A GEOMORPHIC ANALYSIS SUGGESTING THE ORIGIN OF THE MIGRATING DUNES AT NAPEAGUE, N.Y.

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Parabolic dunes are the most poorly understood of the eolian systems. The moving dune at Napeague Harbor, Amagansett, N.Y., provides data to help in the understanding of the origin and systems.

INTRODUCTION

The moving dunes at Napeague, are a series of three bilobate parabolic dunes, designated Dune I, Dune II, and Dune III, that migrate south-southeast in response to prevailing winds from Gardiners Bay. The migration is halted when the dunes encounter the strong countervailing winds off the Atlantic Ocean. This paper focuses on Dune III, the most recent, most active parabolic dune, however the similarities of all three strongly suggests that all three were formed by the same processes. Various scenarios are propsed to suggest the origin of the dunes. They include; the blow out of the tails of the parabolic dunes, the "snowfence effect" and the blow out of the coastal linear dune.

PERTINENT GEOLOGICAL EVENTS

Long Island has been formed by depositional events during the glaciation and subsiquent erosional processes. The Ronkonkoma Moraine on the Island's south fork was deposited during the Wisconsin Glaciation. Sirken (1982) revised the earlier work of Fuller (1914) and futher defined the moraine as consisting of three discrete sections, the Ronkonkoma, the Shinnecock and the Amagansett, each with several glacial lobes. Both the Amagansett Moraine and Gardiners Island formed from the Connecticut-Western Rhode Island lobe. The Napeague Dunes formed in an area where there was a major gap in the moraine. During lower sea levels, sediment movement would have been eolian, but as sea level rose to approximate current levels, the process would have changed to marine transport, resulting in the formation of sand spits and bay mouth bars. Black (1993) discussed the early Holocene filling and sealing off of the inlet at Napeague. The sediments were transported by the currents of both Gardiners Bay and the Atlantic Ocean. With the sealing of the inlet salt marshes formed and as sediment collected vegetaional succession followed. The interdunal of Dune III shows the trunks of a pine forest that were covered and then exposed as the dune migrated.

LOCATION AND SITE DESCRIPTION

The dunes are located immediately east of Napeague Harbor on Long Island's south fork. They are bordered on the north by Gardiners Bay and on the south by the Atlantic Ocean. The

height of the dunes are approximately 26.21 meters for Dune I, 16.46 meters for Dune II and 12.80 meters for Dune III.

The dune field is subject to a high energy wind regime formed by Gardiners Island and the headland to the west of Napeague. The prevailing winds focus through this funnel and form and move the dunes to the southeast, towards the Atlantic. (Figure 1)

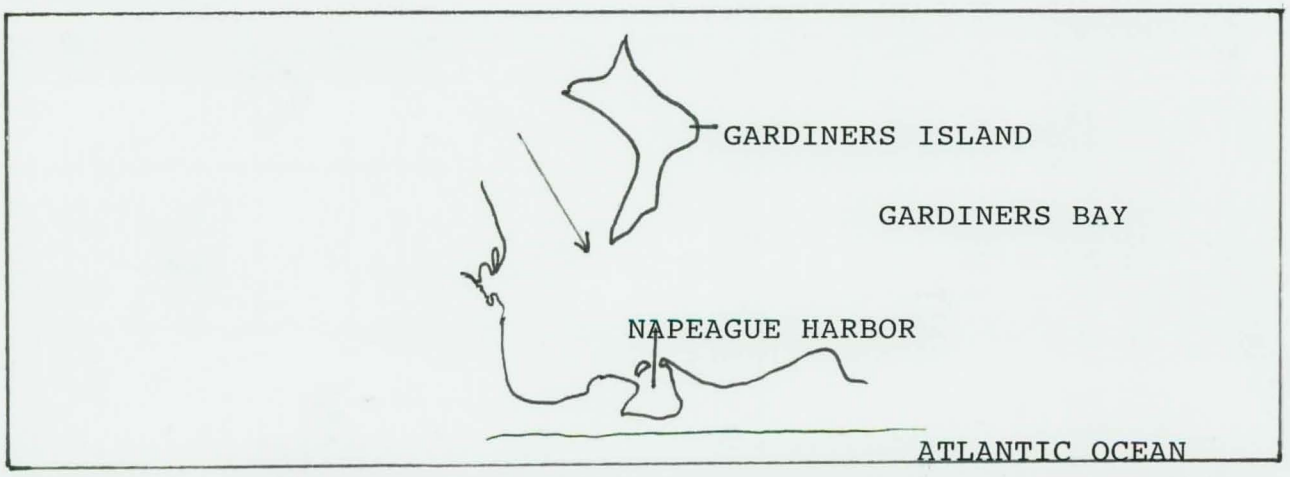

FIGURE 1. WIND FUNNEL BETWEEN GARDINERS ISLAND AND THE HEADLAND TO THE WEST OF NAPEAGUE HARBOR

The western boundary of the study area is Napeague Bay, with a beach face backed by a series of discontinuous north-south trending linear dunes and ridges, separated by a series of evenly spaced cobble sized pavements. Six pavements, spaced approximately 150 feet apart on a heading of 328° have been identified. These pavements are parallel to the ridges and indicate former drainage channels and thus, earlier coastlines.

RIDGE/SEDIMENT RELATIONSHIPS

The ultimate source of the sediments in the study area is derived from the headlands. Sediment eroded from these headlands are transported via marine processes into Napeague Harbor where they are deposited as a series of offshore shoals. At present, two such linear shoals are evident. As they are shaped and built by the coastal currents, water gets trapped behind them on incoming tides. Unable to flow back out to sea over these high spots when the tide falls, the water forms drainage channels. The water moving in and out of these channels with the tides keeps the areas low and carries fine sediments away exposing cobbles, rocks and boulders as pavements. The shoals or ridges ultimately contribute sediment to the moving dunes. As they rise and build above sea level, the ridges accumulate sediment until they come under the influence of the wind funnel and get transported to the parabolic dune. The ridges to the north and south are higher and more continuous, since they are out of the wind funnels influence and get protection

from the wind shadow formed by Gardiners Island. This mechanism is indicated by the angularity of the sediments comprising the ridges and dunes (Black, 1993). As the headland erodes, a variety of sediment types enters the marine system. These sediments, transported by marine processes, retain their original shape, since they are cushioned by water (Williams and Morgan, 1989). Once deposited, the ridge raises sufficiently to become subject to eolian processes. At this point, rounding of sediment will occur. Black (1993) has demonstrated that the sediments become progressivly more rounded from the linear dune to the slipface of the moving dune. (Table 1, Black 1993)

TABLE 1

SEDIMENT SHAPE: NAPEAGUE HARBOR*

Location	Very Angular	Angular	Round
Moraine	5%	68%	27%
Ridges	-	66%	34%
Linear Dune	-	65%	35%
Parabolic Dune			
a) windward slope	-	42%	58%
b) slip face	-	36%	64%

*For simplicity, angular includes angular and subangular sediment. Round includes both subround and round sediment. Sediment shape was determined as per Powers (1953).

DUNE ORIGIN

Several scenarios are presented to suggest the migrating dunes origin, including; a blowout of the tail of a parabolic dune, the "snowfence effect" and the blowout of the linear dunes. Also considered is the possibility that the dunes have their origin in a combination of factors. Parabolic dunes are crescent shaped, with tips pointing upwind, that frequently develop in coastal areas. (Coch, Ludman, 1991). Many factors such as wind velocity, available sediment, type and amount of vegetation, and amount of rainfall affect the movement and geomorphology of the dune. An examination of aerial photographs from 1931 to 1988 shows the eastern tails to be more developed. This may suggest that as the western tails come under the influence of the wind funnel, they blow out and form new parabolic dunes.

The "snowfence" mechanism involves a coastal dune reaching a certain critical height. At such time when this occurs, sediment would be transported landward to accumulate on an older ridge. This ridge would then build and ultimately the sediments would be moved eastward to yet an older ridge where

the process would be repeated. Eventually, the sediment would accumulate to such a height that it would be impacted by the prevailing winds and begin migrating.

The linear dune blowout is demonstrated in the area of the wind funnel. The series of linear dunes that are subject to the strongest winds are lower in height than the dunes to the north and south. As the linear dune subject to the highest winds attains sufficient height, it may blowout forming a parabolic dune that begins to migrate.

At present, due to the excessive use of the beach face by off-the-road vehicles, the beach face and associated ridge systems seaward of the linear coastal dunes are no longer accumulating sediment. Since no new sediment is being supplied to form a dune, the extant linear dune/ parabolic dune systems may now be providing sediment to the most active migrating dune. With the disruption of the sediment supply, none of these processes will continue to form new parabolic dunes.

CONCLUSION

The origin of the sediment composing the moving dune system at Napeague are derived from headlands fronting on Gardiners Bay. These sediments are transported via marine processes to the nearshore and intertidal zones of Napeague Harbor, where they accumulate as shoals. The shoals continue to accumulate sediment and ultimately build beyond the spring tide horizon. Once this occurs, additional sediment accumulation is primarily by eolian processes.

Eventually, a linear dune is formed which evolves into a parabolic dune by either a direct blowout, the "snowfence effect" or the blowout of a previously formed tail. The wind focused by the wind funnel formed by Gardiners Island and the headland to the west of Napeague Harbor is the factor controlling the formation of the system.

Human factors have most likely severly reduced the sediment supply to the system. If this is the case, it is believed that no further Moving Dune systems will form.

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BIBLIOGRAPHY

BLACK, J.A. 1993. "The Napeague Dunes". The Proceedings of the Eighth Symposium on Coastal and Ocean Management. Vol. 2. Amer Soc. Civil Engineers, N.Y. 1993

Coch, N.C. and Ludman, A. Pysical Geology 1991. Macmillan

Fuller, M. 1914. The Geology of Long Island. U.S. Geol. Surv. Prof Paper 82, U.S. Gov. Print. Off., Washington, D.C.

Powers, M. C. 1953. "A New Roundness Scale for Sedimentary Particles", Journal of Sedimentary Petrology, p. 118

Sirken, L. 1982 "Wisconsinian Glaciation of Long Island, New York to Block Island, Rhode Island". Late Wisconsinian Glaciation of New England. Kendall Hunt, Iowa pp. 35-59

Williams, A.T., P Morgan, 1988. "Quartz Grain S.E.M. Textural Variations, of the Beach/Dune Interface, Long Isaland, U.S.A." Journal of Coastal Reasearch, No. 3, pp. 37-45.