The Stratigraphy of the Magothy Formation in the Northern Delmarva Peninsula: New Data from the Bohemia River Corehole and Grove Point Outcrop

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Abstract

A continuous wireline corehole was drilled in 2021 at Bohemia River State Park (northeast Maryland Coastal Plain) to study the Magothy Formation, an estuarine Coniacian deposit that includes regionally important aquifer sands. The Magothy Formation is 32 ft thick at this site. The upper part (120-130 ft) is predominantly silty, lignitic clay. The middle part (130-139 ft) is silty clay with plant fragments and becomes sandier downward. The lower part (139-152 ft) is laminated very fine sand with abundant plant debris that transitions downward from muddy to clean sand. The Magothy deposits are overlain by a marine-influenced Cheesequake? Formation (107-120 ft) which is overlain by glauconite-rich beds of the Santonian lower Merchantville Formation. This unassigned interval includes dark clay, pebbly sandy mud with siderite nodules, and burrowed muddy sands with scattered granules and pebbles. Outcrops at nearby Grove Point consist of cross bedded sand and white "sugar" sand interbedded with lignitic clay. Observed lateral shifts in lithology across the Grove Point outcrop shed light on the nature of the continuity of confined subsurficial aquifer sands.

Palynological analyses have so far been made for six samples in and adjacent to the Magothy Formation in the Bohemia River cores. Three samples from the Magothy Formation (125, 130, and 147 ft) contain normapolles-type angiosperm pollen such as *Plicapollis* sp. F and *Santalacites minor* that, together with several forms of *Momipites*, suggest a position in the lower Magothy Formation in the *Complexiopollis exigua-Santalacites minor* (Ce-Sm) Zone. The rich palynomorph assemblage at 125 ft contains a high relative abundance of reticulate tricolporate types and psilate tricolpate types and a low relative abundance (>1%) of normapolle-type pollen. Pollen at 115 ft in the indeterminate interval (Cheesequake? Fm) suggests a position within the younger Zone CA-2A based on the presence of *Semioculopollis*, *Momipites* sp. K, *Brevicolporites, and* Cf. *Extremipollis* NJ-1; the presence of foraminiferal linings indicates marine influence. The distinct change in pollen assemblages between 115 and 125 ft suggests that the marked change at 120 ft from estuarine Magothy deposits to the overlying marine deposits may represent a disconformity. In contrast, pollen from the Grove Point Magothy section includes several forms which are specific to the *Pseudoplicapollis cuneata-Semioculopollis verrucosa* (Pc-Sv) assemblage zone, highlighting the high degree of lateral variability within the Magothy Formation in this area.

Grove Point Outcrop





- **Top:** Section 1d overview. Cross-bedded sand and a lens of interbedded sand and lignitic clay, Magothy Formation, overlain by marine silty clay of the Merchantville Formation.
- **Bottom-Left:** Thinly interbedded white "sugar" sand with flaser bedding and dark lignitic clay, Magothy Formation.
- **Center-Bottom:** Measured section from which samples 120221 (3 ft above ground) and 20224 (5 ft) were taken for palynological processing.
- **Top-Right:** Angiosperm leaf macrofossils found onsite.
- **Bottom-Right:** Cross-laminated sand, Magothy Formation; herring-bone cross lamination indicates a tidally influenced depositional environment.

Objectives

- Differentiate the lithologic members and depositional timing of the Magothy Formation in the northern Delmarva Peninsula
- Correlate sediments to the Magothy Formation members and pollen zones of central New Jersey
- Take inventory of Magothy Formation palynomorphs in the study area

Methods

- A continuous wireline core was drilled at Bohemia River State Park
- Field sampling was conducted at Grove Point Maryland
- The Magothy Formation and adjacent intervals were sampled for palynomorphs at both sites
- Samples were processed using standard hydrofluoric acid digestion technique and slides prepared from residues.

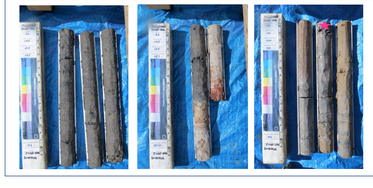
Bohemia River SP Core Photos

Arranged in descending order, left to right; ***sample locations*** *are marked with color-coded stars.*

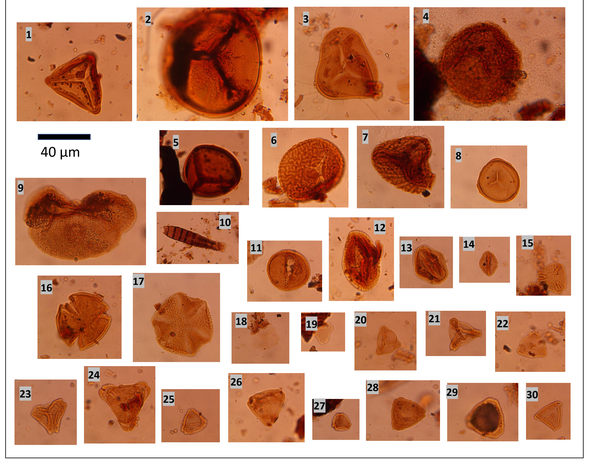
- Merchantville Fm-Cheesequake? Fm gradational contact at 108 ft.
- Cheesequake? Fm-Magothy Fm sharp contact at 119.9 ft.
- Lignite bed at 120.6 ft.
- Paleosol horizon at 123 ft.
- Magothy Fm-Potomac Fm sharp contact at 152.3 ft.

Above: **Red:** 107' (Merchantville Fm), **Yellow:** 115 ft (Cheesequake? Fm), **Light Gray:** 122 ft (Magothy Fm, no data), **Green:** 125 ft (Magothy Fm).

Above: **Orange:** 131 ft (Magothy Fm), **Blue:** 137 ft (Magothy Fm), Below: **Pink:** 212 ft (Potomac Group, Patapsco Aquifer).



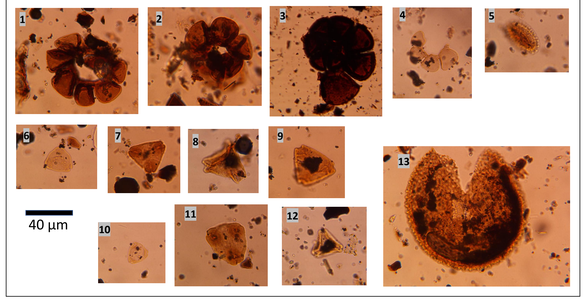
Magothy Formation Palynomorphs from Grove Point



Palynomorphs from the Magothy Formation Outcrop at Grove Point Maryland. Lettered normapolles are identified based on Christopher (1979). Open nomenclature use here used for three Reticulate Tricolporate types. Scale bar is 40 microns.

1. *Gleicheniidites* sp. (3 ft)
2. Trilete Megaspore sp. (3 ft)
3. Aff. *Cyathidites* sp. (3 ft)
4. Reticulate Megaspore sp. (3 ft)
5. Cf. *Cingulatriletes* sp. (Braman, 2001), (3 ft)
6. *Hamulatisporites* sp. (5 ft)
7. *Cicatricosisporites* sp.
8. *Stereisporites* sp (5 ft)
9. Bisaccate Gymnosperm Pollen sp. (5ft)
10. Fungal Spore spp. (3 ft)
11. Cf. *Monosulcites scabrus* (5 ft)
12. Reticulate Tricolporate Type A (3 ft)
13. Reticulate Tricolporate Type B (5 ft)
14. Reticulate Tricolporate Type C (5 ft)
15. Aff. CP3B of Wolfe (1976), (3 ft)
16. Tricolpites spp. (3 ft)
17. Aff. CP3A of Wolfe (1976),
18. *Momipites* sp. G (3 ft)
19. *Momipites* sp B (5 ft)
20. *Pseudoplicapollis cuneata* (3 ft)
21. *Pseudoplicapollis longiannulata* (5 ft)
22. *Pseudoplicapollis endocuspis* (3 ft)
23. Cf. New Genus C sp. A (Christopher, 1979), (3 ft)
24. Cf. New Genus B sp. E (Christopher, 1979), (3 ft)
25. *Complexiopollis* sp. D (5 ft)
26. New Genus D Aff. Sp. H (5 ft)
27. Cf. *Labrapollis* sp. (5 ft)
28. *Trudopollis* sp. B (5 ft)
29. *Osculapollis* Cf. sp. A (5 ft)
30. *Santalacites minor* (5 ft)

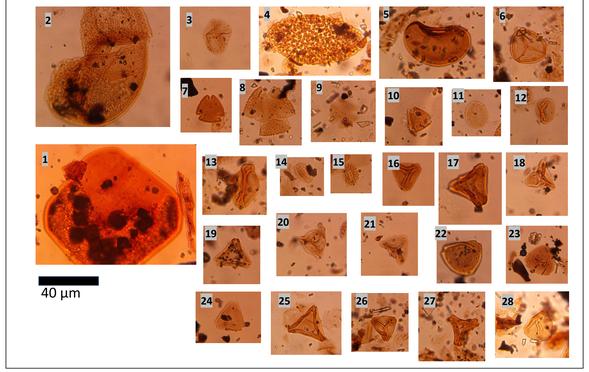
Cheesequake? Interval palynomorphs from the Bohemia River Core



Palynomorphs from the Cheesequake? Interval of the Bohemia River Core (115 ft). Lettered normapolles reference the species of Christopher (1979). Scale bar is 40 microns.

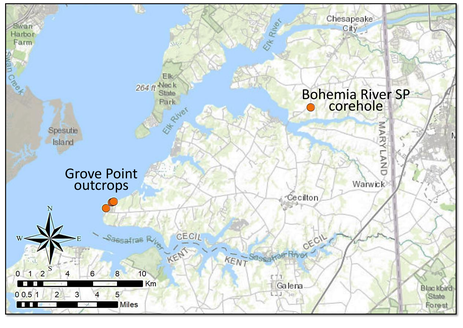
1. Foraminiferal test lining
2. Foraminiferal test lining
3. Foraminiferal test lining
4. Foraminiferal test lining
5. Clavate *Tricolpites* sp. cf. *vermimurus* (Brenner, 1963).
6. Cf. *Momipites* sp.
7. Cf. *Extremipollis* NJ-1 of Wolfe (1976)
8. Cf. *Brevicolporites* CP3F of Wolfe (1976)
9. Cf. *Plicapollis incisa*
10. *Momipites* sp. K
11. *Semiocculopollis verrucosa*
12. *Santalacites minor*
13. Reticulate Megaspore sp.

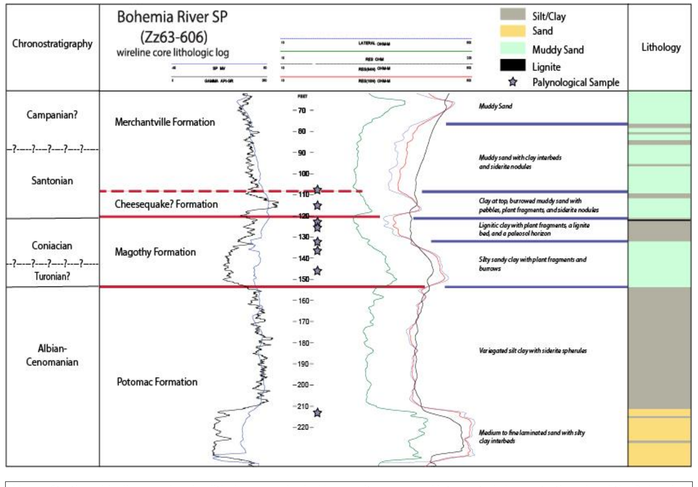
Magothy Formation Palynomorphs from the Bohemia River Core



Palynomorphs from the Magothy interval of the Bohemia River core. Lettered normapolles reference the species of Christopher (1979). I have applied open nomenclature to the two reticulate monosulcate types in lack of a suitable identification.

1. *Cf. Tetraporina* sp. (137 ft)
2. Bisaccate gymnosperm pollen (137 ft)
3. *Inaperturopollenites* sp. (137 ft)
4. *Stellatopollis* sp. (Doyle and Robbins, 1977).
5. *Laevigatosporites* sp. (125 ft), (Brenner, 1963)
6. Cf. *Cingutriletes* sp. (125 ft), (Braman, 2001)
7. *Cf. Retitricolpites* sp. (125 ft)
8. Reticulate *Tricolpites* sp. (125 ft)
9. Tricoplites Aff. C3C of Wolfe (1976), (125 ft)
10. Cf. CP3 of Wolfe (1976), (125 ft)
11. *Clavatipollentites* sp. (125'), Doyle and Robbins, 1977).
12. Reticulate Monosulcate Type A (125 ft)
13. Reticulate Monosulcate Type B (125 ft)
14. Psilate *Tricolpites* sp. (125 ft)
15. Clavate *Tricolpites* sp. cf. *vermimurus* (Brenner, 1963).
16. Cf. *Plicapollis* sp. G (137 ft)
17. *Choanopollenites* sp. A (137 ft)
18. *Complexiopollis* Aff. Sp. H (131 ft)
19. *Santalacites minor* (131 ft)
20. *Pseudoplicapollis longiannulata* (131 ft)
21. *Pseudoplicapollis* Aff. *endocuspis* (131 ft)
22. *Osculapollis* sp. B (131 ft)
23. *Momipites* sp. I (131 ft)t
24. *Momipites* sp. H (131 ft)
25. *Complexiopollis* sp. V (125 ft)
26. *Pseudoplicapollis* sp. F (125 ft)
27. *Complexiopollis* sp. E (125 ft)
28. *Complexiopollis* sp. D





Above: Stratigraphic diagram showing lithology, geophysical logs, unit names, and interpreted chronostratigraphy of the Bohemia River core between 70 and 220 ft. Stars at palynological sample locations.

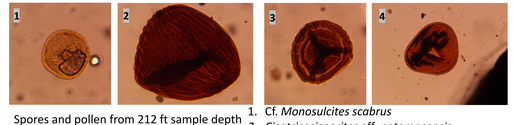
Period	Epoch	Age	Lithostratigraphy		Pollen Zones
Cretaceous	Late	Sant.	Cheesequake Fm.		CA-2A
		Coniacian	Magothy Fm.	Cliffwood Beds	?*Pseudoplicapollis cuneata - Semioculopollis verrucosa*
				Morgan Beds	
				Amboy Stoneware Clay	*Pseudoplicapollis longiannulata - Plicapollis incisa*
		?		Old Bridge Sand	*Complexiopollis exigua - Santalacites minor*
				South Amboy Fire Clay	
				Sayreville Sand	
		Turonian	Raritan Fm. (Woodbridge Clay)		*Complexiopollis-Atlantopollis*
		Cen.			

Lithostratigraphy-pollen stratigraphy chart
Pollen zones defined in members of Magothy Formation in central New Jersey by Christopher (1979) as updated in Sugarman et al. (2021). Pollen zones III and II of the Potomac Group underlie the *Complexiopollis-Atlantopollis* zone.

Results

- Relative abundances of major palynomorph groups was similar between Magothy assemblages at Bohemia River SP and Grove Point..
- Both assemblages were dominated by inaperturates, tricolpate angiosperm pollen, and trilete spores, with relatively subordinate concentrations of normapolles; however the species of tricolpate present differ substantially.
- Bisaccate gymnosperm pollen was more abundant at Grove Point and rare in the Bohemia River core.
- Normapolles palynostratigraphy indicates that the Magothy Formation at Bohemia River can be correlated to the *Complexiopollis exigua-Santalacites minor* zone (Ce-Sm).
- Normapolles and the presence of marine palynomorphs suggest that sediments equivalent to the Cheesequake Formation may overlie the Magothy Formation at Bohemia River.
- Sparse palynomorphs from the Potomac Formation in the Bohemia River core suggest an affinity with pollen zones II or III (Doyle and Robbins, 1977).
- Pollen from the Magothy Formation at Grove Point suggest an affinity with the *Pseudoplicapollis cuneata-Semioculopollis verrucosa* assemblage zone (Pc-Sv). Furthermore, normapolles specific to the Morgan Beds of Central New Jersey were identified from this site.
- Differences between the two assemblages and lithologic observations made at Grove Point suggest high lateral variability within the Magothy Formation in the study area.

Potomac Formation palynomorphs from the Bohemia River Core



Spores and pollen from 212 ft sample depth in the Bohemia River core. Identifications follow Brenner (1963).

1. Cf. *Monosulcites scabrus*
2. *Cicatricosisporites* aff. *potomacensis*
3. *Taurocusporites* aff. *reduncus*
4. Cf. *Cyathidites* sp.