

# PALEOCOMMUNITIES AND DEPOSITIONAL ENVIRONMENTS OF THE UPPER CRETACEOUS NAVESINK FORMATION: A REPORT ON WORK IN PROGRESS

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In Monmouth County, New Jersey, the Upper Cretaceous Navesink Formation is well-exposed along the banks of Big Brook at the Boundary Road Bridge and along the banks of Poricy Brook at Poricy Park on the Middletown-Linecroft Road. Field and laboratory investigations conducted at Hofstra University over the last four years have begun to elucidate the sequence of lithofacies and biofacies preserved within the Navesink Formation at these two localities. Here we summarize our findings to date, present new data on stratigraphic trends in sediment composition at the Big Brook locality, and report on work-in-progress on the taphonomy and paleoecology of the oyster-dominated biofacies from the upper part of the formation.

## Navesink Facies

The Navesink Formation is the transgressive interval in a sedimentary cycle that includes the overlying Red Bank Formation (Owens et al., 1968). Becker et. al. (1996) identified a transgressive lag at the base of the Navesink at Big Brook and other localities. Martino and Curran (1990) described two distinct lithofacies within the Navesink, a transgressive sheet sand overlain by a muddy, glauconite sand. Our work has found evidence for four distinct lithofacies and biofacies overlying the transgressive lag at the base of the Navesink (Figure 1):

**Facies A)** A thin basal interval of fine quartz sand with abundant carbonaceous matter and some glauconite. This interval is extensively burrowed, with the distinctive trace fossil *Spongiomorpha* (similar in form to the better known *Ophiomorpha* but with unlined burrow walls marked by longitudinal ridges [Bromley, 1996]). The claws of the callianassid crustacean *Callianassa sp.* are commonly preserved within the burrows at the Big Brook locality.

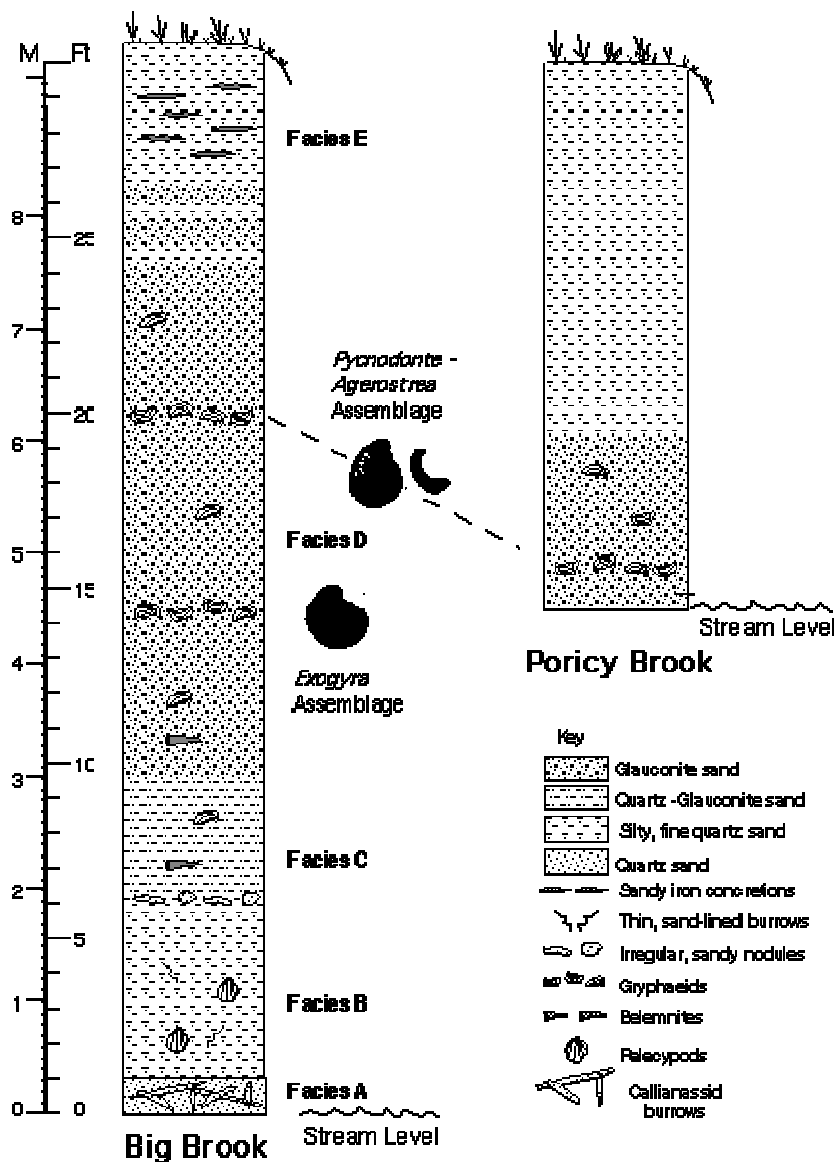
**Facies B)** A fining-upward interval of muddy, fine to very fine quartz sand with abundant carbonaceous matter and some glauconite. This facies is characterized by a diverse bivalve fauna, including both epifaunal and burrowing forms, preserved as composite molds in the unlithified sediment. Genera identified include *Inoceramus*, *Trigonia*,

*Crassatellites*, *Lima*, *Periplomya* (?), and *Linearea*. Small, sand-lined tubes are found in this facies.

**Facies C)** Fine quartz sands that include increasing numbers of glauconite grains and an apparent decrease in carbonaceous matter. Also present are phosphatic grains. Macrofossils in this interval include rare gryphaeid oysters and common belemnites.

**Facies D)** Glauconite sands with little to no detrital quartz grains. This facies includes two shell-rich intervals with abundant gryphaeid oysters. The lower interval is dominated by the oyster *Exogyra quadracostata* and contains few other species. The upper fossiliferous interval is more diverse and dominated by the oysters *Pycnodonte mutabilis* and *Agerostrea mesenterica*, with an accessory fauna of *Choristothyris* brachiopods, byozoans, and echinoids.

**Facies E)** Similar to facies D but with increasing amounts of very fine quartz sand, showing the transition to the overlying Red Bank Formation.

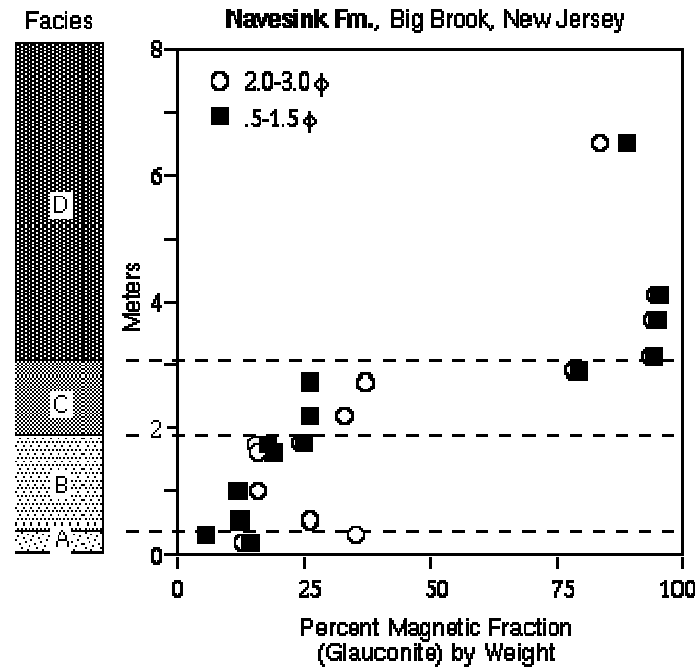


**Figure 1.** Summary stratigraphic diagram of the Navesink Formation at the Big Brook and Poricy Brook localities.

### Trends in sediment composition in the Navesink

Upsection trends in grain size distribution and sorting in the Navesink Formation were previously described by Bennington et al. (1997). The overall trend through the Navesink was found to be difficult to interpret because of the mixture in the samples of sediment grains from two different sources - detrital quartz supplied from terrestrial input and authigenic glauconite which forms in-situ on the sea floor, primarily from the mineral alteration of clays in fecal pellets (Odin and Fullagar, 1988). To investigate the relative contribution to the sediment of quartz grains and glauconite grains at different stratigraphic intervals, a magnetic separation of the quartz and glauconite was performed

on randomly split subsamples of the sand-sized fractions obtained from wet and dry sieving of sediment samples collected throughout the Navesink section at Big Brook.



**Figure 2.** Percentage of coarse to fine glauconite grains by weight in sediments from different facies in the Navesink Formation at Big Brook, New Jersey. Each data point is the mean of separate runs on three splits from a single sample. 95% confidence intervals around each value are +/- 4% or less for all samples.

## Discussion

Bennington et al. (1988) interpreted the upsection trends in sediment characteristics and biofacies in the Navesink Formation to reflect increasing water depth and distance from the shoreline. This interpretation is strengthened by the results of the magnetic separation, which show a steadily decreasing percentage of detrital sediments upsection in samples through facies A, B, and C. There is a rapid increase in percentage of glauconite across the boundary between facies C and D, with the upper interval of the Navesink characterized by an almost complete absence of detrital quartz (most of the non-magnetic sediment fraction in samples from facies D is composed of carbonate fragments). Modern sediments composed almost exclusively of glauconite grains similar in morphology to those of the Navesink Formation are found to occur in current swept, open marine environments of the middle to outer shelf at depths greater than 60 m, with the optimum depth of glauconite formation found to be approximately 200 m near the top of the continental slope (Odin and Fullagar, 1988). This suggests that facies D is the maximum transgressive facies in the Navesink Formation and that it was developed in relatively deep water far from the paleoshoreline.

**Facies D shell beds:** We are currently in the process of investigating the shell beds developed in facies D of the Navesink Formation. These shell beds are composed primarily of large gryphaeid oysters with an accessory fauna of smaller cemented oysters, brachiopods, and encrusting bryozoans. Preliminary collections made from bulk samples show evidence for two distinct fossil assemblages - a low diversity assemblage dominated by *Exogyra* and a higher diversity assemblage dominated by *Pycnodonte*. The shell bed characterized by abundant *Pycnodonte* shows evidence for current reworking of the larger shells followed by biocorrosion and colonization by the smaller, cemented and encrusting species. Thus, this shell bed may record an example of taphonomic feedback, whereby colonization of an unstable substrate by an initial wave of one or several species then provides stable attachment points that allow colonization by a second wave of species.

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