3. SITE 24

The Shipboard Scientific Party[1]

SETTING AND PURPOSE

The drilling objectives at this site were to complete the cored section begun at Site 23 in accordance with the recommendations of the JOIDES Atlantic Advisory Panel, presented in the Site 23 report. Information on the specific location for a favorable drilling site in this area was received from *R/V Vema* by radio on February 2, 1969, too late to allow a move from Site 23, where operations were already under way. Upon termination of work at Site 23, *Glomar Challenger* moved to the recommended position, approximately 10 miles to the southeast of Site 23 (Figure 1).

SITE SURVEY

The location coincides with a position on the southeastern side of the elevated portion of basement in this area, as shown in section D-B-G-E (Figure 2A). The East-West reflection profile F-G-H (Figure 2B) best shows the subbottom reflectors across Site 24. The prominent intermediate reflector at 0.15 to 0.2 second below bottom (sketched in Figure 3) appears to be discontinuous. These discontinuities are apparent in other profiler records (not shown) taken as part of the site survey. The apparent depth of the reflector at Site 24 is approximately 153 meters (502 feet) and falls within a zone of Miocene turbidites sampled in Holes 23 and 24. A reflection record obtained aboard *Glomar Challenger* while the ship was on site at Site 24 suggested the presence of a subbottom reflector at 0.22 second (two-way travel time) below bottom, but the record was of poor quality and difficult to interpret. It would appear, from a comparison of the profiler data and the drilling results at Sites 23 and 24, that the widespread, but somewhat discontinuous, intermediate reflecting horizon is due to turbidite beds of Miocene age. It is, therefore, not analogous to the widespread Horizon "A" associated with Eocene cherts in the North Atlantic, which defied penetration on Legs 1 and 2 (Ewing *et al.,* 1969, Peterson *et al.,* 1970).

The profiler record obtained aboard *Glomar Challenger* while on position at Site 24 confirmed that the "A" horizon was present in this immediate area, but did not reveal any deeper reflectors. The *Vema* reflection profiles (Figures 2A and 2B) indicate the depth of the basement reflector near this position to be 0.15 second below "A". However, the basement reflector descends sharply in this area, and its depth at Site 24 could be considerably greater. The deepest core, at 558 meters (1832 feet), produced a basalt sample which may represent this reflector. Its presence at this depth suggests that the basement acoustic depth at this site should be about 0.57 second two-way travel time.

DRILLING AND CORING

The *Glomar Challenger* moved from Site 23 to Site 24 early in the morning of February 4, 1969, using dead reckoning navigation; no other approach or survey procedures were employed. Upon arrival at Site 24 at 0520 hours, a PCS (Phase Comparison System) beacon was deployed, and attempts were made to hold the ship in position using the automatic positioning equipment. These attempts failed, and a PPM beacon was dropped at the same location and became usable for automatic position keeping by 0800 hours.

The drill tools were made by using a massive diamond bit, and spud-in time was 1845 hours on February 4, 1969 in a water depth of 2815 fathoms (16,889 feet). The upper section of sediment, down to 198 meters (650 feet), was drilled without coring, as it was assumed to correspond to that sampled at Site 23. Continuous coring was attempted in the zone between 198 and 234 meters (650 to 770 feet) below ocean bottom in order to extend the section sampled at Site 23. Three cores were attempted in turbidite sands and clayey sands of lower Lower Miocene age. Recovery was disappointingly low: 4, 8 and 9 per cent, respectively. A fourth core (226 to 235 meters, 740 to 770 feet) obtained 53 per cent recovery, probably due to a higher percentage of clay and the cessation of pumping while coring. Drilling at this hole ended abruptly at 0930 on 5 February due to a failure in the upper portion of the inner core barrel; the "spearpoint" had come up with the overshot (core barrel recovery tool), leaving the core barrel locked in place below. The drill string had

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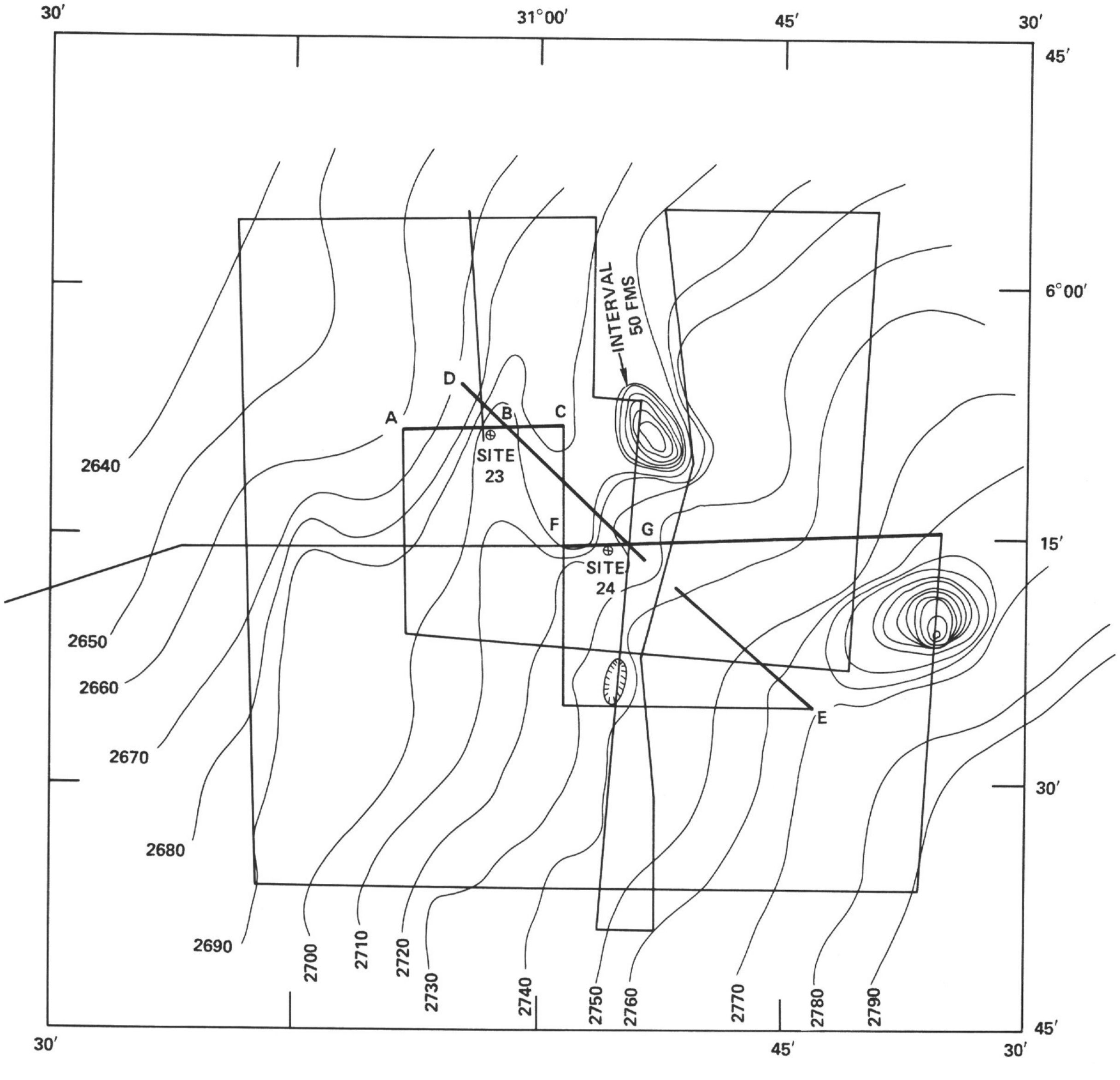

Figure 1. *Topography at Sites 23 and 24; contour interval 10 fathoms. Light lines indicate track of* R/V Vema *made in carrying out site survey. Dark lines indicate locations of reflection profiler transects shown in Figure 2.*

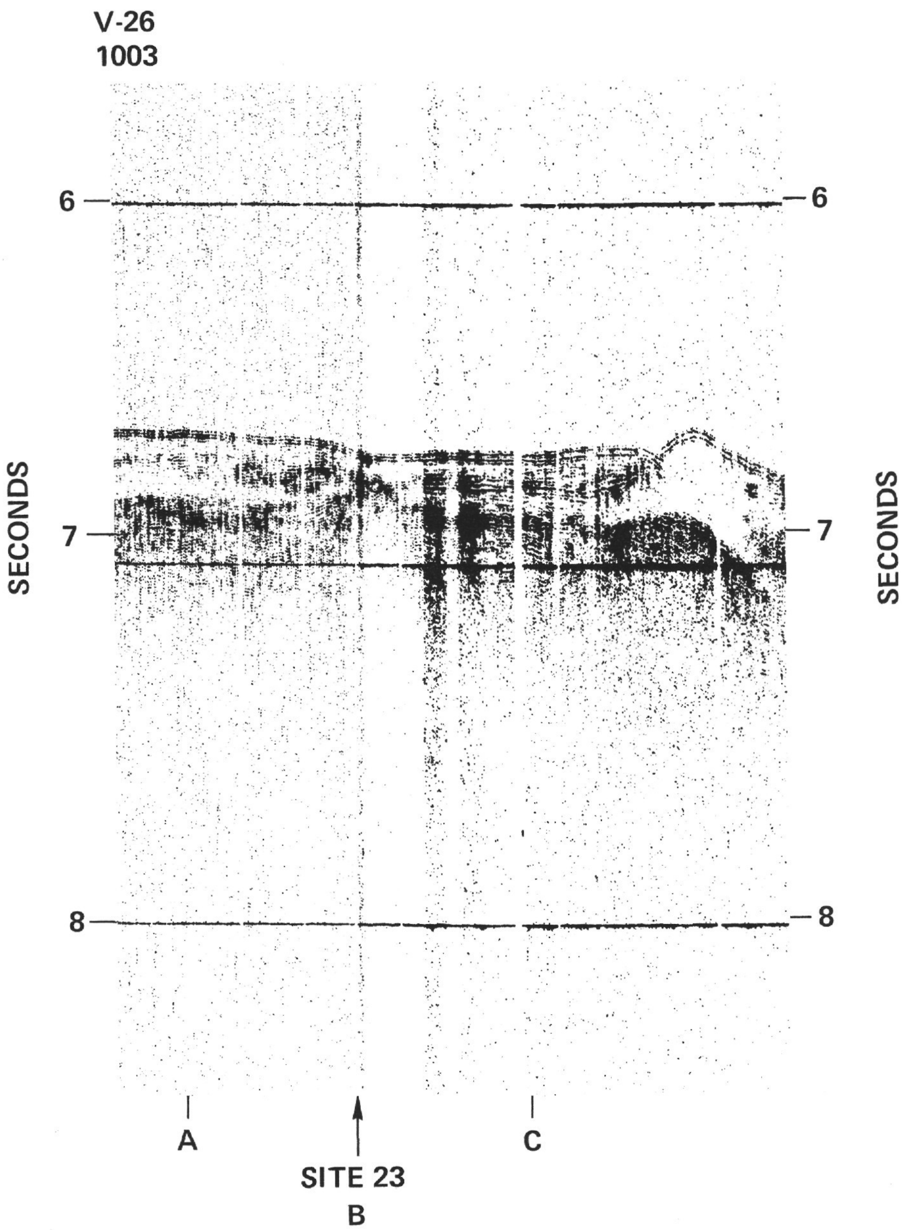

Figure 2A. *Reflection profiler sections A-B-C, across Sites 23 and 24 from the* R/V Vema *survey.*

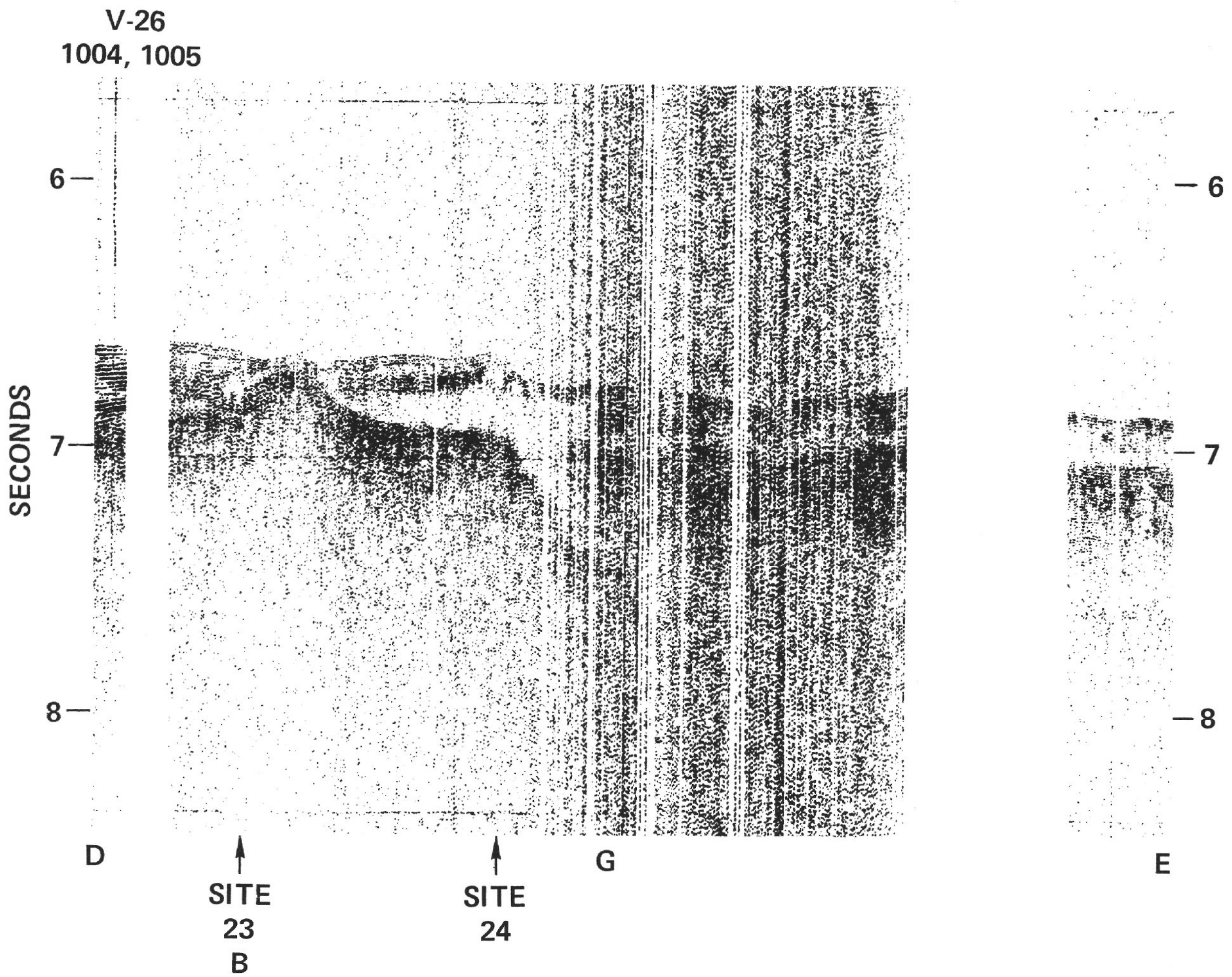

Figure 2B. *Reflection profiler sections D-B-G-E, across Sites 23 and 24 from the* R/V Vema *survey.*

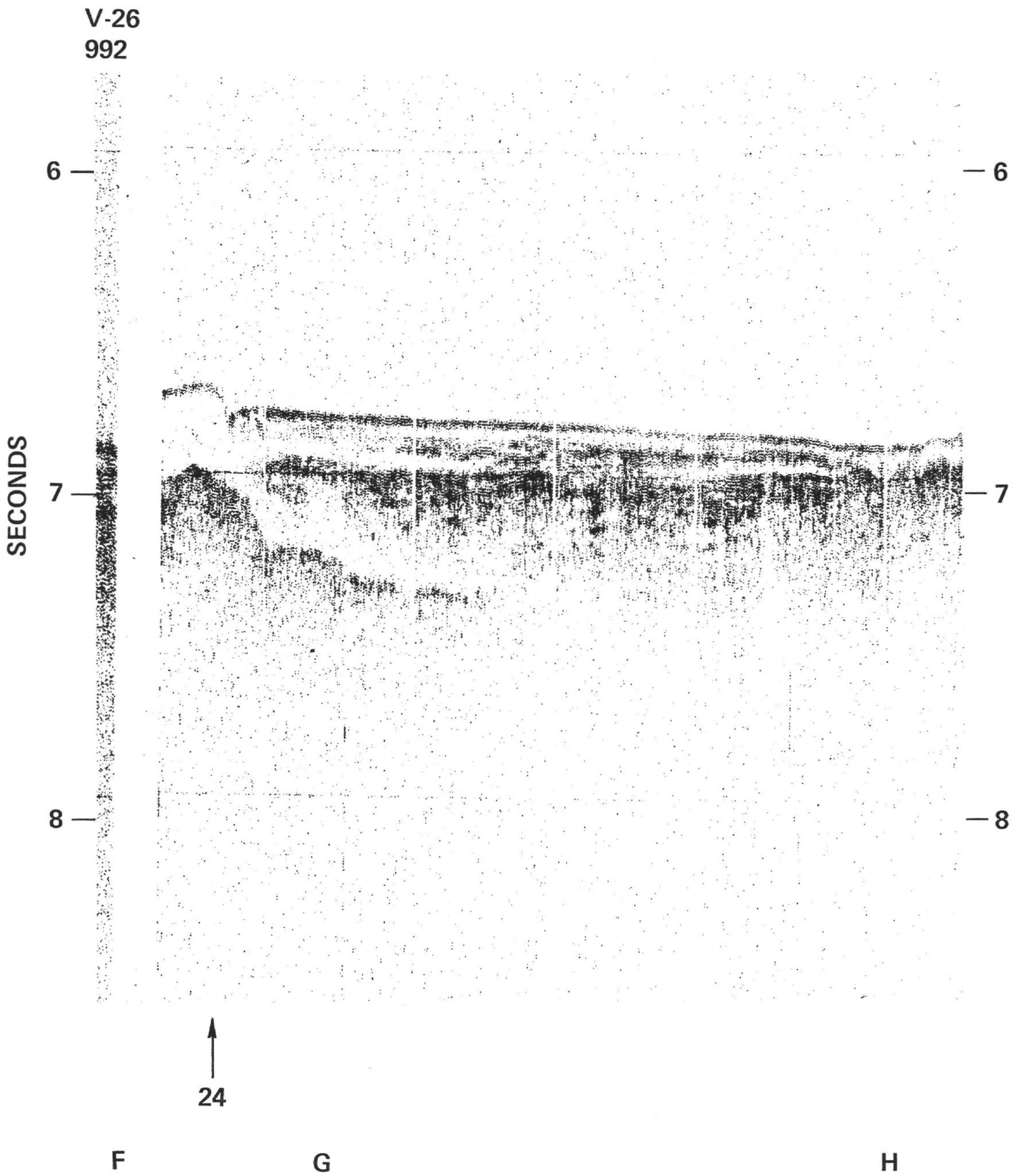

Figure 2C. *Reflection profiler sections F-G-H, across Sites 23 and 24 from the* R/V Vema *survey.*

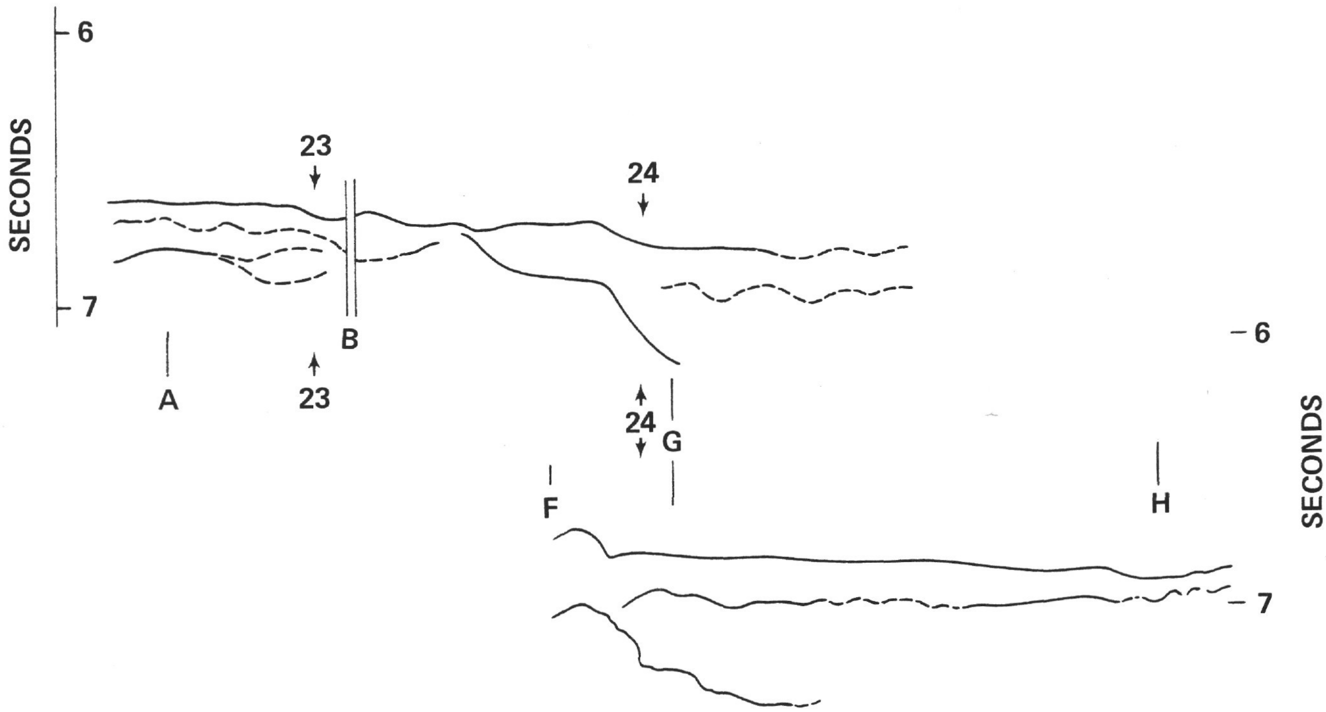

Figure 3. *Tracing of principle subbottom reflectors across Sites 23 and 24 shown on Figure 2.*

barely been tripped above the mud line when, at 1500 hours (February 5), the PPM beacon failed. Not wishing to use the PCS beacon already deployed, because of its still marginal signal, the ship was moved 2500 feet (762.0 meters) from the position and another PPM beacon was dropped. Finding its signal acceptable, positioning began at 1700 hours. This beacon showed signs of signal distortion after a few hours, and after eight hours its signal was of such a distorted envelope shape that it was no longer acceptable to the computer. Therefore, at 0215 hours on February 6, a switch was made to the PCS beacon, whose signal had improved since the initial test, and it was possible to use it with the ship on semi-automatic mode.

TABLE 1
Cores Recovered from Hole 24
(Using a Diamond Bit)

Core	Drill String (m)	Penetration (m)	Core Recovered (m)
1	5361-5371	198-208	0.3
2	5371-5380	208-217	0.0
3	5380-5389	217-226	0.0
4	5389-5398	226-235	4.9
		Total	5.2

TABLE 1 – *Continued*
Cores Recovered from Hole 24A
(Using a Tungsten Carbide Bit)

Core	Drill String (m)	Penetration (m)	Core Recovered (m)
1	5661-5669	503-511	0.3
2	5669-5678	511-520	0.3
3	5699-5708	540-550	0.9
4	5708-5717	550-558	1.8
		Total	3.3

At Hole 24A the drill string spudded in at 0900 hours on February 6, 1969, using a tungsten carbide bit. The plan was to drill to near the basement contact and then core to and into basement. Accordingly, the hole was drilled to 503 meters (1650 feet) below ocean bottom, at which depth coring commenced.

Two attempted 9.1-meter (30-foot) cores between 503 and 520 meters (1650 and 1706 feet) sediment depth averaged only 3 per cent recovery in silty clay of Upper Cretaceous age. A 20.4-meter (67-foot) interval was then drilled in order to speed up the operation and reach basement before serious trouble developed with the positioning system, which had begun to show evidence of improper functioning. On several occasions during the day the ship was moved at the request of the driller due to binding in the guide shoe where the pipe leaves the ship. The need for these adjustments was not apparent from the beacon system. Additional evidence indicating large excursions from position came from several apparently good satellite fixes showing position changes in excess of one mile.

Between 1300 and 2130 hours on February 7, two cores (3 and 4) were taken in the interval 540 to 550 meters (1773 to 1832 feet) with recovery averaging 15 per cent in hard silty clay. Fragments of fine-grained basalt (pebble-to-cobble size) were found in Core 4. No change in drilling rate was apparent in this zone to suggest striking a hard formation. However, considerable sticking and weight change, perhaps due to departure from position, was observed by the driller and may have obscured indications of contact with the basalt. At 2200 hours, while reaming the bottom, a twist-off occurred—probably at the upper bumper sub—losing the tools below.

While tripping the pipe at 0300 hours on February 8, with the broken drill stem just above the ocean bottom, a drilling floor accident caused the loss of 14,900 feet (4541.5 meters) of drill pipe. A lifting bail failed to engage one side of the elevator, leaving the entire weight of the string on one side and causing the pipe to kink and break about 2 feet (0.61 meter) below the box.

The failure of the PPM beacons was later determined to have been caused by water absorption and loss of buoyancy of the syntactic foam flotation material used to float the upward-focusing transducer above the ocean bottom.

LITHOLOGIC SUMMARY

For a detailed lithology and paleontology see Hole Summaries. (See pages 50-57).

Since Site 24 was only about 10 miles from Site 23 (Site 23 was abandoned due to beacon failure), the upper part of Holes 24 and 24A were not cored. The basalt that was cored at about 615 feet (187.5 meters) in Hole 23 was not encountered in either Hole 24 or 24A.

Two zones were cored: one from 650 to 770 feet (198.1 to 234.7 meters)—Hole 24; and, a second from 1650 to 1832 feet (502.9 to 558.4 meters)—Hole 24A. In general aspect, the sediments cored in both holes resemble geosynclinal "flysch"-type deposits (similar to Cores 4 through 6 at Site 23), suggesting that flysch beds can be deposited in very deep water. These sediments have an aggregate thickness of more than 350 meters and can be assumed to be widely distributed over at least the western part of the Pernambuco Basin. They must represent the erosion of a land mass of considerable size.

The upper zone from 650 to 770 feet (198.1 to 234.7 meters) is of Early Miocene age and consists of greenish-gray and brownish-gray compacted clay interbedded with relatively thin beds of medium- to fine-grained sand turbidites. The clays are slightly glauconitic, contain streaks and pellets of manganese oxide, and have minor amounts of terrigenous detritals. The sands are mostly quartz with small amounts of feldspar (mostly plagioclase), muscovite, biotite and a small suite of heavy minerals, including, tourmaline and zircon. The sands are fossiliferous; the clays are barren. The thicker of the sand beds are probably the cause of the so-called "Reflector A" in this area. These beds are probably discontinuous, which would explain the "windows" in "A" reported by the *R/V Vema.*

The top of the lower cored zone consists of greenish-gray and brownish-gray compacted mudstone that is locally indurated and contains up to 20 per cent terrigenous detritals plus a small radiolarian fauna. Some of the indurated beds are cemented by calcite and have veinlets of calcite, pyrite and chlorite. In the less indurated beds, pyrite crystals are fairly common, but carbonate is absent. These mudstones grade downward into dark olive-brown to black mudstone greywackes with thin lenses or patches of grayish blue-green. At least the lower part of these beds is of Late Cretaceous age. The dark color is probably due to disseminated pyrite, which is present also as small crystals. As in the lighter beds just above, the rock is noncalcareous except for veinlets of calcite, pyrite and chlorite. Some of the dark greywackes contain up to 40 per cent silt and fine sand, consisting of quartz, plagioclase, microcline, mica and a large suite of heavy minerals, including: tourmaline, zircon, topaz(?), barite and garnet. Angular calcite fragments are common, but may be secondary.

The hole was bottomed in olivine basalt. This has been assigned arbitrarily to the bottom two feet of the hole—1830 to 1832 feet (557.8 to 558.4 meters)—despite the fact that the "core" contains about 5 feet (1.5 meters) of underlying material. However, drilling was slow at the bottom of the hole, and the material below the basalt fragments was a dark brown fluid mud with

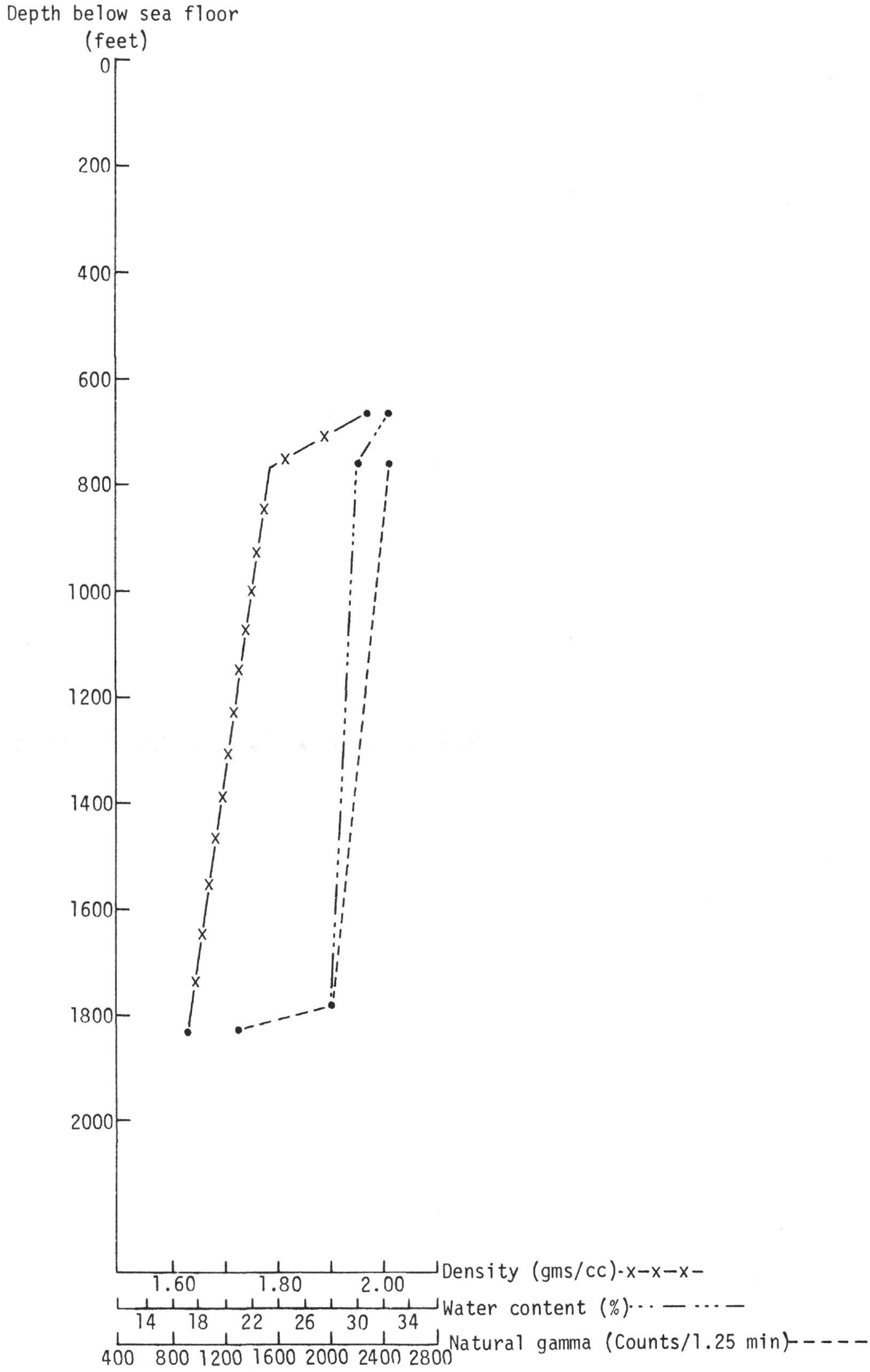

Figure 4. *Summary of physical properties, Site 24.*

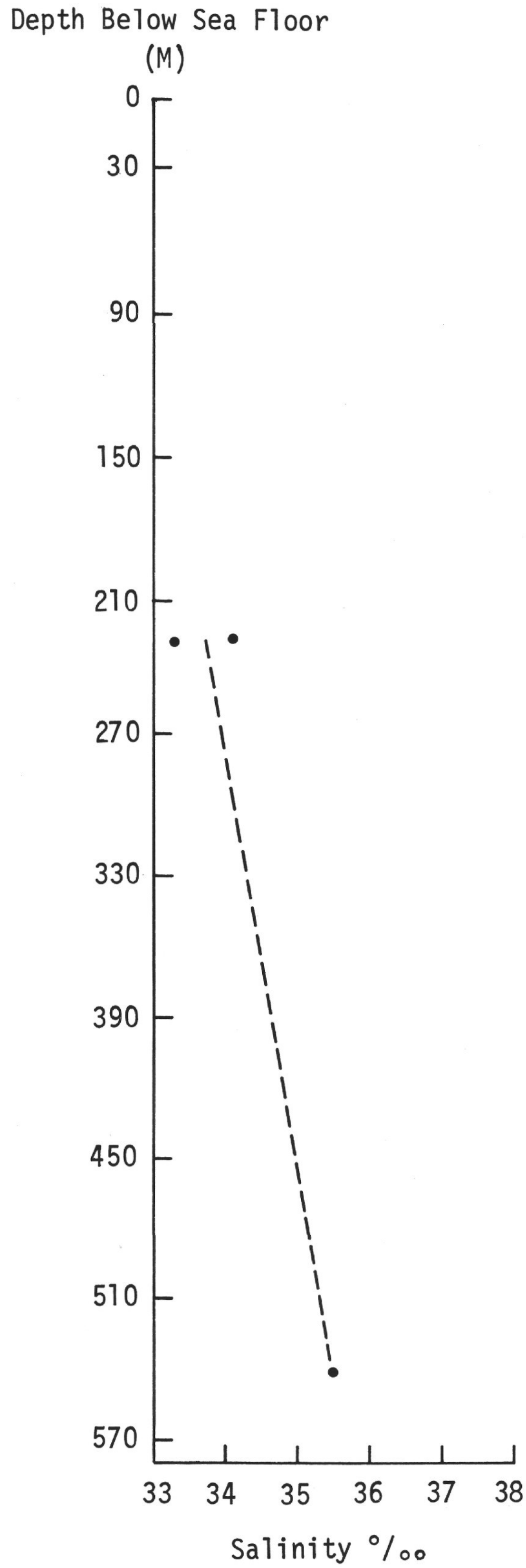

Figure 5. *Summary of chemical properties, Site 24.*

fragments of the mudstone greywacke; the authors interpret it as having been drawn into the core barrel after the coring had been completed.

The basalt is much finer-grained than that cored in Site 23. It has a microcrystalline groundmass, some of which may be altered glass, that has been extensively altered hydrothermally. Phenocrysts are less extensively altered and consist of plagioclase (by 40-55), pyroxene and olivine. The olivine is most altered, and some of the microlites are completely replaced by a fibrous secondary mineral that appears to be of the smectite group. The same smectite mineral also fills vesicles and a few fractures. Opaque oxides (magnetite? and ilmenite?) are common, especially in areas that look like altered glass. Secondary pyrite and calcite occur in veinlets and as disseminated grains.[1]

PHYSICAL AND CHEMICAL PROPERTIES

Natural gamma radiation from the clay-rich sediments at this site fall in the range 2300-2600 counts/1.25 min., consistent with the usually high values associated with clays. The partially indurated mudstone greywackes of Hole 24A are more sandy and show significantly lower gamma radioactivity. The data are so sparse, however, as to render them nearly meaningless. The decrease in density both with depth and decreasing water content is not readily explicable, but it probably reflects both error and fabric change. It may also reflect disturbance of the cores.

Density correlates fairly well with sonic velocity; for materials with a density of 1.80 (±.04) gms/cc, the sonic velocity is close to 1630 m/sec. Measurements of sonic velocities of the indurated samples do not appear meaningful as they are significantly lower than in less consolidated material (1565 m/sec versus 1630 m/sec). The water content of the clays was generally about 30 per cent; porosities were in the range 49 to 54 per cent. The indurated sandstone (24-2-1) had a water content of only 12 per cent. The carbonate content is low in all of the samples collected; it ranges from nil to 5.8 per cent, averaging slightly less than 3 per cent. In coarser layers calcareous fossils are thought to be of turbidite origin as the samples are well below the depth of calcium carbonate compensation. The organic carbon content is low with the exception of samples from Cores 24A-3 and 24A-4 (1.2 per cent and 0.8 per cent, respectively).

Two salinities of 33.3 and 35.5 were recorded; a single *p*H of 7.47 was measured. The only Eh measured was negative.

It should be emphasized that the data are too few to warrant drawing any conclusions. Also the recovery was usually poor (0 to 10 per cent), and while every effort was made to avoid contamination and disturbed samples in order to salvage some measurements, short sections were sometimes used. These must be considered as being of uncertain value.

[1]This description is based largely on preliminary shipboard examination (Benson).

REFERENCES

Ewing, M. *et al.*, 1969. *Initial Reports of the Deep Sea Drilling Project, Volume I.* Washington (U.S. Government Printing Office).

Peterson, M. N. A. *et al.*, 1970. *Initial Reports of the Deep Sea Drilling Project, Volume II.* Washington (U. S. Government Printing Office).

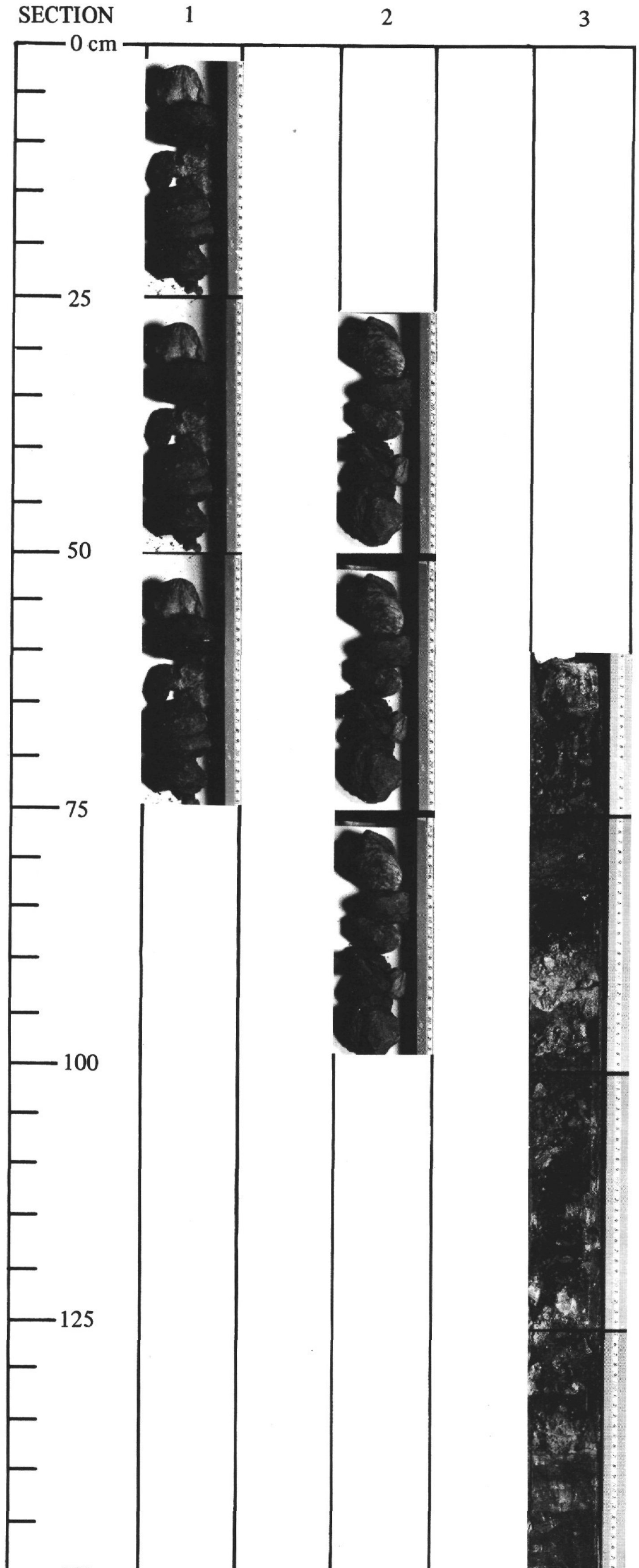

Plate 1. *Cores 1, 2, and 3, Hole 24A.*

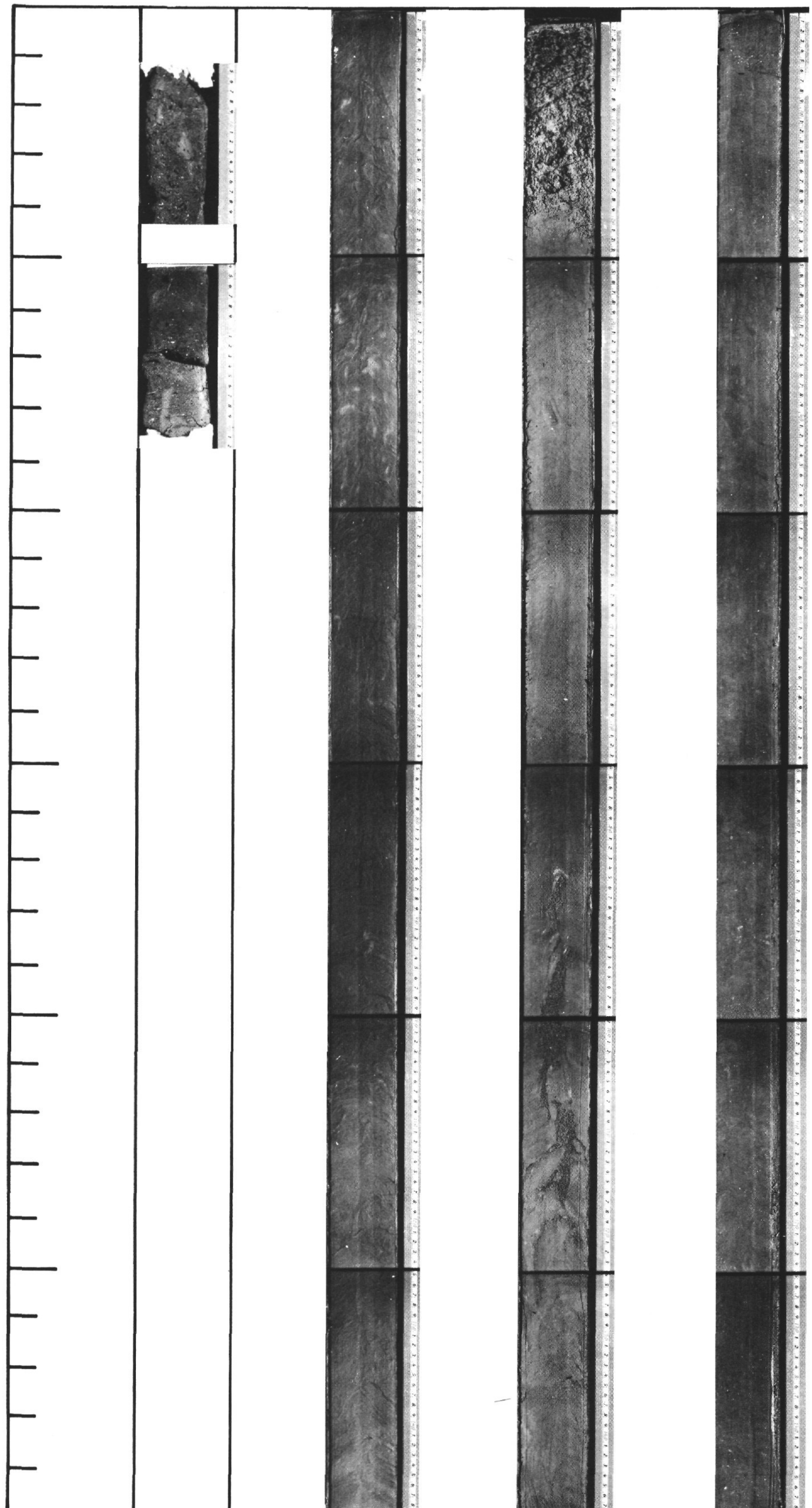

Plate 2. *Core 4, Hole 24.*

SECTION 2

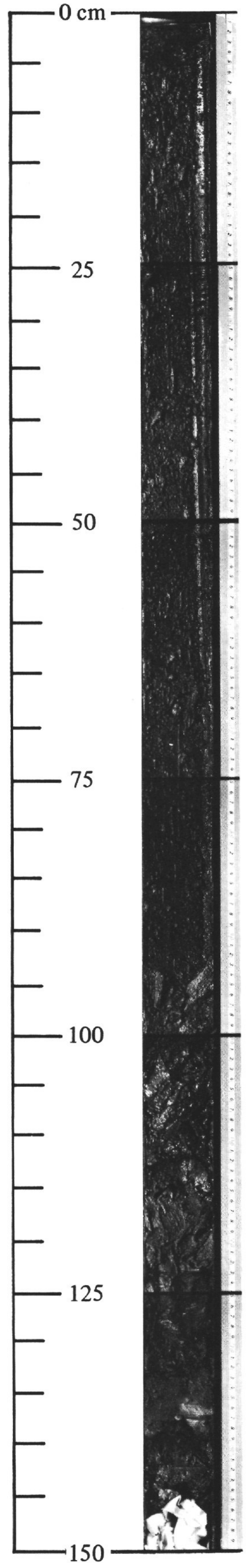

Plate 3. *Core 4, Hole 24.*

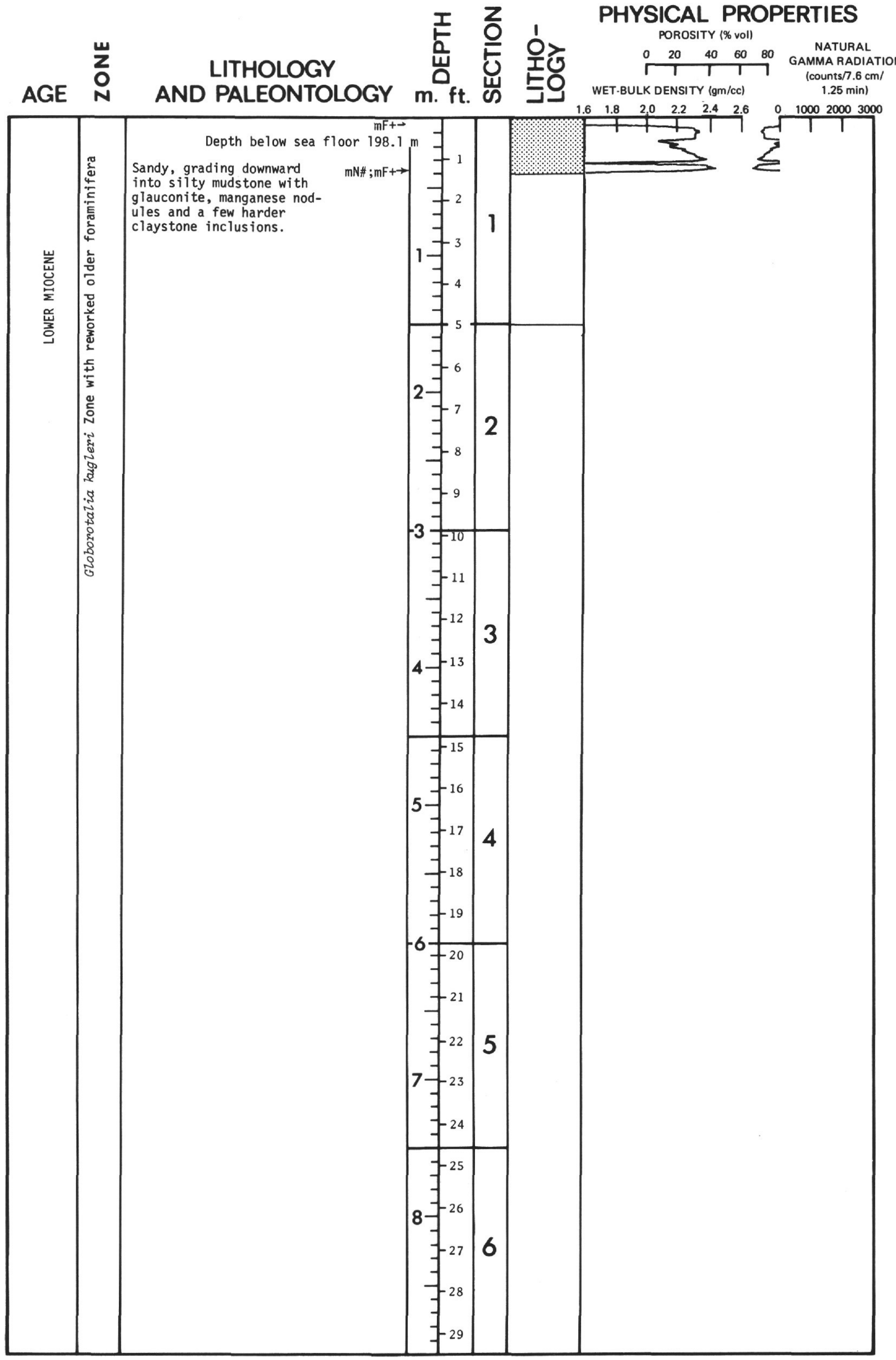

Figure 6. *Core 1. Hole 24,*

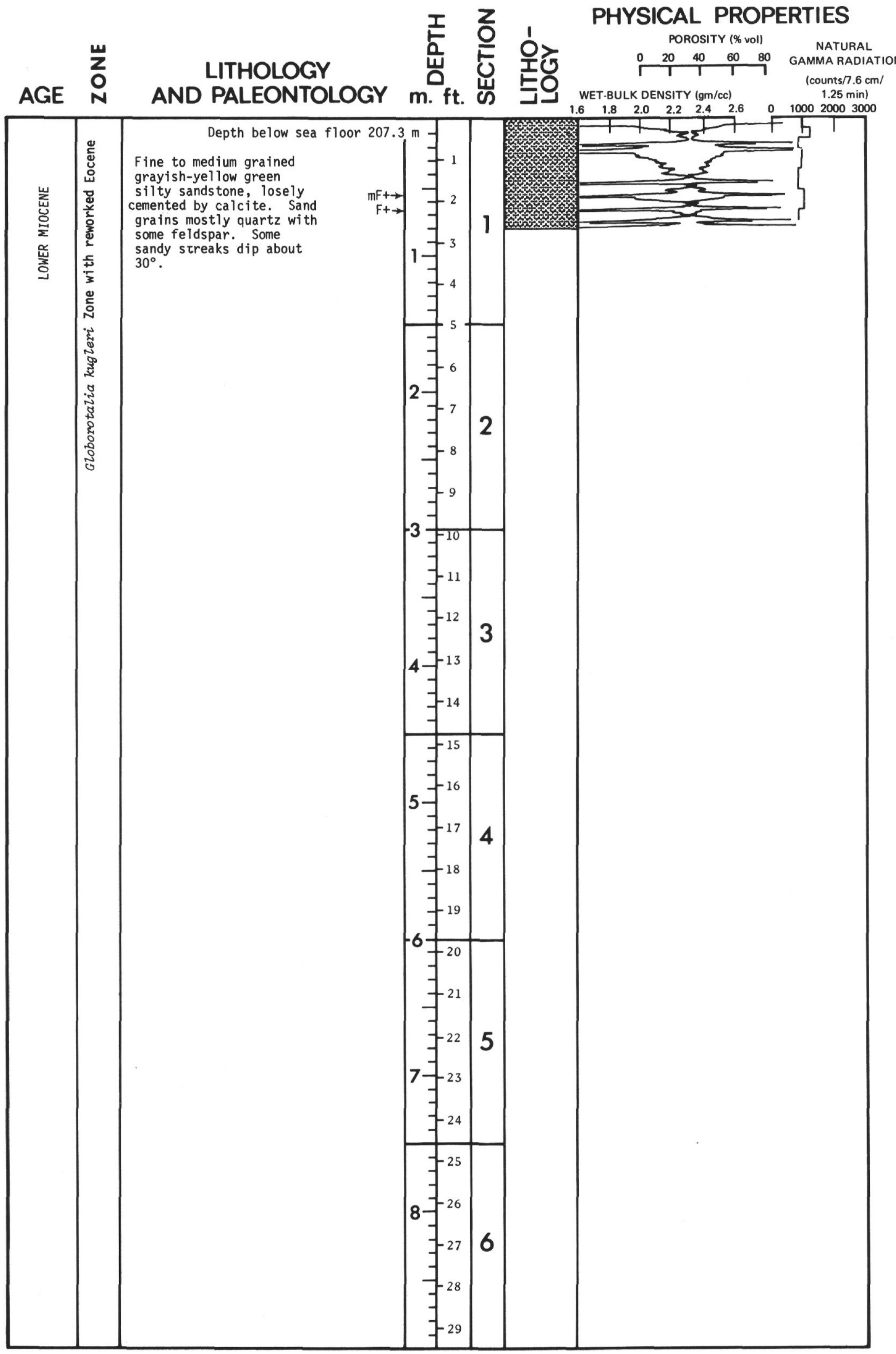

Figure 7. *Core 2. Hole 24,*

NO CORE RECOVERED

Figure 8. *Core 3. Hole 24,*

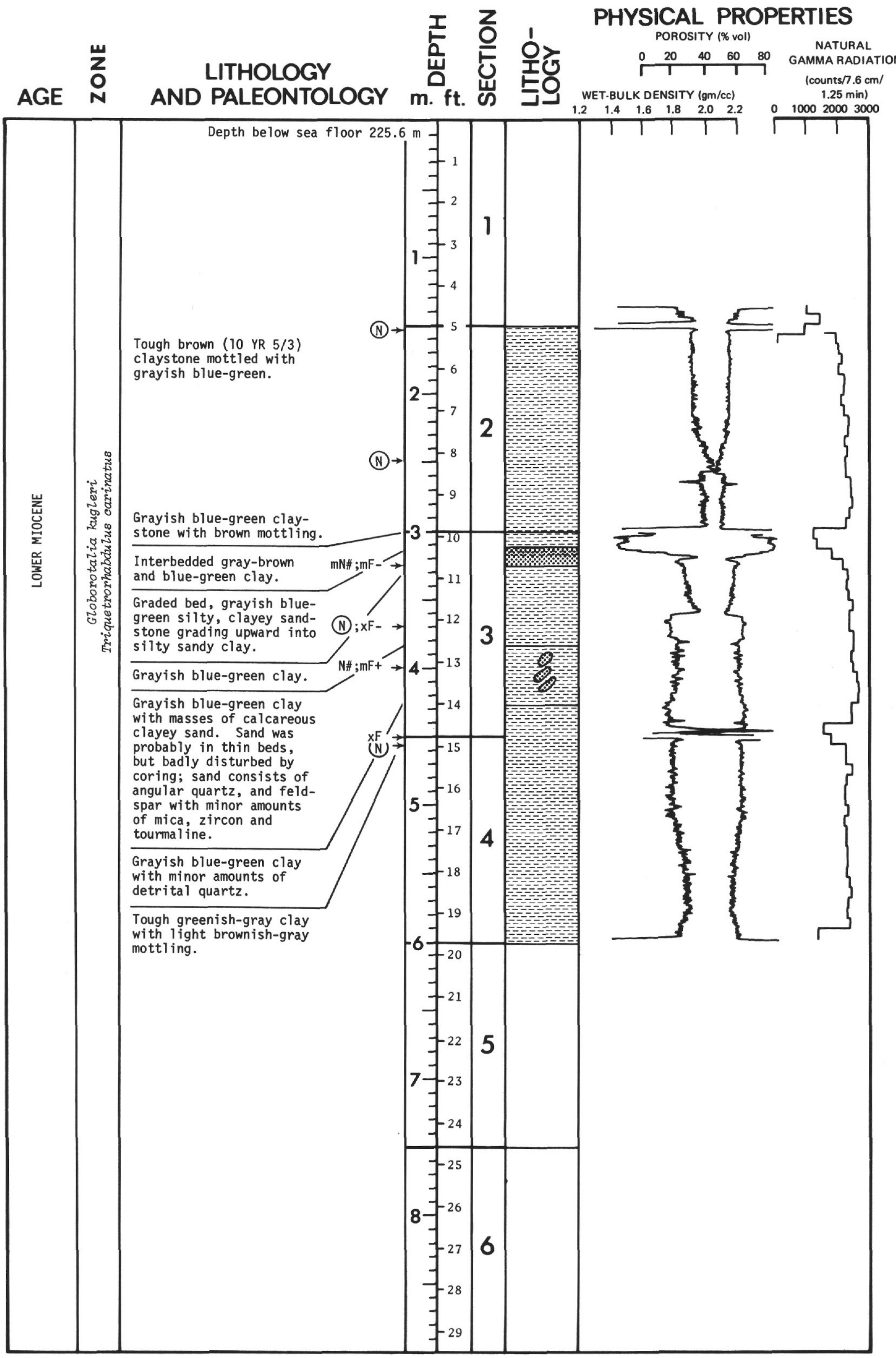

Figure 9. *Core 4. Hole 24,*

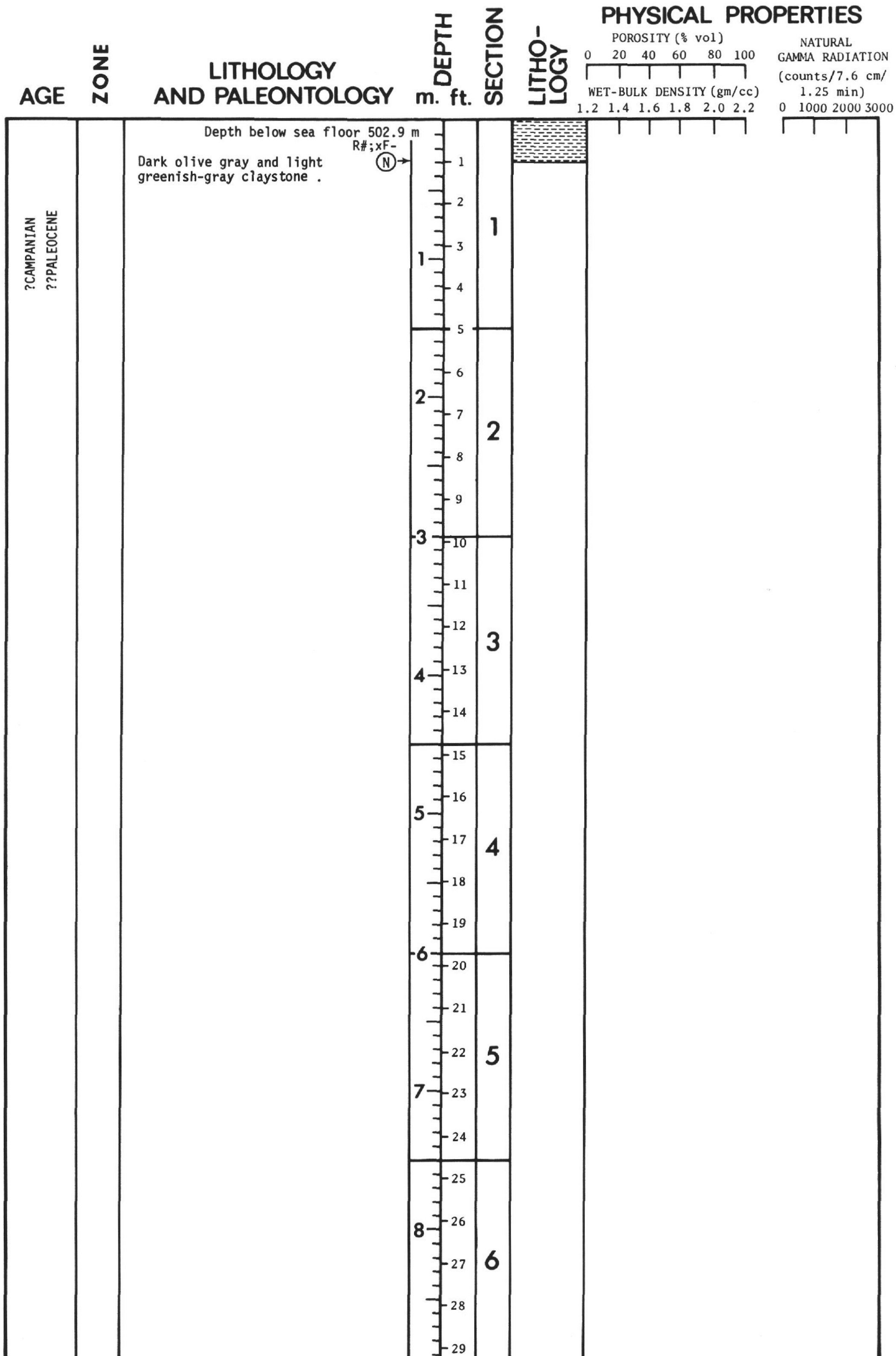

Figure 10. *Core 1. Hole 24A*,

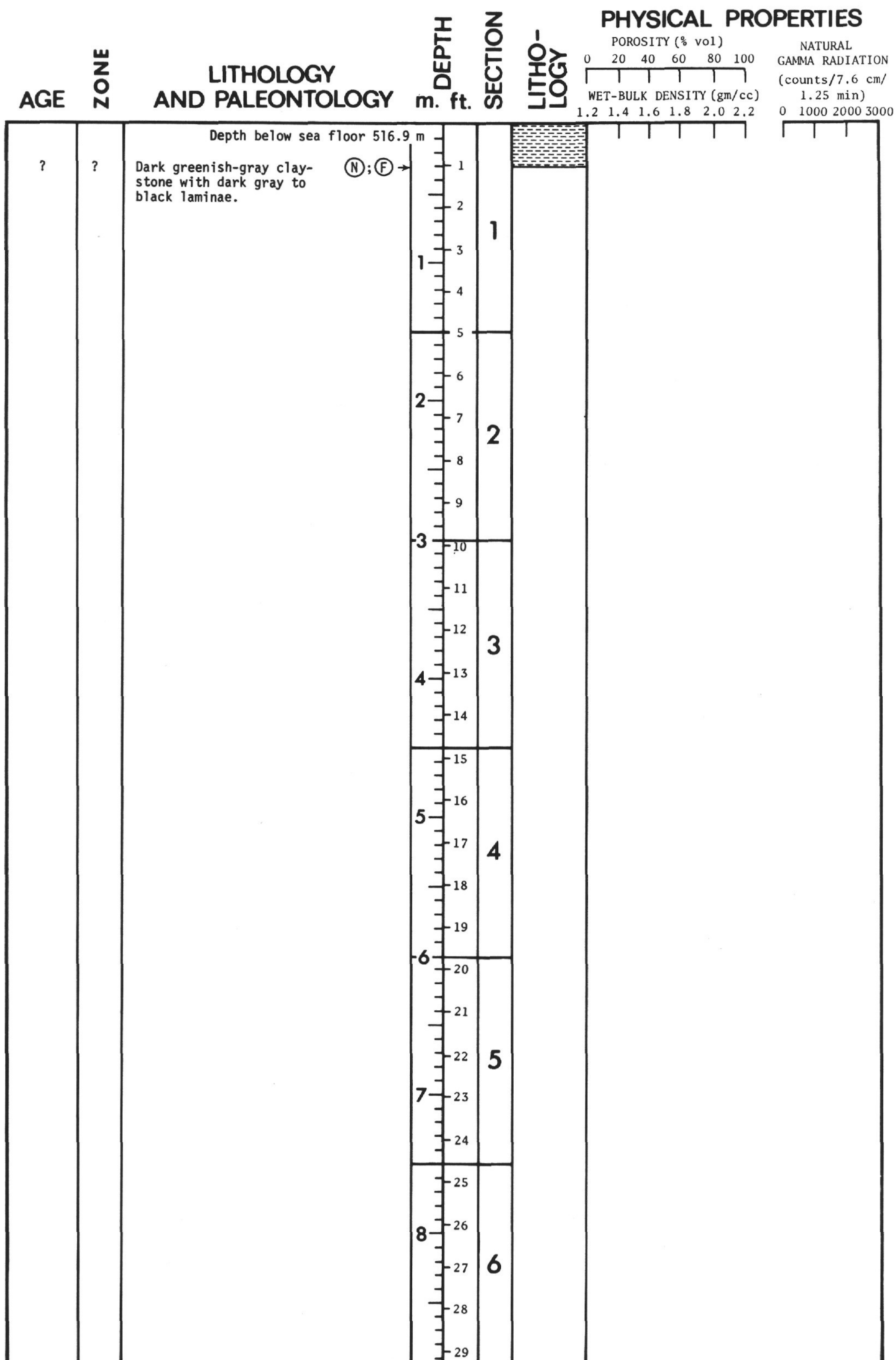

Figure 11. *Core 2. Hole 24A,*

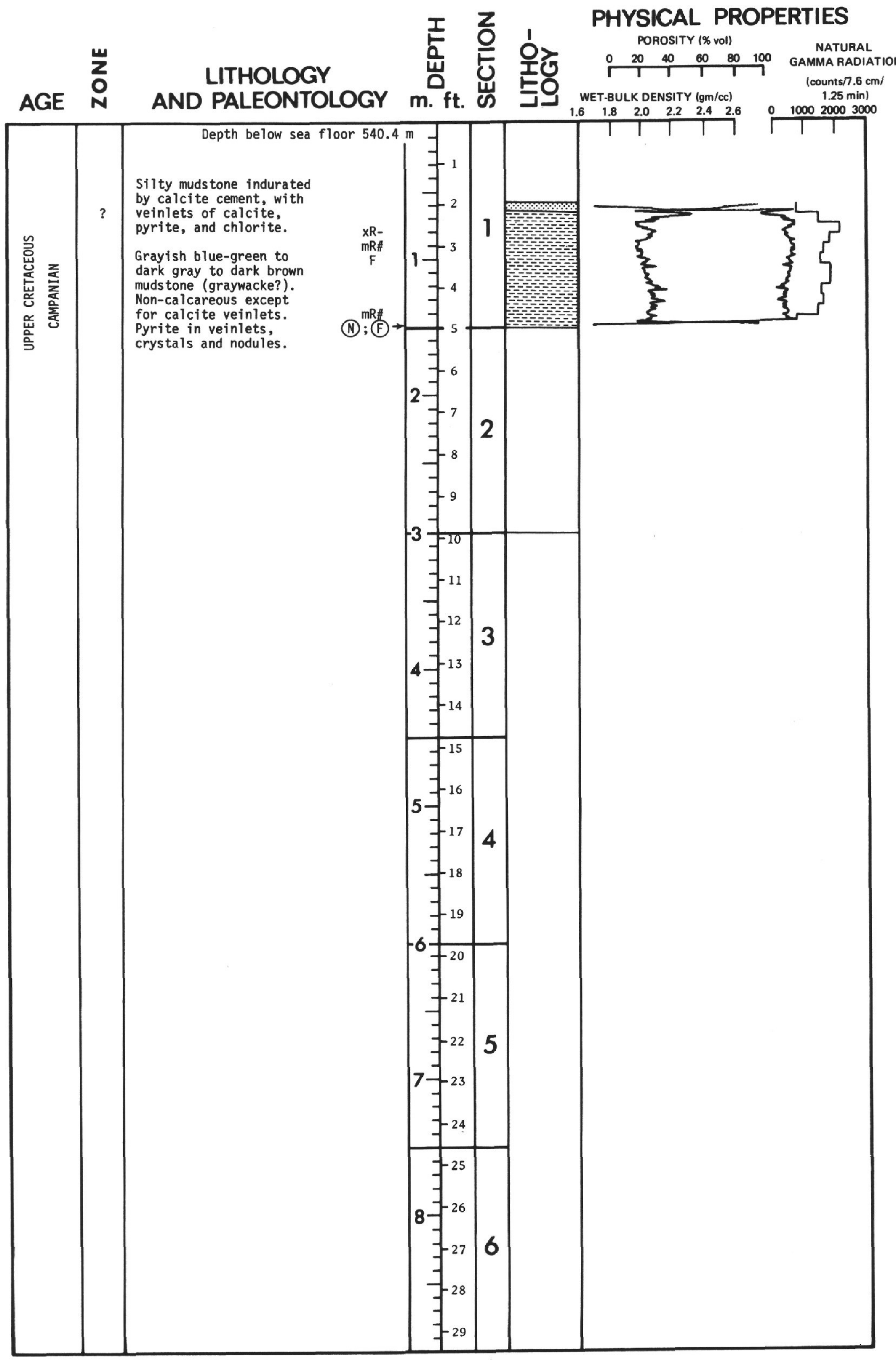

Figure 12. *Core 3. Hole 24A,*

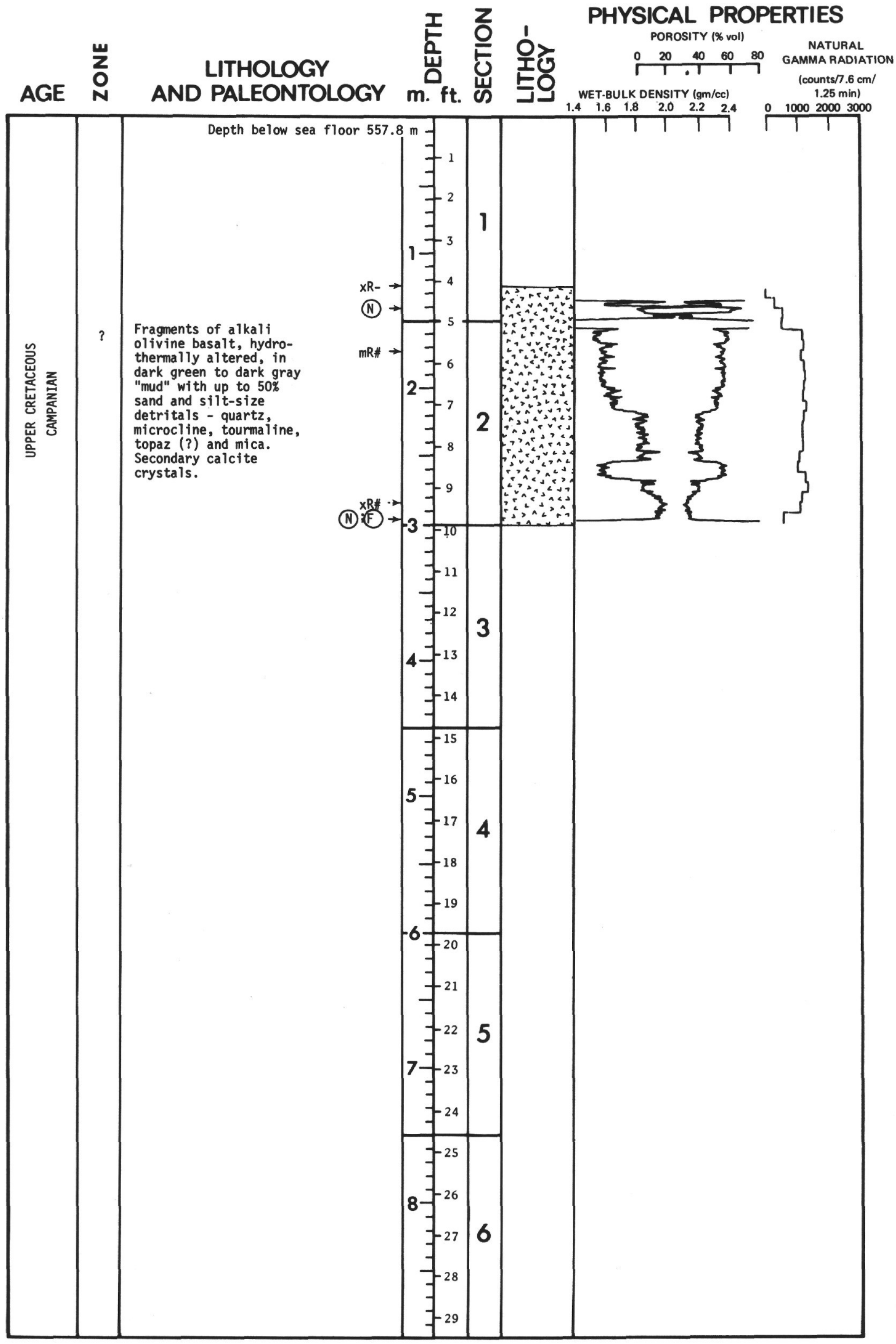

Figure 13. *Core 4. Hole 24A,*