TRIP B: CRETACEOUS DELTAS IN THE NORTHERN NEW JERSEY COASTAL PLAIN

By James P. Owens, James P. Minard, and Norman F. Sohl.
U. S. Geological Survey, Washington, D. C. 20242
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INTRODUCTION

In recent years there has been a growing recognition of the importance of deltaic deposits in many sedimentary basins. The extensive investigation of modern deltas has resulted in the isolation and description of many of the subenvironments of this very complex sedimentation system. On this field trip, some of the subenvironments of an ancient deltaic system will be examined.

GENERAL CHARACTERISTICS OF MARINE DELTAS

Basically two general types of deltas have been recognized; a deep-water type and a shoal-water type. In all probability the deltaic beds examined on this field trip relate to the shoal-water deltas and we shall confine our discussion to this particular type.

Most modern shoal-water deltas are characterized by a preponderance of silt-sized and clay-sized clastic deposits. The lack of marked size variation within the bulk of the sediment delivered by the river obscures environmental differences. The Cretaceous deltas in New Jersey, however, are very sandy, having a large, mostly medium grained, sand content. Only one modern delta in which sand predominates has been described, the Niger River delta in Africa (Allen, 1965). The different facies(?) and kinds of material found within this delta are therefore more analogous to those of the Cretaceous deltas in New Jersey than to any other modern delta described in the literature. The Niger River delta serves as a reference standard for our interpretations of the subenvironments represented in the Cretaceous deltas in the New Jersey Coastal Plain.

A marine delta consists of two main depositional zones (Figure 1): the continental facies, referred to by most authors as the deposits of the subaerial plain, and the marine facies (including the brackish facies) commonly called the deposits of the subaqueous plain. Within these two major depositional zones, the deposits are further subdivided into the following general classes of beds: topset, foreset and bottomset. Topset beds are present in both the subaerial and subaqueous plains, whereas foreset and bottomset beds are only found in the subaqueous plain.

DEPOSITS OF THE SUBAERIAL PLAIN

The continental facies of the delta are collectively referred to as topset beds (Figure 1) (Shepard, 1960). These beds are deposited in an area dominated by fluviatile processes and, therefore, the sediments have the characteristics of channel-fill and overbank deposits. However, because of the proximity of this plain to sea level,

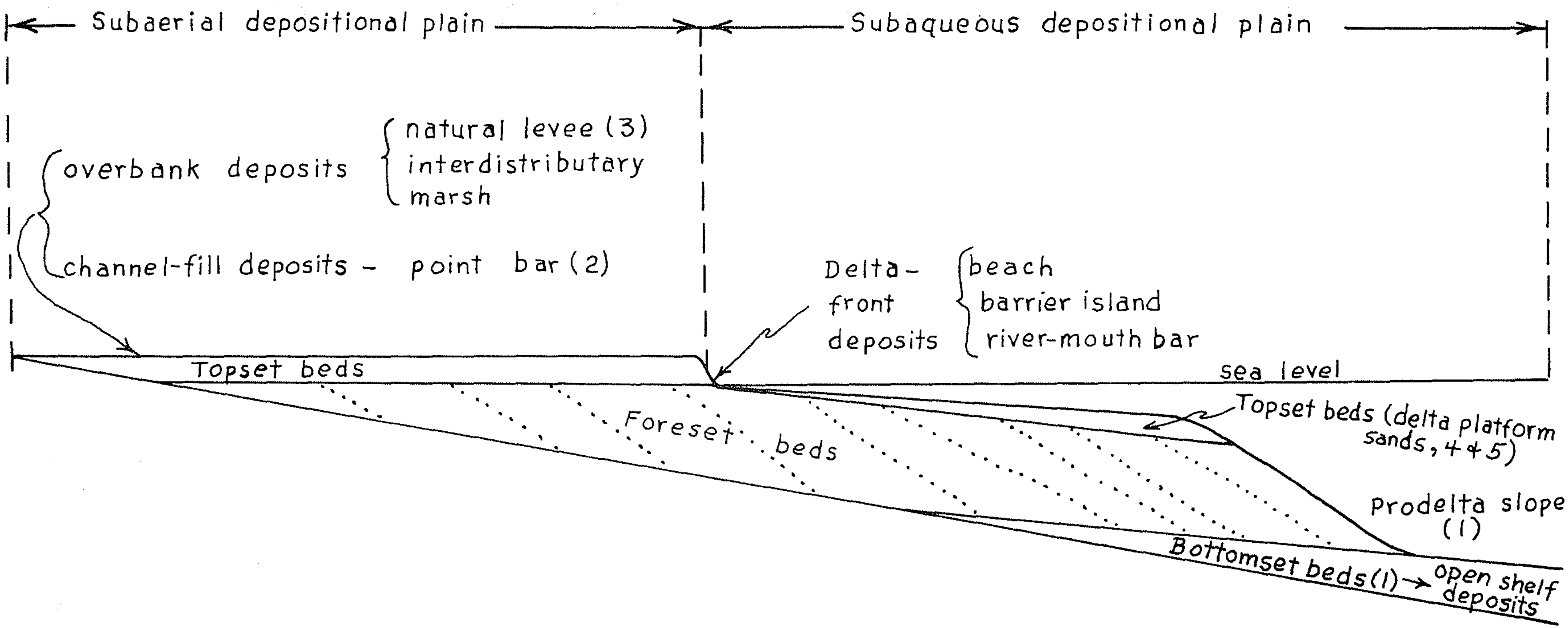

Figure 1. Schematic representation of major depositional zones in a shoal-water marine delta. Numbers indicate field trip stops at which subenvironments shown in diagram will be observed.

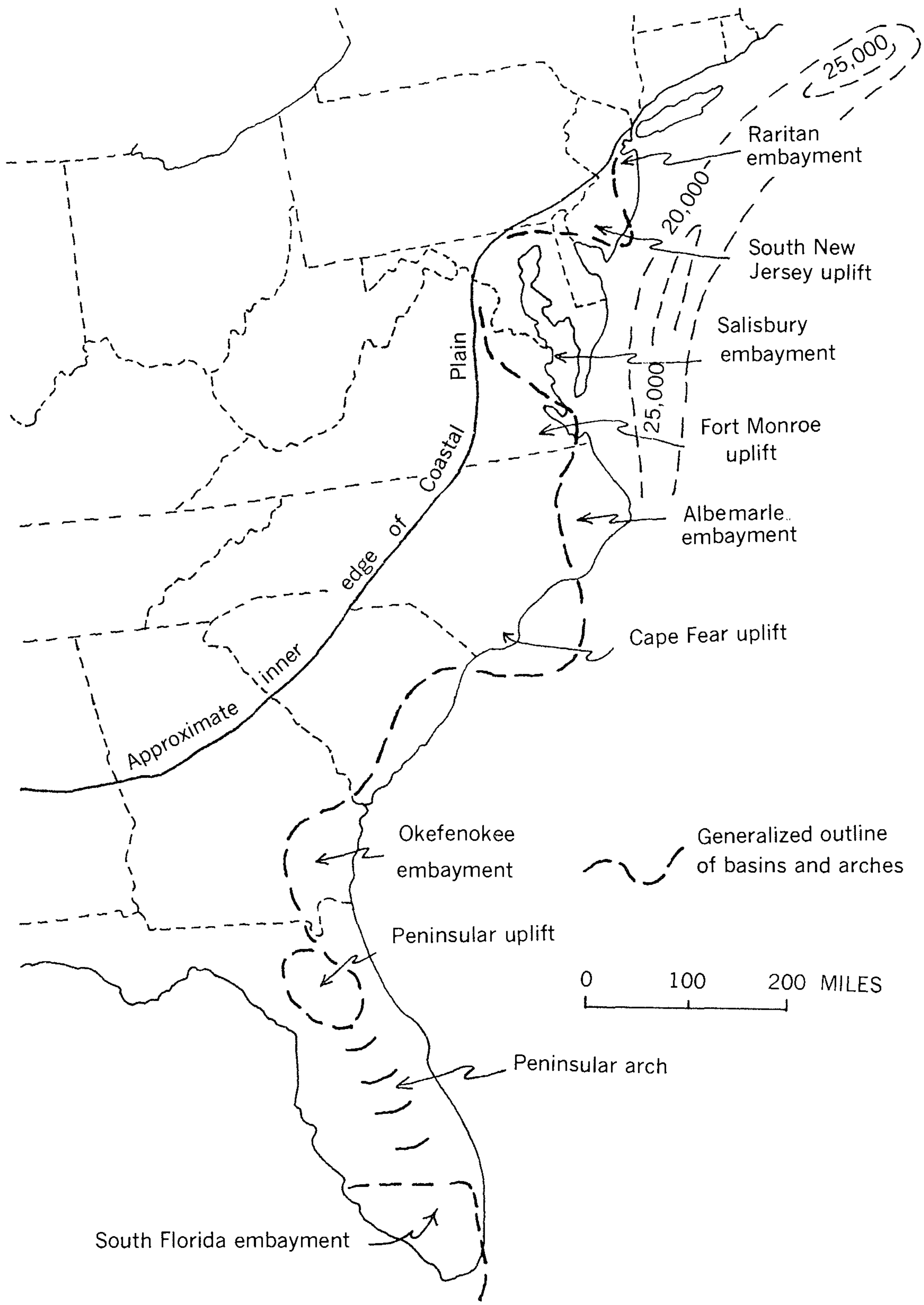

Figure 2. Major tectonic features of the basement beneath the Atlantic Coastal Plain. Contours indicate thickness of post-Triassic deposits.

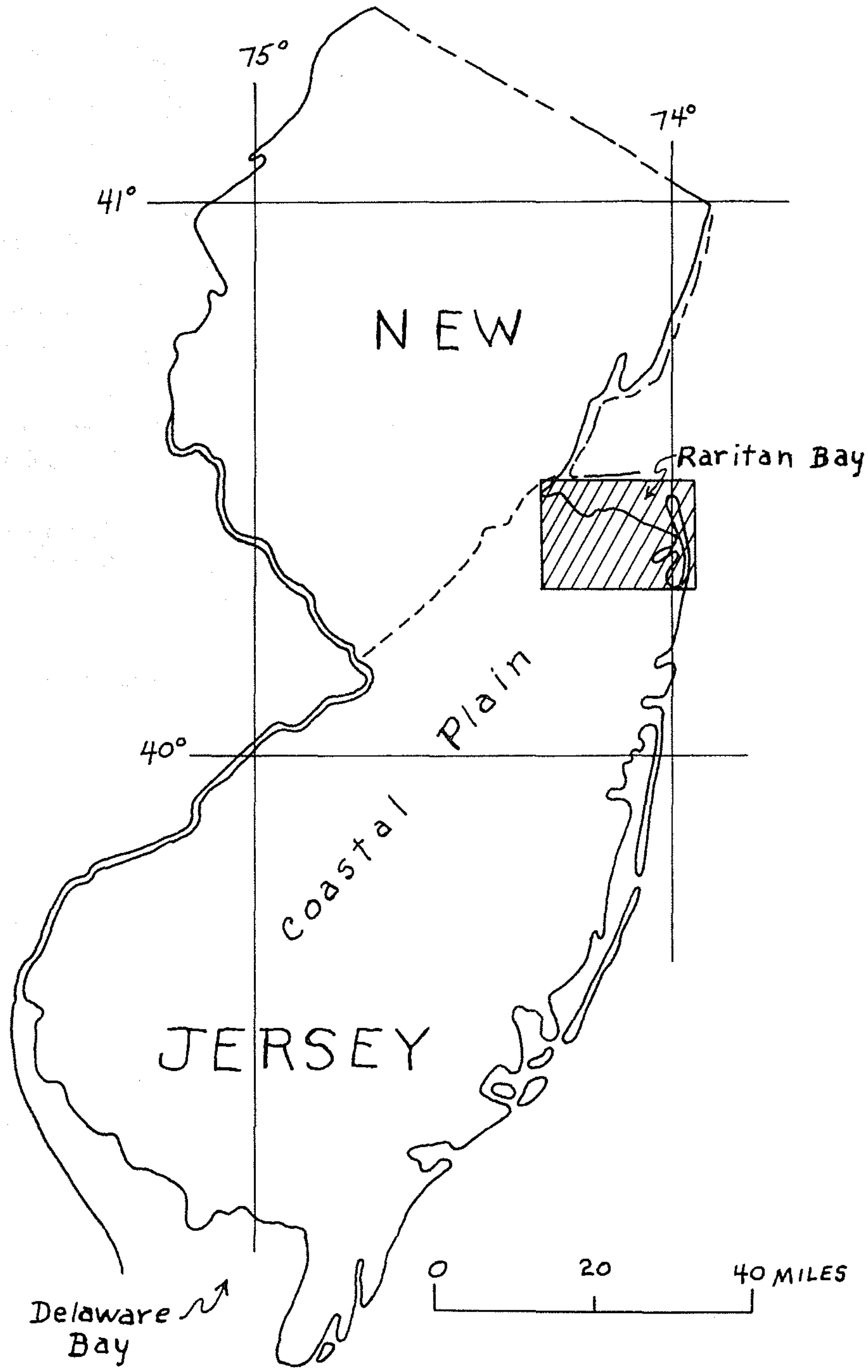

Figure 3. Index map showing location of field trip area (lined). Dashed line is inner edge of Coastal Plain.

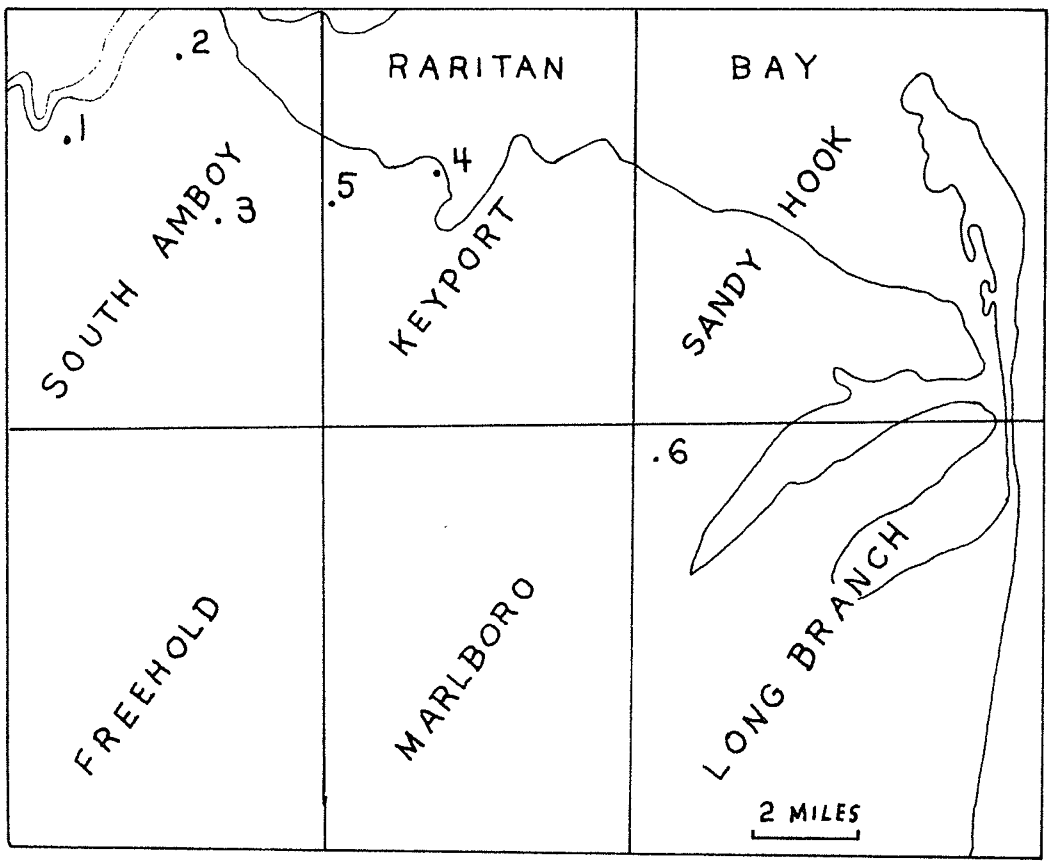

Figure 4. Map showing the six 7 1/2-minute series quadrangles in the area along the south side of Raritan Bay. Locations of field trip stops are shown by numbers.

swamp or marsh deposits are also extensively developed, especially in deltas formed in temperate to tropical regions.

DEPOSITS OF THE SUBAQUEOUS PLAIN

The marine and transitional beds (beach, river-mouth bar, and barrier bar) of the delta are less varied than the continental beds and they commonly have greater lateral continuity.

Delta-front deposits.

These deposits are marginal to the subaerial delta on the oceanward side and are a zone in which the river-introduced sediments are reworked and redistributed by oceanic processes. Normally it is a zone in which sand is concentrated in a narrow zone and the finer sediments are winnowed out and transported seaward over the delta into the basin. Barrier and river-mouth bar deposits are common in this area as are beach deposits. Collectively these beds are grouped with the topset beds.

Prodelta deposits.

The deposits of the subaqueous plain theoretically contain the three classes of beds mentioned earlier, topset, foreset, and bottomset. Topset beds in the subaqueous plain typically are thin and commonly are horizontal to gently inclined. The foreset beds are also horizontal to gently inclined although cross-stratification is extensively developed in sandy beds. The bottomset beds are characteristically massive and very fine grained. The relationships of the three types of beds in the subaqueous depositional plain is shown in Figure 1.

We have been discussing, for the most part, the constructional aspects of deltaic sedimentation. Sedimentation within deltas, however, is highly localized in the vicinity of the major distributaries and, as these shift, the ocean erodes back into the delta and reworks these deposits. Again the character of the reworked deposits is largely dependent upon the material within the delta undergoing erosion. If a sufficient quantity of sand is available, delta platform sands (Fisk, 1955, fig. 1) are formed. These sands are marine in character (commonly supporting a large fauna) and are typically thick and massive in appearance. The "fines" winnowed out from this reworked zone are transported seaward where they are deposited on the adjacent shelf. In many respects these fine-grained deposits resemble the bottomset beds of the active delta but are typically much more fossiliferous.

GEOLOGIC SETTING

The Atlantic Coastal Plain physiographic province consists of a thick wedge of unconsolidated sediments which borders the eastern United States. The wedge is highly variable in thickness, for the most part due to large-scale irregularities in the crystalline basement which underlies the Coastal Plain (Figure 2). As can be seen, the basement is warped into a series of broad troughs and arches along the entire Atlantic seaboard. The thickest accumulations of sediment occur in the troughs and the thinnest on the arches. Two large structural elements control sediment thickness in New Jersey, the south New Jersey uplift and the Raritan embayment. On this trip we shall see the effects of this embayment on deltas in this particular area (Figures 3 and 4).

TERTIARY		Cohansey Sand
		Kirkwood Formation
		Manasquan Formation
		Vincentown Formation
		Hornerstown Sand
UPPER CRETACEOUS		Tinton Sand
	Red Bank Sand	Shrewsbury Member
		Sandy Hook Member
		Navesink Formation
		Mount Laurel Sand
		Wenonah Formation
		Marshalltown Formation
		Englishtown Formation
		Woodbury Clay
		Merchantville Formation
		Magothy Formation
		Raritan Formation

Figure 5. Sedimentary marine and continental formations which crop out in the Coastal Plain of New Jersey.

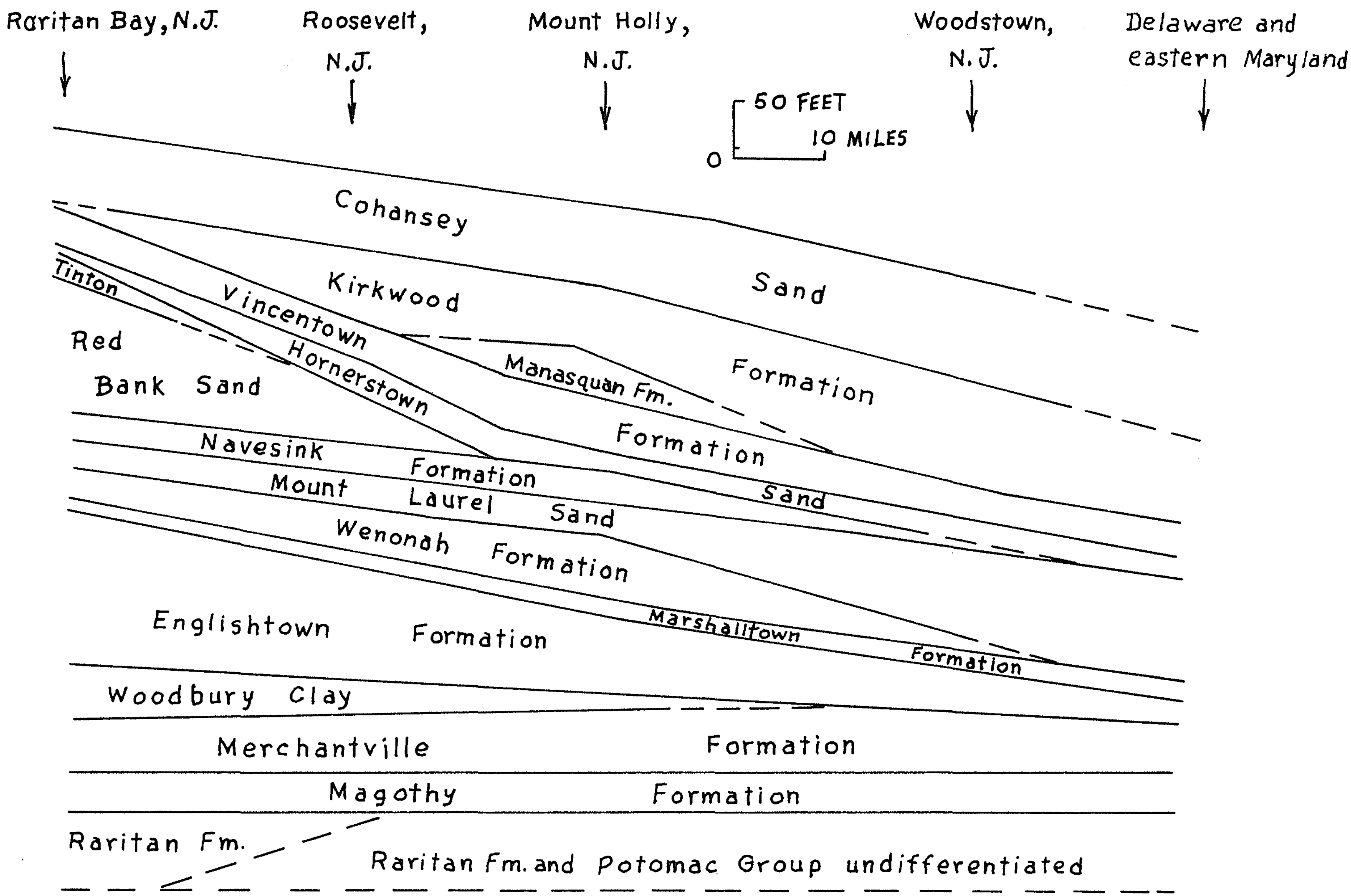

Figure 6. Generalized cross section from Raritan Bay to eastern Maryland showing the approximate thicknesses and lateral relations of the Coastal Plain formations.

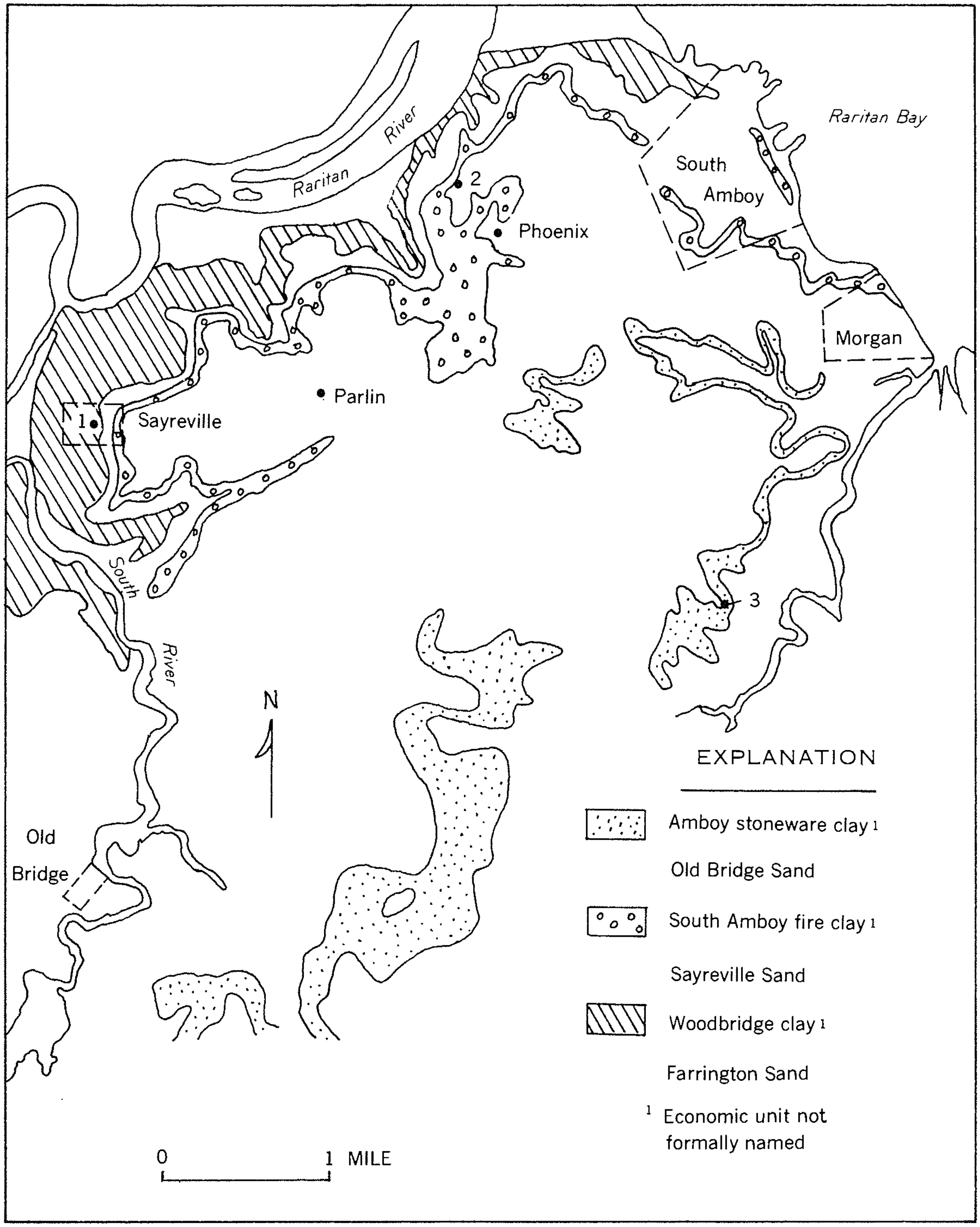

Figure 7. Generalized geologic map of the clay units of the Raritan Formation as mapped by Kümmel in 1902-03 (from Kümmel and Knapp, 1904, pl. XI). Stratigraphic position of the intervening sand members are shown in the explanation. All the clay beds are shown except the basal Raritan fire clay. Outcrops which will be visited on this trip are numbered (1-3).

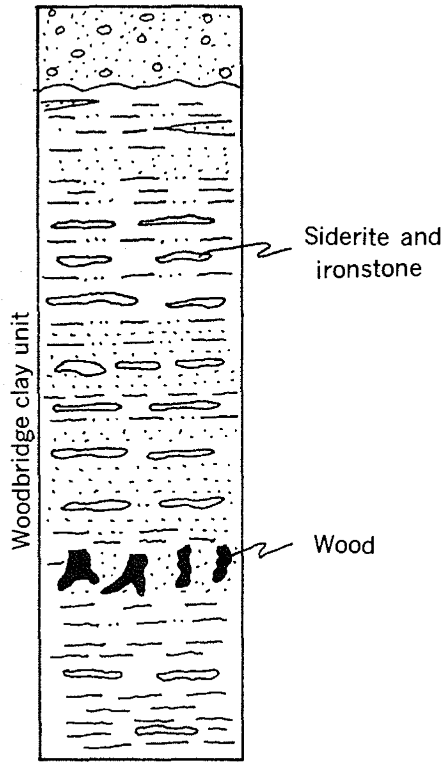

Figure 8

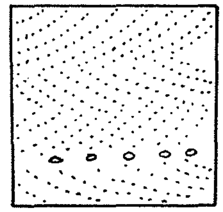

Figure 9

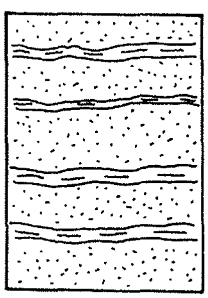

Figure 10

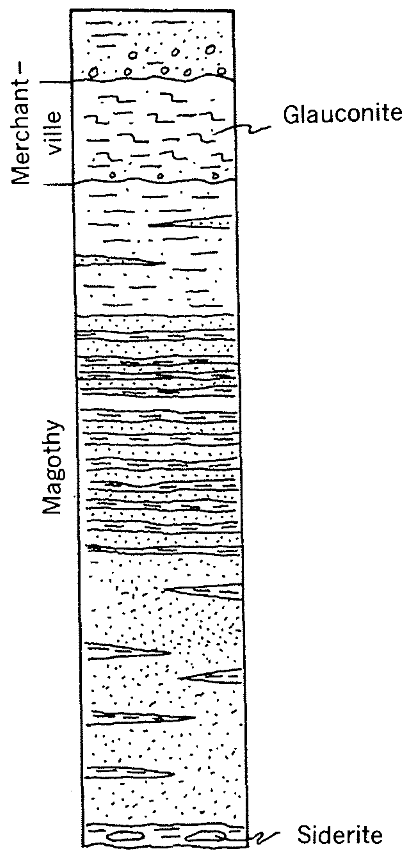

Figure 11

PHYSICAL STRATIGRAPHY

The stratigraphic units which crop out in the New Jersey Coastal Plain are shown in Figure 5. Not all these formations are present everywhere in the New Jersey Coastal Plain; their distribution is shown in the generalized cross-section (Figure 6). As might be expected, a thicker accumulation of sediment, with more stratigraphic units, is present in the Raritan embayment than on the south New Jersey uplift.

On this field trip we shall be primarily interested in the lowest units shown in Figures 5 and 6, the Raritan, Magothy, and Merchantville Formations. Because of the thickness of the Raritan Formation, the areal distribution of its members have been reproduced (Figure 7) from the map by Kümmel (Kümmel and Knapp, 1904, pl. XI). It is within these members and in the two overlying formations that the deltaic characteristics are so well developed.

At the last stop on the field trip we shall examine younger shelf deposits which are typical of a large part of the New Jersey Coastal Plain. These deposits, in part, illustrate the lithofacies produced during the reworking of the deltaic deposits (delta platform sands and inner-shelf deposits).

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<u>Explanation of Figures 8 - 11.</u>

Figure 8. 60 foot section of the Woodbridge clay unit as seen at STOP 1. Gravel above.

Figure 9. 20 foot section of the cross-stratified Sayreville Sand Member as seen at STOP 2.

Figure 10. 25 foot section of the Morgan beds as seen at STOP 3.

Figure 11. 33 foot section of the Magothy Formation as seen at STOP 4. Merchantville Formation and gravel above.

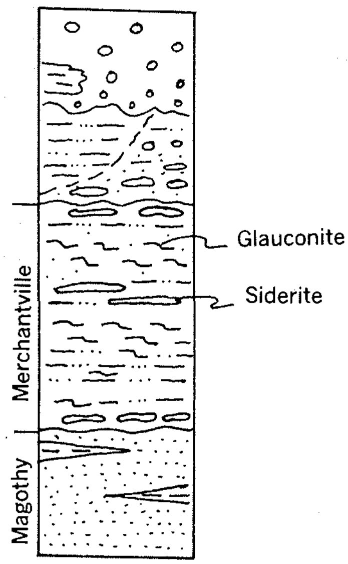

Figure 12

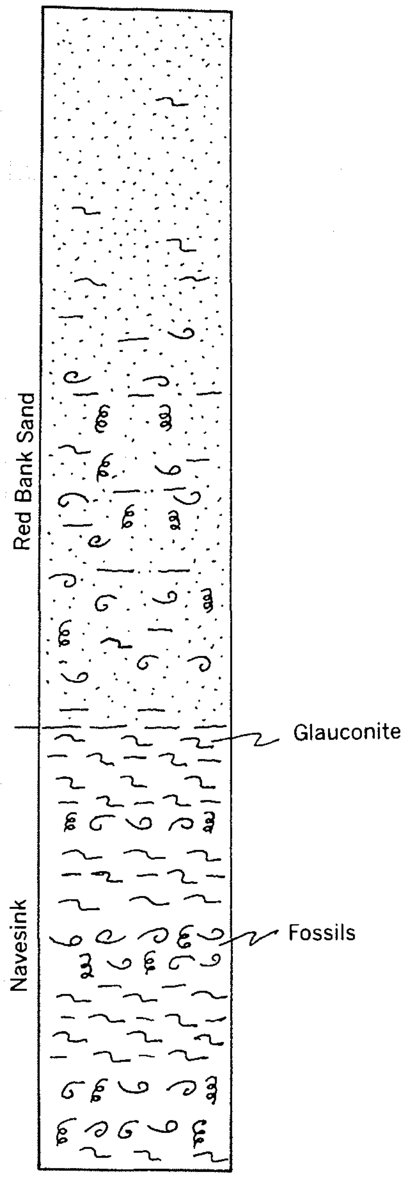

Figure 13

Explanation of Figures 12 and 13.

Figure 12. 20 foot section of the Merchantville Formation as seen at STOP 5. Magothy Formation below, Woodbury Clay spoil and gravel above.

Figure 13. 15 foot section of the Navesink Formation overlain by 25 feet of the lower part of the Red Bank Sand as seen at STOP 6.

ROAD LOG

Mileage.

0.0		Proceed south from New York City; exit from the Garden State Parkway (GSP) at interchange 123 on Route 9.
0.3	0.3	Right on South Amboy Road.
1.0	0.7	Right on Ernston Road.
1.6	0.6	Left on Washington Road.
3.3	1.7	Right on first through road.
4.2	0.9	Left on Main Street.
4.5	0.3	Turn left into large pit. Walk to back of pit.

STOP 1. Woodbridge clay of the Raritan Formation (Figure 8). Section as follows:

5-10 feet of sand and gravel of the Pensauken Formation.

30-40 feet of interbedded sand and clay of the Woodbridge unit of the Raritan Formation. Numerous layers of siderite and iron oxide-cemented sand are present. Some sand layers contain marine fossils. Interpreted as prodelta-bottomset beds.

5-6 feet of sand and clay containing much wood. Some wood appears to be in an upright position. Probable marsh deposits.

20 feet of dark-gray clay which is weathered at the top. Possible lagoonal origin.

Return east along Main Street.

8.0	2.5 1.0	Turn left into Phoenix pit. Drive north about 0.5 mile into main pit area.

STOP 2. Sayreville Sand Member of the Raritan Formation (Figure 9). Section as follows:

20-40 feet of cross-stratified sand exposed in the pit walls. Interpreted as channel-fill and spit facies.

Return to Main Street, turn left and proceed east.

9.2 1.2 Turn right on Route 9 (Main Street) at junction with Route 35; proceed south about 2-1/2 miles.

12.7 2.5 Turn left into Madison Township dump road. Drive about 0.5
1.0 mile to pit and dump area.

STOP 3. Laminated beds of sand and clay of the Morgan beds (Berry, 1906) in the lower part of the Magothy Formation (Figure 10). Section as follows:

15-25 feet of alternating beds of yellow-brown to light-gray micaceous quartz sand and clay. A considerable amount of carbonaceous matter is present throughout. Interpreted as natural levee deposits.

Return to highway (Route 9); turn left (south).

13.1 0.4 Bear left onto Morristown Road; keep curving left.

16.1 3.0 Turn right (east) after rounding 90 degree turn to left.

16.4 0.3 Angle slightly left at fork in road. Continue on Cliffwood Avenue crossing the GSP and Route 35.

19.0 2.6 End of road at beach. Walk to left (northwest) along beach about 100 yards to bluff.

STOP 4. Magothy Formation overlain by several feet of Merchantville Formation and Pleistocene sand and gravel (Figure 11). Section as follows:

5-6 feet of Pleistocene silt, sand, and gravel.

5-6 feet of dark-greenish-black quartz-glauconite sand of the Merchantville Formation. Interpreted as prodelta to open shelf deposits.

8 feet of dark-gray clay with some sand partings.

12 feet of alternating dark-gray to black clay and light-gray quartz sand layers. Layers are about 1/4 to 1/2 inch thick. Pyrite nodules are present throughout.

12 feet of white to light-gray quartz sand with some lignite and clay layers. The above 32 feet of the Magothy is interpreted as topset and foreset beds.

1 foot of gray-black clay with light-gray quartz sand and siderite concretions (exposed at low tide). Fossils are present in the siderite. Interpreted as prodelta and bottomset beds.

Turn around at dead end and return along Cliffwood Avenue.

21.6	2.6	Turn right (north) after crossing Route 35 and the GSP.
22.2	0.6	Angle right after recrossing over the GSP and immediately turn right into the Oschwald pit.

STOP 5. Merchantville Formation overlain by several feet of Pleistocene sand and gravel and spoil from the Woodbury Clay (Figure 12). Section as follows:

5-10 feet or more of Pleistocene sand and gravel and disturbed Woodbury Clay. Apparently was disturbed and intermixed during excavation or subsequent pushing aside.

20 feet, plus or minus, of dark-greenish and grayish-black sandy silt and clay and sandy clay of the Merchantville Formation. Contains abundant mica, glauconite, and layers of siderite. Interpreted as prodelta and bottomset deposits.

Several feet of the upper, weathered sand and clay layers of the Magothy can be seen near the entrance of the pit.

Return to road, turn left and cross over the GSP.

22.8	0.6	Turn left on Cliffwood Avenue; recross the GSP.
24.4	1.6	Turn right (southeast) on Route 35.
28.6	4.2	Turn right (south) on Kings Highway.
29.5	0.9	Turn right (south) on Middletown Road. Pass railroad station.
31.3	1.8	Park in space at right side of road just short of Poricy Brook (northwest corner of the Long Branch quadrangle). Walk downstream along Poricy Brook about 100 yards to a high bank on the southwest side of the brook.

STOP 6. Upper Navesink Formation overlain by lower part of the Red Bank Formation (Figure 13). Section as follows:

25 feet of the lower part of the Red Bank Formation (Sandy Hook Member). Mostly fine-to medium-grained quartz sand

with considerable feldspar, much mica (green and colorless), and some glauconite, particularly in the base. The upper part of the section is weathered to brown, the lower part is dark-gray. Micro-fossils and small megafossils and shell fragments are abundant in the dark basal part, and this unit is more clayey and compact.

15 feet of greenish-black, clayey, glauconite sand of the Navesink Formation. Several shell beds are present. *Exogyra*, *Pycnodonte*, *Ostrea*, *Choristothyris*, and *Belemnitella* are common. (The total thickness of the Navesink is about 25 feet here).

These sediments are interpreted as open shelf marine deposits beyond the laminated prodelta beds. Except for the shell beds there is a lack of conspicuous bedding. The abundance of glauconite is suggestive of deeper water and more uniform sedimentation.

End of field trip.

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