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8. Medford Site[1]

Peter J. Sugarman, Kenneth G. Miller, James V. Browning, Marie-Pierre Aubry, Gilbert J. Brenner, David Bukry, Brian Butari, Mark D. Feigenson, Andrew A. Kulpecz, Peter P. McLaughlin Jr., Svetlana Mizintseva, Donald H. Monteverde, Richard Olsson, Aimee E. Pusz, Helen Rancan, Jaime Tomlinson, Jane Uptegrove, and Claudia C. Velez[2]

INTRODUCTION

The following, who are listed in alphabetic order, are responsible for writing the given sections:

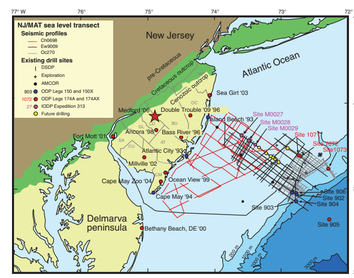
Chief Scientists: Miller, Sugarman
Staff Scientist: Browning
Operations: Cobbs, Miller, Sugarman
Lithostratigraphy: Browning, Kulpecz, McLaughlin, Miller, Mizintseva, Monteverde, Pusz, Rankin, Sugarman, Tomlinson, Uptegrove, Velez
Biostratigraphy:
- Planktonic foraminifers: Olsson
- Calcareous nannofossils: Aubry (Cenozoic), Bukry (Mesozoic), Mizintseva (Mesozoic)
- Spores and pollen: Brenner, McLaughlin

Logging: McLaughlin
Sr isotopic stratigraphy: Browning, Feigenson

MEDFORD SITE SUMMARY

The Medford Site (April–May 2007) was the twelfth continuously cored borehole drilled as part of the New Jersey Coastal Plain Drilling Project (NJCPDP) and the ninth site drilled as part of Leg 174AX (Fig. F1). Located on the property of Medford Township's South Street Main-

F1. Location map, p. 46



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[2]Scientific Party addresses.

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tenance Facility, drilling at Medford (39°53′48.815″N, 74°49′15.904″W; elevation 34.0 ft; Mount Holly U.S. Geological Survey [USGS] 7.5 minute quadrangle; Medford Township, Burlington County, New Jersey) targeted Cretaceous sequences and aquifers. Recovery was good (mean recovery = 70%), ending at a total depth (TD) of 1090 ft (332.23 m) in Lower Cretaceous sediments. A full suite of slimline logs was obtained on formation to 1086 ft (331.01 m), and a gamma log was obtained to 1088 ft (331.62 m). The scientific team provided descriptions of sedimentary textures, structures, colors, and fossil content and identified lithostratigraphic units, lithologic contacts, and sequences (unconformity-bounded units). A team of scientists from the New Jersey Geological Survey (NJGS), Rutgers University, the Delaware Geological Survey (DGS), and the USGS collaborated in drilling and stratigraphic studies of this corehole that was funded by the NJGS. The basic data sets on which this site report is based comprise onsite and postdrilling studies of lithology, sequence stratigraphy, biostratigraphy, hydrostratigraphy, and Sr isotopes.

Lowermost Eocene sediments are found below a thin soil horizon (0–2.5 ft; 0–0.8 m). A thin glauconitic sandy clay of the Manasquan Formation (2.5–6.3 ft; 0.8–1.9 m) overlies a white kaolinitic clay of the Marlboro Clay (6.3–10.2 ft; 1.9–3.1 m), a unit that is associated elsewhere with the earlier Eocene carbon isotopic excursion.

The upper Paleocene (Zones NP7–NP8) Vincentown Formation consists of a thick highstand systems tract (HST) of glauconite-quartz sand that fines downsection to a sandy clayey biomicrite and then becomes more glauconitic downsection in a transgressive systems tract (TST). The lower Paleocene (Zone NP4) Hornerstown Formation is poorly recovered and consists primarily of a glauconite sand broken into two sequences (Zones P1c and P3a).

The Cretaceous/Paleogene boundary separates the green clays of the Hornerstown Formation from the clayey glauconite sands of the Navesink Formation; it lacks the spherules and clay clasts found elsewhere (e.g., the Bass River corehole) at this boundary in New Jersey.

The Upper Cretaceous consists of primarily marine sequences to 493.4 ft (150.4 m): Navesink I/II; Marshalltown; Merchantville I, II, and III; and Cheesequake. The Navesink Formation (60.7–100.4 ft; 18.5–30.5 m) is a Maastrichtian clayey glauconite sand that may be tentatively divided into two sequences. The Marshalltown sequence is upper Campanian (Zone CC20–CC22; 72–76 Ma Sr isotopic ages) and consists of thick slightly glauconitic quartz sands of the Mount Laurel Formation deposited in shoreface environments (upper HST), an offshore silty very fine sand of the Wenonah Formation (lower HST), and silty clayey glauconite sands of the Marshalltown Formation (TST). The upper Englishtown sequence (224.4–329.4 ft; 68.4–100.4 m) is middle Campanian (Zone CC19–CC20; ~76–77 Ma Sr isotopic ages) and is thicker here updip than in downdip sections. This sequence consists of an upper sandy HST deposited in delta front environments, a thick medial micaceous silty clay to clayey silt deposited as the lower HST in offshore to lower shoreface environments, and a basal glauconitic quartz sand deposited as a TST in lower shoreface environments. The Merchantville III sequence (MeIII) (329.4–389.5 ft; 100.4–118.7 m) is lower Campanian (Zones CC18–CC19) and consists of a micaceous lignitic sand (lower Englishtown Formation; upper HST) deposited in shoreface environments, a medial thin sandy silty clay (Woodbury Formation; lower HST) deposited in offshore environments, and a basal clayey glauconite sand deposited in offshore environments (upper part of the Merchantville Formation; TST). The Merchantville II (MeII) (389.5–420 ft; 118.7–246.7 m) and Merchantville I (MeI) (420–434.5 ft; 246.7–374.8 m) sequences are thin glauconite-dominated Santonian sequences (Zones CC17–CC16 and CC16, respectively) deposited in middle neritic environments. The Cheesequake sequence is a thin (434.5–439.4 ft; 374.8–133.9 m), poorly dated ?lower Santonian silty sequence deposited in inner neritic environments.

The Magothy Formation (439.4–573.1 ft; 133.9–174.7 m) is a complex series of nonmarine (delta front and estuarine) to marginal (bay/lagoon and tidal channel) marine sands and clays deposited during the Turonian to ?Coniacian (pollen Zone V, possibly Zone IV at the base). The Magothy Formation is better developed updip at Medford and Sea Girt than it is downdip at Ancora and Bass River. In the updip sites, we tentatively identify five sequences (I–IVB) that appear to correlate with sequences and lithologies observed in outcrop (Kulpecz et al., 2008). Below a major subaerial unconformity with weathered subtropical clays deposited as paleosols, Magothy sequence IVB (439.4–470.3 ft; 133.9–143.3 m) consists of thick lignitic, fining upward medium to coarse sands deposited in tidal channel environments; it may correlate to the Cliffwood Beds. A muddy sequence IVA (470.3–485.7 ft; 143.3–148 m) was deposited in tidal delta environments and may correlate with the Morgan Beds, though pollen data indicate that it may be older at Medford (Zone V versus Zone VII elsewhere). A sandy Sequence III (485.7–523.35 ft; 148–159.5 m) with nonmarine stacked channels overlying tidal channel deposits fines down to a lagoonal clay with marine dinocysts at its base; it is assigned to pollen Zone V and correlated with the Amboy Stoneware Clay. Micaceous lignitic sands fine downsection in Sequence II (523.35–562.6 ft; 159.5–171.5 m), which was deposited in delta front environments, and are tentatively correlated with the Old Bridge Sand and South Amboy Fire Clay Members. The base of the Magothy (Sequence I; 562.6–573.1 ft; 171.5–174.7 m) consists of moderately well sorted, medium-grained quartz sand deposited in estuarine environments and correlated to the Sayreville Sand.

The Raritan Formation (573.1–623.8 ft; 573.1–190.1 m) is sandy at the top, giving way to tightly laminated, slightly sandy silty clay deposited in marsh to swamp environments (in outcrop the equivalent section was interpreted as mangrove swamp by Owens and Sohl [1969] to ~600 ft [182.9 m]). Below this, the Raritan Formation is laminated sandy dark gray clay with disseminated plant debris deposited in lower delta plain environments. The Raritan Formation at Medford is assigned to Zone III (lower Cenomanian); it appears truncated relative to Sea Girt and downdip coreholes, with Zone IV sediments lacking.

The majority of the sediments recovered (566.2 ft; 172.6 m) at Medford were from the Potomac Formation, including Potomac Units I?, II, and III (Lower to Upper Cretaceous; ?Barremian–lower Cenomanian). The Potomac is composed of fluvial sediments that were deposited in anastomosing and braided systems. The deposits overall consist of fluvial channel sand and gravel and finer grained levee, oxbow lake, swamp, and overbank sediment. The fine-grained silt and clay overbank and levee deposits have commonly been overprinted by ancient soil-forming processes, leaving thick paleosol deposits.

Although the Potomac has been successfully divided in the coastal plain using a palynological zonation, most of the samples from Medford yielded meager spore and pollen preservation, and many samples were essentially barren. In addition, stratigraphically diagnostic forms were generally absent. Consequently, the exact stratigraphic contacts between these pollen zones in the core were difficult to place at Medford.

The youngest Potomac subdivision, Potomac Unit III (623.8–681.2 ft; 190.1–207.6 m), is a thick section (163 ft; 49.7 m) of fluvial sediments that is informally divided into two sequences. The upper sequence from 623.8 to 681.2 ft (189.9 to 207.6 m) consists of two distinct fluvial channel sand bodies sandwiched between lignitic sandy clays and clays that were deposited in adjacent overbank, swamp, and oxbow lake environments.

The lower sequence is much thicker (681.2–786.8 ft; 207.6–239.8 m), with a ~25 foot thick paleosol (681.2–706.5 ft; 207.6–215.3 m) at the top of the sequence. Below this paleosol, fluvial facies are present to the base of the sequence. Below a thin clay deposited in oxbow lake environments is a ~14 ft (4.3 m) thick fluvial channel plant-rich sand that fines upward from very coarse to fine sand at the top. Below the channel is a thin ~5 ft (1.5 m) layer of colluvium which sits above a thicker (26 ft; 7.9 m), dominantly overbank clay that has been largely altered to paleosols. Thin oxbow lake clays and overbank clays cap a ~20 ft (6.1 m) succession of fluvial channel sands that lie at the base of the sequence. Pollen assigns the section from 623.8 to 790 ft (190.1 to 240.8 m) to Zone III (lower Cenomanian) and possibly Zone IIC (upper Albian) at the base, consistent with the assignment of the sequence to the Potomac Unit III.

Potomac Unit II is tentatively divided into two sequences. The upper sequence from 786.8 to 844.7 ft (239.8 to 257.5 m) is 57.9 ft (17.65 m) thick and contains predominantly medium- to coarse-grained fluvial channel sands (816–844.7 ft; 248.7–257.5 m) overlain by levee and overbank silt and clay (786.8–816 ft; 239.8–248.7 m) that are overprinted by soil processes.

The lower Potomac II sequence (844.7–983.15 ft; 257.5–299.7 m) is 138.45 ft (42.2 m) thick and, similar to the upper sequence, fines upward from fluvial channels at the base to overbank deposits on top. The overbank deposits consist of 24.6 ft (7.5 m) of thick clayey silts and silty clays. Below this is an interbedded complex of channel sands with a maximum thickness of 10 ft (3 m) and thinner clays and clayey sands deposited in oxbow lake and overbank levee environments that extend to 922.5 ft (281.2 m). The lower part of this sequence is composed of a ~25 ft (7.6 m) thick fluvial channel deposit consisting of poorly sorted sand ranging from fine to medium to very coarse. At the base of the sequence (to 983.15 ft; 299.7 m) is a thin (3.15 ft; 0.96 m) interlaminated clay, silt, and fine sand bed interpreted as a levee deposit. Limited pollen biostratigraphy from this sequence is assigned to Zone IIB (Albian).

The Potomac Unit I sequence (983.15 ft to TD at 1090 ft; 299.7 to 332.2 m) is sand dominated with two thin clay beds deposited in braided stream environments, with the coarsest beds possibly representing colluvium. Sands generally contain dark laminae and are coarse to very coarse with pebbly and gravelly zones. True basement was not reached. The sands are assigned to Zone I (lowermost Albian to Aptian/Barremian) or possibly Zone IIA (lower Albian).

The Medford corehole penetrated 12 distinct water-bearing sands that comprise potential aquifers. Though no hydrologic studies were conducted at this site, sedimentological and log analyses suggest that the Mount Laurel is shallow but a good aquifer, the two Englishtown aquifers are relatively poor, three sandy zones within the Magothy Formation are excellent aquifers, and six sandy zones in the Potomac are good potential aquifers.

BACKGROUND AND OBJECTIVES

This chapter is the site report for Medford corehole, the twelfth continuously cored and logged onshore site drilled as part of the NJCPDP. The NJCPDP began with drilling at Island Beach (March–April 1993), Atlantic City (June–August 1993), and Cape May (March–April 1994) as part of Ocean Drilling Program (ODP) Leg 150X (Miller et al., 1994a, 1994b, 1996; Miller and Snyder, 1997). These three sites targeted Oligocene–Miocene sequences and tried to unravel icehouse sea level changes tied to continental slope drilling by the *JOIDES Resolution* on ODP Leg 150 (Miller and Mountain, 1994; Miller et al., 1996, 1998).

ODP Leg 174AX continued onshore drilling at the following locations with specific objectives:

1. Bass River, New Jersey (October–November 1996) (Miller et al., 1998), targeting Upper Cretaceous to Paleocene strata unsampled during Leg 150X.
2. Ancora, New Jersey (July–August 1998) (Miller et al., 1999), an updip, less deeply buried Cretaceous–Paleocene section complimentary to the Bass River site.
3. Ocean View, New Jersey (September–October 1999) (Miller et al., 2001), focusing on middle Eocene–upper Miocene sequences.
4. Bethany Beach, Delaware (May–June 2000) (Miller et al., 2003), concentrating on thick Miocene sequences in the depocenter of the Salisbury Embayment.
5. Fort Mott, New Jersey (October 2001) (Sugarman et al., 2004), targeting the largely nonmarine Cretaceous Potomac Group and its contained aquifers.
6. Millville, New Jersey (May–June 2002) (Sugarman et al., 2005), targeting upper Cretaceous sequences from southern New Jersey.
7. Sea Girt (September–November 2003) (Miller et al., 2006), targeting upper Cretaceous sequences from northern New Jersey.
8. Cape May Zoo (September–October 2004) (Sugarman, et al., 2007), targeting middle Miocene through Pleistocene sequences to better define the distribution of Miocene sequences and aquifers in the Cape May peninsula.

The Medford site was located to focus on improved correlations of Cretaceous sequences and aquifers. One particular goal for Medford drilling is the nonmarine aquifers of the Potomac, Raritan, and Magothy Formations (Zapecza, 1989). As the deepest unit in the coastal plain above metamorphic basement, information on the Potomac Formation (Neocomian–earliest Cenomanian; Doyle and Robbins, 1977) is largely limited to discontinuously sampled wells in New Jersey and Delaware. Exceptions to this include the continuous corehole at Leg 174AX Fort Mott (Sugarman et al., 2004) and New Castle, Delaware (Benson and McLaughlin, 2006). Both sites provided reasonably complete coring of the Potomac Formation and new insights into this unit, but both were drilled in an updip position and in a restricted geographic area (the southern New Jersey and Delaware coastal plains; the sites are ~6.5 km apart). The Medford corehole provides a more basinal view from the central part of the New Jersey coastal plain and provides an updip location to extend our strike line landward from Sea Girt to Ancora to Medford, as well as a central tie point for correlation of aquifers between the southern (e.g., Fort Mott site) and northern New Jersey coastal plain.

OPERATIONS

Drilling at the Medford site began on Monday, 24 April 2007. Drilling operations were superintended by Gene Cobbs III, Head Driller, USGS Eastern Earth Surface Processes Team (EESPT); Dave Queen and Jeff Grey were the assistants. The Medford Township South Street Maintenance Yard provided space, water, and electricity. The drillers arrived late in the day on 23 April. On 24 April they began rigging up and ran electricity and water from the maintenance yard buildings. On 24 April, a field trailer was set up as a portable laboratory and electric hookups were made to the yard. A Canon PowerShot G5 digital zoom camera (7.2–28.8 mm lens; 5 megapixel resolution), Macintosh G4, and the Delaware Geological Survey (DGS) photography stand were set up to photograph 2 ft (0.61 m) core segments; the camera's default settings with fill-in flash were used.

All cores were measured in feet (all depths are given in feet below land surface with metric conversions provided). We continued to adopt the ODP convention of top justifying depths for intervals with incomplete recovery for all field notes and photos.

The first core was obtained on 24 April using a Christensen 94 mm (HQ) system, 4.5 inch (11 cm) Longyear bit, and 2.5 inch (6.5 cm) core diameter. For unconsolidated sand, an extended ("snout") shoe was used to contact the sample 1.5–2.5 inches (4–6 cm) ahead of the bit; core diameter is 2.4 inches (6 cm) with a rock shoe and 2.1 inches (5 cm) with the snout shoe. The uppermost 1.5 ft (0.5 m) was blown away while setting surface casing. The first core was obtained at 1400 h on 24 April with 2.9 ft (0.9 m) recovered from 4.5 ft (1.4 m) run (1.5–6.0 ft; 0.5–1.8 m) in glauconitic clay. Good coring continued through the rest of the day in glauconite clay. The day ended at 20 ft (6.1 m) with 12.5 ft (3.8 m) recovered from 18.5 ft (5.6 m) drilled (recovery = 67.6%).

On 25 April the first run of the day from 20 to 30 ft (6.1 to 9.1 m) recovered 76%. Because of cemented intervals within the Vincentown Formation, the next run stopped 2.5 ft into the run (30–32.5 ft, 0.8 m; 9.1–10.4 m) with 1.6 ft (0.5 m) of recovery. The following run was limited to 1.5 ft (32.5–34 ft; 10.4–10.9 m) and ended in an indurated zone consisting of medium to coarse calcarenite. Recovery was 120%. The next two runs were 6 ft (1.83 m) from 34 to 40 ft (10.4 to 12.2 m) and 7 ft (2.13 m) long (40–47 ft; 12.2–14.3 m) with excellent recovery of 110% and 80%, respectively. An 8 ft (2.43 m) run (47–55 ft; 14.3–16.8 m) recovered only 1.6 ft (0.5 m). Clayey glauconite sand with a high percentage of broken shell fragments was recovered in the core. The drillers returned to the bottom of the hole (BOH) for a 1 ft (0.3 m) run (55–56 ft; 16.8–17.1 m) with 60% recovery of glauconite sand. Drilling stopped at this point because of a clogged core barrel. Coring restarted with a 4 ft (1.22 m) run (56–60 ft; 17.1–18.3 m) and 2.4 ft (0.7 m) recovery of glauconite sand. The next run also had poor recovery; from 60 to 70 ft (18.3 to 21.3 m), 23% was recovered. It fortuitously contained the Cretaceous/Tertiary (K/T) boundary at 60.7 ft (18.5 m). From 70 to 75 ft (21.3 to 22.9 m), 50% was recovered. The same recovery was duplicated from 75 to 80 ft (22.9 to 24.4 m). Recovery was perfect from 80 to 85 ft (24.4 to 25.9 m). From 85 to 90 ft (25.9 to 27.4 m), 5.2 ft (1.6 m) was recovered. On the final run of the day (90–100 ft; 27.4–30.5 m), 9.2 ft (2.8 m) was recovered, including a beautiful Navesink/Mount Laurel Formation contact. For the day, 80 ft (24.4 m) was drilled with 54.5 ft (16.6 m) recovered (68%).

On 26 April, the first run (19) from 100 to 107 ft (30.48 to 32.61 m) had nearly full (93%) recovery (6.5 ft; 2 m). The next two runs in semi- to indurated glauconitic quartz sand were drilled with a rock shoe with moderate recovery. Run 20 (107–113 ft; 32.6–34.4 m) recovered 3.9 ft (1.2 m), and the next run from 113 to 120 ft (34.4 to 36.6 m) recovered 6.2 ft (1.9 m). During Run 22 from 120 to 130 ft (36.6 to 39.6 m), the rock shoe became loose and recovery was poor (2.7 ft; 0.82 m; 27%). On the next run (130–140 ft; 39.6–42.7 m), shell beds limited recovery to 4.1 ft (1.3 m). Recovery progressively improved on the next two runs (140–150 ft, 42.7–45.7 m; 150–160 ft, 45.7–48.8 m) with 57% and 85% recovery. In coring 160–170 ft (48.8–51.8 m), only 2.9 ft (0.9 m) was recovered. We had excellent recovery during the next several runs. Run 27 (170–180 ft; 51.8–54.9 m) recovered 83%; 180–190 ft (54.9–57.9 m) recovered 97%; 86% from 190 to 200 ft (57.9 to 61 m); and 96% from 200 to 210 ft (61 to 64 m). For the day, 110 ft (33.5 m) was drilled with 76.7 ft (23.4 m) recovered (70%).

Pouring rain in the morning on 27 April slowed the pace of coring. In the afternoon the rain became more sporadic, allowing drilling operations to speed up. The first run of the day (Run 31; 210–220 ft; 64.0–67.1 m) recovered a full 10 ft (3.0 m). The second run (32; 220–223.5 ft; 67.1–68.1 m) recovered 2.7 ft (0.8 m). Run 33 (223.5–225 ft; 68.1–68.6 m) was cut short after encountering an indurated bed; 1.1 ft (0.34 m) was recovered. Sandstone led to poor recovery of 32% between 225 and 230 ft (68.6 and 70.1 m). Runs 35–37 (230–260 ft; 70.1–79.2 m) were much smoother as the rains abated. Better recovery of 75% was recorded between 230 and 240 ft (70.1 and 73.2 m), 89% between 240 and 250 ft (73.2 and 76.2 m), and 104% from 250 to 260 ft (76.2 to 79.3 m). The final run (38) of the day (260–270 ft; 79.2–82.3 m) slipped out of the barrel while being brought to the surface. Most of the core was subsequently recovered (7.95 ft; 2.4 m). The day ended at 270 ft (82.3 m) with 50 ft (15.2 m) recovered from 60 ft (18.3 m) drilled (recovery = 83.3%).

On 28 April, the first run (Run 39) in clayey silt recovered 7.4 ft (2.3 m) from 270 to 280 ft (82.3 to 85.3 m). Run 40 (280–290 ft; 85.3–88.4 m) had excellent recovery of 97%, whereas Run 41 (290–300 ft; 88.4–91.4 m) had even better recovery of 103%. Recovery was 6.7 ft (0.2 m) from 300 to 310 ft (91.4 to 94.5 m), a perfect 10 ft (3 m) from 310 to 320 ft (94.5 to 97.5 m), and 9.5 ft (2.9 m) from 320 to 330 ft (97.5 to 100.6 m). A change in lithology from silty clay above to medium sand below led to a short run of 330–333 ft (100.6–101.5 m) with 3.9 ft (1.2 m) recovered; the top 0.9 ft (0.3 m) is probably from the bottom of the last run. Recovery in the sand was 100% during Run 46 (333–340 ft; 101.5–103.6 m) but fell off sharply during the next two runs: 36% from 340 to 350 ft (103.6 to 106.7 m) and 20% from 350 to 360 ft (106.7 to 109.7 m). The day ended at 360 ft (109.7 m) with 70.1 ft (21.4 m) recovered from 90 ft (27.4 m) drilled (recovery = 77.9%).

The first run of 29 April (360–370 ft; 109.7–112.8 m) slipped out of the barrel on retrieval, but 2.65 ft (0.8 m) was recovered. The drillers went back into the hole and drilled 3 ft more and recovered an additional 9.4 ft (2.9 m). We logged this as two separate runs, the first from 360 to 362.5 ft (109.7 to 110.5 m) and the second from 362.5 to 373 ft (110.5 to 113.7 m). The next run (51) was completed from 373 to 380 ft

(113.7 to 115.8 m) with 8.2 ft (2.5 m) of recovery. Superb recovery continued during the next several runs. Recovery from Run 52 (380–390 ft; 115.8–118.9 m) and Run 53 (390–400 ft; 118.9–121.9 m) was 101%. Two 5 ft (1.5 m) runs from 400 to 410 ft (121.9 to 125 m) recovered 51% and 53%, respectively. On the next run from 410 to 420 ft (125 to 128 m), only 6.1 ft (1.9 m) was recovered, as swelling clays blocked the bottom of the core barrel. The bottom 3 ft (0.9 m) of Run 57 (420–430 ft; 128.0–131.1 m) slipped out of the bottom of the barrel. We drilled another 5 ft (1.5 m) hoping to recover the missing 3 ft (0.9 m). The next run (58; 430–435 ft; 131.1–132.6 m) recovered 8.2 ft (2.5 m) of core from a 5 ft (1.5 m) run. We assume the extra core came from the previous run, and we assigned the overrun to the last core and labeled the cores starting at 427 ft (130.1 m). The last run of the day (Run 59) recovered 5.3 ft (1.6 m) from 5 ft (1.5 m) of drilling (435–440 ft; 132.6–134.1 m). The day ended at 440 ft (134.1 m) with 77.25 ft (23.5 m) recovered from 80 ft (24.4 m) drilled (recovery = 96.6%).

The first core (Run 60) on 30 April (440–448.5 ft; 134.1–136.7 m) recovered 5.5 ft (1.7 m). Run 61 (448.5–452.5 ft; 136.7–137.9 m) recovered 3.8 ft (1.2 m). Run 62 was dominated by sand and recovered 6.5 ft (2.0 m) from 452.5 to 460 ft (137.9 to 140.2 m). Drilling resumed without incident with the next run (460–467 ft; 140.2–142.3 m), retrieving 5.6 ft (1.7 m). Run 64 saw the first break from sand when two thin clay zones appeared in the bottom of the 3.9 ft (1.2 m) recovered (467–476.5 ft; 142.3–145.2 m). Drillers returned to the BOH and drilled another 3.5 ft (1.1 m) from 476.5 to 480 ft (145.2 to 146.3 m) with 3.9 ft (1.2 m) recovered of white kaolinite that varied from silty clay to clayey silt with some thin very fine sand lenses. The top 0.4 ft (0.1 m) appeared to have dropped out of the bottom of the previous run as indicated by markings on the core. Run 66 (480–490 ft; 146.3–149.4 m; 8.4 ft [2.6 m] recovered) contained 4.5 ft (1.4 m) of clay on top and an abrupt change to fine sand with lignitic laminae. Sand continued through the next core as recovery dropped to 5.9 ft (1.8 m) from 490 to 500 ft (149.4 to 152.4 m). The final core of the day (500–510 ft; 152.4–155.4 m; 6.2 ft [1.9 m] recovered) remained in sand but the overall size coarsened. The day ended with 49.7 ft (15.1 m) recovered from 70 ft (21.3 m) drilled (recovery = 71%).

On 1 May, Run 69 recovered only 32.5% (510–520 ft; 155.4–158.5 m) because of gravel. Hard layers in the next two runs (520–526 and 526–528.5 ft; 158.5–160.3 and 160.3–161.1 m) stopped drilling short, though recovery was very good (97% and 80%, respectively). Runs 72–74 (528.5–539 ft; 161.1–164.3 m) each went 10.5 ft (3.2 m) to jam core into the shoe and recovered 9.9, 10.35, and 9.45 ft (3.0, 3.2, and 2.9 m), respectively, of beautiful core, including indurated zones. We ran one last 10 ft (3.0 m) core to 570.0 ft (173.7 m) and anticipated running two 5 ft (1.5 m) runs the next day to capture the Magothy/Raritan Formation contact predicted at ~570–580 ft (173.7–176.8 m). The final run (75; 560–570 ft; 170.7–173.7 m) recovered only 3.4 ft (1.0 m) of core because concretions in the core tore up the shoe. The day ended at 570 ft (173.7 m) with 44.15 ft (13.5 m) recovered from 60 ft (18.3 m) drilled (recovery = 73.6%).

The first run of 2 May recovered 4.2 ft (1.3 m) from 570 to 575 ft (173 to 175.3 m) and captured the Magothy/Raritan Formation contact. On the following 5 ft run (575–580 ft; 175.3–176.8 m), 4.7 ft (1.4 m) was recovered. On Run 78, 3 ft (0.9 m) was recovered from 580 to 585 ft (176.8 to 178.3 m). The next run recovered 3.3 ft (1.0 m) from 585 to 590 ft (178.3 to 179.8 m). While drilling Run 80 from 590 to 600 ft

(179.8 to 182.9 m), the fuel filter clogged. Recovery was 2.8 ft (0.9 m) or 28%. From 600 to 610 ft (182.98 to 185.9 m) 4.6 ft (1.4 m) was recovered. The bottom of the core (604.2–604.6 ft; 184.8–184.3 m) was sand, and the driller believed the rest of the core was also sand and dropped out. The final run of the day from 610 to 620 ft (185.9 to 189.0 m) had 75% recovery. For the day, 29.8 ft (9.1 m) out of 50 ft (15.2 m) was recovered (59.6%).

On 3 May, smooth coring through the lower Raritan Formation from 620 to 675 ft (189.0 to 205.7 m) recovered 42.7 ft (13.0 m) from 55 ft (16.8 m) drilled (recovery = 77.6%).

On 4 May, Run 90 (675–680 ft; 205.7–207.3 m) recovered 3.85 ft (1.2 m), but on Run 91 (680–688.5 ft; 207.3–209.9 m) we recovered only 2 ft (0.6 m), with the remaining core slipping out. The next run (688.5–690 ft; 209.9–210.3 m) recovered 3.7 ft (1.1 m), recovering some from the previous run; this was bottom justified assuming that the lost core was from the middle of the two runs. Runs 93 and 94 (690–695 and 695–700 ft; 210.3–211.8 and 211.8–213.4 m) went 5 ft (1.5 m), recovering 3.15 and 5.0 ft (1.0 and 1.5 m), respectively. Run 95 recovered 10.2 ft (700–710 ft; 3.1 m; 213.4–216.4 m), but Run 96 (710–720 ft; 216.4–219.5 m) recovered only 4.7 ft (1.4 m). The day ended with 34.45 ft (10.5 m) recovered from 45 ft (13.7 m) drilled (recovery = 76.5%).

On 5 May, 4 ft (1.2 m) was recovered from 720 to 730 ft (219.5 to 222.5 m). Run 98 recovered 3.6 ft (1.1 m) from 730 to 733.6 ft (222.5 to 223.6 m). Recovery was 10.5 ft (3.2 m) from 740 to 750 ft (225.6 to 228.6 m); 5.5 ft (1.7 m) from 750 to 760 ft (228.6 to 231.6 m), and 5.2 ft (1.6 m) from 760 to 770 ft (231.6 to 234.7 m). Run 102 (770–780 ft; 234.7–237.7 m) recovered a full 10 ft (3.0 m) in the "birch log" (soft and lignitic) sand that continued to be difficult to wash free of drilling mud without having the core fall apart. Run 103 collected 6.8 ft (2.1 m) out of 10 ft (3.0 m) drilled. The day ended at 790 ft (240.8 m) with 45.6 ft (13.9 m) recovered from 70 ft (21.3 m) drilled (recovery = 65.1%).

On 6 May, the drillers only drilled one core (Run 104; 790–800 ft; 7.7 ft recovered [240.8–243.8 m; 2.3 m]) and returned to Reston, Virginia, for a half-day vacation. Because only one core was planned, none of the scientific team came to the drill site. The drillers washed the core and left it to dry overnight for description the following day.

On 7 May, the first two runs of the day (Run 105; 800–810 ft, 10 ft recovered [243.8–246.9 m; 3.0 m] and Run 106 (810–820 ft; 6.8 ft recovered [246.9–249.9 m; 2.1 m]) came up without incident. Loose sand at the bottom of Run 106 was only partially recovered. While preparing to drill Run 107, the quad latch on one of the inner core barrels would not release, and it had to be pulled. The other inner core barrel was put in, and drilling was delayed for a short time. The faulty quad latch was rebuilt and used later that day. Run 107 (820–830 ft; 249.9–253.0 m) recovered 5.05 ft (1.5 m) in soft, medium to coarse sand. Runs 108 and 109 (830–850 ft [253.0–259.1 m]; 5.1 and 4.7 ft recovered [1.6 and 1.4 m], respectively) continued with about 50% recovery. Run 110 (850–859 ft; 259.1–261.8 m) recovered 10.45 ft (3.2 m) from a 9 ft (2.7 m) run. Core 110 is uniform at top, and we assume the excess core came from the bottom of the previous run (Run 109); therefore, we bottom justified Core 110 at 859 ft (261.8 m). The day ended at 859 ft (261.8 m) with 42.1 ft (12.8 m) recovered from 59 ft (18.0 m) drilled (recovery = 71.4%).

On 8 May, no core was recovered on the first run (859–869.3 ft; 261.8–265.0 m). Drillers went down again to recover core and failed a second time. On the third try, 2 ft (0.6 m) of core was recovered. The core had slid out of the core barrel. On the second run, we had poor recovery (2.4 ft; 0.7 m) from 869.3 to 879.3 ft (265 to 268.0 m). On the final run of the day (879.3–890 ft; 268.0–271.3 m), 3.8 ft (1.2 m) was recovered. The drillers stopped for the day for rig maintenance. For the day, recovery was 8.2 ft (2.5 m) from 31 ft (9.4 m) drilled (27%).

On 9 May, coring resumed with 4.2 ft (1.3 m) recovered from 890 to 900 ft (271.3 to 274.3 m). For the next run (115) from 900 to 910 ft (274.3 to 277.4 m), 7.55 ft (2.3 m) was recovered, and 8.4 ft (2.6 m) was recovered on the following run (116; 910–920 ft; 277.4–280.4 m). Poor recovery of 2.5 ft (0.76 m) occurred during the next run (920–930 ft; 280.4–283.5 m). During the final run of the day from 930 to 940 ft (283.5 to 286.5 m), 7.75 ft (2.4 m) was recovered. For the day, 61% (30.35 ft; 8 m) was recovered from the 50 ft (15.2 m) drilled.

The first run on 10 May recovered 3.2 ft (0.98 m) from 940 to 944.5 ft (286.5 to 287.9 m). The next run to 950 ft (289.6 m) recovered 5.2 ft (1.6 m). Run 121 recovered 8.7 ft (2.7 m) from 950 to 960 ft (289.6 to 292.6 m), and 8.6 ft (2.6 m) was recovered between 960 and 970 ft (292.6 and 295.7 m). Recovery slipped to 22% on the next run between 970 and 980 ft (295.7 and 298.7 m) and finished at 50% on the final run of the day from 980 to 990 ft (298.7 to 301.8 m). Recovery for the day was 66% from 50 ft (15.3 m) drilled.

Recovery gradually improved on 11 May. Run 125 (990–1000 ft; 301.8–304.8 m) only recovered 1.9 ft (0.6 m), but Runs 126 and 127 (1000–1020 ft; 304.8–310.9 m) enjoyed full recovery. The drillers replaced the wireline between Runs 126 and 127. Run 128 (1020–1030 ft; 310.9–313.9 m) was pulled at the end of the day and described on 12 May. In total 32.4 ft (9.9 m) was recovered from 40 ft (12.2 m) drilled (recovery = 81%).

On 12 May, the first core slipped out of Run 129 (1030–1040 ft; 313.9–317 m), so on the second run (Run 130) the drillers only advanced 2 ft (0.6 m), hoping to catch the lost sediment. Run 130 (1040–1042 ft; 317–317.6 m) appeared to have captured 1 ft (0.3 m) from the bottom of Run 129 and the core is bottom justified. Based on drilling behavior, Run 130 (0.9 ft; 0.3 m recovered) is also bottom justified. Run 131 (1042–1047 ft; 317.6–319.1 m) recovered 3.3 ft (1 m) of mostly coarse sand. It is believed the coarse sand slipped out of the bottom of the barrel. The drillers had difficulty getting the inner core barrel to latch into place, preventing full recovery. Run 132 (1047–1055 ft; 319.1–321.6 m) recovered 6.35 ft (1.9 m). On the last run of the day (Run 133; 1055–1065 ft; 321.6–324.6 m), the shoe jammed with pebbles and cobbles, limiting recovery to 1 ft (0.3 m). The day ended at 1065 ft (324.6 m) with 12.55 ft (3.8 m) recovered from 35 ft (10.7 m) drilled (recovery = 35.9%). At the end of the day P. McLaughlin obtained a gamma log through the rods to 1065 ft (324.6 m).

Two cores were drilled on 13 May; they were washed by the drillers and described on 14 May. The sandy gravels made it difficult to latch the inner core barrel in, and Run 134 (1065–1070 ft; 324.6–326.1 m) recovered 1 ft (0.3 m) of pebble-rich coarse sand and Run 135 (1070–1073 ft; 326.1–327.1 m) had no recovery. The day ended at 1073 ft (327.1 m) with 1 ft (0.3 m) recovered from 8 ft (2.4 m) drilled (recovery = 12.5%).

There were two core runs on the last day of drilling (14 May). Run 136 (1073–1080 ft; 327.1–329.2 m) recovered 6.2 ft (1.9 m), and Run 137 (1080–1090 ft; 329.2–332.2 m) recovered 2.9 ft (0.9 m). Pebbles in the cores caused chattering of the drill string while drilling and made penetration difficult. The day ended at 1090 ft (332.2 m) with 9.1 ft (2.8 m) recovered from 17 ft (5.2 m) drilled (recovery = 53.5%).

Following Run 137, the drillers circulated drilling mud to condition the hole for logging and pulled the drill rods. McLaughlin began open-hole logging operations at approximately 1600 h with the DGS Century Gamma-Electric Multitool (Model 8144A). This logging tool simultaneously records a gamma ray log and a suite of electric logs, including spontaneous potential (SP), short normal resistivity (16N), long normal resistivity (64N), point resistance, and lateral resistivity. The first open-hole run was stopped by an obstruction at 463 ft. The drillers put rods back in the hole past the level of the obstruction, circulated the drilling mud, and removed the rods for another attempt at logging. The next attempt to log again encountered an obstruction and several subsequent attempts encountered obstructions at various depths. In the evening, a partial open-hole log was obtained by running the logging tool through the drilling rods to 435 ft and in the open hole to another obstruction at 669 ft; at that point, ~2200 h, logging was abandoned for the day.

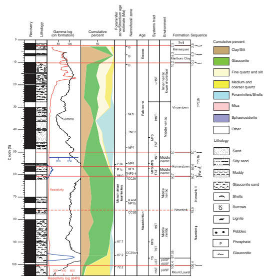
On 15 May, the drillers mixed a new batch of drilling mud, put the entire drill string back into the hole, and circulated the mud for >1 h. Two partial log runs were made as the rods were being pulled in case of further obstruction problems. The drillers pulled the drill rods up to 815 ft and a partial open-hole log was obtained by running the multitool (Model 8144A) through the drilling rods to near the bottom of the hole at 1088 ft. The drillers pulled additional rods, and another run was made with the multitool from 615 to 1088 ft. A continuous gamma-multipoint electric log was constructed in the office by splicing together the logs from the various runs with splice depths of 450 and 655 ft. Logging was completed by ~1430 h.

The Medford site concluded with 137 cores (762.65 ft; 232.46 m) obtained, 70% recovery, and 110 boxes moved to the IODP Rutgers core repository.

T1. Core descriptions, p. 59.

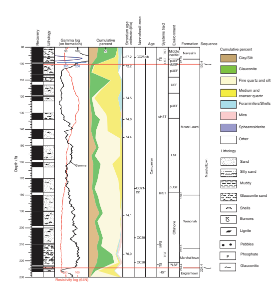
T2. Cumulative percent plot data, p. 63.

F2. Manasquan, Marlboro Clay, Vincentown, Hornerstown, and Navesink formations, p. 47.



LITHOSTRATIGRAPHY AND SEQUENCE STRATIGRAPHY

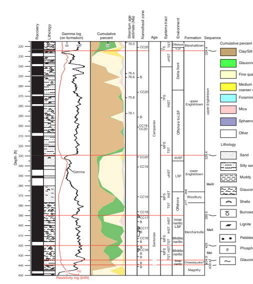
F3. Mount Laurel, Wenonah, and Marshalltown formations, p. 48.



The on-site scientific team provided preliminary descriptions of sedimentary textures, structures, colors, fossil content, identification of lithostratigraphic units (NJGS Information Circular 1, 1990), lithologic contacts, and core photographs illustrating sequence bounding unconformities and facies variation within sequences (Tables T1, T2; Figs. F2, F3, F4, F5, F6, F7, F8, F9, AF1, AF2, AF3, AF4, AF5, AF6, AF7, AF8, AF9, AF10, AF11, AF12, AF13, AF14, AF15, AF16, AF17, AF18). Subsequent studies integrated preliminary descriptions with additional descriptions, biostratigraphy (Tables T3, T4, T5, T6), biofacies studies, isotopic stratigraphy (Table T7), and the downhole gamma log. Unconformities were identified on the basis of physical stratigraphy, including irregular contacts, reworking, bioturbation, major facies changes, and gamma ray peaks. Paraconformities were inferred from biostratigraphic breaks.

For the nonmarine and near-shore sections, lithofacies interpretations and pollen biostratigraphy provide the primary means of recognizing unconformities and interpreting paleoenvironments and systems tracts. For the neritic sections, biostratigraphic studies and Sr isotopes provide an additional means of recognizing unconformities and interpreting paleoenvironments and systems tracts.

F4. Upper Englishtown, lower Englishtown, Woodbury, Merchantville, and Cheesequake formations, p. 49.



Cumulative percent plots of the sediments in the cores were computed from washed samples (Table T2). Each sample was dried and weighed before washing, and the dry weight was used to compute the percentage of sand. This differs from the method used in previous New Jersey coastal plain cores (Bass River, Island Beach, Atlantic City, and Cape May) in which the samples were not dried before washing.

Facies changes within onshore sequences generally follow repetitive transgressive–regressive patterns (Sugarman et al., 1993, 1995) that consist of (1) a basal transgressive glauconite (particularly Paleogene–Upper Cretaceous sections) or quartz sand (particularly Miocene sections) equivalent to the TST of Posamentier et al. (1988) and (2) a coarsening-upward succession of regressive medial silts and upper quartz sand equivalent to the HST of Posamentier et al. (1988). Lowstand systems tracts (LSTs) are usually absent in the coastal plain and TSTs are generally thin. Because TSTs are thin, maximum flooding surfaces (MFSs) are difficult to differentiate from unconformities. Shell beds and gamma-ray peaks can mark both TSTs and MFSs. Flooding surfaces, particularly MFSs, may be differentiated from sequence boundaries by the association of erosion and rip-up clasts at the latter, lithofacies successions, and benthic foraminifer changes. The transgressive surface (TS), marking the top of the LST, represents a change from generally regressive to transgressive facies; because LST are generally absent, these surfaces are generally merged with the sequence boundaries. Where present, LSTs are recognized as generally thin, regressive, fluvial-estuarine sediments underlying TSTs and overlying sequence-bounding unconformities.

Manasquan Formation

Age: early Eocene
Interval: 2.5–6.3 ft (0.8–1.9 m)

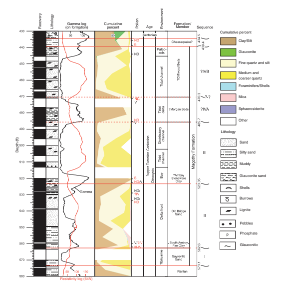
Below a thin soil horizon (1.5–2.5 ft; 0.5–0.8 m), a glauconitic sandy clay with scattered pyrite grains is assigned to the Manasquan Formation that outcrops in the adjacent Southwest Branch of Rancocas Creek. The unit is likely deposited in neritic environments. The section appears bioturbated, but this may reflect soil processes. Concretions (siderite?) appear at 3.4 ft (1.0 m). There is a coring gap from 4.4 to 6.0 ft (1.3 to 1.8 m), with the Manasquan Formation lithology extending to 6.3 ft (1.9 m). Poor recovery, lack of biostratigraphic information, and a thin truncated section prevent application of sequence stratigraphy.

Marlboro Clay

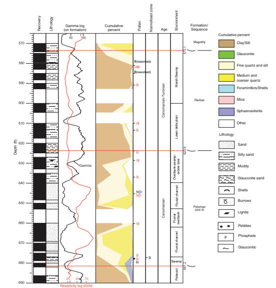
Age: earliest Eocene?
Interval: 6.3–10.2 ft (1.9–3.1 m)

There is a contact at 6.3 ft (1.9 m) with the olive-gray glauconitic sandy clay above and a white kaolinite clay below. There is a possible clay rip-up clast immediately above the contact. The lower clay contains a few percent glauconite, a trace of mica, and iron-stained slightly sandier laminae (0.5 cm thick) that occur every 2–3 cm. The thin (3.9 ft, 1.19 m) kaolinitic clay at Medford has been previously recognized in thick sections (>40 ft, >12 m) at Bass River and Ancora, where it has been associated with the Paleocene/Eocene Thermal Maximum (Cramer et al., 1999). The clay appears to immediately postdate the carbon isotope excursion (Cramer et al., 1999) and hence is earliest Eocene (Aubry et al., 2007). Unusual magnetic properties in the clay led Kent et al. (2003) to suggest that it was a product of an impact vapor cloud. Kaolinite clay

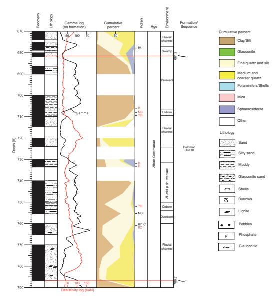
F5. Magothy Formation, p. 50.



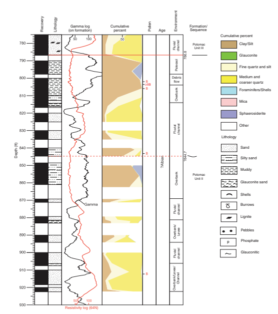
F6. Raritan and Potomac formations, p. 51.



F7. Potomac Formation, Unit III sequence, p. 52.



F8. Potomac Formation, Unit II sequence, p. 53.



also occurs in coreholes at Clayton (Gibson et al., 1993), Wilson Lake (Lippert and Zachos, 2007), Millville (Sugarman et al., 2005), and Sea Girt (Miller et al., 2006). This clay has been discussed as an unnamed clay in previous studies of New Jersey coreholes. It has not been reported from outcrop, though we note a thin clay bed (thickness) adjacent to the Medford corehole on Rancocas Creek. A similar clay was first reported in Virginia and Maryland (Darton, 1948) and named as a formation by Glaser (1971). More recent studies by Edwards (1996) indicate that the Marlboro Clay is earliest Eocene and therefore correlates with the widespread clay in New Jersey. Hence, we apply here the term Marlboro Clay to the thin bed found at Medford.

Based on correlation to other coreholes, the unit probably was deposited in middle neritic paleodepths. There is a coring gap from 7.1 to 10 ft (2.2 to 3.0 m). A clay from 10.0 to 10.2 ft (3.1 to 3.1 m) may be a continuation of the clay above, but it is grayer and apparently less kaolinitic, and with the poor recovery it cannot be determined if this is still the Marlboro Clay.

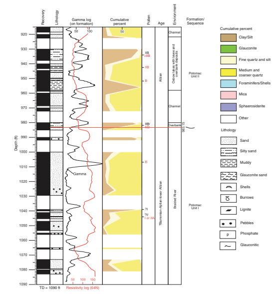
Vincentown Formation

Age: late Paleocene
Interval: 10.2–50 ft (3.1–15.2 m)

The greenish gray clay continues down to an iron-stained layer at 10.2 ft (3.1 m); there is a contact from 10.2 to 10.6 ft (3.1 to 3.2 m) with a gradation from white clay to black clayey glauconite-quartz sand below. Clay decreases below 11.5 ft (3.5 m) and glauconite increases at 13 ft (4.0 m). The section from 13 to 27.6 ft (4.0 to 8.4 m) consists of interbedded clayey sands and slightly clayey glauconite-quartz sands that are heavily and beautifully bioturbated. Small shells appear at 23 ft (7.0 m). Gamma log values are high above 25 ft (7.6 m) because of common glauconite. The environment of deposition was probably an inner neritic, lower shoreface environment. We interpret this section as the upper part of a HST with reworked glauconite (though none appears iron stained, as is often found with recycled glauconite in these environments). The coequal abundances of quartz and glauconite sand are typical of reworked glauconite in HSTs.

There is a lithologic change across a coring gap (27.6–30.0 ft; 8.4–9.1 m) with clayier quartz-glauconite sand below; gamma logs place the contact at the top of the gap. There is a change at 32 ft (9.8 m) to a clayey quartz-glauconite sandy packed biomicrite, where the sandy carbonate fraction consists mostly of shell debris (bryozoans and bivalves). We have not observed this facies in our cores previously, but it is probably equivalent to the patch reef biomicrites that crop out in the type Vincentown Formation section 5 miles to the northeast at Vincentown, New Jersey (Gallagher, 2002). Biomicrite (blue, Fig. F2) peaks from ~33 to 34.8 ft (10.1 to 10.6 m) in association with a gamma log minimum; carbonate decreases and glauconite increases downsection from 34.8 to 41 ft (10.6 to 12.5 m), where the facies consist of clayey biomicritic quartzose glauconite sand. From 41 to 43.8 ft (12.5 to 13.4 m) is a slightly whitish clayey glauconite sand that represents the deepest paleodepths; a gamma log peak at ~43.5 ft (13.3 m) near the base of this interval is interpreted as the MFS (Fig. F2), probably deposited in middle neritic environments. From 43.8 to 46 ft (13.4 to 14.0 m), the section fines up, consistent with a TST, and consists of clayey slightly quartzose biomicrite-glauconite sand. Distinct bluish green clay lami-

F9. Potomac Formation, Unit II and I sequences, p. 54.



T3. Pollen and dinocyst occurrences, p. 67.

T4. Planktonic foraminifer occurrences, p. 71.

T5. Cenozoic calcareous nannoplankton occurrences, p. 72.

T6. Cretaceous calcareous nannoplankton occurrences, p. 73.

T7. Sr isotopic data, p. 75.

nae occur at 44.5 and 45.8 ft (13.6 and 14.0 m). Interlaminations of clayey slightly quartzose glauconite sand and greenish blue glauconitic clay occur from 45.8 to 47.7 ft (14.0 to 14.5 m). There is a clayey shelly glauconite sand to clayey glauconitic shell bed at 47.7–48.4 ft (14.5–14.8 m) (Fig. AF1). There might be a sequence boundary at 48.4 ft (14.8 m) at the contact between the shell bed and a black more uniform clayey glauconite sand that differs from above by having less common quartz and shells. The gamma log suggests that the sequence boundary may occur slightly deeper at ~50 ft (15.2 m) in a coring gap from 48.6 to 55 ft (14.8 to 16.8 m). We prefer the placement of the sequence boundary, and the base of the Vincentown Formation, at ~50 ft (15.2 m), with the interval from ~43.5 to 50 ft (13.3 to 15.2 m) interpreted as the TST. Age control on this sequence is from nannofossil assignments to Zones NP7 and NP8 (see **"Calcareous Nannofossils"**). This suggests correlation to sequence Pa2b of Harris et al. (in press).

Hornerstown Formation

Age: early–late Paleocene
Interval: 50–60.7 ft (15.2–18.5 m)

The Hornerstown Formation is poorly recovered in the Medford corehole, where it consists of a dark olive gray to black, slightly quartzose, and slightly shelly clayey-glauconite sand. The environment of deposition was probably middle neritic. We tentatively identify two thin truncated sequences within the Hornerstown at the Medford site: an upper sequence from 50 to 56.6 ft (15.2 to 17.22 m) and a lower sequence from 56.6 to 60.7 ft (17.22 to 18.5 m). Distinct clay beds (55.2–55.5 and 56.4–56.6 ft; 16.8–16.9 and 17.19–17.22 m) in the upper sequence may mark a MFS in association with a gamma log maximum. Planktonic foraminifer biostratigraphy places sample 56.1 ft (17.1 m) in Zone P3a and 57.4 ft (17.5 m) in Zone P1c (see **"Planktonic Foraminifers"**), suggesting that the base of the lower clay bed at 56.6 ft is a paraconformity with a hiatus of > 0.2 m.y. Both sequences are assigned to Zone NP4, though the lower might include Zone NP3 (see **"Calcareous Nannofossils"**). The excellent planktonic fauna in the lower sample suggest that the older sequence below 56.6 ft (17.2 m) is truncated with a MFS near the top of the sequence. The lower sequence (P1c) can be confidently correlated to sequence Pa1a (Zones P1a and NP4) of Harris et al. (in press). The upper sequence likely correlates with sequence Pa1b (Zones P3b and NP4/NP5), though the assignment to Zone NP3a suggests that this may be a previously unrecognized sequence. The base of the formation (60.35–60.7 ft; 18.4–18.5 m) is marked by pale green clay (5G6/1) that is bioturbated and has glauconite-filled burrows at the top and laminations at the base. The bright green clay matrix contains small (2–10 mm) iron-cemented concretions containing glauconite sand. The heavily bioturbated interval may be correlative with the "Burrowed Unit" of Landman et al. (2007).

The Cretaceous/Paleogene boundary (K/P) occurs at 60.7 ft (18.5 m) (Fig. AF1), separating the pale green clays above from the uniform clayey glauconite sands of the Navesink Formation below. The boundary lacks both spherules and clay clasts that are often found in the New Jersey coastal plain coreholes. The sample at 61.4 ft (18.7 m) contains a typical uppermost Maastrichtian planktonic foraminifer assemblage.

Navesink Formation

Age: Maastrichtian
Interval: 60.7–97.05 ft (18.5–29.6 m)

The Navesink Formation at Medford is a clayey glauconitic sand and sandy glauconitic clay deposited in a middle neritic environment. Glauconite is mainly black with lesser dark green grains. A sharp contact at 75.9 ft (23.1 m) is marked by a lithologic change to brownish clayey medium glauconite sand with mica and quartz. This may be the contact between the Navesink I and Navesink II sequences (although poor recovery above 75.9 ft [23.1 m] makes this pick very tentative). The glauconite sand extends from 75.9 to 85.6 ft (23.1 to 26.1 m) with a gradational contact to heavily bioturbated glauconitic clay at 85.6 ft (26.1 m). The clay content increases toward the base of the Navesink Formation, where it becomes whiter and more calcareous; it reacts strongly with hydrochloric acid. Shells first appear at 82 ft (25.0 m) and are more common downsection. The MFS of this sequence is placed at 90 ft (27.4 m), where clay content is at a maximum. The contact with the Mount Laurel Formation is at 97.05 ft (29.6 m) at the top of an indurated zone consisting of phosphatized Mount Laurel lithology. This contact also represents the TS (Fig. AF1) within the Navesink I sequence.

Mount Laurel Formation

Age: Campanian
Interval: 97.05–180 ft (29.6–54.9 m)

The uppermost part of the Mount Laurel Formation is medium sand in the Medford corehole. The top 3.35 ft (1.02 m) of the Mount Laurel Formation is a lag deposit (located at the base of the Navesink I sequence; Fig. F3), with a sequence boundary at 100.4 ft (30.6 m) separating the Navesink I above from the Marshalltown sequence below. At the top (97.05–97.35 ft; 29.6–29.7 m), the lag deposit consists of an indurated phosphate nodule. The nodule reacts with acid and may have siderite cement. Below the nodule is a very poorly sorted clayey shelly granuliferous fine to medium sand (97.35–100.2 ft; 29.7–30.5 m) deposited in proximal upper shoreface environments. Large shell and belemnite fragments measure up to 3 cm across. The sand is interrupted at 98.5–98.7 ft (30.0–30.1 m), where there is a shell bed with 1–2 cm shells with granules. At 100.2–100.4 ft (30.5–30.6 m) there is a shift to silty quartz sand deposited in distal upper shoreface environments. Thus, the section from 97.35 to 100.4 ft (29.7 to 30.6 m) shallows upsection and is interpreted as a thin, regressive LST. At 100.4 ft (30.6 m) there is a shift to very slightly clayey, slightly glauconitic, slightly shelly medium quartz sand deposited in proximal upper shoreface environments (Fig. AF2). These typical yellow Mount Laurel sands continue to 108.2 ft (33.0 m) with clay- and silt-filled burrows throughout. There is a large oyster shell at 101.7–101.75 ft (31.00–31.01 m) and a very shelly and heavily burrowed section from 102 to 102.7 ft (31.1 to 31.3 m).

Glauconite increases downsection from 108.2 to 109.5 ft (33.0 to 33.4 m), and the section from 109.5 to 118.2 ft (33.4 to 36.0 m) consists of burrowed shelly glauconite-quartz sand with numerous fine, thin, whole shells. The glauconite-quartz sand is semi-indurated. There are two possible interpretations to the section: (1) this is the upper HST with reworked glauconite deposited in upper shoreface environments, as suggested by the high abundance of and covariance with quartz sand, or (2) the glauconite is in situ and represents deeper water, middle neritic environments with a sequence boundary at 118.2 ft (36.0 m). We favor the former interpretation.

Typical Mount Laurel Formation shelly medium quartz sand returns from 118.2 to 122.7 ft (36.0 to 37.4 m) deposited in proximal upper shoreface environments. There is a coring gap from 122.7 to 130 ft (37.4 to 39.6 m). Below this gap, the sand is slightly micaceous fine–medium sand. There is a change downsection at 133.2 ft (40.6 m) to muddy, micaceous fine sand with mud laminae as thick as 1 cm deposited in lower shoreface environments (Fig. AF2). This fine sand continues to 178.3 ft (54.3 m), where there is a coring gap to 180 ft (54.9 m). Below this, the section becomes silty very fine sand that we assign to the Wenonah Formation.

Wenonah Formation

Age: Campanian
Interval: 180–212.3 ft (54.9–64.7 m)

Micaceous, silty, glauconitic very fine sand with scattered lignite and shells was deposited in offshore environments (Fig. AF2) and is assigned to the Wenonah Formation, which is differentiated from the Mount Laurel Formation here by the finer grain size (silty fine versus fine–medium sand) and more common mica. Mica increases slightly downsection within the Wenonah Formation. The formation is heavily bioturbated, with extensive burrowing below 192 ft (58.5 m) along with evidence of gypsum. There may have been a deltaic influence on this shelf, though laminated silty clays typical of prodelta environments in this region are largely absent. Shells increase slightly downsection below 192 ft (58.5 m), and clay content increases downsection below 196 ft (59.7 m) in otherwise uniform micaceous, silty, glauconitic very fine sand. Clay is at a maximum at 210.3–210.7 ft (64.1–64.2 m) where we place the MFS at 209 ft (63.7 m) (Fig. F3). At the top of a section with high gamma log values, there is a shell zone from 211.9 to 212.3 ft (64.6 to 64.7 m) at the base of the Wenonah Formation.

Marshalltown Formation

Age: Campanian
Interval: 212.3–224.4 ft (64.7–68.4 m)

The contact of the Marshalltown with the overlying Wenonah Formation is a gradational contact recognized by the downhole increase in the amount of glauconite in the core. Below 210 ft (64.0 m), the amount of glauconite starts to exceed 15%. From 210 to 210.3 ft (64.0 to 64.1 m), the burrowing changes downsection to large clay-lined and glauconite-filled burrows; we placed the Wenonah/Marshalltown Formation contact here. The Marshalltown Formation is generally a highly bioturbated, shelly, silty clayey quartz and glauconite sand that is approximately correlative to the TST of the Marshalltown sequence. An alternative MFS to the one placed at 210.3–210.7 ft (64.1–64.2 m) could be at 217.5 ft (66.3 m) at the base of a clay-rich section, with more glauconite sand below. Shell concentrations occur at 212.7 and 215.9 ft (64.8 and 65.8 m). The Marshalltown Formation contains more silt and clay here than it has in outcrop; the amount of glauconite sand in the Marshalltown Formation never exceeds 50% in the Medford corehole. This unit was primarily deposited in an offshore environment. The base of the formation below 221 ft (67.4 m) is more heavily laminated and probably represents shallower water environments than the section above.

There is a contact at 222.5 ft (67.8 m) with a clayey glauconite sand above and a lag zone from 222.5 to 224.4 ft (67.8 to 68.4 m). The contact is interpreted as a TS. The lag deposits consist of glauconitic sandy silt with laminae and scattered blebs of yellow Englishtown quartz sand lithology. A large shell occurs at 223.6–223.7 ft (68.15–68.18 m). The formational placement of the lag unit from 222.5 to 224.4 ft (67.8 to 68.4 m) is uncertain but is placed here in the Marshalltown Formation because of the predominance of glauconite. At the base of the lag unit is a sharp irregular contact representing a sequence boundary at 224.4 ft (68.4 m) (Fig. AF2) with the underlying yellow Englishtown quartz sandstone below. Log values suggest the contact might be lower at ~228 ft (69.5 m) in an interval of no recovery (Fig. F4).

Upper Englishtown Formation

Age: Campanian
Interval: 224.4–329.4 ft (68.4–100.4 m)

The upper Englishtown Formation (and sequence) consists of a wide variety of lithologies in the Medford corehole representing paleoenvironments ranging from nearshore (delta front) to open shelf (Fig. AF3). A fine to medium sandstone with scattered glauconite occurs from 224.4 to 226.6 ft (68.4 to 73.2 m); there is an interval of no recovery from 226.6 to 230 ft (69.1 to 70.1 m). Below 230 ft (70.1 m), the section consists of slightly clayey, slightly micaceous fine quartz sand to 232.5 ft (70.9 m) deposited in delta front environments. A concretion at 232.3 ft (70.8 m) separates mostly fine sand above from silty, clayey fine to very fine sand with clay laminae below (232.5–233.3 ft; 70.9–71.1 m). A dark greenish gray organic-rich clay occurs from 233.3 to 234.0 ft (71.1 to 71.3 m). From 234.0 to 234.2 ft (71.3 to 71.4 m) is a laminated lignite with clay, whereas 234.3–235.9 ft (71.4–71.9 m) consists of a micaceous sand with finely disseminated lignite. Lignitic clay with thin interbeds of sand is found from 233.5 to 235.9 ft (71.2 to 71.9 m). Faintly laminated micaceous, slightly shelly medium to mostly fine quartz sand returns from 235.9 to 237.5 ft (71.9 to 72.4 m). There is no recovery from 237.5 to 240.3 ft (72.4 to 73.2 m; sediments from 240.0 to 240.3 ft [73.15 to 73.24 m] may be caved as suggested by the logs). These rapidly changing, organic-rich sediments were deposited in delta front environments (Fig. AF3) and comprise the upper HST of the thick upper Englishtown sequence.

Beginning at 240.3 ft (73.2 m), sediments become increasingly marine (finer grained with shells appearing downsection at 242.6 ft) in nature. The section from 240.3 to 324 ft (73.2 to 98.8 m) is predominantly very dark gray sandy clayey silt to sandy silty clay with abundant fossils and shell fragments (Fig. AF3). The silty clay is slightly micaceous and contains pyritized burrows and concretions. Fine shells are common and consist of thin-shelled bivalves and occasional gastropods. Bedding is uniform with occasional laminae. Very fine to fine quartz sand is common in this interval, concentrated in several thin (2–3 cm thick) beds or sand-filled burrows. Lignite is common and becomes less common below 251 ft (76.5 m), and mica decreases below 264 ft (80.5 m). The section at 271 ft (82.6 m) is slightly glauconitic and at 271.4 ft

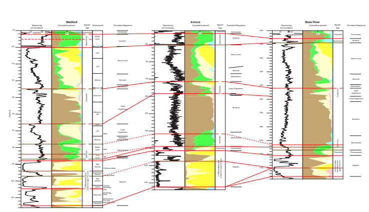
(82.7 m) has gypsum crystals that may indicate carbonate dissolution and a minor flooding surface. A very sandy silt bed occurs at 290–295 ft (88.4–89.9 m) deposited in offshore to lower shoreface environments. Very slightly micaceous silty clay with numerous shell fragments (up to 2 mm) and scattered whole shells returns from 295 to 324 ft (89.9 to 98.8 m); bedding is largely burrowed with occasional laminae and sulfide-filled burrows every few cm.

The environment of deposition of the silty clays to clayey silts is lower shoreface (LSF) to offshore. There is some deltaic influence, although less than is typical of the upper Englishtown Formation in other New Jersey coastal plain cores; we assign this unit to the lower part of the upper Englishtown Formation. A similar thick clay was noted in the upper Englishtown Formation at Sea Girt (Miller et al., 2006); both clays are assigned to Zone CC19. We interpret the section above ~264 ft (80.5 m) with more common lignite, sand, and mica as delta front. The section from 264 to 324 ft (80.5 to 98.8 m) was deposited in offshore environments with a slight prodelta influence. The sand beds in this section may represent LSF environments or storm deposits.

Several laminated intervals are interspersed with moderately bioturbated zones, and the section becomes increasingly glauconitic (5%–10%) from 270 to 277.4 ft (82.3 to 84.6 m). The section from 280.0 to 288.3 ft (85.3 to 87.9 m) consists of laminated clayey silt to silty clay with several ammonite fossils (282.5 ft; 86.1 m). From 288.3 to 289.7 ft (87.9 to 88.3 m), there are common dark green to black glauconite sand-filled burrows. Below 290.0 ft (88.4 m), the section consists of finely laminated slightly silty clay with abundant shell fragments. Laminated, glauconitic (in sand-filled burrows), and slightly micaceous clayey silt grades into to a dark gray, slightly shelly laminated silty clay from 294 to 324 ft (89.6 to 98.8 m). The MFS is placed at 319–319.5 ft (97.2–97.4 m) in an interval with common gypsum crystals and a gamma log kick, with the section above this to ~240 ft (73.2 m) comprising the lower HST of the thick upper Englishtown sequence.

Sand increases in the silty clays from 324 to 329.4 ft (98.8 to 100.4 m), with more coarse mica, common quartz, and glauconite. The section is burrowed. Glauconite is in trace amounts from 300 to 324.7 ft (91.4 to 99.0 m) but begins to increase in abundance from 2% to 3% at 325 ft (99.1 m) to 5% at 327 ft (99.7 m) and 10%–12% below 329 ft (100.3 m). There is a contact at 329.4 ft (100.4 m) that coincides with a major gamma log decrease downsection. Below the contact is a fairly homogeneous, slightly glauconitic, slightly silty fine quartz sand deposited in distal lower shoreface environments. The contact at 329.4 ft (100.4 m; Figs. F4, AF3) is interpreted as a sequence boundary. The thick sequence from 224.4 to 329.4 ft (68.4 to 100.4 m) is correlated to the upper Englishtown sequence and formation based on nannofossil biostratigraphy and Sr isotope age estimates. It is significantly thicker at Medford than the downdip Ancora and Bass River sites (Fig. F10).

F10. Dip section, p. 55.



Lower Englishtown Formation

Age: Campanian
Interval: 329.4–366 ft (100.4–111.6 m)

Micaceous, slightly lignitic, silty, clayey fine sand with lesser medium sand fines downward from 329.4 to 335 ft (100.4 to 102.1 m) and represents distal upper shoreface environments (Fig. AF4). A shell hash occurs from 332.2 to 332.3 ft (101.25 to 101.29 m). From 335 to 366 ft (102.1 to 111.6 m), the section consists of heavily bioturbated, slightly shelly, micaceous silty fine to very fine sand and silty clay deposited in lower shoreface environments (Fig. **AF4**) that generally fines downsection. Shells become more obvious below 360 ft (109.7 m). The lower Englishtown Formation lacks a deltaic influence and is significantly thicker than seen in most other sites. Clay begins to dominate at 366 ft (111.6 m), and we place the base of lower Englishtown at this level at the top of a "hot" gamma log zone. The lower Englishtown Formation comprises the upper HST of the MeIII sequence.

Woodbury Formation

Age: Campanian
Interval: 366–377.0 ft (111.6–114.9 m)

The Woodbury Formation is a micaceous, heavily bioturbated, slightly sandy silty clay to clayey silt with traces of shells. The Woodbury Formation is much thinner and less laminated at Medford than at other sites (Fig. **F10**). It was deposited in lower shoreface to offshore environments (Fig. **AF4**). Glauconite occurs at the top, is largely missing in the middle, and increases toward the base of the formation at 377 ft (114.9 m), where glauconite increases above 50%. We place the MFS at the peak in clay and gypsum at 371 ft (113.1 m), with the gypsum reflecting dissolution and reprecipitation of carbonate. Thus, the Woodbury Formation comprises both the upper TST and lower HST of the MeIII sequence. It is assigned to nannofossil Zones CC19 and CC18.

Merchantville Formation

Age: Campanian and Santonian
Interval: 377.0–434.5 ft (114.9–133.9 m)

The transition to the Merchantville Formation is placed at 377 ft (114.9 m) where the amount of glauconite sand in the corehole first exceeds 50% (Fig. **F4**). The upper part of the Merchantville Formation consists of heavily bioturbated, clayey, fine-medium glauconite sand. Gray-clay lined burrows are common as are siderite concretions; shells are rare. The clayey glauconite sand (385.9–388.5 ft; 117.6–118.4 m) changes to clayey silty quartz sand and silt below 390.3 ft (119.0 m). The interval from 388.5 to 390.3 ft (118.4 to 119.0 m) is a contact zone, with a gamma log kick at the top (Fig. **F4**). Mica increases downsection from 388.5 ft (118.4 m) where it is trace to >3% at 389.5 ft (118.7 m). Scattered shells occur throughout the contact section. Glauconite decreases downsection in the contact zone, occurring mostly in burrows and disappears below 390.3 ft (119.0 m). Nannofossils assign 389.5 ft (118.7 m) to Zone CC18 and 389.85 ft (118.8 m) to Zone CC17. We place a sequence boundary (within the Merchantville Formation) at 389.5 ft (118.7 m) at an irregular surface and a change from clayier to sandier sediments. The sequence from 329.4 to 389.5 ft (100.4 to 118.7 m) is correlated to the MeIII of Miller et al. (2006) and assigned to lowermost Campanian Zones CC18 and CC19.

Bioturbated clayey, micaceous, glauconitic fine quartz sand with scattered shell fragments occurs from 390.3 to 398.2 ft (119.0 to 121.4 m) and was deposited in a inner neritic, predominantly lower shoreface environment (Fig. **AF5**). This comprises the upper HST of the MeII sequence (Fig. F4). Mica drops out below ~399 ft (121.6 m). Heavily burrowed, glauconite clayey silt and clayey glauconite sand with numerous clay burrows becomes progressively clayey from 398.2 to 409.3 ft (121.4 and 124.8 m). There is a brownish siderite zone from 405.8 to 407.9 ft (123.7 to 124.3 m) with numerous siderite concretions; this interval is a bioturbated glauconitic clay that has been diagenetically altered. From 409.3 to 411 ft (124.8 to 125.3 m), the section consists of a brownish heavily bioturbated glauconitic clay. More typical Merchantville lithology deposited in middle neritic environments (Fig. AF5) occurs from 411 to 416 ft (125.3 to 126.8 m) with a glauconite clay to clayey glauconite sand; the section from 411 to 412.7 ft (125.3 to 125.8 m) is heavily bioturbated, whereas the section from 412.7 to 416 ft (125.8 to 126.8 m) is laminated with less obvious burrows. Obvious gypsum crystals occur at 411.9–412.2 and 413.5–413.9 ft (125.5–125.6 and 126.0–126.2 m), suggesting primary carbonate. We tentatively place the MFS at this level and the lower HST from 398.2 to 411.9 ft (121.4 to 125.6 m). Glauconite increases from 415 to 416 ft (126.5 to 126.8 m), with burrows filled by glauconite sand. There is a coring gap from 416.1 to 420 ft (126.8 to 128.0 m). We tentatively place the sequence boundary between the MeII and MeI sequences in the coring gap and the TST from 411.9 to 420 ft (125.6 to 128.0 m). Nannofossil biostratigraphy places the MeII sequence (389.5–416 ft; 118.7–126.8 m) in uppermost Santonian Zones CC17 to CC16; it was deposited primarily in middle neritic environments (Fig. AF5), though the sands of the upper HST were deposited in offshore to LSF, probably inner neritic environments (i.e., shallower than the glauconite sands and clays).

From 420 to 424 ft (128.0 to 129.2 m), the section consists of slightly micaceous burrowed glauconite sandy clay to clayey glauconite sand. The section from 424 to 425.6 ft (129.2 to 129.7 m) (Fig. AF5) is brown clay and glauconite clay burrowed together with a lower percentage of glauconite. There is a siderite concretion from 424.8 to 424.9 ft (129.48 to 129.51 m). Common to dominant glauconite returns in a clayey glauconite sand from 424.0 to 429.1 ft (129.2 to 130.8 m). Mica is obvious above ~430 ft (131.1 m) and occurs in trace abundance from 430 to 431.1 ft (131.1 to 131.4 m). We place the maximum flooding surface at 425.4 ft (129.7 m), near the top of this interval, where glauconite dominates. A cemented siderite zone occurs at 429.1–429.6 ft (130.8–130.9 m). The lithology from 429.6 to 431.1 ft (130.9 to 131.4 m) is similar to above, though it is slightly brownish, reflecting some post-depositional siderite diagenesis. Glauconite clay and sand continue to 434.5 ft (132.4 m) (Fig. AF5). We tentatively place the top of the Cheesequake Formation and possible sequence boundary at this level. The Merchantville I sequence (420–434.5 ft; 128.0–132.4 m) was deposited in middle neritic environments (Fig. AF5) and assigned to Zone CC16 (Santonian).

?Cheesequake Formation

Age: ?Santonian
Interval: 434.5–439.4 ft (114.9–133.9 m)

From 434.5 to 439.4 ft (114.9 to 133.9 m), the section consists of a slightly glauconitic micaceous clayey silt that grades to a gray clay with very little glauconite beginning at 434.5 ft (132.4 m); these fine-grained beds lacking glauconite may be equivalent to the Cheesequake Formation or the base of the Merchantville Formation (Figs. F4, AF5). If this section is the base of Merchantville, then the lithologic contact at 434.5

ft (114.9 m) might be a MFS within the MeI sequence. The clay coarsens downsection to a sandy clayey silt at 436 ft (132.9 m). The base of the unit (436–439.4 ft; 132.9–133.9) is clayey silt with gypsum crystals on the outside of the core. Thus, this thin unit (sequence) fines upsection from silts to clays. The depositional environment was offshore “dirty shelf” but shallower than glauconite sands (i.e., inner neritic). No primary age data are available, though it is bracketed by Zone CC16 (upper Santonian) above and pollen Zone V (?Turonian–Coniacian) below.

Magothy Formation

Age: ?upper Turonian–Coniacian
Interval: 439.4–573.1 ft (133.9–174.7 m)

An abrupt contact at 439.4 ft (133.9 m) (Fig. **AF6**) separates the Cheesequake (or Merchantville; see discussion above) and Magothy Formations. Above the contact (beginning at 438.9 ft; 133.8 m) scattered granules and pebbles up to 1 cm in length are found in a muddy matrix. Below the contact (439.4–443.1 ft; 133.9–135.1 m), clayey silt is intensely weathered to kaolinite with common to abundant microsphaerosiderite; from 439.4 to 439.5 ft (133.9 to 134.0 m), abundant coarse sand and granules are mixed into the silty clay. The section from 439.4 to 440.1 ft (133.9 to 134.1 m) is light gray clayey silt with abundant microsphaerosiderite and some larger hematitic concretions. From 440.1 to 442.7 ft (134.1 to 134.9 m) the microsphaerosiderite is larger (>1–2 mm diameter) and more weathered to hematite. The section from 442.7 to 443.1 ft (134.9 to 135.1 m) is the same weathered lithology without the microsphaerosiderite. Thus, the Magothy Formation represents a major subaerial unconformity with extensive subtropical weathering. From 443.1 to 443.6 ft (135.1 to 135.2 m) the light gray clays transition down to dark gray silts. From 443.6 to 445.2 ft (135.2 to 135.7 m) is an interval of clayey dark gray silt and silty clay with interlaminated very fine sand. These are paleosols deposited in a floodplain environment.

The lithology changes across a sharp contact at 445.2 ft (135.7 m; Fig. **F5**) from overlying clay into dark gray, fine-to-medium sand with numerous very coarse sand and granule-sized quartz grains. The sand from 445.2 to 470 ft (135.7 to 143.3 m) contains lignitic-rich layers and varies from medium quartz sand to medium-to-coarse sand with very coarse sand to granules comprising up to 25% of the sand fraction. From 469.0 to 470.0 ft (143.0 to 143.3 m) the sand is slightly muddier than the sand above 469.0 ft (134.0 m). The sand, possibly representing tidal channels (Fig. **AF6**) (Zeff, 1988), continues to 470 ft (143.3 m). From 470 to 470.3 ft (143.26 to 143.35 m) is dark brown-gray clay. The change from sand to clay is sharp, but there is no evidence for an erosional contact.

At a contact at 470.3 ft (143.4 m), dark clay above passes into light gray clayey sandy silt that continues to 485.7 ft (148.0 m). This contact could be a sequence boundary representing an exposure surface with a shift to more heavily weathered clay below 470.3 ft (143.3 m). This possible sequence from 439.4 to 470.3 ft (133.93 to 143.4 m) may be equivalent to the Magothy IVB of Kulpecz et al. (2008) and the Cliffwood Beach Beds, though definitive pollen data are lacking (i.e., this sequence is associated with pollen Zone VII elsewhere, which is Coniacian to Santonian) (Fig. **F5**).

The muddy interval from 470.3 to 485.7 ft (143.3 to 148.0 m) represents one unit that becomes increasingly altered by soil-forming processes upsection and can be divided into four parts.

1. The upper part (470.3–477.6 ft; 143.4–145.6) is generally light gray, silty, sandy clay with vague mottling.
2. From 477.6 to 477.8 ft (145.6 to 145.8 m) is a muddy sand zone with hematitic concretions.
3. From 477.8 to 479.9 ft (145.8 to 146.3 m) is light gray, slightly sandy, silty clay with scattered microsphaerosiderite with hematite rinds. Microsphaerosiderite becomes smaller and less evident downsection.
4. From 479.9 to 484.6 ft (146.3 to 147.7 m) is interlaminated, light gray clay, silt, and muddy, very fine sand.

The laminations are interpreted to represent lenticular bedding deposited in a tidal-delta environment. This interval was later overprinted by soil processes in an overbank setting. The section from 484.6 to 485.7 ft (147.7 to 148.0 m) is similar to the lithology above (479.9–484.6 ft; 146.3–147.7 m) but is darker and sandier. It probably represents a similar environment but is not as gleyed as the material above.

A contact at 485.7 ft (148.0 m) separates the interlaminated clay and sand above from a thick sand below. The contact is a gradual transition with the two lithologies mixed and interlaminated together. It is associated with a major gamma log peak. The unit from 439.4 to 485.7 ft (133.9 to 148.0 m) is interpreted as a sequence and tentatively correlated to the Magothy IVA sequence of Kulpecz et al. (2008), equivalent to the Morgan Beds. It is assigned to pollen Zone V (Turonian to Coniacian; see **"Pollen"**), which is inconsistent with its assignment to Zone VII at Sea Girt (Coniacian to Santonian; Kulpecz et al., 2008).

The sand from 485.7 to 513.25 ft (148.0 to 156.4 m) represents two fining-upward cycles that we infer to represent channels separated by a break at 502.15 ft (153.1 m). The upper channel contains fine sand on top (485.7–494 ft; 148.0–150.6 m) with some preserved laminae consisting mainly of plant debris (e.g., 488 ft; 148.7 m). It transitions downsection to medium sand at 494 ft (150.6 m) and to coarse sand at 501–501.7 ft (152.7–152.9 m). It becomes gravel with clasts as large as 15 mm from 501.7 ft (152.6 m) to the contact at 501.8 ft (152.9 m). There are zones with bedded plant debris or lignite at 492.6, 493.0, 493.7, 494.2, and 494.8 ft (150.1, 150.3, 150.5, 150.6, and 150.8 m). Charcoal woody debris is concentrated at 501–501.1 ft (152.7–152.74 m) and scattered pieces of charcoal at 501.1–501.7 ft (152.7–152.9 m). From 501.8 to 502.15 ft (152.9 to 153.1 m) is a bed of gravelly, sandy clay with fragments of woody material. This channel looks nonmarine, and possibly is a distributary channel (Fig. **AF7**).

The lower channel extends from 502.15 to 513.25 ft (153.1 to 156.4 m). Coarse sand (502.15–512.7 ft; 153.1–156.3 m) at the top has zones containing granules and scattered gravel. There is a transition at 512.7 ft (156.3 m) to a granule-rich, somewhat gravelly, slightly clayey sand. There are clay blebs at ~503.7–503.8 ft (153.5–153.6 m) and at 502.8 ft (153.3 m) that are likely burrows. The overall fining-upward lithology in a thick structureless sand with burrows suggests a tidal channel (Fig. **AF7**) over which a distributary prograded.

Below a coring gap (513.25–520 ft; 156.4–158.5 m) a clay extends from 520 to 523.35 ft (158.5 to 159.5 m). The interval from 520.0 to 521.0 ft (158.5 to 158.8 m) is medium gray clay with some small thin wisps of very fine sand in laminae. Below an irregular contact at 521.0 ft (158.8 m) the lithology changes to darker, faintly laminated, more organic rich clay that changes color downhole from grayish to brownish gray (521.0–523.35 ft; 158.8–159.5 m). This darker, more organic rich (from plant debris) clay contains dinoflagellates and represents a bay environment.

A contact at 523.35 ft (159.5 m) (Fig. AF7) with 0.05 ft (1.5 cm) of relief on it separates clay above from burrowed micaceous marine–looking sands below. We interpret this as a sequence boundary. We tentatively correlate the sequence from 485.7 to 523.35 ft (148.0 to 159.5 m) with the Magothy III sequence (Kulpecz et al., 2008), though this sequence and its contained facies at Medford are more marine than at other New Jersey sites. It may be the sequence equivalent to the Amboy Stoneware Clay of the Magothy III, though the facies are sandier at Medford. The unit is assigned to pollen Zone V (Turonian–Coniacian).

The lithology from 523.35 to 525.2 ft (159.5 to 160.1 m) is sandy, very micaceous mud and muddy sand with sporadic lignite and cleaner sand in small (~1 mm diameter) burrows and a weakly cemented zone (probably hematite cement) from 523.5 to 523.6 ft (159.56 to 159.59 m). The interval from 525.2 to 530.05 ft (160.1 to 161.6 m) is lignitic, sandy clay with a few 1–3 cm thick laminations of muddy sand. The sandy clay has a somewhat irregular, mottled appearance probably due to burrowing. Red sandy micaceous hematite concretions are found at 525.6–525.8 ft (160.2–160.3 m), 527.8–528 ft (160.87–160.93 m), and 528.5–528.7 ft (161.09–161.15 m), and a thin concretion at 529–530.05 ft (161.2–161.6 m) separates the sandy clay above from sand below. This interval was probably deposited in a delta front environment and is tentatively correlated to the Old Bridge Sand/Magothy II sequence. A tentative assignment to pollen Zone IV is not entirely consistent with this correlation, as it has been assigned to pollen Zone V elsewhere (Kulpecz, 2008).

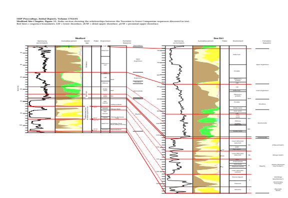
A thick fine–medium sand from 530.05 to 562.7 ft (161.6 to 171.5 m) is also correlated with the Old Bridge Sand Member and the Magothy II sequence (Kulpecz et al., 2008). This interval is interpreted as marine-influenced upper delta front environments (Fig. AF7). The top of the sand (530.05–542.2 ft; 161.6–165.3 m) is a micaceous medium-grained quartz sand that is muddy at the top (530.05–530.5 ft; 161.6–161.7 m), changing downhole into cleaner sand below. There are a few thin muddy laminae and common laminae with concentrations of plant debris in the muddy interval. Some of the laminations are inclined, suggesting cross-bedding. From 542.2 to 543.35 ft (165.3 to 165.6 m), there is a shift to micaceous very clayey fine sand with faintly preserved laminations and finely disseminated plant debris. The section from 543.35 to 548.3 ft (165.6 to 167.1 m) is micaceous medium sand with a few laminae with concentrations of plant debris and a few muddy laminae. From 547.5 to 547.7 ft (166.88 to 166.94 m) there is some rust-colored banding in the sand.

Micaceous very clayey fine sand with some faint lamination is found from 548.3 to 549 ft (167.1 to 167.3 m). The upper 548.3–548.4 ft (167.1–167.2 m) appears to be weathered under the contact with a slightly reddish brownish color and with slightly coarser sand mixed in. A reddish, micaceous hematite-cemented fine-grained sandstone extends from 549 to 549.5 ft (167.3 to 167.5 m). The interval from 549.5 to 555.2 ft (167.5 to 169.2 m) consists of sandy sediment that exhibits soft-sediment deformation. A thin (1.5 cm) dark clay laminae occurs at 549.5 ft (167.5 m) and is underlain by a contorted bed of light gray very micaceous very fine sandy silt (549.6–550.75 ft; 167.5–167.9) subvertically juxtaposed against dark gray clayey, very micaceous very fine to fine sand. From 550.75 to 551.6 ft (167.9 to 168.1 m) is very micaceous, very silty, slightly clayey, light gray sand that oxidizes to reddish hematite on the outside of the core. A contorted mixture of dark and light gray very clayey sand is observed from 551.7 to 552.55 ft (168.2 to 168.4 m), underlain by dark gray, very muddy (clay and silt), very micaceous fine sand from 552.55 to 553.8 ft (168.4 to 168.8 m). At 553.8–554.45 ft (168.8–169.0 m), a mottled light gray clayey silty, very micaceous very fine to fine sand grades to a silty very micaceous light gray sand with small clay blebs (~3–4 cm), possible clay lined burrows, and laminae of dark gray very fine sandy clay to 555.2 ft (169.2 m). From 555.2 to 558.95 ft (169.2 to 170.4 m) (Fig. AF8) the interval consists of intercalated beds of slightly clayey silty, very micaceous light gray fine sand and laminae of sandy, micaceous dark gray clay with streaking of plant debris concentrated on laminations and several small clay blebs that may represent burrows. This thick sand section is correlated with the Old Bridge Sand.

The section from 560 to 562.6 ft (170.7 to 171.5 m) consists of a bioturbated very sandy silty micaceous dark gray clay and very clayey sand with preserved laminations. Several laminae are hematite enriched and orange in color, and a hematite concretion is found at 560.8 ft (170.9 m). This interval is correlated to the South Amboy Fire Clay, consistent with its assignment to Zone V or possibly Zones III–IV (Cenomanian). Assignment to Zones III–IV is inconsistent with this correlation (Fig. F5; see "Pollen"). A contact at 562.7 ft (171.5 m) is tentatively interpreted as a sequence boundary separating the Magothy II sequence above from the Magothy I below (Fig. F5).

The interval from 562.6 to 572 ft (171.5 to 174.3 m) consists of moderately well sorted, subangular to subrounded, medium-grained quartz sand that is muddy in places (563.8–564.0 and 570.0–570.2 ft; 171.8–171.9 and 173.7–173.8 m). Predominantly clean quartz sand extends from 570.2 to 572.9 ft (173.8 to 174.6 m) except for a lignite bed 571.1–571.25 ft (174.07–174.12 m), a small (3 cm) hematite concretion at 571.8 ft (174.3 m), and increasing percentage of mud downsection from 572.6 to 572.9 ft (174.5 to 174.6 m). From 572.7 to 572.9 ft (174.56 to 174.62 m) is lignitic medium sand, and 572.9–573.1 ft (174.6–174.7 m) is micaceous clayey fine sand. The interval from 562.7 to 573.1 ft (171.5 to 174.7 m) is correlated with the Magothy I sequence and the Sayreville Sand and is tentatively interpreted as estuarine environments. Whereas correlations suggested by the pollen zonation are somewhat uncertain, it appears that the Magothy Formation at Medford can be broken into five distinct sequences as at Sea Girt (Miller et al., 2006; Kulpecz et al., 2008). Further pollen studies are warranted to test the correlations to Sea Girt (Fig. F11).

F11. Strike section, p. 56.



Raritan Formation

Age: Cenomanian–Turonian
Interval: 573.1–623.8 ft (174.7–190.1 m)

A contact at 573.1 ft (174.7 m) (Fig. AF8) between medium with some coarse sand above and dark grayish brown clay with scattered sand-filled burrows below marks the contact between the Magothy and Raritan Formations. Below the contact, the section from 573.1 to 573.8 ft (174.7 to 174.9 m) is interlaminated clayey sand and sandy clay; some of this section appears to be burrowed with a few organic-rich laminae. The color in this interval is slightly lighter than the clays below and may represent soil alteration of the clays underneath. The interval from 573.8 to 578.5 ft (174.9 to 176.3 m) is mostly gray to slightly reddish brown clayey sand with some laminae of sandy clay. It is burrowed with faint lamination preserved and grades downward to become more clayey. Also present are scattered bits of charcoal fragments, along with siderite concretions at 576.9 and 578.1 ft (175.8 and 176.2 m). Light brown to predominantly gray laminated slightly sandy silty clay with common disseminated plant fragments/lignite occurs from 578.5 to 590.3 ft (176.3 to 179.9 m). There are hematite-cemented zones at 580.1–580.2 (176.81–176.84), 586.45–586.55 (178.75–178.78), and 587.2–587.3 ft (178.98–179.01 m) and a sandy lignitic zone at 586.85–586.95 ft (178.87–178.90 m). The interval from 590.3 to 592.8 ft (179.9 to 180.7 m) is similar to above but with regular laminae of very fine sand and concretions at 592.7 (180.65) and 592.8 ft (180.69 m). The environment of deposition was probably marsh to swamp (in outcrop the equivalent section was interpreted as mangrove swamp by Owens and Sohl [1969]). There is a coring gap from 592.8 to 600.0 ft (180.7 to 182.9 m). From 600 to 601 ft (182.9 to 183.2 m) is faintly laminated dark gray clay with red bands, along with charcoal. Laminated, micaceous, burrowed clayey fine–very fine sand fining downward to very fine sandy clay occurs from 601.0 to 604.3 ft (183.2 to 184.2 m); the upper part of this interval is heavily burrowed and is less burrowed as sand becomes less obvious. A hematite concretion occurs at 602.9 ft (183.8 m), and a sandy pyrite concretion occurs at 603.8 ft (184 m). A thin sand bed is registered above a coring gap at 604.3–604.6 ft; logs suggest that the sand occurs from 606 to 611 ft (184.7 to 186.2 m) and that there is a 2 ft (0.6 m) registry shift. A sequence boundary could be placed at the top of the sand, but much more likely the 5 ft (1.5 m) sand reflects a facies succession within a bay-fill, lower delta plain deposit (Fig. **F6**).

From 610 to 622.15 ft (185.9 to 189.6 m) (Fig. **AF9**) is sporadically laminated, dark gray clay with brownish red bands and disseminated plant debris. This interval also contains fine to very fine sand found in 1–2 mm diameter burrows. Hematite-cemented zones occur at 610.65, 617.2, 617.4–617.5, and 621.6–621.7 ft (186.1, 188.1, 188.18–188.2, and 189.3–189.5 m), a sandy lignite from 612.2 to 612.5 ft (186.6 to 186.7 m), a sulfur bloom at 621.6 ft (189.3 m), and gypsum crystals occur sporadically. The environment of deposition is interpreted as bay-fill deposits in the lower delta plain. Sand disappears at a contact at 622.15 ft (189.6 m) with sandy clay above and lignitic, fairly homogeneous dark gray clay below with gypsum crystals on the surface and charcoal chunks up to 1 cm (622.15–623.8 ft; 186.9–190.1 m). There is a faint irregular contact at 623.8 ft (190.1 m) with light gray (?kaolinitic) gleyed or weathered clay (623.8–624.9 ft; 190.1–190.5 m) below that is siltier than above with zones of very fine sand. This clay overlies a coring gap (624.9–627.0 ft; 190.5–191.1 m), below which there is a change to nonmarine, very lignitic clays. We tentatively place the Raritan/Potomac contact and a major sequence boundary at 623.8 ft (190.1 m) (Figs. **F6, AF9**) and interpret the gray clays as overbank deposits.

Potomac Formation

Age: Lower Cretaceous–lowermost Upper Cretaceous (?Barremian–?lower Cenomanian)
Interval: 623.8–1090 ft (190.1–332.2 m)

Potomac Formation Unit III

Interval: 623.8–786.8 ft (190.1–239.8 m)

Below the ?kaolinitic light gray clay at its top (that likely indicates subaerial subtropical weathering) (Fig. AF9), the Potomac Formation consists of interbedded, very lignitic and charcoal-rich micaceous very fine sandy clay interbedded with dark gray to medium gray clay with common charcoal, lignite, and plant debris (627.0–636.5 ft; 191.1–194 m). Bedding is faint, and there is scattered pyrite and sulfur. Some of the woody debris is >5 cm long. From 636.5 to 637.9 ft (194 to 194.4 m) is homogeneous, slightly mottled light gray clay and charcoal. From 637.9 to 639.8 ft (194.4 to 195 m) is medium dark gray clay with a few laminae of micaceous fine sand and scattered charcoal and plant debris. The environment of deposition is fluvial delta plain, probably overbank swamp/oxbow lake environments (Fig. AF10).

A sandy unit occurs from 639.8 to 651.8 ft (195 to 198.7 m). The sand consists of slightly micaceous fine quartz that coarsens slightly downsection to medium sand with thin clay from 646.2 to 646.6 ft (197 to 197.1 m). The sand has clay blebs 0.25–0.5 cm in width (e.g., 642.4–642.6, 643.7–644.0 ft) that gives it aspects of bioturbation, but it is likely that these are mud rip-up clasts. Fine to medium sand coarsens downsection from 646.6 ft (197.1 m), becoming coarse sand at 651 ft (198.4 m) that continues to the base of a channel at 651.8 ft (198.7 m). The sections from 647.2 to 647.7 ft (197.3 to 197.4 m) and 650.5 to 650.6 ft (198.27 to 198.3 m) are lignitic, which reveal cross-bedding in the upper section. The environment of deposition is fluvial channel (Fig. AF10).

The section from 651.8 to 662.3 (198.7 to 201.9 m) is primarily clay, albeit poorly recovered. Kaolinized clay with an orange medium sand laminae and charcoal chunks (651.8–652.1 ft; 198.7–198.8 m) marks the top of a weathered zone at the base of the channel. Interbedded, lignitic/charcoal-rich muddy sand, clay, and clean fine sand with scattered small (5 mm–2 cm) hematite concretions are found below the kaolinitic clay. Clays vary from dark to light gray. There is a sandstone concretion from 653.0 to 653.3 ft (199 to 199.1 m). The environment is interpreted as fluvial overbank including paleosols.

“Birch log” sands occur from 662.3 to 677.0 ft (201.9 to 206.3 m). They are micaceous very fine to medium-grained quartz sands that display several distinct fining successions (e.g., 662.3–670, 670–672, 672–674, 674.0–677.0 ft; 201.9–204.2, 204.2–204.8, 204.8–205.4, 205.4–206.3 m). There is a clay bed at 675.4–675.5 ft (205.86–205.89 m). The sands have distinct cross beds and have scattered lignite and mica. The section from 664.2 to 664.8 ft (202.4 to 202.6 m) has inclined clay laminae. The environment of deposition is fluvial channel (Fig. AF10).

The section from 677.0 to 678.8 ft (206.3 to 206.9 m) consists of laminated very fine sandy clay, with the sand in laminae and possibly burrows. Lignite occurs from 678.2 to 678.8 ft (206.7 to 206.9 m). The environment of deposition is probably a swamp or marsh (Fig. AF10).

There are significant contacts at 678.8 (206.9) and 681.2 ft (207.6 m). Between these contacts is a reworked zone (678.8–681.2 ft; 206.9–207.6 m) that transitions downward from a sandy clay–clast conglomerate to a coarse-grained sand. The conglomerate has mostly light gray silty clay clasts and a few red clay clasts in a matrix of red muddy sand. There is a possible break in the bedding at 680.9–680.95 ft (207.5–207.6 m) where a thin laminae of gray clay occurs immediately under a cemented zone.

The reworked zone between these contacts is possibly colluvium; the surface at 681.2 ft (207.6 m) may represent a sequence boundary (Fig. F6).

Below the contact (681.2–706.5 ft; 207.6–215.3 m) is light gray silty clay to very clayey silt. Extensive mottling reflecting soil processes (Fig. AF11) is found from 681.2 to 696 ft (207.6 to 212.1 m) and 700 to 705 ft (213.4 to 214.9 m), with numerous subvertical reddish mottles (several centimeters in diameter) and lesser olive-brown mottles and banding that may be root traces. Microsphaerosiderite is common with high concentrations from 688.7 to 689.8 ft (209.9 to 210.3 m) and 702.3 to 703.5 ft (214.1 to 214.4 m). This mottled very silty clay was deposited as alluvial plain paleosols (Fig. AF11). At the base (705–706.5 ft; 214.9–215.3 m), the section becomes slightly darker downhole with suggestions of laminations increasingly preserved downcore.

Dark gray clay with common very thin laminae of fine to very fine sand (706.5–709.65 ft; 215.3–216.3 m) represents strikingly different facies. The clay contains lignite and sulfur, and its bedding is subtly contorted and wavy. Some sand-filled structures from 706.5 to 707 ft (215.3 to 215.5 m) may represent either burrows or root fillings. These sediments represent a beautiful example of an oxbow lake environment (Fig. AF11).

The interval from 709.7 to 731.9 ft (216.3 to 223.1 m) consists of plant-rich sand with common clay beds. From 709.7 to 711.6 ft (216.3 to 216.9 m) is interbedded fine-grained sand with common plant-rich laminations and dark gray clay with thin very fine sand laminae. From 710.1 to 710.2 ft (216.4 to 216.4 m) is a pyrite-cemented sand concretion. From 711.6 to 721.7 ft (216.9 to 220 m) is a sand bed that coarsens downsection from fine-to-medium to very coarse sand; there are scattered cross laminae from 712 to 714 ft (217 to 217.6 m) (Fig. AF12) and 720 to 720.2 ft (219.46 to 219.5 m) of plant debris. An erosional surface interpreted as the base of a channel occurs at 721.7 ft (220 m). A slightly micaceous, cross-bedded medium sand subtly coarsens downsection from 721.7 to 724 ft (220 to 220.7 m) with a few organic-rich laminae. There is a coring gap from 724 to 730 ft (220.7 to 222.5 m). The sands above the gap are fluvial channel sands with possible point bar deposits near the base (e.g., 711.6–721.7 ft; 216.9–220 m). Medium gray clay is found immediately below the coring gap (730.0–730.2 ft; 222.5–222.6 m). Below this clay is a zone of reworked paleosols from 730.2 to 731.9 ft (222.6 to 223.1 m) that includes clay clasts pressed together in thin clay beds, woody debris, concentrations of hematized microsphaerosiderite and red paleosol mud clasts, and sand. From 731.75 to 731.85 ft (223 to 223.1 m) is a bed of clay rip-up clasts interpreted as colluvium.

Paleosols return from 731.85 to 750.85 ft (223.1 to 228.9 m) (Figs. F7, AF12), consisting of clayey slightly sandy silt with zones of clay or sand. The upper 0.15 ft (0.05 m) is paleosol clay with clay clasts of light gray, medium gray, and reddish clay and is also interpreted as colluvium. Below this is light gray silt with medium gray mottles (732.0–733.0 ft; 223.1–223.4 m), silt with increasing amounts of fine–very fine sand downsection (733.0–733.6 ft; 223.4–223.6 m), a coring gap (733.6–740.0 ft; 223.6–225.6 m), and a thin bed of slightly muddy sand and hematized microsphaerosiderite (740.0–740.1 ft; 225.6 m). The section from 740.1 to 750.0 ft (225.6 to 228.6 m) consists of mottled silt that alternates from predominately light gray to red, with mottles suggestive of root traces (Fig. AF12). The bottom of this interval (750.0–750.85 ft;

228.6–228.9 m) is slightly muddy fine sand. These environments are interpreted as well-drained alluvial plain overbank.

There is a weathering contact at 750.85 ft (228.9 m), with a transition from weathered clay to increasingly dark gray clay below to 753.9 ft (229.8 m). The clay is organic rich, contains common laminae of very fine sand and zones with minor burrows/roots, and was deposited in oxbow lake environments (Fig. AF12). From 753.9 to 760.9 ft (229.8 to 231.9 m) are interbedded gray, organic-rich fine sand and clay beds with 0.2–0.4 ft (0.06–0.12 m) thickness deposited in cut-off channel/overbank sands.

From 760.9 to 786.8 ft (231.9 to 239.8 m) is an interval characterized by fining-upward sand successions with common cross-bedding and scattered plant debris–rich laminae. The uppermost succession (760.9–764.5 ft; 231.9–233 m) coarsens downward from fine-grained to poorly sorted medium- and coarse-grained sand. The next fining-upward sand succession from 764.5 to 772 ft (233 to 235.3 m) coarsens downward from a thin sandy clay to orange fine sand to coarse sand to a sandy conglomerate of light gray clay clasts that are mostly 0.5–2 cm in diameter. The contact below is not clear. From 772 to 786.8 ft (235.3 to 239.8 m) is micaceous medium cross-bedded sand with abundant lignitic laminae coarsening downward to cross-bedded medium to coarse sand. There are a few scattered clasts of white gray clay at 780–786.8 ft (237.7–239.8 m). The likely environment of deposition is a fluvial channel (Fig. AF13). We place a sequence boundary at 786.8 ft (239.8 m), separating the fluvial channels above from paleosols below (Fig. F7). This follows Benson (2006) and Sugarman et al. (2004, 2006) in placing the base of Potomac Unit III consistently below a relatively thick sand. Pollen assigns the section from 623.8 to 790 ft (190.1 to 240.8 m) to Zone III (lower Cenomanian) and possibly Zone IIC (upper Albian) at the base (see "Pollen"), consistent with the assignment to the Potomac Unit III sequence (Fig. F7).

Potomac Formation Unit II

Interval: 786.8–983.15 ft (239.8–299.7 m)

Below a coring gap (786.8–790 ft; 239.8–240.8 m), there is a change to stiff clayey silts alternating between red extensively mottled silt and light gray less mottled silt representing paleosols from 790 to 797.7 ft (240.8 to 243.1 m) (Figs. F8, AF14). Microsphaerosiderite is abundant through most of this interval. It appears to include root traces and soil cracks (cutains). There is coring gap from 797.7 to 800 ft (243.1 to 243.8 m). Below the coring gap from 800 to 803.9 ft (243.8 to 245 m) is an interesting heterolithic mix of dark to medium gray sandy clayey silt with abundant mud clasts ranging from 1 mm to 2 cm in diameter. They include dark gray clay, light gray clay, and a few reddish brown clay clasts, and rare pyrite. The mix also includes abundant charcoal that is more common upcore. The environment of this muddy bed is not clear but could possibly represent a debris flow in an alluvial plain environment (Fig. AF14).

A sharp contact at 803.95 ft (245 m) separates the clay above from an interval of mud and sand (803.9–814.4 ft; 245–248.2 m). The contact is a mixture of a large bleb of light gray silty clay that is mixed irregularly with the matrix of the dark gray material above. The interval changes from light gray, hard silty clay and clayey silt that has a number of cracks with scattered microsphaerosiderite that begins to pick up thin laminae of sand at 810 ft (246.9 m). It becomes increasingly sandy downcore with sand predominating at the base from 812.7 to 814.4 ft (247.7 to 248.2 m). There is a high abundance of plant debris from 813.9 to 814.4 ft (248.1 to 248.2 m), including a thin charcoal bed at 814.3 ft (248.2 m). From 814.4 to 816.0 ft (248.2 to 248.7 m) is organic-rich (plant debris and charcoal) laminated dark gray clay with thin laminae of slightly micaceous fine to very fine sand. Laminae are slightly irregular in places. The upper part down to 814.7 ft (248.3 m) is slightly sandier with more carbonaceous material mixed in. This unit was deposited in levee and overbank environments with basal levee sands overlain by overbank clays that are overprinted by soil processes (Fig. **AF15**).

There is a thick sandy interval from 816 to 844.7 ft (248.7 to 257.5 m) with mud increasing toward the base. Coarse and medium sand is found from 816 to 822 ft (248.7 to 250.6 m) with lignite-rich sand between 822 (250.5 m) and 823 ft (250.9 m). A 0.2 ft thick bed of clay occurs at 823.4 ft (251 m) that is underlain by a 0.1 ft thick bed of charcoal fragments at 823.6 ft (251 m). From 823.7 to 824 ft (251.1 to 251.2 m) is coarse sand with a charcoal bed at its base. Below a coring gap from 824 to 830 ft (251.2 to 253 m), sand (830–834 ft; 253–254.2 m) ranges from coarse to fine with clear cross-bedding in places and with several thin beds of clay and muddy sand and lignite. There is also a pyrite-cemented sand concretion (3 cm diameter) at 832.8 ft (253.8 m). From 834 to 841.4 ft (254.2 to 256.5 m), the section is sandy clay with some sand beds and laminae. In the lower part (840.7–841.4 ft; 256.2–256.5 m), it appears to be composed of clay rip-up clasts (0.1–1 cm diameter) in a sandy mud matrix. From 841.4 to 843.7 ft (256.5 to 257.2 m), the section exhibits a downward coarsening transition from poorly sorted medium to coarse sand to a sandy clay clast conglomerate with abundant chunks of hematite that are probably the remnants or microsphaerosiderite. From 843.7 to 844.3 ft (257.2 to 257.3 m) is mostly medium sand. The bottom of the unit (844.3–844.7 ft; 257.3–257.5 m) is sandy medium to dark gray clay with large chunks of lignite and charcoal. These sands represent deposition in and around fluvial channels. Some might be in a channel, and others might represent levee deposits.

We place a possible sequence boundary at 844.7 ft (257.5 m) in association with a downhole change to high gamma log values in a clayey silt and silty clay (Fig. **F8**). The lower Potomac II sequence (844.7–983.15 ft; 257.5–299.7 m) is 138.45 ft (42.2 m) thick and similar to the upper sequence, fining upward from fluvial channels at the base to overbank deposits on top.

Below a coring gap from 844.7 to 848.6 ft (257.5 to 259.1 m), clayey silt and silty clay returns from 848.6 to 860.75 ft (258.7 to 262.4 m). The top of the interval is light gray that exhibits progressively redder mottling below 851.1 ft (259.4 ft). Much of the mottling is vertical to subvertical and several centimeters in diameter, suggestive of root traces (Fig. **AF16**). Microsphaerosiderite is common throughout. From 859 to 860.75 ft (261.8 to 262.4 m) the core is banded red, pink, light gray, and greenish brown with a few mottles and includes common small hematite concretions from 859 to 859.9 ft (261.8 to 262.1 m). Medium gray clayey sandy silt returns from 860.75 to 861 ft (262.4 to 262.4 m), below which is a coring gap to 869.3 ft (265 m). This is a gleyed soil versus the oxidized soils above. This section is interpreted as overbank deposits.

The section from 869.3 to 871.4 ft (265 to 265.6 m) is predominantly dark-to-light gray to black sandy mud with some muddy sand. The sandy mud is dark gray with faint lamination and common plant debris. The muddy sand is light–medium gray, predominantly medium grained, with common to abundant plant debris. The intervals from 869.8 to 869.9 ft (265.1 to 265.2 m) and 870.8 to 870.9 ft (265.4 to 265.5 m) are ligntic.

Poorly recovered intervals from 871.4 to 871.7 ft (265.6 to 265.7 m) and 879.3 to 881.55 ft (268 to 268.7 m) across a coring gap (871.7–879.3 ft; 265.7–268 m) consist of a gray sand that fines upward from medium coarse to medium fine and contains rare plant debris laminations and clay clasts; this is a fining-upward fluvial channel to overbank deposit.

The contact at the base of the sand at 881.55 ft (268.7 m) is sharp. From 881.55 to 882.5 ft (268.7 to 269 m) is a light to medium gray, vaguely laminated and mottled mix of sandy clay to clayey sand deposited as a paleosol in a gleyed overbank environment with mottles possibly reflecting rooting. From 882.5 to 894.15 ft (269 to 272.5 m including a 6.9 ft [2.1 m] core gap) is interbedded slightly silty sand, lignitic muddy sand, clayey sand, sandy clays, and clay; the sands are primarily fine grained. Beds range from 0.1 to 0.5 ft (0.03 to 0.2 m) in thickness and the sands appear cross-laminated. This likely represents deposition in a wet overbank to levee environment. There is a coring gap from 894.15 to 900 ft (272.5 to 274.3 m).

A fluvial channel deposit (Fig. **AF16**) occurs from 900 to 906.55 ft (274.3 to 276.3 m) and consists of coarse sand that fines up to medium sand in the top 1 ft (0.3 m) and contains a few thin (2 cm) beds of lignite. The sand is immature and poorly sorted at the base. The interval from 903.5 to 903.8 ft (275.4 to 275.5 m) is kaolintic.

An overbank-levee-channel complex occurs from 906.55 to 920.6 ft (276.3 to 280.6 m). From 906.55 to 910.2 ft (276.3 to 277.4 m including a coring gap [907.55–910.0 ft; 276.6–277.4 m]) is laminated and has thin beds of clay, silty clay, clayey silt, and clayey sand, with colors in bands from darker gray (more organic material) to lighter gray (lightly gleyed). These sediments represent an overbank environment. A levee deposit from 910.2 to 914.7 ft (277.4 to 278.8 m) consists of laminated to thinly bedded silty to clayey medium to fine sand with interbedded silty and clayey laminae. It coarsens downward to medium sand in the lower part. A channel deposit from 914.7 to 920.6 ft (278.8 to 280.6 m) consists of a coarsening-downward succession from silty poorly sorted medium-coarse to coarse sand with black charcoal and small (up to 4 cm) clay rip-up clasts. From 920.6 to 921.8 ft (280.6 to 281 m) is a sand that changes downward from a very clayey and silty white light gray poorly sorted medium–coarse sand (920.6–920.9 ft; 280.6–280.7 m) to slightly silty medium sand. This probably is a paleosol formed on a thin levee deposit. A wet overbank deposit from 921.8 to 922.5 ft (281 to 281.2 m) consists of thinly interbedded light gray and dark gray clay, clayey sand, clayey silt, and lignitic sand. There is a coring gap from 922.5 to 930.0 ft (281.2 to 283.5 m).

A varying complex of oxbow lakes, overbank levee, and small channels occurs from 930.0 to 958.1 ft (283.5 to 292 m), marked at its base by a sharp gamma log decrease (Fig. **F9**) and shift in depositional environments to braided river deposits below this contact. From 930.0 to 930.7 (283.5 to 283.7 m) is very muddy, poorly sorted, very coarse grained to fine-grained sands; the heterolithic nature may be due to paleosol mixing processes. From 930.7 to 932.4 ft (283.7 to 284.2 m) is a gray, silty micaceous clay that becomes darker downward, suggesting some gleying in the top. The section from 932.4 to 933.7 ft (284.2 to 284.6 m) consists of two light gray sand beds (upper coarse, lower medium) separated by darker gray sandy silty clay. The sediments from 930.7 to 933.7 ft (283.7 to 284.6 m) were deposited in an overbank environment (Fig. **AF17**). There is an interesting zone of dark gray clay from 933.7 to 937.75 ft (284.6 to 285.8 m) that changes from vaguely laminated to 934.7 ft (284.9 m) to homogeneous, mottled-looking sandy clay with sand burrows to 937.5 ft (285.8 m) to laminated at the base. The environment is enigmatic but is interpreted as an oxbow lake deposit perhaps influenced by bioturbation or later rooting (Fig. **AF17**). There is a coring gap from 937.7 to 940.1 ft (285.8 to 286.5 m). From 940.1 to 941.7 ft (286.5 to 287.0 m) is well-sorted medium sand that has a light gray clayey matrix and faint laminations from 940.3 to 940.8 ft (286.6 to 286.8 m). Interlaminated dark gray clay and sandy clay returns from 941.7 to 945.7 ft (287 to 288.2 m), with cleaner sand-filled root/burrow traces; this again is likely an oxbow lake. Sand reappears from 945.7 to 949.7 ft (288.2 to 289.5 m), comprising three fining-upward successions (945.7–947.2, 947.2–948.0, and 948.0–949.7 ft; 288.2–288.7, 288.7–289, and 289–289.5 m) from medium–coarse at the bases to well-sorted, medium–fine sand at the tops deposited in a proximal levee environment. The section from 950.0 to 953.5 ft (289.6 to 290.6 m) consists of a succession of interbedded/interlaminated slightly micaeous silty sand, clayey sand, and sandy clay where laminations have been somewhat homogenized by soil processes; the sand is primarily medium grained with some coarse- and fine-grained quartz laminae and scattered charcoal concentrations. A clayey interval from 953.5 to 958.1 ft (290.6 to 292 m) changes from sandy light gray silty clay at the top to mottled, brownish red–light gray clay from 954.7 to 955.5 ft (291 to 291.8 m); to increasing laminated, increasing dark gray clay from 955.5 to 957.3 ft (291.2 to 291.8 m); to increasingly lighter gray laminated silty clay from 957.3 to 958.1 ft (291.8 to 292 m). This clayey interval represents changes in depositional oxbow lake environments (Fig. **AF17**) upsection from gleyed, to ungleyed, to gleyed, to oxidized, and back to gleyed.

"Zebra" (alternating black–white) sands (Fig. **AF17**) occur from 958.1 to 972.2 ft (292 to 296.3 m). The sands are very poorly sorted with silt beds from 0.1 to 0.6 ft (0.03 to 0.18 m) in thickness that range from fine to medium to very coarse sand. Very coarse beds occur at 971.6 (296.1), 968 ft (295 m), and 964.3 ft (293.9 m). There are dark cross-laminae of dark organic-rich silt. This sandy interval appears to be a fluvial channel bar deposit. Though resistivity shows high values typical of sands, the gamma logs show two unexplained peaks at 964 ft (293.8 m) and 970 ft (295.7 m) that may reflect the mineralogy (Fig. **F9**). Pyrite concretions occur at 967–968 ft (294.7–295 m). There is a coring gap from 972.2 to 980 ft (296.3 to 298.7 m).

The section from 980 to 983.15 ft (298.7 to 299.7 m) consists of interlaminated clay, silt, and silty fine sand that varies from darker to light gray; the section below 982.5 ft (299.5 m) is lighter gray and may represent some gleying. This represents an overbank distal levee deposit. There is a possible sequence boundary at 983.15 ft (299.7 m) separating the finer grained fluvial deposits above from much coarser braided river deposits below. The surface also separates pollen Zone IIB (Albian) from I/IIA (lower Albian) (pollen resolution is poor in this interval of the core). We are tentatively assigning the remaining section below 983.15 ft (299.7 m) to the base of the hole (TD) to Potomac Unit I (Fig. F9).

Potomac Formation Unit I

Interval: 983.15–1090 ft (299.7–332.2 m)

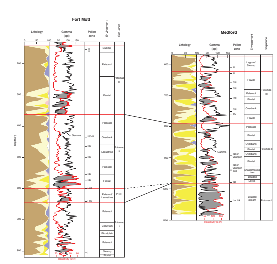
Sand is present from 983.15 ft (299.7 m) to the base of the hole (TD at 1090 ft; 332.2 m) except for two thin clay beds at 1039–1039.8 ft (316.7–316.9 m) and 1043.7–1043.9 ft (318.1–318.2 m). There appears to be distinct sand-size patterns within several of the channels contained in this sandy interval. Sand with dark laminae ("zebra facies") and rare quartzite pebbles from 983.15 to 1020 ft (299.7 to 310.9 m) is predominantly coarse grained with gravelly zones. There are a few thin clay beds (maximum thickness 1 ft) from 990.6 to 991.6 ft (301.9 to 302.2 m; light gray), 1009.3 to 1009.5 ft (307.6 to 307.7 m), and 1011.5 to 1011.7 ft (308.3 to 308.4 m). The matrix is silty to slightly clayey in many places. This predominantly sandy section was deposited in a braided river system (Fig. AF18).

The facies from 1020 to 1025 ft (310.9 to 312.4 m) consist of poorly sorted very coarse to coarse sand with whitish blebs that appear to be weathered feldspars and give a speckled appearance. The sand is poorly sorted from predominantly coarse to pebble size. Pebbles concentrated from 1023 to 1023.5 ft (311.8 to 311.96 m) are mostly quartzite. This speckled facies was deposited either as braided river deposits or possible colluvium (slope wash).

Interbedded coarse–medium sands with dark laminae (zebra facies) and gravelly sands return from 1025 to 1079.2 ft (312.4 to 328.9 m) and again represent braided river deposits (Fig. AF18). They contain gravelly zones from 1026 to 1026.3 ft (312.7 to 312.8 m), 1026.8 to 1027.1 ft (312.97 to 313.06 m), 1027.8 to 1028.0 ft (313.27 to 313.33 m), 1029 to 1029.4 ft (313.64 to 313.76 m), 1050.0 to 1051.6 ft (320 to 320.53 m; the latter including cobbles), 1055 to 1056 ft (321.56 to 321.87 m), and 1080 to 1082.9 ft (329.18 to 330.07 m). The intervals in between consist of medium–coarse sands with dark laminae and coring gaps. Muddy sand occurs in the gravels from 1081.1 to 1081.6 ft (329.5 to 329.7 m). True basement was not reached. These sands are assigned to Zone I (lowermost Albian to Aptian/Barremian) or possibly IIA (lower Albian; see "Pollen").

As a general comment, the Potomac Formation at Medford differs from that at Fort Mott by the greater dominance of sand, the lesser amount of red soils, and the greater diversity of fluvial environments (Fig. F12).

F12. Potomac Formation sequences, p. 57.



BIOSTRATIGRAPHY

Pollen

Sixteen samples from the Medford corehole were analyzed by G. Brenner for pollen, as well as spores (Table T3) ranging in age from Turonian to lower Cretaceous (Albian–Barremian). Thirty-four additional samples plus ten of Brenner's samples were later reanalyzed by P. McLaughlin to further refine Brenner's biozonation. Most of the samples yielded meager spore and pollen preservation, and many samples were essentially barren. Stratigraphically diagnostic forms were generally absent. Samples are assigned ages using the zonations of Brenner (1963) and Doyle and Robbins (1977).

The Cheesequake Formation contained only rare pollen that could not be zoned. Samples between 471 and 560 ft (142.7 and 169.7 m) (essentially all of the Magothy Formation) contain a poorly preserved flora assigned by Brenner to Zone V (Turonian to Coniacian). McLaughlin notes the presence of some older forms at 529, 560, and 561.8 ft (160.3, 169.7, and 170.2 m) that are found commonly in Zones IV and III; the latter sample is provisionally assigned to undifferentiated III–IV (Cenomanian). Samples at 522.4 and 562 ft (158.3 and 170.3 m) contain dinoflagellates, indicating marine conditions for the material assigned to the Amboy Stoneware Clay and the South Amboy Fire Clay.

The Raritan Formation and Potomac Formation Unit III are assigned to Zone III (Cenomanian). Samples at 581 and 585 ft (227.7 and 177.3 m) contain specimens of *Apiculatisporis babsae* and *Neoraistrickia robustus* normally confined to Zone II. This would make the Raritan Formation much older (middle Albian) than at other localities (middle Cenomanian to lower Turonian) and these specimens are assumed to be reworked by Brenner. McLaughlin notes numerous finely reticulate tricolpates and small tricolp/tricolporates with slightly thickened rims, possible *Tricolpites nemejcii* (the only marker present for Zone III or higher) and no triporates, normapolles, or other advanced angiosperms indicative of Zone IV; he thus assigns samples from 610, 628.5, and 660.7 ft (184.8, 190.5, and 200.2 m) to Zone III. However, Brenner, based on the presence of *R. multilex*, assigns the sample at 677.8 ft (205.4 m) to Zone IV. It is hard to reconcile these data. Zone IV is very unusual for the Potomac Formation, which is Zones I–III, and it is assumed that the identification of *Rugibivesiculites multilex* is incorrect because of poor preservation or contamination.

Poor preservation prevents the confident distinction between Zones IIC (upper Albian) from III (lower Cenomanian). Samples from 709.5 and 752.0 ft (215 and 227.9 m) are assigned to Zone III. A sample from 761.1 ft (230.6 m) could be assigned to either Zones IIC or III. The lack of definitive Zone III forms may indicate IIC is more likely. Samples from 933.8, 942.5, and 982.2 ft (283, 285.6, and 297.6 m) are assigned to Zone IIB. The sample from 893.4 ft (179.8 m) is Zone IIB (middle Albian) or younger. Other samples between 761.1 and 933.8 ft (230.6 and 283 m) were barren, and thus the Zone IIC/IIB boundary is difficult to place. Two samples from near the bottom of the hole contain common occurrences of species of Schizaeaceae spores more typical of Zone I lowermost Albian to Aptian/Barremian) than Zone IIA (lower Albian).

Planktonic Foraminifers

Cretaceous/Paleogene Boundary

Planktonic foraminifers were only analyzed to identify the location of the Cretaceous/Paleogene boundary (Table **T4**) that was identified between samples from 57.4 and 57.5 ft (17.5 and 17.53 m) and 61.4 and 61.5 ft (18.71 and 18.75 m). The zonal scheme used below is that of Berggren et al. (1995). The uppermost samples from 55.4 to 55.5 ft (16.89 to 16.92 m) and 56.1 to 56.2 ft (17.1 to 17.13 m) are assigned to Zone P3a based on the occurrence of *Acarinina strabocella*, *Globanomalina compressa*, and *Morozovella angulata*.

The interval from 57.4 to 57.5 ft (17.5 to 17.53 m) is assigned to Zone P1c and contains the following planktonic species diagnostic of this zone: *Subbotina triloculinoides*, *Parasubbotina pseudobulloides*, *G. compressa*, *Globoconusa daubjergensis*, *Praemurica inconstans*, *Praemurica pseudoinconstans*, and *Chiloguembelina midwayensis*.

The first Maastrichtian foraminifers are encountered at 61.4–61.5 ft (18.71–18.75 m), indicating that the K/P boundary occurs between this sample and the one above. Although the sample can be placed in the Maastrichtian, no zonal species occur, probably because of the shallow environment of deposition. Maastrichtian foraminifers include *Heterohelix globulosa*, *Guembelitria cretacea*, *Rugoglobigerina reicheli*, *Rugoglobigerina rugosa*, and *Globigerinelloides multispina*.

Calcareous Nannofossils

Cenozoic

The calcareous nannoplankton biozonal subdivision of the Cenozoic section of the corehole provided surprisingly good results considering how thin and shallow the Cenozoic section is at the Medford site (Table T5). The upper three samples down to 11 ft (3.4 m) were barren because of secondary silicification. However, except for the sample at 60.6 ft (18.5 m) that contained rare coccoliths, the remainder of the samples contained common to abundant, well to moderately preserved calcareous nannofossils. The zonal scheme used below is that of Martini (1971) and Martini and Müller (1986).

The sample from 33.0 ft (10.1 m) is assigned to Zone NN8 based in the occurrence of *Heliolithus riedelii* and *Discoaster mohleri*. The sample from 41 ft (12.5 m) is tentatively assigned to Zone NP7 because of the occurrence of *D. mohleri*. Zone NP7 is more definitively assigned to the sample at 48 ft (14.6 m) based on the co-occurrence of *Fasciculithus tympaniformis*, *Heliolithus kleinpelli*, and *D. mohleri*. The dominance of pentatiths of *Braarudosphaera* spp. and *Micrantholithis* spp. at 41 ft (12.5 m) may be related to shallowing that is supported by is position above the MFS of the Pa2b sequence.

There is a clear stratigraphic gap between the sample at 48 ft (14.6 m; Zone NP7) and the next lower sample at 55.5 ft (16.9 m) with a hiatus of ~3 m.y. This supports the placement of a sequence boundary at 50 ft (15.2 m) placed within an interval of no recovery. The samples from 55.5, 57.0, 57.25, 57.7, and 60.1 ft (16.9, 17.4, 17.45, 17.6, and 18.3 m) are all assigned to the lower part of Zone NN4 based on the co-occurrence of *Chiasmolithus danicus*, *Cruciplacolithus tenuis*, and *Ellipsolithus macellus*.

A sample at 60.6 ft (18.47 m) just above the K/P boundary (60.7 ft; 18.5 m) contained rare poorly preserved coccoliths with *Chiasmolithus danicus* and *Cruciplacolithus danicus*. It is assigned at a minimum to Zone NP3, although lower NP4 cannot be ruled out. This sample also contained reworked Cretaceous coccoliths from below the K/P boundary. The sample from 72 ft (18.5 m) contained abundant Cretaceous species with *Arkhangelskiella cymbiformis*, *Eiffeillithus turriseiffelii, Micula* spp., *Watznaueria barnesae*, and rare Danian species (assigned to Subzone NP1b), indicating mixing of younger species from above.

Cretaceous

We obtained 19 initial samples from the Medford corehole that were studied by Bukry for Cretaceous calcareous nannofossils (Table T6). Ten of these samples contain calcareous nannofossils and could be zoned;

the other nine samples were barren. An additional 43 samples (19 barren) focusing on the biostratigraphy of the Merchantville sequences were studied by Mizintseva (Table T6). Cretaceous calcareous nannofossils were locally abundant, although there were many barren samples. The nannofossil zonation and CC terminology of Sissingh (1977) were used to subdivide the section.

Samples from 61 and 76 ft (18.6 and 23.2 m) in the Navesink II sequence are assigned to Zone CC26, although there was abundant mixing of Paleocene forms in the 61 ft sample (18.6 m). A sample from 96 ft (29.3 m) in the Navesink I sequence is assigned to Zone CC25c or CC25b.

Three samples from the Marshalltown sequence are assigned to Zone CC21–CC22 (176 ft; 53.6 m) and Zone CC20 (206 and 21 ft; 62.8 and 67.4 m). Rare specimens in two samples (266 and 301 ft; 81.1 and 91.7 m) from the upper Englishtown Formation are assigned to Zone CC20 and Zone CC18–CC20.

The top of sequence MeIII (331 ft; 100.9 m; top of the lower Englishtown Formation) is assigned to Zone CC20. The middle of sequence MeIII (341–381 ft; 103.9–116.1 m; basal lower Englishtown, Woodbury, and upper Merchantville Formations) is assigned to Zone CC19. The base of sequence MeIII (386 ft; 117.7 m; Merchantville Formation) is assigned to Zone CC18. The top of Sequence MeII (390–404 ft; 118.9–123.1 m; Merchantville Formation) is assigned to Zone CC17. The bottom of sequence MeII (413 ft; 125.9 m; Merchantville Formation) is assigned to Zone CC16. Sequence MeI (423–425 ft; 1128.9–129.5 m; Merchantville Formation) is assigned to Zone CC16. All samples below the Merchantville Formation were barren for calcareous nannofossils.

STRONTIUM ISOTOPE CHRONOSTRATIGRAPHY

Sr isotopic age estimates were obtained from mollusk shells. Approximately 4–6 mg of shells was cleaned in an ultrasonic bath and HCl and dissolved in 1.5 N HCl. Sr was separated using standard ion exchange techniques (Hart and Brooks, 1974). The samples were analyzed on an Isoprobe T Multicollector thermal ionization mass spectrometer (TIM). Internal precision on the Isoprobe for the data set averaged 0.000007 and the external precision is approximately ±0.000008 (based on replicate analyses of standards). National Bureau of Standards (NBS) 987 is measured for these analysis at 0.710241 normalized to $^{86}Sr/^{88}Sr$ of 0.1194.

Cretaceous ages were assigned (Table T7) using linear regressions developed for upper Coniacian through Maastrichtian sections by Miller et al. (2004). Using a similar late Campanian–Maastrichtian regression, Sugarman et al. (1995) conservatively estimated age errors of ±1.9 m.y. at the 95% confidence interval for one Sr isotopic analysis; age errors for the coeval and older sections are purportedly one order of magnitude better according to Howarth and McArthur (1997). We estimate that the maximum Sr isotopic age resolution for this interval is ±0.5 to ±1.0 m.y. (i.e., the external precision of 0.000010 divided by the slopes of the regressions of ~0.000020/m.y.). For comparison, Table T7 also shows ages derived from the look-up tables of McArthur et al. (2001).

The youngest sediments recovered in the corehole (Eocene to Paleocene) are not suitable for strontium isotopic dating because strontium ratios change too slowly to allow time discrimination. Two samples from the Vincentown Formation were analyzed from these sections and had ages of 57.1 and 57.9 Ma (30 and 47 ft [9.1 and 14.2 m], respectively), confirming the Paleocene age of the sediments, but the ages are not plotted on Figure F2 because of low age resolution.

Strontium isotopic ages were obtained from three samples (at 61, 90, and 93 ft; 18.5, 27.3, and 28.2 m) in the Navesink Formation. Ages range from 66.0 to 67.7 Ma. This is in agreement with calcareous nannofossil biostratigraphy indicating a late Maastrichtian age, and previous age estimates from other localities in New Jersey using Sr isotopes and nannofossils (Sugarman et al., 1995). The sedimentation rate for the sequence is ~8.3 m/m.y.

Six Sr isotopic ages were obtained from the Marshalltown sequence. The youngest age of 72.2 Ma was at the top of the sequence at 101.0 ft (30.6 m) and the oldest age 0f 76.0 Ma was at the bottom of the sequence at 216.0 ft (65.5 m). The two ages yield an overall age for the sequence of 72.2–76.0 Ma and a sedimentation rate of ~9 m/m.y.

Six samples including two duplicates yielded four ages from the upper Englishtown sequence. The four ages range from 75.8 to 78.1 Ma. This is consistent with calcareous nannofossil biostratigraphy, and the ages are similar to those obtained at the Sea Girt site (Miller et al., 2006). Because of the scatter in the data (Table T7), a sedimentation rate cannot be calculated.

DISCUSSION, SUMMARY, AND CONCLUSIONS

The Medford corehole successfully recovered a thick Upper Cretaceous succession, allowing identification of potential aquifers and correlation to previously drilled holes. We constructed three cross sections that illustrate updip to downdip (Medford-Ancora-Bass River; Fig. F10) and along-strike variability (Medford-Sea Girt; Fig. F11). Medford recovered a thick Potomac Formation that can be compared with the first continually cored Potomac record along strike at Fort Mott (Fig. F12). We describe the facies and hydrogeologic significance top to bottom.

The Maastrichtian Navesink sequence(s) are thin at all three coreholes, comprised predominantly of glauconite sand (Medford) to clayey glauconite sand (Ancora) to glauconite marl (Bass River), thus fining downdip as expected (Fig. F10). The Marshalltown sequence is thicker downdip at Bass River than it is at Ancora or Medford, though all three have coarse sands in the Mount Laurel Formation (Fig. F10). The Bass River section is also finer grained than the updip sections, and the Wenonah Formation there is dominated by silt (Fig. F10). The upper Englishtown sequence (mid-Campanian) and formation is thick at Medford and thins downdip (Fig. F10), though it is thickest along strike at Sea Girt (Fig. F11). Environments in the upper Englishtown sequence change from lower shoreface and delta front at Medford and Sea Girt to inner neritic and lower shoreface at Ancora to middle neritic deposits at Bass River. The Merchantville III sequence is much thicker downdip at Bass River (~170 ft; 51.5 m) than it is at Medford (~100 ft; 30.3 m) (Fig. F10). In particular, the middle neritic and prodelta clays from the Woodbury Formation are very thick at Bass River, thick at Ancora, and thin at Medford. At Medford, the MeIII (Campanian) sequence is dominated by lower shoreface sands lacking a deltaic influence and assigned to the lower Englishtown Formation (Fig. F10). Thus, the MeIII sequence had a deltaic influence downdip, but in the Medford region, it was a storm-dominated shoreface. MeII and MeI (Santonian) sequences are thin glauconite sequences (Fig. F10), with the MeI absent at Ancora.

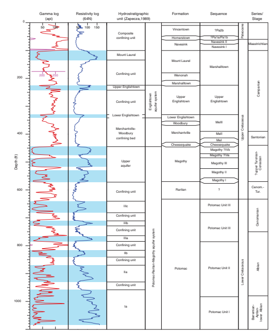
The largely nonmarine Magothy Formation is poorly represented downdip at Ancora and Bass River (Fig. **F10**) but is well represented at Medford and Sea Girt (Fig. **F11**). Five upper Turonian–Coniacian sequences occur at both sites, with the Medford site apparently reflecting more marine influences (tidal channel, lagoon, and estuarine environments, in addition to the distributary channel, overbank, paleosols, lower delta plain environments found at Sea Girt). These sequences appear to correlate with members identified in outcrop and correlated to Sea Girt.

Potomac sequences (?Barremian to lower Cenomanian) at Medford appear to be closer to the source than at Fort Mott (Fig. **F12**). Though both are fluvial and fluvial-lacustrine, Fort Mott is very fine grained and dominated by more floodplain/overbanks/paleosol environments, whereas Medford is sandier. The upper sequence, the Potomac III at Medford, has three sand bodies within it, versus on main lower sand at Fort Mott, though both appear to represent anastamosing river systems. The lower Potomac I at Medford was deposited in braided environments, whereas the medial Potomac II sequence also displays more braided environments at Medford than at Fort Mott. The sequence stratigraphy outlined here allows evaluation of the hydrostratigraphy and predictions about aquifer continuity and quality.

Hydrogeologic Summary

The Medford site penetrated several significant aquifer-quality sand bodies outlined by Sugarman et al. (2005) (Fig. **F13**). The Mount Laurel aquifer is ~33 ft (10.1 m) thick at Medford and is composed predominantly of medium sand grading downward to fine to medium sand. The Englishtown aquifer system contains an upper and lower aquifer at Medford. The upper sand (224.4–240.3 ft; 68.4–73.2 m) is thin (~15 ft; 4.6 m) and fine grained and probably a minor aquifer at best. The lower Englishtown aquifer is even thinner (329.4–340 ft; 100.4–108.2 m) and is also a minor aquifer because it fines downward from fine sand with lesser medium fine sand to a silty fine to very fine sand.

F13. Lithologic and hydrostratigraphic terminology, p. 58.



The Potomac-Raritan-Magothy aquifer system contains several major aquifers. The Magothy aquifer, or upper aquifer of Zapecza (1989), is ~128 ft (39 m) thick at Medford. The Magothy aquifer contains two thick (27 and 29 ft; 8.2 and 8.8 m) sand beds from 446 to 473 ft (135.9 to 144.2 m) and 487 to 516 ft (148.4 to 157.3 m) in the upper portion of the aquifer separated by a thinner (14 ft; 4.3 m) clay-silt bed from 473 to 487 ft (144.2 to 148.4 m) that may act as a minor confining unit. This upper sandy interval is separated from the lower part of the aquifer by a 14 ft (4.3 m) thick confining unit from 516 to 530 ft (157.3 to 161.5 m) correlative with the Amboy Stoneware Clay. The lower section of the Magothy aquifer from ~530 to 573.1 ft (157.3 to 174.7 m) at Medford contains more fine sand than the upper section and might be a less productive interval within the aquifer.

An ~67 ft (20.4 m) thick confining unit from 573.1 to 640 ft (174.7 to 195.1 m) separates the Magothy or upper aquifer from several sand intervals within the Potomac that may provide high-quality aquifers. There are three aquifers within the Potomac Unit III. The uppermost one, the IIIc aquifer, is from 640 to 681.2 ft (195.1 to 207.6 m) and is ~40 ft (12.2 m) thick. A 30.4 ft (9.3 m) confining unit from 681.2 to 711.6 ft (207.6 to 216.9 m) separates the IIIc above from the IIIb aquifer below. The IIIb is a thinner (16.4 ft; 5 m) aquifer than the IIIc. A thick

37 ft (11.3 m) confining unit separates the IIIb aquifer from the IIIa aquifer that is 21.8 ft (6.6 m) thick (765–786.8 ft; 233.2–239.8 m).

The uppermost aquifer within the Potomac Unit II is the IIb, and it is separated from the IIIa aquifer by a 29.2 ft (8.9 m) thick confining unit between 786.8 and 816 ft (239.8 and 248.7 m). The IIb aquifer is 26 ft (7.9 m) thick. A confining unit from 842 to 870 ft (256.6 to 265.2 m) sits above the 60 ft (18.3 m) thick IIa aquifer. A confining unit from 930 to 958.1 ft (283.5 to 292 m) separates the IIa aquifer from a thick interval of aquifer sands predominantly in the Potomac Unit I termed the Ia aquifer. The Ia aquifer extends to the base of the hole (1090 ft; 332.2 m).

The Medford corehole provided our second continuously cored view of Potomac sequences and hydrogeologic units and surprises as to remarkable differences along strike from Fort Mott (Sugarman et al., 2006). Both share a fluvial origin, but the Medford corehole was sandier, close to source, yet had more a a marine influence. It is clear that the Potomac Formation is a complex unit that will defy predictability, versus the Upper Cretaceous sequences that display predictable updip-downdip and along-strike variability.

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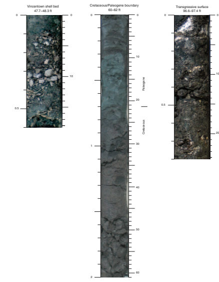
APPENDIX

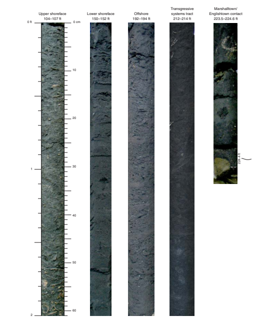
Representative Lithofacies from the Medford Corehole

Representative lithofacies from the Medford corehole are shown in Figures **AF1, AF2, AF3, AF4, AF5, AF6, AF7, AF8, AF9, AF10, AF11, AF12, AF13, AF14, AF15, AF16, AF17,** and **AF18.**

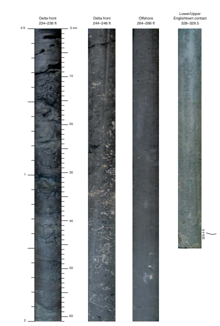
AF1. Shell bed, K/P boundary and transgressive surface, p. 77.



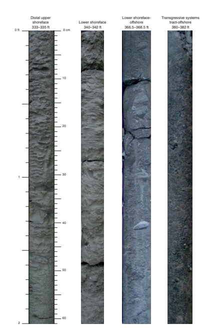
AF2. Upper and lower shoreface sediments, p. 77.



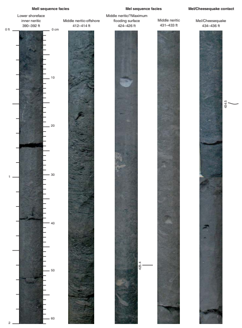
AF3. Delta front deposits and offshore sediments, p. 78.



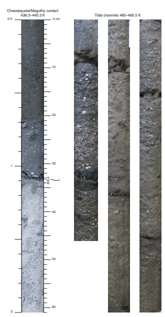
AF4. Upper and lower shoreface to offshore sediments, p. 79.



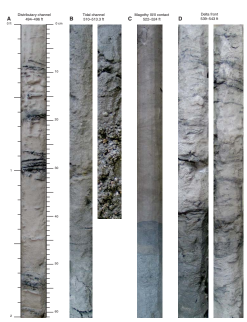
AF5. Inner and middle neritic deposits, p. 80.



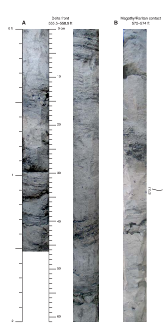
AF6. Tidal channel sediments, p. 81.



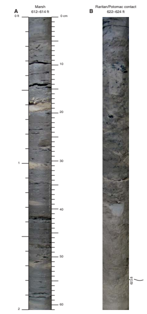
AF7. Distributary channel, tidal channel, and delta front sediments, p. 82.



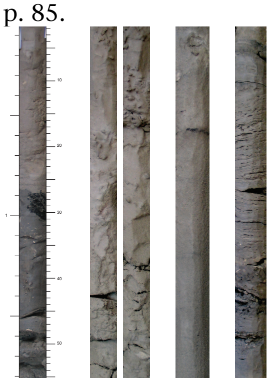
AF8. Delta front sediments, p. 83.



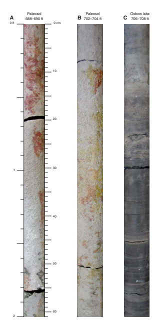
AF9. Marsh sediments, p. 84.



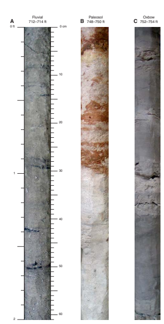
AF10. Overbank/swamp sediments and fluvial channel sediments, p. 85.



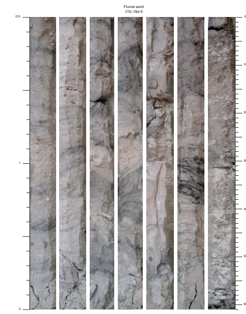
AF11. Paleosol and oxbow lake sediments, p. 86.



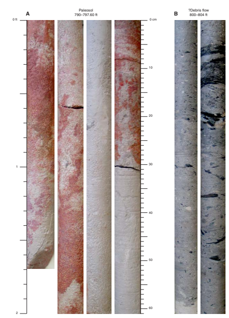
AF12. Fluvial sediments, paleosol, and oxbow lake sediments, p. 87.



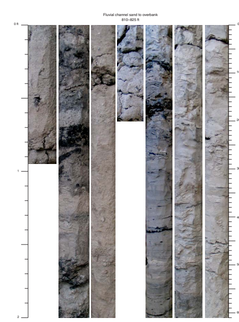
AF13. Fluvial sediments, p. 88.



AF14. Paleosol and possible debris flow sediments, p. 89.

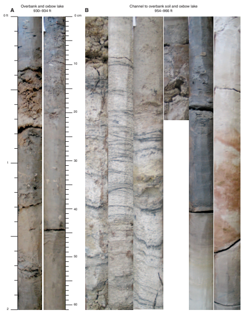


AF15. Fluvial channel sediments transitioning to overbank sediments, p. 90.



AF16. Paleosol and fluvial sediments, p. 91.

AF17. Overbank and oxbow lake sediments, p. 92.



AF18. Braided stream sediments, p. 93.

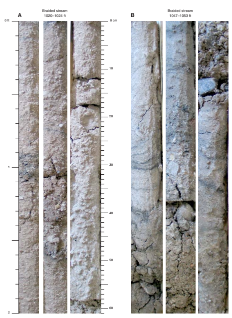


Figure F1. Location map showing the Medford site (red star), existing Deep Sea Drilling Project (DSDP), Atlantic Margin Coring Project (AMCOR), Ocean Drilling Program (ODP), and Integrated Ocean Drilling Program (IODP) coreholes analyzed as a part of the New Jersey (NJ)/Mid-Atlantic (MAT) sea level transect. Also shown are multichannel seismic data from *Ewing* (EW9009), *Oceanus* (Oc270), and *Cape Hatteras* (Ch0698) cruises. MN = Monmouth County, OC = Ocean County, BU = Burlington County, CD = Camden County, GL = Gloucester County, AT = Atlantic County, SA = Salem County, CU = Cumberland County, CM = Cape May County.

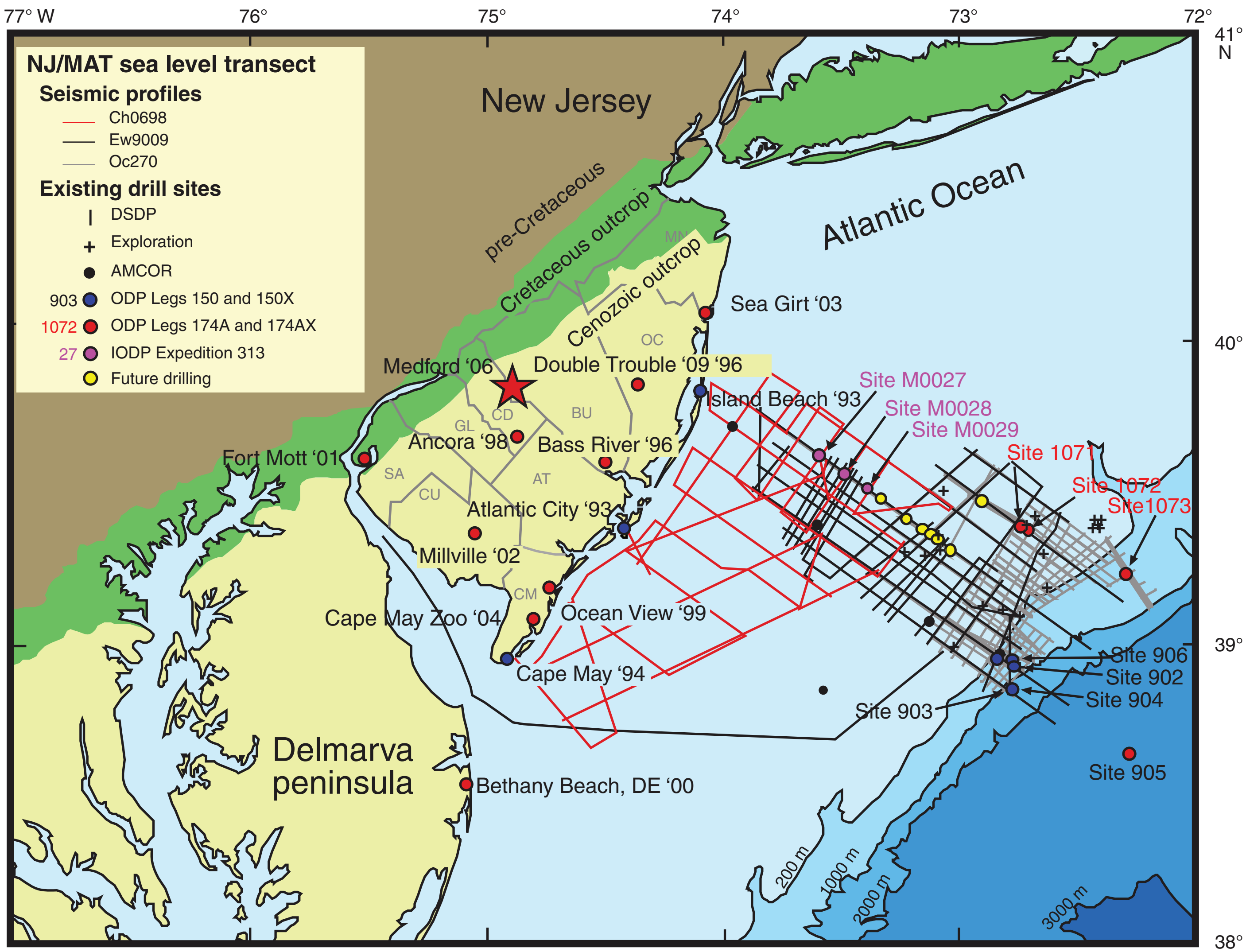


Figure F2. Summary stratigraphic section for the Manasquan Formation (lower Eocene), Marlboro Clay (lowermost Eocene), Vincentown (Paleocene), Hornerstown (Paleocene), and Navesink (Maastrichtian) formations in the Medford borehole. NP Zones are from Martini (1971) and Martini and Müller (1986). P Zones are from Berggren et al. (1995). Pa1a, Pa1b, and Pa2b are sequences defined by Harris et al. (submitted). Navesink I and Navesink II are sequences defined by Miller et al. (2003). B = barren. K = Cretaceous. Red lines = sequence boundaries. MFS = maximum flooding surface, TS = transgressive surface, uHST = upper highstand systems tract, lHST = lower highstand systems tract, TST = transgressive systems tract, HST = highstand systems tract, LST = lowstand systems tract. pUSF = proximal upper shoreface, dUSF = distal upper shoreface.

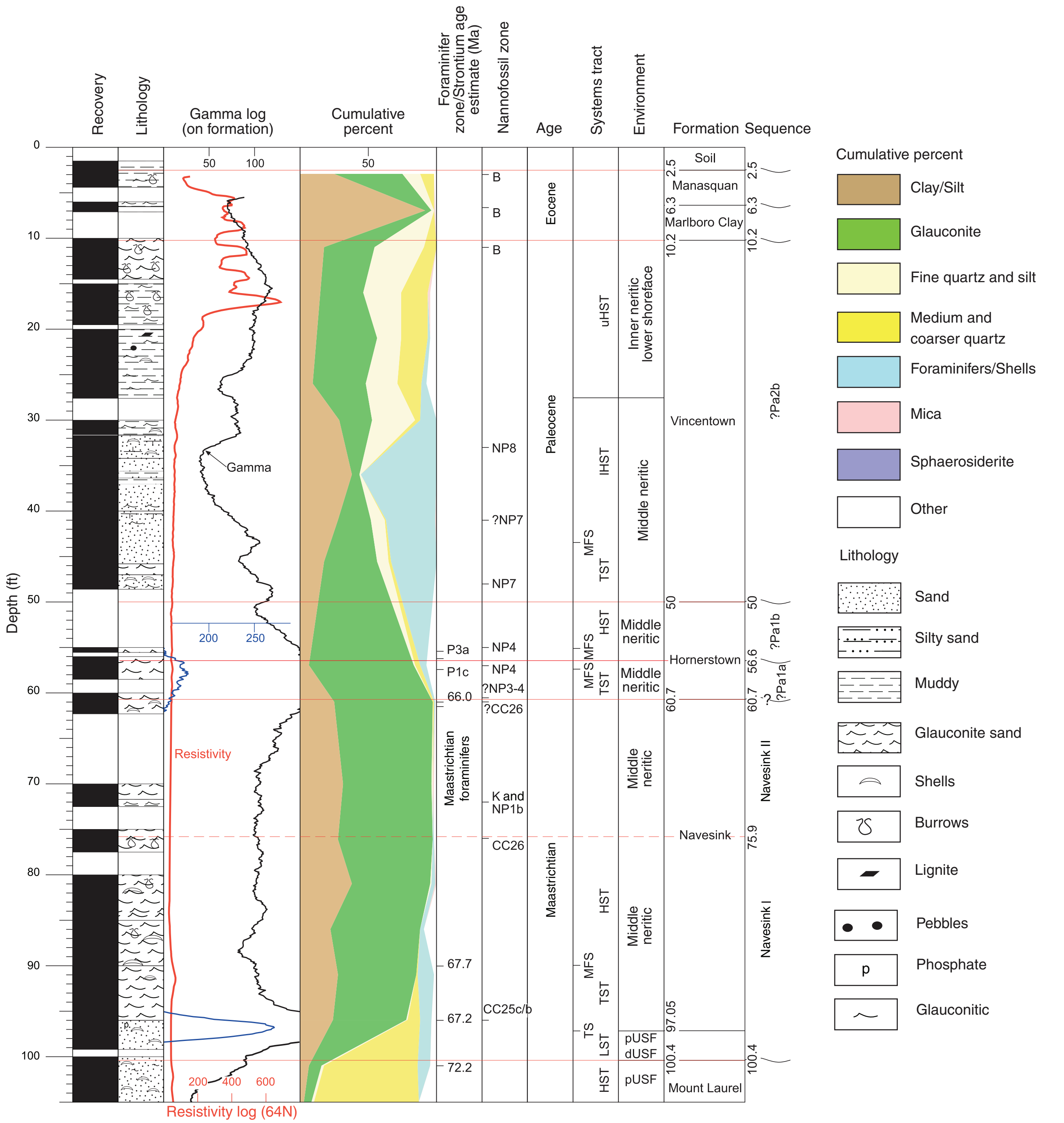


Figure F3. Summary stratigraphic section for the Mount Laurel (Campanian), Wenonah (Campanian), and Marshalltown (Campanian) formations in the Medford borehole. Marshalltown sequence defined by Miller et al. (2003). CC Zones are from Sissingh (1977). Red lines = sequence boundaries. TS = transgressive surface, MFS = maximum flooding surface, TST = transgressive systems tract, LST = lowstand systems tract, uHST = upper highstand systems tract, lHST = lower highstand systems tract, HST = highstand systems tract.

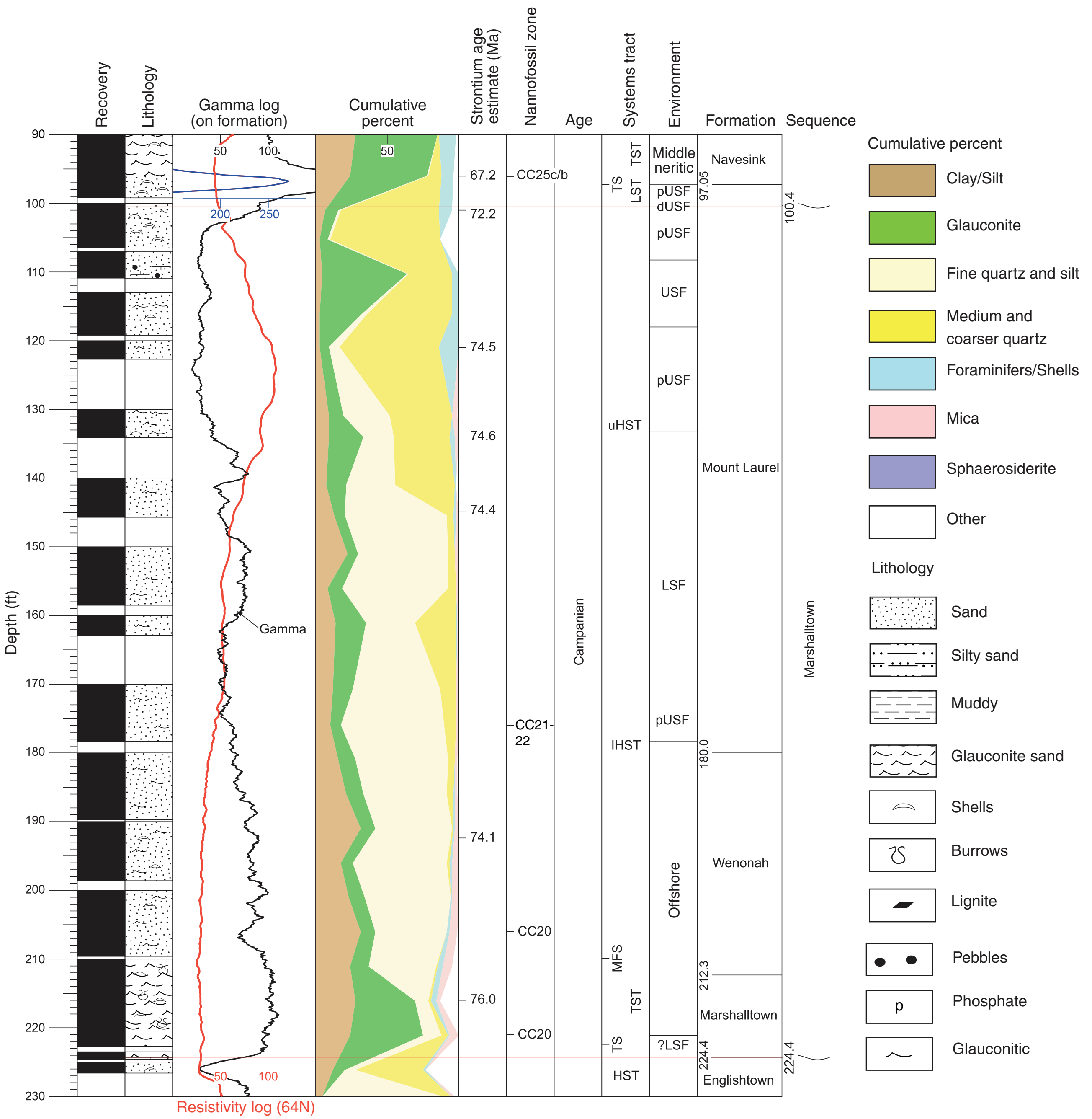


Figure F4. Summary stratigraphic section for the upper Englishtown (Campanian), lower Englishtown (Campanian), Woodbury (Campanian), Merchantville (Campanian–Santonian), and Cheesequake (Santonian) formations in the Medford borehole. Merchantville sequences I–III are defined by Miller et al. (2003). CC Zones are from Sissingh (1977). Red lines = sequence boundaries. B = barren. TS = transgressive surface, FS = flooding surface, MFS = maximum flooding surface, TST = transgressive systems tract, uHST = upper highstand systems tract, lHST = lower highstand systems tract, HST = highstand systems tract. LSF = lower shoreface, dUSF = distal upper shoreface.

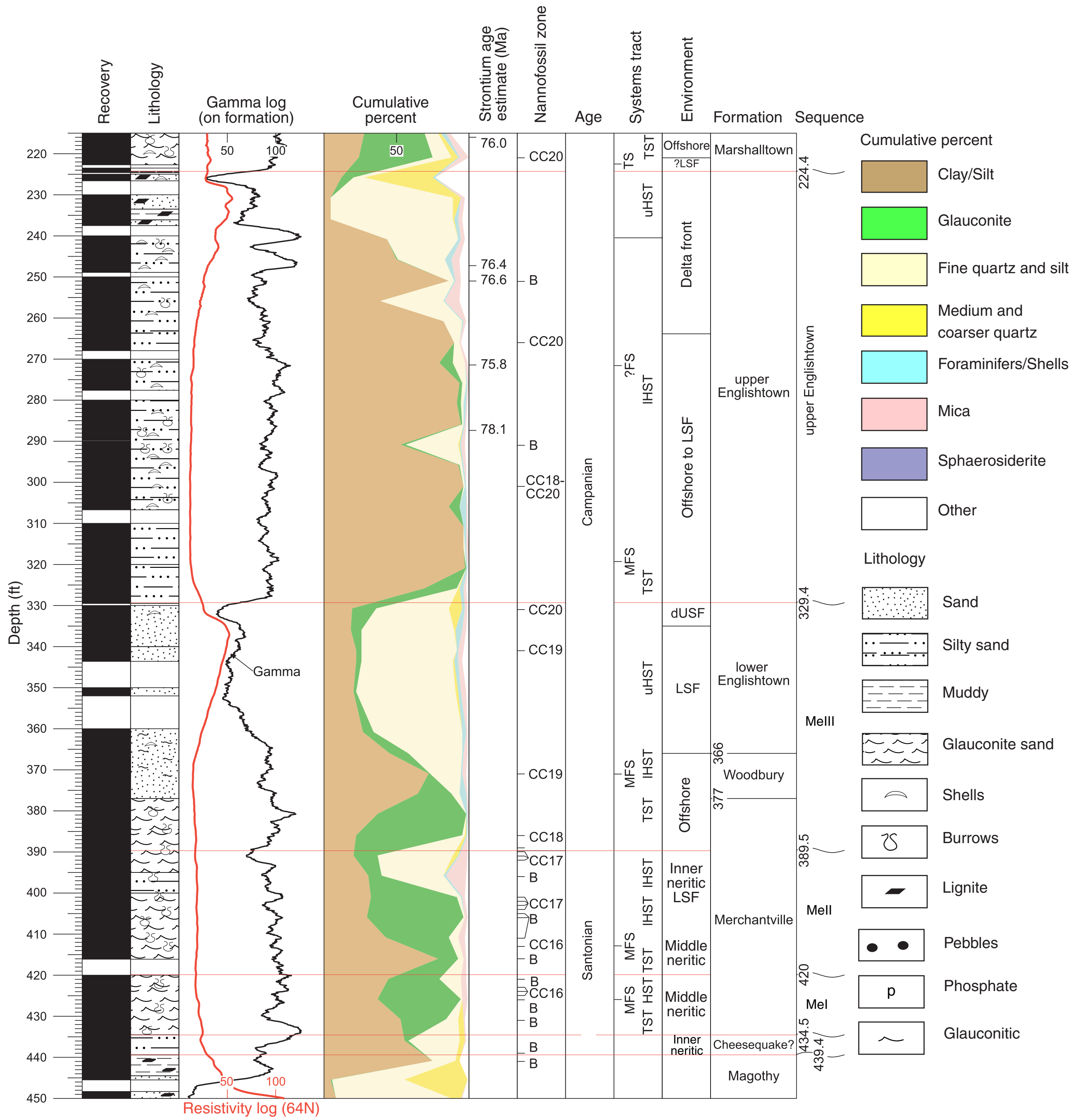


Figure F5. Summary stratigraphic section for the Magothy (upper Turonian–Santonian) Formation in the Medford borehole. Magothy sequences I–IV from Miller et al. (2003, 2006) and Kulpecz et al. (2008). Pollen zonation of Brenner (1963, 1967) and Doyle and Robbins (1977). Red lines = sequence boundaries. ND = nondiagnostic, B = barren.

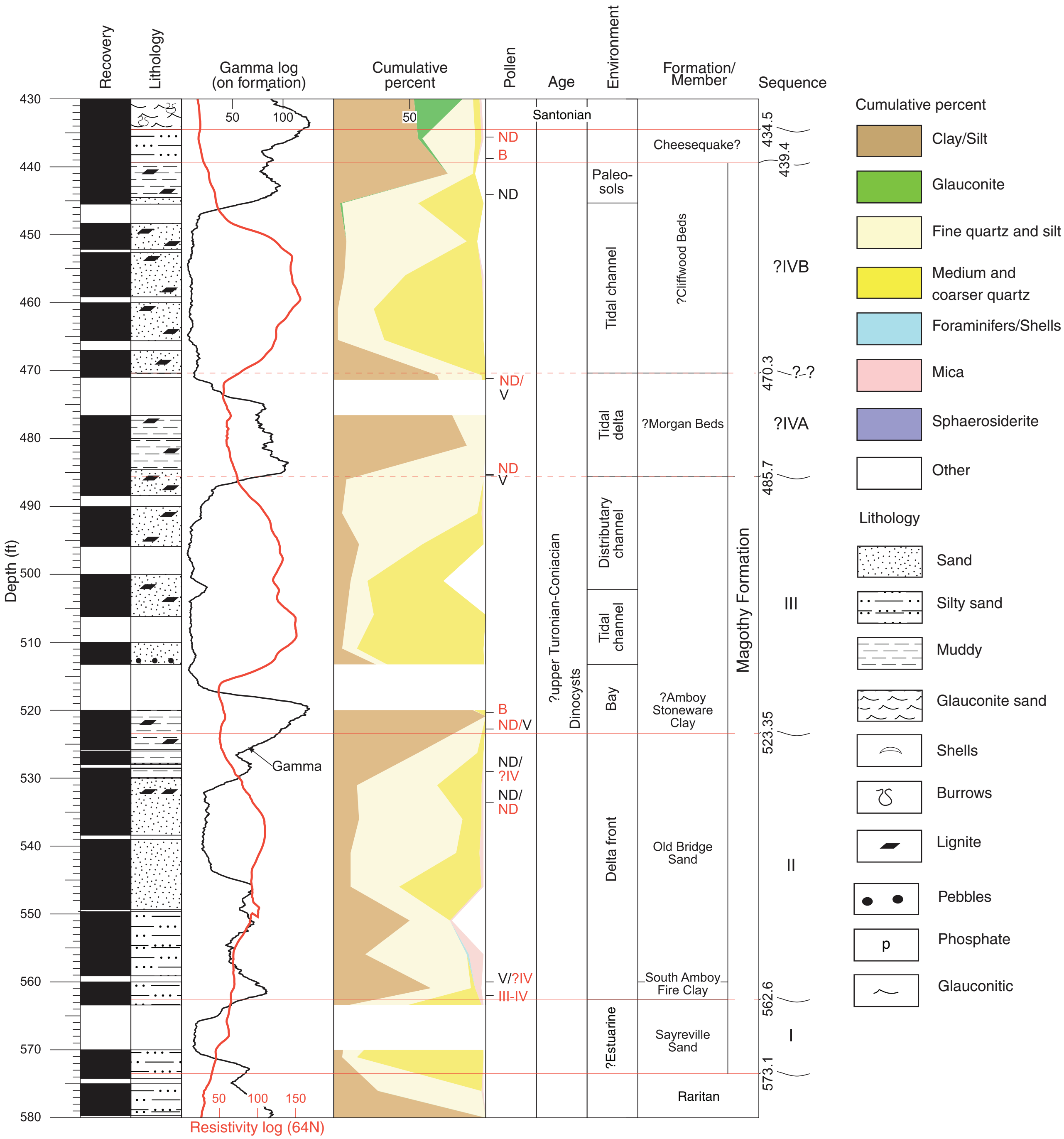


Figure F6. Summary stratigraphic section for the Raritan (upper Cenomanian–Turonian) and Potomac (partim, lower Cenomanian) formations in the Medford borehole. Potomac Unit III sequence is defined in Sugarman et al. (2004). Pollen zonation of Brenner (1963, 1967) and Doyle and Robbins (1977). Red lines = sequence boundaries. B = barren, ND = nondiagnostic.

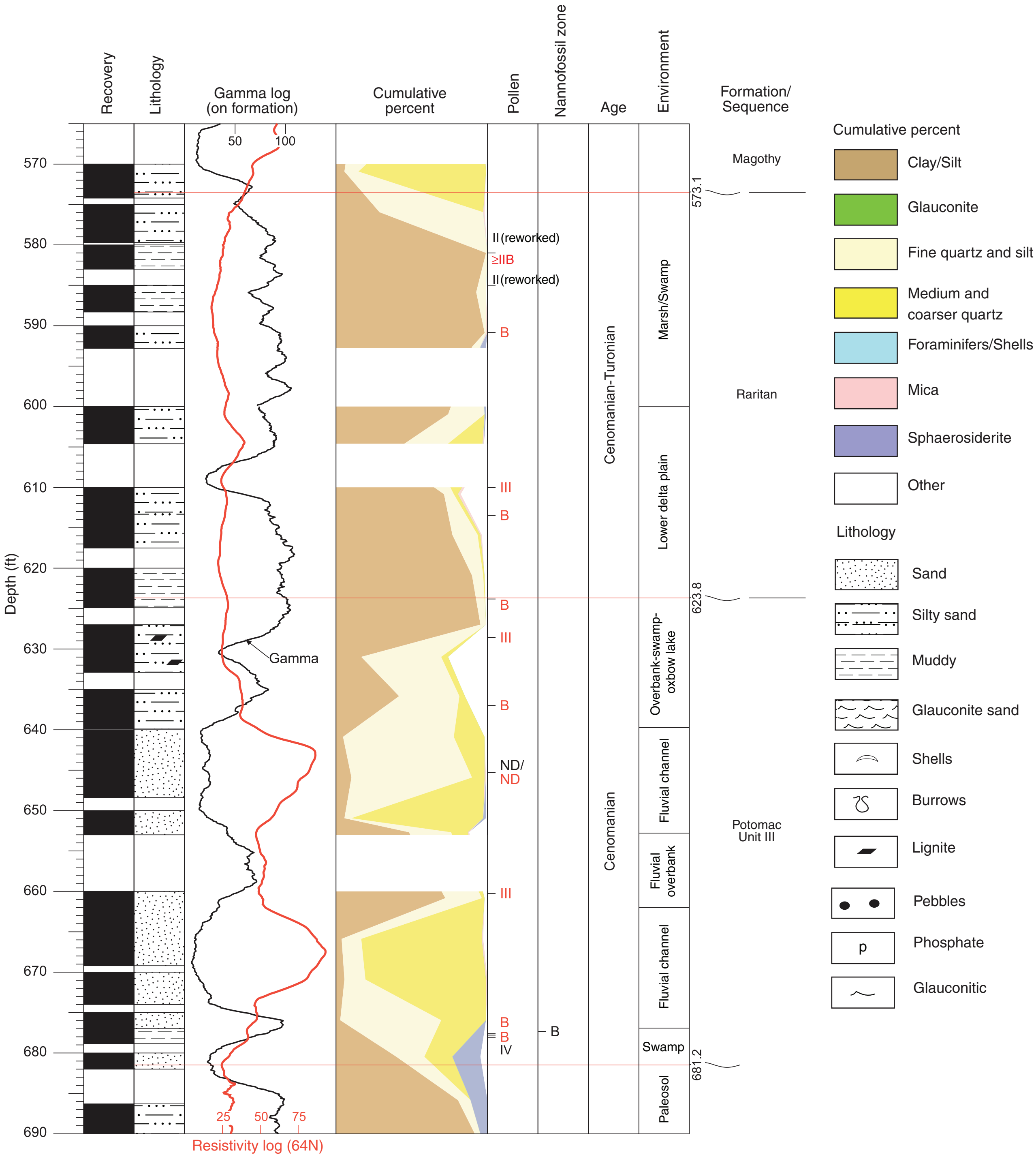


Figure F7. Summary stratigraphic section for the Potomac (partim, lower Cenomanian) Formation in the Medford borehole. Potomac Unit III sequence is defined in Sugarman et al. (2004). Pollen zonation of Brenner (1963, 1967) and Doyle and Robbins (1977). Red lines = sequence boundaries. B = barren, ND = nondiagnostic.

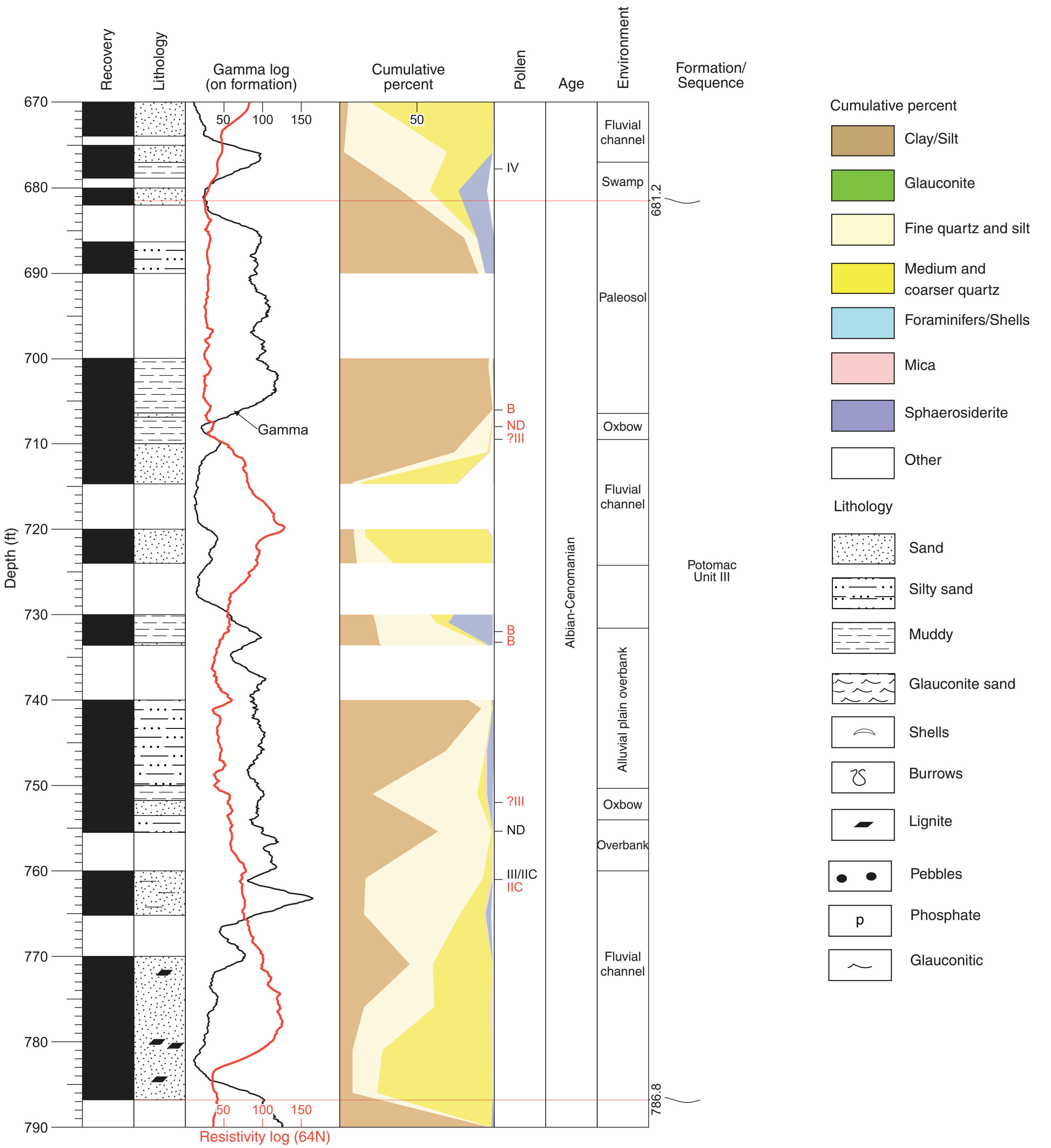


Figure F8. Summary stratigraphic section for the Potomac (partim, ?Albian) Formation in the Medford borehole. Potomac Unit II sequence is defined in Sugarman et al. (2004). Pollen zonation of Brenner (1963, 1967) and Doyle and Robbins (1977). Red lines = sequence boundaries. B = barren.

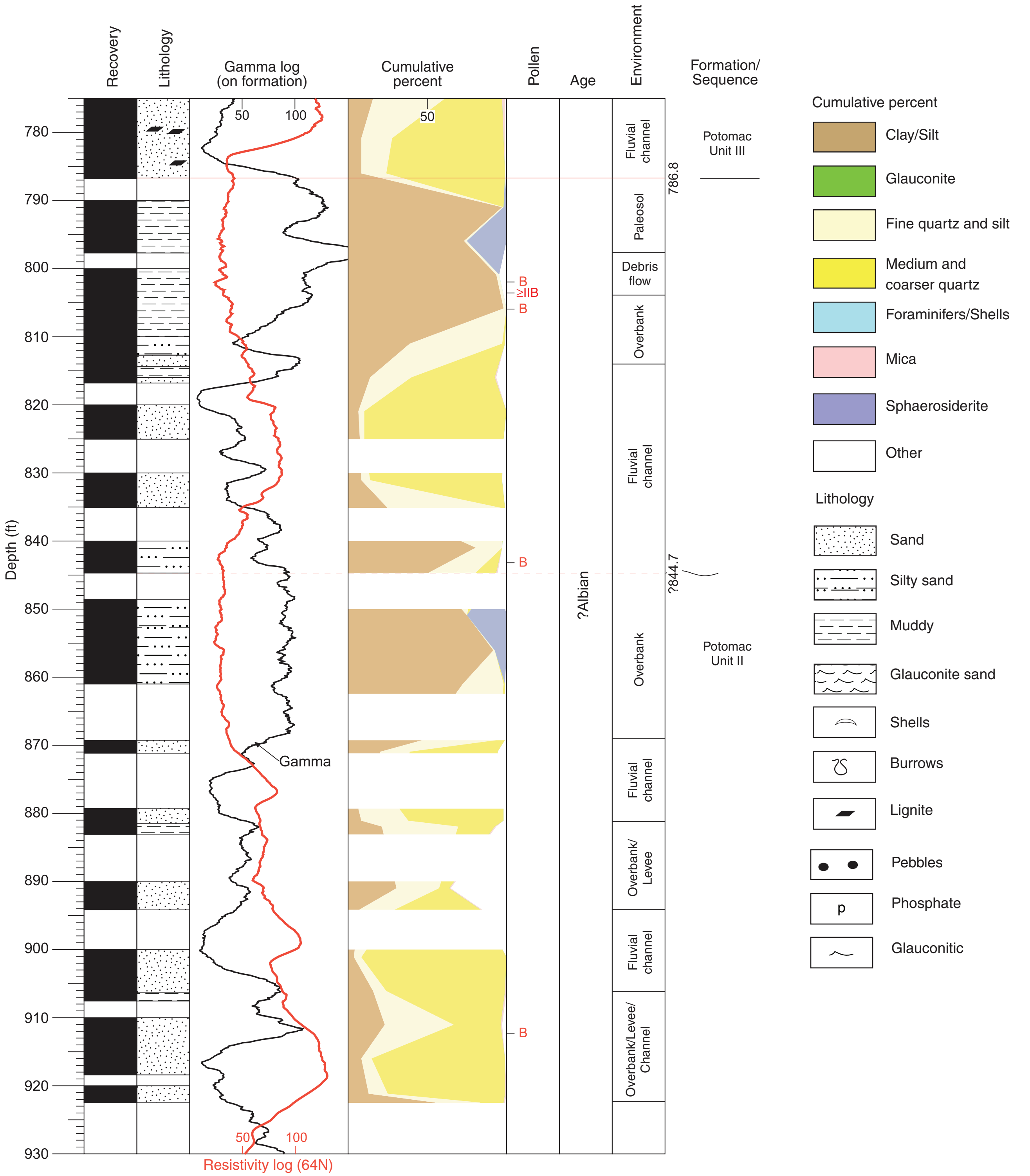


Figure F9. Summary stratigraphic section for the Potomac (partim, ?Barremian-lower Albian) Formation in the Medford borehole. Potomac Unit II and Potomac Unit I sequences are defined in Sugarman et al. (2004). Pollen zonation of Brenner (1963, 1967) and Doyle and Robbins (1977). Red lines = sequence boundaries. TD = total depth. B = barren, ND = nondiagnostic.

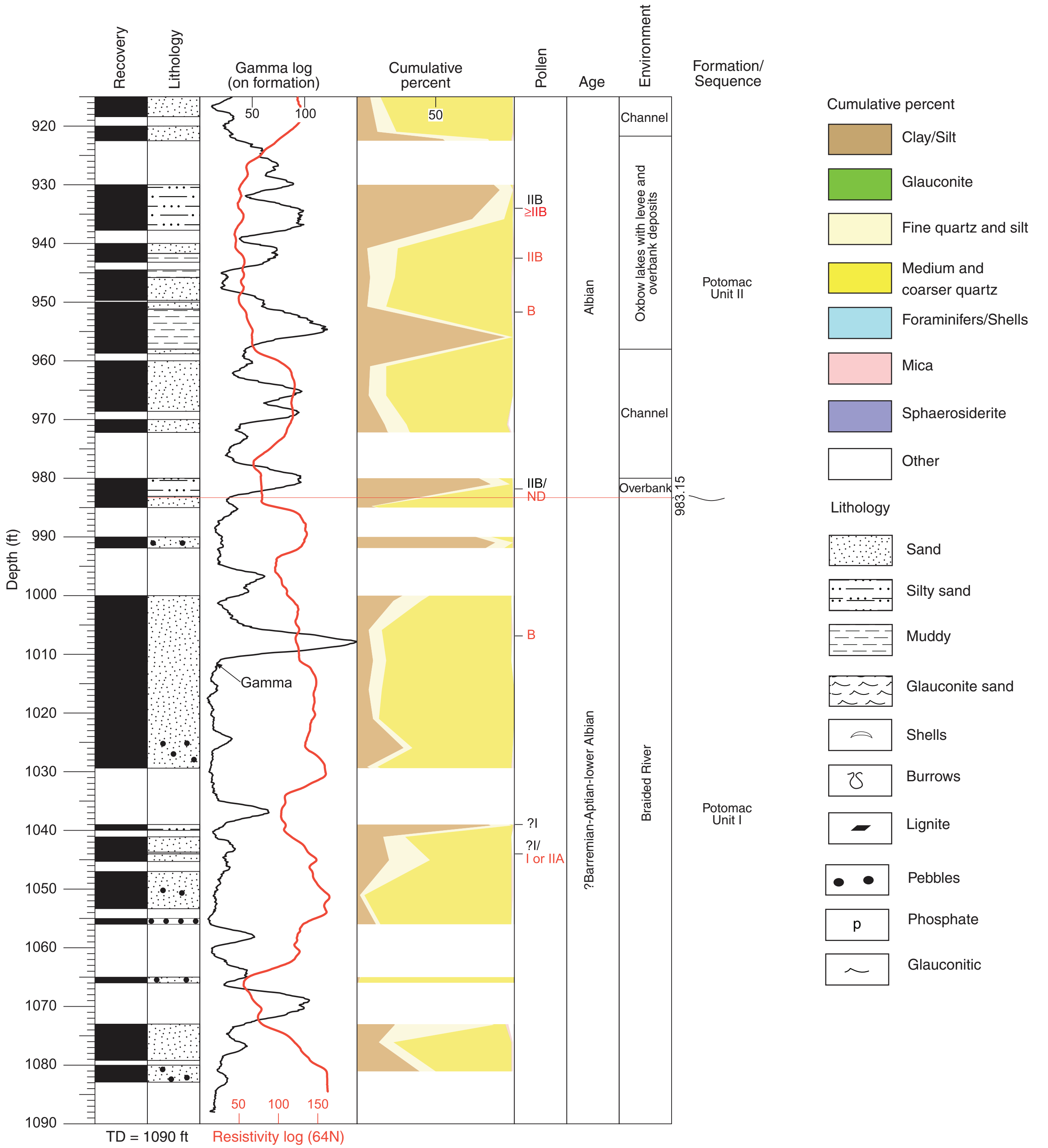


Figure F10. Dip section showing the relationships among the Upper Cretaceous sequences discussed in the text. Red lines = sequence boundaries. dUSF = distal upper shoreface, USF = upper shoreface, LSF = lower shoreface. (This figure is available in an **oversized format.**)

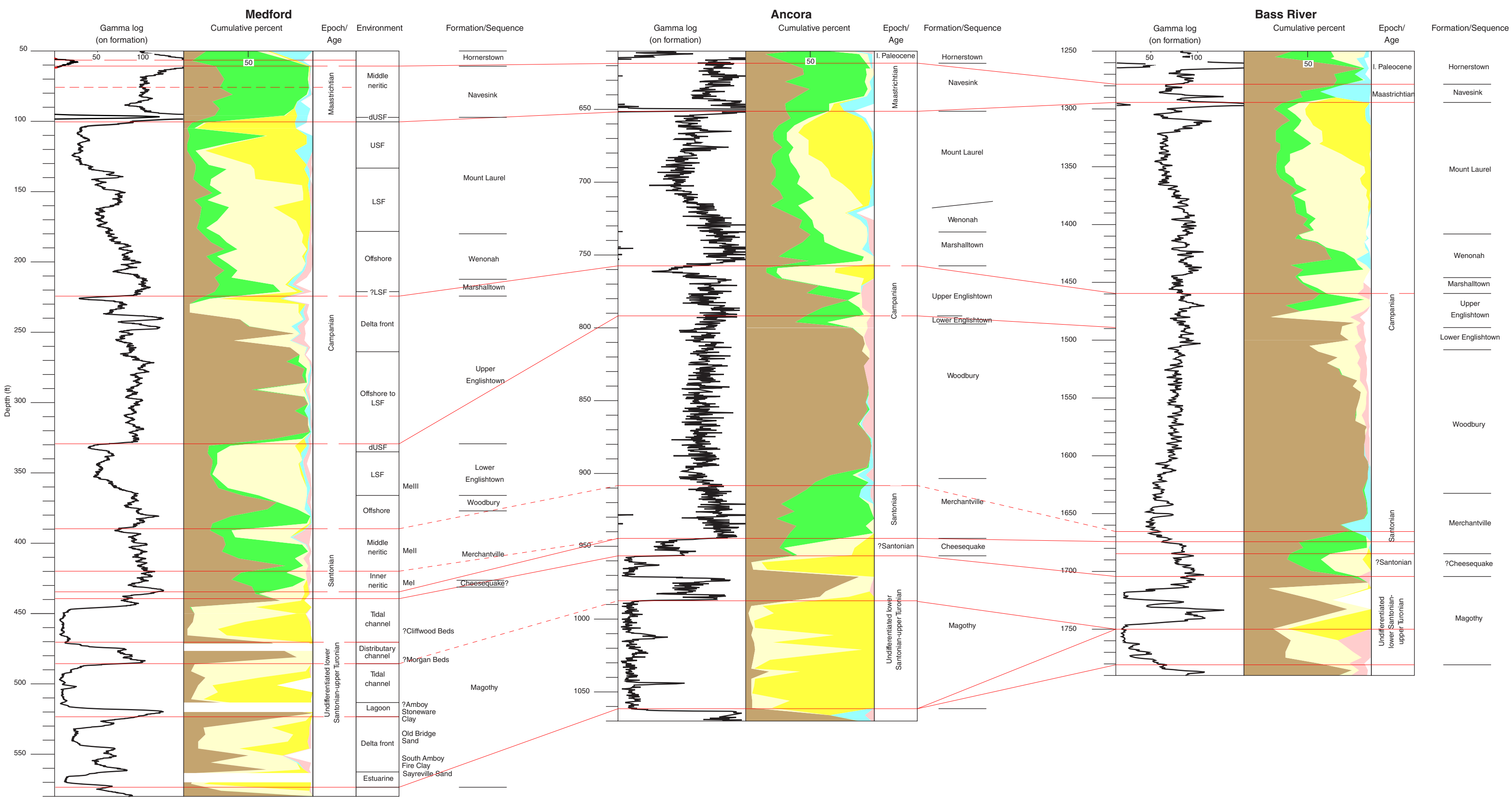


Figure F11. Strike section showing the relationships between the Turonian to lower Campanian sequences discussed in the text. Red lines = sequence boundaries. LSF = lower shoreface, dUSF = distal upper shoreface, pUSF = proximal upper shoreface. (This figure is available in an oversized format.)

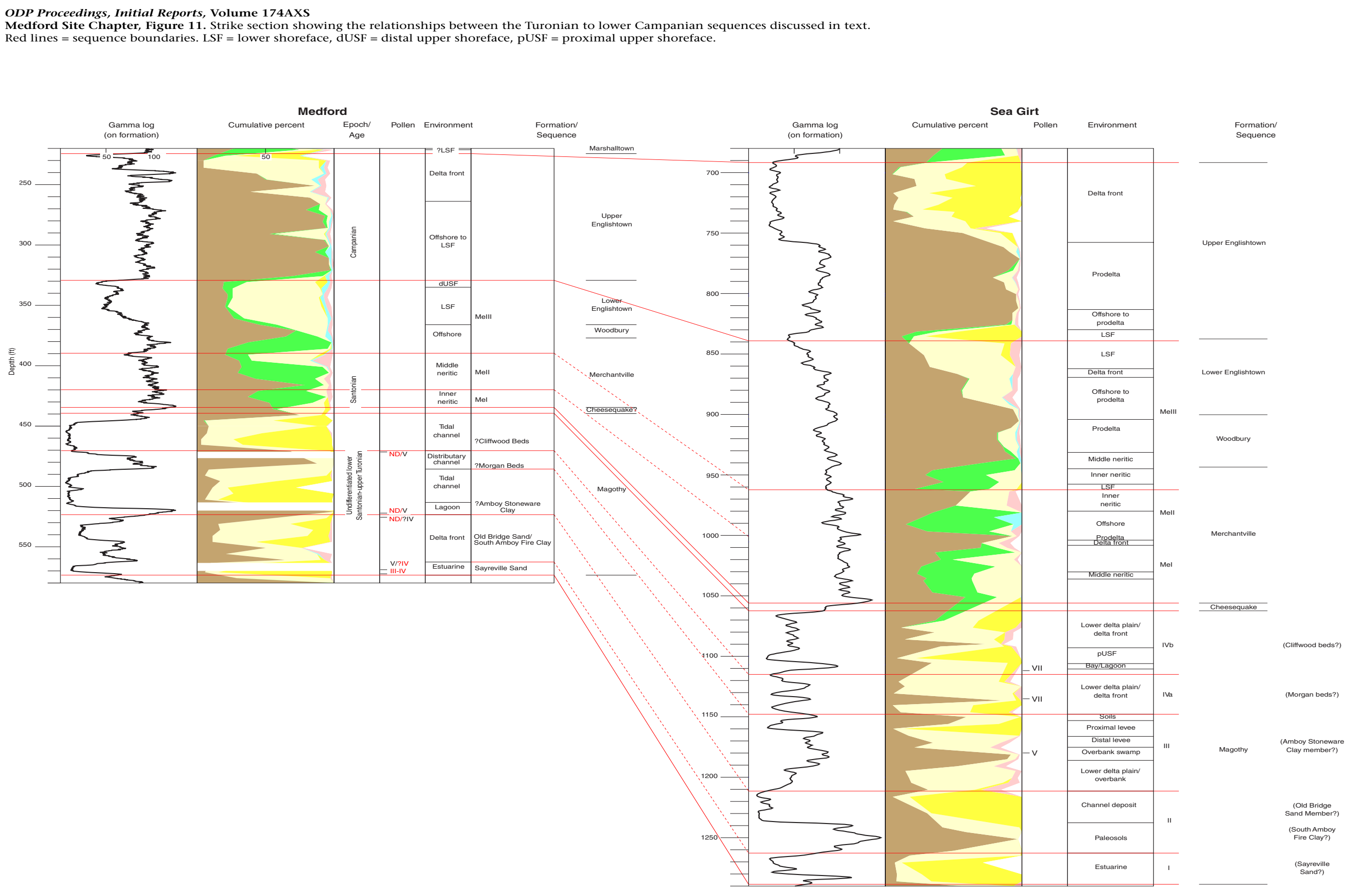


Figure F12. Stratigraphic section showing the relationships between the Potomac Formation sequences (?Barremian-lower Cenomanian) discussed in the text. Red lines = sequence boundaries.

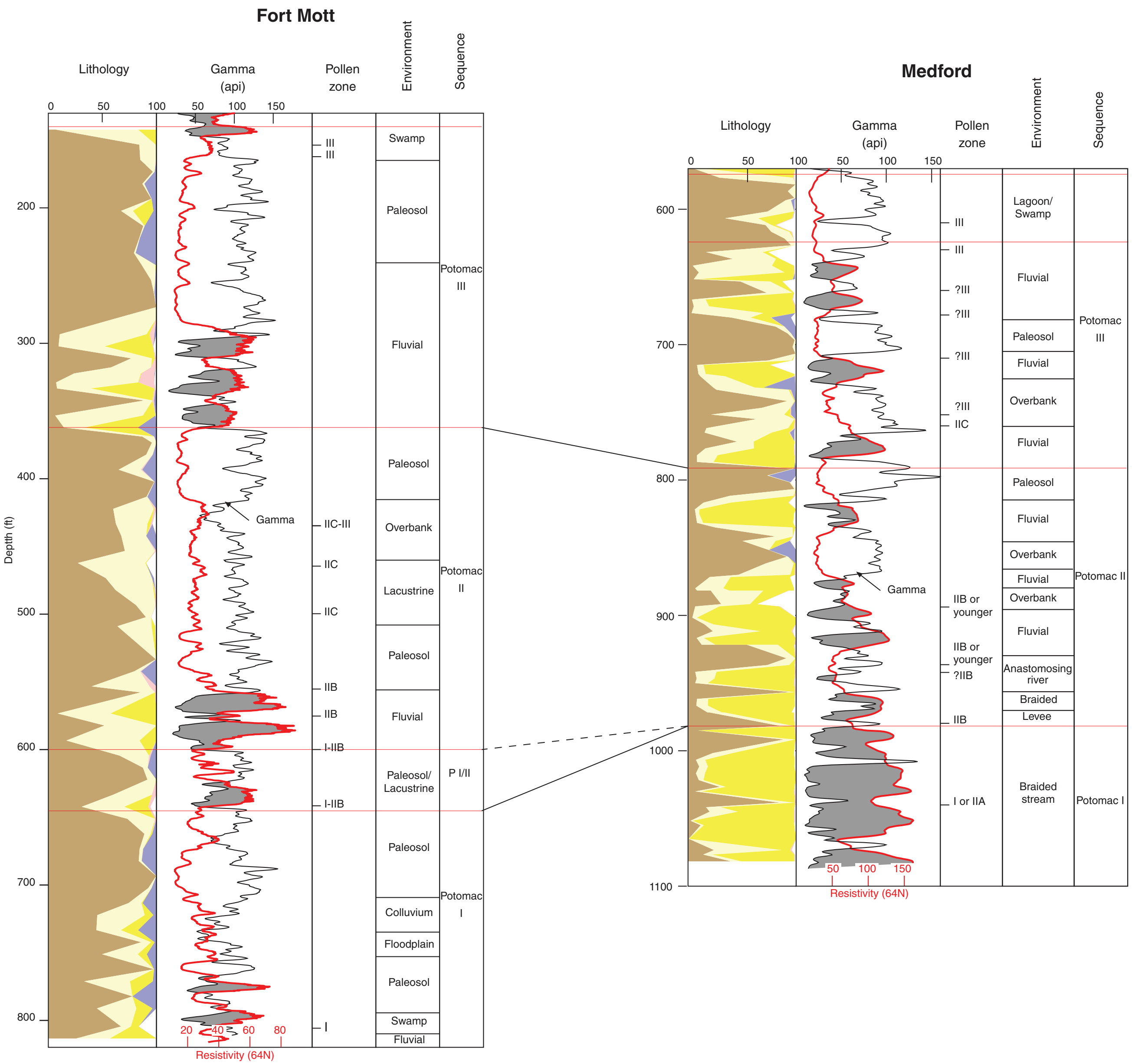


Figure F13. Lithologic and hydrostratigraphic terminology for units recovered from the Medford corehole. Blue areas in the gamma and resistivity log columns indicate aquifers.

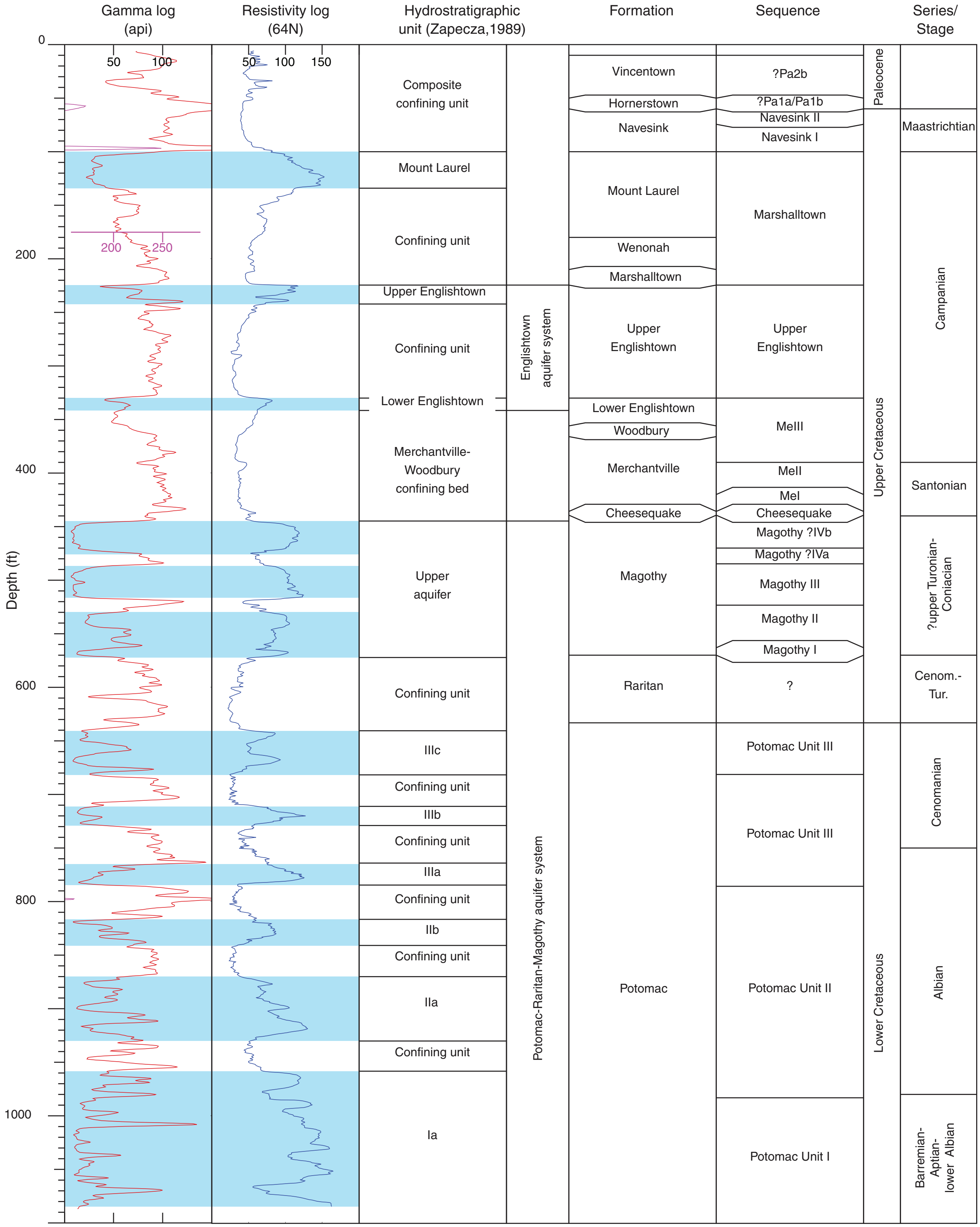


Table T1. Core descriptions, Medford borehole, Leg 174AXS. (**Continued on next three pages.**)

Run number	Date (2007)	Cored interval (ft)	Run length (ft)	Recovered (ft)	Recovered (%)	Lithology	Formation	Color
1	24 Apr	1.5–6	4.5	2.90	64	Glauconitic clay	Manasquan	5Y 4/2 Olive gray
2	24 Apr	6–10	4	1.10	28	Glauconitic clay	Manasquan/ Vincentown contact	5Y 7/2 Light gray
3	24 Apr	10–15	5	4.5	90	Glauconitic sand to clay	Vincentown	2.5Y 2.5/1 Black
4	24 Apr	15–20	5	4	80	Glauconitic clay	Vincentown	2.5Y 2.5/1 Black
5	25 Apr	20–30	10	7.6	76	Glauconitic sand to clay	Vincentown	2.5Y 4/1 Dark gray
6	25 Apr	30–32.5	2.5	1.6	64	Clayey glauconitic quartz sand	Vincentown	2.5Y 4/1 Dark gray
7	25 Apr	32.5–34	1.5	1.8	120	Calcarenite	Vincentown	5GY 6/1 Greenish gray
8	25 Apr	34–40	6	6.50	108	Calcarenite and glauconitic clayey sand	Vincentown	5GY 4/1 Dark greenish gray
9	25 Apr	40–47	7	5.7	81	Clayey glauconitic quartz sand; glauconite sand	Vincentown	5GY 4/1 Dark greenish gray
10	25 Apr	47–55	8	1.6	20	Clayey glauconitic quartz sand with shells over glauconite quartz sand	Vincentown/ Hornerstown contact	5B 4/1 Dark bluish gray
11	25 Apr	55–56	1	0.6	60	Glauconite sand	Hornerstown	2.5Y 2.5/1 Black
12	25 Apr	56–60	4	2.4	60	Slightly clayey glauconite sand	Hornerstown	5G 4/2 Greenish gray
13	25 Apr	60–70	10	2.3	23	Interbedded clay and glauconite sand	Hornerstown/ Navesink contact	5G 4/2 Greenish gray
14	25 Apr	70–75	5	2.5	50	Glauconitic sand to clay	Navesink	2.5Y 2.5/1 Black; Clay: 2.5YR 3/1 Dark reddish gray
15	25 Apr	75–80	5	2.5	50	Clayey glauconitic sand	Navesink	2.5Y 2.5/1 Black
16	25 Apr	80–85	5	5	100	Clayey glauconitic sand	Navesink	10YR 3/1 Very dark gray
17	25 Apr	85–90	5	5.2	104	Shelly clayey glauconite sand	Navesink	10YR 3/1 Very dark gray
18	25 Apr	90–100	10	9.2	92	Glauconite sand over dirty shelly sand	Navesink	2.5YR 4/1 Dark reddish gray
19	26 Apr	100–107	7	6.5	93	Glauconitic medium very coarse sand	Navesink/ Mount Laurel contact	5Y 5/2 Olive gray
20	26 Apr	107–113	6	3.9	65	Shelly glauconitic medium to very coarse sand	Mount Laurel	5Y 4/2 Olive gray
21	26 Apr	113–120	7	6.2	89	Shelly glauconitic medium to very coarse sand	Mount Laurel	5B 2.5/1 Bluish black
22	26 Apr	120–130	10.0	2.7	27	Shelly glauconitic medium to very coarse sand	Mount Laurel	5GY 2.5/1 Greenish black
23	26 Apr	130–140	10	4.1	41	Shelly glauconitic medium to very coarse sand	Mount Laurel	5GY 2.5/1 Greenish black
24	26 Apr	140–150	10	5.7	57	Slightly glauconitic fine to medium quartz sand	Mount Laurel	10GY 3/1 Very dark greenish gray
25	26 Apr	150–160	10	8.5	85	Laminated silty fine sand and silt, trace of shells	Mount Laurel	5G 3/1 Very dark greenish gray
26	26 Apr	160–170	10	2.9	29	Glauconitic fine to medium sand with some clay laminae	Mount Laurel	5G 3/1 Very dark greenish gray
27	26 Apr	170–180	10	8.3	83	Interbedded silty very fine sand and silty clay; glauconitic	Mount Laurel/ Wenonah contact	5G 3/1 Very dark greenish gray
28	26 Apr	180–190	10	9.7	97	Muddy very fine sands with silty clay	Wenonah	10Y 2.5/1 Greenish black
29	26 Apr	190–200	10	8.6	86	Muddy very fine sands with silty clay	Wenonah	10Y 3/1 Very dark greenish gray
30	26 Apr	200–210	10	9.6	96	Glauconitic very fine sandy clayey silt	Wenonah	10Y 3/1 Very dark greenish gray
31	27 Apr	210–220	10	10	100	Glauconitic very fine sandy clayey silt	Wenonah/ Marshalltown contact	10Y 3/1 Very dark greenish gray
32	27 Apr	220–223.5	3.5	2.7	77	Glauconitic very fine sandy clayey silt	Marshalltown	10Y 3/1 Very dark greenish gray
33	27 Apr	223.5–225	1.5	1.1	73	Glauconitic very fine sandy clayey silt; sandstone	Marshalltown/ Englishtown contact	10Y 3/1 Very dark greenish gray
34	27 Apr	225–230	5	1.6	32	Sandstone	Upper Englishtown	5BG 5/1 Greenish gray
35	27 Apr	230–240	10	7.5	75	Interbedded quartz sand and clay	Upper Englishtown	5BG 5/1 Greenish gray
36	27 Apr	240–250	10	8.9	89	Clayey silt	Upper Englishtown	N3/ Very dark gray
37	27 Apr	250–260	10	10.25	103	Clayey silt	Upper Englishtown	N3/ Very dark gray
38	27 Apr	260–270	10	7.95	80	Silty clay	Upper Englishtown	N3/ Very dark gray
39	28 Apr	270–280	10	7.4	74	Clayey silt	Upper Englishtown	N3/ Very dark gray
40	28 Apr	280–290	10	9.7	97	Clayey silt to silty clay	Upper Englishtown	N3/ Very dark gray
41	28 Apr	290–300	10	10.3	103	Clayey silt to silty clay	Upper Englishtown	2.5Y 3/2 Very dark grayish brown
42	28 Apr	300–310	10	6.7	67	Silty clay	Upper Englishtown	2.5Y 3/2 Very dark grayish brown

Table T1 (continued). (Continued on next page.)

Run number	Date (2007)	Cored interval (ft)	Run length (ft)	Recovered (ft)	Recovered (%)	Lithology	Formation	Color
43	28 Apr	310–320	10	10	100	Silty clay	Upper Englishtown	N3/ Very dark gray
44	28 Apr	320–330	10	9.5	95	Clayey silt to glauconitic silty clay	Upper Englishtown/ Lower Englishtown contact	2.5Y 3/1 Very dark gray to 2.5Y 3/2 Very dark grayish brown
45	28 Apr	330–333	3	3.9	130	Fine to medium quartz sand	Lower Englishtown	5Y 7/2 Light gray
46	28 Apr	333–340	7	7	100	Fine to medium quartz sand	Lower Englishtown	5Y 4/1 Dark gray
47	28 Apr	340–350	10	3.6	36	Very fine sand with clay and silt	Lower Englishtown	5Y 4/1 Dark gray
48	28 Apr	350–360	10	2	20	Fine sand with clay and silt	Lower Englishtown	2.5YR 3/2 Very dark grayish brown
49	29 Apr	360–362.45	2.45	2.45	100	Fine sand with clay and silt; increasing glauconite	Lower Englishtown	N 2.5/ Black
50	29 Apr	362.45–373	10.55	9.4	89	Fine sand with glauconite; clayey silt	Lower Englishtown/ Woodbury contact	N 2.5/ Black
51	29 Apr	373–380	7	8.2	117	Glauconitic clay and clayey glauconite sand	Woodbury/ Merchantville contact	N 2.5/ Black
52	29 Apr	380–390	10	10.1	101	Clayey glauconite sand	Merchantville	N 2.5/ Black
53	29 Apr	390–400	10	10.1	101	Clayey glauconite sand; silt	Merchantville	N 2.5/ Black
54	29 Apr	400–405	5	5.1	102	Clayey glauconite sand	Merchantville	N 2.5/ Black
55	29 Apr	405–410	5	5.3	106	Glauconitic sand to clay	Merchantville	N 2.5/ Black
56	29 Apr	410–420	10	6.1	61	Glauconitic sand to clay	Merchantville	N 2.5/ Black
57	29 Apr	420–430	10	7	70	Glauconitic sand to clay	Merchantville	N 2.5/ Black
58	29 Apr	430–435	5	8.2	164	Glauconitic sand to clay	Merchantville/ ?Cheesequake contact	N 2.5/ Black
59	29 Apr	435–440	5	5.3	106	Glauconitic sand to clay	?Cheesequake/ Magothy contact	N 2.5/ Black
60	30 Apr	440–448.5	8.5	5.5	65	Clay	Magothy	10YR 6/1 Gray
61	30 Apr	448.5–452.5	4	3.8	95	Medium to coarse sand	Magothy	2.5Y 4/1 Dark gray
62	30 Apr	452.5–460	7.5	6.5	87	Medium to coarse sand	Magothy	5Y 4/1 Dark gray
63	30 Apr	460–467	7	5.6	80	Medium to coarse sand	Magothy	5Y 4/1 Dark gray
64	30 Apr	467–467.5	9.5	3.9	41	Medium sand to clay	Magothy	10YR 6/1 Gray
65	30 Apr	467.5–480	3.5	3.9	111	Clayey silt to silty clay	Magothy	2.5Y 6/1 Gray
66	30 Apr	480–490	10	8.4	84	Clay to fine quartz sand	Magothy	2.5YR 4/1 Dark gray
67	30 Apr	490–500	10	5.9	59	Fine sand with lignitic laminae	Magothy	5Y 5/1 Gray
68	30 Apr	500–510	10	6.2	62	Coarse sand and granules	Magothy	5Y 5/ Gray
69	1 May	510–520	10	3.25	33	Medium to coarse sand over sandy gravel	Magothy	N5/ Gray
70	1 May	520–526	6	5.8	97	Clay, clay, and silt	Magothy	N4/ Dark gray to N6/ Gray
71	1 May	526–528.5	2.5	2	80	Very fine very silty clayey sand; sandstone	Magothy	N5/ Gray
72	1 May	528.5–539	10.5	9.9	94	Very fine very silty clayey sand; sandstone; medium sand; very fine sand	Magothy	N5/ Gray
73	1 May	539–549.5	10.5	10.35	99	Fine to medium lignitic sand; sandstone	Magothy	N5/ Gray
74	1 May	549.5–560	10.5	9.45	90	Fine to medium lignitic sand; sandstone	Magothy	N5/ Gray and N6/ Gray
75	1 May	560–570	10	3.4	34	Silty sand and silty clay	Magothy	N4/ Dark gray to N3/ Very dark gray
76	2 May	570–575	5	4.2	84	Laminated clay with lignite	Magothy/ Raritan contact	10YR 4/1 Dark gray
77	2 May	575–580	5	4.7	94	Laminated clay with lignite	Raritan	10YR 5/2 Grayish brown
78	2 May	580–585	5	3	60	Laminated clay with lignite	Raritan	10YR 3/2 Grayish brown
79	2 May	585–590	5	3	60	Laminated clay	Raritan	10YR 4/1 Dark gray
80	2 May	590–600	10	2.8	28	Laminated clay	Raritan	10YR 5/2 Grayish brown
81	2 May	600–610	10	4.6	46	Clayey silty very fine sand over silty clay over medium sand	Raritan	10YR 4/1 Dark gray
82	2 May	610–620	10	7.5	75	Clay, clay, and silt	Raritan	10YR 3/1 Very dark gray
83	3 May	620–627	7	7	100	Laminated clay	Raritan	10YR 4/2 Dark grayish brown
84	3 May	627–635	8	5.9	74	Lignitic clayey silt to clay	Raritan	10YR 4/2 Dark grayish brown

Table T1 (continued). (Continued on next page.)

Run number	Date (2007)	Cored interval (ft)	Run length (ft)	Recovered (ft)	Recovered (%)	Lithology	Formation	Color
85	3 May	635–640	5	4.9	98	Silty clay	Raritan	10YR 6/1 Gray to 10YR 4/2 Dark grayish brown
86	3 May	640–650	10	8.4	84	Quartz sand from fine to medium	Raritan	10YR 6/1 Gray
87	3 May	650–660	10	3.3	33	Medium to coarse sand	Raritan	10YR 5/1 Gray
88	3 May	660–670	10	9.2	92	Quartz sand from fine to medium	Raritan	10YR 5/1 Gray
89	3 May	670–675	5	4	80	Quartz sand from fine to medium	Raritan	10YR 5/1 Gray
90	4 May	675–680	5	3.85	77	Interbedded quartz sand and clay; muddy sand at bottom	Raritan	10Y 3/1 Very dark greenish gray to 10Y 5/1 Greenish gray
91	4 May	680–688.5	8.5	2	24	Muddy sand with granules, mud clasts, siderite; mottled silt at bottom	Raritan/ Potomac contact	2.5Y 5/2 Grayish brown
92	4 May	688.5–690	1.5	3.7	247	Silt, mottled, clayey	Potomac	N 6/1 Gray to 10R 4/6 Red
93	4 May	690–695	5	5	100	Silt, mottled, clayey	Potomac	10Y 5/1 Greenish gray, 10R 4/2 Weak red, 5Y 5/4 Olive
94	4 May	695–700	5	5	100	Clay, very silty, mottled	Potomac	10Y 5/1 Greenish gray, N4/Dark gray, N6/Gray
95	4 May	700–710	10	10.2	102	Clayey silt; clay; sand	Potomac	5Y 4/2 Olive gray
96	4 May	710–720	10	4.7	47	Sand; sand with clay	Potomac	5Y 4/1 Dark gray
97	5 May	720–730	10	4	40	Coarse to very coarse sand; fine to medium sand	Potomac	5Y 4/1 Dark gray
98	5 May	730–740	10	3.6	36	Interbedded clay and silty fine to medium sand with some lignite	Potomac	N7/ Light gray
99	5 May	740–750	10	10.5	105	Clayey silt with very fine sand	Potomac	10R 7/1 Light gray to 10R 4/6 Red
100	5 May	750–760	10	5.5	55	Interbedded silty fine to medium sand and laminated silty clay	Potomac	7.5YR 4/1 Dark gray
101	5 May	760–770	10	5.2	52	Laminated silty fine to medium sand with thin clay beds	Potomac	5YR 6/1 Gray
102	5 May	770–780	10	10	100	Sand, medium with lignite and rip-up clasts	Potomac	6/N Gray
103	5 May	780–790	10	6.8	68	Medium to coarse sand	Potomac	10Y 6/1 Gray
104	6 May	790–800	10	7.7	77	Clay	Potomac	10R 4/8 Red
105	7 May	800–810	10	10	100	Clay	Potomac	N/4 Dark gray
106	7 May	810–820	10	6.8	68	Silty sand and silty clay	Potomac	N/6 Gray
107	7 May	820–830	10	5.05	51	Medium to coarse sand with lignite	Potomac	2.5Y 5/2 Grayish brown
108	7 May	830–840	10	5.1	51	Medium to coarse sand with lignite	Potomac	2.5Y 5/1 Gray
109	7 May	840–850	10	4.7	47	Silty sand and silty clay	Potomac	2.5Y 5/1 Gray
110	7 May	850–859	9	10.45	116	Mottled clay	Potomac	10YR 7/1 Light gray/ 2.5YR 4/6 Dark red
111	8 May	859–869.3	10.3	2	19	Mottled red clay	Potomac	2.5YR 4/6 Red
112	8 May	869.3–879.3	10	2.4	24	Silty fine to medium sand with lignite	Potomac	2.5Y 6/1 Gray; 2.5Y 4/1 Dark gray
113	8 May	879.3–890	10.7	3.8	36	Sand over clay	Potomac	2.5Y 6/1 Gray; 2.5Y 4/1 Dark gray
114	9 May	890–900	10	4.15	42	Interbedded quartz sand and grayish clay	Potomac	10Y 6/1 Gray
115	9 May	900–910	10	7.55	76	Mostly medium sand, some clay, some plant debris	Potomac	10Y 6/1 Gray
116	9 May	910–920	10	8.4	84	Mostly sand, coarse, some granules	Potomac	10Y 6/1 Gray
117	9 May	920–930	10	2.5	25	Mostly sand, very coarse to medium, thin clay	Potomac	10Y 6/1 Gray
118	9 May	930–940	10	7.75	78	Mostly silty clay, some sand, clean to very muddy	Potomac	10Y 6/1 Gray
119	10 May	940–944.5	4.5	3.2	71	Clean fine to medium sand with lignite, clay silt	Potomac	10Y 4/1 Dark gray
120	10 May	944.5–950	5.5	5.2	95	Clay, clean fine to medium sand with lignite	Potomac	10Y 4/1 Dark gray
121	10 May	950–960	10	8.7	87	Clean fine to medium sand with lignite, paleosol, clay	Potomac	5Y 7/1 Light Gray, 5Y 5/1 Gray, 10Y R 5/2 Grayish brown
122	10 May	960–970	10	8.6	86	Muddy to clean sand with dark lamination, pyrite at the bottom	Potomac	5Y 7/1 Light gray, 5Y 3/1 Very dark gray
123	10 May	970–980	10	2.2	22	Sand and clayey sand	Potomac	5Y 4/1 Dark gray
124	10 May	980–990	10	5	50	Laminated clay over coarse to very coarse sand	Potomac	7/N Light gray
125	11 May	990–1000	10	1.9	19	Gravel, very coarse sand, and laminated clay	Potomac	7/N Light gray
126	11 May	1000–1010	10	10	100	Very coarse sand with pebbles and clay laminae	Potomac	7/N Light gray
127	11 May	1010–1020	10	10	100	Very coarse sand with pebbles and clay laminae	Potomac	7/N Light gray

Table T1 (continued).

Run number	Date (2007)	Cored interval (ft)	Run length (ft)	Recovered (ft)	Recovered (%)	Lithology	Formation	Color
128	11 May	1020–1030	10	9.4	94	Very coarse sand with pebbles and clay laminae	Potomac	7/N Light gray
129	12 May	1030–1040	10	1	10	Sandy, silty clay	Potomac	7/N Light gray
130	12 May	1040–1042	2	0.9	45	Medium to coarse sand	Potomac	7/N Light gray
131	12 May	1042–1047	5	3.3	66	Medium to coarse sand	Potomac	7/N Light gray
132	12 May	1047–1055	8	6.35	79	Medium to coarse sand	Potomac	7/N Light gray
133	12 May	1055–1065	10	1	10	Gravel	Potomac	7/N Light gray
134	13 May	1065–1070	5	1	20	Gravel	Potomac	7/N Light gray
135	13 May	1070–1073	3	0	50	No recovery	Potomac	
136	13 May	1073–1080	7	6.2	89	Medium to coarse sand	Potomac	7/N Light gray
137	13 May	1080–1090	10	2.9	29	Medium to coarse sand	Potomac	7/N Light gray

Table T2. Data used to construct cumulative percent plots. (**See table notes.**) (**Continued on next three pages.**)

Depth (ft)	Clay and silt (%)	Glauconite* (%)	Fine quartz (%)	Medium and coarser sand* (%)	Carbonate* (%)	Mica* (%)	Sphaero-siderite* (%)	Other* (%)
3.0	24.8	50	13	10	0	0	0	2
7.0	92.0	4	1	1	0	0	0	1
11.0	17.3	37	36	9	0	0	0	0
16.0	14.4	32	28	19	0	2	0	4
21.0	12.0	44	18	19	2	0	0	4
26.0	9.5	39	23	17	5	0	0	7
30.0	28.5	24	32	4	12	0	0	0
36.0	38.3	6	1	0	55	0	0	0
41.0	27.5	24	10	1	36	1	0	0
45.6	17.8	39	8	2	33	0	0	0
57.0	6.3	77	1	4	5	0	0	8
61.0	24.7	72	0	1	1	0	0	1
70.0	31.5	65	0	0	0	1	0	1
76.2	28.2	69	0	0	1	1	0	2
81.0	37.7	58	0	0	3	0	0	0
86.0	22.1	66	0	0	2	0	0	9
91.0	27.9	57	0	1	13	0	0	1
96.0	24.3	53	1	10	8	0	0	4
101.0	6.4	10	1	69	9	0	0	5
105.4	2.8	6	1	77	0	0	0	13
110.3	4.5	59	1	30	5	0	0	0
116.2	3.1	30	4	59	5	0	0	0
121.0	2.3	7	7	70	13	0	0	0
131.0	8.9	11	32	44	0	4	0	1
134.0	9.1	24	21	39	4	2	0	0
141.0	7.7	14	35	42	1	0	0	1
145.5	13.1	7	71	5	1	2	0	0
151.0	22.0	8	63	5	1	2	0	0
156.0	8.5	10	74	5	0	2	0	0
161.0	14.1	21	34	29	0	1	0	0
170.7	11.7	14	61	11	0	2	0	0
176.0	10.4	7	73	8	0	2	0	0
181.0	15.6	13	64	5	1	2	0	1
186.0	21.6	12	58	5	1	2	0	1
191.0	31.4	10	53	1	1	3	0	0
196.0	17.3	9	65	2	1	5	0	0
201.0	22.7	12	60	0	1	4	0	0
206.0	31.9	10	50	0	2	5	0	1
211.0	24.2	13	47	1	4	6	0	5
216.0	27.7	41	9	3	4	2	0	13
221.0	23.8	51	13	5	1	7	0	0
226.0	11.8	8	7	48	2	0	0	23
231.0	5.0	0	84	6	0	2	0	3
236.0	4.2	0	84	1	3	3	0	5
241.0	43.4	0	49	0	2	3	0	3
246.0	50.3	0	32	0	5	5	0	7
251.0	86.4	0	4	0	1	4	0	5
256.0	39.0	0	43	0	2	10	0	7
261.0	82.0	0	13	0	1	1	0	2
266.0	89.6	0	3	0	0	1	0	5
271.0	79.5	9	8	0	1	1	0	1
276.0	93.5	2	2	0	1	1	0	0
281.0	91.8	2	2	0	1	1	0	1
286.0	94.5	1	1	0	1	1	0	2
291.0	52.5	4	37	0	1	3	0	3
296.0	92.8	1	2	0	1	1	0	2
301.0	96.3	0	1	0	1	1	0	1
306.0	85.7	8	0	0	5	1	0	1
311.0	96.2	0	0	0	2	1	0	1
316.0	96.2	0	1	0	1	2	0	0
321.0	97.5	1	0	0	1	1	0	1
326.0	69.1	22	1	1	3	2	0	2
331.0	19.9	16	50	9	2	1	0	1
336.0	18.2	8	63	2	5	3	0	2
341.0	21.8	4	66	0	1	3	0	4
343.5	22.5	4	63	1	3	3	0	4
351.0	20.6	2	68	3	2	3	0	2

Table T2 (continued). (Continued on next page.)

Depth (ft)	Clay and silt (%)	Glauconite* (%)	Fine quartz (%)	Medium and coarser sand* (%)	Carbonate* (%)	Mica* (%)	Sphaero-siderite* (%)	Other* (%)
361.0	27.0	7	61	0	3	1	0	1
366.0	45.6	12	37	0	1	3	0	1
371.0	72.6	1	21	0	2	3	0	2
376.0	64.9	23	6	0	4	2	0	0
381.0	37.1	61	0	0	1	0	0	0
386.0	22.1	74	2	0	1	0	0	1
391.0	20.4	17	52	3	1	6	0	1
396.0	30.9	9	43	0	2	14	0	2
401.0	32.6	59	2	0	1	2	0	3
406.0	29.8	67	0	0	0	1	0	1
411.0	42.6	44	7	0	0	5	0	2
416.0	79.0	13	4	0	0	2	0	2
421.0	44.8	35	15	0	0	4	0	1
426.0	37.3	57	1	0	0	3	0	1
431.0	53.0	32	7	4	0	1	0	3
436.0	56.0	2	36	4	0	1	0	1
441.0	74.8	0	16	2	0	0	0	7
445.4	4.8	1	50	43	0	0	0	1
451.0	8.0	0	80	6	0	1	0	5
456.0	6.6	0	41	50	0	1	0	2
461.0	2.8	0	23	73	0	0	0	1
465.5	2.8	0	31	65	0	0	0	1
470.8	68.5	0	29	1	0	0	0	1
476.6	78.0	0	22	0	0	0	0	0
481.0	88.2	0	11	0	0	0	0	0
486.0	8.1	0	91	0	0	0	0	1
491.0	4.9	0	90	3	0	1	0	1
495.6	16.1	0	42	41	0	0	0	1
501.0	11.5	0	11	51	0	0	0	27
506.0	7.7	0	19	73	0	0	0	0
511.0	5.0	0	11	83	0	0	0	1
520.8	99.9	0	0	0	0	0	0	0
526.3	54.9	0	40	4	0	0	0	1
531.0	15.7	0	52	30	0	1	0	1
536.0	16.6	0	68	13	0	1	0	1
541.0	11.8	0	68	16	0	2	0	2
546.0	11.0	0	32	55	0	1	0	2
551.0	49.8	0	26	0	0	2	0	22
556.0	20.8	0	67	0	1	9	0	2
561.0	63.3	0	27	3	0	4	0	3
563.3	10.2	0	39	48	0	1	0	2
571.0	5.4	0	9	84	0	0	0	1
576.0	28.9	0	68	0	0	1	0	2
581.0	99.5	0	0	0	0	0	0	0
586.0	92.3	0	7	0	0	0	0	1
591.0	98.4	0	1	0	0	0	0	0
592.7	90.2	0	5	0	0	0	3	1
601.0	73.8	0	24	0	0	0	0	1
606.0	34.4	0	31	31	0	1	0	3
611.0	71.6	0	6	3	0	1	0	18
616.0	77.1	0	16	2	0	1	0	4
621.0	89.5	0	8	0	0	0	0	2
627.0	95.2	0	4	0	0	0	0	1
631.0	16.6	0	53	5	0	0	0	25
636.0	41.3	0	40	4	0	0	0	15
641.0	4.3	0	73	20	0	0	0	2
646.0	9.9	0	80	9	0	1	0	1
651.0	5.5	0	5	87	0	0	2	1
652.8	48.2	0	28	11	0	1	0	12
661.0	72.6	0	24	1	0	0	0	2
666.0	3.6	0	13	80	0	1	0	3
671.0	5.4	0	14	79	0	1	0	0
676.0	3.2	0	66	29	0	0	0	1
680.5	40.1	0	18	18	0	1	18	5
686.0	81.0	0	8	0	0	0	10	0
691.0	92.1	0	3	0	0	0	4	0
696.0	98.6	0	1	0	0	0	0	0
701.0	96.6	0	2	0	0	0	1	0

Table T2 (continued). (Continued on next page.)

Depth (ft)	Clay and silt (%)	Glauconite* (%)	Fine quartz (%)	Medium and coarser sand* (%)	Carbonate* (%)	Mica* (%)	Sphaero-siderite* (%)	Other* (%)
706.0	99.3	0	0	0	0	0	0	0
711.0	74.5	0	21	1	0	0	0	3
714.6	8.5	0	6	62	0	1	0	23
721.0	9.6	0	7	82	0	0	0	1
723.9	11.2	0	23	64	0	1	0	1
731.0	23.5	0	38	8	0	0	29	1
733.5	26.3	0	67	2	0	1	4	1
741.0	91.8	0	7	1	0	0	1	0
746.0	68.5	0	26	0	0	0	5	0
751.0	21.2	0	68	5	0	1	4	1
755.4	63.4	0	35	1	0	0	0	1
761.0	17.1	0	76	5	0	1	0	1
765.1	15.4	0	62	16	0	1	4	1
771.0	45.3	0	15	38	0	0	0	1
776.0	16.1	0	45	37	0	1	0	1
781.0	8.5	0	19	71	0	1	0	1
786.0	8.5	0	15	75	0	0	0	1
791.0	97.0	0	1	0	0	0	2	0
796.0	73.2	0	1	0	0	0	25	0
801.0	94.0	0	1	0	0	0	0	5
806.0	98.3	0	1	0	0	0	0	0
811.0	38.7	0	59	1	0	1	0	1
816.0	14.3	0	25	53	0	1	0	6
821.0	6.3	0	4	89	0	0	0	0
825.0	7.1	0	3	88	0	0	0	2
831.0	8.4	0	6	83	0	0	0	2
835.1	25.1	0	72	2	0	0	0	1
841.0	80.8	0	16	0	0	0	0	3
844.6	50.5	0	30	13	0	1	0	6
851.0	74.7	0	0	0	0	0	25	0
856.0	91.3	0	1	0	0	0	7	0
861.0	71.8	0	26	1	0	0	0	1
869.3	46.8	0	48	4	0	1	0	1
871.0	20.0	0	19	55	0	0	0	6
879.3	6.8	0	26	65	0	0	0	2
881.0	8.5	0	30	60	0	1	0	2
882.0	20.9	0	49	23	0	1	0	6
891.0	30.6	0	27	7	0	1	0	35
894.1	6.6	0	22	55	0	1	0	15
901.0	4.1	0	4	91	0	0	0	0
906.0	15.3	0	8	76	0	0	0	0
911.0	23.1	0	44	29	0	1	0	3
916.0	7.9	0	7	84	0	0	0	1
921.0	12.7	0	13	73	0	1	0	0
922.4	54.3	0	29	15	0	1	0	1
931.0	91.0	0	8	0	0	0	0	0
936.0	73.2	0	21	5	0	0	0	1
941.0	6.8	0	19	73	0	1	0	0
946.0	8.1	0	16	74	0	1	0	1
950.9	6.8	0	12	80	0	1	0	1
956.0	94.6	0	5	0	0	0	0	1
961.0	8.5	0	10	80	0	0	0	1
966.0	7.6	0	11	81	0	0	0	1
971.0	17.9	0	13	64	0	0	0	4
972.1	19.6	0	14	64	0	1	0	2
981.0	85.6	0	12	1	0	0	0	1
984.9	9.4	0	1	89	0	1	0	0
991.0	88.3	0	11	0	0	0	0	0
1001.0	23.1	0	18	57	0	0	0	2
1006.0	7.3	0	9	83	0	0	0	1
1011.0	10.5	0	8	80	0	0	0	2
1016.0	7.2	0	9	84	0	0	0	0
1021.0	10.1	0	4	85	0	0	0	0
1026.0	29.5	0	5	64	0	0	0	1
1029.3	6.6	0	6	85	0	1	0	1
1039.0	84.8	0	13	1	0	1	0	0
1041.0	16.7	0	14	68	0	0	0	1
1045.0	20.1	0	26	52	0	1	0	1

Table T2 (continued).

Depth (ft)	Clay and silt (%)	Glauconite* (%)	Fine quartz (%)	Medium and coarser sand* (%)	Carbonate* (%)	Mica* (%)	Sphaero-siderite* (%)	Other* (%)
1051.0	2.3	0	2	94	0	1	0	1
1055.9	11.8	0	3	84	0	0	0	2
1065.9	0.8	0	0	99	0	0	0	0
1073.0	24.1	0	62	8	0	2	0	4
1076.0	13.9	0	9	75	0	1	0	1
1081.0	39.7	0	10	49	0	1	0	1

Notes: See Figures **F2, F3, F4, F5, F6, F7, F8,** and **F9** for cumulative percent plots. * = obtained by visual best estimate; see **"Lithostratigraphy and Sequence Stratigraphy."** Percent silt and clay was quantitatively measured by weighing each sample before and after washing off the clay and silt. The weight of the remaining sand was compared to the weight of the original sample to calculate percent silt and clay. All other percentages were arrived at qualitatively by visually estimating the proportion of each constituent in the sand fraction.

Table T3. Pollen and dinocyst occurrences in the Medford corehole, Leg 174AXS. (See table notes.) (Continued on next three pages.)

Level (ft)	Spores	Pollen	Comments
444–444.2			Essentially barren except for a single tricolpate grain.
471.1–471.2			Zone V.
485.5–485.7			Some long ranging spores, Zone V.
522.4			Zone V, Magothy Formation, *Deflandria* (dinoflagellate).
529			Some nondiagnostic long ranging spores.
533.3–533.5			A few nondiagnostic Cretaceous spores.
*560	*Appendicisporites multicornutus* Kinyai.	*Sabalpollenites dividuus* Kimyai.	Zone V, Raritan Formation.
581.0–581.2	*Apiculatisporis babsae, Neoraistricktia robustus.*		Reworked Patapsco Zone II spores.
585.2	*Neoraistrickia robustus.*		Reworked Patapsco spore.
646.2–646.3			A few nondiagnostic spores and lots of durain.
*677.8–678.05	*Rugibivesiculites multiplex* Pierce, *Tricolpites wilsoni* Kimyai.		Zone IV, Raritan Formation.
755.3–755.5			Essentially barren with a few grains of nondiagnostic spores.
*761.1	*Cicatricosisporites patapscoensis* Zone II–Zone III, *Rugibivesiculites rugosa* common in Zone IIC, *Cicatricosisporites patapscoensis* Zone IIB–Zone III.	*Tricolporopollenites triangulus* Zone IIC–Zone III.	Zone IIC–Zone III, uppermost Patapsco. Zone IIC cannot be distinguished from Zone III because of poor palynomorph recovery.
*933.8–934.0	*Appendicisporites patapscoensis* Zone II.	*Auraucariacites australis* common occurrence of this gymnosperm pollen typical in Zone IIB, *Clavatipollenites minutus* common occurrence at this horizon suggests Zone II.	Zone II B, Patapsco. Common occurrence of various species of *Cicatricosisporites* more typical of Zone II than Zone III.
982.2–982.4	*Neoraistricktia robustus* Zone IIB.		Very poor sample.
1039.1–1039.3	*Cicatricoisporites hallei* common, *Cicatricoisporites* spp. common, *Granulatisporites dailyi.*		Very poor sample that resembles Patuxent Arundel Horizon Zone I? Impoverished assemblage makes it impossible to distinguish Zone I from Zone II. Common occurrence of species of Schizaeaceae spores more typical of Zone I.
1043.7–1043.9	*Cicatricosisporites australensis* common, *Cicatricosisporites hallei, Cingulatisporites distaverrucosus, Granulatisporites dailyi.*		Zone I? Common occurrence of species of Schizaeaceae spores more typical of Zone I.
435.5–435.6			Poor recovery some spores, rare small tricolporate triangular pollen.
438.9–484			No organic residue.
444.1–444.2			Unsure of status.
444–444.2			Very poor recovery some spores, a few pollen (gymnosperms and rare angiosperms).
471.1–471.2	*Cyathidites* type spores common, Bisaccates (abundant, mostly mineral-filled), *Cicatricosisporites?* sp. (schizaceous fern spores); common, small oblate tricolporate, medium oblate tricolporate (aff. *Colpoporopollenites*?), small prolate tricolporate, advanced triporate (deformed, unidentified); very rare, *Taxiodiaceaepollenites hiatus* type, Cf. *Minorpollis minima*?; very rare, not any good normapolles.		(PPMcL: Zone ?) Good sample but good zone markers are lacking.
485.3–485.4	*Cicatricosisporites*? sp. (schizaceous fern spores), common.	*Taxiodiaceaepollenites* sp. (taxodiaceous type), common bisacccate conifers.	(PPMcL: Zone ?). Good sample but good zone markers are lacking. Nondescript mid-size tricolpates, smaller subtriangular oblate tricolpates with slightly thickened pink rims on colpi, small normapolle, nondescript thin-walled smallish subtriangular triporate with simple open pores, monolete polypod type.
485.5–485.7			Essentially barren. Some nondiagnostic long ranging spores, including schizaceous type.
520–520.2			Barren.

Table T3 (continued). (Continued on next page.)

Level (ft)	Spores	Pollen	Comments
522.9–523.0	*Complexiopollis* sp., *Cicatricosisporites* sp.	*Taxiodiaceaepollenites* hiatus type, common saccate conifers, *Momipites* sp.?, *Complexiopollis* cf. sp. K? Christopher (punctuate appearance from columellae, distinct annulus) Zone IV, *Complexiopollis* sp. V? Christopher (thick arci, concave sides) Zone V, *Complexiopollis* sp. D? Christopher (convex sides with folded-over arci) Zone IV.	(PPMcL: Zone IV or V?). Good sample, should be zonable. Several other species of smaller, more triangular normapolles, smaller subtriangular oblate tricolpates with slightly thickened pink rims on colpi, circular oblate tripolorate with small u-shaped thickenings at pores.
529–529.1	*Laevigatosporites* cf. *gracilis*, *Cyathidites* sp., *Concavissimisporites* sp. (small, thickened exine), *Sphagnumsporites* sp.	*Taxiodiaceaepollenites hiatus, Abietineaepollenites*? sp., other bisaccates spp., "*Tricolporopollenites*" cf. *triangulus*.	(GJB: nondiagnostic; PPMcL: Zone IV? Higher?). I don't have a lot of experience in this interval so only estimate as Zone IV; only really suggestive form is the *T.* cf. *triangulus*, which ranges down to Zone III but looks like an advanced form like that shown for Zone IV by Doyle and Robbins (1977).
533.3–533.5			Poor recovery.
560.1–560.2	*Plicatella multicornutus* Kimyai (described in Woodbridge clay), *Cicatricosisporites* spp.*, Concavissimisporites* sp. *(psilate), Lycopodiacidites cerniidites, Gleicheniidites senonicus?, Plicatella multicornutus* (Zone IV/ Woodbridge clay or higher), *Equisitosporites* cf. *virginiaensis.*	*Sabalpollenites dividuus* Kimyai (described in Woodbridge clay), *Abietineaepollenites* sp.*, Pinuspollenites* sp., other bisaccate conifers, *Taxiodiaceaepollenites hiatus, Tricolporopollenites* cf. *triangulus.*	(GJB: Zone IV?; PPMcL: Zone IV?). Abundant bisaccates, a few inaperturates and spores, in generally junky sample; spore assemblage has a different look than the samples below; I don't have a lot of experience in this interval so only estimate as Zone IV.
561.8–562.0	*Plicatella tricornitatus, Sphagnumsporites* sp.?, *Cicatricosisporites* spp., *Cicatricosisporites* cf. *hallei*, *Cyathidites* sp., *Laevigatosporites gracilis, Triporoletes* sp.	*Classopollis classoides, Equisitopollenites*/*Ephedripites* sp., *Taxiodiaceaepollenites hiatus, Rugibivesiculites rugosus* (Zone IIC to at least top K), common *Saccate Conifer* spp., *Brenneripollis peroreticulatus*?, *Peromonolites* (*Brenneripollis*) *reticulatus*, *Reticulate* monosulcates, *Retimonocolpites dividuus*?, small tricolp/tricolporates, cf. *"Tricolpoporopollenites"* sp. B of D&R (Zone III upward), Cf. *Rousea geranioides*? (Zone II upward), *Tricolpites* sp. cf. *T. retiformis* (long range, to Paleogene?) or *T. micromunus* (from Zone II), *Tricolpites* sp., *Triatriopollenites*? sp. (triporate, probably Zone IV and younger), *Foveotricolporites rhombohedralis* (typical form; Zone III upward), *Tricolpites* sp. cf. *T. retiformis*?, *Tricolpites minutus*?	(PPMcL: upper Zone III to lower Zone IV?). Many oblate tricolporates (Zone III upward) but only one triporate species; marine influence indicated by dinoflagellates. Very rare dinoflagellates and fragments.
581.0–581.2	*Apiculatisporis babsae* (reworked, GJB), *Neoraistrickia robustus* (reworked, GJB).	*Tricolpate angiosperm.*	(Zone IIB or younger). Gymnosperm pollen, some spores, rare angiosperm pollen, generally poor recovery.
585.2–585.3	*Neoraistrickia robustus* (reworked, GJB).		Unzoned.
591.0–591.1			Barren.
610.0–610.1	*Plicatella* sp., *Plicatella tricornitatus, Taurucusporites reduncus, Cyathidites* sp., *Cicatricosisporites* sp.	*Taxiodiaceaepollenites hiatus,* a few bisaccates, *Monosulcites* sp., *Porocolpopollenites* or *Tricolporopollenites* sp. (higher in Zone III?), *Tricolporoidites* sp. A D&R (Zone III, possibly higher), *Tricolpites*? sp., Cf. *Psilatricolporites distinctus* (Zone IIC through Zone V [SAFC] maybe higher), Cf. *Tricolpopollenites micropunctatus* Groot or aff. *Tricolporoidites* sp. A D&R, *Clavatipollenites* cf. *minutus* (Zone I to at least Zone III, maybe higher) common, cf. *Tricolporopollenites* sp. A (Zone III and upward), Dinoflagellate.	(PPMcL: Zone III, upper?). Many oblate tricolporates (Zone III upward) but no triporates or advanced tricolporates so not likely Zone IV; marine influence indicated by dinoflagellates.
612.7–612.9			No spores or pollen.
623.9–624			No organic residue.

Table T3 (continued). (Continued on next page.)

Level (ft)	Spores	Pollen	Comments
628.5–628.6	*Cicatricosisporites* sp., *Cicatricosisporites hallei, Gleicheniidites senonicus*? *Cyathidites* sp.	*Abietieaepollenites* sp., *Eucommiidites troedssoni*? *Inaperturopollenits dubius, Taxiodiaceaepollenites hiatus, Sabalpollenites scabrus, Classopollis classoides, Clavatipollenites minutus, Clavatipollenites hughesii, Tricolporopollenites* cf. sp. B (Zone III and upward), *Cupuliferoidaepollenites parvulus, Tricolpites minutus, Psilatricolporites distinctus* (upper Zone IIC and Zone III? and above), *Tricolporoidites* sp. A (typical forms like this more typical of Zone III, some forms down into Zone IIC).	(PPMcL: Zone III). A lot of fine debris and most of the pollen are small; includes forms that start in Zone III but no advanced types or triporates so not likely Zone IV.
637.0–637.2			Essentially barren.
646.2–646.4			Little recovery, a few nondiagnostic spores and lots of durain.
660.7–660.8	Spores: *Plicatella* sp., *Cicatricosisporites* sp., *Triporoletes* cf. *cenomanius*, *Sphagnumsporites* sp. cf. *antiquisporites*.	*Taxiodiaceaepollenites hiatus*, common saccate conifers, *Porocolpopollenites* sp., *Clavatipollenites* cf. *minutus* (Zone I to at least Zone III, maybe higher), *Psilatricolporites* cf. *subtilis* (Zone IIC, Zone III, probably higher to at least late Cenomanian), *Tricolpites* cf. *micromunus*?, "*Tricolporopollenites*" aff. *triangulus* (Zone IIB upwards to at least Zone IV), *Tricolpites* cf. *micromunus*?, *Tricolpites* cf. *crassimurus*, *Tricolpites nemejcii*? (Zone III).	(PPMcL: Zone III?). Good sample; numerous finely reticulate tricolpates and small tricolp/tricolporates with slightly thickened rims; possible *T. nemejcii* is only marker for Zone III or higher; no triporates, normapolles or other advanced angiosperms indicative of Zone IV.
677.85–678.05			Essentially barren.
677.8–677.9			Essentially barren.
677.85–678.05		*Rugibivesiculites multiplex* Pierce, *Clavatipollenites* sp.,*Tricolpites wilsoni* Kimyai.	(GJB: Zone IV; PPMcL: Zone III? based on position). PPMcL has no slides but noted numerous *Plicatella* before sent; is it possible that *R. multiplex* and *T. wilsoni* could have been confused with similar Zone III forms? I would be surprised by Zone IV at this depth given other samples above.
705.9–706			No organic residue.
708–708.2	*Cicatricosisporites* sp.		Very poor recovery.
709.5–709.6	Spores: *Cicatricosisporites* sp.	*Taxiodiaceaepollenites hiatus,* a few bisaccates, *Clavatipollenites* cf. *minutus* (Zone I to at least Zone III, maybe higher), *Tricolpites* sp. B (Zone IIB to Zone III), "*Tricolpopollenites*" *parvulus* (Zone IIA to Zone III), *Tricolpites* cf. *albiensis*? (Zone IIA–Zone IIC per D&R, into Zone III per Hochuli), *Tricolpites minutus* (from base Zone IIB, poroidate forms more common from upper Zone IIB upward), *Psilatricolporites* cf. *subtilis* (Zone IIC-–Zone III), *Tricolpites* cf. *micromunus* (Zone IIA upward), *Tricolporopollenites* aff. *triangulus* (Zone IIB upward thru Zone III, but this less triangular type probably lower in range).	(PPMcL: Zone III?). Zone call based on position; tricolporoidates common, no advanced or triporate forms, no definite clear Zone III indicators.
732.0–732.2			Barren.
733.35–733.45			No organic residue.
752.0–752.1	*Cyathidites* sp., *Cicatricosisporites hallei*?, *Cicatricisporites* cf. *potomacensis*, *Cicatricosisporites subrotundus* (Zone IIB upward), *Lycopodiacidites* sp., *Plicatella tricornitatus, Foveotriletes subtriangularis* (Zone I and Zone II per Brenner 1963).	*Taxiodiaceaepollenites hiatus*, *Podocarpidites* sp., *Liliacidites variegatus*?, *Sabalpollenites scabrus, Normapolle* sp. (psilate 40 micron triangular brevitricolporate; Complexiopollis? Plicapollis?), *Tricolporopollenites*? sp.	(PPMcL: Zone III?). This sample contains what looks to be an anomalously early appearance (based on all other pollen) of a normapolle-type pollen. This is a single but definite specimen (I am not good with these yet so not sure of species). These usually do not appear until Zone IV in eastern North America. However, *Complexiopollis* appears in the mid-Cenomanian in Europe and in DSDP cores from the western North Atlantic. So, I am thinking Zone III is reasonable. Bisaccate conifers (mostly broken and pyrite? filled), large monosulcate.
755.3–755.5			Essentially barren.

Table T3 (continued).

Level (ft)	Spores	Pollen	Comments
761.1–762.2	*Cicatricosisporites patapscoensis* Zone II–Zone III, *Cicatricosisporites patapscoensis* Zone IIB–Zone III.	*Rugibivesiculites rugosus* common in Zone IIC, *Tricolporopollenites triangulus* Zone IIC–III. Spores: *Cicatricosisporites* sp., Pollen: *Rugubivesiculites rugosus* (appears and is common in Zone IIC), *Abietineaepollenites* sp.,several other types of *bisaccates*, *Taxiodiaceaepollenites dubius*, *Sabalpollenites scabrus*?	(GJB: Zone IIC–Zone III; PPMcL: Zone IIC). PPMcL's slides are the leftovers and don't have as much spore and pollen material; not many small pollen so lack of Zone III forms may not be meaningful, but Zone IIC may be reasonable on basis of lack of Zone III forms in this and higher samples.
801.8–802.0			Essentially barren.
893.4–893.5	*Cyathidites* sp.,*Trilobosporites marylandicus, Plicatella tricornitatus, Plicatella dentimarginatus, Apiculatisporites babsae* (Zone IIA and higher), *Cirratriradites spinulosus, Cicatricosisporites* sp.	*Parvisaccites rugulus, Abietineaepollenites* sp, and other abundant pyrite? Filled unidentified *saccates, Sabalpollenites scabrous, Araucariacites australis, Eucommidites trodesonni, Taxiodiaceaepollenites hiatus,* "*Tricolporopollenites*" *parvulus* (Zone IIA to at least Zone III).	(PPMcL: Zone IIB or higher). Angiosperm pollen very rare, mostly conifers and lesser spores, *N. robustus* present at lower level.
805.9–806			No organic residue.
843–843.1			No organic residue.
912–912.1			No organic residue.
933.8–934.0	*Plicatella patapscoensis* Zone II, *Plicatella potomacensis, Plicatella tricornitatus, Granulatisporites dailyi, Cicatricoisporites hallei, Cicatricoisporites australiensis, Cicatricoisporites subrotundus*?, *Polycingulatisporites spackmani*?	*Araucariacites australis* common occurrence of this gymnosperm pollen typical in Zone IIB, *Clavatipollenites minutus* common occurrence at this horizon suggests Zone II, *Cicatricosisporites* spp. when common more typical of Zone II than Zone III. Pollen: *Araucariacites australis* most common, *Taxiodiaceaepollenites hiatus, Podocarpidites potomacensis, Abietieaepollenites* sp., *Sabalpollenites scabrus, Clavatipollenites hughesi*?, *Tricolpites crassimurus* (uppermost Zone I thru at least Zone III).	GJB: Zone IIB; PPMcL: Zone IIB or higher). One of the best s/p samples, with spores, gymnosperms, and rare angiosperms, many *Clavatipollenites*, *N. robustus* is at lower level.
942.5–942.6	*Cyathidities* spp. (common), *Laevigatosporites gracilis, Cicatricisisporites* sp. (includes *C. australiensis*), *Gleicheniidites senonicus*?, *Gleicheniidites apilobatus.*	Abundant pyrite-filled unidentified saccates (multiple spp. including *Alisporites* cf. *bilateralis*, and *Abietieaepollenites* sp.), *Eucommidites trodesonni, Clavatipollenites hughesi, Sabalpollenites scabrus*?, *Araucariacites australis, Concavissimisporites punctatus, Tricolpites* aff. *crassimurus*? (uppermost Zone I upward), *Tricolpites micromunus*? (Zone IIA upward, lacks poroid forms that become common in upper Zone IIB).	(PPMcL: lower Zone IIB?). Common small prolate tricolpates but lacks tricolporoidate types present above, more monosulcates, *N. robustus* present at lower level.
952.5–952.6			No organic residue.
982.2–982.4	*Neoraistricktia robustus* appears in Zone IIB.		(GJB: Zone IIB). Very poor sample. Little recovery, a few s/p - some bubble problems two slides with one coverslip each.
1008–1008.1			No organic residue.
1039.1–1039.3	*Cicatricoisporites hallei* (common), *Cicatricoisporites* spp. (common), *Granulatisporites dailyi.*		(GJB: Zone I?). Only slides to GJB, notes very poor sample Zone I?; before sent, PPMcL noted very lean, a few gymnos and spores, abundant fine plant debris.
1043.7–1043.9	*Cicatricosisporites australensis* (common), *Cicatricosisporites hallei, Cingulatisporites distaverrucosus, Granulatisporites dailyi, Plicatella tricornitatus, Lycopodiacidites intraverucatus*?, *Cicatricosisporites* sp., *Gleicheniidites senonicus*?, *Granulatisporites dailyi, Taurocusporites reduncus, Matonisporites excavatus*?	*Abietieaepollenites* sp., *Taxiodiaceaepollenites hiatus, Podocarpidites potomacensis*?, *Eucommidites trodesonni, Monosulcites* sp.	(GJB: Zone I?; PPMcL: Zone I or possibly Zone IIA?). GJB suggests Zone I? because common occurrence of species of Schizaeaceae spores that are more typical of Zone I. PPMcL notes no angiosperm pollen, no really clear markers, so likely Zone I but possibly could be depauperate Zone II.

Notes: The palynomorphs from 16 samples in the Medford, New Jersey, corehole were examined to determine a biozonation. Slides were prepared at the Delaware Geological Survey. Most samples yielded meager spore and pollen preservation. This is most likely due to lithotype selection or availability. A few slightly better prepared samples could be dated as Raritan by the presence of a few stratigraphically diagnostic forms. Samples that have some certainty are preceded by an asterisk.

Table T4. Planktonic foraminifer occurrences in the Medford corehole, Leg 174AXS. (See table note.)

Level (ft)	Planktonic foraminifers	Comments
55.4–55.5	*Acarinina strabocella*	P3a with some mixture of older foraminifers
	Chiloguembelina midwayensis	
	Globanomalina compressa	
	Globanomalina ehrenbergi	
	Morozovella angulata	
	Morozovella occlusa	Out of place
	Parasubbotina pseudobulloides	
	Parasubbotina varianta	
	Parasubbotina variospira	
	Subbotina triloculinoides	
56.1–56.2	*Acarinina strabocella*	P3a
	Chiloguembelina midwayensis	
	Chiloguembelina morsei	
	Globanomalina compressa	
	Globanomalina imitata	
	Globoconusa daubjergensis	Mixed in
	Guembelitria cretacea	Way out of place
	Parasubbotina pseudobulloides	
	Parasubbotina varianta	
	Subbotina triloculinoides	
57.4–57.5	*Chiloguembelina midwayensis*	P1c abundant foraminifers TST
	Globanomalina compressa	
	Globoconusa daubjergensis	
	Parasubbotina pseudobulloides	
	Praemurica inconstans	
	Praemurica pseudoinconstans	
	Subbotina triloculinoides	
61.4–61.5	*Heterohelix globulosa*	Maastrichtian
	Globigerinelloides multispina	
	Guembelitria cretacea	
	Rugoglobigerina reicheli	
	Rugoglobigerina rugosa	

Note: TST = transgressive systems tract.

Table T5. Cenozoic calcareous nannoplankton occurrences in the Medford corehole, Leg 174AXS. (See table notes.)

Level (ft)	Comments
	Biostratigraphy
33.0	*Heliolithus riedelii* (common) and *Discoaster mohleri* (rare), occurrences that indicate Zone NN8. Other taxa include, i.al., *Chiasmolithus bidens, C. consuetus, Fasciculithus tympaniformis, Neochiastozygus junctus, Toweius eminens,* and *Zygodiscus plectopons*. *Braarudosphaera* spp. and *Micrantholithus* spp. are unusually common.
41.0	An assemblage dominated by the pentatiths of *Braarudosphaera* spp. and *Micrantholithus* spp. The occurrence of *D. mohleri* indicates Zone NP7. However, the assemblage is little diversified; in particular species of *Heliolithus* are absent. The zonal assignment based on a single sample is thus tentative.
48.0	An assemblage very similar to that at 41.0 m. The co-occurrence of *Fasciculithus tympaniformis, Heliolithus kleinpelli,* and *Discoaster mohleri* allow a confident assignment to Zone NP7.
55.5–60.1	A high diversity assemblage very different from those at 41.0 and above, with few pentaliths (of *Braarudosphaera bigelowii*) and with *Chiasmolithus danicus*, *Cruciplacolithus tenuis,* and *Ellipsollithus macellus*, indicative of the lower part of Zone NN4.
60.6	Very rare, poorly preserved coccoliths with *Chiasmolithus danicus* and *Cruciplacolithus danicus*, which confer to this level a minimum NP3 zonal age. The possibility that this level belongs to lower Zone NP4 as well cannot be excluded. Cretaceous coccoliths are reworked at this level.
72.0	Abundant Cretaceous species with *Arkhangelskiella cymbiformis*, *Eiffeilithus turriseiffelii*, *Micula* spp., *Watznaueria barnesae*, and rare Danian species. The occurrence of *Biantholithus sparsus* and *Cruciplacolithus primus* indicate Subzone NP1b species are being mixed into this interval.
	Stratigraphic interpretation
48.0–55.5	There is a clear stratigraphic gap between Zone NP7 and lower Zone NP4. The sampling is insufficient to resolve the hiatus which may be ~3 m.y.
57.0–72.0	The sampling is also insufficient to resolve the stratigraphic succession where one or several stratigraphic gaps are suspected.
	Paleoenvironment
48–55.5	The marked change in the composition of the assemblages may be related to shallowing. Although the ecology of pentalith-bearing species is not well established, they seem to be more common in shallower waters. The sedimentary gap may be associated with shallowing.

Notes: The upper three stratigraphic levels (3.0, 6.6, and 11.0 ft) were barren, probably because of secondary silicification. Level 60.6 ft contained only very rare coccoliths. All other stratigraphic levels contained common to abundant, well to moderately well preserved calcareous nannofossils.

Table T6. Cretaceous calcareous nannoplankton occurrences in the Medford corehole, Leg 174AXS. (See table notes.) (Continued on next page.)

Depth (ft):	231	241	251	261	271	286	291	301	311	321	331	341	351	361	371	381	386	389	389.95	390	391	392	396	401
Depth (m):	70.4	73.5	76.5	79.6	82.6	87.2	88.7	91.7	94.8	97.8	100.9	103.9	107.0	110.0	113.1	116.1	117.7	118.6	118.9	118.9	119.2	119.5	120.7	122.2
Nannofossil zone:	?	B	?	?	B	B	B	B	B	B	CC20	CC19	CC19	CC19	CC19	CC19	CC18	CC18	CC18	CC17	CC17	CC17	CC17	CC17
A. cymbiformis											X				X									
B. parcus CC17/18	X										X					X	X	X	X					
B. constrictus CC18a											X					X?	X?		X (cf.)					
B. expansa	X														X					X	X	X		X
B. hayi CC18/19																								
Braarudosphaera sp.												X												
C. aculeus FO CC20	X?		X?	X																				
C. arcuatus CC21B																								
C. obscurus	X														X	X	X		X	X	X			
C. ovalis												X				X	X	X		X	X			
C. verbeekii FO CC18C			X	X?											X									
E. eximus	X?														X	X	X		X	X	X	X		X
E. floralis	X?																							
L. cayeuxii	X											X			X	X	X		X	X	X	X		X
L. grillii												X												
M. concava																								
M. furcatus																	X	X			X			X
R. anthophorus	X?																							
R. levis																								
U. sissinghii			X?	X?																				
U. trifidus	X?			X																				
W. barnesae	X															X								X
Biscutum sp.				X																				
Absence of *M. furcatus*				X							X	X				X?								
Absence of *B. parcus*																				X	X	X		X

Notes: Shaded cells = species relied upon for zonation. FO = first occurrence.

Table T6. (continued.)

Depth (ft):	401.8	403	404	405	406	411	416	421	431	441	413	416	421	421.2	422.75	423	424.1	425	425.9
Depth (m):	122.5	122.8	123.1	123.4	123.7	125.3	126.8	128.3	131.4	134.4	125.9	126.8	128.3	128.4	128.9	128.9	129.3	129.5	129.8
Nannofossil zone:	CC17	CC17	CC17	B	B	B	B	B	B	B	CC16	B	B	B	B	CC16	CC16	CC16	B
A. cymbiformis																			
B. parcus CC17/18																			
B. constrictus CC18a																			
B. expansa	X		X																
B. hayi CC18/19																			
Braarudosphaera sp.																			
C. aculeus FO CC20																			
C. arcuatus CC21B																			
C. obscurus	X	X	X																
C. ovalis																			
C. verbeekii FO CC18C																			
E. eximus	X										X								
E. floralis		Premature									X?								
L. cayeuxii											X					X?	X?	X	
L. grillii			X																
M. concava											X						X		
M. furcatus			X																
R. anthophorus																			
R. levis																			
U. sissinghii																			
U. trifidus																			
W. barnesae																			
Biscutum sp.																			
Absence of *M. furcatus*																			
Absence of *B. parcus*																			

Table T7. Sr isotopic data, Medford corehole, Leg 174AXS.

Depth (ft)	Depth (m)	Material	Sr value	Error	Age (Ma) Miller (2004)	Age (Ma) MacArthur et al. (2001)
30.0	9.1	Shell	0.707776	0.000007	Paleo	57.1
47.0	14.3	Shell	0.707783	0.000007	Paleo	57.9
61.0	18.6	Shell	0.707837	0.000008	66.0	33.5
90.0	27.4	Shell	0.707799	0.000010	67.7	67.4
93.0	28.3	Shell	0.707811	0.000008	67.2	66.8
101.0	30.8	Shell	0.707700	0.000008	72.2	71.9
121.0	36.9	Shell	0.707628	0.000007	74.5	74.3
134.0	40.8	Shell	0.707626	0.000006	74.6	74.4
145.5	44.3	Shell	0.707629	0.000007	74.4	74.2
192.3	58.6	Shell	0.707634	0.000007	74.1	74.0
216.0	65.8	Shell	0.707601	0.000010	76.0	75.7
225.0	68.6	Shell	0.707628	0.000007	74.5	74.3
247.1	75.3	Shell	0.707593	0.000007	76.4	75.9
250.8	76.4	Shell	0.707589	0.000007	76.6	76.0
250.8	76.4	Shell	0.707585	0.000006	76.8	76.1
271.4	82.7	Shell	0.707604	0.000006	75.8	75.5
287.3	87.6	Shell	0.707562	0.000007	78.1	77.1
287.3	87.6	Shell	0.707586	0.000008	76.8	76.1

Figure AF1. Representative lithofacies from the Medford corehole: shell bed in the Vincentown Formation (47.7–48.3 ft; 14.5–14.7 m); Cretaceous/Paleogene boundary (60–62 ft; 18.3–18.9 m); transgressive surface in the Navesink I sequence (96.7–97.4 ft; 29.5–29.7 m).

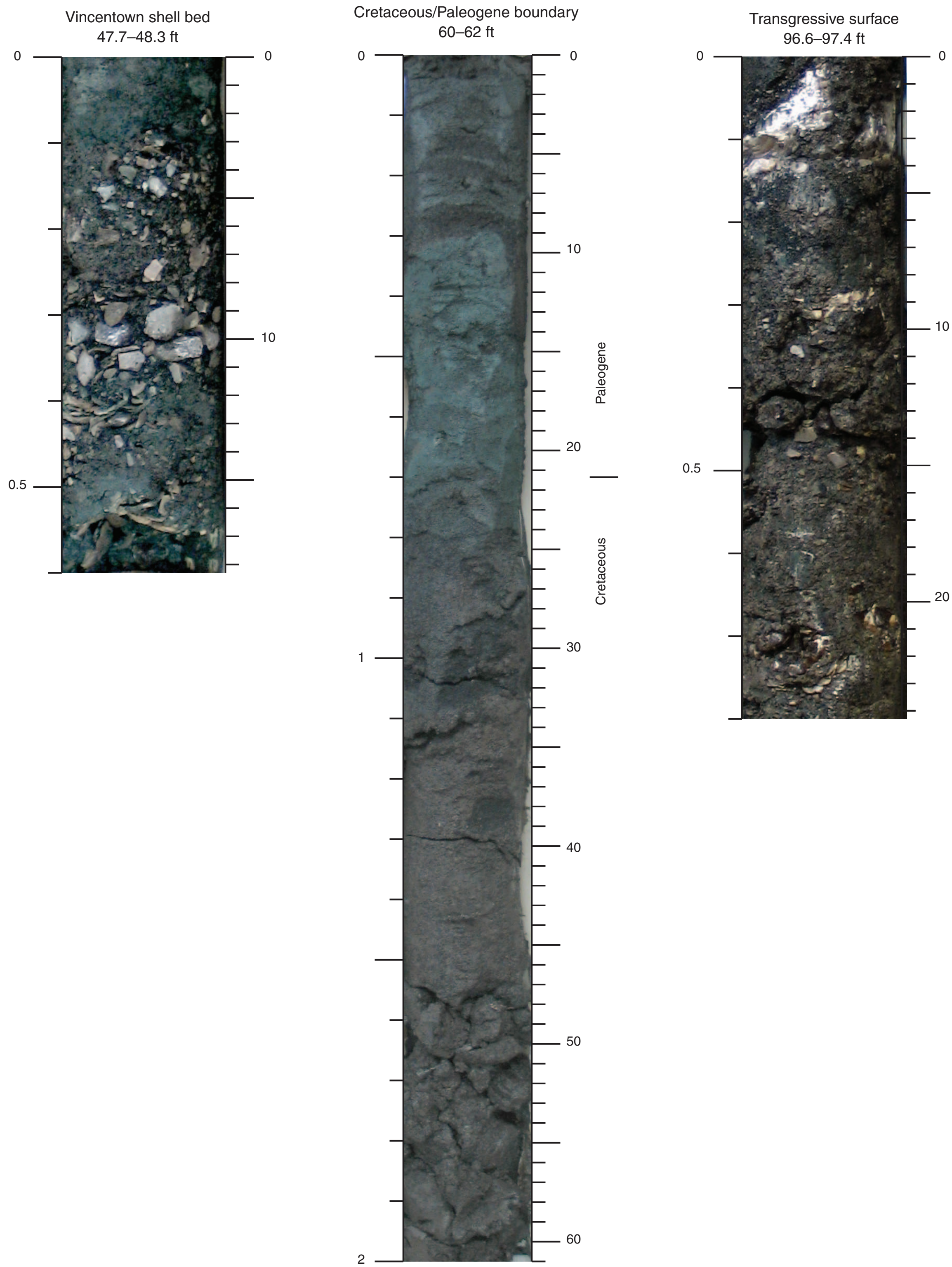


Figure AF2. Representative lithofacies from the Medford corehole: upper shoreface sediments from the Mount Laurel Formation (104–107 ft; 31.7–32.6 m); lower shoreface sediments from the Mount Laurel Formation (150–152 ft; 45.7–46.3 m); offshore sediments from the Wenonah Formation (192–194 ft; 58.5–59.1 m); part of the transgressive systems tract from the Marshalltown sequence (Marshalltown Formation; 212–214 ft; 64.5–65.2 m); contact between the Marshalltown and Englishtown formations (223.5–224.6 ft; 68.1–68.5 m).

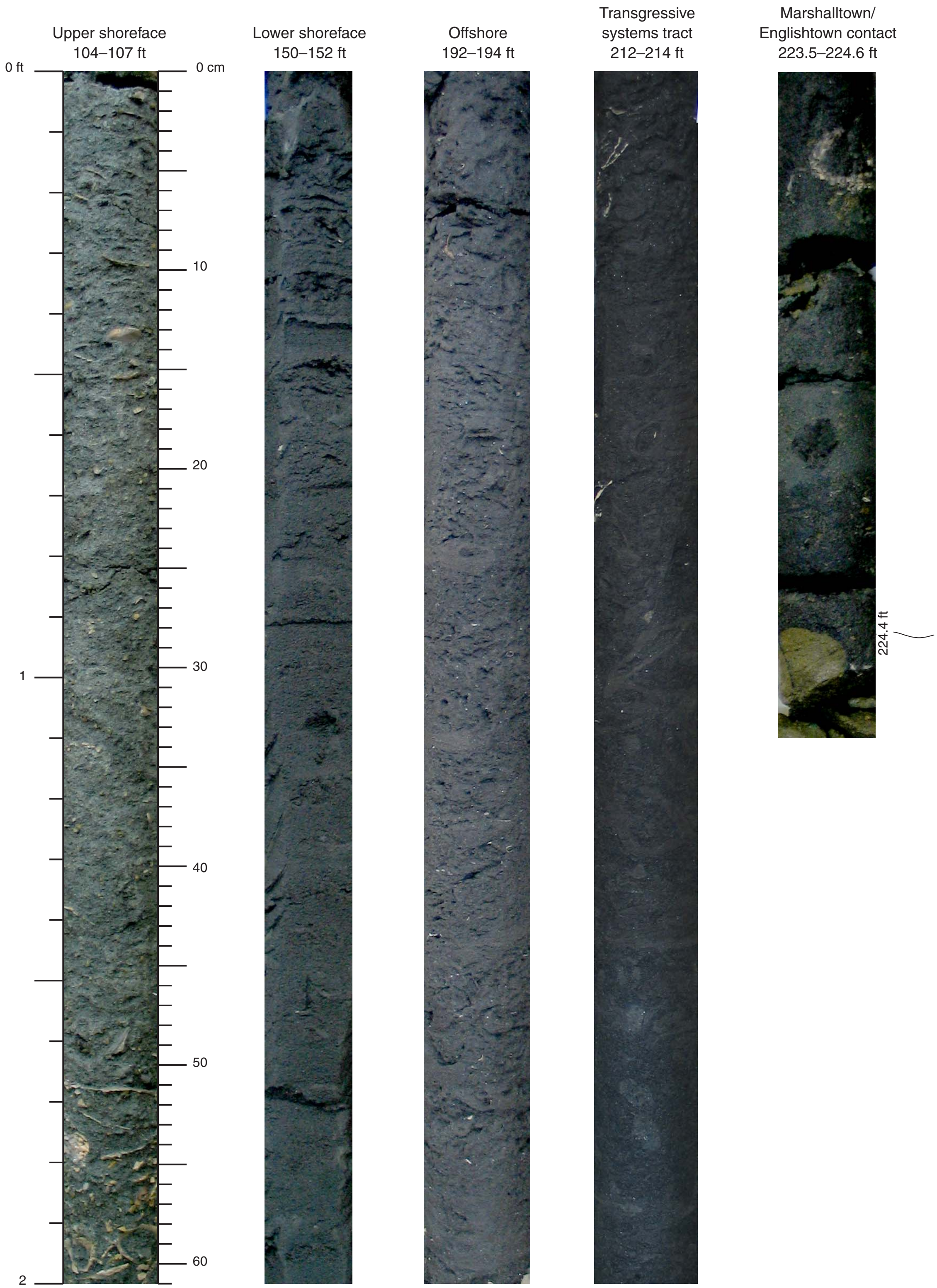


Figure AF3. Representative lithofacies from the Medford corehole: delta front deposits from the upper Englishtown Formation (234–236 and 244–246 ft; 71.3–71.9 and 74.4–75.0 m); offshore sediments from the upper Englishtown Formation (264–266 ft; 80.5–81.1 m); contact between the lower and upper parts of the Englishtown Formation (328–329.5 ft; 100.0–100.4 m).

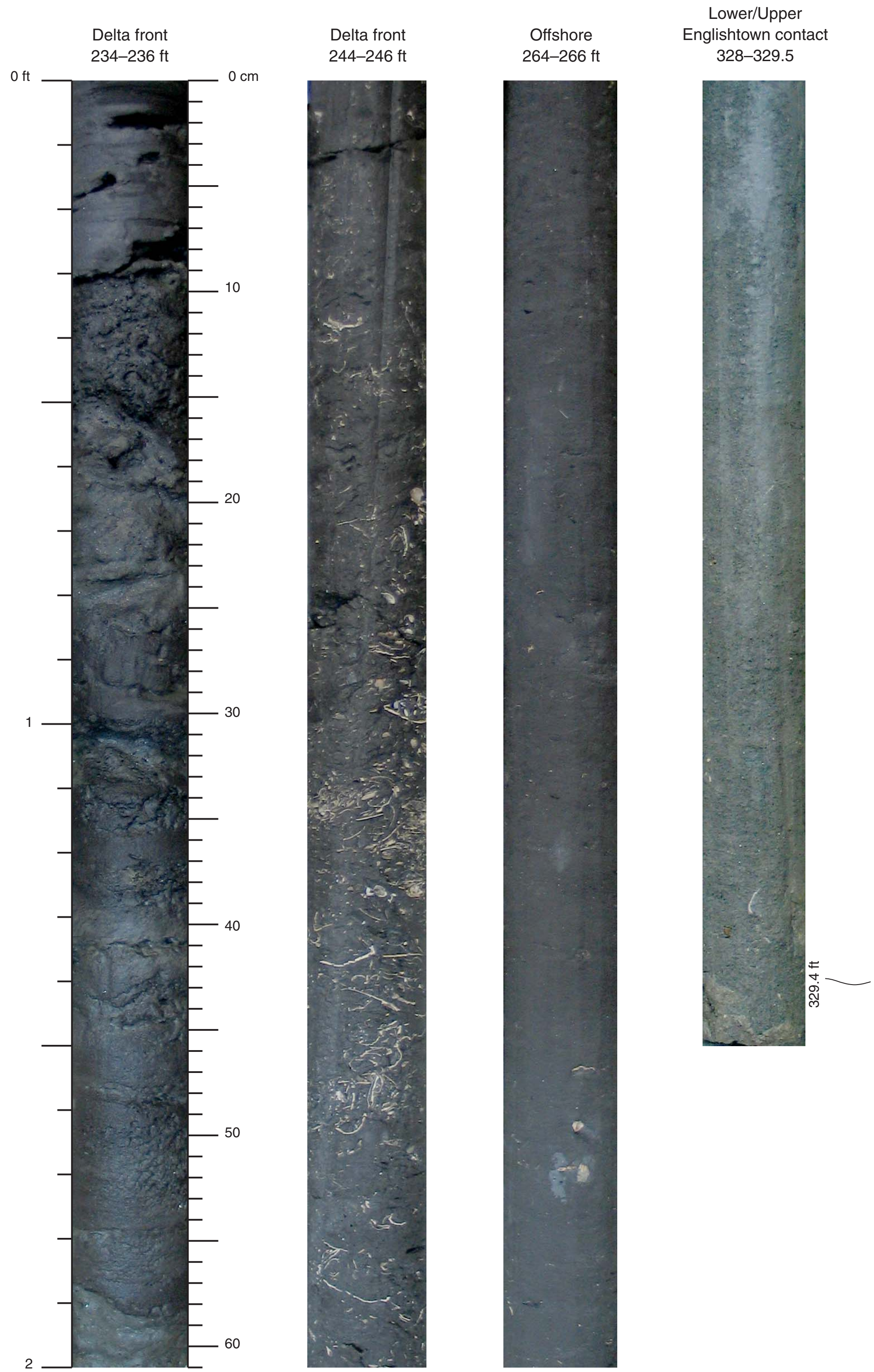


Figure AF4. Representative lithofacies from the Medford corehole: distal upper shoreface sediments from the lower Englishtown Formation (333–335 ft; 101.5–102.1 m); lower shoreface sediments from the lower Englishtown Formation (340–342 ft; 103.6–104.2 m); lower shoreface to offshore sediments from the Woodbury Formation (380–382 ft; 115.8–116.4 m); part of the transgressive systems tract (offshore facies) from the MeIII sequence (Marshalltown Formation; 380–382 ft; 115.8–116.4 m).

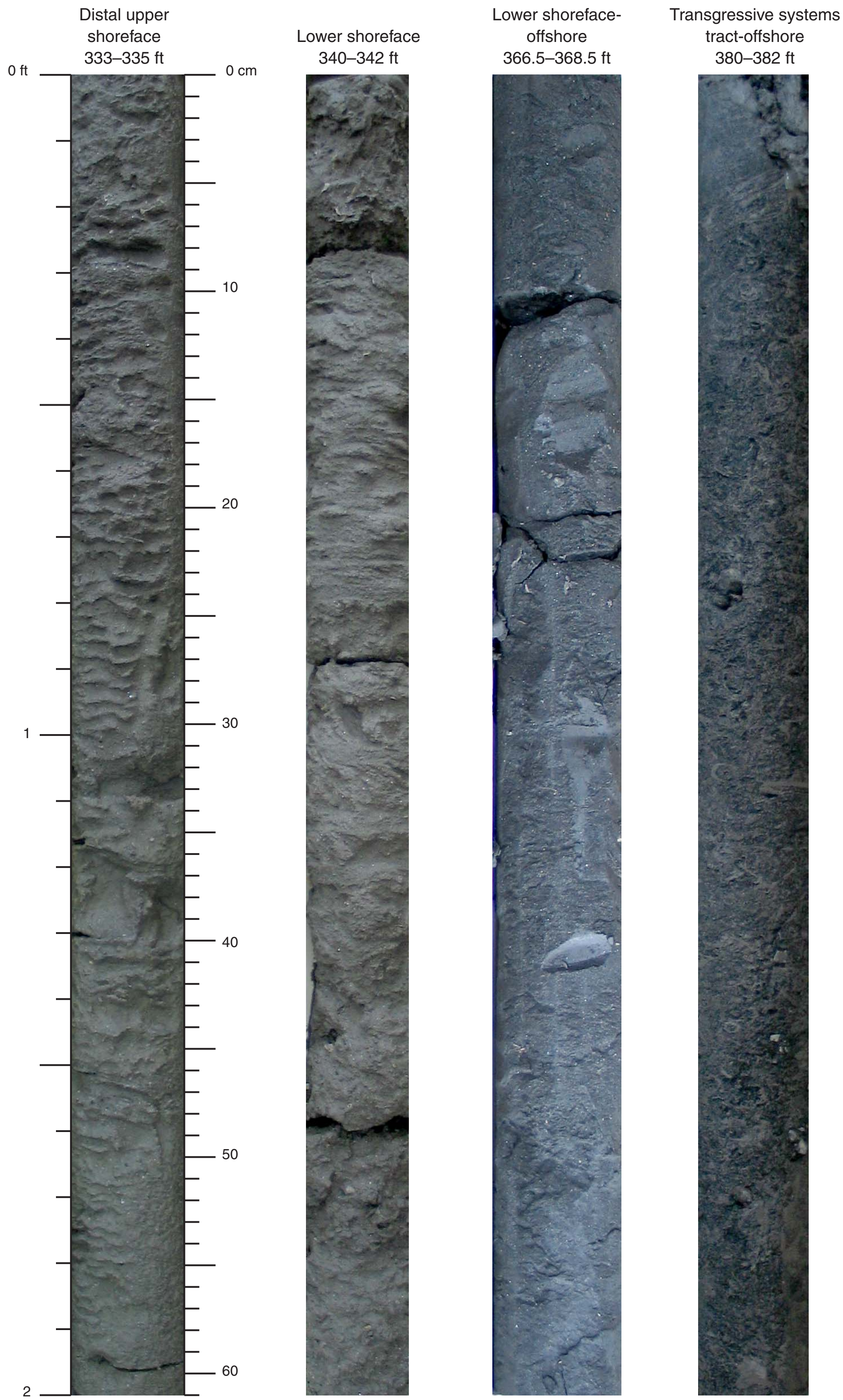


Figure AF5. Representative lithofacies from the Medford corehole: inner neritic/lower shoreface deposits from the Merchantville Formation (390–392 ft; 118.9–119.5 m); middle neritic/offshore deposits from the Merchantville Formation (412–414 ft; 125.6–126.2 m); middle neritic sediments representing the maximum flooding surface from the Merchantville I sequence (424–426 ft; 129.2–129.8 m); middle neritic sediments from the Merchantville I sequence (431–433 ft; 131.4–132.0 m); contact between the Merchantville and Cheesequake formations (434–436 ft; 132.3–132.9 m).

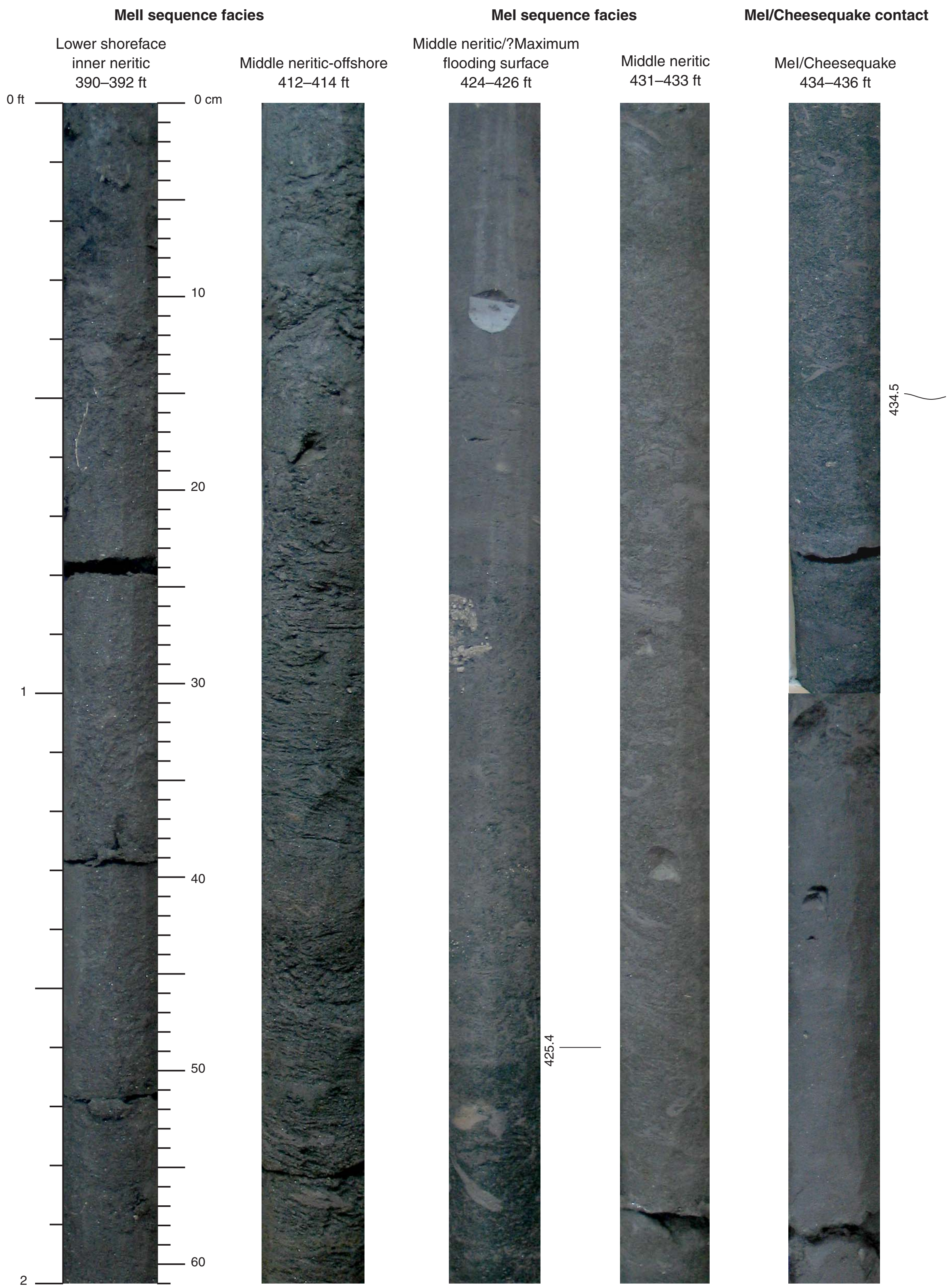


Figure AF6. Representative lithofacies from the Medford corehole: contact between the Cheesequake and Magothy formations (438.3–440.3 ft; 133.6–134.2 m); tidal channel sediments from the Magothy Formation (460–465.5 ft; 140.2–141.9 m).

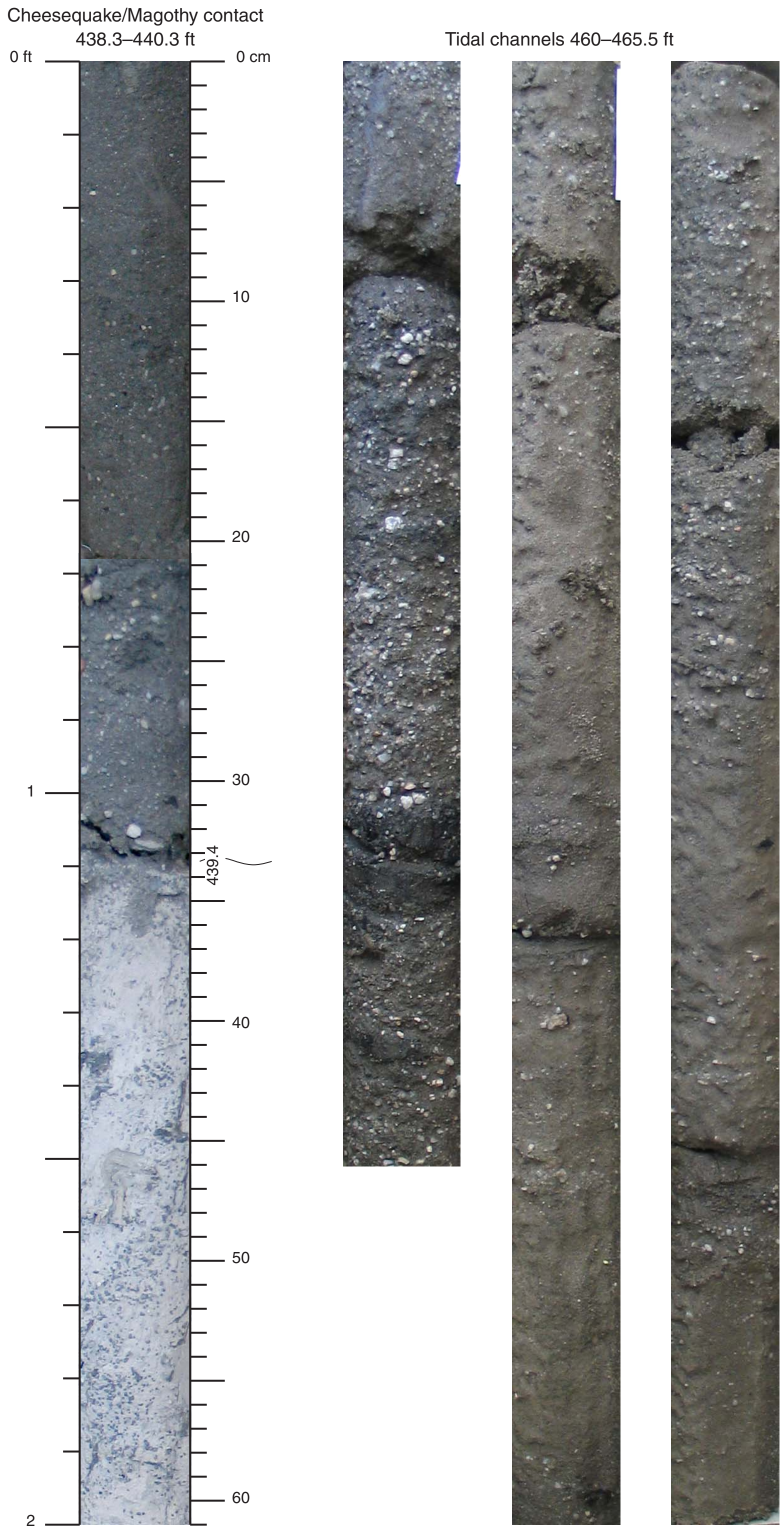


Figure AF7. Representative lithofacies from the Medford corehole. **A.** Distributary channel sediments from the Magothy Formation (494–496 ft; 150.6–151.2 m). **B.** Tidal channel sediments from the Magothy Formation (510–513.3 ft; 155.4–156.5 m). **C.** Contact between the Magothy III and Magothy II sequences (522–524 ft; 159.1–159.7 m). **D.** Delta front sediments from the Magothy Formation (539–543 ft; 164.3–165.5 m).

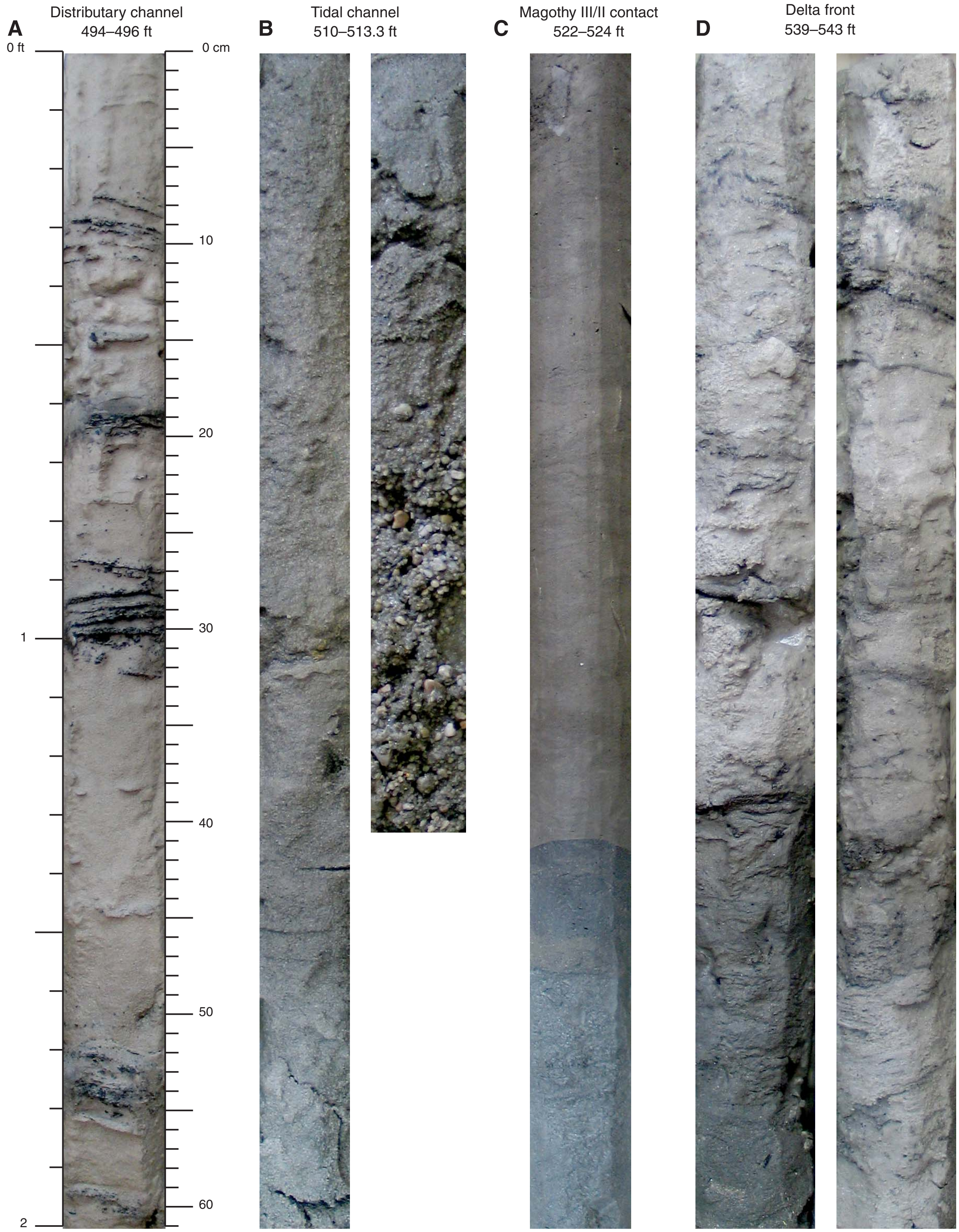


Figure AF8. Representative lithofacies from the Medford corehole. **A.** Delta front sediments from the Magothy Formation (555.5–558.9 ft; 169.3–170.4 m). **B.** Contact between the Magothy and Raritan formations (572–574 ft; 174.3–175 m).

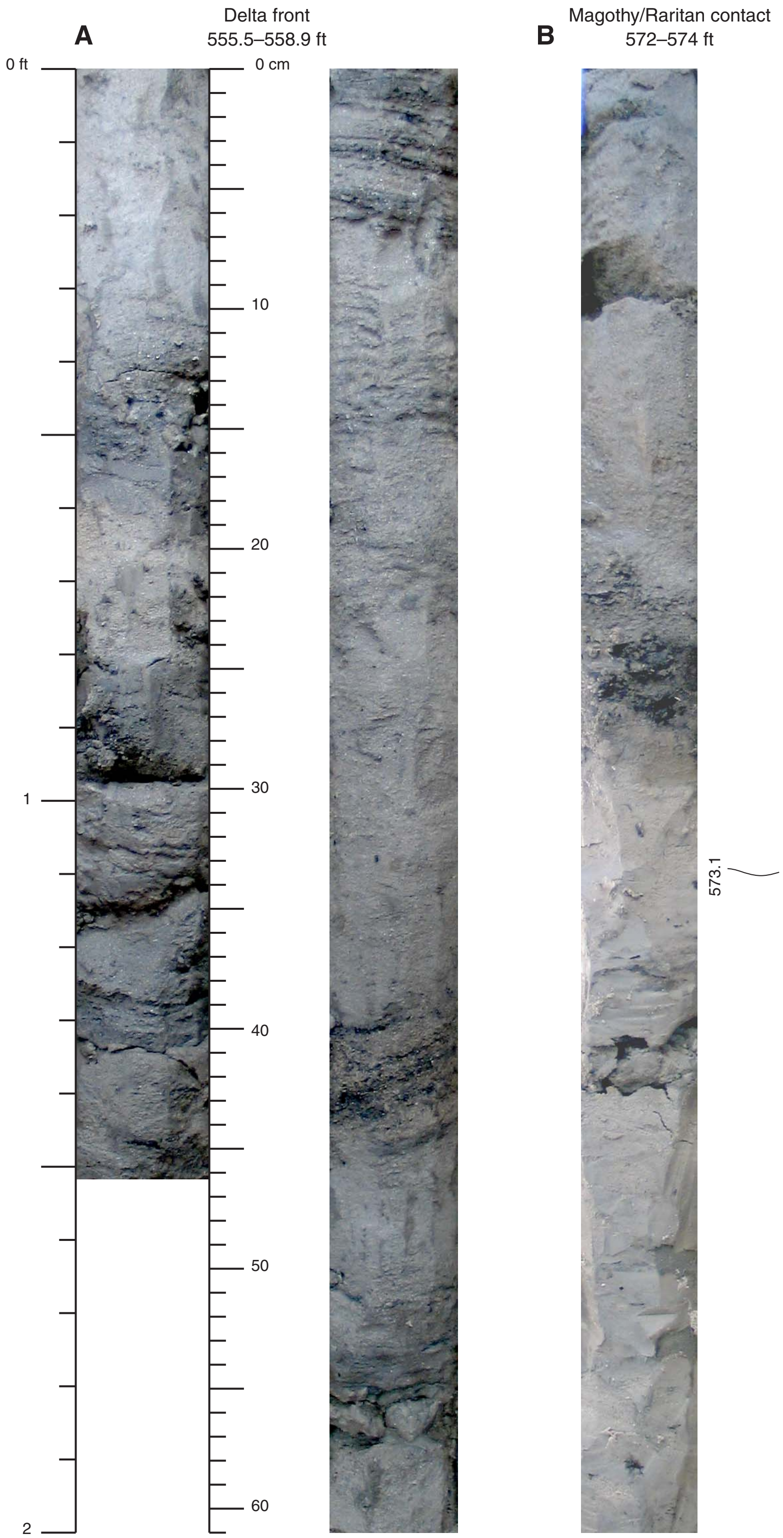


Figure AF9. Representative lithofacies from the Medford corehole. A. Marsh sediments from the Raritan Formation (612–614 ft; 186.5–187.1 m). B. Contact between the Raritan and Potomac formations (622–624 ft; 189.6–190.2 m).

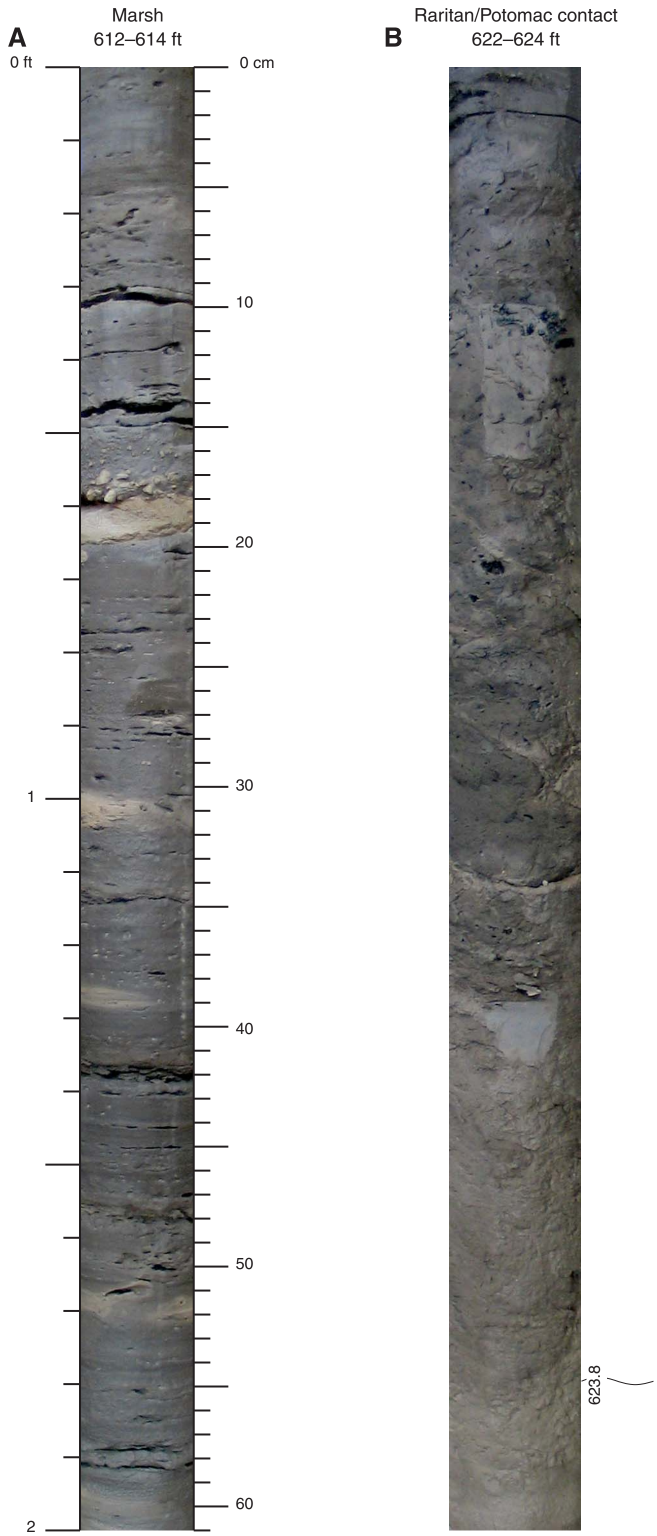


Figure AF10. Representative lithofacies from the Medford corehole. **A.** Overbank/swamp sediments from the Potomac Formation (637–639 ft; 194.2–194.8 m). **B.** Fluvial channel sediments from the Potomac Formation (642–646 ft; 195.7–196.9 m). **C.** Fluvial sands from the Potomac Formation (672–674 ft; 204.8–205.4 m). **D.** Swamp sediments from the Potomac Formation (676.85–678.85 ft; 206.3–206.9 m).

Figure AF11. Representative lithofacies from the Medford corehole. **A.** Paleosol from the Potomac Formation (688–690 ft; 209.7–210.3 m). **B.** Paleosol from the Potomac Formation (702–704 ft; 214.0–214.6 m). **C.** Oxbow lake sediments from the Potomac Formation (706–708 ft; 215.2–215.8 m).

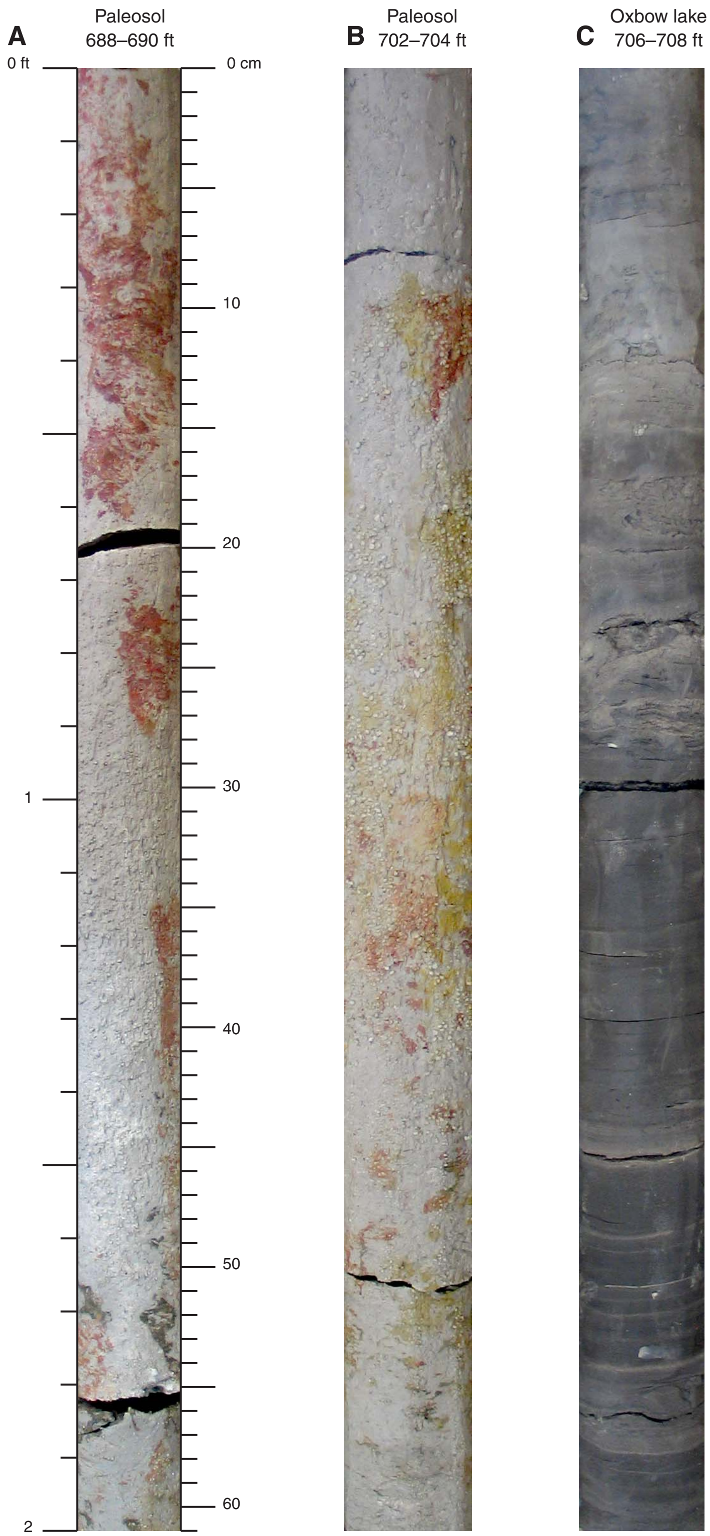


Figure AF12. Representative lithofacies from the Medford corehole. **A.** Fluvial sediments from the Potomac Formation (712–714 ft; 217.0–217.6 m). **B.** Paleosol from the Potomac Formation (748–750 ft; 228.0–228.6 m). **C.** Oxbow lake sediments from the Potomac Formation (752–754 ft; 229.2–229.8 m).

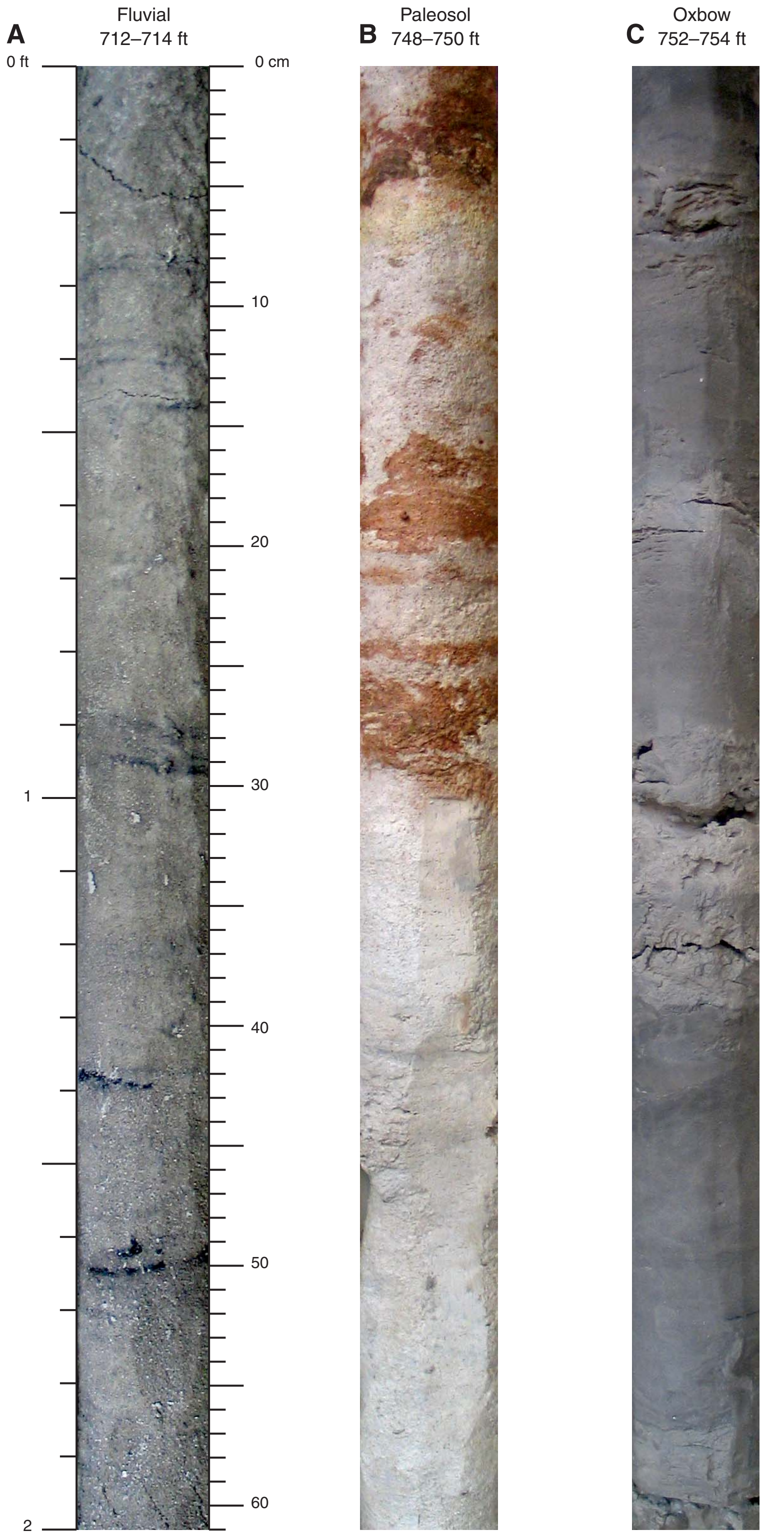


Figure AF13. Representative lithofacies from the Medford corehole: fluvial sediments from the Potomac Formation (770–784 ft; 234.7–239.0 m).

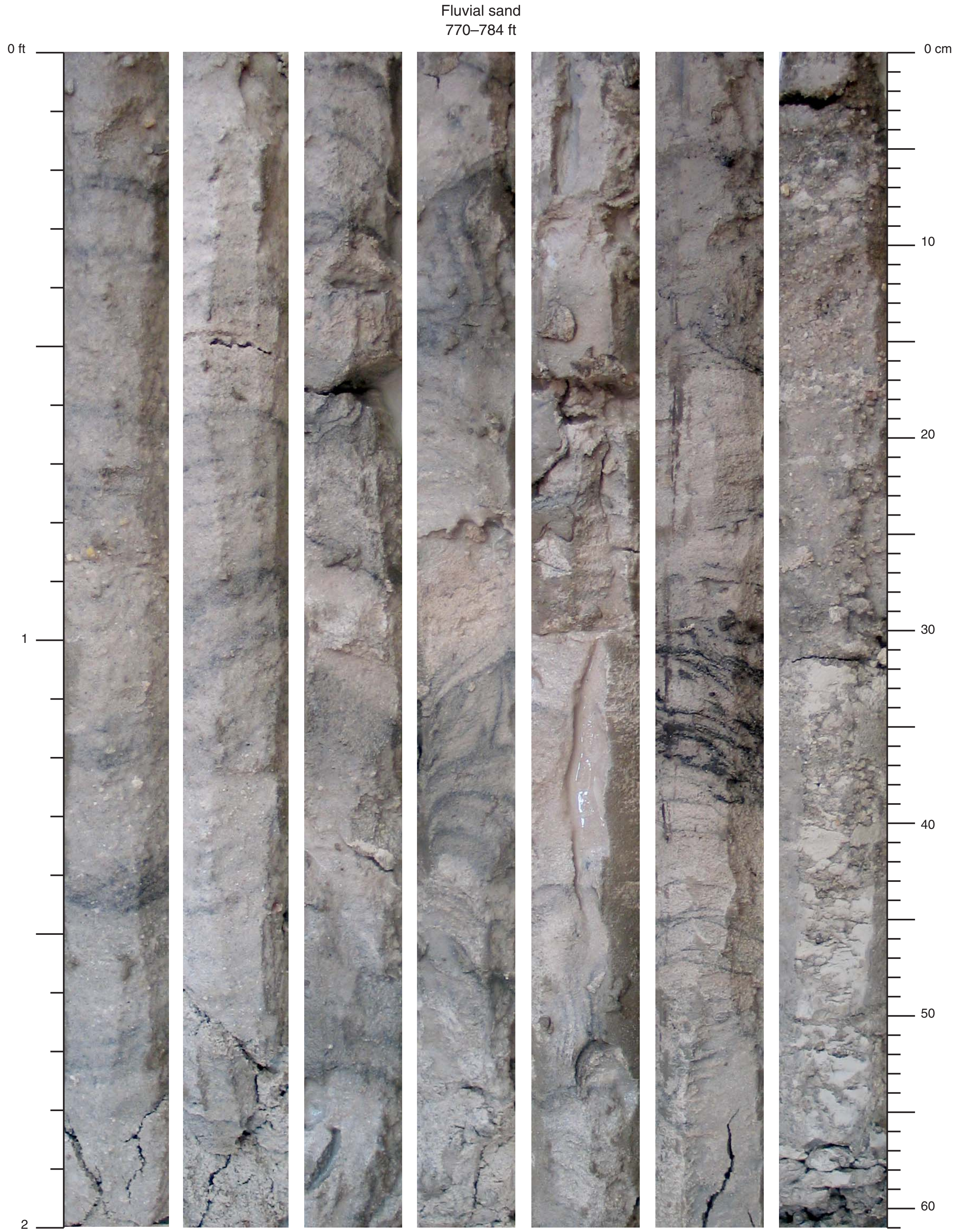


Figure AF14. Representative lithofacies from the Medford corehole. **A.** Paleosol from the Potomac Formation (790–797.6 ft; 240.8–243.1 m). **B.** Possible debris flow sediments from the Potomac Formation (800–804 ft; 243.8–245.1 m).

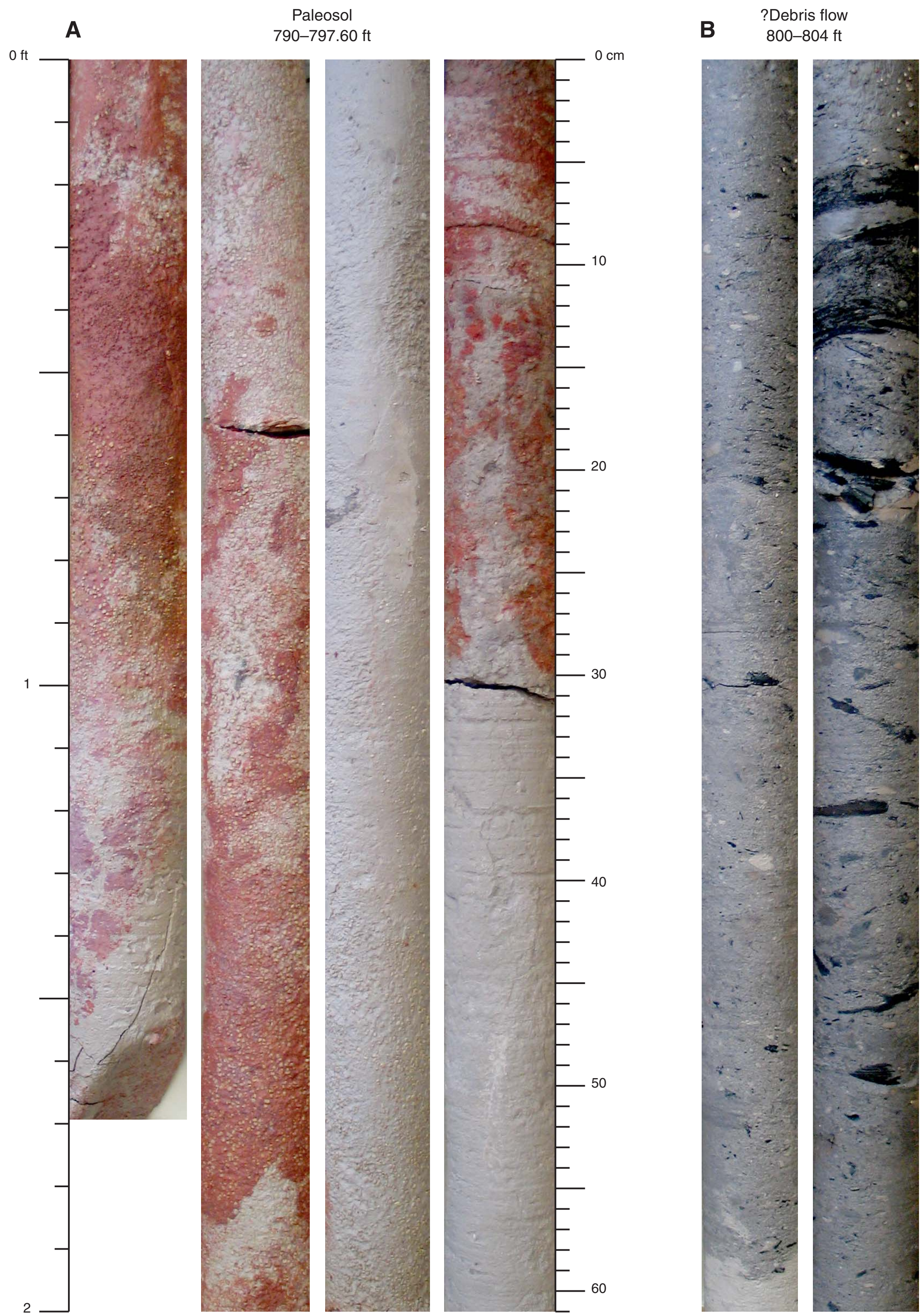


Figure AF15. Representative lithofacies from the Medford corehole: fluvial channel sediments transitioning to overbank sediments from the Potomac Formation (810–825 ft; 246.9–251.5 m).

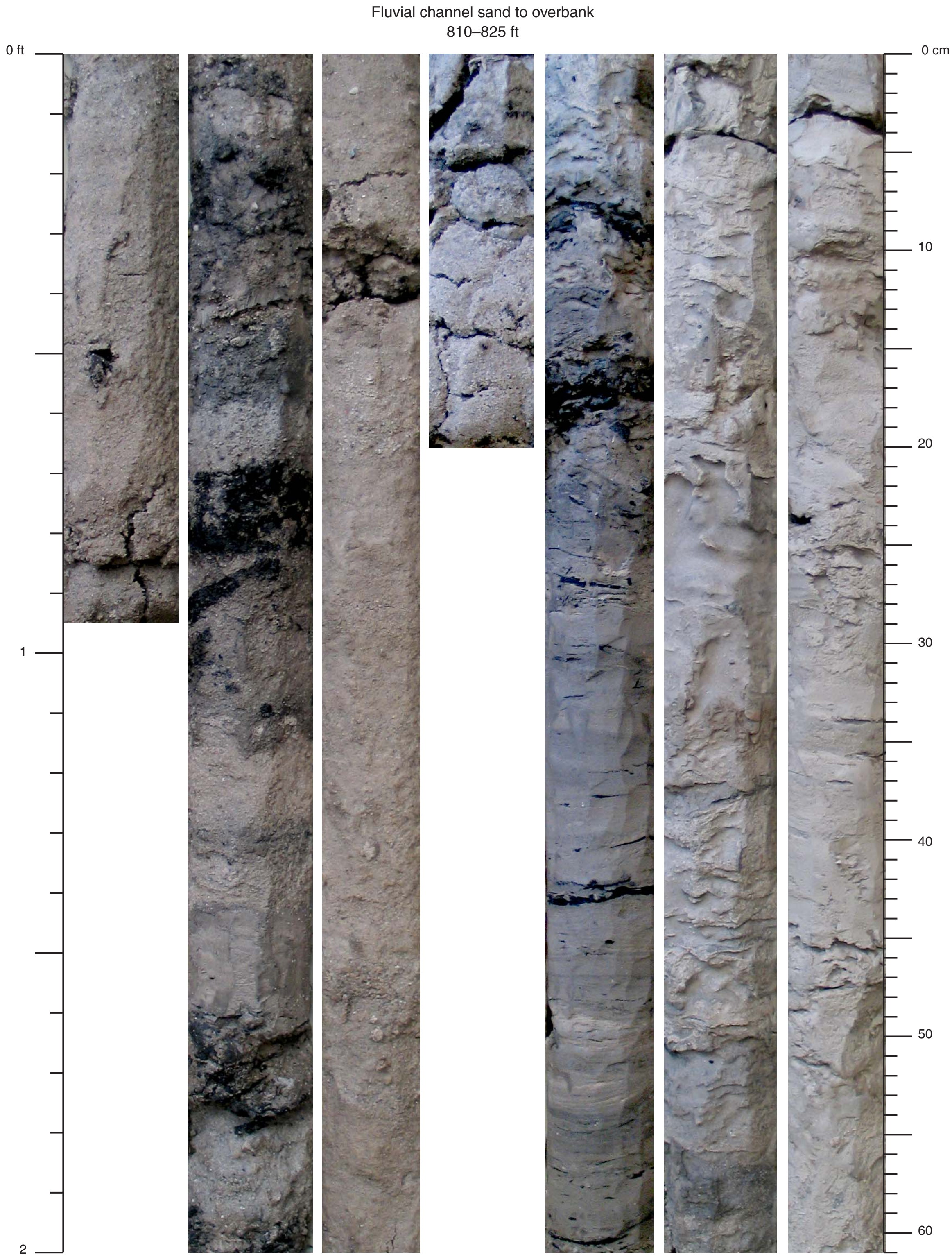


Figure AF16. Representative lithofacies from the Medford corehole. **A.** Paleosol from the Potomac Formation (848.6–854.6 ft; 258.7–260.5 m). **B.** Fluvial sediments from the Potomac Formation (900–906.55 ft; 274.3–276.3 m).

Figure AF17. Representative lithofacies from the Medford corehole. **A.** Overbank and oxbow lake sediments from the Potomac Formation (930–934 ft; 293.5–284.7 m). **B.** Channel to overbank soil and oxbow lake sediments from the Potomac Formation (954–966 ft; 290.8–294.4 m).

Figure AF18. Representative lithofacies from the Medford corehole. **A.** Braided stream sediments from the Potomac Formation (1020–1024 ft; 310.9–312.1 m). **B.** Braided stream sediments from the Potomac Formation (1047–1053 ft; 319.1–321.0 m).