixing by benthic organisms – suggested. Present rates of accumulation = 25 cm/1000 yrs. Early rates = 130 cm/1000 yrs.

As Georges Bank considered for oil development need to consider Mud Patch in monitoring.

Geochemical evidence for modern sediment accumulation on the continental shelf off southern New England

MH Bothner, EC Spiker, PP Johnson… - Journal of Sedimentary

Abstract

An area of fine-grained sediment approximately 170 km x 74 km in size, located in water depths between 60 m and 150 m, south of Martha's Vineyard, Mass., is a site of modern sediment deposition. The ^{14}C ages systematically increase with sediment depth from about 1,300 years B.P. at the surface to 8,000-10,000 years B.P. at the depth of maximum core penetration. The old age for the surface sediments probably results from a combination of deposition of old carbon and faunal mixing. In the finest sediments, the sedimentation rates were approximately 130 cm/1,000 yrs when deposition began and have decreased to about 25 cm/1,000 yrs. The decreasing sedimentation rate reflects a diminishing source of fine sediments, which presumably came from the Georges Bank and Nantucket Shoals area. Inventories of excess ^{210}Pb in undisturbed cores average 70 dpm/cm^{2} (disintegrations per minute per square centimeter), more than two times higher than the flux of ^{210}Pb from the atmosphere and from ^{226}Ra decay in the overlying water. This additional influx of ^{210}Pb either must be with new fine-grained sediment material or from solutions that are stripped of their ^{210}Pb by particulates in the bottom nepheloid layer. Stable Pb concentrations in surface sediments are about 28 ppm, as much as two times higher than concentrations at depth. The high accumulation rates, ^{210}Pb inventories, and trace-metal profiles imply that this area is a modern sink for fine-grained sediments and for pollutants associated with particulate matter in the water column. To our knowledge, this is the only site of present-day natural deposition on the Continental Shelf off the eastern United States, exclusive of the Gulf of Maine. Because the net currents on the outer half of this Continental Shelf flow from northeast to southwest, this fine-grained deposit may receive its sediments and possible contaminants from the Nantucket Shoals and Georges Bank regions.

Oldale 1988. Late Wisconsinan Incursion into Cape Cod Bay

Late Wisconsinan marine deposit overlies glaciomarine mud that can be traced to Stellwagen Basin. Mud dates to about time that ice was in Boston – 14-13,000 yrs BP.

Crust isostatically depressed below LW eustatic sea level and so deglaciation and marine submergence occurred simultaneously. Marine incursion, regression and Holocene transgression due to northward passage of isostatically produced bulge following deglaciation. Ice retreat with submergence due to crustal depression – emergence then following ice retreat – transgression by sea during Holocene times. Initial submergence and emergence were isostatically controlled. Bulge = response to crustal loading and unloading – indicates thicker ice in the terminal zone. – so maximum Laurentide ice model. Ground rebounded crustally more rapidly than eustatic sea-level rise. Then got submergence as crustal rebound slowed and eustatic accelerated. As ice retreated got submergence due to isostatic depression – calving of floating glacier terminus resulted in rapid ice-front retreat – and glaciomarine mud plumes. Got Late Wisconsinan low stand when now submerged sediments were aerially exposed. Amount of submergence not well know – less than 35 M. Low stand was about 65 m. Peats date to about 12320 BP – withpollen much colder.

Originally interpreted as glaciolacustrine – associated with glacial lake developed between retreating ice and glacial drift on Cape Cod – Oldale 1982. But connects to glaciomarine sediments on Stellwagen.

CC drift overlain by glaciomarine mud overlain by delta that came from source kms in front of ice.

There was a proglacial lake in Cape Cod Bay during early stages of ice retreat. Could have drained catastrophically when marine incursion buoyed the ice – but no evidence. May have been rapid but not with much force.

LI Sounds may show same submergence, emergence, transgression.

J. Gordon Ogden. 1963. The Squibnocket Cliff Peat; radiocarbon dates and pollen stratigraphy. American Journal of Science 261:344-353.

A peat deposit exposed in a wave-cut cliff on the island of Martha's Vineyard, Massachusetts (31 degrees 25'N., 70 degrees 30'W.), has been sampled for radiocarbon and pollen content. The section is 2.29 m long, including 12 cm of till at the base. The deposit is overlain by 30 to 50 cm of windblown sand, and the upper 25 cm of the peat is weathered and oxidized. The till at the base of the section contains randomly oriented pebbles overlying stratified till. Pollen studies indicate that much of the pollen in the till is primary. The pollen stratigraphy of the sediments overlying the till is similar to the pollen sequence of core MV-7 in Duarte's Bog. Four radiocarbon dates from clay gyttja at the base of the deposit show radiocarbon ages from 12,300 to 12,700 B. P. The base of the deposit is, therefore, chronologically equivalent to the A1 pollen zones of southeastern Connecticut. Correlation of the Squibnocket pollen sequence with that from core MV-7, though possible even in details, is now believed to imply nothing more than a late-glacial ecology and date for pollen zone V; the further inference that V must be older than T (at Totoket, Connecticut) is abandoned. If V and T are contemporary, however, several correlations of glacial substages in southern New England are shown to be probably incorrect, and the moraines on Cape Cod may be of Port Huron age.

Cross-scalar satellite phenology from ground, Landsat, and MODIS data

J.I Fisher… - Remote Sensing of Environment, 2007

Abstract

Phenological records constructed from global mapping satellite platforms (e.g. AVHRR and MODIS) hold the potential to be valuable tools for monitoring vegetation response to global climate change. However, most satellite phenology products are not validated, and field checking coarse scale (≥ 500 m) data with confidence is a difficult endeavor. In this research, we compare phenology from Landsat (field scale, 30 m) to MODIS (500 m), and compare datasets derived from each instrument. Landsat and MODIS yield similar estimates of the start of greenness ($r^2 = 0.60$), although we find that a high degree of spatial phenological variability within coarser-scale MODIS pixels may be the cause of the remaining uncertainty. In addition, spatial variability is smoothed in MODIS, a potential source of error when comparing *in situ* or climate data to satellite phenology. We show that our method for deriving phenology from satellite data generates spatially coherent interannual phenology departures in MODIS data. We test these estimates from 2000 to 2005 against long-term records from Harvard Forest (Massachusetts) and Hubbard Brook (New Hampshire) Experimental Forests. MODIS successfully predicts 86% of the variance at Harvard forest and 70% of the variance at Hubbard Brook; the more extreme topography of the later is inferred to be a significant source of error. In both analyses, the satellite estimate is significantly dampened from the ground-based observations, suggesting systematic error (slopes of 0.56 and 0.63, respectively). The satellite data effectively estimates interannual phenology at two relatively simple deciduous forest sites and is internally consistent, even with changing spatial scale. We propose that continued analyses of interannual phenology will be an effective tool for monitoring native forest responses to global-scale climate variability.

Coastal environmental changes revealed in geophysical images of Nantucket Island, Massachusetts, USA

IV Buynevich - Environmental and Engineering Geoscience, 2006

Ground-penetrating radar surveys along a highly dynamic, paraglacial coastline of Nantucket Island, Massachusetts, reveal geological signatures of coastal environmental changes that are presently masked by coastal dunes and vegetation. The high-resolution geophysical records reveal 1) the geometry and genesis of discontinuities produced by spit migration, 2) thickness and progradation style of beach and nearshore deposits, 3) subsurface expression of a paleo-scarp beneath a prograded coastal sequence, and 4) dimensions and mode of infilling of a proglacial valley containing an ephemeral inlet channel. This study illustrates the value of geophysical research in complementing and extending the historical shoreline change data, providing the basis for quantitative assessment of landscape change, and offering a more complete picture of Holocene coastal dynamics.

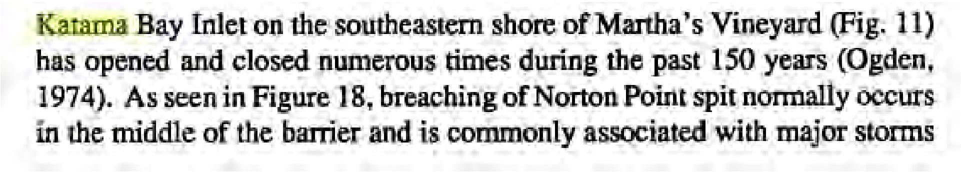
FRESH GROUND WATER STORED IN AQUIFERS UNDER THE CONTINENTAL SHELF: IMPLICATIONS FROM A DEEP TEST, NANTUCKET ISLAND, …

FA Kohout, JC Hathaway, DW Folger… - JAWRA Journal of …, 1977

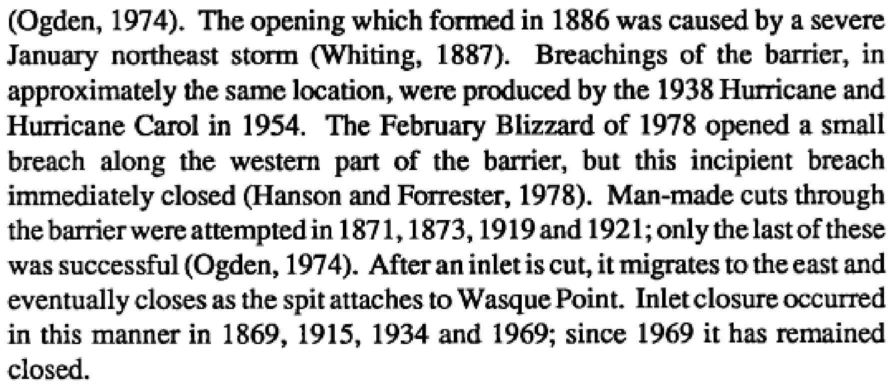
ABSTRACT: A deep water-resource and stratigraphic test well near the center of Nantucket Island, about 40 miles (64 km) off the New England Coast, has encountered freshwater at greater depth than predicted by the Ghyben-Herzberg principle. An uppermost lens of fresh-water, which occupies relatively permeable glacial-outwash sand and gravel to a depth of 520 ft. (158 m), is probably in hydrodynamic equilibrium with the present level of the sea and the height of the water table. However, two zones of freshwater between 730-820 ft. (222-250 m) and 900-930 ft. (274-283 m) are anomalously deep. A third zone extending from 1150-1500 ft. (350-457 m) contains slightly salty ground water (2 to 3 parts per thousand dissolved solids). Several explanations are possible, but the most likely is that large areas of the Continental Shelf were exposed to recharge by precipitation during long periods of low sea level in Pleistocene time. After the last retreat of glacial ice, seawater rapidly drowned the shelf around Nantucket Island. Since then, about 8000 years ago, the deep freshwater zones which underlie dense clay layers have not had time to adjust to a new equilibrium. Under similar circumstances freshwater may remain trapped under extensive areas of the Continental Shelf wherever clay confining beds have not permitted saltwater to intrude rapidly to new positions of hydrodynamic equilibrium. The implications are far reaching because all continental shelfs were exposed to similar hydrologic influences during Pleistocene time.

Formation and evolution of multiple tidal inlets

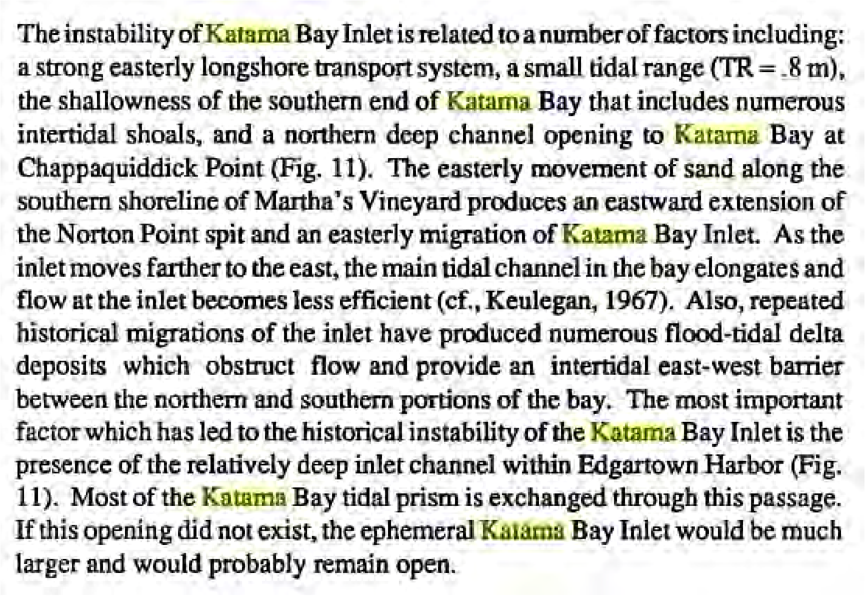
By David G. Aubrey, Graham S. Giese



Katama Bay Inlet on the southeastern shore of Martha's Vineyard (Fig. 11) has opened and closed numerous times during the past 150 years (Ogden, 1974). As seen in Figure 18, breaching of Norton Point spit normally occurs in the middle of the barrier and is commonly associated with major storms



(Ogden, 1974). The opening which formed in 1886 was caused by a severe January northeast storm (Whiting, 1887). Breachings of the barrier, in approximately the same location, were produced by the 1938 Hurricane and Hurricane Carol in 1954. The February Blizzard of 1978 opened a small breach along the western part of the barrier, but this incipient breach immediately closed (Hanson and Forrester, 1978). Man-made cuts through the barrier were attempted in 1871, 1873, 1919 and 1921; only the last of these was successful (Ogden, 1974). After an inlet is cut, it migrates to the east and eventually closes as the spit attaches to Wasque Point. Inlet closure occurred in this manner in 1869, 1915, 1934 and 1969; since 1969 it has remained closed.



The instability of Katama Bay Inlet is related to a number of factors including: a strong easterly longshore transport system, a small tidal range (TR = .8 m), the shallowness of the southern end of Katama Bay that includes numerous intertidal shoals, and a northern deep channel opening to Katama Bay at Chappaquiddick Point (Fig. 11). The easterly movement of sand along the southern shoreline of Martha's Vineyard produces an eastward extension of the Norton Point spit and an easterly migration of Katama Bay Inlet. As the inlet moves farther to the east, the main tidal channel in the bay elongates and flow at the inlet becomes less efficient (cf., Keulegan, 1967). Also, repeated historical migrations of the inlet have produced numerous flood-tidal delta deposits which obstruct flow and provide an intertidal east-west barrier between the northern and southern portions of the bay. The most important factor which has led to the historical instability of the Katama Bay Inlet is the presence of the relatively deep inlet channel within Edgartown Harbor (Fig. 11). Most of the Katama Bay tidal prism is exchanged through this passage. If this opening did not exist, the ephemeral Katama Bay Inlet would be much larger and would probably remain open.

From EOS article

Michael Finkbeiner PERMALINK

Thanks for the honor of being called both your friend and an expert in such matters.

Erosion of sand against wind and waves is just a matter of time. Your scene and news flash look typical of many sand banks pushed up millennia ago, and now returning more or less quickly to the sea, as do all hills and mountains over time.

Jesus said it best in the conclusion to the Sermon on the Mount (Matthew 7:24-29):

“Therefore everyone that hears these sayings of mine and does them will be likened to a discreet man, who built his house upon the rock-mass.

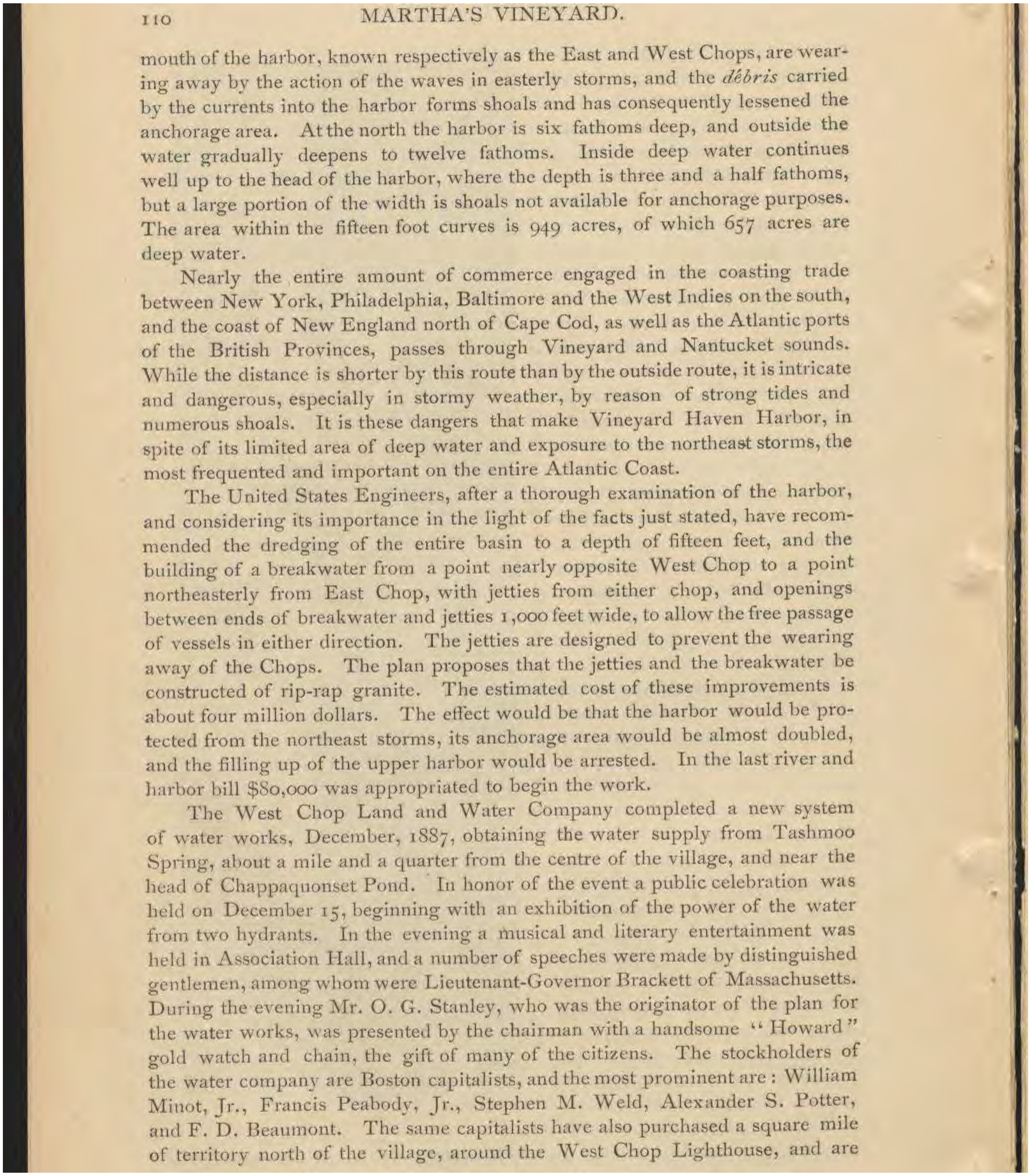
25 And the rain poured down and the floods came and the winds blew and lashed against that house, but it did not cave in, for it had been founded upon the rock-mass.

26 Furthermore, everyone hearing these sayings of mine and not doing them will be likened to a foolish man, who built his house upon the sand.

27 And the rain poured down and the floods came and the winds blew and struck against that house and it caved in, and its collapse was great.”

28 Now when Jesus finished these sayings, the effect was that the crowds were astounded at his way of teaching; 29 for he was teaching them as a person having authority, and not as their scribes.”

Proposal to build a breakwater across from West Chop – East Chop 1880s



mouth of the harbor, known respectively as the East and West Chops, are wearing away by the action of the waves in easterly storms, and the *débris* carried by the currents into the harbor forms shoals and has consequently lessened the anchorage area. At the north the harbor is six fathoms deep, and outside the water gradually deepens to twelve fathoms. Inside deep water continues well up to the head of the harbor, where the depth is three and a half fathoms, but a large portion of the width is shoals not available for anchorage purposes. The area within the fifteen foot curves is 949 acres, of which 657 acres are deep water.

Nearly the entire amount of commerce engaged in the coasting trade between New York, Philadelphia, Baltimore and the West Indies on the south, and the coast of New England north of Cape Cod, as well as the Atlantic ports of the British Provinces, passes through Vineyard and Nantucket sounds. While the distance is shorter by this route than by the outside route, it is intricate and dangerous, especially in stormy weather, by reason of strong tides and numerous shoals. It is these dangers that make Vineyard Haven Harbor, in spite of its limited area of deep water and exposure to the northeast storms, the most frequented and important on the entire Atlantic Coast.

The United States Engineers, after a thorough examination of the harbor, and considering its importance in the light of the facts just stated, have recommended the dredging of the entire basin to a depth of fifteen feet, and the building of a breakwater from a point nearly opposite West Chop to a point northeasterly from East Chop, with jetties from either chop, and openings between ends of breakwater and jetties 1,000 feet wide, to allow the free passage of vessels in either direction. The jetties are designed to prevent the wearing away of the Chops. The plan proposes that the jetties and the breakwater be constructed of rip-rap granite. The estimated cost of these improvements is about four million dollars. The effect would be that the harbor would be protected from the northeast storms, its anchorage area would be almost doubled, and the filling up of the upper harbor would be arrested. In the last river and harbor bill $80,000 was appropriated to begin the work.

The West Chop Land and Water Company completed a new system of water works, December, 1887, obtaining the water supply from Tashmoo Spring, about a mile and a quarter from the centre of the village, and near the head of Chappaquonset Pond. In honor of the event a public celebration was held on December 15, beginning with an exhibition of the power of the water from two hydrants. In the evening a musical and literary entertainment was held in Association Hall, and a number of speeches were made by distinguished gentlemen, among whom were Lieutenant-Governor Brackett of Massachusetts. During the evening Mr. O. G. Stanley, who was the originator of the plan for the water works, was presented by the chairman with a handsome "Howard" gold watch and chain, the gift of many of the citizens. The stockholders of the water company are Boston capitalists, and the most prominent are: William Minot, Jr., Francis Peabody, Jr., Stephen M. Weld, Alexander S. Potter, and F. D. Beaumont. The same capitalists have also purchased a square mile of territory north of the village, around the West Chop Lighthouse, and are