6. SITE 6[1]

The Shipboard Scientific Party[2]

SITE REPORT

Setting and Purpose

Holes 6 and 6A were drilled at the same location on the flank of the Bermuda Rise (Figure 1). The Bermuda Rise lies between the Hatteras Abyssal Plain on the west and the Nares Abyssal Plain on the east. J. Ewing, J. L. Worzel, M. Ewing, and C. Windisch (1966) have interpreted reflecting Horizons A, β, and B as outstanding reflectors found over much of the Western Atlantic Basin west of the Mid-Atlantic Ridge. Layer A extends out to the eastern flanks of the ridge; Layer β can no longer be identified east of the crest of the Bermuda Rise; and, Layer B cannot be identified east of the west flank of the Bermuda Rise.

Since the cherts encountered in Holes 4 and 5 were associated with turbidites, a site was sought on the west flank of the Bermuda Rise, sufficiently elevated above the Hatteras Abyssal Plain to be expected to be beyond the turbidites known to make up the floor of the plain. In order to obtain as full a suite of calcareous fossils as possible, it was also felt to be desirable to find a location near to, but above, the carbonate compensation depth. A track of *Vema* Cruise 22, for which profiler records were available, seemed to show a location with these attributes – where both Layers A and β were present above a rough basement (Figure 2).

The profiler on the *Glomar Challenger* became marginally operative; and, at the site which had been chosen an unexpected peak in the basement was observed. This was undoubtedly indicative of an error in the report of position from the *Vema,* since the *Vema* had not acquired a satellite navigation system at the time of the profiler survey. It was decided that the *Glomar Challenger* should hold her course and speed until her own profiler indicated a suitable site. About five miles beyond the peak, Site 6 was established. Here Layers A and β were again reasonably horizontal and within reach of the expected drilling depth.

Hole 6 was drilled at 30° 50.39′N, 67° 38.86′W, in a water depth of 5125 meters (16,815 feet) (corrected for sound velocity in sea water and the transducer on the hull). A drag bit was used on Hole 6. After Core 6 was taken from a depth of 256.6 meters (840 feet) subbottom, progress in drilling ceased and it was judged that the cherts which were encountered had once again destroyed the bit.

A hard layer had been reported by the drillers as soon as contact with the bottom had been made for Hole 6 and it was still not sampled. As soon as the bit was clear of the bottom, the drill string was lowered several times, punching into the bottom in an attempt to sample the hard surface layer. No hard layer could be found. The core recovered in this punching operation was called 6A.

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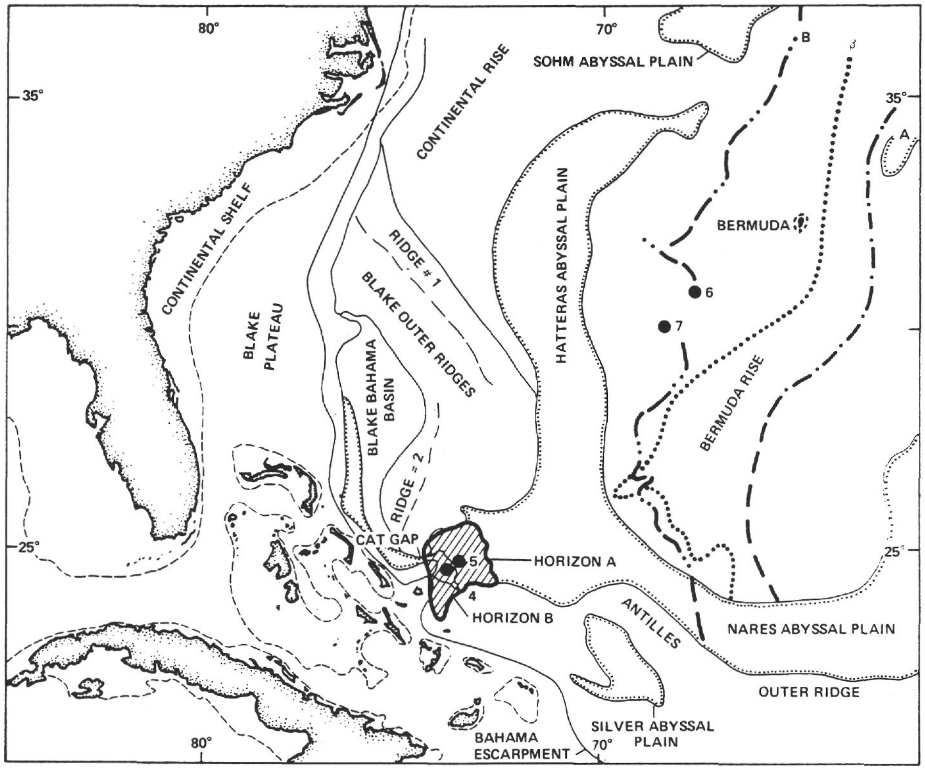


Figure 1. *Physiographic chart showing Sites 4, 5, 6, and 7.*

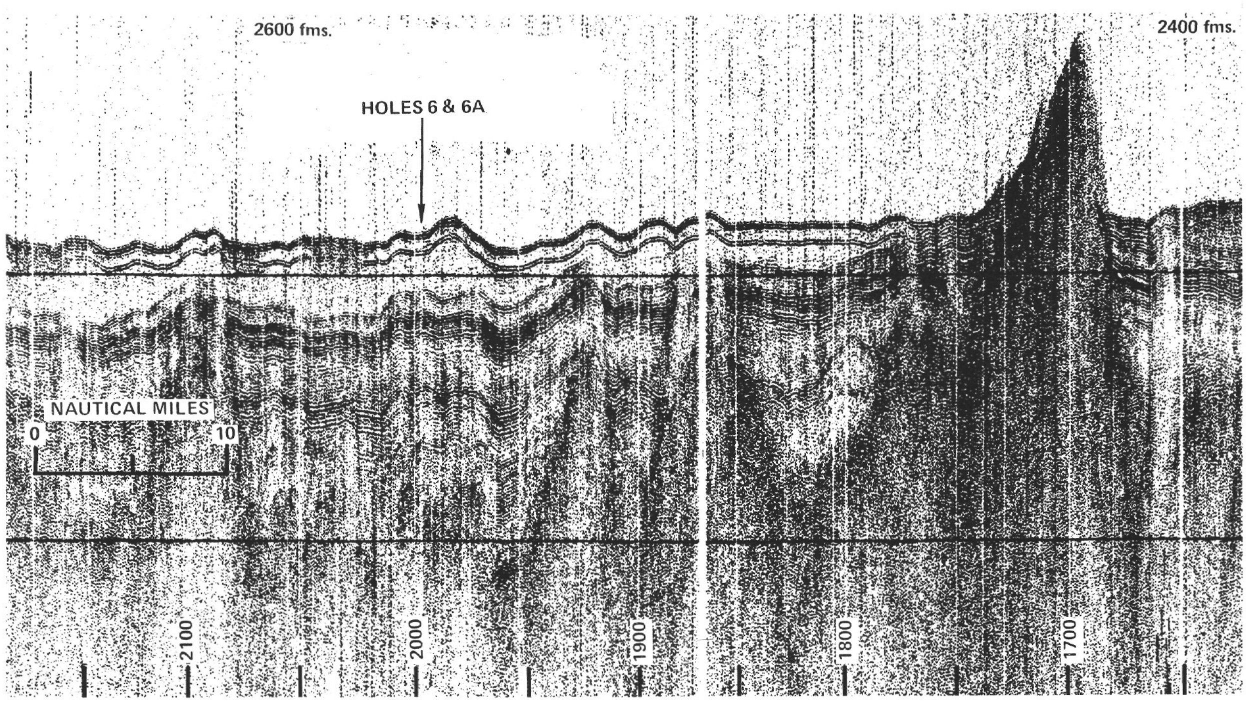


Figure 2. *Profiler section near Site 6. For location of this section, see Figure 40, Section EE'.* (Vema-*21, 17 February 1965, 1500-2200).*

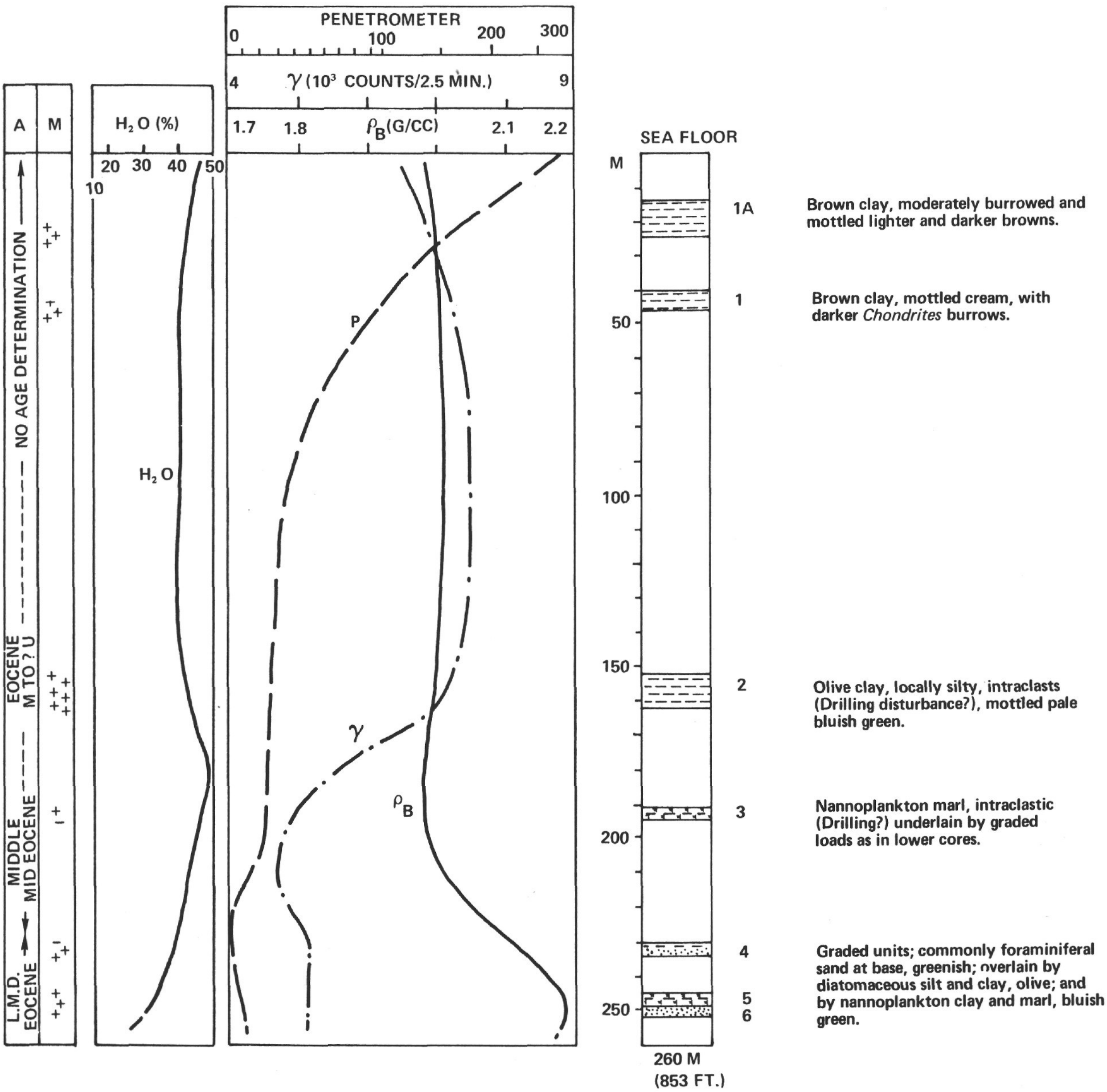


Figure 3. *Summary of drilling and coring at Site 6.*

The Cores Recovered from Site 6

Figures 4 through 10 on the graphic summaries of the cores recovered at Site 6.

These figures show, for each core:

(1) The stratigraphic age.
(2) The paleomagnetic results – normal (+) or reversed (-).
(3) The natural gamma radiation (full line).
(4) The bulk density as determined by the GRAPE (Gamma Ray Attenuation Porosity Evaluator) equipment (broken line).
(5) The length of the core in meters measured from the top of the core and the subbottom depth of the top of the cored interval.
(6) The lithology (see key with Site 1 report).
(7) The positions of the tops of each core section.
(8) Some notes on the lithology.

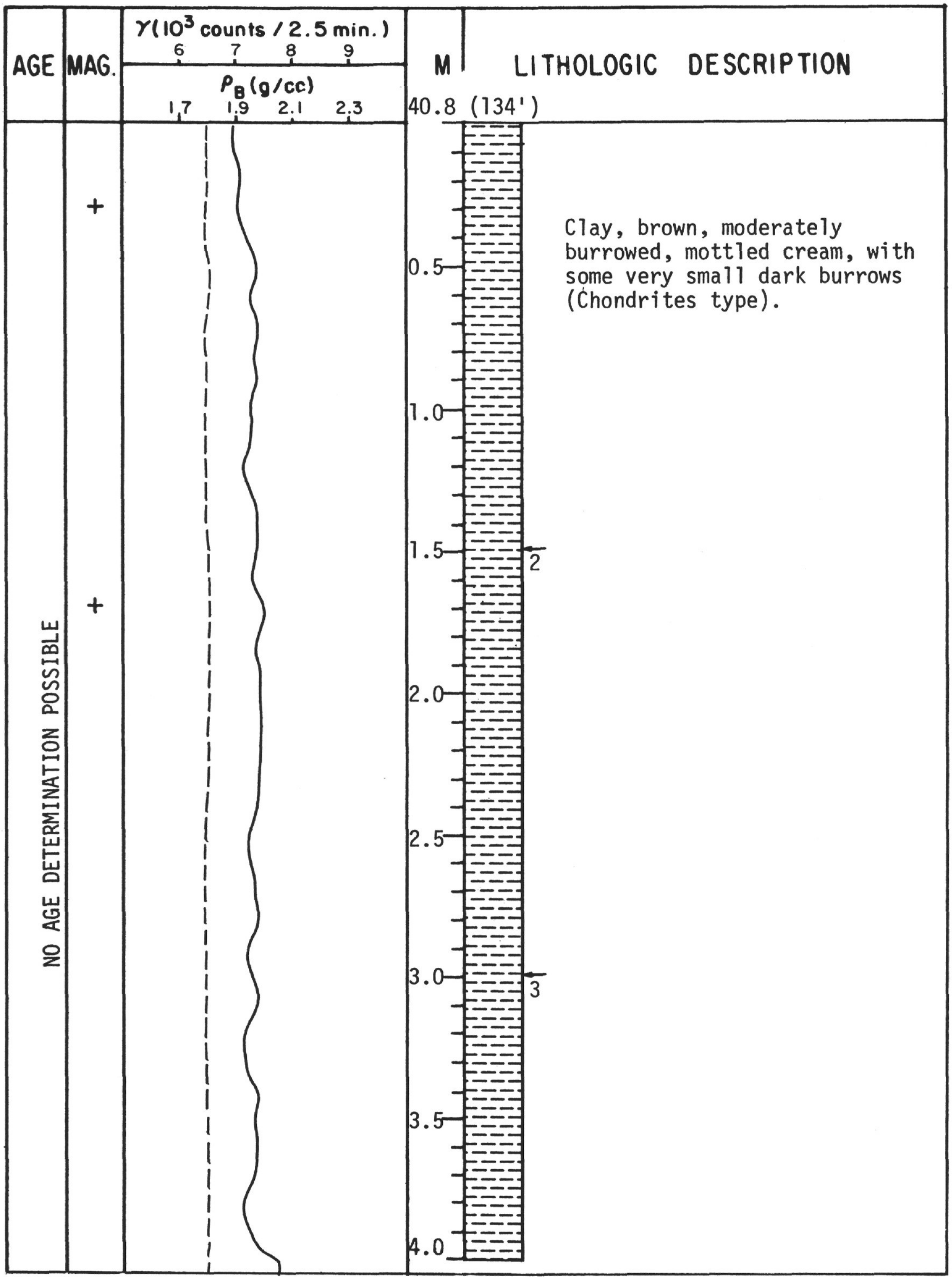


Figure 4. *Hole 6, Core 1.*

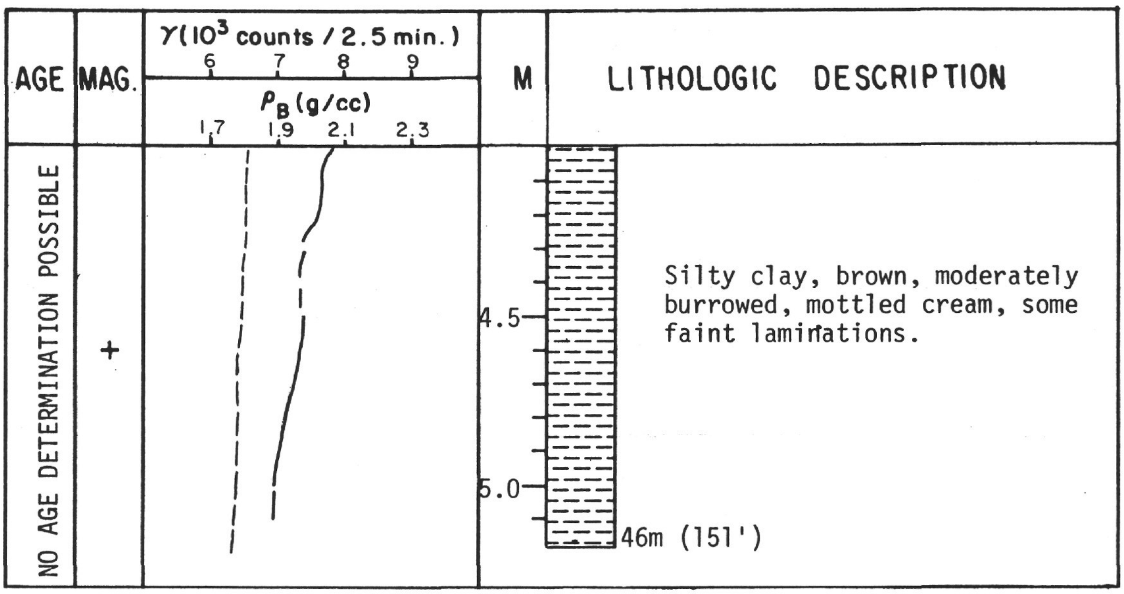


Figure 4. *Continued.*

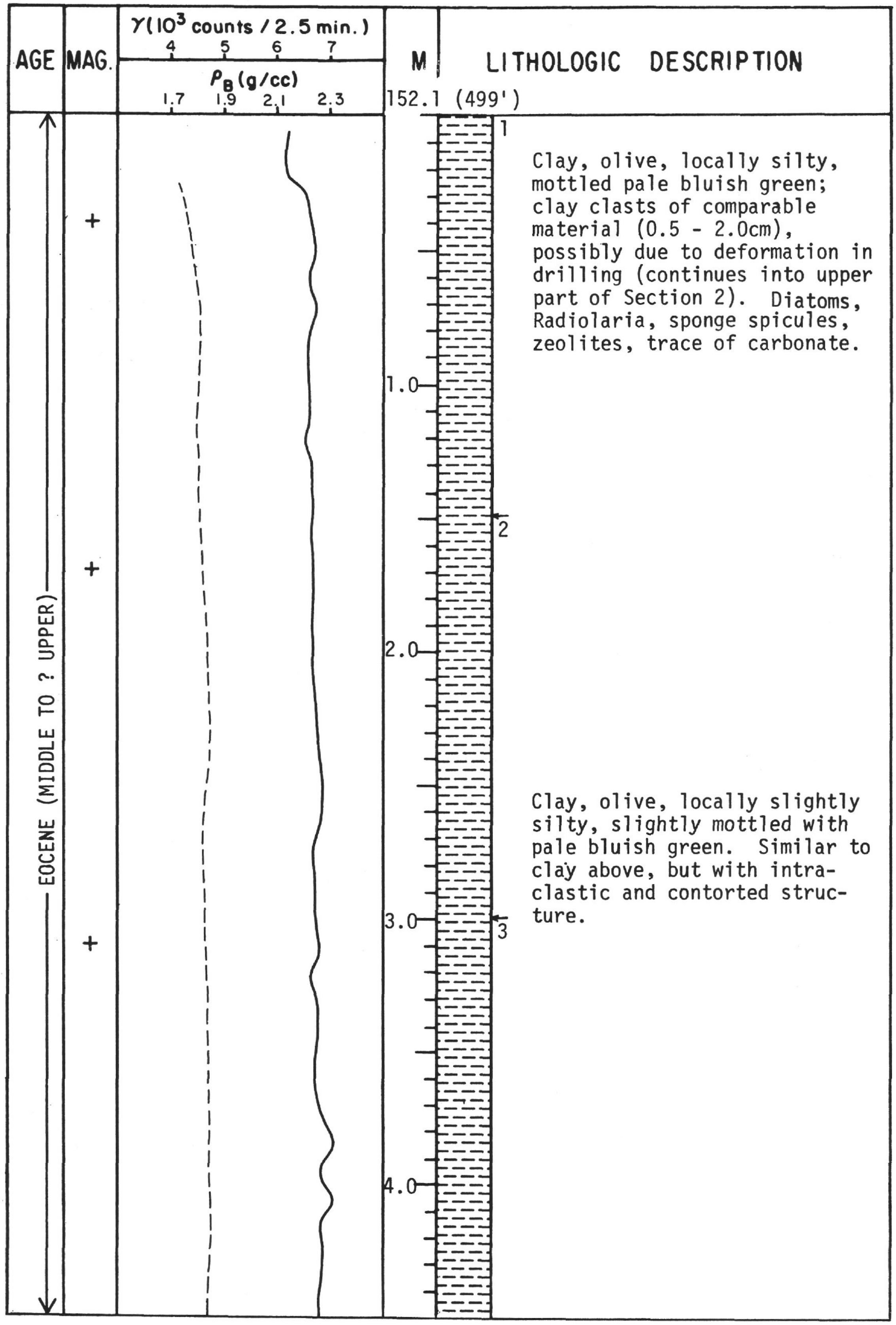


Figure 5. *Hole 6, Core 2.*

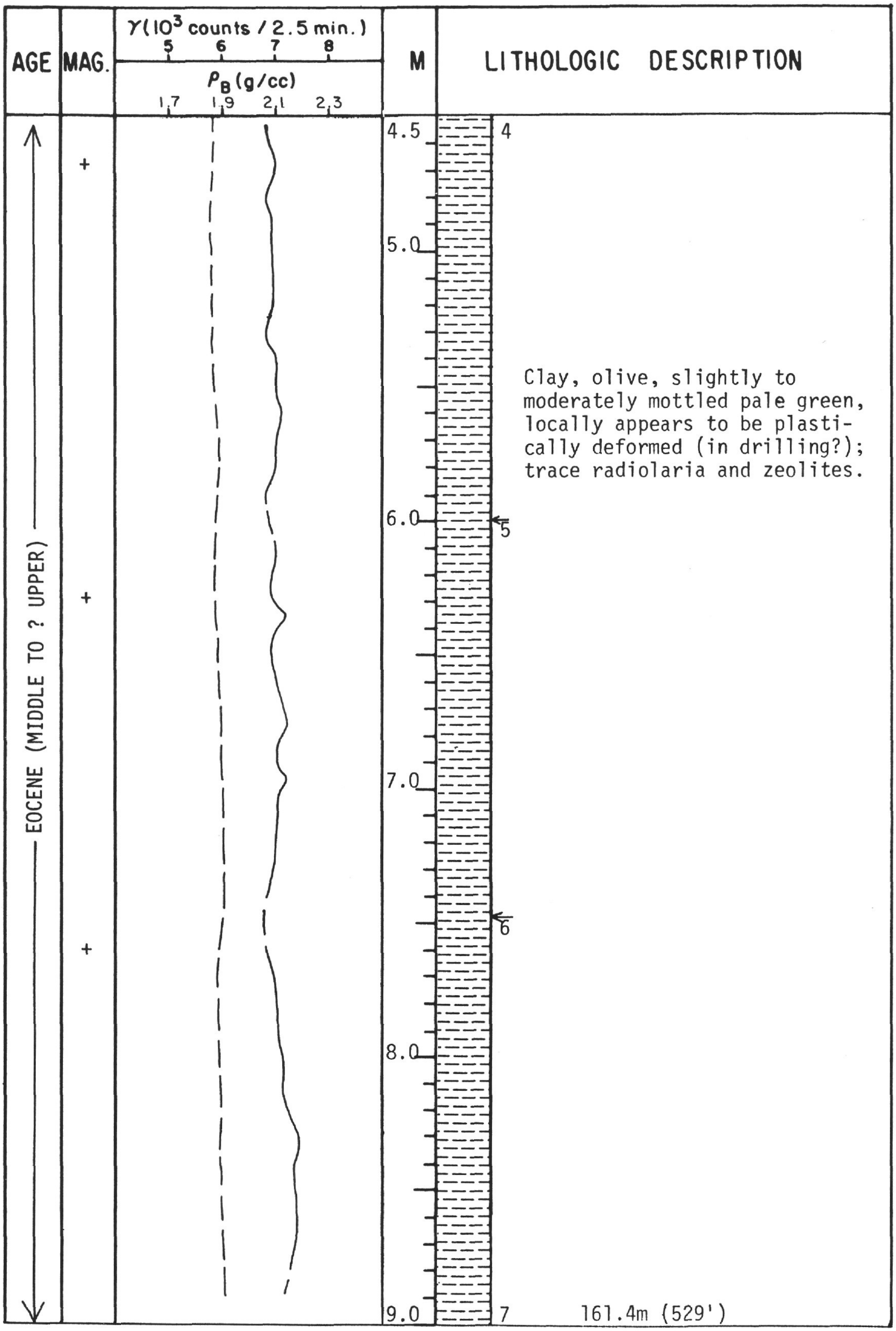


Figure 5. *Continued.*

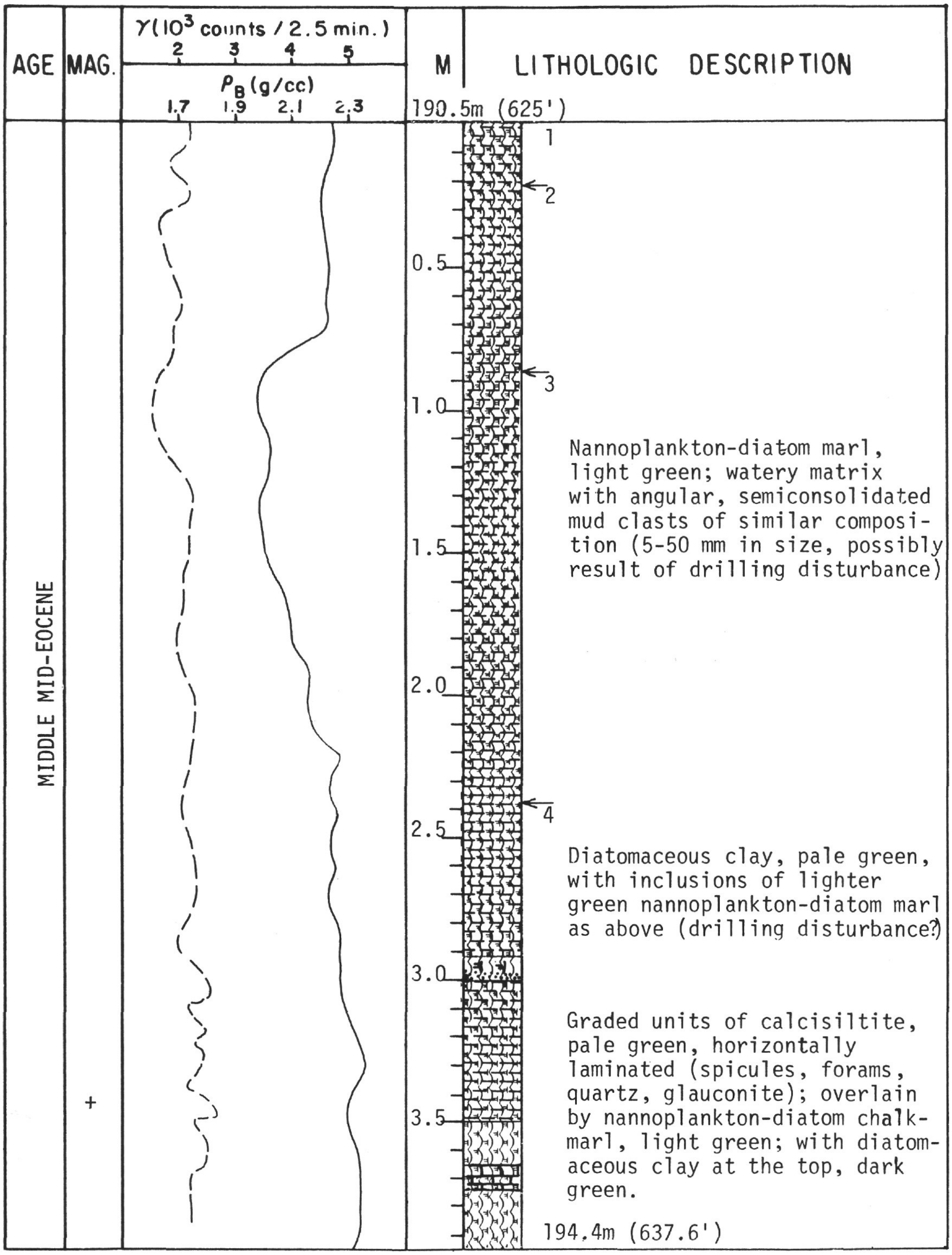


Figure 6. *Hole 6, Core 3.*

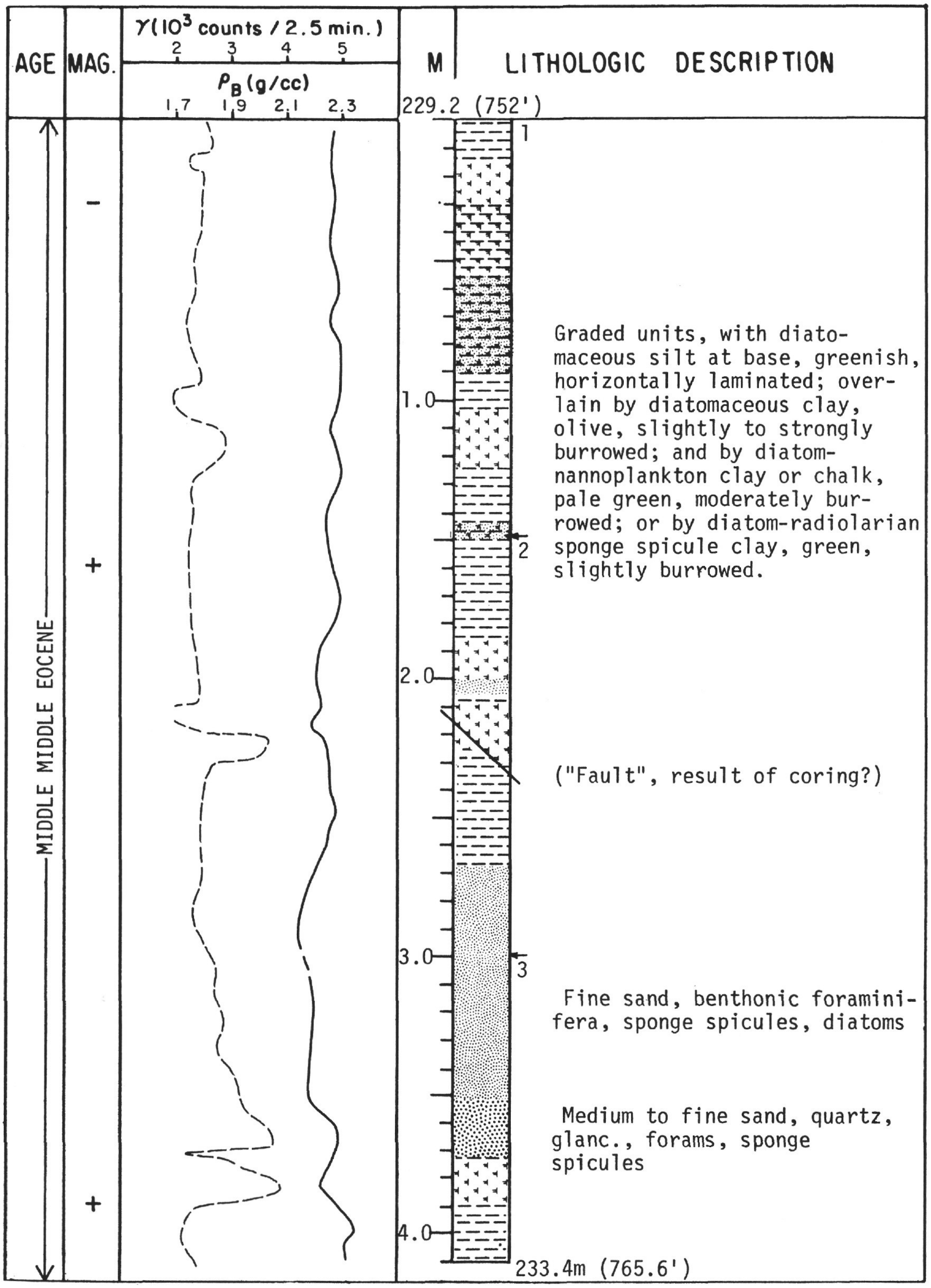


Figure 7. *Hole 6, Core 4.*

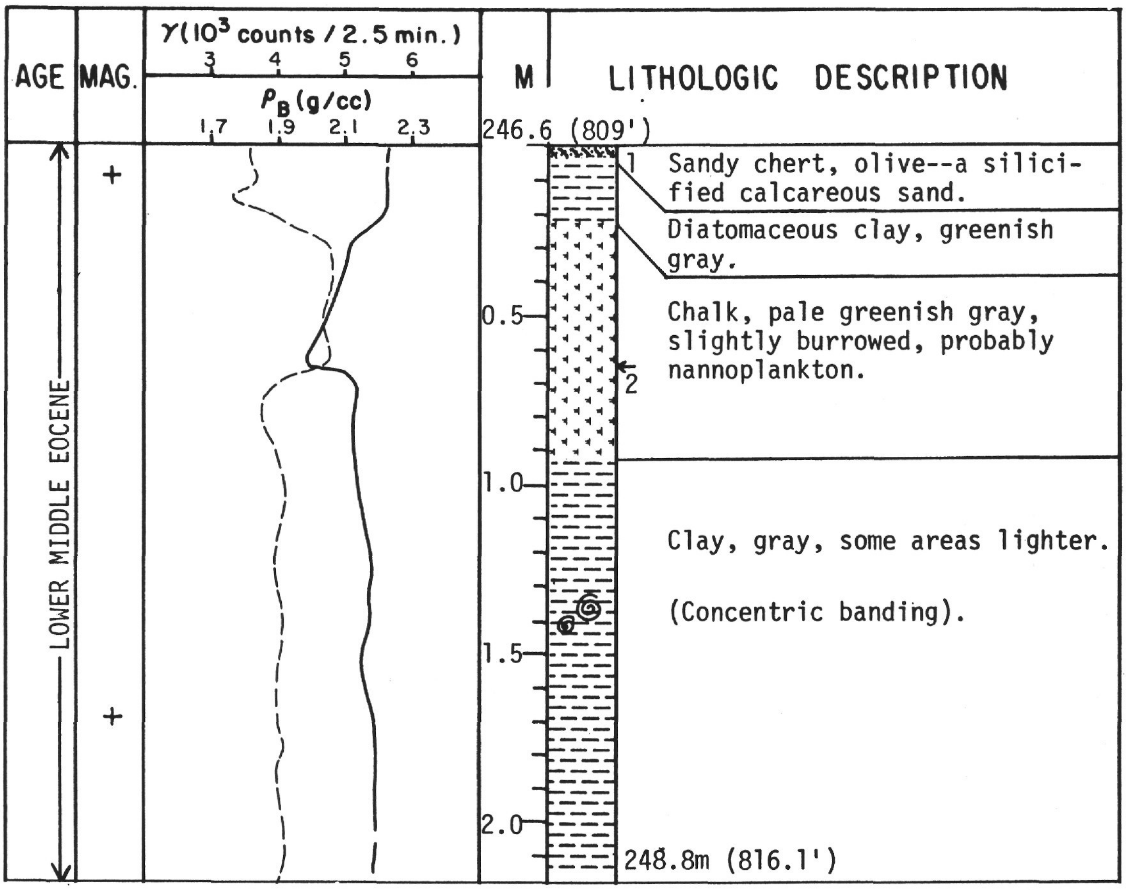


Figure 8. *Hole 6, Core 5.*

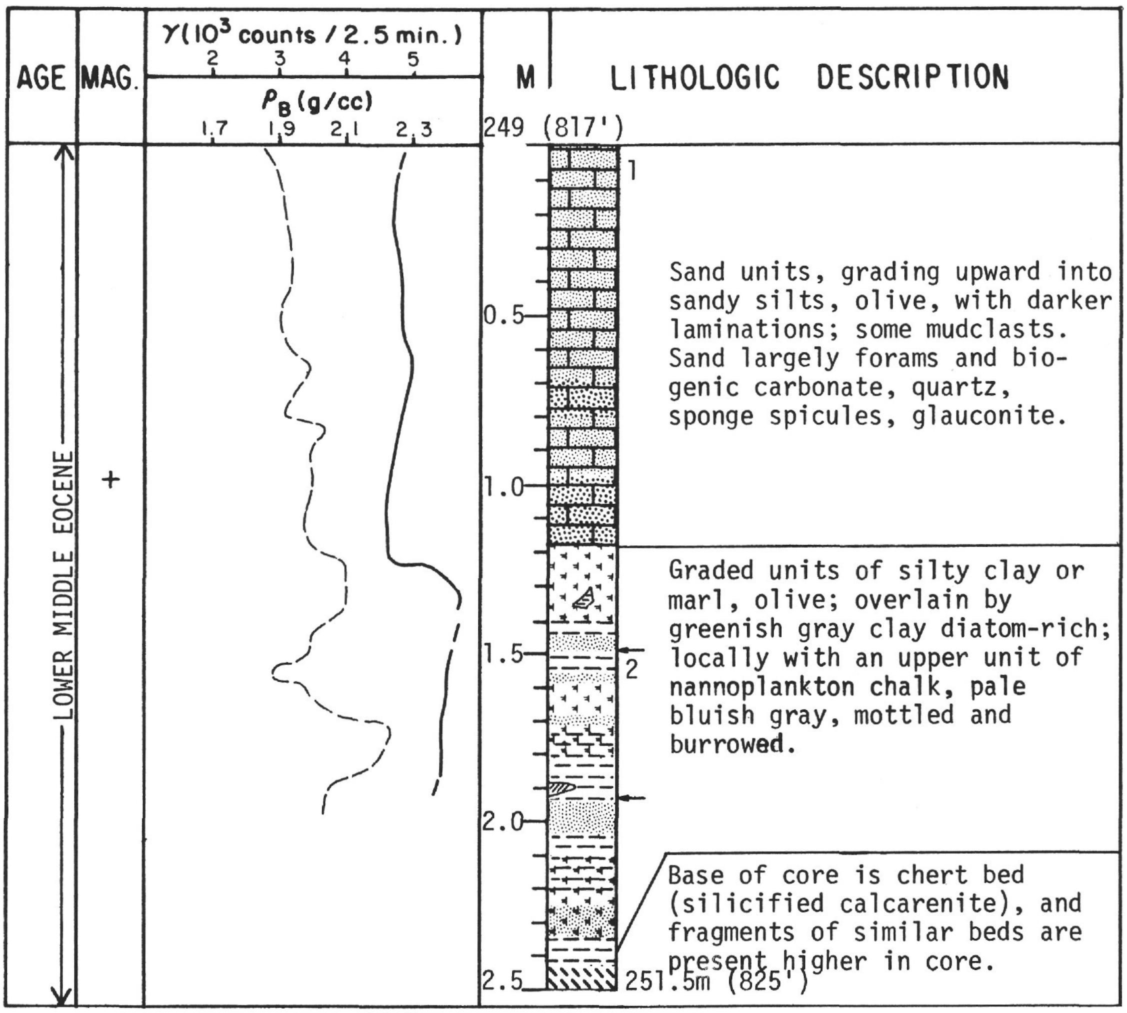


Figure 9. *Hole 6, Core 6.*

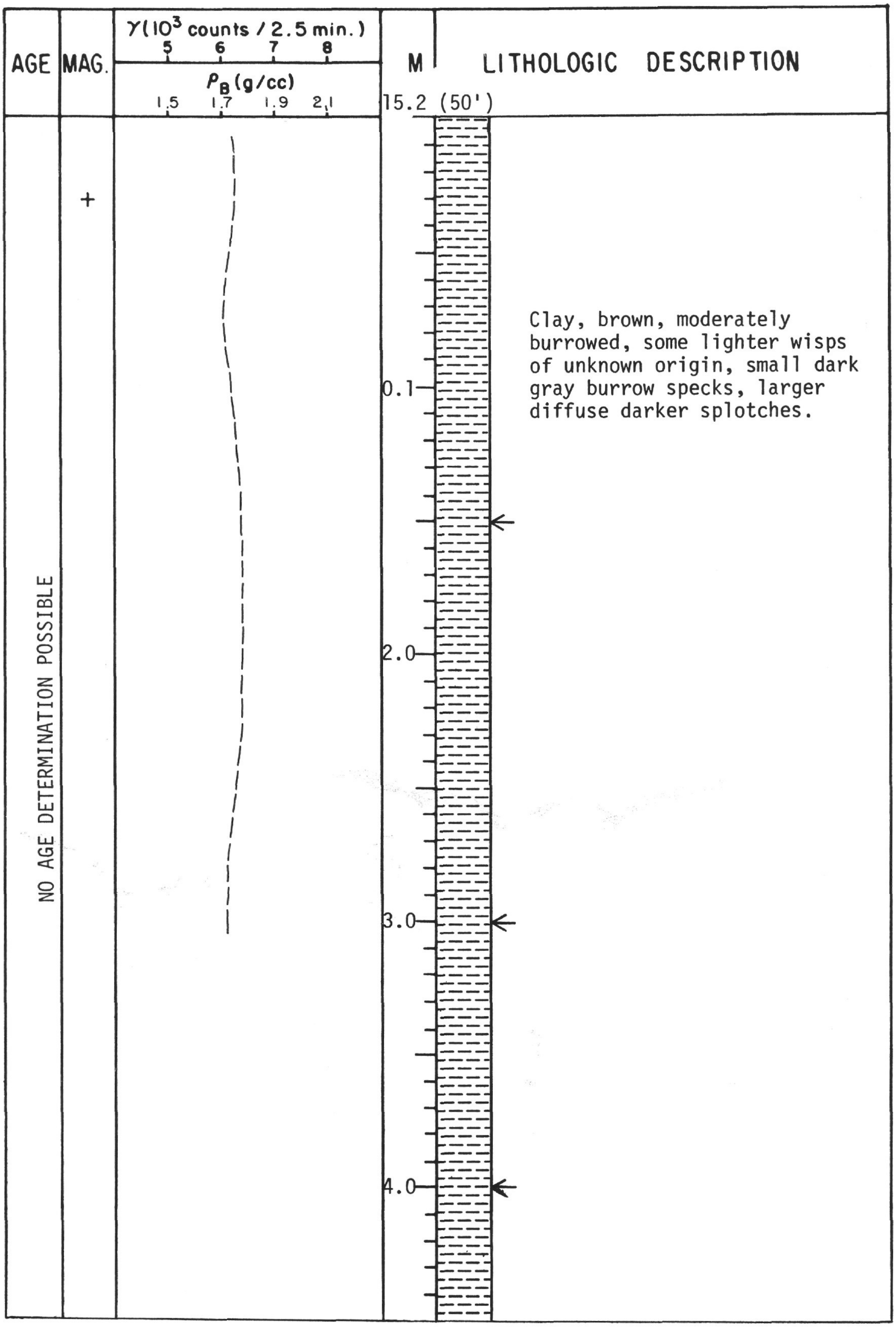


Figure 10. *Hole 6A, Core 1.*

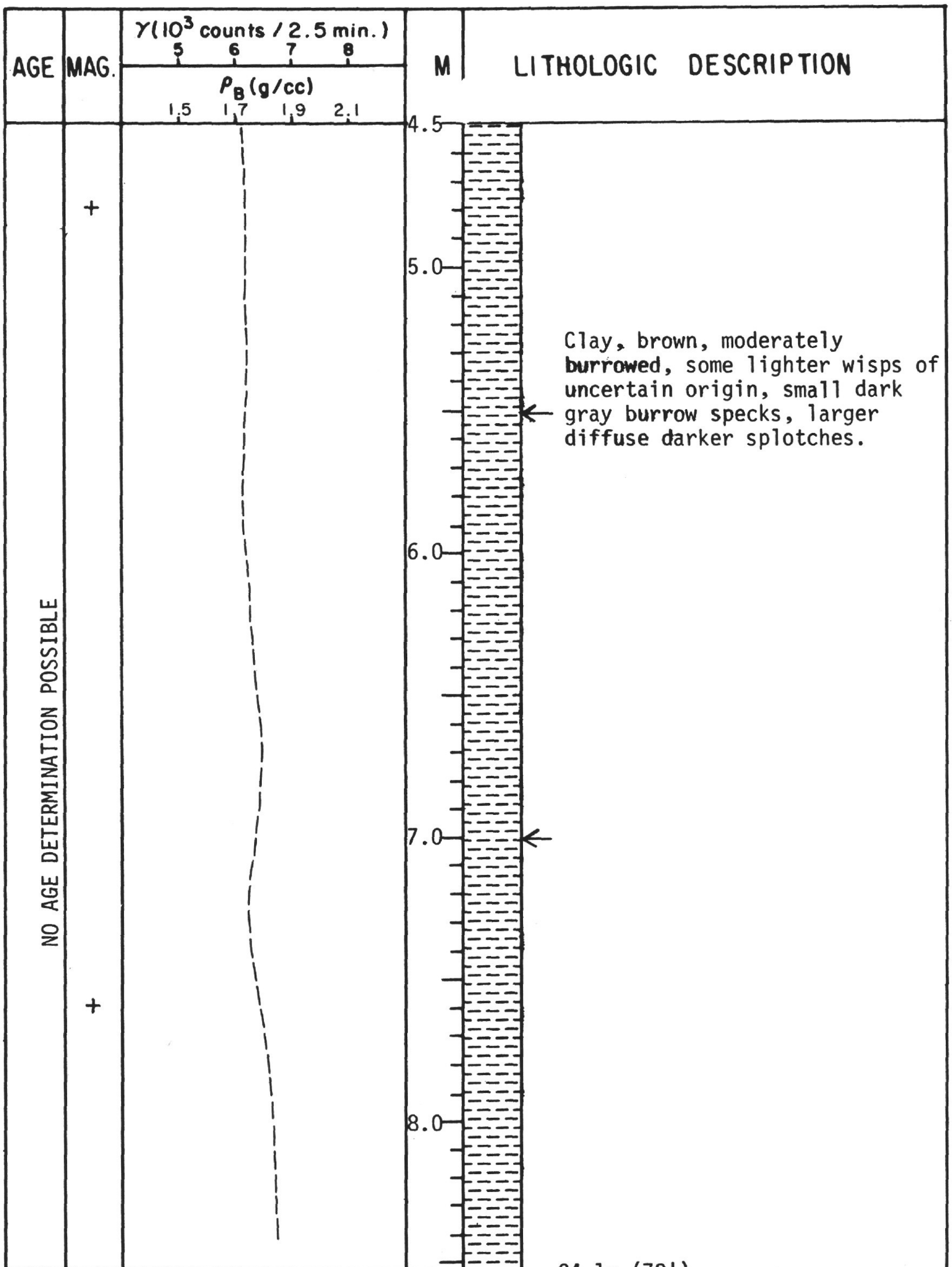
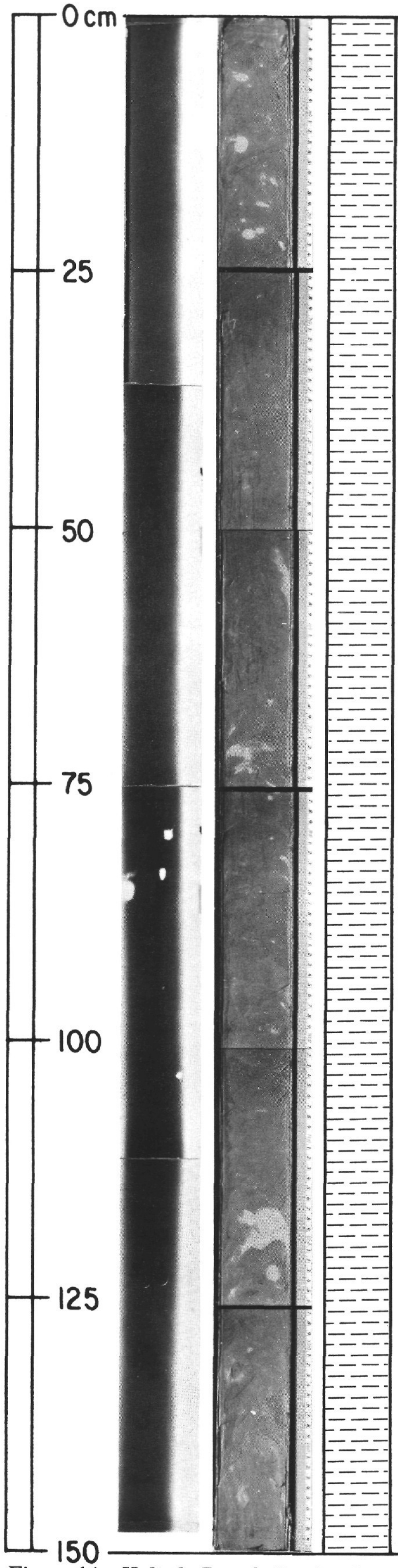


Figure 10. *Continued.*

Figures 11 through 39 show details of the individual core sections of the cores from Site 6.

Each figure shows:

(1) A scale of centimeters from the top of each section.
(2) An X radiograph of the core section.
(3) A photograph of the core section.
(4) The lithology (see key with Site 1 report).
(5) The positions of smear slides (x).
(6) Notes on the lithology, carbon content, expressed as a percentage of total sediment (see Chapter 11), the water content (see Chapter 10) and the grain size (see Chapter 9). Colors are given with reference to the GSA Rock Color Chart.

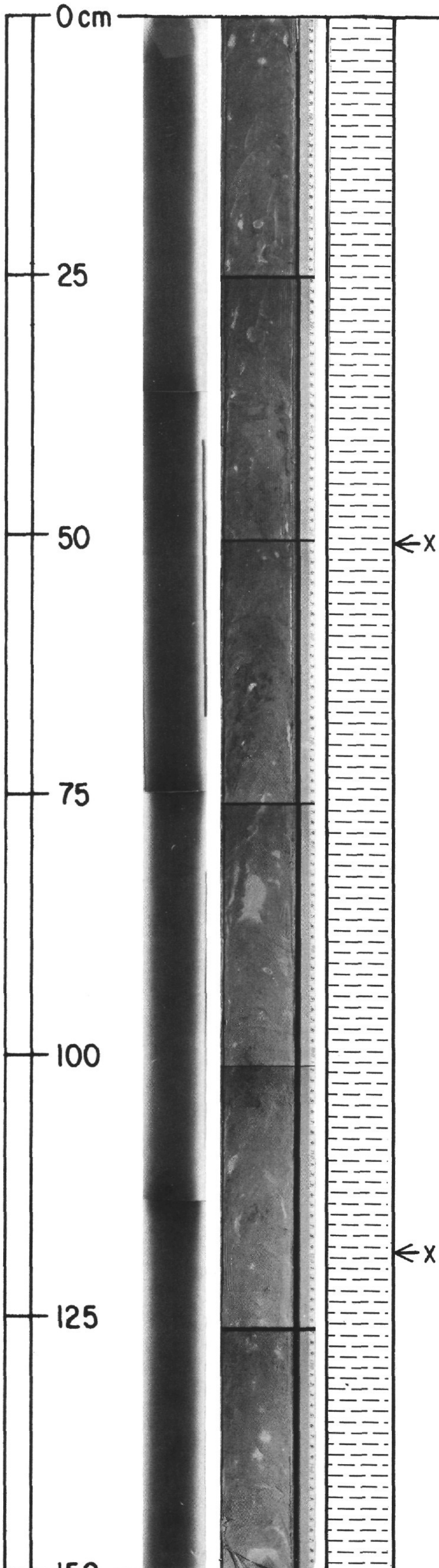


Total C 0.1; Org. C 0.1; $CaCO_3$ 0.0.
Water content 44.0.

Sand 0.0; silt 6.7; clay 93.3.

Clay, brown (10YR 4/2), moderately burrow-mottled cream (10YR 7/4), with patches of small, dark, (*Chondrites*-type) burrows.

Figure 11. *Hole 6, Core 1, Section 1.*

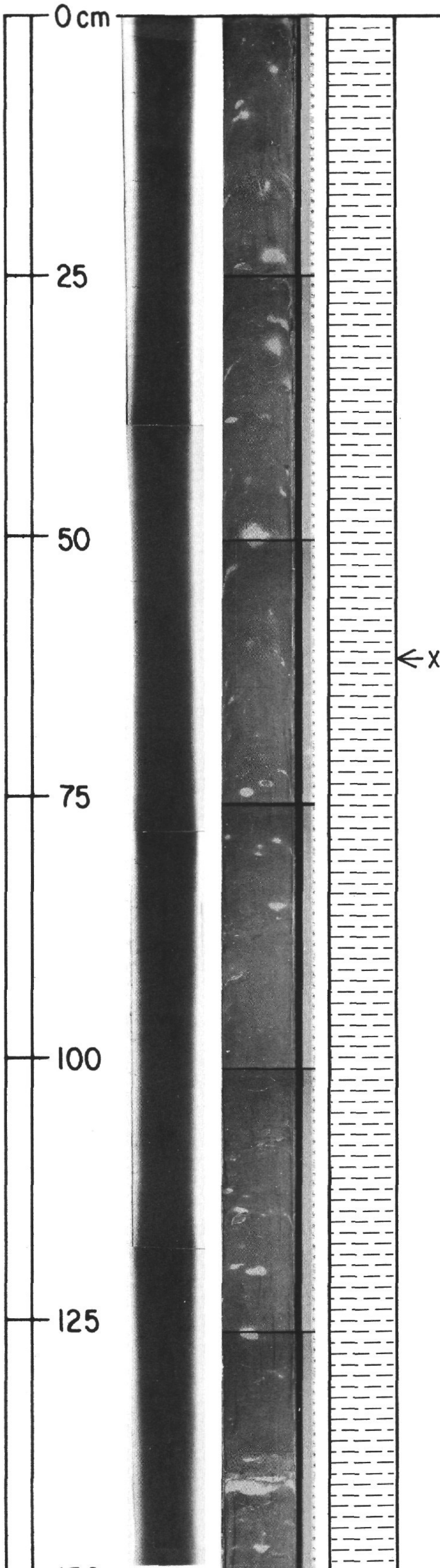


Total C 0.1; Org. C 0.1; $CaCO_3$ 0.0.
Water content 44.0.

Sand 0.0; silt 7.0; clay 93.0.

Clay, brown (10YR 4/2), moderately burrow-mottled (10YR 7/3) cream, with some very small dark burrows (10YR 3/1) in groups (*Chondrites*-type).

Figure 12. *Hole 6, Core 1, Section 2.*



Total C 0.1; Org. C 0.1; $CaCO_3$ 0.3.
Water content 45.2.
Sand 1.1; silt 6.1; clay 92.8.

Clay, brown (10YR 4/2 - 5/3), moderately burrow-mottled cream (10YR 7/4), with fine burrow speckling of black color, (*Chondrites*-type) in patches.

Figure 13. *Hole 6, Core 1, Section 3.*

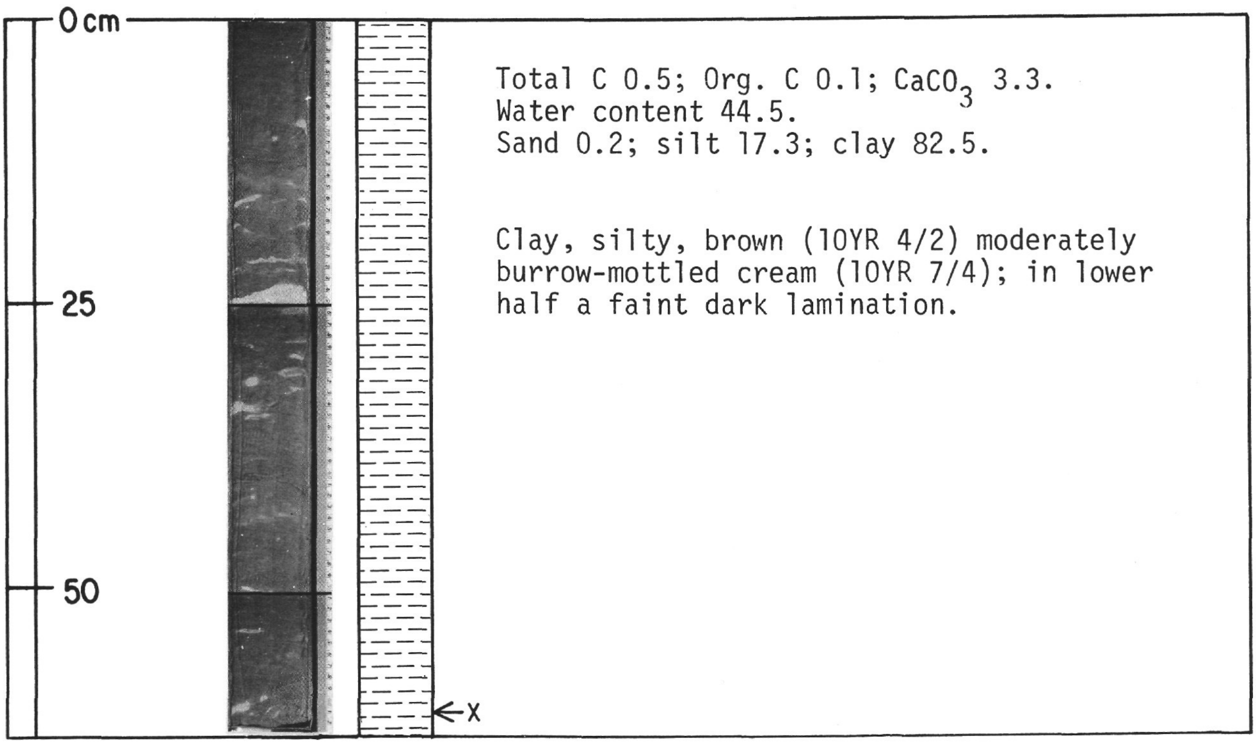
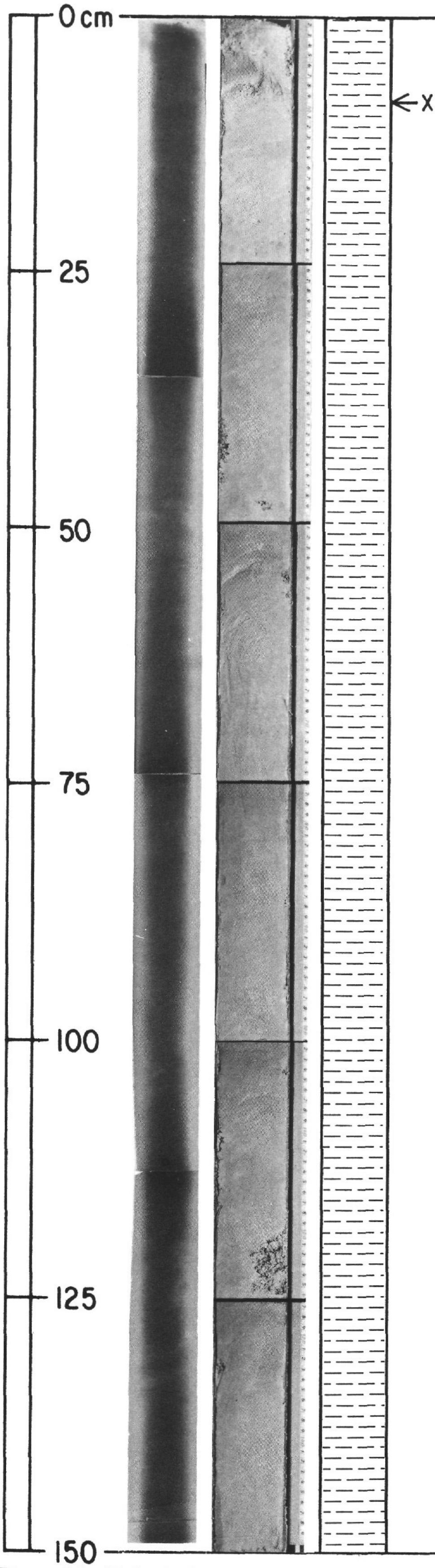


Figure 14. *Hole 6, Core 1, Section 4.*



Total C 0.1; Org. C 0.1; $CaCO_3$ 0.5.
Water content 44.4.

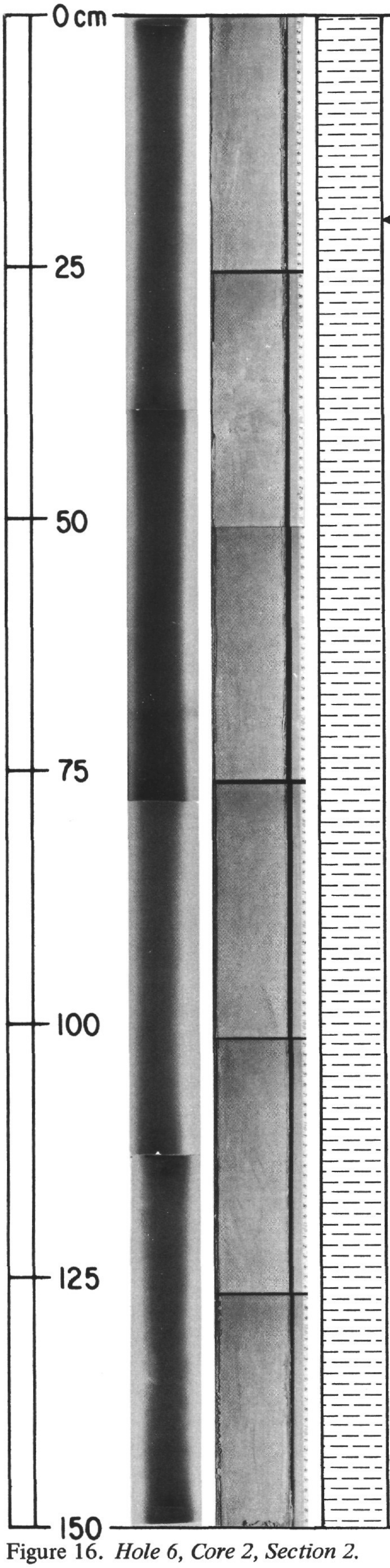
Clay, olive (5Y 5/3), mottled greenish (5G 6/1) and (10GY 6/2): clay matrix soft, watery, with harder clay clasts: possibly due to deformation in drilling. Diatoms, Radiolaria, sponge spicules, zeolites; traces of silt-size carbonate; some zeolite.

Sand 0.5; silt 8.9; clay 90.6.

Note speckling by an X-ray opaque mineral in top part of core.

Lower part of section appears highly contorted.

Figure 15. *Hole 6, Core 2, Section 1.*

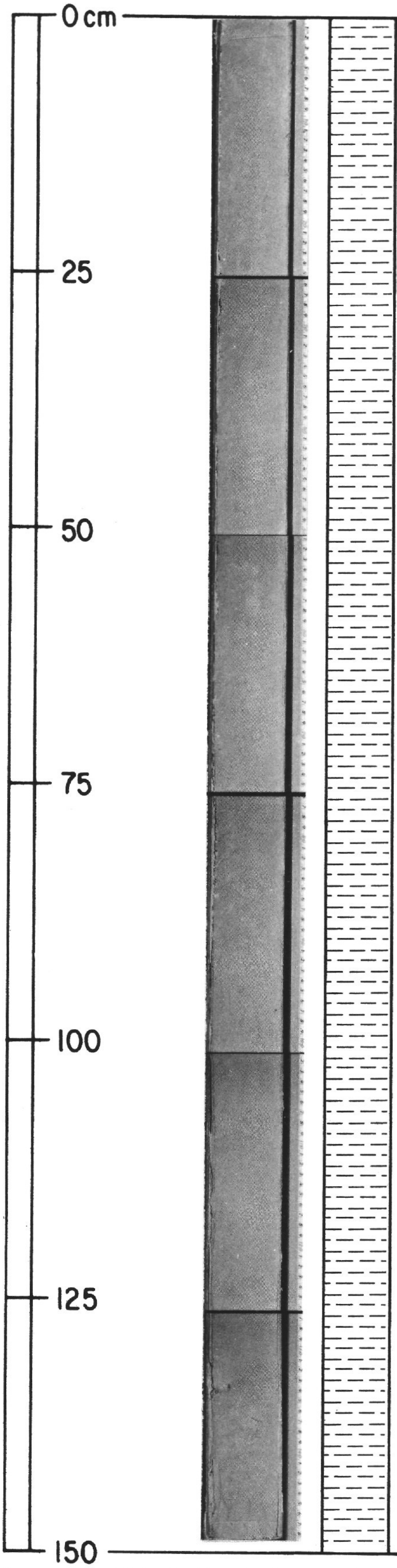


Total C 2.7; Org. C 0.6; $CaCO_3$ 18.1.
Water content 41.1.

X Sand 0.4; silt 11.8; clay 87.8.

Clay, silty, olive-green (5Y 5/3), slightly mottled with pale bluish-green (5G 6/1); the "intraclastic" structure of Section 1 continues into upper part of Section 2, with clasts 0.5 - 2.0 cm - due to disturbance in drilling? Trace of diatoms. Some zeolite.

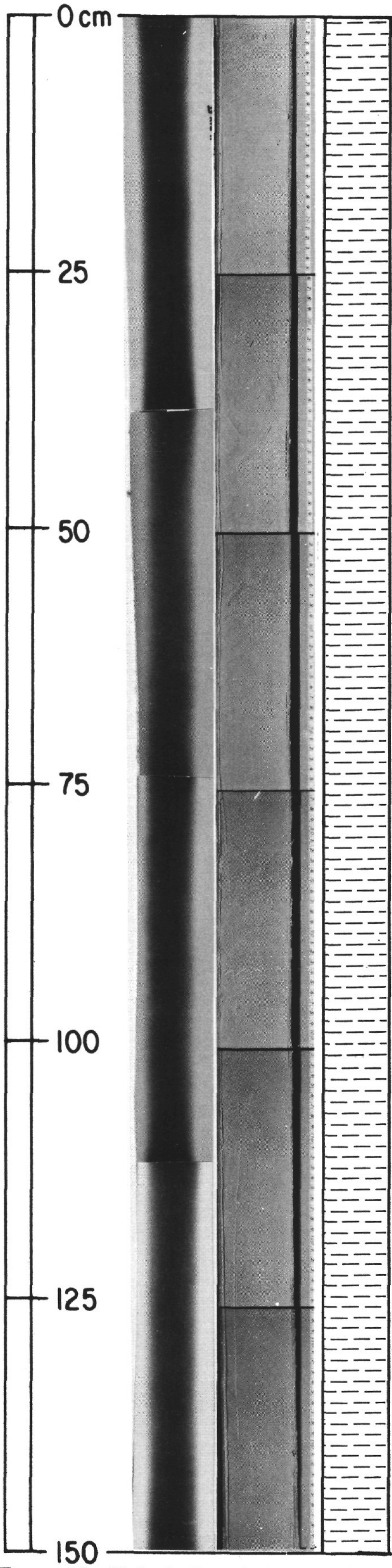
Figure 16. *Hole 6, Core 2, Section 2.*



Total C 0.2; Org. C 0.1; $CaCO_3$ 1.1.
Water content 43.2.
Sand 0.4; silt 9.4; clay 90.2.

Clay, olive (5Y 5/3), slightly mottled with pale green (5G 6/1). Some zeolite.

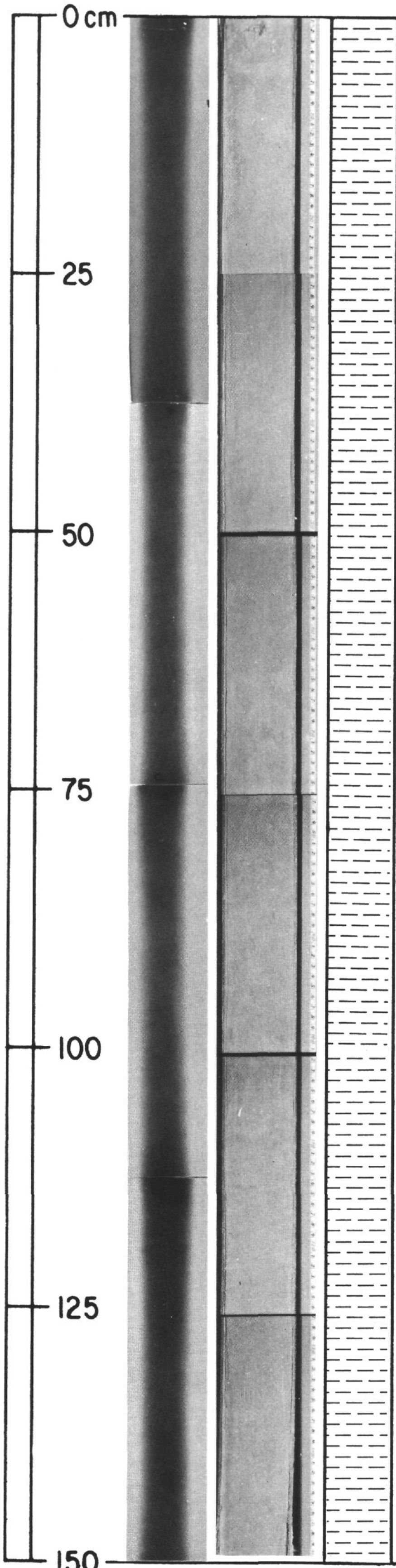
Figure 17. *Hole 6, Core 2, Section 3.*



Total C 0.2; Org. C 0.2; $CaCO_3$ 0.0.
Water content 41.2.
Sand 1.7; silt 7.0; clay 91.3.

Clay, olive (5Y 5/3), slightly mottled with pale green (5G 6/1). Some zeolite.

Figure 18. *Hole 6, Core 2, Section 4.*



Total C 0.1; Org. C 0.1; $CaCO_3$ 0.0.
Water content 41.2.
Sand 0.5; silt 8.5; clay 91.0.

Clay, olive (5Y 5/3) moderately mottled pale green (5G 6/1), appears plastically deferred (in drilling?); trace Radiolaria and zeolite.

Figure 19. *Hole 6, Core 2, Section 5.*

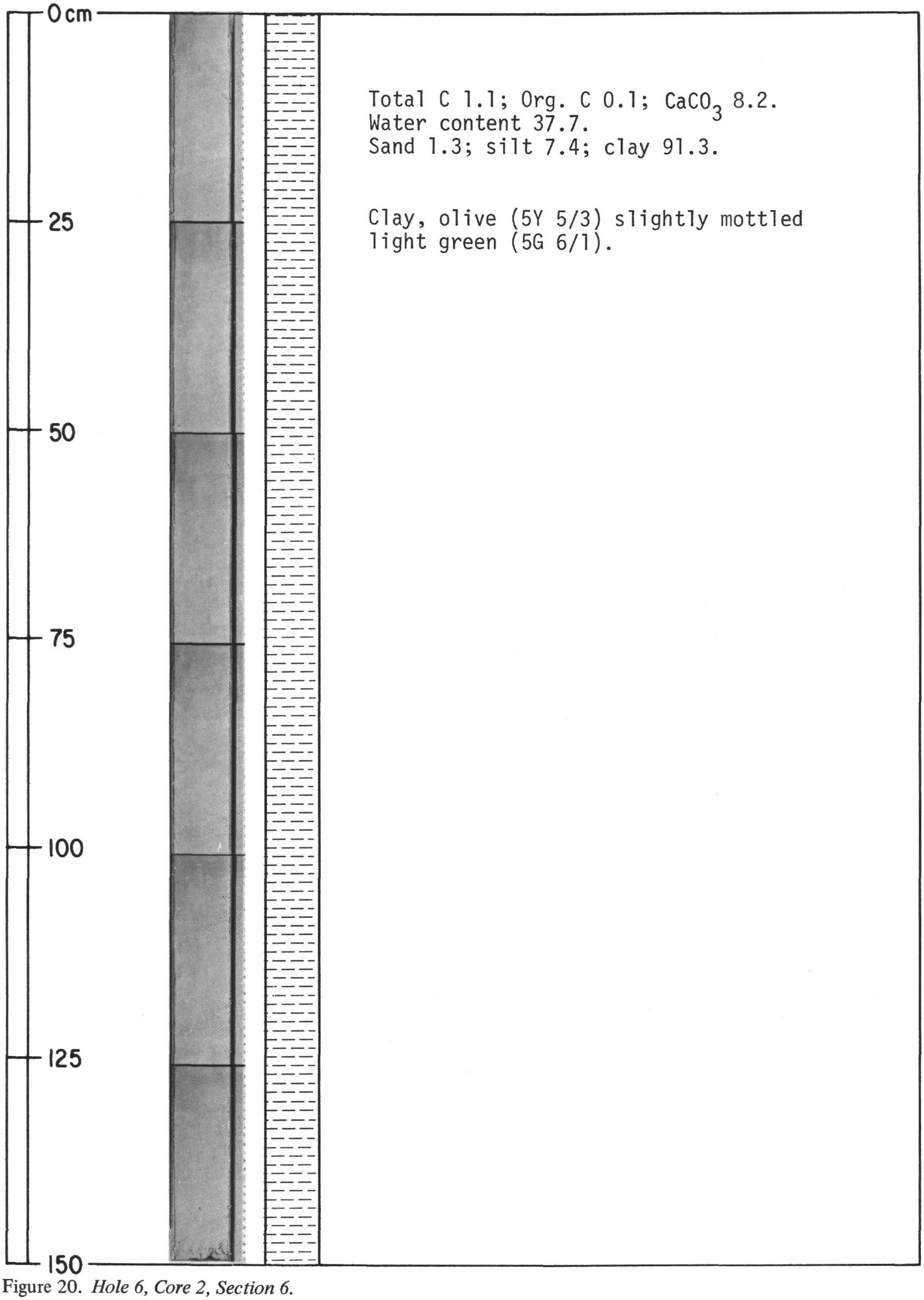


Figure 20. *Hole 6, Core 2, Section 6.*

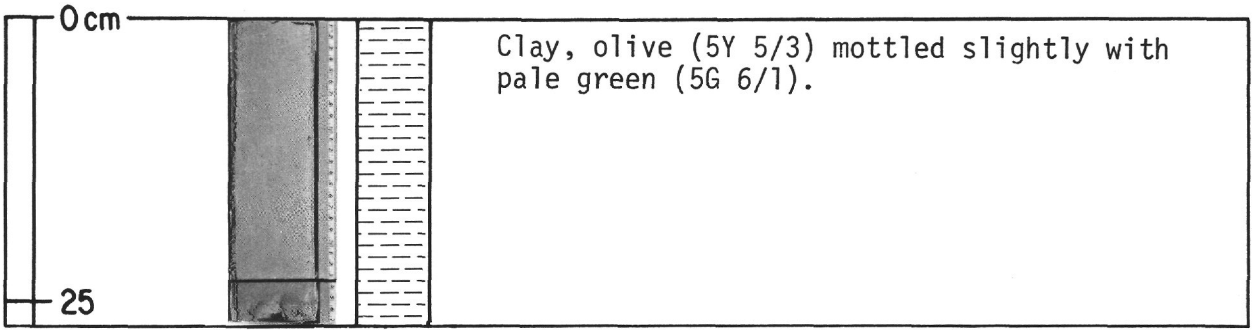


Figure 21. *Hole 6, Core 2, Section 7.*

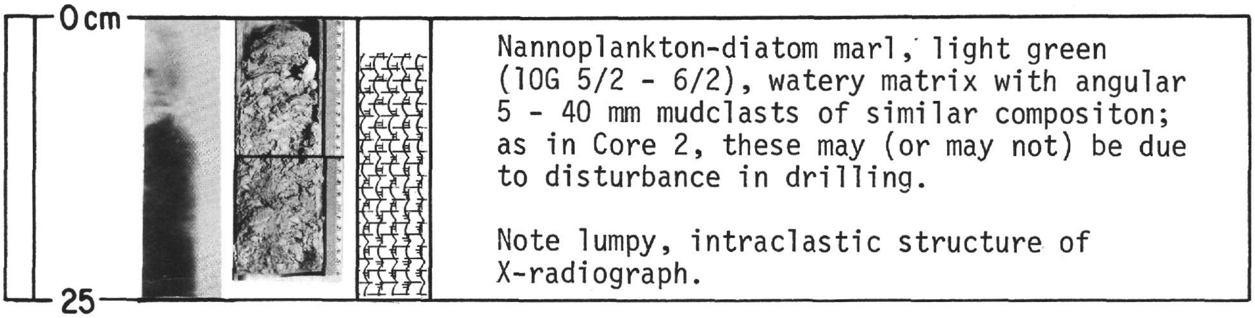
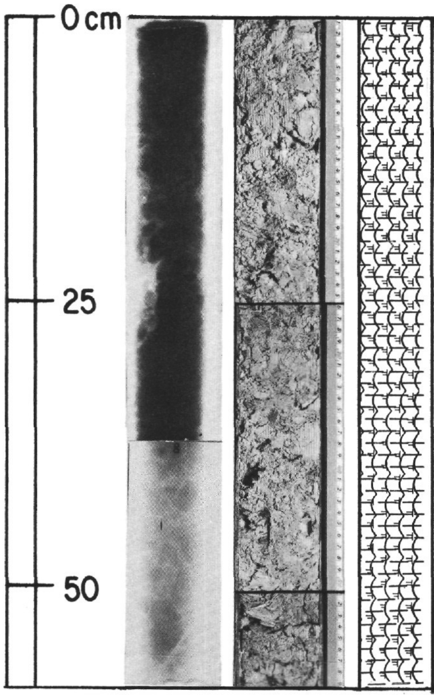


Figure 22. *Hole 6, Core 3, Section 1.*

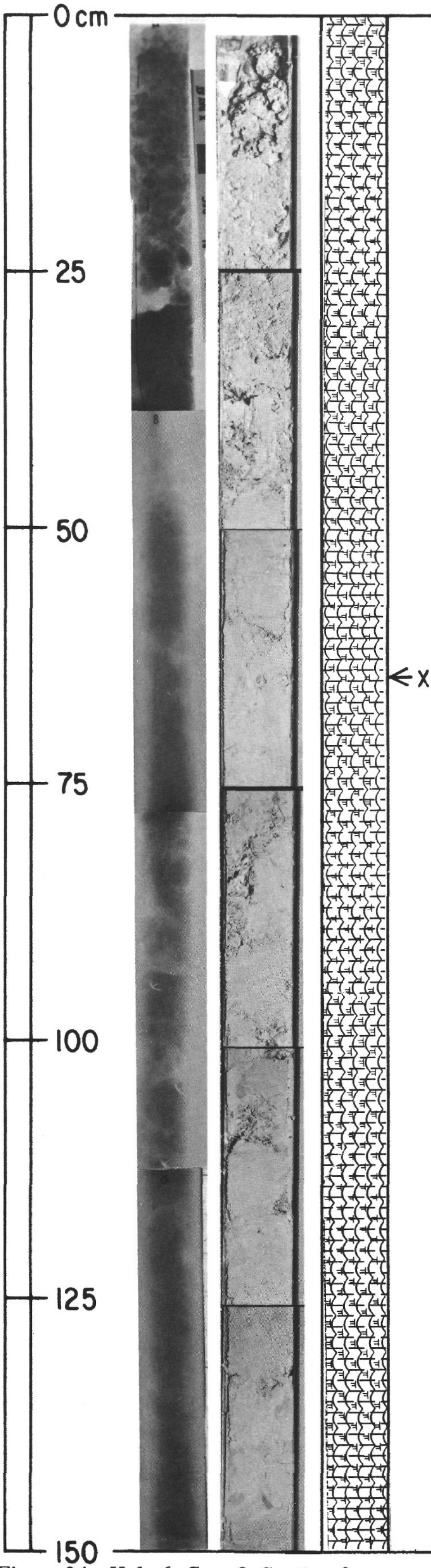


Total C 2.8; Org. C 0.1; $CaCO_3$ 22.6.
Water content 48.6.

Sand 0.1; silt 24.7; clay 75.2.

Nannoplankton-diatom marl, light green (10G 5/2 O 6/2), watery matrix with angular semi-consolidated mud clasts (5 - 50 mm) and similar composition; possibly caused by drilling. (See X-radiograph). Very rich in diatoms, some radiolaria, abundant nannoplankton.

Figure 23. *Hole 6, Core 3, Section 2.*



Nannoplankton-diatom marl, gray-green (10G 5/2 - 6/2), more watery matrix (especially 0 - 40 cm) with harder, angular mud clasts of same composition (5 - 50 mm) - possibly due to disturbance in drilling (see top part of X-radiograph). Abundant nannoplankton, diatoms, sponge spicules.

Total C 3.7; Org. C 0.2; $CaCO_3$ 29.1.

Sand 0.0; silt 20.4; clay 79.6.

Figure 24. *Hole 6, Core 3, Section 3.*

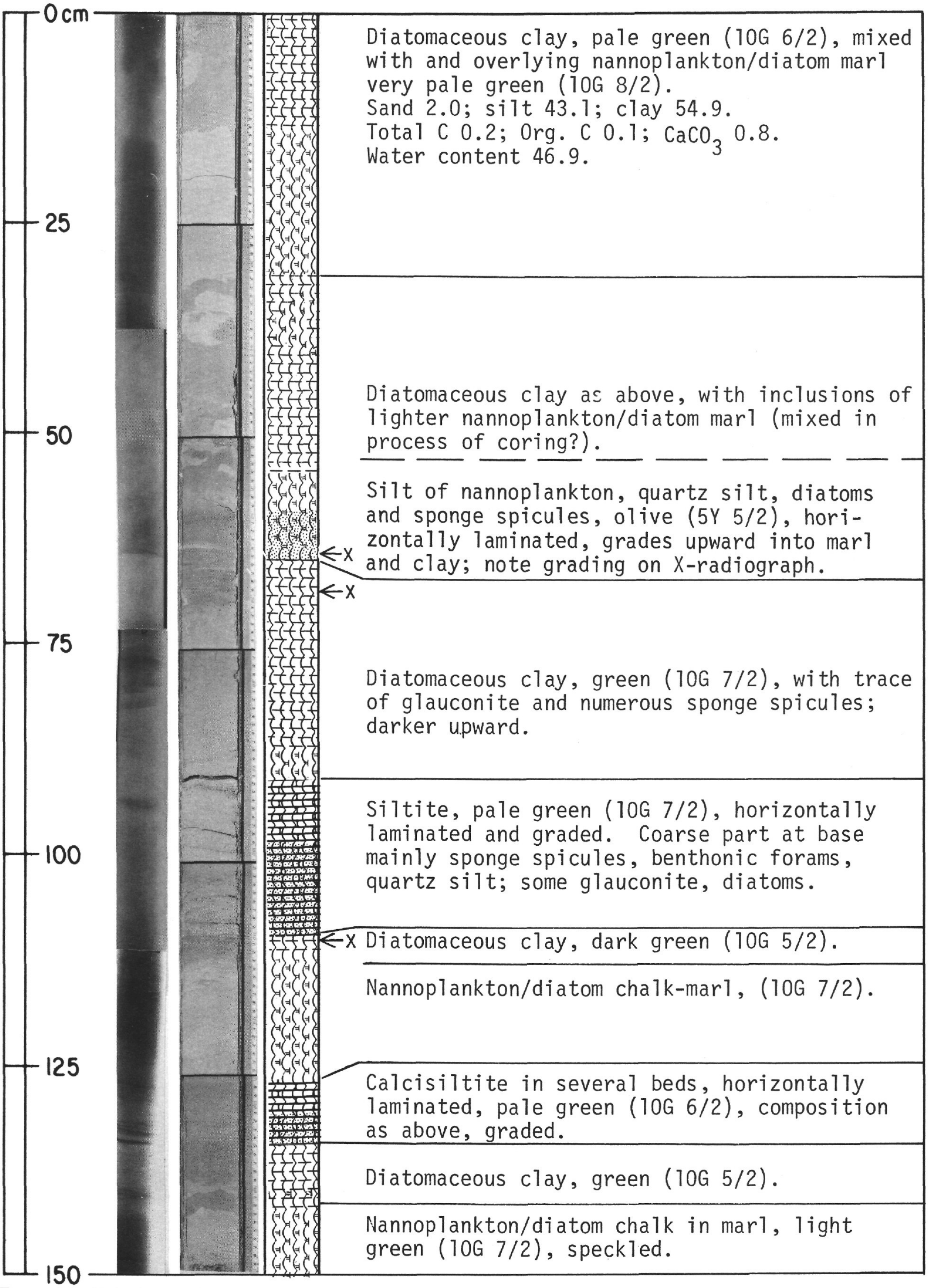


Figure 25. *Hole 6, Core 3, Section 4.*

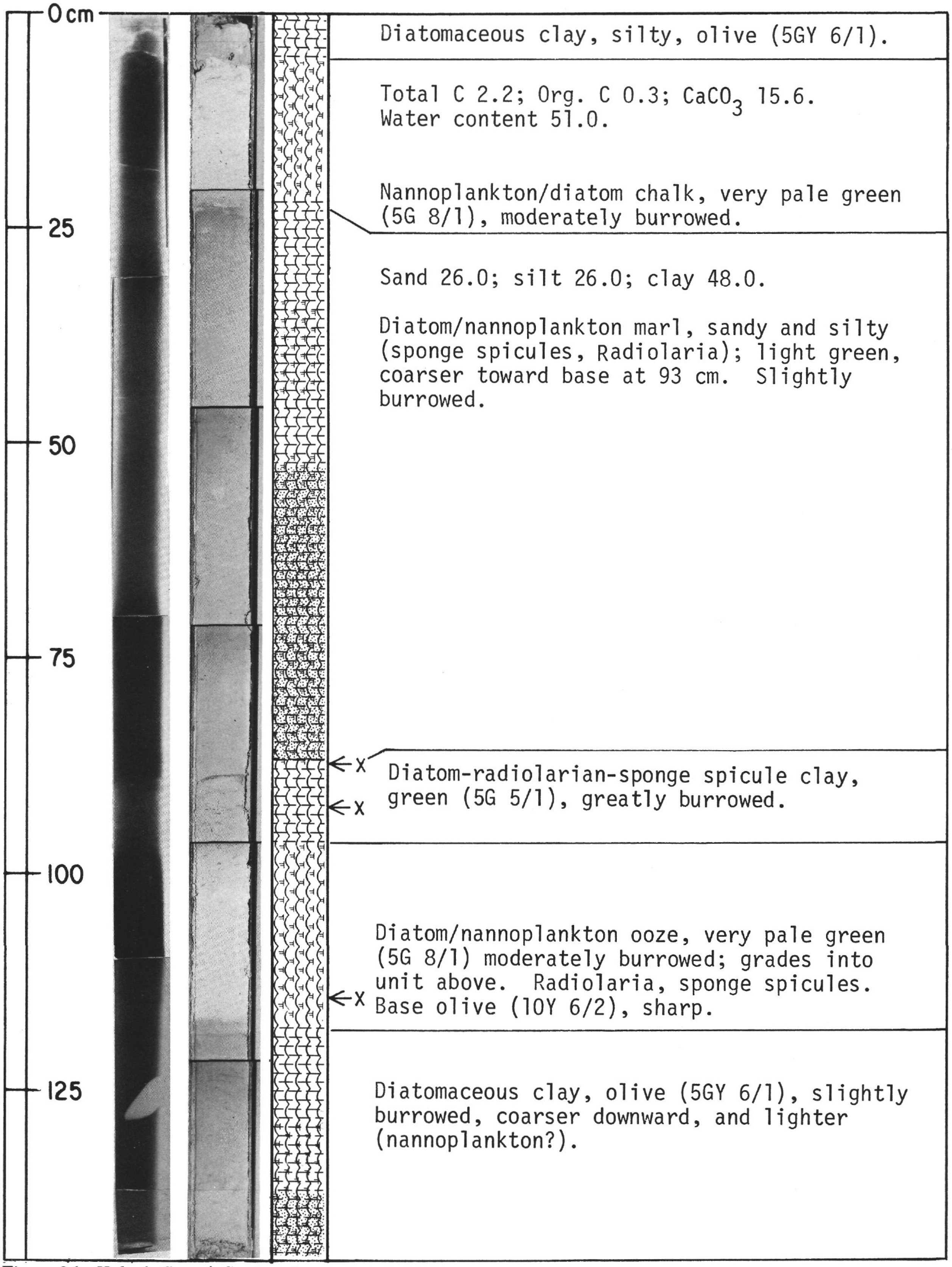
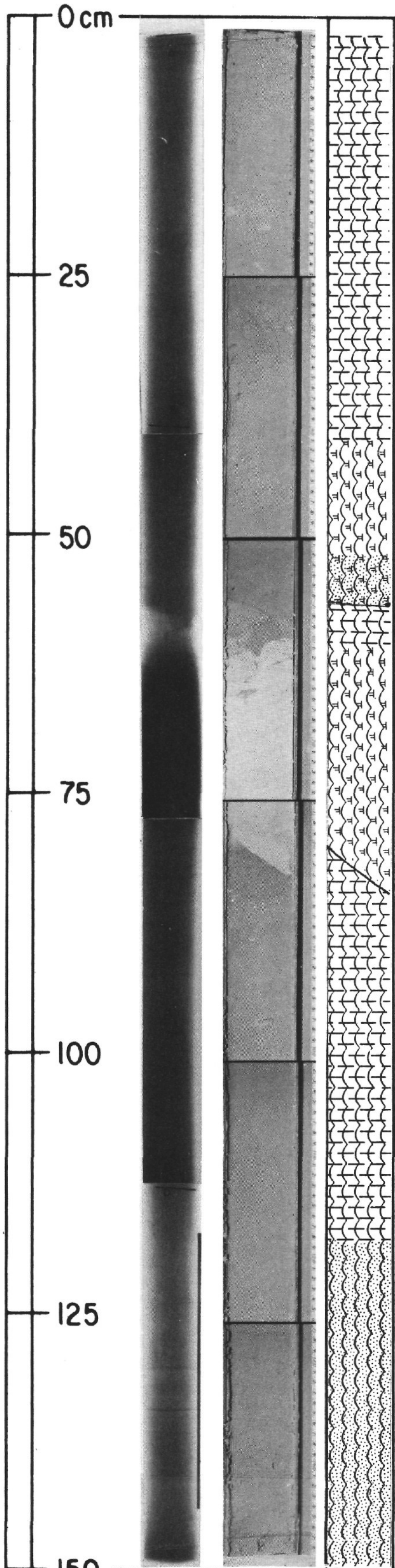


Figure 26. *Hole 6, Core 4, Section 1.*



Diatomaceous clay, greenish (5G 6/1), gradational with underlying silt.

Sand 9.9; silt 33.0; clay 57.1.

Total C 3.8; Org. C 0.3; $CaCO_3$ 29.8.
Water content 41.9.

X Diatom-sponge spicule-radiolarian-nannoplankton silt, horizontally laminated, greenish (5G 6/1), graded.

X 56 - 59 green (5G 5/1), diatom-radiolarian-sponge spicule clay, strongly burrowed.

X Nannoplankton-diatom chalk, very pale green (5G 8/1), moderately to strongly burrowed.

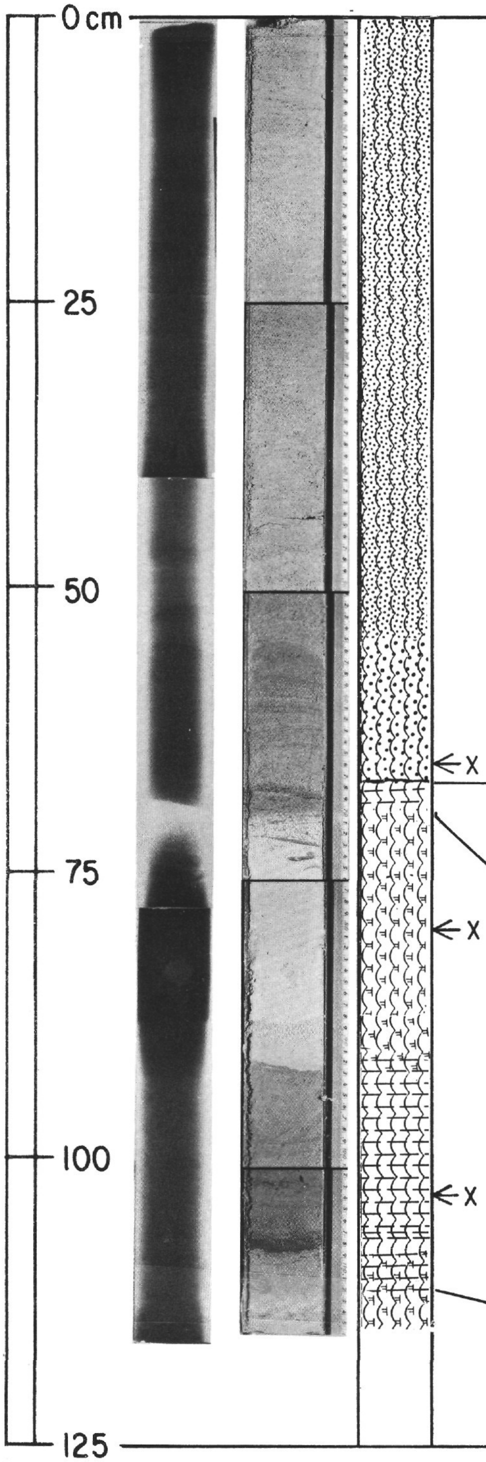
"Fault" (caused by coring?)

Diatomaceous clay, possibly nannoplankton-rich; greenish (5G 6/1); strongly burrowed-gradational with subjacent unit.

Gradational

Diatomaceous silt, graded, horizontally laminated, greenish (5G 6/1).

Figure 27. *Hole 6, Core 4, Section 2.*



Total C 3.8; Org. C 0.2; $CaCO_3$ 30.8.
Water content 35.5.

Fine sand, silty, (quartz, glauconite, benthonic foraminifera, sponge spicules, some diatoms and nannofossils). Greenish-gray (5GY 6/1), horizontally laminated (see X-radiograph).

Gradational sand, medium to fine, silty, (quartz, glauconite, benthonic forams, sponge spicules, some diatoms and nannofossils). Dark greenish-gray (5GY 5/1), horizontally laminated. Base sharp.

Diatomaceous clay, bluish-green (5B 5/1 - 5G 5/1), burrowed.

Calcisiltite, white, of what may be nannoplankton debris; diatoms, Radiolaria, sponge spicules; upper part heavily burrowed.

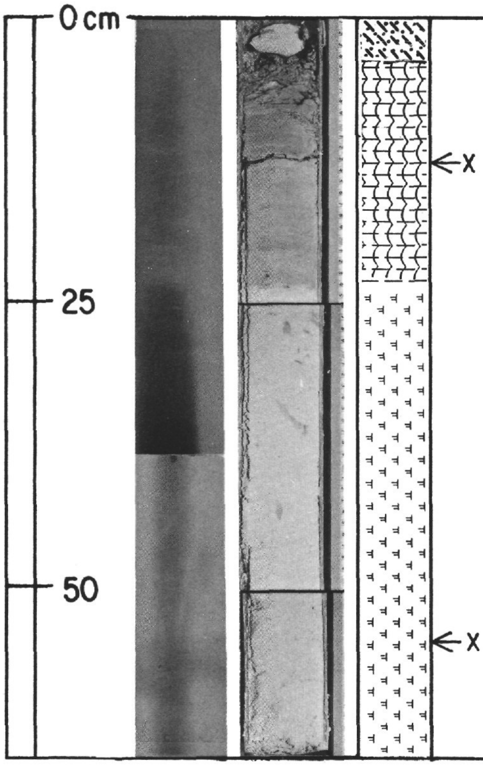
Sand 0.2; silt 34.7; clay 65.1.

Diatomaceous clay, greenish-gray (5G 6/1), strongly intraclastic (disturbed in drilling?).

Diatomaceous clay, dark greenish (5G 5/1), heavily burrowed.

Nannoplankton-diatom chalk-marl, pale geeenish-gray (5G 7/1), moderately burrowed.

Figure 28. *Hole 6, Core 4, Section 3.*

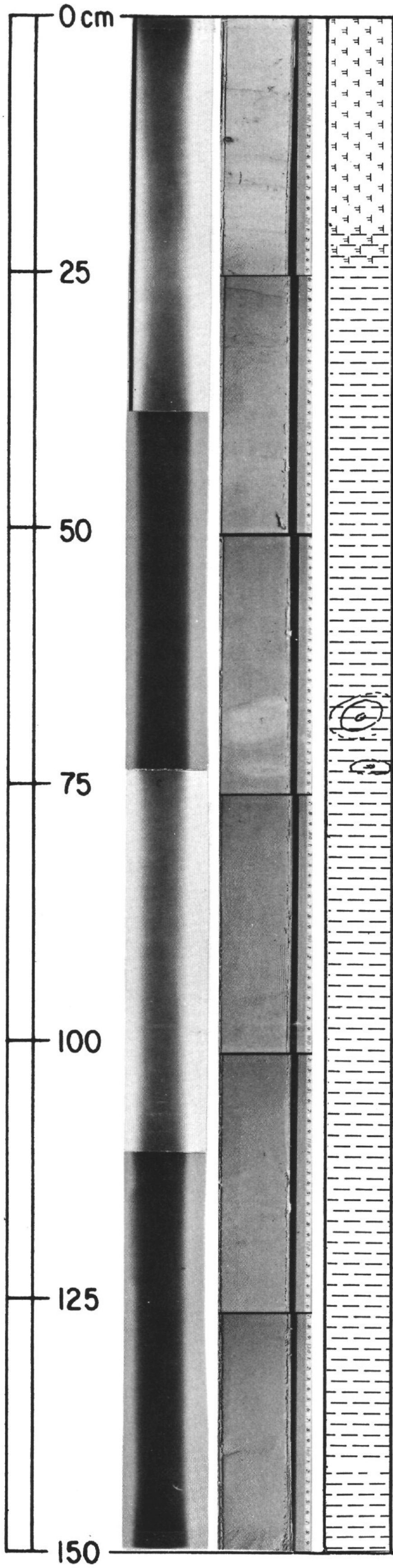


Sandy chert, olive (5Y 5/1); a silicified calcareous sand of quartz, glauconite, sponge spicules and foraminifera.
Total C 0.2; Org. C 0.2;   0.0.
Water content 38.3.
Sand 0.3; silt 24.0; clay 75.7.

Diatomaceous clay, greenish-gray (5G 6/1) with some nannoplankton and sponge spicules; somewhat burrow-mottled.

Chalk, probably of nannoplankton origin but most grains not identifiable. Some nannofossils, diatoms, sponge spicules; pale greenish-gray (5G 8/1), burrow-mottled especially upper part.

Figure 29. *Hole 6, Core 5, Section 1.*

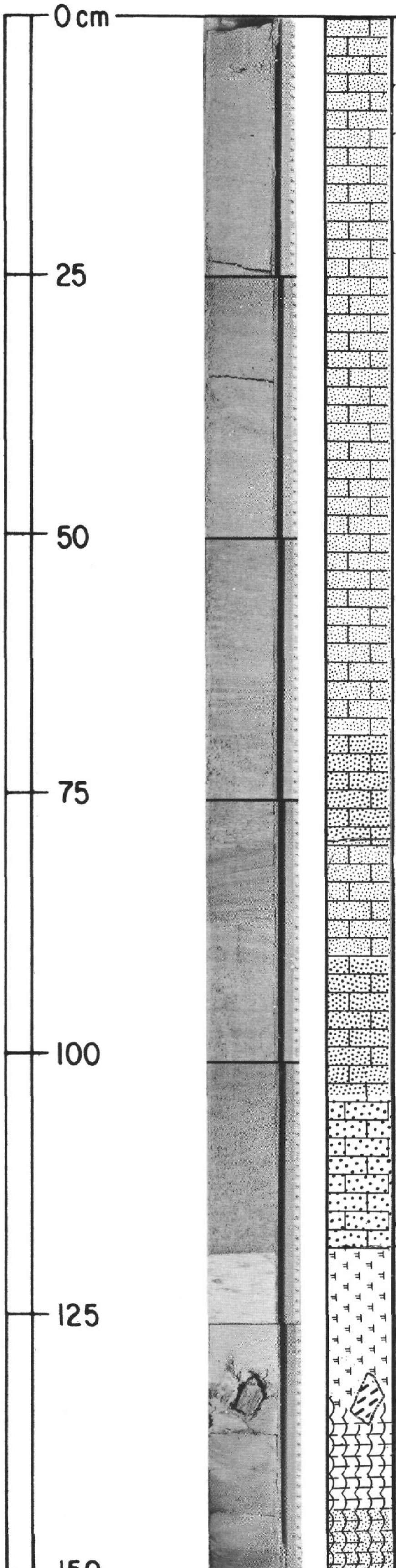


Chalk, pale greenish-gray (5G 8/1), probably of nannoplankton origin, slightly burrow-mottled, grading downward through marl into nannoplankton-diatom-rich clay, greenish-gray (5GY 6/1) with arcas of lighter color (5GY 8/1), concentrically banded.

Sand 0.9; silt 3.8; clay 95.3.

Total C 5.0; Org. C 0.4; $CaCO_3$ 38.7.
Water content 31.3.

Figure 30. *Hole 6, Core 5, Section 2.*



Total C 4.4; Org. C 0.1; $CaCO_3$ 35.6.
Water content 28.7.
Sand 29.7; silt 47.8; clay 22.5.

Sand, grading up into sandy silt; olive (5GY 6/1) with darker (5G 5/1) laminations, grading is multiple; zones of mudclasts at 50 - 54, 76 - 80, and 100 - 118.5 cm. Sand about 45% forams and other biogenic carbonate, 30% quartz, 15% sponge spicules, 5% glauconite, trace coccoliths and diatoms.

Sand 72.0; silt 2.4; clay 25.6.

X Sharp base.

Nannoplankton chalk, pale bluish-gray (5B 8/1), burrow-mottled; grades.

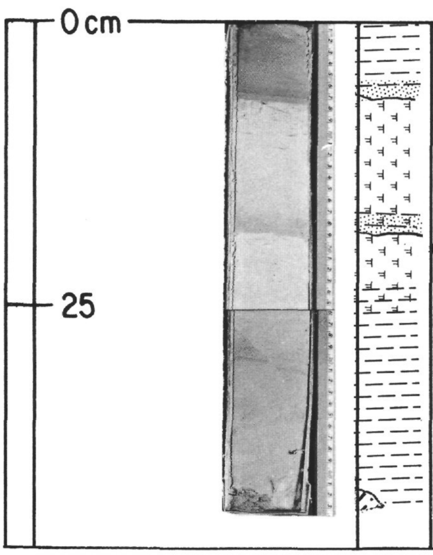
Chert, a silicified calcarenite - fragment of a bed broken in drilling?

Clay, greenish-gray (5G 6/1) - probably diatom-rich.

Clay, greenish-gray (5G 6/1), silty.

Silty clay, greenish-gray (5G 5/1), with silty laminae.

Figure 31. *Hole 6, Core 6, Section 1.*



Clay, dark greenish-gray (5G 5/1), probably diatom and sponge-spicule rich; sharp base.

Total C 0.7; Org. C 0.1; $CaCO_3$ 4.9.
Water content 35.6.
Sand 0.0; silt 42.3; clay 57.7.

Chalk, probably nannoplankton, more clayey-silty (marly) downward; greenish-gray (5G 7/1); top burrow mottled.

Chalk, probably nannoplankton, very pale greenish-gray (5G 8/1), grading downward into marl, darker (5G 7/1), probably diatom-sponge spicule rich. Top burrow-mottled. A fault offsets two dark laminae.
At base: fragment of chert, dark greenish-gray (5G 5/1).

Figure 32. *Hole 6, Core 6, Section 2.*

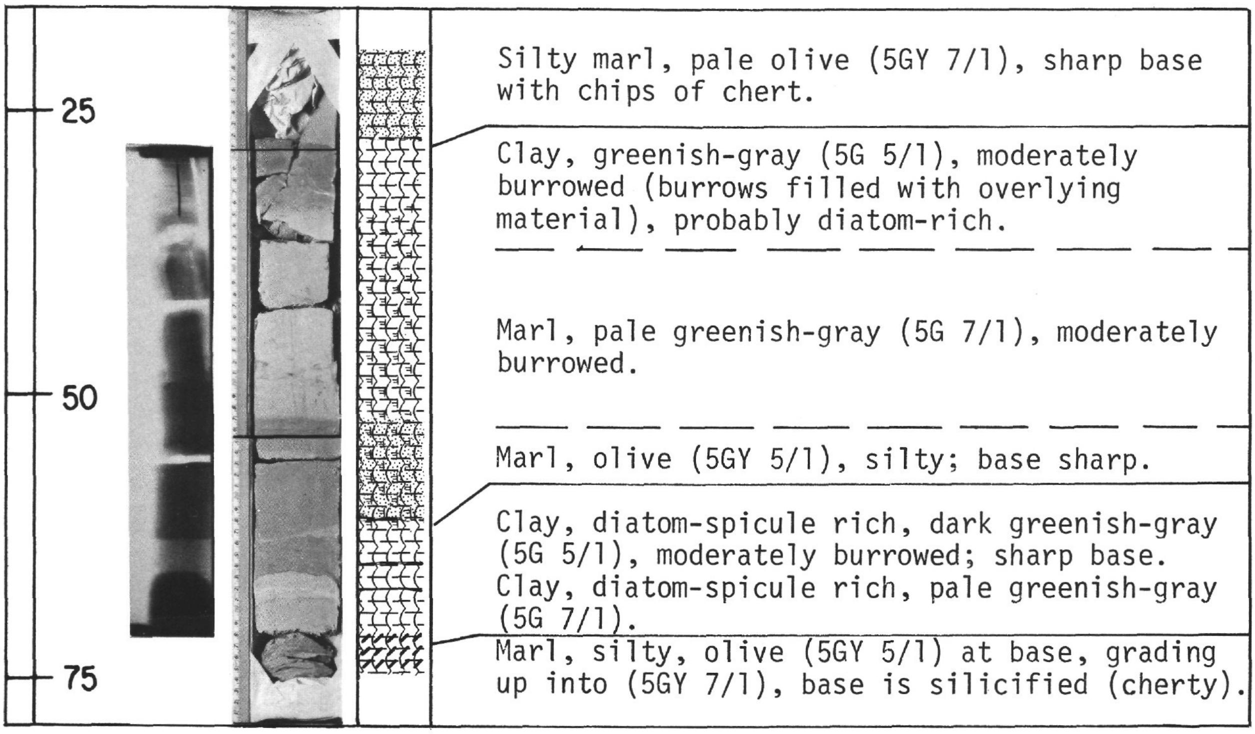
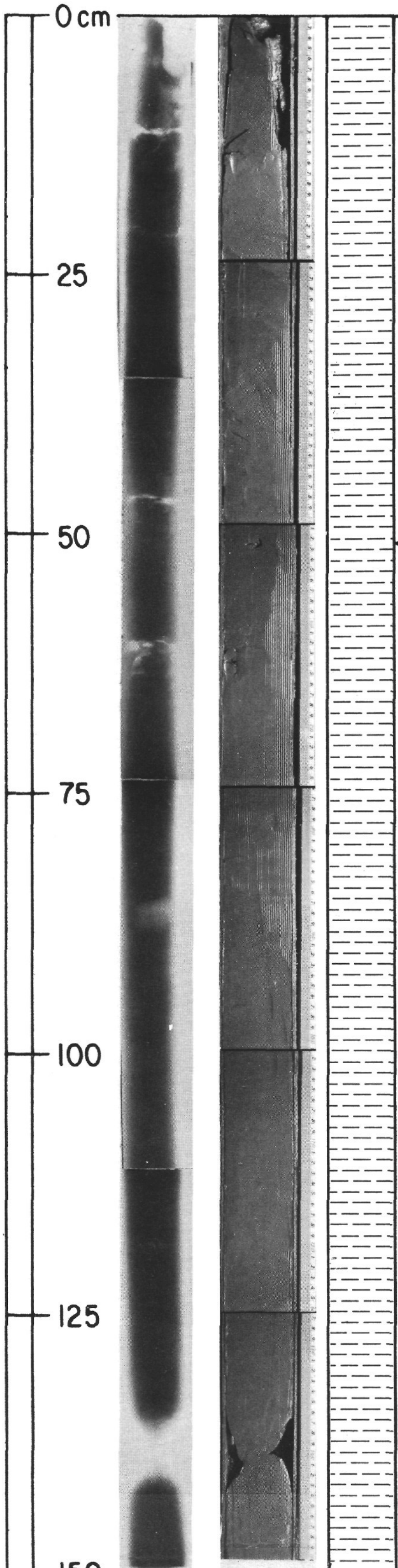


Figure 33. *Hole 6, Core 6, Section 3.*

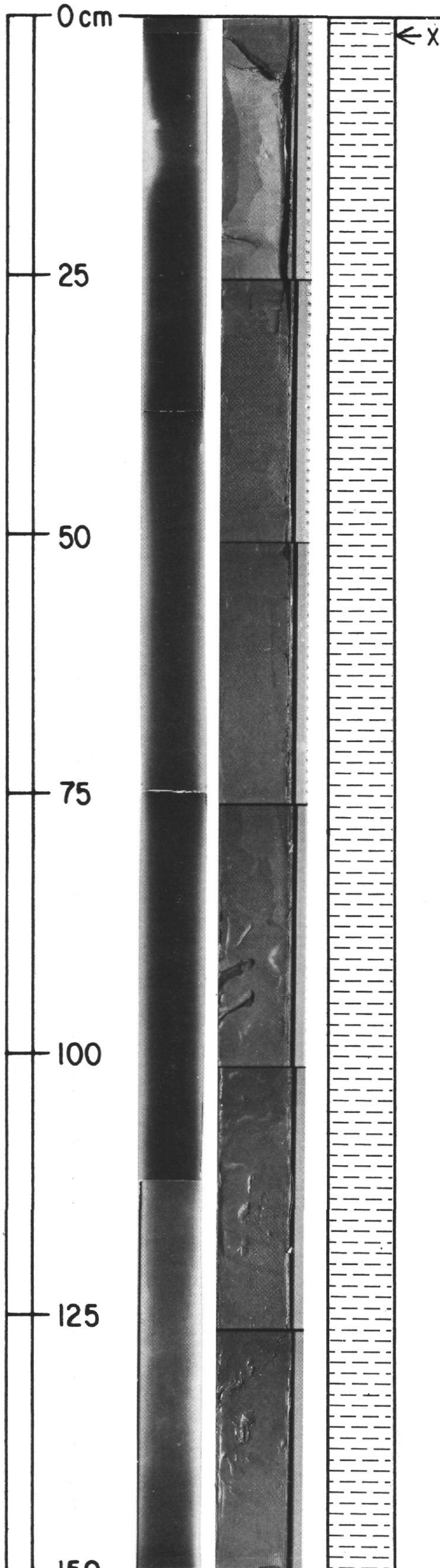


Total C 0.2; Org. C 0.1; $CaCO_3$ 0.8.
Water content 48.8.

Sand 0.1; silt 7.2; clay 92.7.

X Clay, brown (10YR 4/4), massive, slightly burrow-mottled (10YR 7/6), with dark specks. Silt-size limonitic aggregates; trace sponge spicules.

Figure 34. *Hole 6A, Core 1, Section 1.*



Total C 0.6; Org. C 0.1; $CaCO_3$ 4.2.
Water content 47.6.

Sand 0.1; silt 5.1; clay 94.8.

Clay, brown (7.5YR 4/2), slightly to moderately burrow-mottled (7.5YR 7/4), burrows near base remain open. Limonite in silt-size granules.

Figure 35. *Hole 6A, Core 1, Section 2.*

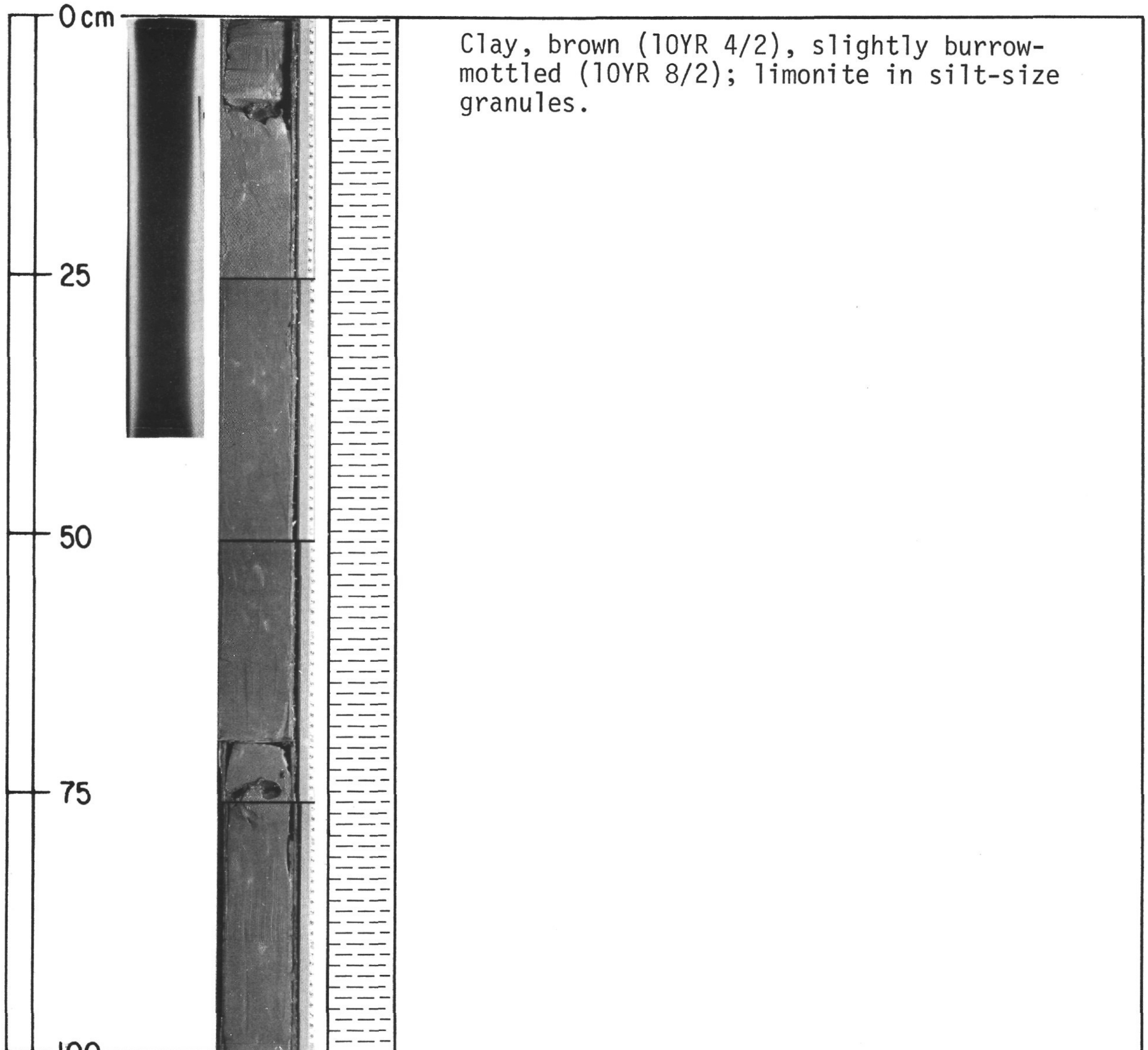
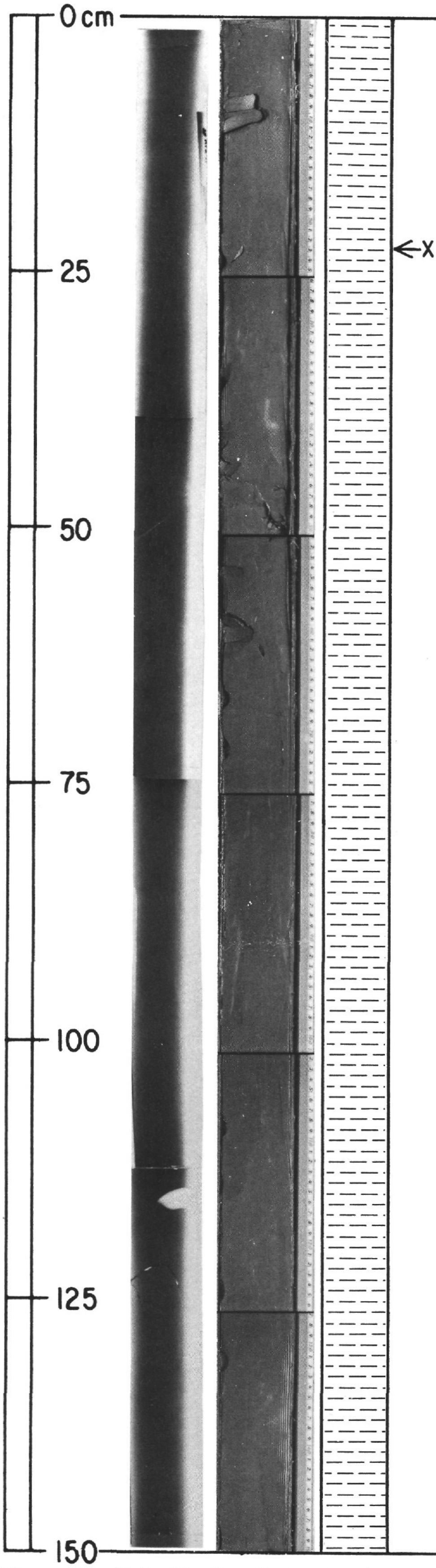


Figure 36. *Hole 6A, Core 1, Section 3.*

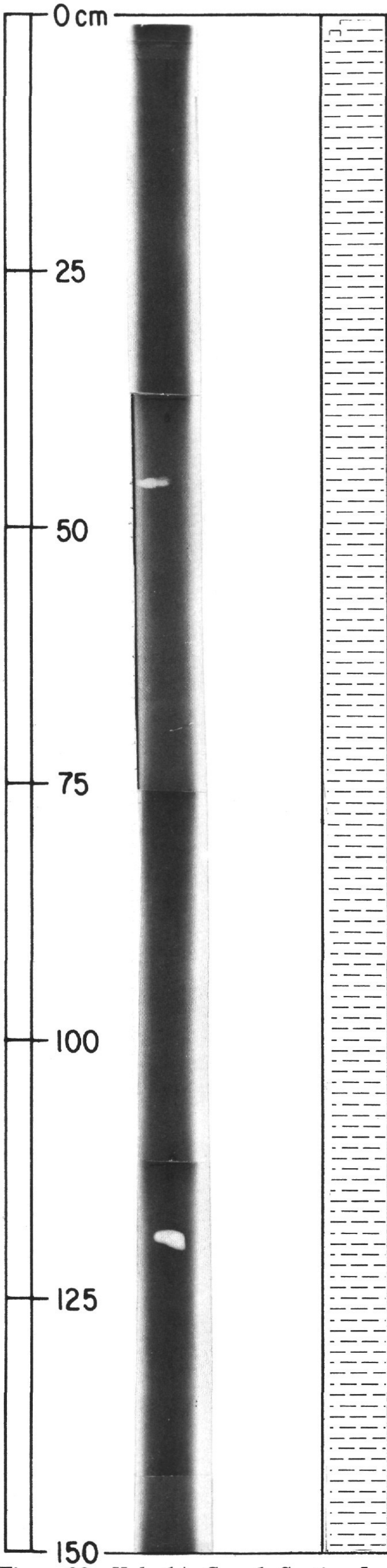


Total C 0.4; Org. C 0.1; $CaCO_3$ 2.5.
Water content 48.7.

Sand 0.0; silt 7.6; clay 92.4.

Clay, brown (7.5YR 4/2), slightly burrow-mottled (7YR 7/4) some burrows open. Limonite in silt-size granules.

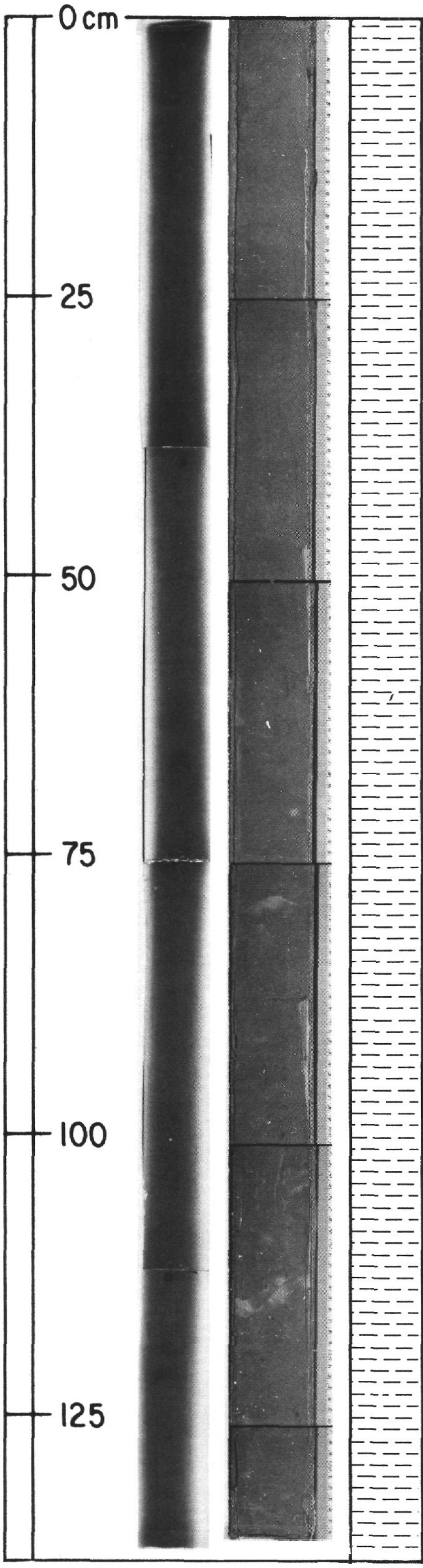
Figure 37. *Hole 6A, Core 1, Section 4.*



Clay, brown (7.5YR 4/3), slightly burrow-mottled (7.5YR 7/4).

Note: This core was not split and photographed, and was left on board for practice for Leg II. But it is obviously like the sections above and below.

Figure 38. *Hole 6A, Core 1, Section 5.*



Total C 0.8; Org. C 0.1; $CaCO_3$ 5.8.
Water content 45.7.

Sand 0.0; silt 6.2; clay 93.8.

Clay, brown (7.5YR 4/2), slightly burrow mottled (7.5YR 7/4); some light-colored wisps of uncertain origin; small dark gray burrow specks; larger, diffuse dark splotches.

Figure 39. *Hole 6A, Core 1, Section 6.*

Nature of the Sediments

General Description of the Sediments

The sediments obtained at Site 6 may be grouped into three major types: Middle Eocene sequence of graded silts and sands intercalated with marls and clays and containing throughout an abundance of siliceous skeletal remains; an overlying Eocene sequence of clays with apparent breccia structure (probably induced by drilling); and, a surficial sequence of Plio-Pleistocene brown deep-sea clay. These will be discussed in stratigraphic order.

The sandy-silty Middle Eocene Section was recovered in the lower part of Core 3, and in Cores 4, 5, and 6. The sediments occur in rhythmic sequences. Each of these begins with a light green, horizontally laminated sand (Chapter 24, Plate 4B) which is composed mainly of foraminifera, sponge spicules, quartz grains and glauconite pellets, and contains an admixture of other carbonate skeletal debris, diatoms, Radiolaria, and coccoliths (Chapter 24, Plate 17, A & B). Such sands grade up into olive-green, silty marls composed mainly of nannoplankton, sponge spicules and diatoms, and contain an admixture of foraminifera and Radiolaria (Chapter 24, Plate 6, E & F and Plate 7, A, B, E & F). The third and final member of this rhythm is a dark green, heavily burrowed diatomaceous clay with abundant sponge spicules and some Radiolaria (Chapter 24, Plate 7, C & D). The sands, which range in thickness up to 1.5 meters (at the base of Core 6), are fine-to-medium-grained at the base. A more detailed study of such a graded unit is presented in Chapter 24. The clays in this sequence are in part markedly rich in montmorillonite, suggesting some volcanic influence.

Some of the sands and silts in this section are silicified (Chapter 24, Plate 20) into sandy spiculate cherts. A more extended discussion of these is presented in the section on diagenesis in Chapter 24. These cherts appear to provide the acoustic reflections termed "Horizon A."

These Middle Eocene sediments have all the characteristics of a typical turbidite sequence. This interpretation will be discussed in a subsequent section.

The clays of the upper part of Core 3 and of Core 2, overlying this turbidite sequence, are tan to greenish in color. They contain coccoliths and diatoms in the lower portion, and are nonfossiliferous above, with the exception of some phosphatic remains. Some rhodochrosite and/or siderite is also present here. These clays are in part chloritic and in part montmorillonitic, as shown by X-ray analysis (Rex, Chapter 13), thus suggesting volcanic influence.

At first glance these clays appear to be intraformational conglomerates or "Pebbly mudstones," with angular clasts of firmer clay in a more watery matrix (Chapter 24, Plate 5A). Initially, these disturbances were attributed to penecontemporaneous slumping or to intrastratal flow. However, the flat abyssal plain setting made this seem unlikely, and the presence of washed-out gaps in the cores, as well as pertinent observations made on similar clays by the Leg II scientists (M. N. A. Peterson and N. T. Edgar, Personal Communication), make it virtually certain that this brecciation is an artifact of the drilling process.

The uppermost cores at Site 6 – specifically, Core 1 of Hole 6 and the core from 6A – consist of brown, massive to moderately burrowed, largely nonfossiliferous clay. Traces of phosphatic material (fish teeth), planktonic foraminifera, radiolarian tests, and authigenic carbonates (siderite or rhodochrosite) are present. Large burrows are vague and uncommon; small ones filled with dark faecal material or authigenically enriched in sulfides are more common and sharply defined. This is the brown deep-sea clay which is discussed more generally in Chapter 24.

Discussion

The authors believe that Site 6 lay below the carbonate compensation depth during the Eocene; and, the non-calcareous diatomaceous clay, which forms the third member of the rhythms deposited during that period, represents the normal pelagic "background" sediment. In addition, it is thought that the sands and silts at the base of the rhythms, and the chalks and marls of the middle were emplaced catastrophically by turbidity currents. The quartz grains (as well as the rarer feldspars and other silicates) are of terrigenous origin, and are probably resedimented from a temporary resting place on the shelf. The associated glauconite pellets either grew contemporaneously on the shelf, or they were derived by submarine erosion from somewhat older shelf sediments. The late Cretaceous and Paleocene-Eocene sediments of the American Atlantic shelf are particularly rich in glauconite, and provide the most likely source. The nannoplankton-rich marls and chalks are of penecontemporaneous origin, and were most likely swept up by the turbidity currents on the continental slope and rise to be deposited on an abyssal plain.

The total sequence penetrated at Site 6 can be considered as a major cycle of sedimentation. Turbidity current sedimentation on an existing abyssal plain during Eocene time was subsequently replaced by a gradual change to pelagic sedimentation. Pelagic sedimentation was further changed by a gradual reduction in supply of biogenic debris and, possibly, an increase in supply of volcanogenic debris in upper Tertiary time.

Upper Tertiary and certainly Pleistocene turbidity current deposits are known to exist in the Hatteras Abyssal

Plain immediately to the west of Site 6 as determined by various investigations of the Lamont-Doherty group. Dominantly pelagic sedimentation on the Bermuda Rise during this time interval suggests uplift or elevation of the Bermuda Rise region above the level of the Hatteras Plain, quite possibly in mid-Eocene time as suggested by the transition of turbidites to pelagites at Site 6. The possibility that this uplift was episodic led to the postulation of older cycles of pelagic sedimentation as was subsequently found at Site 7.

The possibility that turbidity currents are able to travel for considerable distances up-slope is not supported by available evidence. The very flatness of modern abyssal plains appears to refute such a process. Late Tertiary sequences of "ponded" turbidites have been well documented in the oceanographic literature. The ponded nature of Pliocene turbidites from the Los Angeles Basin might be cited as an ancient example.

If one considers the Bermuda Rise to have been persistent through much of the Mesozoic as well as the Cenozoic, then up-slope flowing turbidity currents appear to be required. This is especially true if major reflectors such as β are also predominantly turbidity current deposits. Possibly detailed dating of volcanic rocks from the Bermuda region could resolve some of the controversy. If one assumes that wide-spread volcanism corresponds to major regional elevation of the Bermuda Rise, then dates of Eocene volcanism, as well as older episodes of volcanism, might provide further insight to the Geologic history of the Bermuda Rise.

Physical Properties of the Sediments

Measurement of gamma-radiation and bulk density on Cores 1, 2 and 3, and the core from 6A shows very little vertical variation within cores due to the homogeneous textural and mineralogical composition of the sediment. Results are so consistent for Core 1 that it might be used as a sediment standard for statistical counting purposes. Disturbance during coring is evidenced by the anomalously low density and gamma-ray values in Core 3.

Bulk density determinations from Core 4 show good correspondence of density build-ups at the bases of graded sand units immediately overlying a low density zone of clay-rich diatom ooze. The slightly coarser and definitely more consolidated calcareous ooze shows a high bulk density. Note that gamma-ray response does not correlate well with textural and compositional changes.

Results for Core 5 show yet another example of high bulk density values and low gamma-ray count opposite a calcareous silt unit. The more clay-rich, diatom ooze is represented by lowered bulk densities and higher gamma-ray counts. The same relationships are repeated in Core 6, where carbonate sands show intermediate values of bulk density and low gamma-ray count as compared with the pelagic units.

Averaged results on a core-by-core comparison are shown in Figure 3. GRAPE values show a moderate increase in bulk density with depth. Notable departures from the overall trend occur in Cores 3 and 4. The low densities in Core 3 are interpreted as arising from disturbance during coring, whereas that of Core 4 represents low density turbidity-current related fine-grained sediments. Such differences as the latter have been previously discussed for other sites.

The overall change in composition of the sequence is well defined by natural gamma-ray determination. A marked decrease in gamma-ray count between Cores 2 and 3 corresponds with a change from dominantly clay mineral-bearing sediment to dominantly calcareous-siliceous sediment. A slight increase in average gamma-ray count in Cores 5 and 6 is apparently related to a slight increase in clay mineral content of pelagic intervals along with concomitant consolidation.

Penetrometer tests show a more or less consistent increase in consolidation with depth, ranging from very unconsolidated in the core from 6A to semi-consolidated in Cores 4, 5 and 6. Core 3 shows a large difference in consolidation of the matrix as compared to clasts. Since the matrix may represent mechanical disturbance during coring, only penetrometer values derived from clasts were used in constructing the curve shown in Figure 3.

As previously outlined, the overall transition from turbidity current deposits below to pelagic deep-sea clays above is clearly reflected in physical measurements on the cores. Results of penetrometer testing show a very consistent increase in consolidation with depth. When considerations as to type of lithology are taken into account, bulk density values also reflect a trend of lowered porosity with depth.

Biostratigraphy

Foraminifera

The biostratigraphy of Site 6, as deduced from the planktonic foraminifera, is shown in Figure 40. The faunas of the samples listed in Figure 40 are discussed below. As with previous sites, the faunal lists are not necessarily complete or representative, but show only the most abundant or stratigraphically significant species.

Sample 1 (1-6-1-1, core catcher):
Barren.

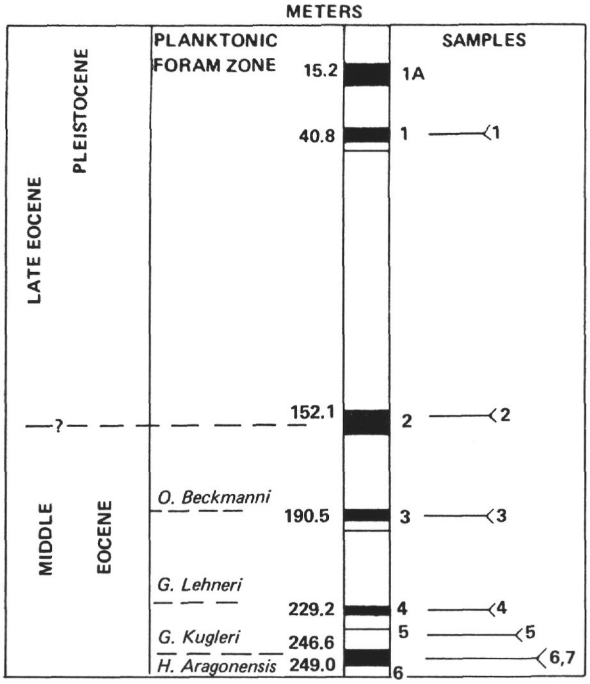


Figure 40. *Biostratigraphy of Site 6 as deduced from the foraminifera.*

Remarks: Core 1 is a "red clay"; and, only the core catcher sample was examined and it was found to be barren of foraminifera.

Sample 2 (1-6-2-1, top):
Barren.

Remarks: This core is essentially a diatom-radiolarian core. Planktonic foraminifera are not found in this sample, the only one examined from this core.

Sample 3 (1-6-3-4, core catcher):
Globigerina patagonica, G. linaperta, Globigerapsis index, Truncorotaloides rohri, Acarinina densa, Globotalia coronata, G. lehneri, G. crassata (Cushman) (=*G. spinuloinflata* Bolli *non* Bandy), *?Globigerapsis higginsi.*
Reworked fauna: *Globotruncana arca, G. bulloides, G. contusa, G. fornicata, G. linneiana, G. stuartiformis, G. trinidadensis, G. ventricosa, Rugoglobigerina rugosa.*
Age: Eocene (Middle).

Remarks: The sample is from a turbidite silt layer and contains a typical lower Middle Eocene planktonic foraminiferal fauna. In addition, Upper Cretaceous planktonic foraminifera are found commonly throughout this sample, and they appear to represent a relatively homogeneous assemblage with an age range of Campanian-Maestrichtian.

Sample 4 (1-6-4-3, 37-40 cm):
Acarinina densa, A. broedermanni, A. sp. ex. gp., *A. pentacameratasoldadoensis, Truncorotaloides collactea, Globigerina* sp.
Age: Eocene (Middle).

Remarks: This sample is a turbidite silt intercalated in a radiolarian-diatom ooze. Benthonic fauna of cibicidids, nonionids, gyroidinids, *Nuttalides* and other forms indicates displacement from shallower depths.

Sample 5 (1-6-5-1, top):
Truncorotaloides rohri, Globigerapsis index, Chiloguembelina sp.
Age: Eocene (Middle).

Remarks: This sample is a turbidite silt in radiolarian-diatom ooze. Planktonic foraminifera are very rare – only a few specimens were found. Benthonic fauna contains epistominids, cibicidids, and similar rotaliid forms.

Sample 6 (1-6-6-1, 40-43 cm):
Acarinina densa, Truncorotaloides rohri, T. collactea, Globigerina patagonica.
Age: Eocene (Middle).

Remarks: This sample is turbidite silt within a radiolarian-diatom ooze. The planktonic foraminiferal fauna is not unusual, but it is rather restricted in terms of specific diversity.

Sample 7 (1-6-6-1, 90-110 cm):
Acarinina densa, A. coalingensis (=A. triplex), A. broedermanni, Truncorotaloides rohri, Globorotalia caucasica, Globigerina boweri, G. patagonica.
Age: Eocene (Middle).

Remarks: The fauna occurs in a turbidite silt within a radiolarian-diatom ooze sequence and is lower Middle Eocene in age. If the planktonic fauna is essentially homogeneous (i.e., it does not contain reworked elements of significantly older horizons), this occurrence would document the range of *Globorotalia caucasica* into the upper half of the *Hantkenina aragonensis* Zone. There are no forms present in this sample which are known to be restricted to the Lower Eocene, so the present assumption is that the displacement of this fauna involves a relatively homogeneous (i.e., pene-contemporaneous) fauna.

Discussion:
Planktonic and benthonic foraminifera occur as allochthonous components in silty turbidites within a diatom-radiolarian ooze sequence in Cores 3 through 6.

The planktonic fauna in Core 3 suggests that this level is at least above the *Hantkenina aragonensis* Zone. The presence of *G. higginsi* and *G. broedermanni* in Core 3 further suggests that this level is within the upper part of the *Globigerapsis kugleri* Zone. However, on the basis of first occurrence, Bukry and Bramlette (see Chapter 15), find in this core nannofossils which suggest a younger age *(G. lehneri - P. mexicana) (vel O. beckmanni)* zone. That considerable reworking has occurred is seen from the abundant globotruncanids which occur (nine species have been recorded) and which range in age from Campanian-Maestrichtian. It is possible that some of the elements of the Eocene planktonic foraminiferal fauna are also reworked and that the age of the sample is younger than that which the fauna suggests. In the absence of evidence to the contrary, the age determination of Bukry and Bramlette is tentatively accepted here.

Cores 5 and 6 contain similar planktonic foraminiferal faunas, the main difference being that in Core 6 *Globigerapsis index* is absent and *Globorotalia caucasica* is present. This suggests that the boundary of the *Hantkenina aragonensis* Zone (below) and the *Globigerapsis kugleri* Zone (above) lies within or between these two cores.

Calcareous Nannoplankton

The biostratigraphy of Site 6, as deduced from the calcareous nannoplankton, is summarized in Figure 41. For a detailed discussion of the faunas see Bukry and Bramlette, Chapter 15.

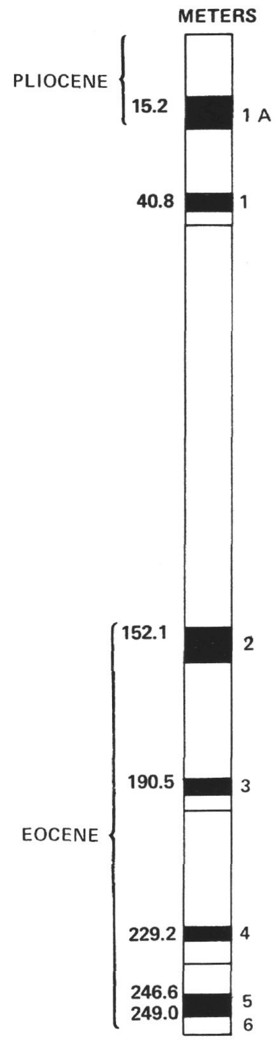


Figure 41. *Biostratigraphy of Site 6 as deduced from the calcareous nannoplankton.*

SUMMARY: HISTORICAL AND REGIONAL ASPECTS

The Bermuda Rise is a broad topographic swell, approximately 800 by 400 miles in extent. The Bermuda Rise, as well as Horizon A, can be considered as a broad, gentle arch; Horizon A rises nearly a kilometer above the depth at which it is found in the bordering areas. From the Rise, it dips beneath the young turbidites of the adjacent abyssal plains (Sohm, Hatteras and Nares), except to the south and east where the sedimentary sequence is absent. Horizons A, β, and B become complicated in parts of the Bermuda Rise, and neither of the younger two can be positively identified east of the Rise and on parts of its eastern flank (Ewing *et al.*, 1966).

There has been speculation that in this area Horizon A is a unique sort of pelagic deposit and therefore requires no significant uplift in the Bermuda Rise. But the preferred hypothesis has been that it is an ancient turbidite interval, which would imply subsequent elevation by arching of the Rise (Ewing and Ewing, 1962).

Site 6 was located well up on the flank of the Bermuda Rise (Figure 42). approximately 170 nautical miles southwest of the island of Bermuda, in 5125 meters (16,812 feet) of water. The penetration below the sea floor was 260 meters (853 feet) before the hole had to be abandoned because of the hard chert. Nearby seismic reflection data suggest that Horizon A is present at a depth near 250 meters, with B near 500 meters, both overlying a rough acoustic basement of 750 meters. The sequence overlying Layer A is largely acoustically transparent.

Two cores at the sea floor yielded brown deep-sea clay, barren of fossils except for spores and pollen. Extrapolation of age, using rates of sedimentation from deeper in the hole, suggest that these may be Miocene to Pleistocene, accumulating at 0.34 cm/10^3 years. A core at about 150 meters is similar in the abundance of

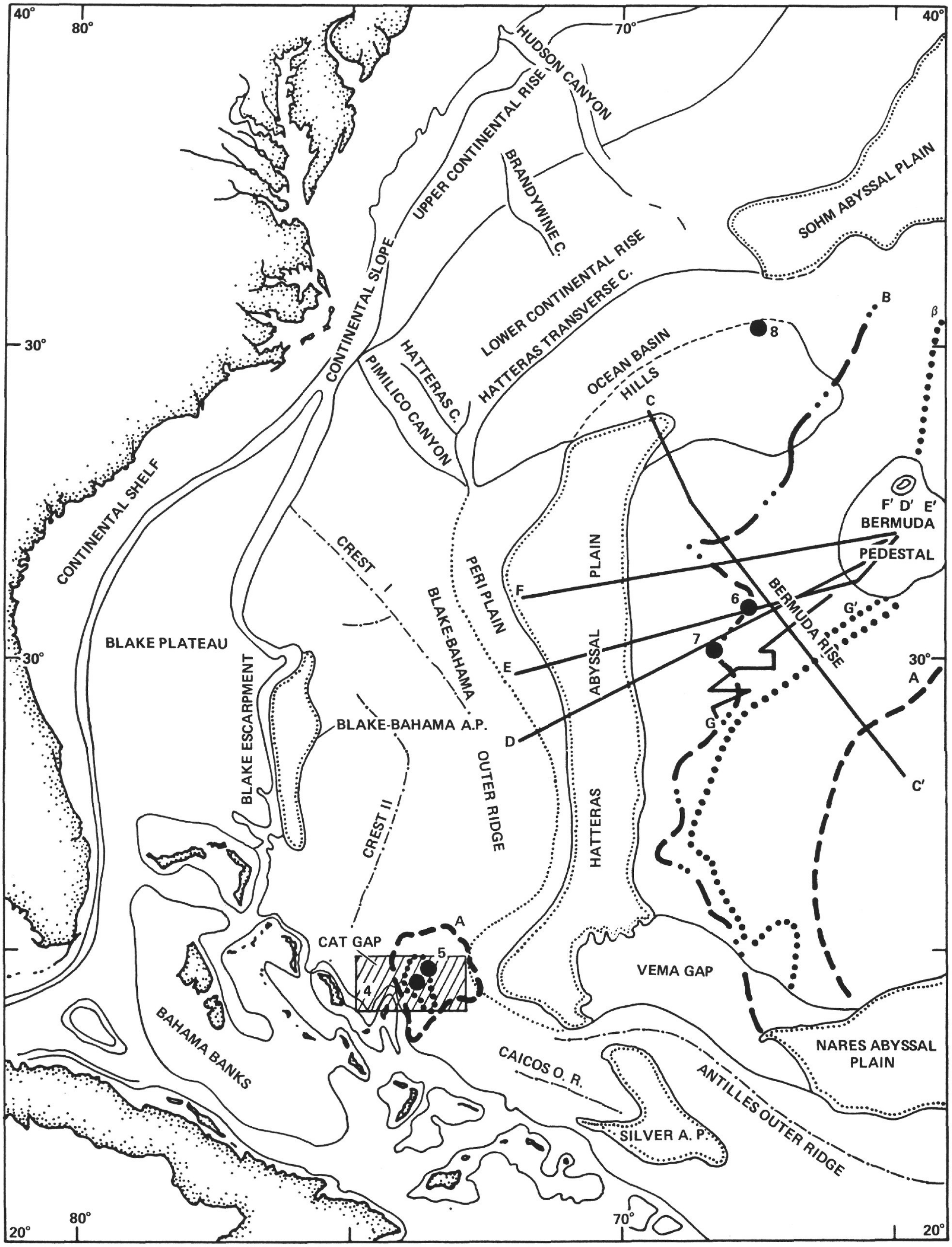


Figure 42. *Regional chart showing Sites 4, 5, 6, 7, and 8, and eastward limits of Horizons A, β, and B, as mapped by these and several additional traverses (after Schneider, 1969).*

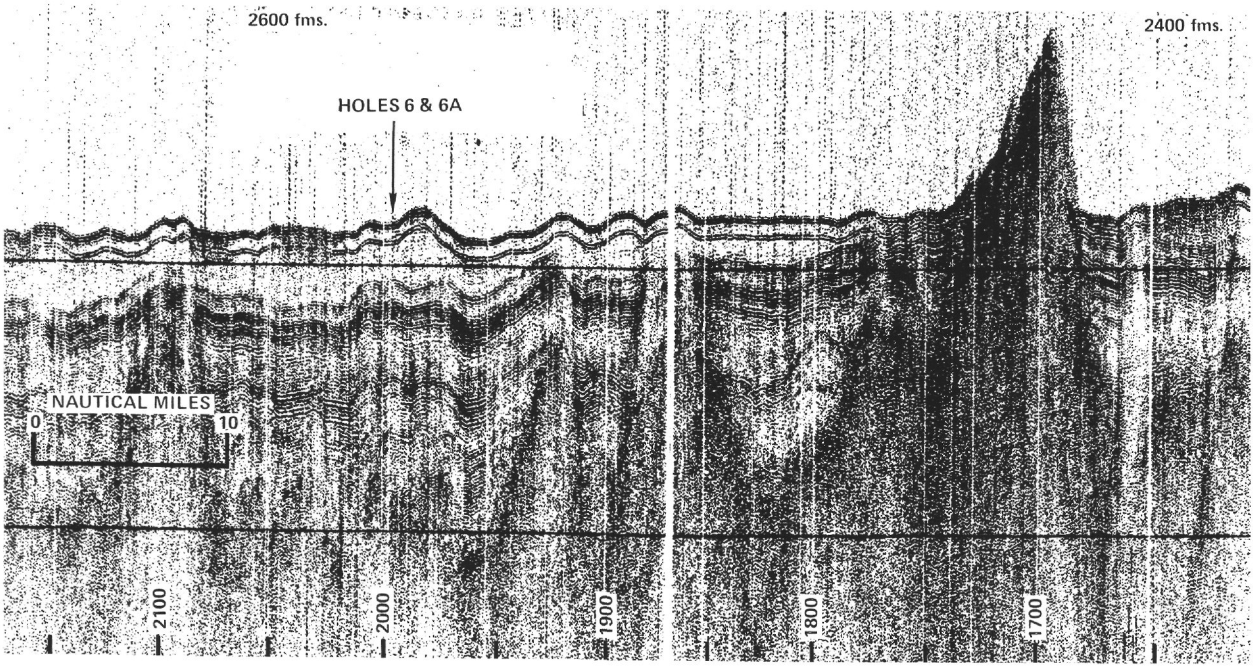


Figure 43. *Profiler section near Site 6. Location is given in Figure 40, Section EE'. (*Vema *-21, 17 February 1965, 1500-2200)*

clay minerals (possibly montmorillonitic in part), but is greenish and waxy with small angular clasts of clay similar to the matrix. It contains reworked Campanian-Maestrichtian benthonic foraminifera. A flora of Middle to late (?) Eocene diatoms was present at the top. A core at about 200 meters recovered a similar intraformational mud-pebble conglomerate with clasts and matrix of green diatom-coccolith mudstone of mid-Eocene age.

The lowest three cores also showed a pelagic background of bluish-green diatom ooze, but the sequence is dominated by turbidites. Turbidites are normally a basal unit of olive sand or silt, which is composed chiefly of benthonic foraminifera (some reworked Cretaceous forms), quartz, large sponge spicules and glauconite, and, usually an upper unit of pale green coccolith ooze or chalk with an admixture of small sponge spicules, Radiolaria and diatoms. These cores are all early Middle Eocene (middle and early Lutetian). The lowest core had a strong odor of hydrocarbons.

The turbidites appear to become coarser and thicker downward in the section. Locally, the basal part is silicified forming thin beds of chert, which also appear to increase in thickness and frequency downward. The shipboard profiling system did not produce a reliable measure for these intervals, however, an exact determination of the depths to these reflectors will be available following a site survey by *Vema* in April, 1969. Examination of three nearby Lamont-Doherty traverses shows that the position of Reflector A is within reasonable agreement with the chert layers encountered at Site 6. In Figure 43 a *Vema* Cruise 21 profiler section, mapped as passing about 3 miles south of Site 6, shows a series of three reflectors, the uppermost of which agrees well with the data from Site 6. There seems to be little doubt that the top of Layer A in this area is Middle to possibly Lower Eocene in age.

This hole again illustrates the large extent to which turbidites incorporate and resediment deep water pelagic deposits, and the susceptibility of turbidites to diagenesis, lithification and silicification. As observed in previous holes, carbonates can apparently be preserved below the depth of compensation when they are brought into that environment in sufficiently large quantities and in a short time interval – as in the case of turbidites. It is unlikely that the mid-Eocene depth of compensation was significantly different than that of today, or that the area of Site 6 has been lowered since the Eocene. All of the regional data suggest a broad crustal uplift. Furthermore, the pelagic component is a siliceous ooze, also indicating that the interbedded calcareous turbidites were emplaced below the depth of carbonate compensation.

The general history revealed at Site 6 is one of an abyssal plain in early mid-Eocene, below the depth of carbonate compensation of that time, and open to influx of turbidite sediment from the Atlantic shelf of North America, and perhaps the Greater Antilles. Later in the Eocene, the turbidite influx stopped and deposition of deep-sea clays dominated the area, either because of uplift of the Bermuda Rise (at least the western flank) or because of subsidence of the Hatteras-

Sohm Abyssal Plain region to the west and north. The regional aspects of the Bermuda Rise suggest that a broad uplift is the more reasonable explanation.

The apparent sharp termination of turbidite deposition at Site 6 (Figure 43) – which was presumably the result of uplift of the Bermuda Rise – is in obvious contrast to the gradual decrease of turbidites in some other areas where deposition was controlled more by the source area.

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