8. SITE 348

The Shipboard Scientific Party[1]
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SITE DATA

Position: 68°30.18'N, 12°27.72'W

Water Depth (from sea level): 1763.0 corrected meters (echo sounding)

Bottom Felt at: 1777.0 meters (drill pipe)

Penetration: 544.0 meters

Number of Holes: 1

Number of Cores: 34

Total Length of Cored Section: 316.0 meters

Total Core Recovered: 215.1 meters

Percentage of Core Recovery: 68.0%

Oldest Sediment Cored:
Depth below sea floor: 531.5 meters
Nature: Mud/mudstone
Age: Oligocene (?) Core 32
Measured velocity: 2.05 km/sec

Basement:
Depth below sea floor: 526.6 meters (drilled)
Nature: Variolitic basalt
K/AR age: 18-19 m.y. (early Miocene)

Principal Results: This site is located in an area of well-defined linear magnetic anomalies on the Icelandic Plateau, east of the 10 m.y. isochron of the Iceland-Jan Mayen Ridge. It is west of the magnetically quiet Jan Mayen Ridge. "Glacial" sediments consisting of a mixture of terrigenous mud, sandy mud, and clay, with occasional layers of volcanic ash, extend to 47 meters. Pliocene to lower/middle Miocene, extending from 47 to 256 meters, contains biogenic siliceous sediments which also include terrigenous clay and mud. The underlying Oligocene (?) unit consists almost entirely of terrigenous sediments which lie on basement. Basement is composed of tholeiitic basalt, which varies in texture from fine to medium grained, but contains no pillow lavas. No distinct opaque layer was found. Most likely the "opaque" layer is the basalt itself. Radiometric and paleontologic age determinations are not inconsistent with an age corresponding to anomaly 6 (21 m.y., early Miocene) for basement.

BACKGROUND AND OBJECTIVES

Background

Site 348 is located on the Icelandic Plateau in the region lying between the presently active Iceland-Jan Mayen Ridge and the presumed "continental" Jan Mayen Ridge. The region of the site contains well-defined magnetic lineations symmetrically situated around an extinct spreading axis. Site 348 is located on anomaly 6 (See Chapter 34, This Volume).

The reflection profiler record shows about 500 meters of sediment above basement, which is apparently draped by the ubiquitous opaque layer of the Icelandic Plateau. An intermediate reflector is present at varying depths below the bottom.

Objectives

1. To determine the age and nature of basement, especially to ascertain if it is oceanic (in spite of the linear magnetic anomalies, some investigators have maintained that the area may be continental in origin). If basement is indeed oceanic, its age will help to establish the spreading pattern in the Norwegian Sea in the area between the Jan Mayen Fracture Zone and Iceland. In particular, it would help to confirm when the spreading axis shifted from the Norway Basin; it shifted first to the Icelandic Plateau in the vicinity of this site, and then in a second shift, moved to its present location, the axis of the Iceland-Jan Mayen Ridge.
2. To determine the nature of the opaque layer which appears to drape basement in this area. Does the opaque layer itself constitute basement?
3. To learn about the history of sedimentation of the Icelandic Plateau.

OPERATIONS

Site Approach

Glomar Challenger approached Site 348 on 9 September after steaming 179 nmi, including surveying, in 19 hr 23 min, at an average speed of 9.2 knots. The site was approached from the north on course 198°. At 1010Z, 9 September, the course was corrected to 202° (Figure 1), and at 1054Z the speed was reduced to 6 knots (145 rpm). The beacon was dropped at 1221Z, and the ship continued on this course and speed until

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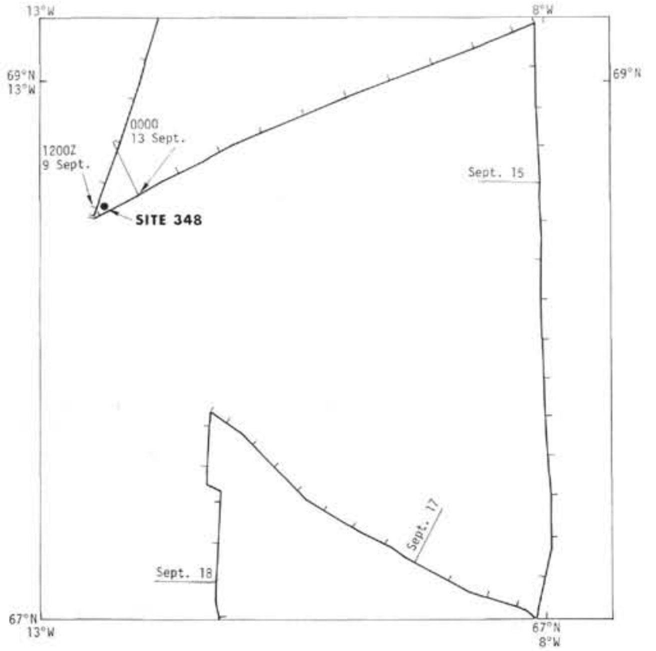


Figure 1. *Track chart, Site 348.*

1250Z. At this time the ship maneuvered to return to the site of the beacon (Figure 2).

Drilling Operations

An additional stand of 8-¼ drill collars was added to the center section of the BHA for improved versatility on this or future sites, where harder sediments were expected.

The sea bed was continuously cored from 1777 meters to 1805 meters, in order to recover the uppermost sediments. Following the taking of Core 3, a program of coring and washing was adopted, with additional control cores when required, to 2223 meters, where a loss of electrical power to the Bowen power-sub hydraulic system accounted for a shutdown of 24 hr. The bit was pulled back nearer to the sea bed and reciprocated with circulation during the delay; hole conditions remained good. After running back and conditioning the hole to bottom, the core/wash program was resumed to 2280 meters, from where continuous cores were taken with successful recoveries.

The top of the basalt was identified at 2303.9 meters, 526.6 meters below the sea bed, and cored to final depth at 2321 meters, 544 meters below sea bed, with 50% recovery at an AROP of 4 m/hr. From the total of 316 meters cored, 215.1 meters were recovered or 68% (Table 1).

After recovering the final core, the Lynes RFT was set in the testing mode and a functional evaluation test was successfully performed over the 530.5-544 meter basalt interval. The hole remained clean throughout; no hydrocarbon indications were encountered, and the hole was abandoned accordingly.

LITHOLOGY

Approximately 316 meters of sediments and sedimentary rocks were cored above igneous rocks at

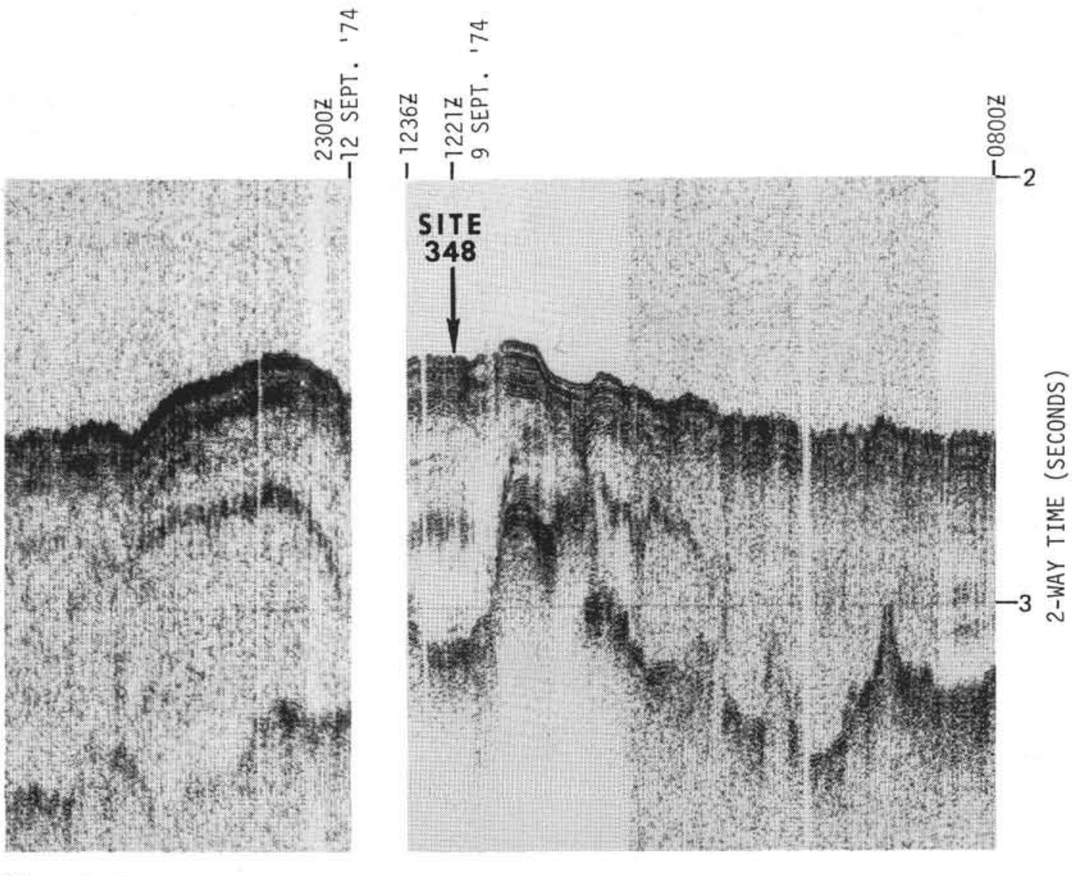


Figure 2. *Profiler record, Site 348.*

TABLE 1
Coring Summary, Site 348

Core	Date (September 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	9	2050	1777.0-1786.0	0-9.0	9.0	9.3	100
2	9	2135	1785.0-1795.5	9.0-18.5	9.5	5.8	66.3
3	9	2220	1795.5-1805.0	18.5-28.0	9.5	9.2	96.8
Washed			1805.0-1814.5	28.0-37.5			
4	9	2305	1814.5-1824.0	37.5-47.0	9.5	3.8	61
Washed			1824.0-1833.5	47.0-56.5			
5	9	2345	1833.5-1843.0	56.5-66.0	9.5	3.4	35.7
6	10	0025	1843.0-1852.5	66.0-75.5	9.5	7.2	75.8
7	10	0125	1852.5-1862.0	75.5-85.0	9.5	7.5	78.9
Washed			1862.0-1871.5	85.0-94.5			
8	10	0222	1871.5-1881.0	94.5-104.0	9.5	5.9	62.1
Washed			1881.0-1890.5	104.0-113.5			
9	10	0317	1890.5-1900.0	113.5-123.0	9.5	7.0	73.6
Washed			1900.0-1909.5	123.0-132.5			
10	10	0412	1909.5-1919.0	132.5-142.0	9.5	CC (0.3)	3.0
Washed			1919.0-1928.5	142.0-151.5			
11	10	0510	1928.5-1938.0	151.5-161.0	9.5	7.6	78.9
12	10	0600	1938.0-1947.5	161.0-170.5	9.5	8.7	91.6
13	10	0715	1947.5-1957.0	170.5-180.0	9.5	4.0	42.1
Washed			1957.0-1966.5	180.0-189.5			
14	10	0815	1966.5-1976.0	189.5-199.0	9.5	9.5	100
Washed			1976.0-1985.5	199.0-208.5			
15	10	0925	1985.5-1995.0	208.5-218.0	9.5	4.7	49
Washed			1995.0-2004.5	218.0-227.5			
16	10	1015	2004.5-2014.0	227.5-237.0	9.5	9.5	100
Washed			2014.0-2023.5	237.0-246.5			
17	10	1105	2023.5-2033.0	246.5-256.0	9.5	0.5	5.3
18	10	1205	2033.0-2042.5	256.0-265.0	9.5	0.2	2.1
19	10	1315	2042.5-2052.0	265.0-275.0	9.5	8.5	89.0
20	10	1420	2052.0-2061.4	275.0-284.5	9.5	9.5	100
21	10	1510	2061.5-2071.0	284.5-294.0	9.5	9.7	100
Washed			2071.0-2080.5	294.0-303.5			
22	10	1615	2080.5-2090.0	303.5-313.0	9.5	0.2	2.1
Washed			2090.0-2099.4	313.0-322.5			
23	10	1720	2099.5-2109.0	322.5-332.0	9.5	8.5	89.4
Washed			2109.0-2118.5	332.0-341.5			
24	10	1830	2118.5-2128.0	341.5-351.0	9.5	9.5	100
Washed			2128.0-2147.0	351.0-370.0			
25	10	1942	2147.0-2156.5	370.0-379.5	9.5	9.7	100
Washed			2156.0-2175.5	379.5-398.5			
26	10	2100	2175.5-2185.0	398.5-408.0	9.5	7.5	78.9
Washed			2185.0-2204.0	408.0-427.0			
27	11	2140	2204.0-2213.5	427.0-436.5	9.5	6.7	67.6
Washed			2213.5-2223.0	436.5-446.0			
28	12	1020	2223.0-2232.5	446.0-455.5	9.5	2.6	27.4
Washed			2232.5-2261.0	446.0-484.0			
29	12	1030	2261.0-2270.5	484.0-493.5	9.5	9.7	100
Washed			2270.5-2280.0	403.5-503.0			
30	12	0230	2280.0-2289.5	503.0-512.5	9.5	9.5	100
31	12	0415	2289.5-2299.0		9.5	9.6	100
32	12	0640	2299.0-2308.5	522.0-531.5	9.5	5.0	52.6
33	12	0945	2308.5-2318.0	531.5-541.0	9.5	2.8	29.5
34	12	1145	2318.0-2322.0	541.0-544.0	3.0	2.0	66.7
Total			2322.0	544.0	316.0	215.1	68

Site 348. The sedimentary sequence can conveniently be divided into three units. Significant characteristics of each unit are summarized in Table 2 and Figure 3.

Unit Descriptions

Unit 1 (Pleistocene, 63.7 m thick?)

Unit 1 consists of a mixture of terrigenous mud, calcareous mud, nannofossil-rich mud, and clay with conspicuous, but scattered amounts of volcanic ash. Fine pebbles of various types are scattered throughout the unit. A thin, calcareous nannofossil foraminiferal ooze(?) is present at Sample 2-2, 75 cm. The unit, in general, becomes finer grained downward, grading from mud with 10%-20% sand in Core 1 to mud with 1%-10% sand in Cores 3 and 4, to clay in Core 5.

It is predominantly soft, but locally firm to stiff, and coring deformation ranges from moderate to intense.

TABLE 2
Lithologic Summary, Site 348

Unit	Depth and Core Numbers[a]	Age	Characteristics
1	0-63.7 (1-1 to 5-4, 120)	Pleistocene	Predominantly mud and clay that generally becomes finer grained downward and contains scattered fine pebbles of various types; minor amounts of scattered volcanic ash, nannofossil-rich mud and calcareous mud
2	63.7-265.5 (5-4, 120 to 18, CC)	Pleistocene to middle Miocene	Predominantly transitional siliceous mud; highly variable in upper part (Cores 6-9), where it includes clay, mud, nannofossil ooze, siliceous-nannofossil ooze, and transitional nannofossil sediment; more uniform in lower part (Cores 10-18); abundant volcanic ash throughout, as discrete units and as volcanic glass mixed with other sediment types; massive, no sedimentary structures
3	265.5-526.8 (19-1 to 32.4, 33 cm)	Early Miocene-Oligocene	Dominantly terrigenous mud/mudstone with clay/claystone in the upper part grading downward into sandy mudstone at base; locally calcareous; no biogenic component visible from smear slides; soft to hard and indurated

[a]Core numbers in parentheses.

The various sediments are massive, display little or no interval stratification, and do not contain sedimentary structures. Mottling is common in some intervals, but because of coring deformation and lack of compaction, bioturbation was not recognized.

Volcanic ash units are abundant and are generally thinner than 10 cm and dispersed as a result of core deformation. They are particularly common near the middle of Core 1, and in the top of Cores 2 and 5. The ash layers consist primarily of sand and silt-sized particles of volcanic glass with small, but with varying amounts of quartz, mica, heavy minerals, opaque minerals, carbonate, foraminifera, and calcareous nannofossils.

Unit 2 (Pleistocene-middle Miocene, 201.8 m thick)

Unit 2 consists primarily of transitional siliceous mud/sandy mud that typically contain 10%-50% siliceous fossils in various proportions, but with diatoms generally being most abundant. The unit also contains a variety of other sediment types in lesser amounts, including: (1) terrigenous clay, (2) terrigenous mud, (3) volcanic ash, (4) ash-rich mud, (5) ash-rich transitional siliceous mud, (6) nannofossil ooze, (7) siliceous-nannofossil ooze, (8) transitional nannofossil sediments, and (9) transitional diatomaceous mud. Because of the irregular intermixing of these sediment types, and a wide variety of gradations in both sediment type and stratigraphic relations, it is not possible on the basis of available data to conveniently subdivide Unit 2. However, the greatest lithologic variability in Unit 2 is present in its upper part, from Cores 6 through 9. Within this part, all of the nannofossil oozes and siliceous-nannofossil oozes are present, as well as the majority of terrigenous sediments, and a large number of volcanic ash units. The lower part of Unit 2, from Cores 10 through 18, consists almost wholly of transitional siliceous mud with volcanic ash inclusions.

Unit 2 is varicolored, it is soft to firm, and core deformation ranges from none to intense; in general, it becomes firmer and less deformed downward. The sediments are generally massive and contain no sedimentary structures, although mottling is common, particularly in lower cores. Volcanic ash units are commonly broken and irregularly distributed through the cores.

The transitional siliceous mud varies greatly in: (1) relative percentages of biogenic siliceous and terrigenous components, (2) relative percentages of the various biogenic siliceous components, (3) grain size, and (4) composition of the terrigenous component. The transitional siliceous muds locally contain as much as 46% volcanic glass and palagonite, either as a result of syndepositional mixing of volcanic components with other sediments, or coring deformation.

Volcanic ash layers are particularly common in Cores 6 through 9, 12, 14, and 16. The ash units include both light and dark colored varieties and consist mostly of sand-sized fragments of volcanic glass and palagonite, although some consist primarily of clay and silt-sized fragments of volcanic glass and palagonite. Volcanic glass is far more abundant than palagonite, locally comprising 99% of the ash units. Devitrified or partly recrystallized glass is an abundant or dominant constituent in some ash units. The ash units are seldom more than 5-10 cm thick, and no size grading was noted in any of the ash units that form distinctive strata.

Terrigenous clay and mud is common in Unit 2 and is apparently intimately intermixed with the transitional siliceous muds, but not in observable interlayered sequences. The clays and muds commonly contain minor amounts of biogenic siliceous material, mostly sponge spicules. The terrigenous sediments are most common in Cores 6 through 13, which is probably indicative of the upward gradational change into the terrigenous sediments of Unit 1.

Nannofossil and siliceous-nannofossil oozes are infrequent but conspicuous components of the upper part of Unit 2. They are present in Cores 6 and 7, but total less than 1 meter in thickness; in addition, a transitional nannofossil mud is present in Sample 9, CC.

Unit 3 (lower Miocene to Oligocene)

Unit 3 is entirely terrigenous, consisting primarily of mud/mudstone, but contains abundant clay/claystone in its upper part and sandy mudstone in its lower part. It is locally calcareous and very hard, but whether these zones represent concretions or interbeds of limestone is not known; most probably they are simply con-

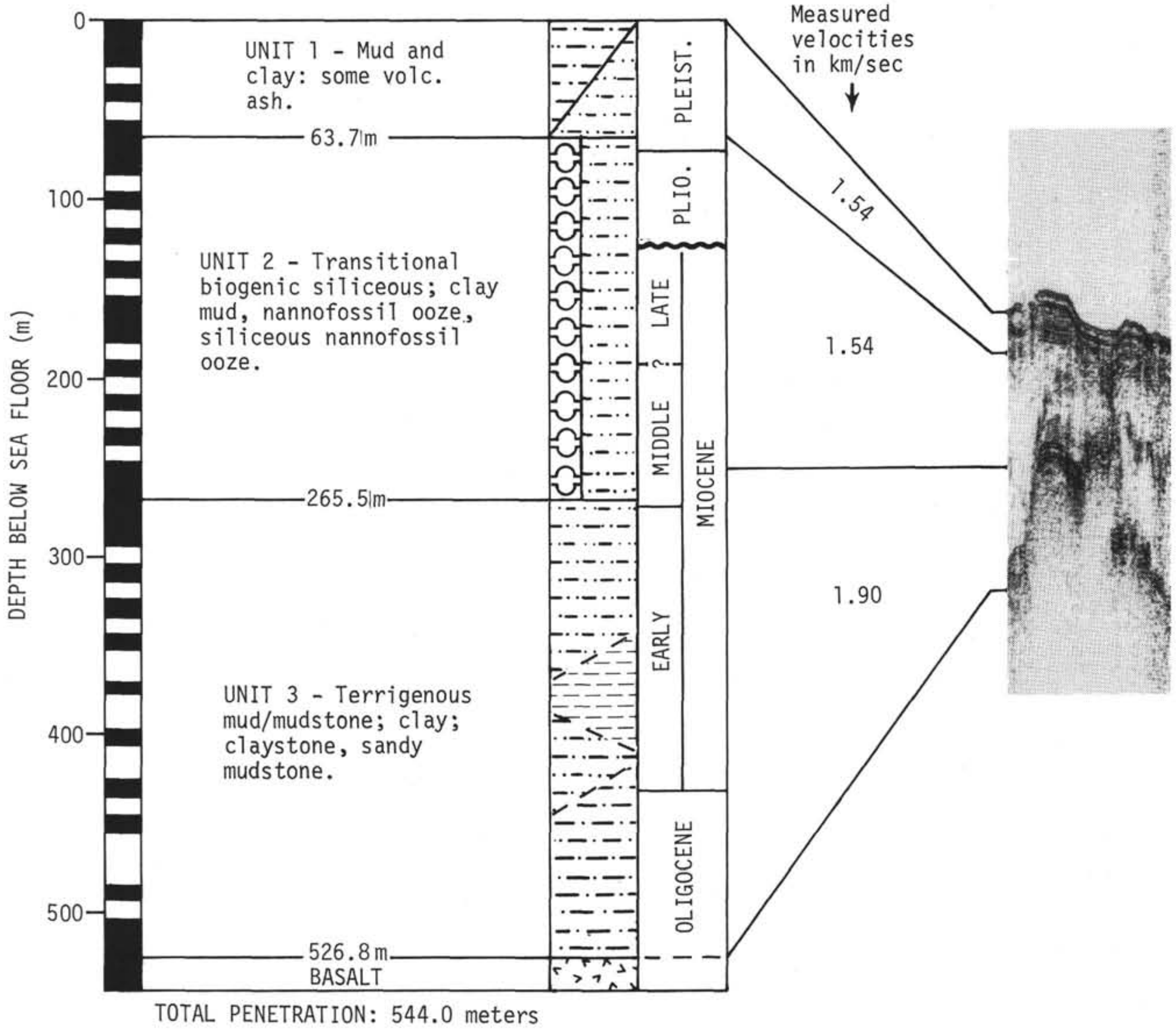


Figure 3. *Lithologic summary and seismic profile, Site 348.*

cretionary zones. The upper part of Unit 3 is soft to firm, but it is indurated from Cores 20 to 32. Drilling deformation is locally intense at the top of the unit in Cores 19 and 20, but is not present below Core 20. Colors vary from dark greenish-gray and greenish-black in the upper parts to olive-gray and grayish-olive in the lower parts. The unit is typically massive, with no internal stratification or current-formed sedimentary structures, except for local very thin parallel laminations. Bioturbation increases downward from moderate to intense, and worm tubes are abundant in Cores 25 to 32. Pyrite nodules become more abundant downward, and are common from Cores 25 through 32. Scattered fine pebbles less than 0.5 cm in diameter are abundant in the middle of the unit; they are composed of quartz, chert, and claystone. Toward the base of the unit, basalt pebbles are common.

The mud-mudstone is abundant throughout and grades texturally into clay/claystone in Cores 20-21 and sandy mudstone in Cores 27 to 32. The clay/claystone in the upper part of Unit 3 contains as much as 95% clay minerals. The calcareous zones contain 89% carbonate, with the remainder primarily clay minerals. It is not clear whether these zones are true limestones or simply concretions.

Unit 3 consists almost exclusively of intermixed mudstone and sandy mudstone from Core 25 downward to the top of the igneous basement rocks. The mudstone and sandy mudstone are not interstratified; but are intimately intermixed with the same massive, bioturbated unit. The mineralogical composition of the mudstone/sandy mudstone is variable, but does not change consistently downward. A thin mudstone is present within the igneous rocks below the main sedimentary sequence; it appears to be similar to the rest of Unit 3.

Interpretations

The three distinctive sedimentary units of Site 348 record an upper Tertiary and Quaternary depositional history that consisted of in ascending order: (1) deposition of clastic pebbly and sandy mudstone and mudstone (Unit 3), (2) desposition of hemipelagic transitional siliceous sediments (Unit 2), and (3) deposition of glacial-marine sandy muds and pelagic biogenic oozes (Unit 1). The most characteristic aspect of the sedimentary sequence is the abundance of volcanic glass throughout the entire sequence, and the presence of frequent discrete volcanic ash layers in Units 1 and 2.

The glacial-marine and pelagic sediments of Unit 1 probably record both glacial, interglacial, and postglacial sedimentation. Because of the extensive core deformation in these uppermost soft sediments, and the unknown extent of biogenic reworking, the sedimentary history as indicated by the cores is not too reliable. Coarse clastic detritus, presumably ice-rafted volcanic material, could have been derived from Iceland or adjacent suboceanic volcanos. The progressive downward fining in average grain size indicates gradation into underlying Unit 2; no evidence for a major unconformity or hiatus is sedimentation between Units 1 and 2 was noted.

Unit 2 represents a long history of probably slow hemipelagic sedimentation with persistant contributions of volcanic materials. The upper part is variable, and contains some terrigenous sediments that are similar to terrigenous sediments near the base of Unit 2. Siliceous organisms are numerically dominant over calcareous ones, except for some thin nannofossil oozes in the upper part.

Unit 3 represents deposition of terrigenous sediments at probably relatively slow rates of sedimentation and reasonably deep water, although the lack of sedimentary structures and stratification severely restricts the interpretation of depositional processes, environments, and bathymetry. Extensive bioturbation, worm tubes, and pyrite nodules suggest slow rates of sedimentation under reducing conditions. Source areas and directions of sediment transport are not known.

IGNEOUS-PETROGRAPHY-PETROLOGY-GEOCHEMISTRY

General Description

Basaltic rocks of acoustic basement in Hole 348 were penetrated at a depth of 526.6 meters (BSB). Basement rock was drilled an additional 17.4 meters to a total depth of 544 meters. Five cores (Sections 32-4, 33-1, 2, and 34-1, 2), contained 5.75 meters. At 526.6 meters the boundary between the basaltic rocks and the overlying sedimentary rocks is present. Near this boundary, the basalt is aphyric, aphanitic, and very fine-grained, but does not show glassy rims typical of a pillow lava. The color is dark gray to grayish-black. Below this boundary, the basalt has a medium dark gray to dark gray color, and a fine to medium-grained texture. Rare slickensides and veins filled by black chlorite, white calcite, and pyrite were observed.

In Sample 33-1, 110-120 cm, a sandy mudstone is present. Near the lower and upper contacts with this sandstone, the basalt is vesicular, aphyric, aphanitic, and very fine grained. A glassy surface is not present on these contacts. Below the contact, the basalt has fine and medium-grained textures. In the lower portion of the section (Section 34-2), amygdaloidal basalt with calcite-chlorite amygdules is present (10%-15%, size 0.2-1 mm). Abundant calcite veins (1-15 mm) with chlorite and fresh pyrite are present in Sections 33-2 and 34-2. Large prismatic calcite crystals (8-10 mm) are sometimes observed.

Petrography

On the basis of megascopic and microscopic examinations, the basalt can be divided into three types: (1) variolitic basalt (hyalobasalt), (2) basalt (diabase-basalt), and (3) amygdaloidal basalt.

Variolitic Basalt (hyalobasalt)

This rock type is present near the contacts with the sedimentary rocks (Sections 32-4 and 33-1). The basalt has a variolitic texture, although a poorly developed trachyte texture may be observed. Thin skeletal plagioclase laths (labradorite, An 60-62, average 30%), contain a brown-green devitrified material inside. The laths (0.2-2 mm) are generally randomly dispersed, and rarely is a lath orientation present. Commonly, the plagioclase is replaced by smectite, chlorite, and calcite.

Branched varioles consist of pyroxene, skeletal microlites of labradorite, and a glassy material. Pyroxene (augite, average 30%) is also replaced by chlorite-smectite(?). The glassy matrix (average 30%) is green-brown, and is replaced by chlorite and smectite. Altered euhedral olivine crystals (size 0.3-0.5 mm, average 3%), which have been replaced by calcite and iddingsite, are also present. Tabular phenocrysts and crystal aggregates of altered plagioclase (size 0.2-0.5 mm, average 2%) were observed. Opaque minerals are represented by magnetite dust (average 7%), and formless pyrite aggregates.

Basalt (diabase-basalt)

This rock type is present over most of the cored section. The basalt has microporphyric, micro diabase, intersertal, tholeiitic, and subophitic textures. It is often nearly holocrystalline and fine to medium grained. Twinned plagioclase laths (labradorite, An 60-70) 0.5-1.5 mm long, form the framework, which also contains fine-grained compact aggregates of augite crystals—average 45%, C:Ny(X)=45-48°. Commonly, the large augite aggregates (length 2-3 mm) contain poikilitic plagioclase microlites and small tabular plagioclase. Near the contact with the sedimentary rocks, the basalt has branched pyroxene crystals. Sometimes there is an altered glassy matrix in intergranular areas.

Rare euhedral crystals of altered olivine (average 3%) replaced by iddingsite and calcite-goethite are present. Only one basalt specimen (Sample 34-1, 132-135 cm) has a higher concentration of olivine (5%).

The opaque minerals are represented by small xenomorphic and skeletal crystals of magnetite (average 5%) and euhedral crystals of pyrite. Commonly pyrite with calcite and smectite-chlorite fills the veins. Secondary minerals (smectite, chlorite, calcite, amphibole[?]) are commonly observed (average 15%), but they are especially abundant near the sedimentary contacts

Amygdaloidal Basalt

This basalt is present in the lower portion of the cored section (Core 34, Section 2). The mineral composition of the amygdaloidal basalt is very similar to the diabase-basalt, but contains 10%-15% round amygdules (diameter 0.2-1 mm). These are filled by chlorite, smectite, and rarely by calcite. The texture is subophitic. It is nearly holo-crystalline, fine grained, and also contains branched augite crystals. The average composition is: altered olivine (1%), pyroxene (40%), plagioclase (labradorite-30%), magnetite (5%), and secondary minerals (smectite, chlorite, calcite, amphibole, pyrite, 15% to20%).

Summary

The igneous rocks from Site 348 are represented by variolitic basalt (hyalobasalt), basalt (diabase-basalt), and amygdaloidal basalt. These basalts probably represent a sill or dike body. This conclusion is supported by the absence of pillow lava with typical glassy rims and glassy brecciated surfaces. The basalts are probably normal tholeiites. Secondary mineral alterations of the basalts from Site 348 are slightly more than those observed in Site 337 and 345.

Geochemistry (H.R. and F.-J.E.)

The content of 1.5%-4.4% H^2O and values between 70.8-51.3 for 100 FeO/FeO + Fe_2O_3 for the four specimens analysed indicate the great variation of alteration of Site 348 basalt. Three of the best analyses and norms are shown in Table 3. It is not quite clear, if a primary in-homogeneity exists between the different samples.

The major element chemistry (Table 3) is within the range of Cann's (1971) ocean floor basalt except a low Al_2O_3, Na_2O, and an extremely low K_2O content (average 0.05%). In the AFM diagram (See Raschka et al., this volume) the strong iron enrichment is visible (average crystallization index FeO/MgO = 1.85). According to their normative composition both quartz- and olivine-tholeiites are present. The high normative quartz-content of sample RF 9844 is in good agreement with the modal quartz found in this sample. Trace element chemistry is characterized by a strong depletion of elements: Sr: 60 ppm; Rb: <5 ppm; Zr; 68 ppm, (Table 4).

TABLE 3
Analyses of Site 348 Basalts

	32-4, 97-100 cm	33-1, 56-59 cm	34-2, 91-105 cm
	RF 9843	RF 9844	RF 9846
SiO_2	47.15	49.57	47.63
TiO_2	1.38	1.28	1.24
Al_2O_3	14.78	13.64	13.33
Fe_2O_3	6.25	3.83	5.42
FeO	7.25	9.28	7.51
MnO	0.25	0.22	0.20
MgO	6.13	6.90	7.91
CaO	11.22	11.12	10.43
Na_2O	2.31	1.94	2.02
K_2O	0.06	0.04	0.06
H_2O_{tot}	3.54	1.56	2.60
SO_3	0.04	0.13	0.32
P_2O_5	0.11	0.10	0.10
Total	100.47	99.61	99.00
C.I.P.W. Norms[a]			
Qz	0.00	3.42	0.61
Or	0.37	0.24	0.37
Ab	20.24	16.76	17.86
An	30.83	28.99	28.34
Di	21.52	21.94	20.49
Hy	17.92	21.53	25.19
Ol	1.73	0.00	–
Mt	4.32	4.12	4.15
Il	2.71	2.48	2.46
Ap	0.27	0.24	0.25
Pr	0.08	0.25	0.25
Norm.Plag.An	60.37	63.37	61.34
Diff.Ind.	20.60	20.42	18.84
Norm.C.I.	48.56	50.56	52.79

[a] Norms are based on analyses recalculated to 100% H_2O free and with %Fe_2O_3 standardized at %TiO_2 + 1.5 (Irvine and Baragar, 1971).

TABLE 4
Trace Elements of Site 348 Basalts (ppm)

	RF 9843	RF 9844	RF 9846
Sr	75	63	77
Nb	3	7	<3
Zr	74	61	63
Y	38	30	29
Ni	104	100	107
Co	57	56	57
V	441	406	395
Zn	120	110	106
Cu	163	181	128
Cr	191	184	180
Ce	16	13	17
Sc	60	53	49

PHYSICAL PROPERTIES

Based on the velocity profile (Figure 4) and the composite density-impedance-water content profile (Figure 5), six subdivisions of the sediments above basement can be made (Table 5).

Discussion

The stratigraphic sequence is marked by several discontinuities in physical properties, usually indicating an abrupt change in depositional conditions or an unconformity. The lower limit of the "glacial" sediments is shown at 67 meters by a sharp change in water content and, to a lesser extent, bulk density. This results from the loss of terrigenous material, primarily cohesive clays. There appears to be an abruptness to this situation that perhaps may not be real. The Pliocene

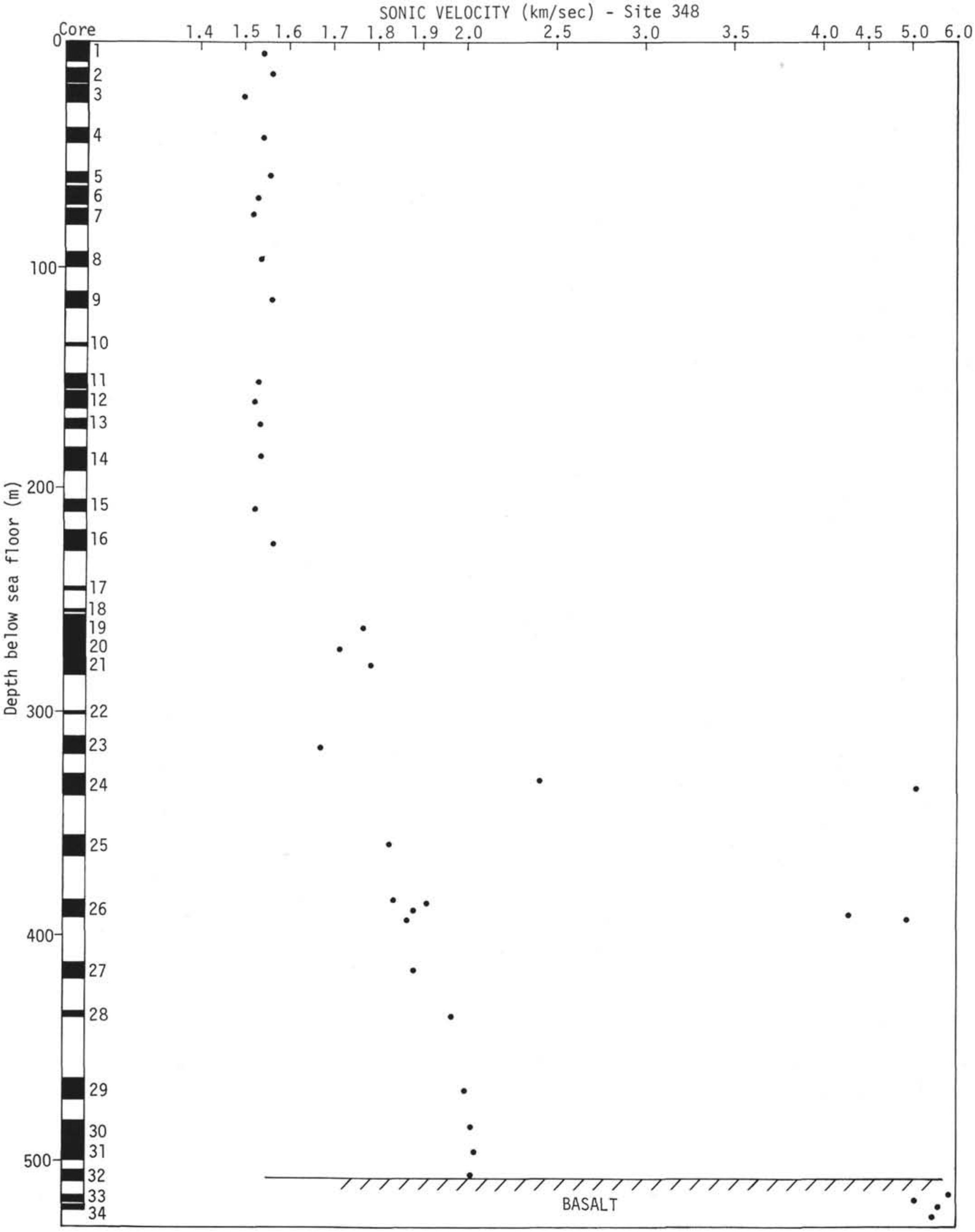


Figure 4. *Velocity profile.*

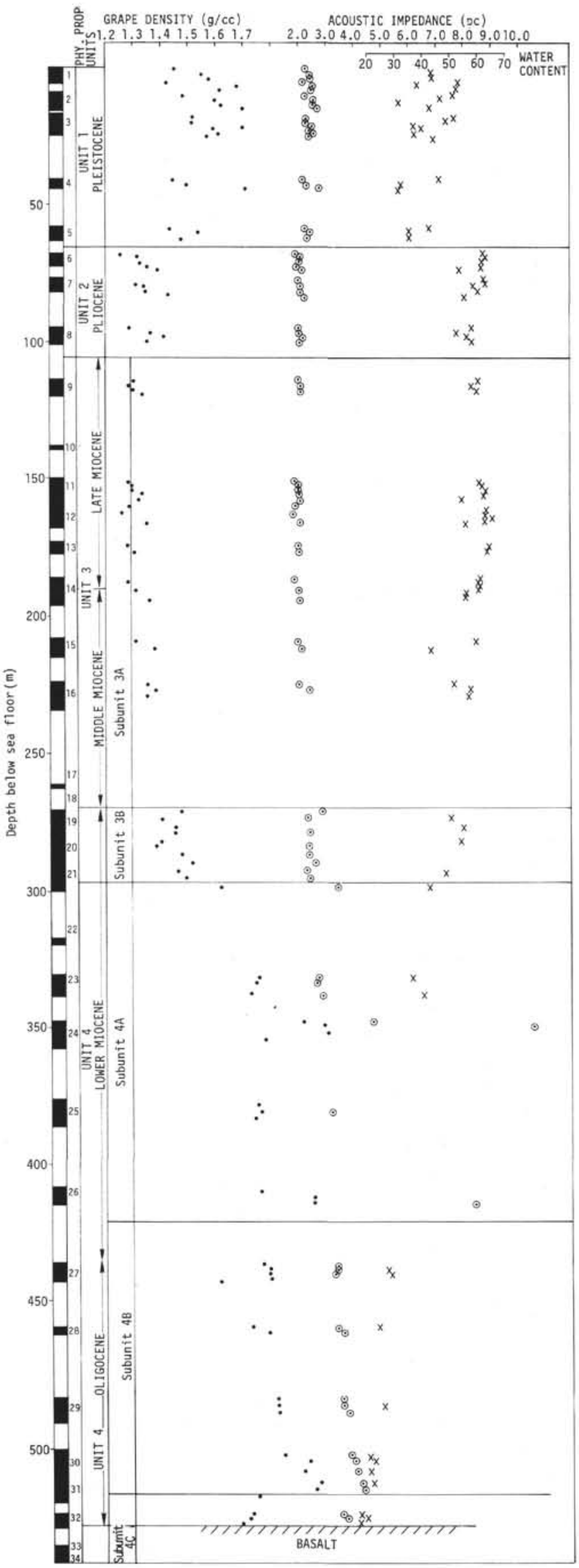


Figure 5. *Density, water content, impedance.*

TABLE 5
Sediment Subdivisions Based on Physical Properties

Unit 1 –	surface through Core 5, Section 4 (66 m). Relatively high density, terrigenous sandy muds of Quaternary age. Sonic velocity varies between 1.48-1.56 km/sec. Considerable variation in wet density and water content is seen. Average bulk (wet) density – 1.56 g/cm^3 Average water content – 41.04% Average sonic velocity – 1.54 km/sec Average impedance – 2.40
Unit 2 –	Core 5, Section 4 through Core 8, Section 5 (41 m). Sediments form a zone intermediate between terrigenous clastics above and biogenic siliceous oozes below. Density fluctuations are attributed to interbedding of sediments of both types, intermixed with occasional volcanic ash layers. Sonic velocity changes very little. Average bulk (wet) density – 1.35 g/cm^3 Average water content – 58.89% Average sonic velocity – 1.53 km/sec Average impedance – 2.09
Unit 3 –	Core 8, Section 5 through Core 17 (165 m). Transitional biogenic siliceous oozes interbedded with minor amounts of terrigenous muds and sandy muds. Density fluctuates within a narrow range, and with depth in section. Little change in sonic velocity or impedance occurs. Sediments are generally noncohesive except where thin clay interbeds are present. Average bulk (wet) density – 1.32 g/cm^3 Average water content – 59.12% Average sonic velocity – 1.56 km/sec Average impedance – 2.03
Unit 4 –	Core 19 to Core 21, Section 5 (124 m). Semiconsolidated to well-lithified silt and mudstones, having slightly higher wet density (1.4-1.5 g/cm^3) and considerably higher sonic velocity. Impedance rises slightly above 2.2. Average bulk (wet) density – 1.45 g/cm^3 Average water content – 50.30% Average sonic velocity – 1.66 km/sec Average impedance – 2.42
Unit 5 –	Core 21, Section 5 through Core 26 (99.5 m). Well-lithified mudstone, little different from Unit 4 with occasional hard limestone lenses. Toward base of section, increasing amounts of clastic material are present, becoming quite coarse (a muddy sandstone) in Cores 30 and 31. Two high sonic velocity units (>3.5 km/sec), each composed of thin well-lithified limestones overlying a thin (10 cm) interval of lithified mudstones, are present at 342-352 meters and 412-416 meters. Normal velocities (1.8 km/sec) are found in the interval between them. Average bulk (wet) density – 1.76 g/cm Average water content – 40.88% Average sonic velocity – 1.91 km/sec Average impedance – 3.42
Unit 6 –	Core 31, Section 4 to the top of the basalt in Core 32 (11 m). Very fine-grained mudstone showing decreasing density. Velocity continues high (>2.0 km/sec), with sharp discontinuity entering basalt in the lower part of Core 32. Average bulk (wet) density – 1.810 g/cm Average water content – 23.61% Average sonic velocity – 2.05 km/sec Average Impedance – 3.72

sediments form a transitional sedimentary series, being composed of alternating terrigenous clastics and transitional biogenic sediments.

No striking discontinuity in physical properties exists across the late Miocene Pliocene boundary. The break is based on paleontological results, as the sediments grade upward from a nearly homogeneous transitional biogenic siliceous ooze into the glacial sequence. Sonic velocity remains constant at 1.55 km/sec through this interval.

The paleontologic break between lower Miocene and middle Miocene is not expressed in the physical properties. The sediments pass across the boundary with little change, however, density does increase slightly in Cores 19, 20, and 21. This is interpreted as resultiing from normal compaction in an uninterrupted sedimentary series. Sonic velocity shows an increase in cores 16-22, possibly reflecting an increase in consolidation.

Physical properties point to a change at 297 meters in Core 21, approximately 30 meters below the time-stratigraphic break between lower and middle Miocene. A large increase in density and decrease in water content is associated with the lithologic change to terrigenous mudstone. Sediments are semiconsolidated, becoming more consolidated with depth. Variable lithologies are present, including several limestone units. Density and velocity continue to increase, with decrease in water content to Core 31, where an abrupt change occurs in lithology and density. Within this basal unit density decreases from 2.5 g/cm³ to 1.7 g/cm³, but water content continues to decrease. It is possible that thermal events associated with sill intrusion have caused the reduction in water content.

Drilling Deformation

Unit 3, from Core 24 to the base of the section presented a problem of interpretation. Cores 24 and 26 appeared to be affected by drilling deformation to a considerable degree, with blocks of solid mudstone lying between intervals of crumbly, brecciated mudstone fragments. The bulk density of the brecciated interval (from GRAPE record) averaged 1.93 g/cm³ in Core 24 and 1.90 g/cm³ in Core 26. However, the density of the discrete mudstone blocks averaged 2.53 g/cm³ in Core 24 and 2.27 g/cm³ in Core 26. Porosity of the brecciated material averaged 48%, whereas the porosity of the coherent mudstone blocks averaged 9.5%. Figure 5 is obviously misleading with respect to the brecciated interval, if it is believed that the unit was originally solid rock. The entire interval in which the brecciated mudstone is present represents drilling deformation, and the physical properties do not represent in situ conditions.

GEOCHEMISTRY

Inorganic Geochemistry

The results of interstitial water analyses on selected samples is found in Table 6.

Organic Geochemistry

Shipboard Analysis of Dissolved Gas in Tertiary Cores from Site 348

During the course of coring at Site 348, only two gas samples could be obtained, the analysis of which are presented in Table 7. The sample recovered from Core 9 had a volume of about 23 cc, and the sample from Core 16, only 10 cc. Neither sample contained any detectable hydrocarbons.

Sample 16, CC from a depth of 246.5 meters had a strong petroliferous odor and subsequent fluroscopic examination produced a faint yellow fluorescence. However, gas was not present in any of the sections from Core 16 nor in any of the subsequent cores. In an attempt to determine if hydrocarbons were present the liner sections of Core 16 were warmed with a heat gun to liberate some gas. Only about 10 cc of gas was evolved from Section 1, and as indicated in Table 7, no hydrocarbons were detected. Subsequent splitting and detailed fluoroscopic examination of Core 16 indicated that no soluble hydrocarbons were present, and it was concluded that yellow fluorescence detected in Sample 16, CC was not indigenous to the mudstone, but probably resulted from contamination during the coring operation.

BIOSTRATIGRAPHY

Biostratigraphic Summary

A complete section from Oligocene to Pleistocene has been recovered. Pleistocene sediments are present in Core 1 to Core 6 Section 5 (0-74 m) with *Globergina pachyderma*, few nannoplankton, and diatoms and few radiolarians in Core 1 and in Cores 5 and 6. Only few reworked Cretaceous and Paleogene nannofossils and pollen are present.

Pliocene siliceous ooze (Core 6, Section 5 to Core 10, 75-142 m) is rich in moderate to good preserved diatoms, silicoflagellates, and radiolarians. Nannoplankton is restricted to some thin horizons intercalated in the siliceous ooze and consist only of *Coccolithus pelagicus*. In Core 6, a diversified Arctic benthonic foraminiferal fauna and a few small planktonic species were found. The late Miocene to middle Miocene was determined for Cores 11 to 18 (151.5-436.5 m) based on diatoms, silicoflagellates, dinoflagellates, and radiolarians.

Below this sequence sediments are barren of siliceous microfossils. Determination of early Miocene age for Cores 19 to 27 is based on the presence of few nannofossils and foraminifera. Cores 28 to 32 (446-531.5 m) belong to the Oligocene as indicated by the foraminifer assemblage. Dinoflagellates are only rare in this sequence. Terrestrial plant debris and pollen are dominant.

Foraminifera

"Glacial," Pleistocene, Cores 1 through 5

Cores 1 and 2 have abundant foraminifera; the amount of ice-rafted material (quartz, rock fragments, basalt, and Cretaceous *Inoceramus* prisms) varies between less than 1% or more than 99% of the washed residue. Left-coiling *Neogloboquadrina pachyderma* is the most numerous species in all fossiliferous samples. Rare *Globigerina quinqueloba* and very rare *Globerigina bulloides* are the only other planktonic foraminifera found. Benthonic foraminifera form never more than

TABLE 6
Summary of Shipboard Geochemical Data, Site 348

Sample (Interval in cm)	Subdepth (m)	*p*H	Alkalinity (meq/kg)	Salinity (°/oo)	Ca^{++} (mmoles/1)	Mg^{++} (mmoles/1)
Surface Seawater	–	8.06	2.30	34.5	10.50	52.45
1-4, 142-150	6.0	7.51	2.82	34.6	13.83	48.98
4-2, 144-150	40.5	7.72	2.36	34.4	29.80	33.87
7-3, 144-150	80.0	7.50	2.06	34.9	40.10	24.01
9-2, 144-150	116.5	8.27	1.83	35.5	44.10	22.60
12-5, 144-150	168.5	7.61	1.81	34.9	54.93	13.08
16-5, 144-150	235.0	7.39	1.71	35.2	60.99	10.40
20-5, 144-150	282.5	7.21	0.19	35.2	71.67	5.07
24-5, 144-150	349.0	7.82	0.26	35.2	89.81	0.79
29-5, 140-150	491.5	7.02	0.21	36.0	115.82	-4.3[a]
32-2, 141-150	525.0	7.74	0.23	36.3	120.49	-2.88[a]

[a]Considered as zero.

TABLE 7
Shipboard Analysis of Dissolved Gas in Tertiary Cores From DSDP Leg 38, Site 348

Depth (m) Below Mud Line	Sample (Interval in cm)	As Sampled in Liner[a] Air	Carbon Dioxide
115	9-2, 0	99.98	0.02
229	16-1, 0	99.92	0.08

[a]In mol %.

5% of the fauna. "*Cibicides*" *wuellerstorfi* is the dominant species whereas *Islandiella teretis* is second. Others present are *Pyrgo williamsoni*, *Bulimina aculeata*, *Dentalina frobisherensis*, *Melonis zaandamae*, *Pullenia bulloides*, and *Eponides umbonatus*. Foraminifera are very rare in Core 3; Cores 4 and 5 are practically barren.

The relatively poor levels in Cores 1 and 2 do not show signs of strong dissolution and probably are due to low production = heavy ice cover. However, in Core 3 carbonate dissolution plays a more important role and the barren nature of Cores 3-5 seems, at least partly, due to dissolution.

Pliocene, Cores 6 through 7, Section 4

The sediment of Cores 6 and 7 has been deposited near the carbonate compensation surface. The washed residues consist largely of ash and some volcanic glass, but some samples yielded a few identifiable calcareous tests. *Islandiella teretis* is most common. Others are: *I. islandica*, *Melonis zaandamae*, *Sphaeroidinella bulloides*, *Pullenia bulloides*, *Eponides umbonatus*, *Gyroidina* sp., *Lenticulina* sp., and *Dentalina* sp. Planktonic foraminifera are very rarely preserved, the few specimens found are small and could be loosely built *N. pachyderma*, as well as juvenile *N. atlantica*; a second form is *Globigerinita glutinata*. Several samples have (ice-rafted?) quartz grains as a minor constituent of the residues.

Undiagnostic Interval, Core 7, Section 5 through Core 9

Only three (out of 20) samples yielded a few foraminifera. Siliceous *Spirosigmoilinella* sp. occurs in 8, CC and 9-1, 130-132 cm, whereas 8, CC also has *Eggerella* sp. A few calcareous fragments of *Cibicides* sp. and *Dentalina* sp. were found in Sample 9-2, 40-42 cm.

Like the above, the washed residues largely consist of shiny ash and (less) volcanic glass. A few quartz grains are present in most samples and although quartz is common at a few levels only its persistent presence may suggest an ice-rafted origin. This part of the section was dated as Pliocene with diatoms and silicoflagellates.

Upper and Middle Miocene, Cores 10 through 23, Section 1

In Cores 10 through 17, a siliceous foraminiferal fauna is consistently present: *Martinottiella communis*, *Spirosigmoilinella* sp., with less *Spirolocammina* sp. and *Eggerella* sp. The washed residues consist, as above, of ash and volcanic glass with a few quartz grains.

Cores 18 through 23, Section 1, on the other hand, are characterized by having very small washed residues which consist of some fragments of nondisintegrated zeolitic clay, a few quartz grains, and at some levels, dull gray ash. *Martinottiella communis* is still common in 18, CC but lower only a few specimens were found at 19-2, 40-42 cm and 21-5, 50-52 cm. Other siliceous forams (also rare) are: *Haplophragmoides* sp., *Spirosigmoilinella* sp., and from 23-1 down rather consistently *Bathysiphon* sp.

Early Miocene (and Oligocene) Cores 23, Section 1 through Core 32

The presence of an arenaceous fauna (in abundance or common) characterizes the lower interval of this hole. It has species of *Bathysiphon*, *Cyclammina*, *Cribrostomoides*, *Haplophragmoides*, *Reophax*, *Psammosphaera*, *Tolypammina*, and *Ammodiscus*. The relative abundance of these forms varies, which may be a basis for further subdivision. Scattered fragments of calcareous foraminiferal tests are present. The only marker found in this unit is a specimen of *Ehrenbergina variabilis aculeata* in Sample 24-5, 121-123 cm which suggests a late Oligocene-early Miocene age (Chattunteres Hemmoor; Spiegler, 1973).

The washed residues of this interval consist of sand grains (quartz and some rock fragments up to pebble size) with common to abundant pyrite. Noteworthy is the abundance of glauconite in Sample 23-2, 94-96 cm at the top of this unit.

Nannoplankton

At Site 348 probably a complete section of upper Oligocene to Quaternary was recovered. Nannofossils are present in Cores 1 and 2 (0-18.5 m). Sample 1-1, top, is abundant in well-preserved nannoplankton. The assemblage is of low diversity with *Coccolithus pelagicus*, *Emiliania huxleyi*, *Gephyrocapsa ericsonii*, and rare specimens of *Cyclococcolithus leptoporus*. The same assemblage was observed in the other samples of Cores 1 and 2, plus a few specimens of *Helicosphaera carteri*. The preservation is very good in the nannofossil ooze layers. Only few reworked species were observed in these horizons.

Cores 3 to 5 (18.5-66 m) are barren of nannoplankton. In Cores 6 to 11 (66-161 m), some thin layers of nannofossil ooze are intercalated in the siliceous ooze, containing only *Coccolithus pelagicus*.

Cores 12 through 12 (161-332 m) are without nannoplankton. *Helicosphaera ampliaperta*, *Coccolithus pelagicus*, and *Reticulofenestra pseudoumbilica* were found in Sample 24-4, 118-119 cm to Sample 26-3, 48-49 cm (341.5-408 m) indicating an early Miocene age (NN 3/NN 4). Cores 27 through 33 (427-541 m) are barren of nannofossils.

Radiolarians

The radiolarian preservation is poor to moderate; however, three units could be identified.

Unit 1 (Cores 1 through Sample 5-1, 105-107) is rare in siliceous fossils except in Cores 1-1, 65-67 and 1-2, 85-87, where a well-preserved, modern radiolarian assemblage is present, rich in *Amphimelissa setosa*, *Echinomina leptodermum*, and *Pseudodictyophimus gracilipes*, and in Sample 4-2, 106-108, where the internal cephalic bars and rings of a not yet identified nassellarian species are abundant.

Unit 2 (Samples 5, CC through 18, CC) is characterized by a radiolarian assemblage of moderate to good preservation. Samples 5, CC through 8-3, 140-142 cm are characterized by a frequent occurrence of *Antarctissa whitei*. It is most likely that the internal remnants described from Sample 4-2, 106-108 cm belong to *Antarctissa whitei*. Scattered throughout this unit, and abundant in Sample 6, CC, is a phaeodarian species very similar to the present *Challengeron diodon*. In Sample 15-2, 30-32 cm, there is a maximum occurrence of *Hexalonche* sp. A which referable to similar maxima at Sample 338, 7, CC and Sample 341-31-5, 17-19 cm through 341-31, CC, which are of a late Miocene age.

Unit 3 (Cores 18 through 31) is barren of siliceous microfossils.

Diatoms

Diatoms are common to abundant and are moderately to well preserved in Cores 1 through 16. The following interval zones were established: Samples 1-1, 60 cm to 6-5, 15 cm *Thalassiosira oestrupii* Zone (0.0-1.8 m.y.); Samples 6-5, 115 cm to 8-1, 70 cm *Rhizosolenia barboi* Zone (1.8-2.5 m.y.); Samples 8-1, 90 cm to 9-2, 50 cm *Thalassiosira kryophila* Zone (2.5-(?) m.y.); Samples 9-3, 80 cm to 10, CC *Coscinodiscus marginatus* Zone (0.0-5.5 m.y.); Samples 11-1, 20 cm to 11-2, 85 cm *Denticula hustedtii* Zone (5.5-6.5 m.y.); Samples 11-3, 70 cm to 12-3, 95 cm *Cymatosira biharensis* Zone (?); Samples 12-4, 90 cm to 13-3, 90 cm *Goniothecium tenue* Zone (6.8-7.3 m.y.); Samples 13, CC to 14-3, 130 cm *Rhizosolenia miocenica* Zone (?); Samples 14-6, 85 cm to 15-3, 90 cm *Thalassiosira gravida* Zone (?); Samples 15, CC to 16-3, 85 cm *Actinocyclus ingens* Zone (?).

Samples 16-3, 85 cm through 17, CC are tentatively placed into the *Sceptroneis caducea*, *Nitschia* sp. 8 and *Actinocyclus ingens* zones, and is of middle Miocene age. *Thalassiosira fraga* and *Thalassionema hirosakiensis* are interpreted as being reworked. This correlation gives a tentative absolute age for this interval of 10.5-14 m.y.

Silicoflagellates

The assemblage of Core (56.5-66 m) is distinguished by the presence of several varities of *Distephanus speculum* indicating cold water temperatures. This part of the profile belongs to the upper Pliocene-Pleistocene (*Distephanus speculum* Zone). The *Distephanus boliviensis* Zone was determined from Samples 6-1, 105-106 cm to 10, CC (66-142 m) of the uppermost Miocene to lower Pliocene.

The *Mesocena circulus* Zone is determined from Samples 11-1, 20-21 cm to 18, CC (151.5-265 m) of the middle-upper Miocene. The assemblage consists of *Mesocena circulus*, *Mesocena diodon*, *Mesocena apiculata*, *Distephanus crux*, *Distephanus speculum*, *Mesocena elliptica*, *Cannopilus hemisphaericus*, and *Dictyocha fibula*. The determination of this zone is based on the presence of *Mesocena circulus*. Only one specimen was found in Sample 18, CC, the next one is present in Sample 14-1, 90-91 cm. Thus, it is very likely that the lower part of the profile (Core 14, Section 2 to Sample 18, CC) still belongs to the *Dictyocha triacantha* Zone of the midde Miocene, with few specimens of *Distephanus longispinus*.

Palynology

Dinocysts

Cysts are very rare below Core 23. In Cores 23 to 8 they are, in general, frequent, but their diagnostic value is low. Small undiagnostic cysts dominate (often only two or three species), and key zonation species are very rare. The comparison with Site 338 zonation is, therefore, tentative (Figure 6).

In Cores 30 to 24 *Problematicum I* is present, indicating Zone I to III. Core 23, Section 3 has the following diagnostic species: cf *Plathycystidia* sp. II, *Impletosphaeridium* sp. I, *Dinocyst* sp. V; and *Dinocyst* sp. III which is the most significant, indicating Zones IIa to Ib. In Cores 13, Section 2 and Core 12, Section 3 *Hystrichosphaeropsis* cf. obscurum indicates Zones IIa to Ia, however, in Core 12, Section 2 *Leptodinium* sp. II (more suggestive of IIa) is also present. Zone Ia is suggested for Core 11, Section 1 by the occurrence of

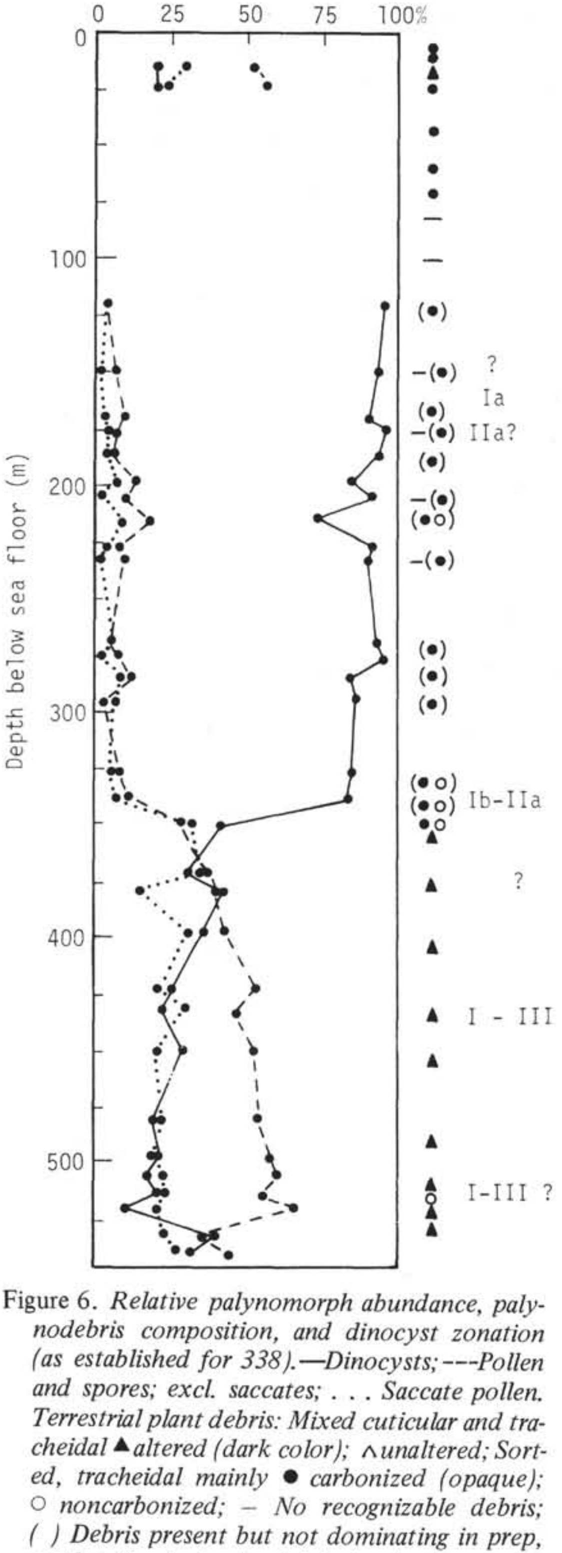


Figure 6. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation (as established for 338).—Dinocysts; ---Pollen and spores; excl. saccates; . . . Saccate pollen. Terrestrial plant debris: Mixed cuticular and tracheidal ▲ altered (dark color); ∧ unaltered; Sorted, tracheidal mainly ● carbonized (opaque); ○ noncarbonized; – No recognizable debris; ( ) Debris present but not dominating in prep, residue. Symbol only: debris dominating.*

Cordosphaeridium sp. III. Higher cores cannot be related to the Site 338 zonation.

Debris, Reworked Material

Diverse terrestrial plant debris dominates in Cores 24 and below. Late Upper Cretaceous to early Tertiary sources are suggested by the reworked pollen. Cores 23 to 9 have only minor amounts of carbonized tracheidal matter. For the "glacial" cores, Cores 3, Section 1 and in particular, Core 2, Section 3 differ distinctly from the others in having very diverse debris with reworked pollen and spore assemblages of roughtly mid-Cretaceous age (bisaccates dominate; triletes; no angiosperms).

SUMMARY AND CONCLUSIONS

Summary

The cored sediments at this site fall into three lithologic units; the top unit being Pleistocene in age, the second unit ranges in age from Pleistocene to middle or late Miocene, and the bottom unit extends from the lower Miocene to the Oligocene (?). The lowest unit lies on top of a basaltic basement.

Pleistocene

This unit extending from 0 to 64 meters consists of a mixture of terrigenous mud, sandy mud and clay, with occasional layers of volcanic ash. Left-coiling *Neogloberigina pachyderma* was the most numerous planktonic foraminifera found in this unit. Nannoplankton are present and have a small diversity of species; radiolarians are absent. At the lower boundary of the unit, there is a sharp downward decrease in density into the unit below.

Pleistocene, Pliocene to Middle or Late Miocene

This unit extends from 64 meters to 202 meters. It is characterized by biogenic siliceous sediments, especially near the top. However, the sediments also include terrigenous clay and mud, as well as volcanic ash. The Pliocene in the top part of this unit (75 to 142 m) is marked by cold water fauna, mainly siliceous (silicoflagellates, radiolarians, and diatoms). Calcareous nannoplankton and foraminifera are present, but are rare. In the lower part of this unit which is of late and middle Miocene, calcareous fossils are absent. The sonic velocity and density are nearly constant in this unit, although there is more scatter in the density values within the Pliocene.

Early Miocene to Oligocene (?)

This unit extends from 270 meters to the top of the basalt at 527 meters. The boundary at the top of this unit is marked by a sharp downward increase in sonic velocity and a less pronounced, but definite increase in density. Both the velocity and density increase progressively downwards to the basalt boundary.

The unit is apparently entirely terrigenous, consisting primarily of mud/mudstone, but containing abundant clay/claystone in its upper part, and sandy mudstone in its lower part. Scattered fine pebbles are abundant in the middle of the unit; they are composed of quartz, chert, and claystone. Towards the base of the unit, basalt (?) pebbles are common.

Except for some nannoplankton in restricted horizons (Samples 24, CC, 25, CC), this unit is barren of nannoplankton as well as calcareous foraminifera, radiolarians, and silicoflagellates. Only arenaceous foraminifera are present, and the tentative age determination is based on these fossils.

A thin mudstone is also present between basalt layers below the main sedimentary sequence, and it appears to be similar to the unit described above.

Basalt

Basalt, ranging in texture from fine grained to fine and medium grained, is found below the sediments. Continuous coring was attempted from 527 meters to the bottom of the hole at 544 meters, however only about 6 meters of basement rocks were recovered. The basalts do not contain pillow lavas with typical glassy rims or glassy brecciated surfaces. They are probably normal tholeiitic basalt, although secondary mineral alteration with the introduction of pyrite, smectite, chlorite, calcite, amphibole, and albite has occurred.

Age for basement determined radiometrically is 18.8 ± 1.7 m.y. by the German group (Kharin et al., this volume). This is only slightly younger than the age of 21 m.y. from magnetic anomalies corresponding to anomaly 6 (see Chapter 34, this volume). Paleotologically, the age for the overlying sediments is early Miocene to Oligocene (?). The possible Oligocene age is from a single marker foraminifera with the range late Oligocene to early Miocene. It is therefore quite possible that the oldest sediments at this site are early Miocene and the basement age is indeed about 21 m.y. The age of the extinct axis gives the age of cessation of spreading at this axis at about 18.5 m.y.

The seismic profiler record (Figure 2) shows reflectors at about 0.08 sec, 0.22 sec, 0.34 sec, and 0.65 sec. In comparing these times with observed velocities the following units have been chosen:

Unit A (corresponding to lithologic unit 1) Cores 1-5, 0-63.7 m; average velocity = 1.54 km/sec; two-way travel time = 0.082 sec.

Unit B (corresponding to lithological unit 2, except that the base is at 250 m); average velocity = 1.54 km/sec; two-way travel time = 0.242 sec.

Unit C (corresponding to lithological unit 3, except that the top is at 250 m); average velocity (ignoring some streaks of high-velocity limestone—over 4.0 km/sec) = 1.904 km/sec; two-way travel time = 0.291 sec.

Hence, calculation values for two-way travel times to major reflectors are 0.08, 0.32, and 0.62 sec.

Thus, the reflector at 0.22 sec is not identified in the core record. The measured velocity values below the 0.08 reflector are about 5% too high.

Discussion and Conclusions

1. Basement consisting of normal tholeiitic basalt and the presence of linear magnetic anomalies leads us to the conclusion that this part of the Icelandic Plateau, lying between the Iceland-Jan Mayen Ridge and the Jan Mayen Ridge, evolved by the process of sea-floor spreading.

2. Basement age here is about 21 m.y. The use of the magnetic anomalies identified in this area gives an age of about 25 m.y. to 18.5 m.y. for this intermediate spreading axis.

3. The change in sediments character from dominantly terrigenous sediments in the Oligocene and early Miocene to an increase of pelagic biogenic siliceous oozes in the middle and late Miocene can probably be explained in the following way. The earlier sediments were obtained directly from Greenland. They are dominantly terrigenous and incidentally contain only arenaceous foraminifera (and are barren in all other fauna) which seems to characterize sediments obtained from Greenland in the early opening phase, not only of this oceanic area but also earlier of the Norway Basin.

As the axis of spreading shifted to produce a new ridge between the Icelandic Plateau and Greenland, the rate of terrigenous sediments was reduced and biogenic oozes became important in the middle and late Miocene.

4. No distinct "opaque" layer lying above the basalt was identified. This suggests that the opaque layer is basalt basement.

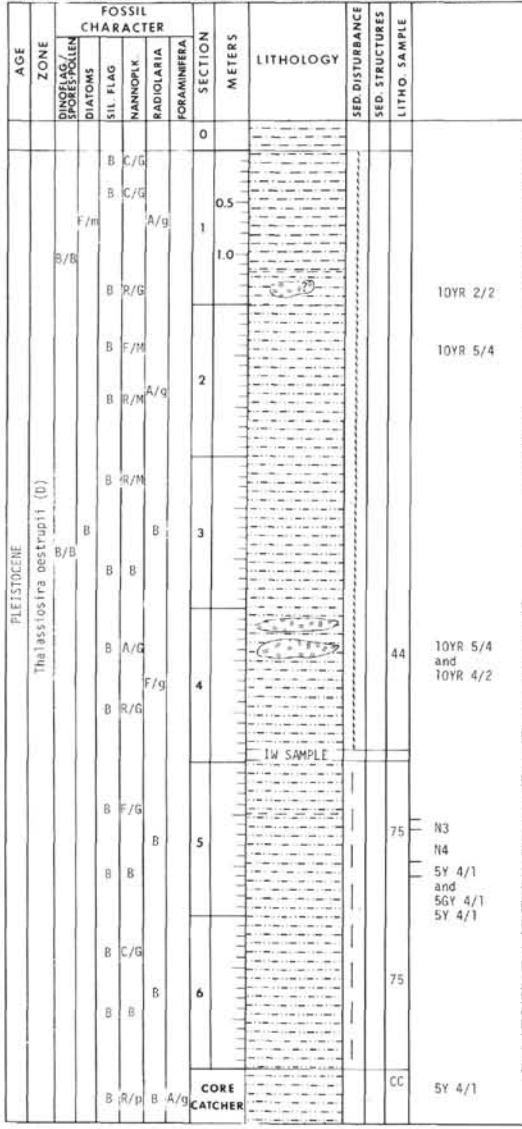
REFERENCES

Cann, J.R., 1971. Major element variation in ocean floor basalts: Phil. Trans. Roy. Soc. London, v. 268A, p. 495-506.

Irvine, T.N. and Baragar, W.R.A., 1971. A guide to the chemical classification of the common volcanic rocks: Canadian Jour. Earth Sci., v. 8, p. 523-548.

Spiegler, D., 1973. Die Entwicklung von *Ehrenbergina* (Foram.) im höheren Tertiär NW-Deutschlands: Geol. Jb., v. A6, p. 3-23.

SITE 348 HOLE CORE 1 CORED INTERVAL: 0.0-9.0 m



LITHOLOGIC DESCRIPTION

Colors: moderate yellowish brown (10YR 5/4), dusky yellowish brown (10YR 2/2), dark yellowish brown (10YR 4/2), dark gray (N3), medium dark gray (N4), olive gray (5Y 4/1), dark greenish gray (5GY 4/1), light olive gray (5Y 5/1). Moderate to intense deformation, soft. Concretion of volcanic ash(?) at 1-130.

MAJOR LITHOLOGY

MUD (Smears 5-75, 6-75, CC)

10-20% Sand
25-40% Silt
50-60% Clay

21-27% Quartz
5-10% Feldspar
1- 2% Mica
5- 9% Heavy minerals (Epidote, Zircon)
50-60% Clay minerals

0- 1% Volcanic glass
TR- 1% Lithics (Chert, Siltstone?)
1% Glauconite
2- 5% Authigenic? carbonate
1- 2% Opaques
TR- 2% Foraminifera
0-TR% Nannofossils
0-TR% Sponge spicules

MINOR LITHOLOGY

VOLCANIC ASH (Smear 4-44)

20% Sand
40% Silt
40% Clay

5% Quartz
5% Mica
4% Heavy minerals (Zircon, Epidote, Clinopyroxene)

25% Volcanic glass
3% Carbonate
5% Foraminifera
2% Nannofossils
1% Feldspar
40% Clay minerals
10% Opaques

Carbon-Carbonate (DSDP)

1-30 (4.8, 0.1, 39)
1-76 (4.2, 0.2, 34)
1-126 (2.6, 0.1, 20)
2-26 (1.3, 0.2, 10)
2-50 (1.7, 0.1, 13)
3-27 (1.8, 0.2, 13)
3-28 (0.8, 0.2, 4)
3-82 (0.9, 0.2, 6)
4-26 (0.8, 0.1, 6)
4-76 (3.8, 0.1, 31)
5-26 (0.4, 0.1, 2)
5-78 (0.8, 0.6, 2)
6-26 (0.6, 0.2, 3)
6-76 (0.4, 0.2, 1)

Carbon-Carbonate (PP)

1-5 (top) (0.30, 0.04)
1-5 (bottom) (0.28, 0.53)

Grain Size (DSDP)

1-28 (38.9, 32.4, 28.7)
1-78 (38.8, 35.8, 25.5)
1-129 (27.1, 33.7, 39.2)
2-10 (10.9, 41.9, 47.2)
2-28 (15.1, 26.3, 58.5)
3-28 (14.6, 32.9, 52.5)
4-28 (28.1, 38.0, 33.8)
4-78 (26.3, 39.5, 34.1)
5-28 (15.9, 33.7, 50.4)
5-76 (8.2, 31.4, 60.4)
6-28 (5.4, 35.0, 59.6)
6-78 (7.1, 26.2, 66.7)

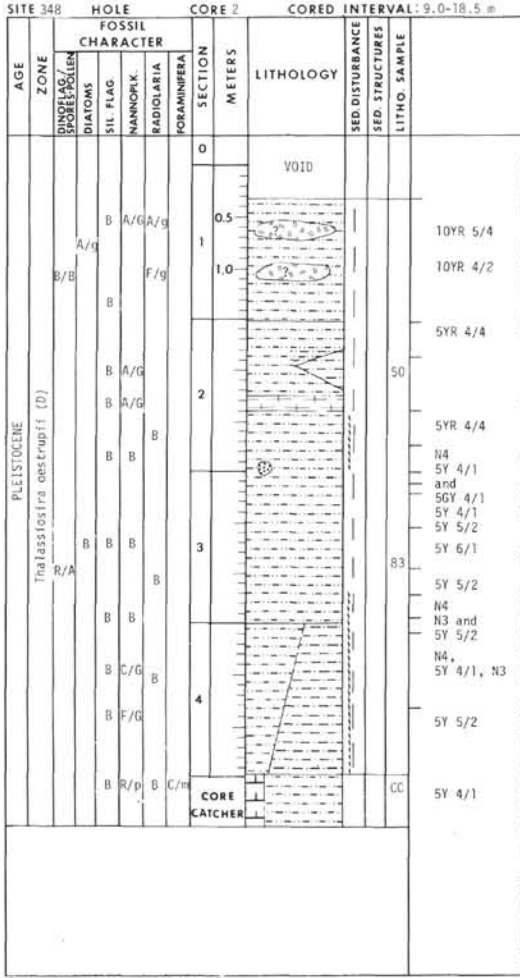
X-Ray (PP)

2-40 (Bulk)		2-40 (<2μ)	
M	Quar.	52%	Micas
P	Plag.	9%	Kaol.
TR%	Micas	10%	Chlo.
TR%	K/C	29%	MXL (60% Mont.)
P	Calc.		

X-Ray (PP)

6-120 (Bulk)		6-120 (<2μ)	
A	Quar.	47%	Micas
P	Plag.	10%	Kaol.
TR%	Micas	10%	Chlo.
TR%	K/C	33%	MXL (60% Mont.)
A	Calc.		

SITE 348 HOLE CORE 2 CORED INTERVAL: 9.0-18.5 m



LITHOLOGIC DESCRIPTION

Colors: moderate yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/2), moderate brown (5YR 4/4), medium dark gray (N4), olive gray (5Y 4/1), dark greenish gray (5GY 4/1), light olive gray (5Y 5/2), light olive gray (5Y 6/1), dark gray (N3). Moderate to intense deformation, soft to locally stiff. Scattered pebbles and clay clasts.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smears 2-50, 3-83)

5-15% Sand
35-40% Silt
45-55% Clay

7-28% Quartz
2- 5% Feldspar
1% Mica
TR- 2% Heavy minerals (Epidote, Zircon)
1- 2% Opaques

TR- 3% Volcanic glass
50-60% Clay minerals
0- 1% Glauconite
10-15% Authigenic carbonate
0- 2% Lithics (Chert, Siltstone)
0- 7% Foraminifera
0- 1% Nannofossils
0- 2% Diatoms
0-TR% Sponge spicules

MINOR LITHOLOGY

NANNOFOSSIL MUD (Smear CC)

10% Sand
50% Silt
40% Clay

26% Quartz
10% Feldspar

7% Heavy minerals (Epidote, Orthopyroxene)
40% Clay minerals
1% Foraminfiera
15% Nannofossils
1% Mica

Carbon-Carbonate (DSDP)

1-80 (2.7, 0.2, 21)
1-116 (0.9, 0.1, 6)
1-126 (1.1, 0.2, 8)
2-26 (0.3, 0.2, 1)
2-45 (1.6, 0.2, 11)
2-126 (0.7, 0.5, 2)
3-32 (0.5, 0.3, 1)
3-82 (0.4, 0.3, 1)
4-26 (1.4, 0.5, 8)
4-76 (1.0, 0.7, 3)
4-134 (0.8, 0.3, 4)

Grain Size (DSDP)

1-78 (41.8, 42.6, 15.5)
1-118 (13.8, 36.6, 49.6)
1-128 (14.6, 33.7, 51.8)
2-28 (8.3, 35.4, 56.3)
2-50 (12.8, 41.8, 45.4)
2-128 (12.5, 32.6, 54.9)
3-78 (8.5, 29.7, 61.8)
4-28 (13.6, 33.6, 52.8)
4-78 (14.2, 31.7, 54.1)
4-132 (9.6, 33.3, 57.1)

X-Ray (PP)

2-40 (Bulk)		2-40 (<2μ)	
M	Quar.	46%	Micas
P	Plag.	8%	Kaol.
TR%	Micas	8%	Chlo.
TR%	K/C	38%	MXL (60% Mont.)
P	Calc.		

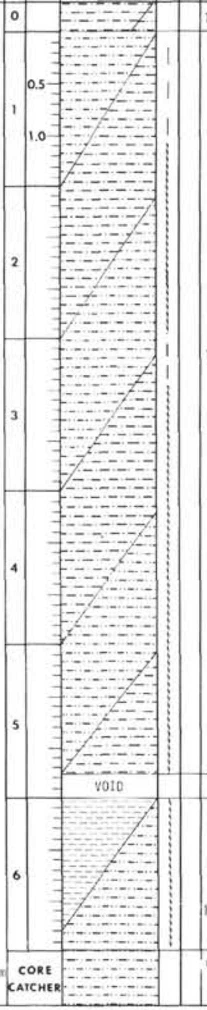
Explanatory notes in Chapter 1

SITE 348 HOLE CORE 3 CORED INTERVAL:18.5-28.0 m

AGE: PLEISTOCENE

ZONE: *Thalassiosira oestrupii* (D)

SECTION	DINOFLAG./ SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA	LITHO. SAMPLE	
0							10	
1	R/C	B	B	B	B			5G 6/1
1			B	B				
2			B	B				5G 6/1 N5 5Y 7/2 5Y 4/1
2					B			
2			B	B				
3			B	B			10	5G 6/1 N4 5Y 6/1 5GY 6/1
3	T/R	B	B	B				
4		B	B	B	B			5G 6/1 5Y 6/1
4			B	B				
5			B	B	B			
6			B	B	B			5GY 5/2 N3 N5 5GY 6/1 5Y 6/1
6			B	B			116	
CORE CATCHER			B	B	B	R/m	CC	5GY 4/1



LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), greenish gray (5GY 6/1), olive gray (5Y 4/1), yellowish gray (5Y 7/2), medium gray (N5), light olive gray (5Y 6/1), medium dark gray (N4), dusky yellow green (5GY 5/2), dark gray (N3). Moderate to intense deformation. Soft, locally ash-rich. Locally mottled, scattered clasts.

MAJOR LITHOLOGY

MUD (Smears 0-10, 3-10, CC)

3-10% Sand	60-70% Clay minerals
20-37% Silt	TR% Glauconite
60-70% Clay	0- 3% Lithics (Chert, Siltstone, Volcanic)
17-20% Quartz	0- 1% Authigenic(?) carbonate
6-15% Feldspar (some unaltered and euhedral plagioclase)	1- 3% Opaques
	0-TR% Nannofossils
TR- 1% Mica	0-TR% Diatoms
1-10% Heavy minerals (Epidote, Ortho & Clino-pyroxene, Hornblende, Garnet?)	0-TR% Sponge spicules
	0-TR% Volcanic glass
	0-TR% Palagonite

MINOR LITHOLOGY

CLAY (Smear CC)

3% Sand	TR% Volcanic glass
20% Silt	TR% Palagonite
77% Clay	TR% Zeolite
	78% Clay minerals
20% Quartz	TR% Mica

Carbon-Carbonate (DSDP)

1-26 (0.4, 0.3, 1) 4-26 (0.4, 0.3, 0)
1-56 (0.3, 0.3, 0) 4-82 (0.5, 0.4, 1)
1-125 (0.4, 0.2, 2) 4-132 (0.3, 0.3, 0)
2-34 (0.3, 0.3, 0) 5-26 (0.3, 0.2, 0)
2-82 (0.3, 0.2, 1) 5-76 (0.4, 0.3, 1)
2-126 (0.3, 0.2, 0) 5-118 (0.3, 0.2, 0)
3-26 (0.4, 0.4, 0) 6-26 (0.2, 0.2, 0)
3-73 (0.3, 0.3, 0) 6-82 (0.4, 0.4, 0)
3-126 (0.4, 0.3, 0)

Carbon-Carbonate (PP)

3-5 (top) (1.43, 0.05)
3-5 (bottom) (0.07, 0.21)

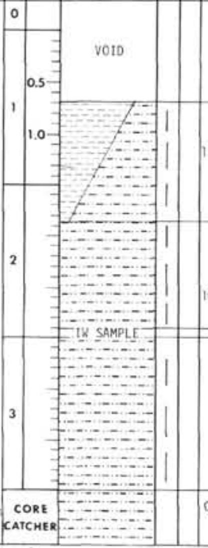
Grain Size (DSDP)	X-Ray (PP)	
1-28 (4.8, 34.8, 60.5)	M	Quar.
1-78 (24.5, 29.6, 46.0)	P	Plag.
2-28 (10.7, 27.9, 61.4)	P	Micas
2-32 (9.5, 30.1, 60.4)	P	K/C
2-78 (5.7, 33.5, 60.7)	3-68 (<2μ)	
2-128 (2.7, 29.7, 67.6)	42%	Mica
3-28 (8.8, 33.5, 57.7)	10%	Kaol.
3-74 (8.9, 34.7, 56.4)	14%	Chlo.
3-128 (7.1, 33.0, 59.8)	34%	MXL (50% Mont.)
4-28 (9.8, 41.1, 49.1)		
4-78 (9.1, 32.7, 58.2)		
5-28 (8.3, 48.8, 42.9)		
5-78 (10.0, 34.0, 56.0)		
6-28 (7.3, 36.3, 56.4)		
6-78 (10.4, 27.8, 61.8)		

SITE 348 HOLE CORE 4 CORED INTERVAL: 37.5-47.0 m

AGE: PLEISTOCENE

ZONE: *Thalassiosira oestrupii* (D)

SECTION	DINOFLAG./ SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA	LITHO. SAMPLE	
0								
1		B						N3 10GY 5/2
1	B/B		B	B	B		110	5GY 4/1
2			B	B	B			5GY 5/2
2			B	B	C/m		100	10YR 4/2
3			B	B	B			10Y 4/2- 5Y 5/2 5G 6/1 5G 4/1 5Y 4/1- 5GY 6/1
3	B/B							
3					B			N3-N4-N5
CORE CATCHER			B B	B B	B	R/m	CC	5GY 2/1



LITHOLOGIC DESCRIPTION

Colors: dark gray (N3), grayish green (10GY 5/2), dark greenish gray (5GY 4/1), dusky yellow green (5GY 5/2), light olive gray (5Y 5/2), grayish olive (10Y 4/2), greenish gray (5G 6/1), dark greenish gray (5G 4/1), greenish gray (5G 6/1). Low to moderate deformation, soft to firm. Massive.

MAJOR LITHOLOGY

MUD (Smears 1-110, 2-100, CC)

1-10% Sand	TR-10% Volcanic glass
20-40% Silt	58-80% Clay minerals
58-74% Clay	0-TR% Nannofossils
	0- 5% Diatoms
10% Quartz	TR- 2% Sponge spicules
3- 5% Feldspar	TR% Radiolarians
1- 7% Opaques	TR% Glauconite
2-10% Heavy minerals (Epidote, Ortho-clino pyroxene, Zircon)	
0- 1% Lithics	

Carbon-Carbonate (DSDP)

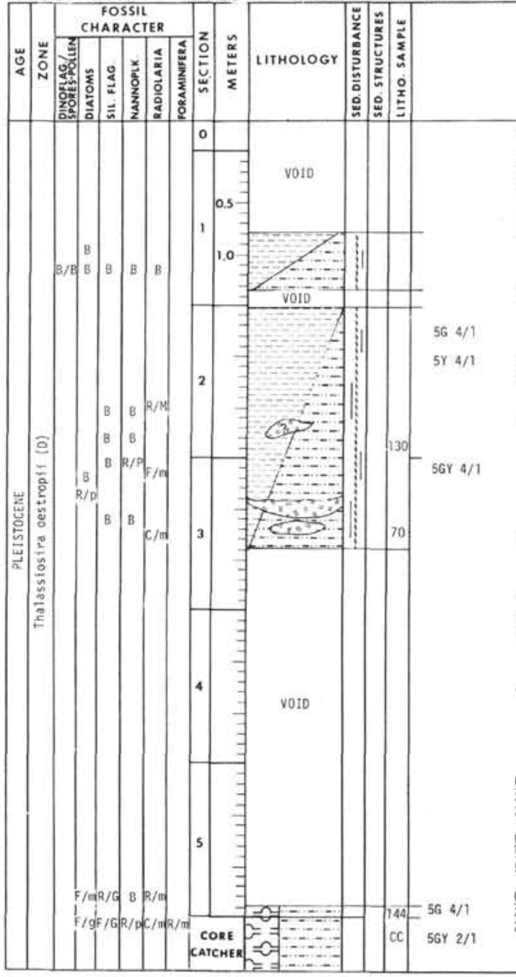
1-76 (0.4, 0.4, 0)
2-26 (0.4, 0.3, 0)
2-76 (0.3, 0.3, 0)
2-123 (0.2, 0.2, 0)
3-71 (0.3, 0.3, 0)
3-126 (0.2, 0.2, 0)

Grain Size (DSDP)

1-78 (5.1, 42.8, 52.0)
2-28 (6.1, 39.9, 54.0)
2-78 (3.3, 46.7, 50.0)
2-125 (5.9, 65.0, 29.1)
3-74 (5.9, 65.0, 29.1)
3-128 (7.2, 37.0, 55.8)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 5 CORED INTERVAL: 56.5-66.0 m



LITHOLOGIC DESCRIPTION

Colors: greenish black (5GY 2/1), dark greenish gray (5G 4/1), olive gray (5Y 4/1). Moderate to intense deformation, soft to stiff.

MAJOR LITHOLOGY

DIATOMACEOUS MUD (Smear 5-144, CC)

5-15% Sand	52-60% Clay minerals
25-45% Silt	0-TR% Lithics (Chert)
50-60% Clay	1% Opaques
	0- 1% Nannofossils
7-12% Quartz	10-15% Diatoms
2% Feldspar	2- 5% Radiolarians
TR- 1% Mica	TR- 1% Sponge spicules
1% Heavy minerals (Epidote, Clinopyroxene, Garnet?)	0- 1% Silicoflagellates
	10-15% Volcanic glass

MINOR LITHOLOGIES

a) CLAY (Smear 2-130)

1% Sand	TR% Mica
9% Silt	TR% Glauconite
90% Clay	TR- 3% Authigenic carbonate
7% Quartz/Feldspar	1% Lithics
2% Heavy minerals (Epidote, Garnet, Zircon)	TR% Diatoms
	TR% Sponge spicules
	90% Clay minerals
	TR% Volcanic glass
TR% Opaques	

b) VOLCANIC ASH (Smear 3-70)

30% Opaques
70% Volcanic glass
TR% Quartz

c) *TRANSITIONAL SILICEOUS MUDS* (Smear 5-144)

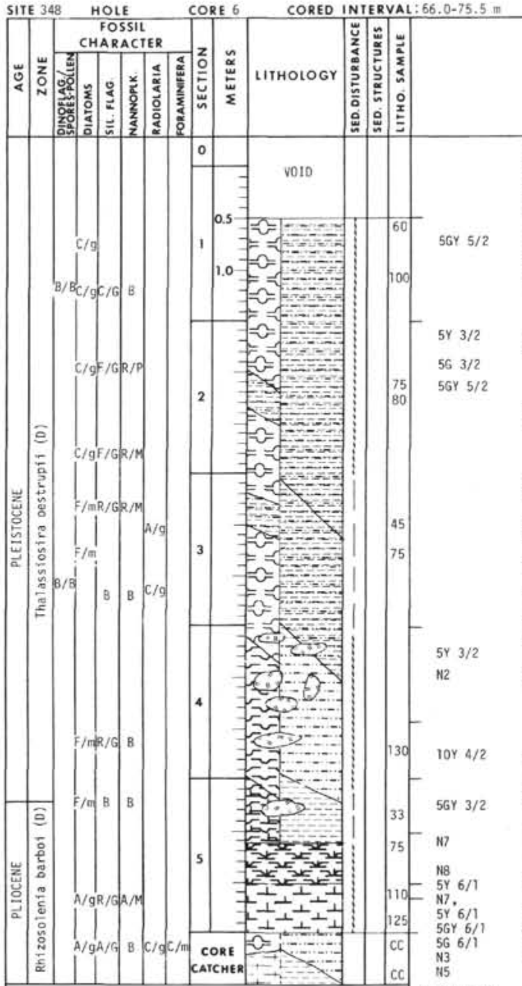
5-15% Sand	1% Opaques
25-45% Silt	10-15% Volcanic glass
50-60% Clay	52-60% Clay minerals
	10-15% Diatoms
7-12% Quartz	2- 5% Radiolarians
2% Feldspar	TR- 1% Sponge spicules
TR- 1% Mica	0- 1% Silicoflagellates
1% Heavy minerals (Epidote, Garnet, Clinopyroxene)	0- 1% Lithics (Chert)

Carbon-Carbonate (DSDP)
2-26 (0.3, 0.3, 0)
2-76 (0.4, 0.3, 0)

Carbon-Carbonate (PP)
5-1 (top) (0.42, 0.11)
5-1 (bottom) (0.31, 0.01)

Grain Size (DSDP)
2-28 (6.2, 43.6, 50.1)
2-78 (9.1, 35.4, 55.5)

SITE 348 HOLE CORE 6 CORED INTERVAL: 66.0-75.5 m



* 0-TR% Foraminifera
TR% Lithics
5% Authigenic carbonate
10% Clay
TR% Heavy minerals

LITHOLOGIC DESCRIPTION

Colors: dark gray (N3), medium gray (N5), dusky yellow green (5GY 5/2), olive gray (5Y 3/2), dusky green (5G 3/2), grayish olive (10Y 4/2), grayish olive green (5GY 3/2), grayish black (N2), grayish olive (10Y 4/2), light gray (N7), very light gray (N8), light olive gray (5Y 6/1), greenish gray (5G 6/1). Moderate to intense deformation, soft.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smears 1-60, 1-100, 2-75, 3-75, 4-130, CC)

1-20% Sand	0- 2% Zeolites
37-50% Silt	0- 3% Carbonate
30-60% Clay	2-10% Diatoms
	0-10% Radiolarians
2-15% Quartz	2-20% Sponge spicules
0-10% Feldspar	0- 2% Silicoflagellates
TR- 3% Mica	
TR- 3% Heavy minerals (Epidote)	0-TR% Lithics
	0- 7% Foraminifera
0-15% Opaques	0-TR% Nannofossils
5-20% Volcanic glass	30-60% Clay minerals

MINOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smears 5-110, 5-125, CC)

20% Sand	TR% Heavy minerals (Epidote, Orthopyroxene)
40-60% Silt	
20-60% Clay	
	1% Opaques
TR- 5% Diatoms	5-10% Volcanic glass
1% Radiolarians	0- 4% Clay minerals
TR- 1% Quartz	55-70% Nannofossils
0- 1% Feldspar	5-20% Sponge spicules
TR- 1% Mica	*

b) SILICEOUS-NANNOFOSSIL OOZE (Smear 5-75)

5% Sand	1% Zeolite
40% Silt	55% Nannofossils
55% Clay	10% Diatoms
	2% Radiolarians
3% Quartz	7% Sponge spicules
1% Feldspar	1% Silicoflagellates
1% Opaques	5% Volcanic glass

c) TERRIGENOUS MUD AND CLAY (Smear 2-80, 3-45)

5-10% Sand	81-90% Clay minerals
40-50% Silt	4- 5% Volcanic glass
40-55% Clay	1- 3% Opaques
	0- 1% Diatoms
0- 3% Quartz	TR- 1% Radiolarians
0- 1% Feldspar	0- 2% Sponge spicules
0- 2% Heavy minerals (Epidote)	0- 1% Mica

d) DEVITRIFIED VOLCANIC ASH (Smear 5-33)

5% Sand	TR% Heavy minerals (Epidote)
10% Silt	
85% Clay	1% Opaques
	1% Volcanic glass
10% Quartz	85% Devitrified ash
2% Feldspar (some unaltered and euhedral)	TR% Glauconite
	TR% Lithics (Chert)
	1% Mica

X-Ray (PP)
2-104 (Bulk)

M	Quar.
P	Plag.
TR%	Pyri.
TR%	K/C

2-104 (<2μ)

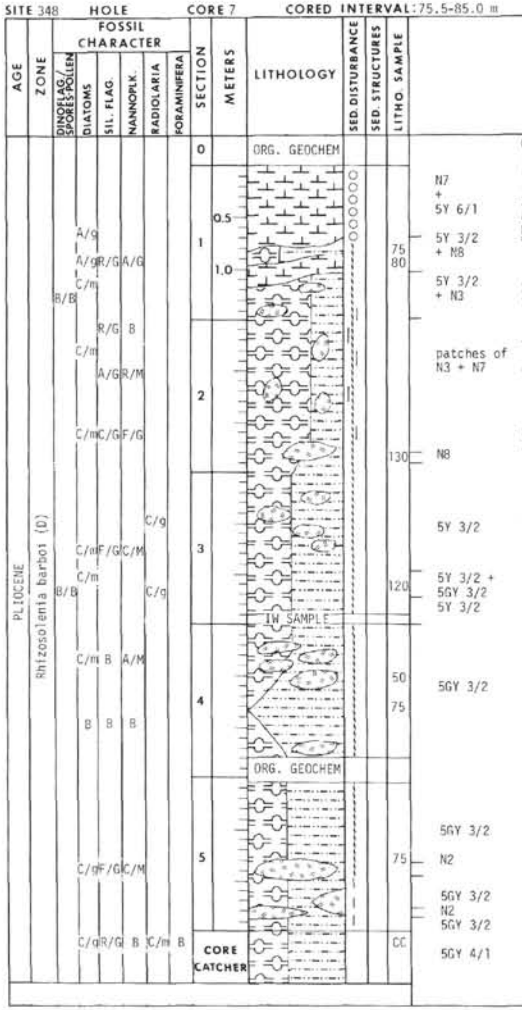
23% Mica
9% Kaol.
9% Chlo., 59% MXL (50% Mont.)

Carbon-Carbonate (DSDP)
2-66 (0.3, 0.2, 1)
2-70 (0.3, 0.2, 1)
3-55 (0.3, 0.3, 0)
4-72 (0.3, 0.2, 0)
5-72 (1.9, 0.3, 14)

Grain Size (DSDP)
1-78 (5.5, 49.8, 44.7)
2-82 (2.9, 55.3, 41.8)
2-99 (4.0, 53.8, 42.2)
3-82 (4.3, 52.9, 42.9)
4-70 (1.6, 53.1, 45.0)
5-70 (3.2, 46.8, 48.5)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 7 CORED INTERVAL: 75.5-85.0 m



LITHOLOGIC DESCRIPTION

Colors: greenish gray (5GY 4/1), light gray (N7), light olive gray (5Y 6/1), olive gray (5Y 3/2), very light gray (N8), dark gray (N3), light gray (N7), grayish green (5GY 3/2), grayish black (N2). Soupy, moderate, and intensely deformed, soft to firm.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smears 1-75, 2-130, 3-120, 5-75, CC)

5-30% Sand	7-10% Volcanic glass
30-60% Silt	15-65% Clay minerals
35-65% Clay	0-TR% Glauconite
	0- 1% Authigenic carbonate
3- 8% Quartz	15-50% Diatoms
TR- 3% Feldspar	2-10% Radiolarians
1- 5% Mica	1- 5% Sponge spicules
TR- 1% Heavy minerals (Epidote, Zircon)	0- 2% Silicoflagellates
1- 2% Opaques	

MINOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smear 1-80)

10% Sand	1% Opaques
40% Silt	10% Sponge spicules
50% Clay	64% Nannofossils
1% Radiolarians	TR% Glauconite
TR% Foraminifera	2% Volcanic glass
TR% Heavy minerals	2% Diatoms

b) VOLCANIC ASH (Smear 4-50)

80% Sand	3% Quartz
10% Silt	1% Opaques
10% Clay	80% Volcanic glass
	15% Nannofossils
TR% Heavy minerals	1% Lithics

c) MUD (Smear 4-75)

5% Sand	7% Quartz/Feldspar
50% Silt	2% Mica
45% Clay	2% Heavy minerals (Epidote)
7% Volcanic glass	2% Opaques
78% Clay minerals	TR% Glauconite
TR% Diatoms	1% Radiolarians
1% Sponge spicules	

Carbon-Carbonate (DSDP)
3-19 (0.3, 0.3, 0)

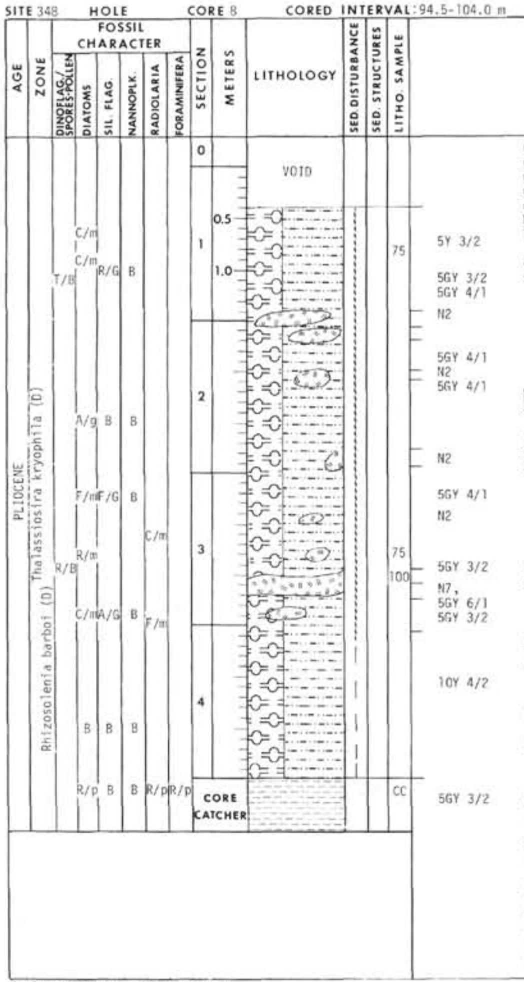
Carbon-Carbonate (PP)
7-4 (top) (0.35, 0.02)
7-4 (bottom) (0.11, 0.08)

Grain Size (DSDP)
3-50 (4.7, 46.8, 48.5)

X-Ray (PP)

3-60 (Bulk)		3-60 (<2μ)	
M	Quar.	30%	Micas
P	Plag.	9%	Kaol.
TR%	Micas	8%	Chlo.
TR%	K/C	53%	MXL (60% Mont.)

SITE 348 HOLE CORE 8 CORED INTERVAL: 94.5-104.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2), grayish olive green (5GY 3/2), grayish black (N2), dark greenish gray (5GY 4/1), light gray (N7), greenish gray (5GY 6/1). Moderate to intense deformation, soft to firm.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smear 1-75)

5% Sand	40% Clay minerals
45% Silt	2% Zeolites
50% Clay	33% Diatoms
	5% Radiolarians
4% Quartz	3% Silicoflagellates
2% Feldspar	2% Sponge spicules
1% Mica	TR% Authigenic carbonate
1% Heavy minerals (Epidote)	TR% Glauconite
	5% Volcanic glass
2% Opaques	

MINOR LITHOLOGIES

a) VOLCANIC ASH-RICH TRANSITIONAL SILICEOUS MUD (Smear 3-75)

25% Sand	40% Clay minerals
40% Silt	35% Volcanic glass
35% Clay	2% Opaques
	TR% Glauconite
4% Quartz	10% Diatoms
1% Feldspar	1% Radiolarians
1% Mica	5% Sponge spicules
1% Heavy minerals (Epidote)	

b) VOLCANIC ASH (Smear 3-100)

90% Sand	2% Quartz
5% Silt	1% Heavy minerals (Epidote)
5% Clay	1% Opaques
95% Volcanic glass	1% Mica
TR% Feldspar	

c) CLAY (Smear CC)

1% Sand	4% Quartz
9% Silt	2% Mica
90% Clay	1% Opaques
	1% Sponge spicules
90% Clay minerals	1% Volcanic glass
TR% Authigenic carbonate	TR% Diatoms

Carbon-Carbonate (DSDP)
3-59 (0.3, 0.3, 0)

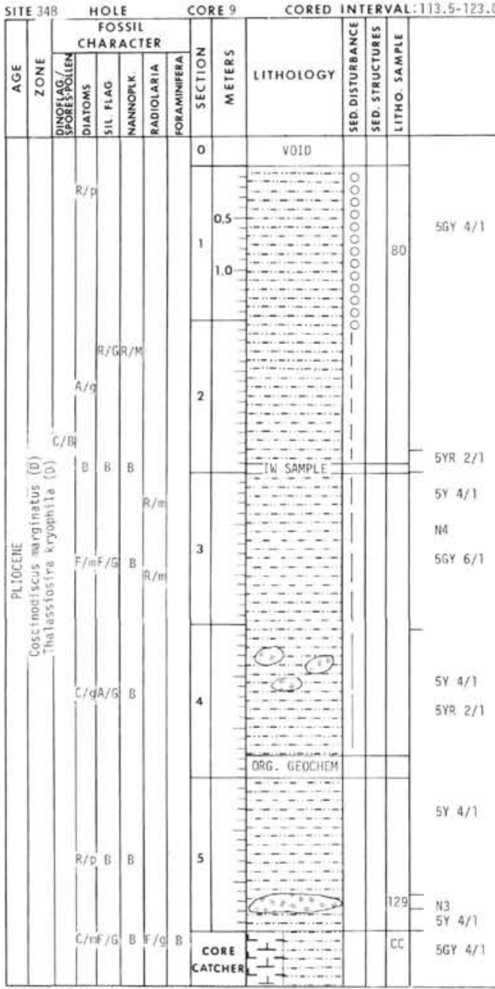
Grain Size (DSDP)
3-50 (3.7, 42.9, 53.4)

X-Ray (PP)

3-39 (Bulk)		3-39 (<2μ)	
M	Quar.	11%	Micas
P	Plag.	5%	Kaol.
TR%	Pyri.	3%	Chlo.
TR%	Micas	81%	MXL (60% Mont.)
TR%	K/C		

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 9 CORED INTERVAL: 113.5-123.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), brownish black (5YR 2/1), olive gray (5Y 4/1), medium dark gray (N4), greenish gray (5GY 6/1), dark gray (N3). Soupy to moderate deformation, soft to firm.

MAJOR LITHOLOGY

MUD (Smear 1-80)

15% Sand
30% Silt
55% Clay

TR% Glauconite, Authigenic carbonate, Detrital carbonate
1% Radiolarians

1% Diatoms
1% Sponge spicules
4% Quartz
2% Mica
7% Heavy minerals (Epidote)
7% Opaques
10% Volcanic glass
65% Clay minerals
TR% Lithics (Chert)
2% Feldspar

MINOR LITHOLOGIES

a) VOLCANIC ASH (Smear 5-129)

95% Sand
3% Silt
2% Clay

3% Mica
87% Volcanic glass
2% Quartz
1% Glauconite
7% Opaques

b) TRANSITIONAL NANNOFOSSIL MUD (Smear CC)

7% Sand
13% Silt
80% Clay

TR% Radiolarians
2% Diatoms
1% Mica
2% Authigenic carbonate

2% Quartz
1% Opaques
7% Volcanic glass
51% Clay minerals
30% Nannofossils
3% Sponge spicules
TR% Feldspar, Heavy minerals, Detrital carbonate

Carbon-Carbonate (DSDP)
3-60 (0.3, 0.2, 0)

Carbon-Carbonate (PP)
9-4 (top) (0.43, 2.53)
9-4 (bottom) (0.41, 0.02)

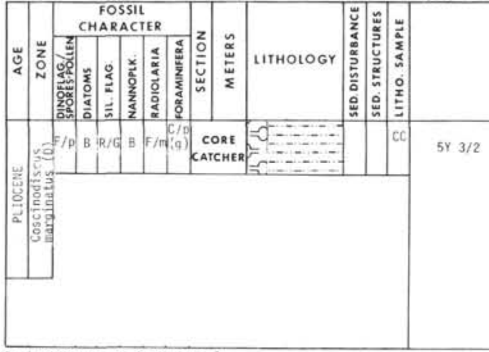
Grain Size (DSDP)
3-66 (10.4, 49.3, 40.2)

X-Ray (PP)

3-50 (Bulk)		3-50 (<2μ)	
M	Quar.	24%	Micas
P	Plag.	9%	Kaol.
TR%	Micas	6%	Chlo.
TR%	K/C	61%	MXL (70% Mont.)

EXPLANATORY NOTES IN CHAPTER 1

SITE 348 HOLE CORE 10 CORED INTERVAL: 132.5-142.0 m



LITHOLOGIC DESCRIPTION

Color: olive gray (5Y 3/2).

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smear CC)

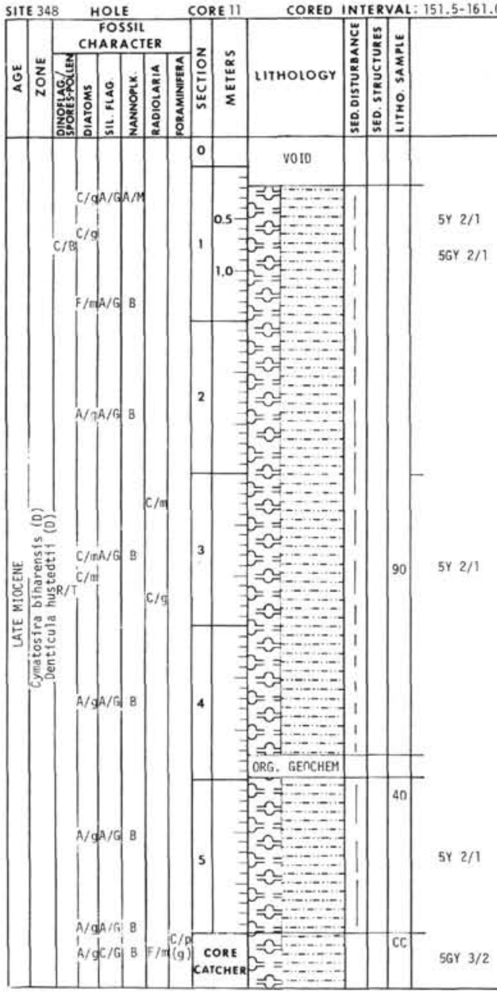
5% Sand
35% Silt
65% Clay

7% Volcanic glass
TR% Radiolarians
3% Feldspar
1% Micronodules

5% Quartz
2% Mica
1% Heavy minerals
1% Opaques
68% Clay minerals
5% Diatoms
5% Sponge spicules
1% Silicoflagellates

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 11 CORED INTERVAL: 151.5-161.0 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), olive black (5Y 2/1), greenish black (5GY 2/1), moderate to low deformation, soft throughout. Massive.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smears 3-90, 5-40, CC)
5-10% Sand
35-55% Silt
40-55% Clay

TR- 3% Opaques
5-10% Volcanic glass
0- 6% Palagonite
2- 5% Radiolarians
0- 2% Silicoflagellates

3-10% Quartz, Feldspar
TR- 1% Mica
TR- 2% Heavy minerals (Epidote)
31-50% Clay minerals
10-45% Diatoms
7-10% Sponge spicules

Carbon-Carbonate (DSDP)
3-40 (0.4, 0.0, 3)

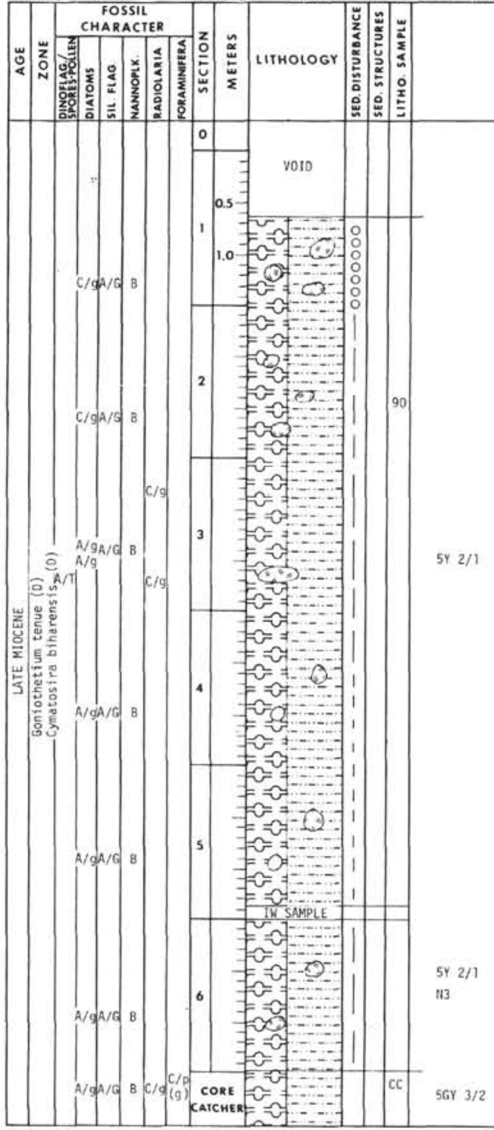
Carbon-Carbonate (PP)
11-4 (top) (0.45, 0.02)
11-4 (bottom) (0.53, 0.04)

Grain Size (DSDP)
3-50 (7.4, 44.8, 47.8)

X-Ray (PP)

3-60 (Bulk)		3-60 (<2μ)	
A	Quar.	19%	Micas
A	Plag.	8%	Kaol.
		4%	Chlo.
		69%	MXL (50% Mont.)

SITE 348 HOLE CORE 12 CORED INTERVAL: 161.0-170.5 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), olive black (5Y 2/1), dark gray (N3). Soft, soupy to moderate and low deformation.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smears 2-90, CC)
10-15% Sand
40% Silt
45-50% Clay

TR- 2% Heavy minerals (Epidote)
0-TR% Authigenic carbonate
5-15% Sponge spicules
0- 1% Lithics (Chert)

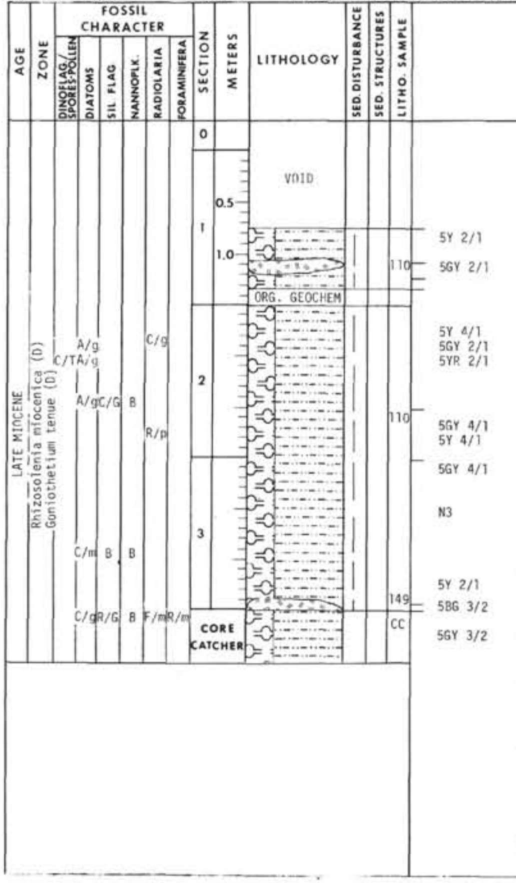
1- 3% Quartz
1- 2% Feldspar
1% Mica
2% Opaques
8-10% Volcanic glass
43-51% Clay minerals
10-30% Diatoms
5% Radiolarians
TR% Glauconite

Carbon-Carbonate (DSDP)
3-10 (0.5, 0.4, 1)

Grain Size (DSDP)
3-80 (9.5, 38.1, 52.4)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 13 CORED INTERVAL: 170.5-180.0 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), olive black (5Y 2/1), greenish black (5GY 2/1), olive gray (5Y 4/1), brownish black (5YR 2/1), dark greenish gray (5GY 4/1), dark gray (N3), olive gray (5Y 2/1), dusky blue green (5BG 3/2). Moderate deformation, soft to firm. Massive.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smear 2-110)

10% Sand	4% Quartz/Feldspar
20% Silt	1% Mica
70% Clay	3% Volcanic glass
	76% Clay minerals
1% Heavy minerals	5% Diatoms
1% Radiolarians	1% Silicoflagellates
7% Sponge spicules	

MINOR LITHOLOGIES

a) VOLCANIC ASH (Smear 3-149)

98% Sand	99% Volcanic glass
1% Silt	0- 1% Clay minerals(?)
1% Clay	TR% Quartz, Feldspar
1% Opaques	TR% Glauconite

b) CLAY (Smear 1-110)

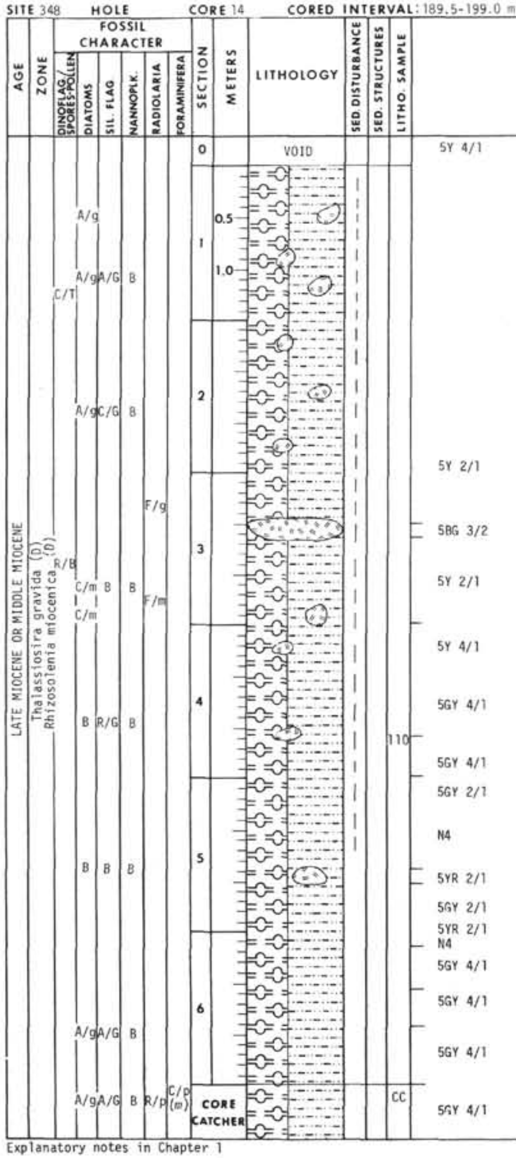
1% Sand	2% Quartz
9% Silt	3% Feldspar
90% Clay	TR% Heavy minerals
	94% Clay minerals
TR% Volcanic glass, Diatoms, Radiolarians	TR% Opaques
	1% Sponge spicules

c) ASH-RICH TRANSITIONAL SILICEOUS MUD (Smear CC)

15% Sand	5% Feldspar, Quartz
45% Silt	10% Lithics
40% Clay	30% Volcanic glass
	43% Clay minerals
5% Diatoms	3% Radiolarians
2% Sponge spicules	2% Silicoflagellates
TR% Heavy minerals (Epidote)	TR% Glauconite

Carbon-Carbonate (PP)
13-1 (top) (0.13, 0.02)
13-1 (bottom) (0.15, 0.01)

SITE 348 HOLE CORE 14 CORED INTERVAL: 189.5-199.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), olive gray (5Y 4/1), olive black (5Y 2/1), dusky blue green (5BG 3/2), dark greenish gray (5GY 2/1), medium dark gray (N4), brownish black (5YR 2/1). Little to no deformation. Soft to firm. Dominantly massive.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS SANDY MUD/MUD (Smear CC)

40% Sand	4% Quartz/Feldspar
35% Silt	TR% Mica
25% Clay	16% Clay minerals
	50% Volcanic glass
TR% Heavy minerals (Epidote)	25% Diatoms
2% Sponge spicules	3% Radiolarians

MINOR LITHOLOGY

ALTERED VOLCANIC ASH (Smear 4-110)

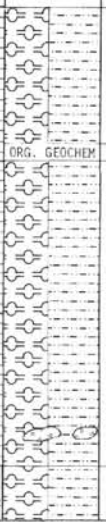
85% Sand	TR% Mica, Quartz
10% Silt	70-80% Opaques (5% Hematite, 65% Pyrite)
5% Clay	
TR% Heavy minerals(?) (Epidote)	5% Clay minerals
	10-15% Volcanic glass

Carbon-Carbonate (DSDP)
4-10 (0.4, 0.4, 0)

Grain Size (DSDP)
4-30 (8.6, 40.2, 51.2)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 15 CORED INTERVAL: 208.5-218.0 m



AGE	ZONE	FOSSIL CHARACTER: DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG.	NANNOPLK.	RADIOLARIA	FORAMINIFERA	SECTION	METERS	LITHOLOGY	SED. DISTURBANCE	SED. STRUCTURES	LITHO. SAMPLE	
LATE MIOCENE OR MIDDLE MIOCENE	(D); (S)							0		VOID				
		C/T	A/g	C/G	B			1	0.5 1.0	ORG. GEOCHEM				
			A/g	C/G	B	C/g F/m		2					73	5GY 4/1
		C/R	A/g	C/G	B			3						5YR 2/1
			A/g	C/G	B	C/m	R/m	CORE CATCHER					CC	5GY 4/1

LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), brownish black (5YR 2/1). Soft to firm, soupy to little deformation.

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smears 2-73, CC)

10-15%	Sand	1%	Glauconite
40-50%	Silt	0- 1%	Micronodules
40-55%	Clay	TR- 1%	Authigenic carbonate
3- 5%	Quartz	38-50%	Clay minerals
1- 2%	Feldspar	15-20%	Diatoms
1%	Mica	7-10%	Radiolarians
1%	Heavy minerals	7-15%	Sponge spicules
5-10%	Volcanic glass	0- 2%	Silicoflagellates
TR- 3%	Opaques		

Carbon-Carbonate (DSDP)
2-45 (0.6, 0.6, 0)

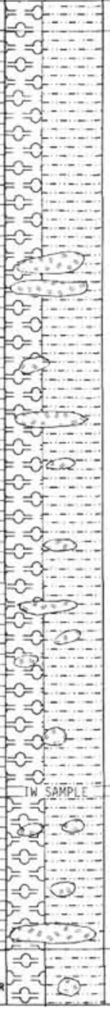
Carbon-Carbonate (PP)
15-1 (top) (0.22, 0.07)
15-1 (bottom) (0.61, 0.02)

Grain Size (DSDP)
2-45 (3.2, 38.4, 58.3)

X-Ray (PP)

2-50 (Bulk)		2-50 (<2μ)	
M	Quar.	15%	Micas
P	Plag.	9%	Kaol.
P	Pyri.	3%	Chlo.
TR%	Micas	78%	MXL (60% Mont.)
TR%	K/C		
TR%	Gyps.		

SITE 348 HOLE CORE 16 CORED INTERVAL: 227.5-237.0 m



AGE	ZONE	FOSSIL CHARACTER: DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG.	NANNOPLK.	RADIOLARIA	FORAMINIFERA	SECTION	METERS	LITHOLOGY	SED. DISTURBANCE	SED. STRUCTURES	LITHO. SAMPLE	
EARLY/MIDDLE MIOCENE	Dictyocha triacantha (S)							0						
		A/R	A/g A/g	A/G	B			1	0.5 1.0					
			A/g					2						
		C/R	A/g A/m			R/m R/g		3						
			C/m	F/G	B			4						5GY 4/1
			C/m	C/G	B			5		IW SAMPLE				
			C/m	C/G	B			6					147	5YR 2/1
			C/m	F/G	B	R/m	B	CORE CATCHER					CC	5YR 2/2

LITHOLOGIC DESCRIPTION

Colors: dusky brown (5YR 2/2), dark greenish gray (5GY 4/1), brownish black (5YR 2/1). Little or no deformation, firm.

MAJOR LITHOLOGY

ASH-RICH TRANSITIONAL SILICEOUS MUD (Smears 6-147, CC)

15-30%	Sand	2- 5%	Quartz
40-50%	Silt	1- 5%	Mica
20-45%	Clay	TR%	Heavy minerals
		5%	Opaques
10-20%	Clay minerals	15-46%	Palagonite and Volcanic glass
30%	Diatoms		
8-15%	Radiolarians		
0- 2%	Sponge spicules	0- 1%	Glauconite

Carbon-Carbonate (DSDP)
3-25 (0.6, 0.5, 0)

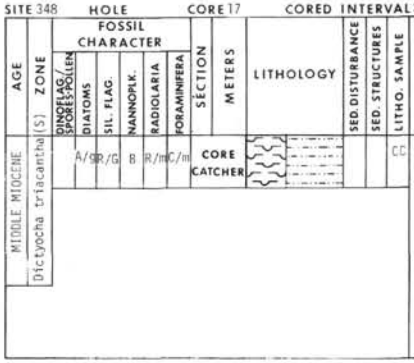
Grain Size (DSDP)
3-40 (10.8, 38.1, 51.2)

X-Ray (PP)

3-50 (Bulk)		3-50 (<2μ)	
M	Quar.	20%	Micas
P	Plag.	6%	Kaol.
P	Pyri.	6%	Chlo.
TR%	Micas	68%	MXL (60% Mont.)
TR%	K/C		

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 17 CORED INTERVAL:237.0-246.5 m



LITHOLOGIC DESCRIPTION

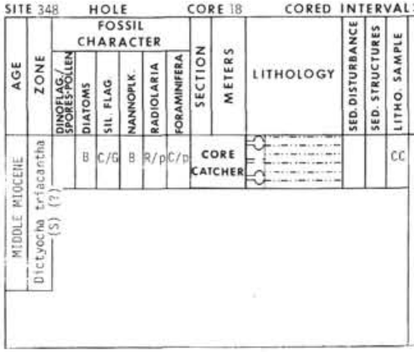
10YR 2/2 Colors: dusky yellowish brown (10YR 2/2).

MAJOR LITHOLOGY

TRANSITIONAL DIATOMACEOUS MUD (Smear CC)

5% Sand	7% Quartz
55% Silt	3% Feldspar
40% Clay	2% Opaques
	5% Volcanic glass
30% Clay minerals	TR% Micronodules
40% Diatoms	5% Radiolarians
5% Sponge spicules	2% Silicoflagellates
1% Heavy minerals (Epidote)	

SITE 348 HOLE CORE 18 CORED INTERVAL:246.5-256.0 m



LITHOLOGIC DESCRIPTION

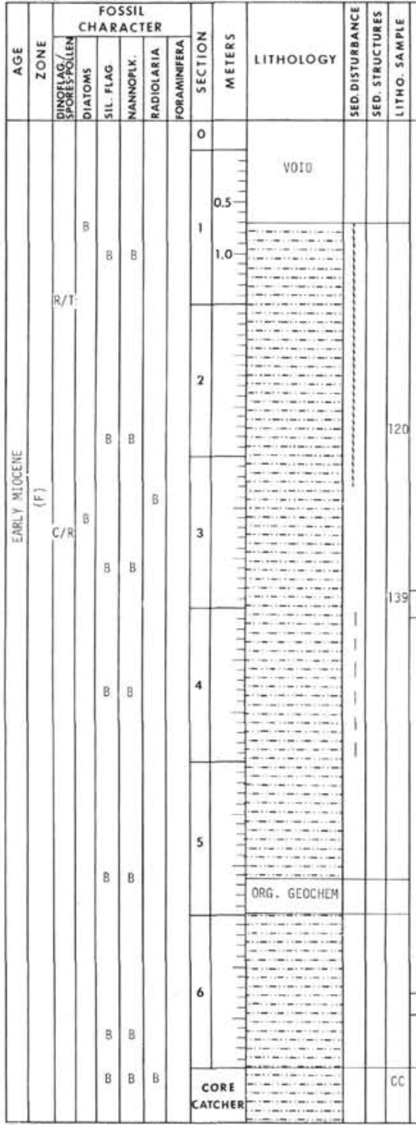
5GY 2/1 Colors: greenish black (5GY 2/1).

MAJOR LITHOLOGY

TRANSITIONAL SILICEOUS MUD (Smear CC)

5% Sand	4% Quartz
30% Silt	3% Mica
65% Clay	1% Heavy minerals (Epidote)
69% Clay minerals	5% Volcanic glass
7% Diatoms	2% Radiolarians
5% Sponge spicules	1% Glauconite
TR% Lithics (Schist)	

SITE 348 HOLE CORE 19 CORED INTERVAL:265.5-275.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), brownish black (5YR 2/1), greenish black (5GY 2/1). Soft to indurated. Intense to no deformation. Mudstone and mud intermixed. Locally bioturbated, massive.

MAJOR LITHOLOGY

MUD/MUDSTONE (Smears 2-120, 3-139, CC)

1- 5% Sand	0- 5% Quartz
14-20% Silt	0-TR% Feldspar
79% Clay	1% Mica
	TR% Heavy minerals (Epidote, Zircon, Garnet)
87-88% Clay minerals	0- 2% Volcanic glass
0-TR% Lithics	3- 7% Zeolites
0-TR% Glauconite	0- 5% Authigenic carbonate
2- 3% Opaques	0-TR% Diatoms
	0-TR% Sponge spicules

Carbon-Carbonate (DSDP)
6-15 (0.2, 0.2, 0)

Carbon-Carbonate (PP)
19-5 (top) (0.34, 0.14)
19-5 (bottom) (0.18, 0.01)

Grain Size (DSDP)
5-30 (0.5, 25.2, 74.3

X-Ray (PP)

5-20 (Bulk)		5-20 (<2μ)
P	Quar.	100% Mont.
TR%	Plag.	
P	Clin.-Heul.	

5GY 4/1

5YR 2/1

5GY 4/1

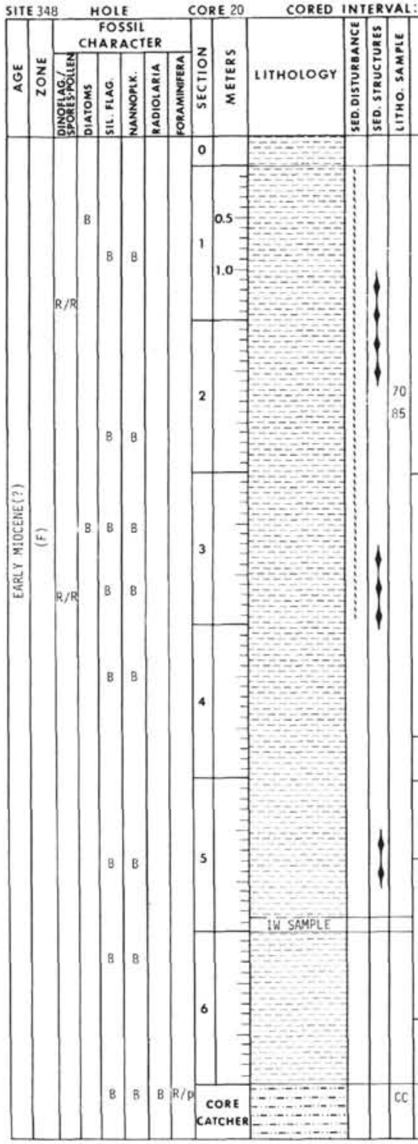
5GY 2/1

5GY 4/1

5GY 2/1

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 20 CORED INTERVAL: 275.0-284.5 m



5GY 4/1
5Y 7/2
5GY 4/1
5YR 2/1
5GY 4/1
5Y 2/1
5GY 2/1
5GY 4/1
5GY 2/1
5Y 6/1
5G 2/2

LITHOLOGIC DESCRIPTION

Colors: greenish black (5G 2/2), dark greenish gray (5GY 4/1), yellowish gray (5Y 7/2), brownish black (5YR 2/1), olive black (5Y 2/1), greenish black (5GY 2/1), light olive gray (5Y 6/1). Hard, indurated. No core deformation except breaking of rock separate fragments. Extensive bioturbation locally.

MAJOR LITHOLOGY

CLAYSTONE-CLAY (Smears 2-70, 2-85)

TR% Sand	1- 5% Quartz, Feldspar
5% Silt	0-TR% Glauconite
95% Clay	94-95% Clay minerals
0- 1% Mica	TR- 1% Authigenic carbonate
TR- 2% Opaques	TR- 1% Zeolites

MINOR LITHOLOGY

MUDSTONE (Smear CC)

TR% Sand	TR% Feldspar
20% Silt	2% Opaques
80% Clay	85% Clay minerals
	10% Zeolites
	3% Authigenic carbonate
	TR% Lithics (micrite?)

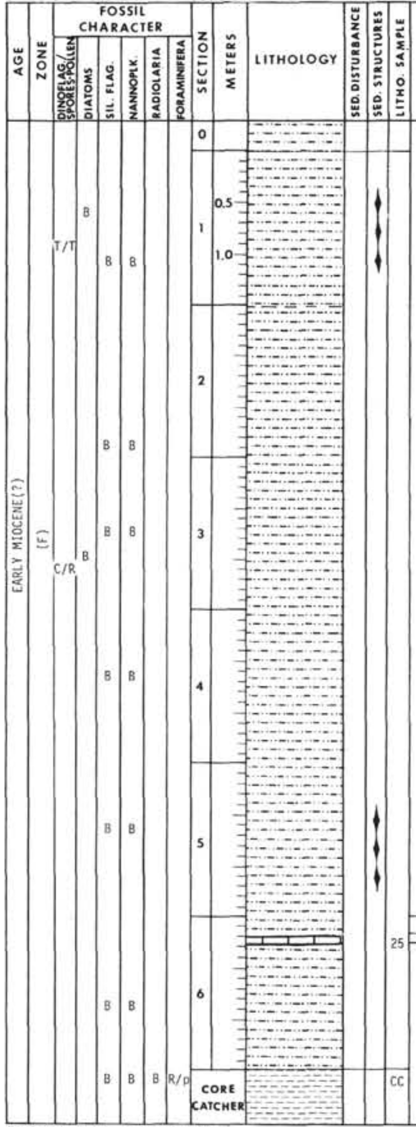
Carbon-Carbonate (DSDP)
2-45 (0.3, 0.2, 1)

Grain Size (DSDP)
2-40 (0.2, 28.3, 71.5)

X-Ray (PP)

2-50 (Bulk)	2-50 (<2μ)
P Quar.	100% MXL (80% Mont.)
P Plag.	

SITE 348 HOLE CORE 21 CORED INTERVAL: 284.5-294.0 m



5GY 2/1 +
5GY 4/1
5GY 4/1
5YR 2/1,
5GY 2/1
5YR 4/1
5GY 4/1
5Y 2/1

LITHOLOGIC DESCRIPTION

Colors: olive black (5Y 2/1), greenish black (5GY 2/1), dark greenish gray (5GY 4/1), brownish black (5YR 2/1), brownish gray (5YR 4/1). Some mudstone, single thin layer of limestone. Undeformed, indurated. Extensive bioturbation. Limestone may be concretionary unit.

MAJOR LITHOLOGY

CLAYSTONE (Smear CC)

10% Silt	96% Clay minerals
90% Clay	TR% Feldspar
	1% Mica
	TR% Heavy minerals (Epidote)
	3% Zeolites
	TR% Authigenic carbonate

MINOR LITHOLOGY

LIMESTONE (Smear 6-25)

30% Sand	89% Carbonate
60% Silt	10% Clay minerals
10% Clay	1% Lithics (Micrite)

Carbon-Carbonate (DSDP)
2-90 (0.3, 0.2, 0)

Carbon-Carbonate (PP)
21-5 (top) (0.08, 0.08)
21-5 (bottom) (0.14, 0.53)

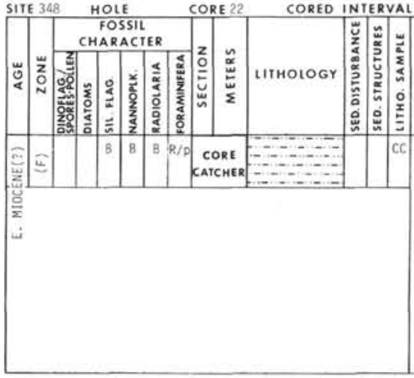
Grain Size (DSDP)
2-120 (0.2, 28.7, 71.1)

X-Ray (PP)

2-124 (Bulk)	2-124 (<2μ)
A Quar.	100% MXL (80% Mont.)
P Plag.	

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 22 CORED INTERVAL: 303.5-313.0 m



LITHOLOGIC DESCRIPTION

5GY 2/1

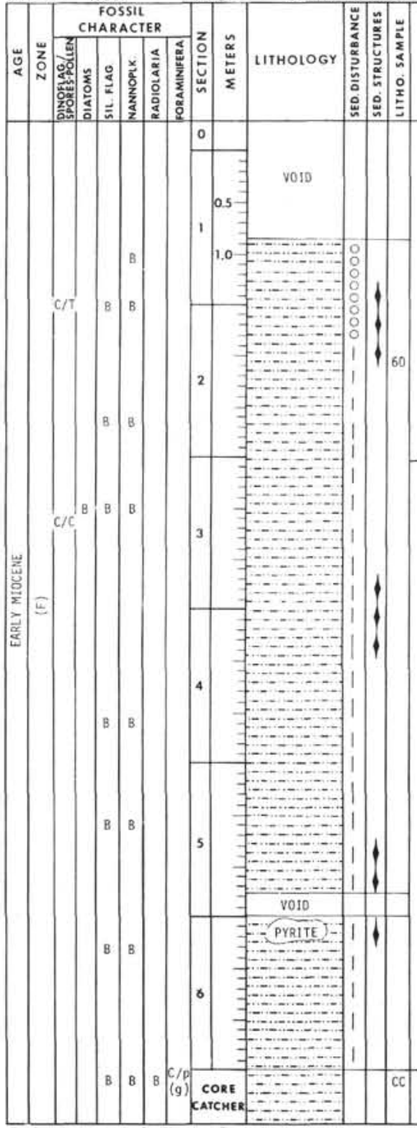
Color: greenish black (5GY 2/1).

MAJOR LITHOLOGY

MUDSTONE (Smear CC)

5% Sand	1% Quartz
25% Silt	4% Feldspar
70% Clay	2% Mica
	1% Heavy minerals (Epidote)
	7% Opaque minerals
	80% Clay minerals
	1% Glauconite
	TR% Lithics
	1% Zeolites
	3% Authigenic carbonate

SITE 348 HOLE CORE 23 CORED INTERVAL: 322.5-332.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), olive gray (5Y 3/2), grayish olive (10Y 4/2). Indurated, essentially undeformed except for drilling breccia at top of core and rotation of broken lithified blocks in core barrel. Bioturbated, massive. Pyrite nodule at 6-11.

MAJOR LITHOLOGY

5Y 3/2

MUDSTONE (Smears 2-60, CC)

10-15% Sand	5- 6% Quartz
20-30% Silt	11-25% Feldspar
50-70% Clay	2% Mica
	2% Heavy minerals (Epidote, Garnet, Zircon, Clinopyroxene, Rutile?)
	1- 5% Opaques
	50-75% Clay minerals
	TR- 1% Glauconite
	TR% Zeolites
	0-TR% Authigenic carbonate
	3-10% Lithics (Chert, Orthoquartzite, Basalt, Schist)
	0-TR% Nannofossils

10Y 4/2

10Y 4/2

10G 4/2

Carbon-Carbonate (DSDP)
3-70 (0.4, 0.3, 0)

Carbon-Carbonate (PP)
23-5 (top) (0.47, 0.03)
23-5 (bottom) (0.58, 0.03)

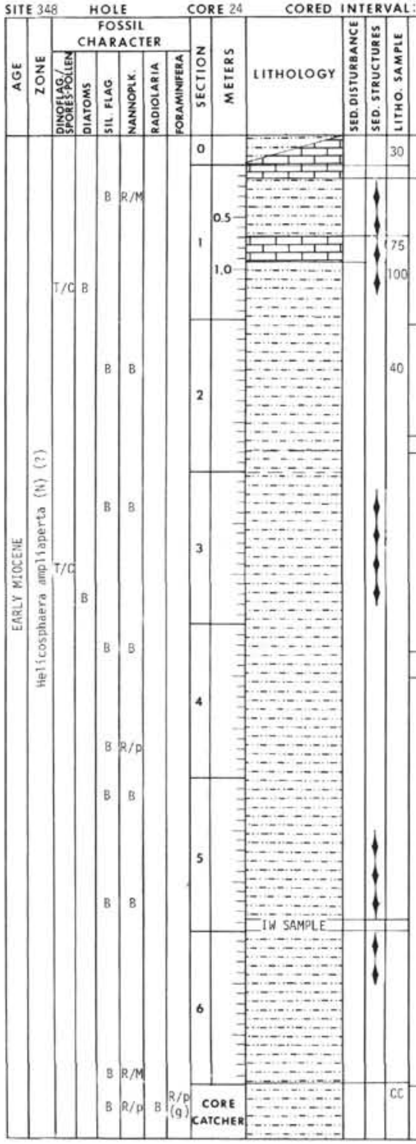
Grain Size (DSDP)
3-74 (4.1, 36.5, 59.5)

N3

5GY 4/1

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 24 CORED INTERVAL:341.5-351.0 m



10Y 4/2
N4
N4

Colors: grayish olive (10Y 4/2), medium dark gray (N4), olive gray (5Y 4/1), olive gray (5Y 3/2), dark greenish gray (5GY 2/1). Indurated, no deformation. Abundant calcareous zones and a limestone in 0 section. Extensively bioturbated.

5Y 4/1
5Y 3/2
5Y 4/1
5Y 3/2
5Y 4/1
5Y 3/2
5GY 2/1

MAJOR LITHOLOGY

MUDSTONE (Smears 1-100, 2-40, CC)

7-20% Sand	7- 9% Quartz
20-40% Silt	15-35% Feldspar
40-65% Clay	2- 7% Mica
	2- 3% Heavy minerals
	2- 5% Opaques
	TR% Glauconite
	5-15% Lithics
	40-55% Clay minerals
	0-TR% Authigenic carbonate, Foraminifera, Nannofossils

MINOR LITHOLOGY

LIMESTONE (Smears 0-30, 1-75)
2- 5% Quartz
0-10% Clay minerals
0-TR% Glauconite
88-95% Carbonate
0-TR% Mica, Heavy minerals
TR% Lithics (Chert)

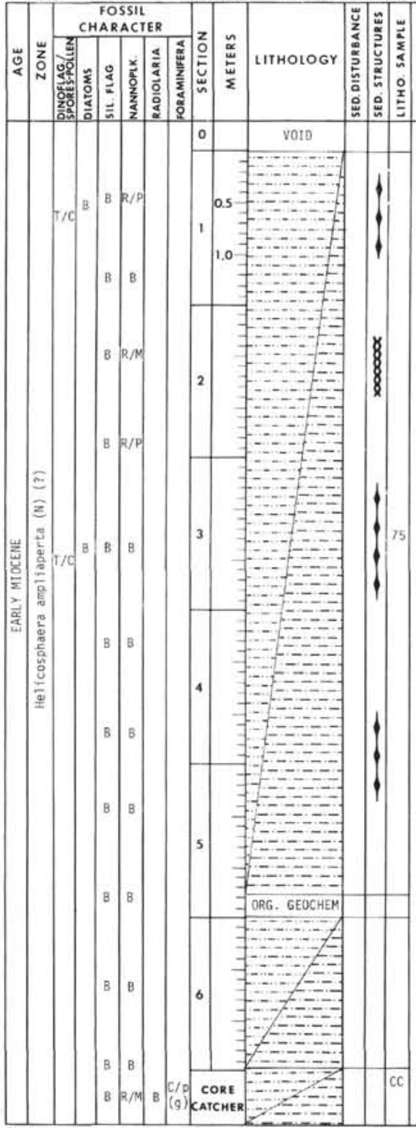
Carbon-Carbonate (DSDP)
3-56 (0.7, 0.6, 1)

Grain Size (DSDP)
3-50 (7.2, 49.2, 43.6)

X-Ray (PP)

3-99 (Bulk)		3-99 (<2μ)	
M	Quar.	9%	Micas
P	Plag.	4%	Kaol.
TR%	Pyri.	4%	Chlo.
P	Micas	83%	MXL (90% Mont.)
TR%	K/C		

SITE 348 HOLE CORE 25 CORED INTERVAL:370.0-374.5 m



Colors: olive gray (5Y 3/2) with some grayish black (N2) streaks. Indurated, no deformation. Abundant bioturbation, worm tubes, and scattered lithic pebbles (quartz, chert, claystone). Massive. Abundant pyrite.

5Y 3/2
N2

MAJOR LITHOLOGY

MUDSTONE (Smears 3-75, CC)

10-15% Sand	4% Quartz
25-30% Silt	12-20% Feldspar
40-60% Clay	2-10% Mica
	1- 2% Heavy minerals
	2- 5% Opaques
	TR% Glauconite
	0-TR% Zeolites
	1- 2% Authigenic carbonate
	10% Lithics (Chert, Quartzite)
	55-65% Clay minerals
	0-TR% Foraminifera, Diatoms

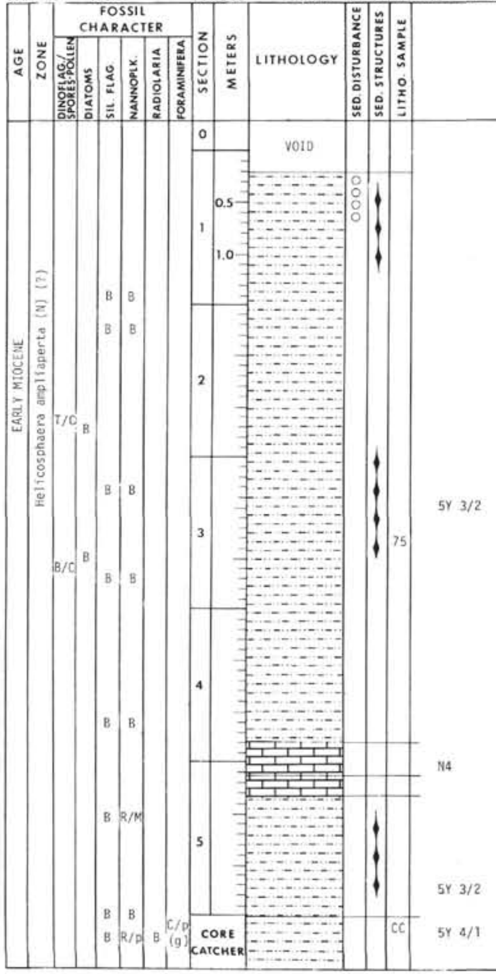
Carbon-Carbonate (DSDP)
4-106 (0.7, 0.6, 1)

Carbon-Carbonate (PP)
25-5 (top) (0.69, 0.03)
25-5 (bottom) (0.64, 0.03)

Grain Size (DSDP)
4-103 (7.8, 55.6, 36.6)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 26 CORED INTERVAL:398.5-408.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), olive gray (5Y 3/2), medium dark gray (N4). Undeformed, lithified. Abundant worm tubes, pyrite, bioturbation. Massive. Minor limestone at 4-130 to 5-30.

MAJOR LITHOLOGY

MUDSTONE (Smear 3-75)

10% Sand	12% Quartz
30% Silt	8% Feldspar
60% Clay	5% Mica
	1% Heavy minerals (Epidote, Zircon)
	2% Opaques
	1% Zeolites
	2% Carbonate
	70% Clay minerals

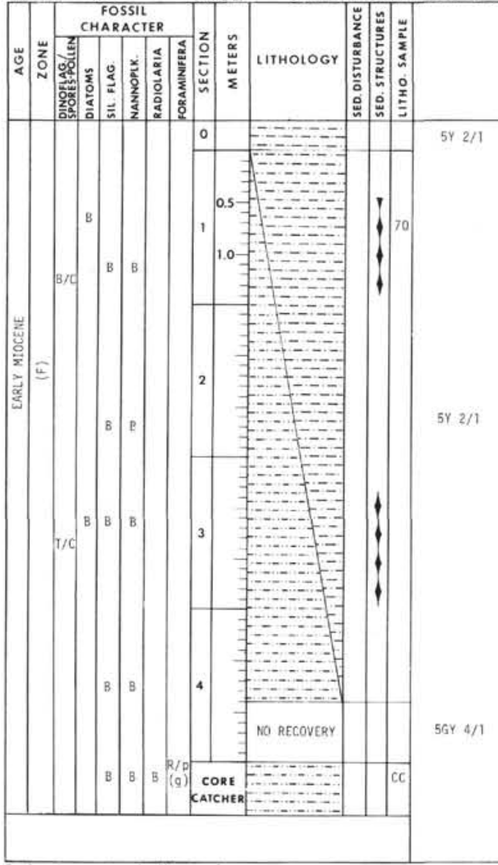
Carbon-Carbonate (DSDP)
3-14 (0.7, 0.6, 1)

Grain Size (DSDP)
3-41 (12.7, 57.3, 30.1)

X-Ray (PP)

3-29 (Bulk)		3-29 (<2μ)	
M	Quar.	4%	Micas
P	Plag.	94%	MXL (60% Mont.)
TR%	Pyri.	2%	K/C
P	Micas		
P	K/C		

SITE 348 HOLE CORE 27 CORED INTERVAL:427.0-436.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 2/1), dark greenish gray (5GY 4/1). Little or no core deformation. Indurated. Abundant bioturbation, pyrite nodules. Scattered foraminifera and locally fine pebbles. Worm tubes(?).

MAJOR LITHOLOGIES

a) MUDSTONE (Smear CC)

5% Sand	2% Glauconite
15% Silt	3% Authigenic carbonate
80% Clay	1% Mica
3% Quartz	TR% Foraminifera
2% Feldspar	1% Sponge spicules
1% Heavy minerals (Epidote)	75% Clay minerals
2% Volcanic glass	5% Nannofossils
3% Radiolarians	2% Diatoms

b) SANDY MUDSTONE (Smear 1-70)

35% Sand	TR% Zeolite, Glauconite
25% Silt	3% Opaques
40% Clay	50% Clay minerals
12% Quartz	10% Lithics (Chert, Basalt, Quartz)
10% Feldspar	1% Authigenic carbonate
7% Mica	
5% Heavy minerals (Epidote, Zircon, Orthopyroxene)	

NOTE: Long break (almost 24 hrs.) between Cores 26 and 27, therefore may be contamination in Core 27.

Carbon-Carbonate (DSDP)
2-42 (0.7, 0.6, 1)

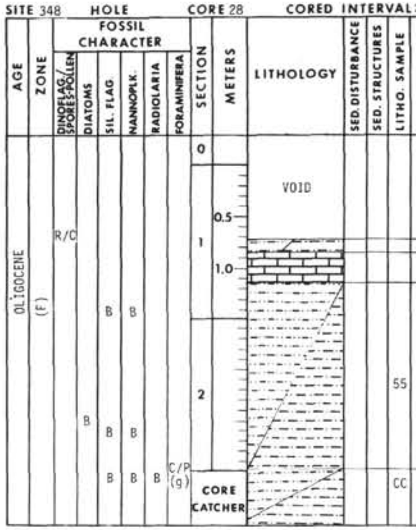
Grain Size (DSDP)
2-16 (11.5, 53.0, 35.5)

X-Ray (PP)

2-116 (Bulk)		2-116 (<2μ)	
M	Quar.	2%	Micas
P	Plag.	97%	MXL (80% Mont.)
TR%	Pyri.	1%	K/C
P	Micas		
TR%	K/C		

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 28 CORED INTERVAL: 446.0-455.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2), medium dark gray (N4). Massive. No deformation. Indurated. Locally abundant bioturbation. Scattered pyrite nodules. Locally very calcareous at 1-100, probably concretions rather than beds. Worm tubes(?).

5Y 3/2
N4
5Y 3/2

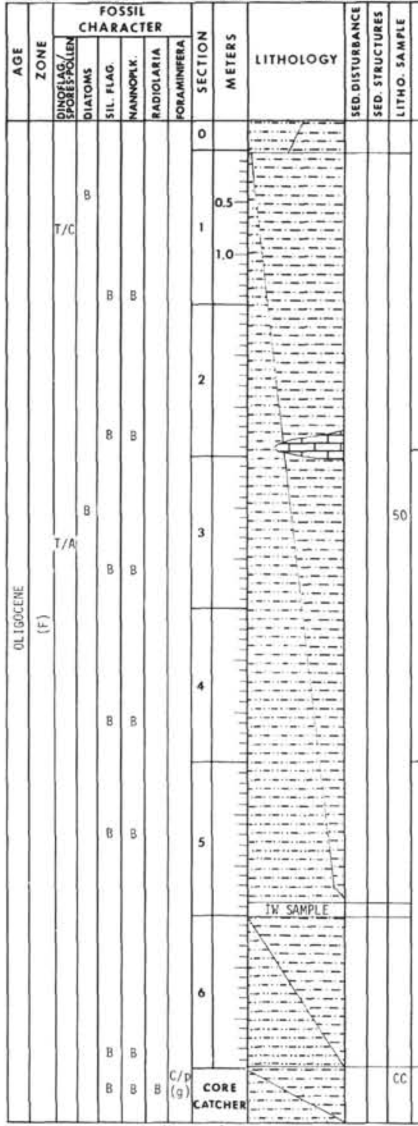
MAJOR LITHOLOGY

MUDSTONE-SANDY MUDSTONE (Smears 2-55, CC)

25-40% Sand	3- 5% Opaques
30-40% Silt	20-45% Clay minerals
20-45% Clay	10% Lithics
	1% Glauconite
8-10% Quartz	TR- 1% Carbonate (Authigenic)
24-50% Feldspar	
3- 5% Mica	0-TR% Zeolites
2% Heavy minerals (Epidote, Garnet, Hbde., Pyroxenes, Zircon)	

5Y 3/2

SITE 348 HOLE CORE 29 CORED INTERVAL: 484.0-493.5 m



LITHOLOGIC DESCRIPTION

5Y 3/2

Colors: olive gray (5Y 3/2), olive gray (5Y 3/2). No deformation, undurated. Extensive bioturbation. Scattered pryite nodules. Locally calcareous, massive. Scattered fine pebbles and worm tubes(?).

MAJOR LITHOLOGY

MUDSTONE/SANDY MUDSTONE (Smears 3-50, CC)

10-31% Sand	2% Mica
20-29% Silt	1% Heavy minerals (Epidote, Hbde., Ortho-pyrozene, Zircon)
40-70% Clay	
12-25% Quartz	
8-15% Feldspar	2- 3% Opaques
TR% Glauconite, Authigenic carbonate	40-69% Clay minerals
	5-15% Lithics (Chert, Quartzites)
0-TR% Detrital carbonate	

5Y 3/2

Carbon-Carbonate (DSDP)
4-16 (0.9, 0.8, 1)

Carbon-Carbonate (PP)
29-0 (top) (0.48, 0.05)
29-0 (bottom) (0.84, 0.06)

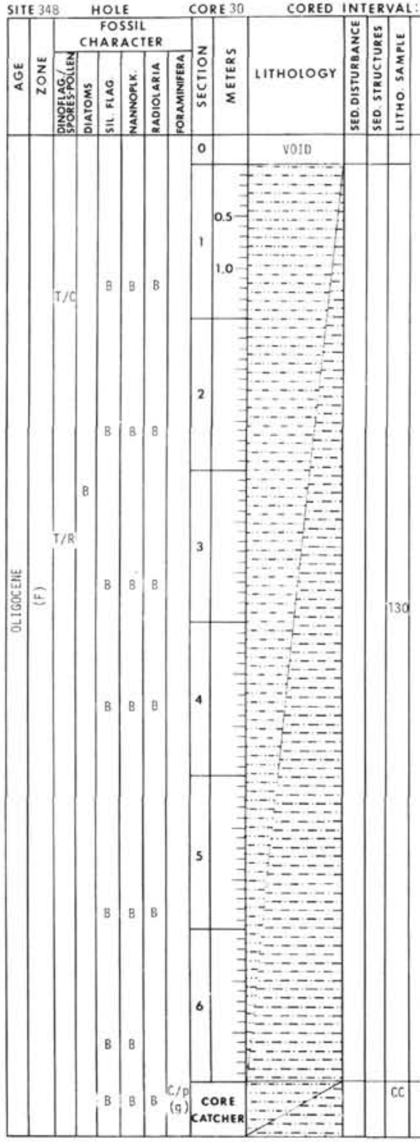
Grain Size (DSDP)
4-86 (5.4, 55.5, 39.1)

5Y 4/1

5Y 3/2

Explanatory notes in Chapter 1

SITE 348 **HOLE** **CORE** 30 **CORED INTERVAL**: 503.0-512.5 m



5Y 4/1

5Y 4/1

5Y 3/2

LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), olive gray (5Y 3/2). No deformation, indurated. Massive, locally thinly laminated and extensively bioturbated. Scattered pebbles, pyrite nodules, worm tubes(?).

MAJOR LITHOLOGY

MUDSTONE (Smears 3-130, CC)
10-25% Sand
25-28% Silt
53-65% Clay

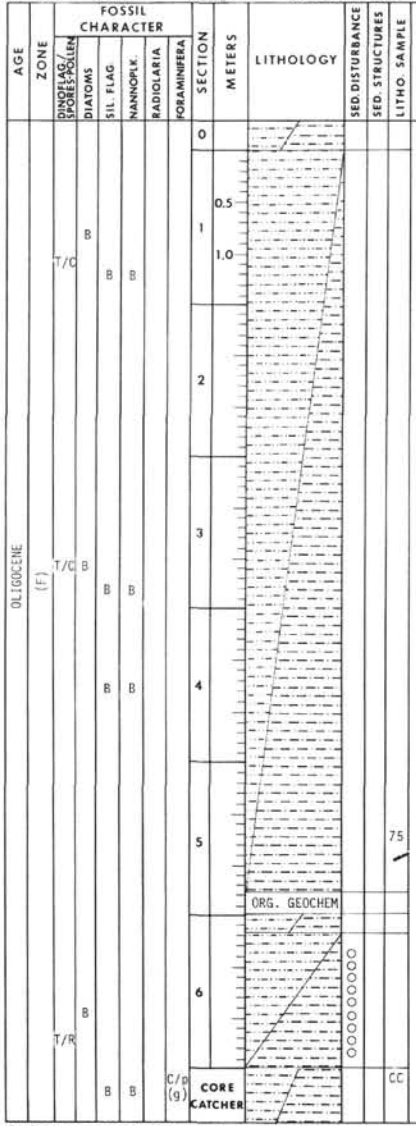
16-25% Quartz
10-21% Feldspar
2- 5% Mica
0- 5% Lithics (Chert, Basalt)
49-65% Clay minerals
TR- 1% Heavy minerals (Epidote, Orthopyroxene, Zircon)
2- 7% Opaques
0- 1% Volcanic glass
TR% Glauconite, Authigenic carbonate

Carbon-Carbonate (DSDP)
3-39 (0.7, 0.6, 0)

X-Ray (PP)

3-48 (Bulk)		3-48 (<2μ)	
M	Quar.	1%	Micas
P	Plag.	98%	MXL (70% Mont.)
TR%	Pyri.	1%	K/C
P	Micas		
TR%	K/C		
TR%	Gyps.		

SITE 348 **HOLE** **CORE** 31 **CORED INTERVAL**: 512.5-522.0 m



5Y 4/1

5Y 4/1

5Y 4/1

5Y 3/2

LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), olive gray (5Y 3/2). Massive, no deformation, indurated, soupy in lower part of Sec. 6. Scattered pebbles of basalt(?), pyrite nodules, worm tubes.

MAJOR LITHOLOGY

MUDSTONE (Smear 5-75, CC)
10-15% Sand
20-40% Silt
45-75% Clay
8-20% Quartz
4-15% Feldspar
5-10% Mica
1% Heavy minerals (Epidote, Hbde., Zircon)
2- 7% Opaques
45-70% Clay minerals
TR- 1% Glauconite
1- 5% Authigenic carbonate
TR- 5% Lithics (Cherts, Metaquartzite)

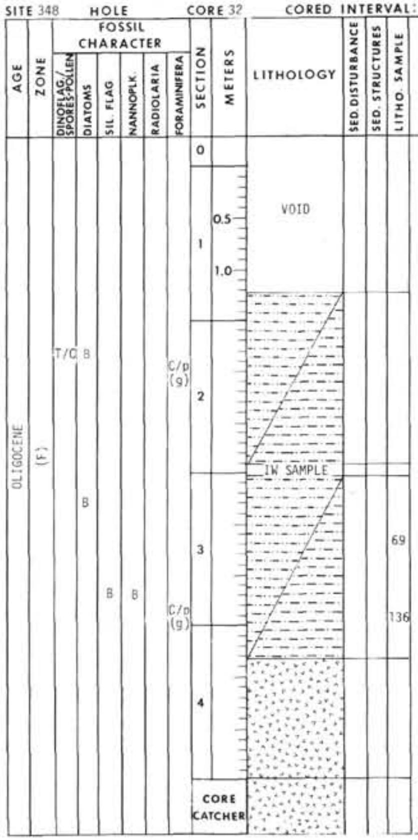
Carbon-Carbonate (DSDP)
3-68 (0.4, 0.3, 0)

Carbon-Carbonate (PP)
31-5 (top) (0.52, 0.03)
31-5 (bottom) (0.66, 0.02)

Grain Size (DSDP)
3-102 (5.5, 48.7, 45.8)

Explanatory notes in Chapter 1

SITE 348 HOLE CORE 32 CORED INTERVAL:522.0-531.5 m



5Y 3/2

LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2). Mudstone with burrows, pyrite nodules, heavy mineral bands, worm tubes. Lithified, no core deformation. Scattered basalt, chert, lithic pebbles.

MAJOR LITHOLOGY

MUDSTONE (Smears 3-69, 3-136)

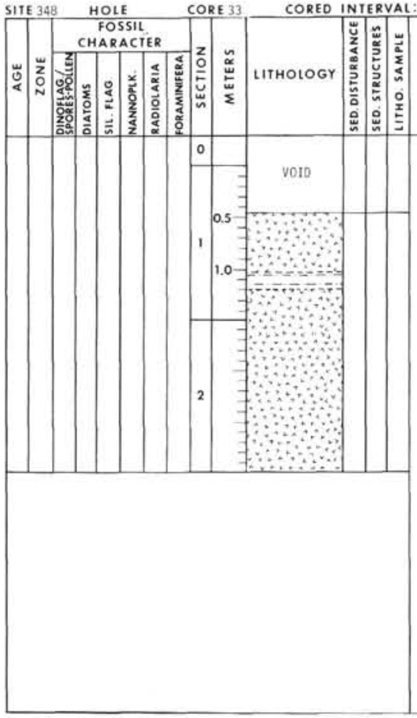
15% Sand	5- 7% Quartz
40% Silt	19-23% Feldspar
45% Clay	3- 7% Mica
	1- 5% Heavy minerals (Epidote, Clinopyroxene, Garnet, Zircon)
	15% Lithics
	0- 3% Volcanic glass
	45% Clay minerals
	2% Opaque minerals
	0- 1% Authigenic? carbonate
	0-TR% Zeolites

BASALT

Sec. 4 (0-35 cm) - sandy mudstone. Olive gray to olive black with mica sheets; (35-150 cm) - dark gray (N3) to grayish black (N2) fine grained variolitic hyalobasalt with slickensides and veins, filled by black chlorite, pyrite and white calcite. Chlorite-calcite veins.

Thin Section - variolitic hyalobasalt plagioclase-30%, pyroxene-30%, altered glass-40%, smectite(?), chlorite, calcite, altered olivine, phenocrysts-2%. Above represents 36-38 cm. Lower, basalt with ophitic, subophitic, doleritic texture, plagioclase (An_{68}) 35-40%, augite 40-50%, altered olivine-3%, magnetite-1%, pyrite-3%, smectite(?), chlorite, calcite, amphibole.

SITE 348 HOLE CORE 33 CORED INTERVAL:531.5-541.0 m



LITHOLOGIC DESCRIPTION

BASALT

Sec. 1 (45-110 cm) - medium dark gray (N4) to dark gray (N3) fine grained basalt with thin chlorite-calcite veins and slickensides; (110-125 cm) - olive gray (5Y 4/1) sandy mudstone with mica sheets and small pyrite crystals; (125-150 cm) - basalt as above, but near the contact with mudstone is aphanitic with thin green chlorite veins.

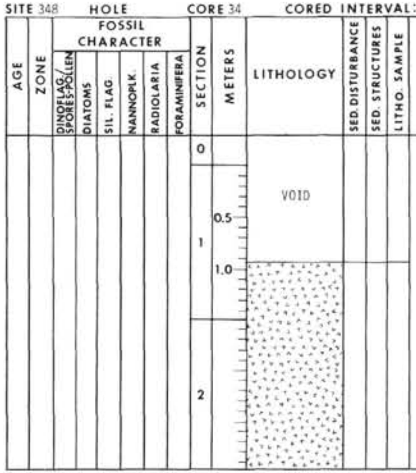
Thin Section (56-59, 102-105, 145-148) - ophitic, doleritic, subophitic textures, plagioclase (labradorite) 35-45%, augite 45-60%, altered olivine-3%, smectite, chlorite, amphibole, calcite; (118-119, 126-129 cm) - variolitic with skeletal plagioclase laths-35%, pyroxene variolites 30-35%, altered glass-30%, smectite, chlorite, calcite.

Sec. 2 (0-125 cm) - grayish black (N2) to black (N1) fine grained aphyric homogeneous basalt. Large (1 cm) crystals of calcite. Calcite veins with pyrite and black chlorite; (75-125 cm) - medium grained doleritic micro-doleretic basalt; (125-150 cm) - calcite-chlorite-pyrite veins. On veins there are large calcite crystals.

Thin Section - dolerite basalt, doleritic, ophitic, subophitic texture, fine-medium grained, holocrystalline. Plagioclase (labradorite (An_{66}) 30-45%, augite 40-55%, altered olivine-3%, smectite, chlorite, calcite, amphibole, pyrite(2), magnetite-1%.

Sec. 3 (85-150 cm) - basalt as above, but coarse. Rare thin branching black chlorite veins (0.1-1 mm) and slickensides with black chlorite.

SITE 348 HOLE CORE 34 CORED INTERVAL:541.0-544.0 m



LITHOLOGIC DESCRIPTION

BASALT

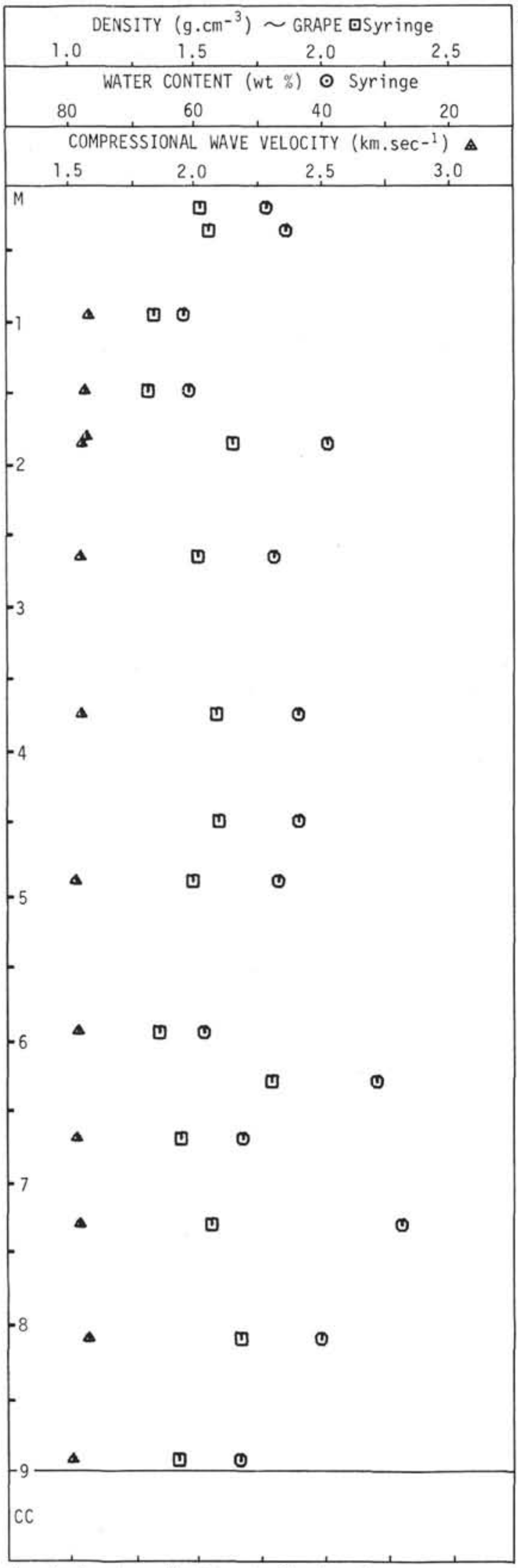
Sec. 1

Thin Section - basalt with doleritic, ophitic, subophitic textures, medium-fine grained, halocrystalline. Plagioclase (labradorite) 30-45%, augite 40-60%, altered olivine 10-30%, smectite, chlorite, amphibole, pyrite, magnetite.

Sec. 2 (0-15 cm) - dark gray (N3) amygdaloidal basalt. Amygdules (10-15%) of chlorite-smectite. Calcite veins with pyrite. Some mylonitized basalt with rare (3-5%) amygdules; (75-80 cm) - myloniteu basalt and calcite veins with pyrite and chlorite; (75-150 cm) - calcite amygdules in amygdaloidal basalt.

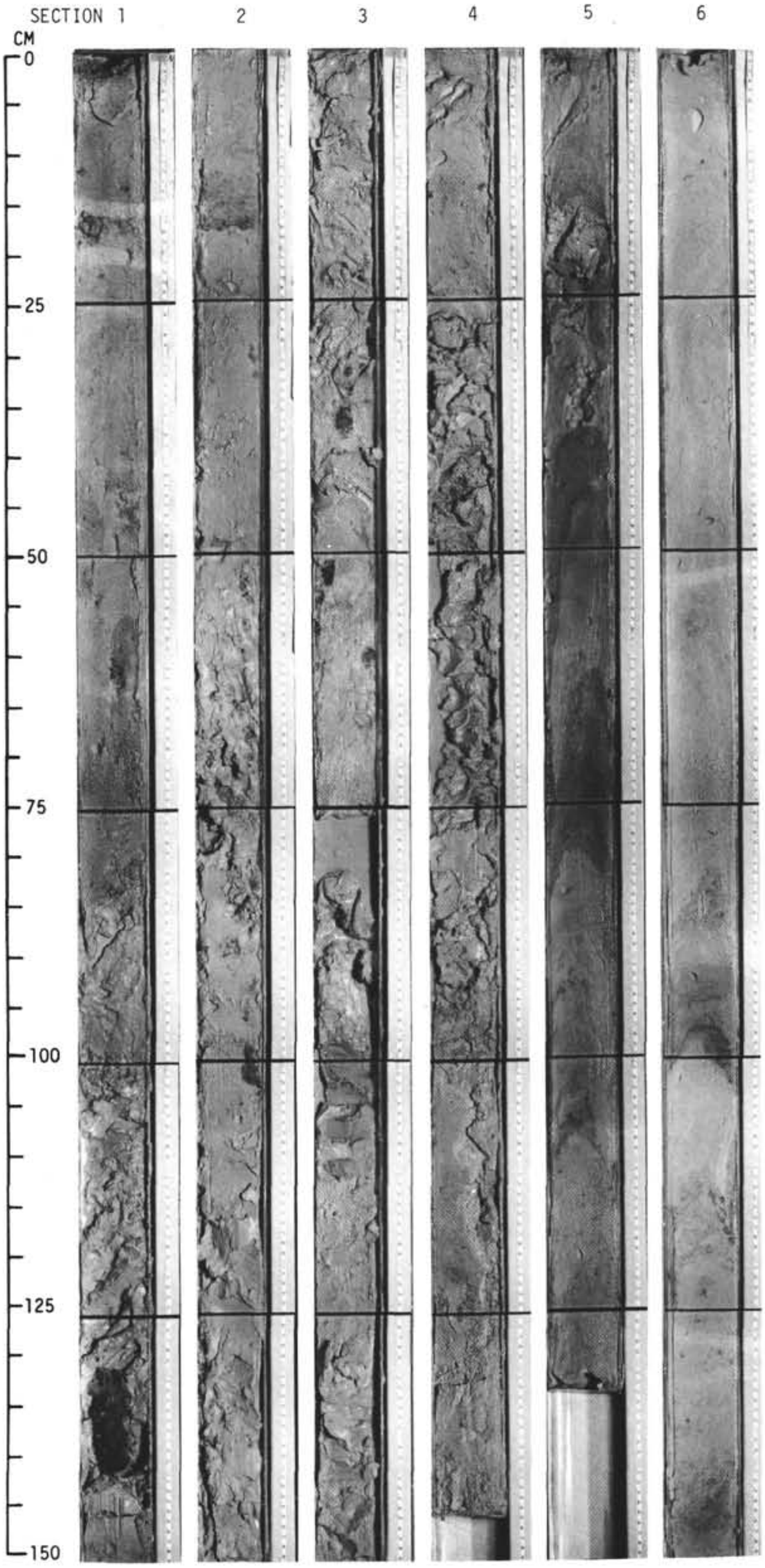
Thin Section - subophitic texture plagioclase 30-40%, pyroxene 45-60%, altered olivine-2%, smectite, chlorite, amphibole.

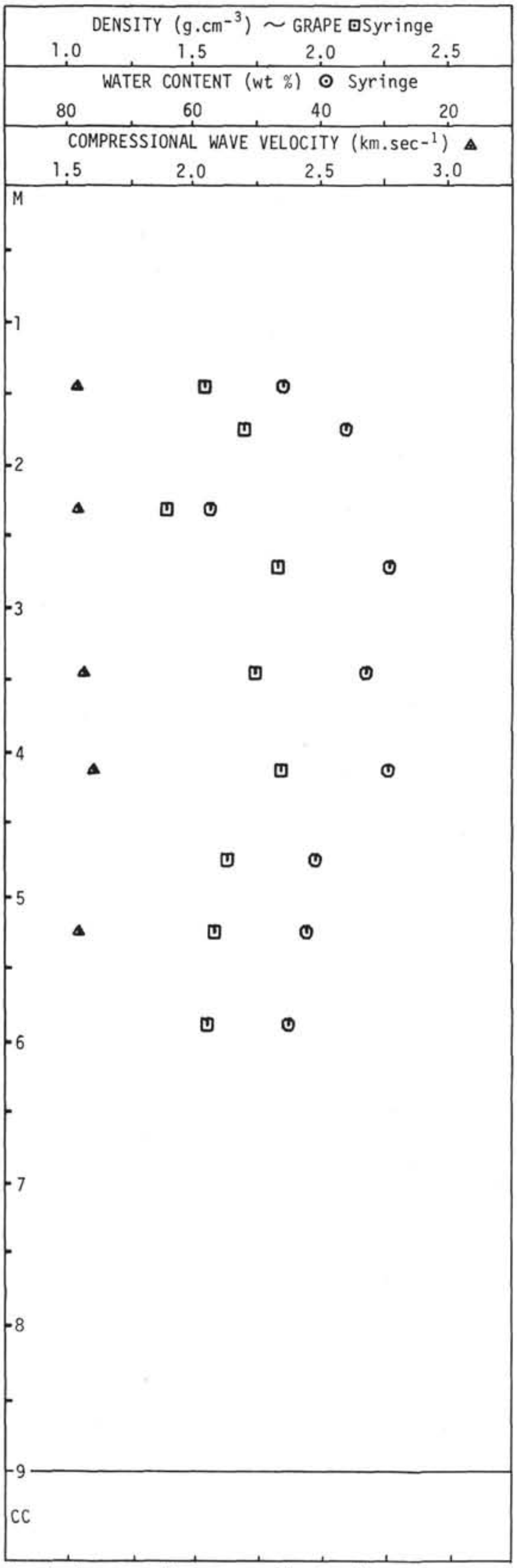
Explanatory notes in Chapter 1



For Explanatory Notes, see Chapter 1

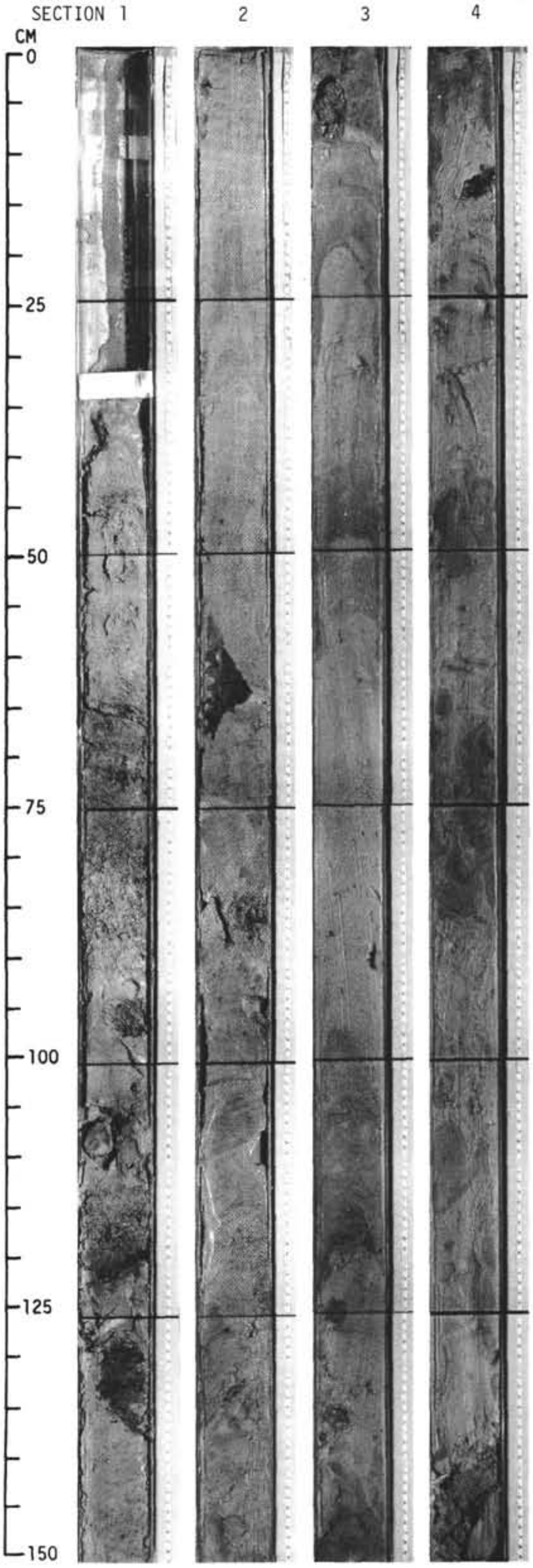
348-1

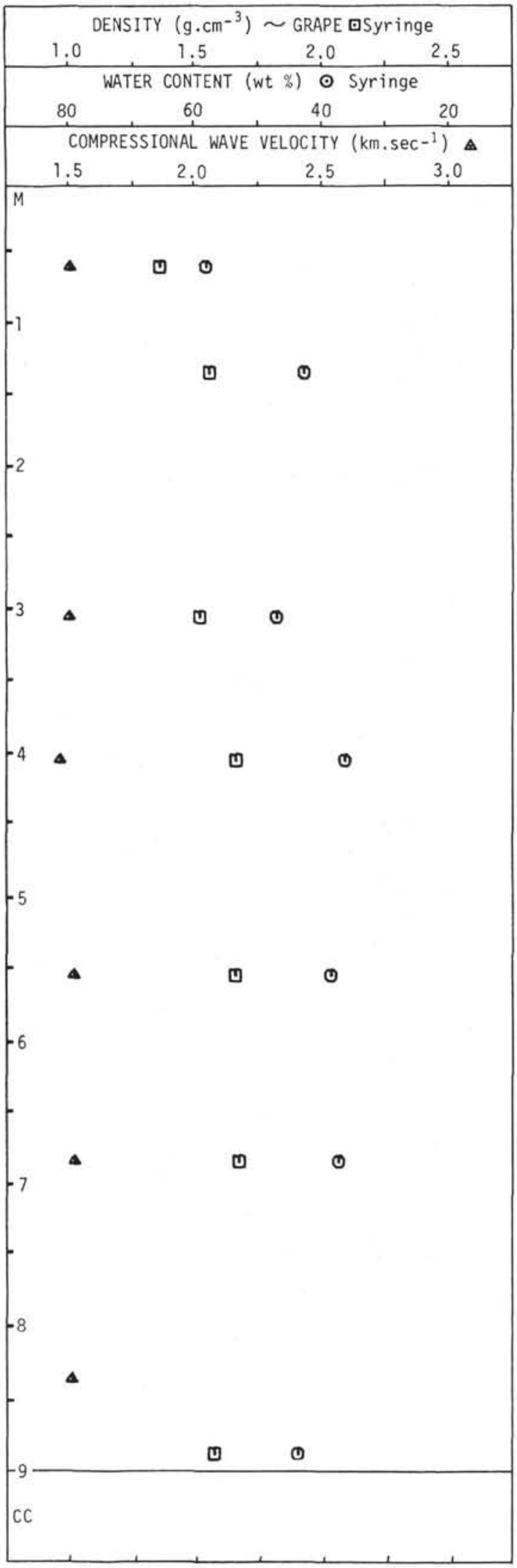




For Explanatory Notes, see Chapter 1

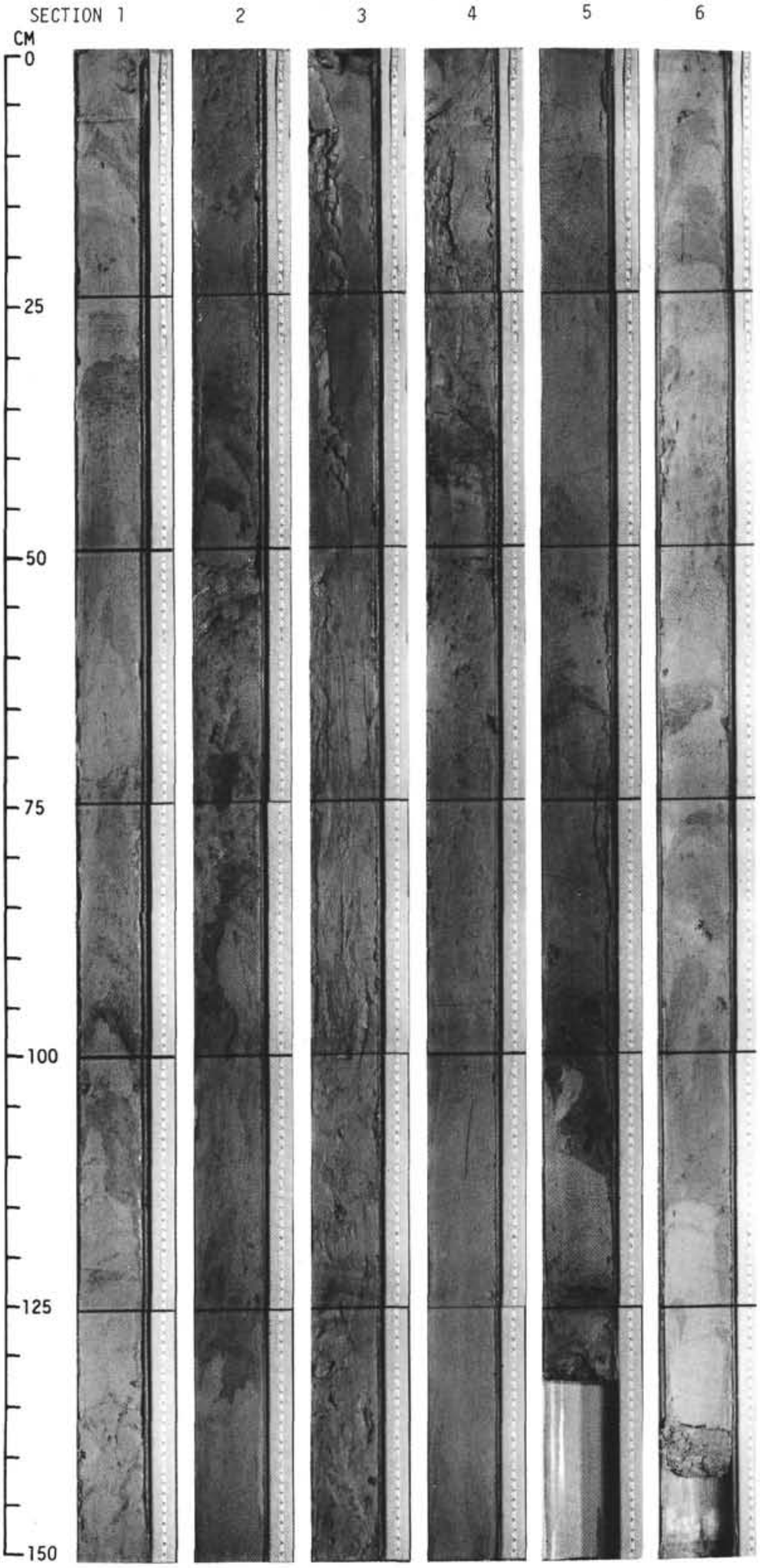
348-2

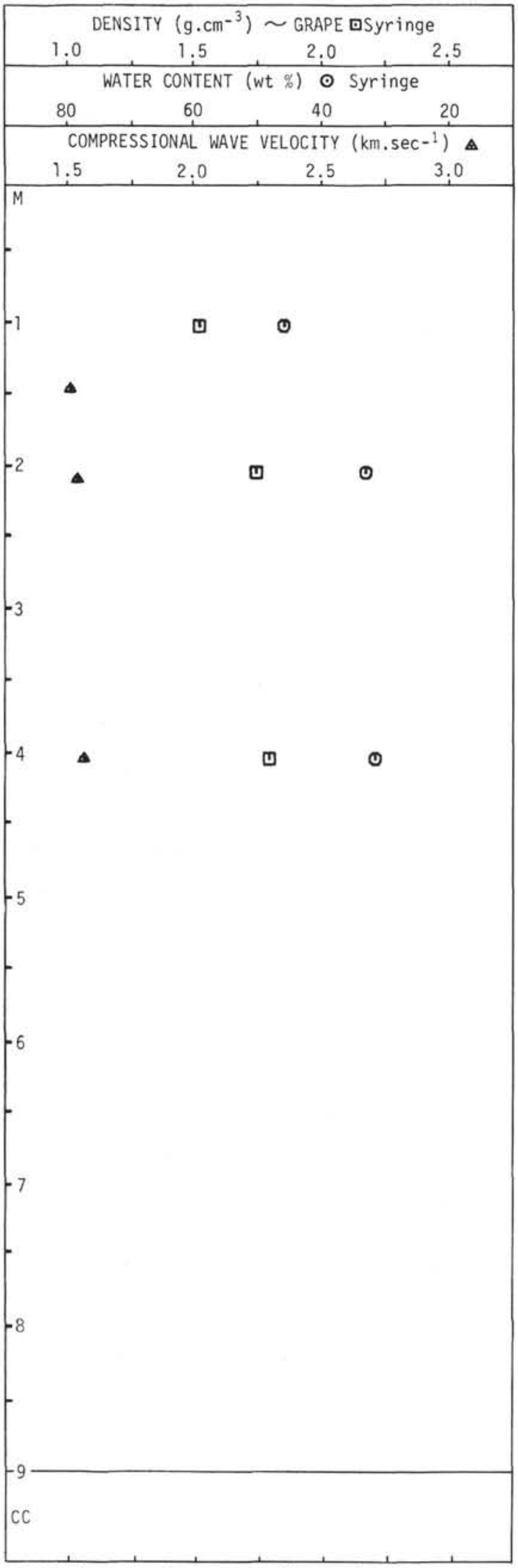




For Explanatory Notes, see Chapter 1

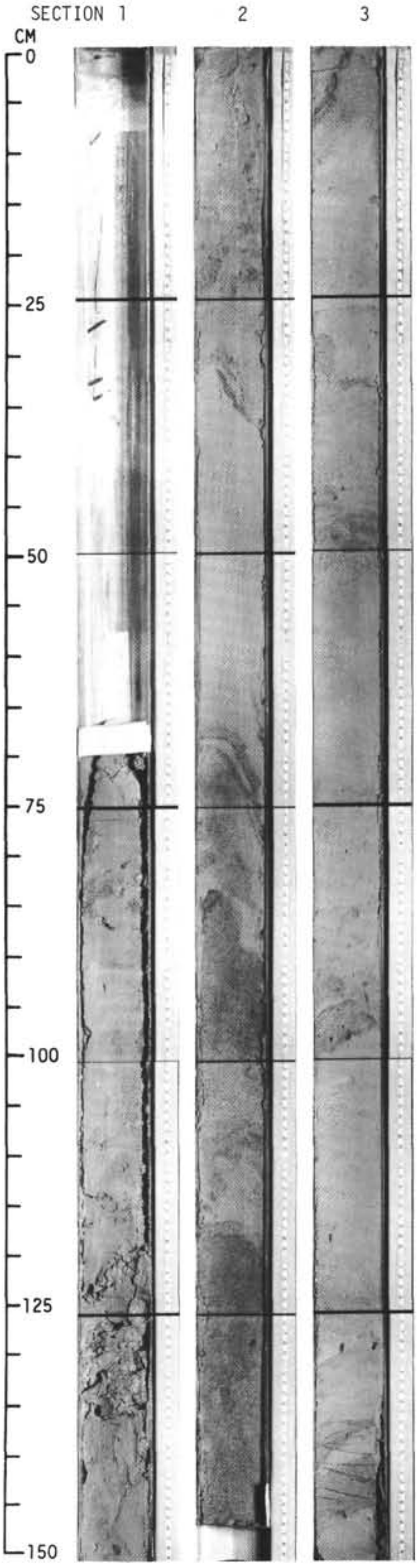
348-3

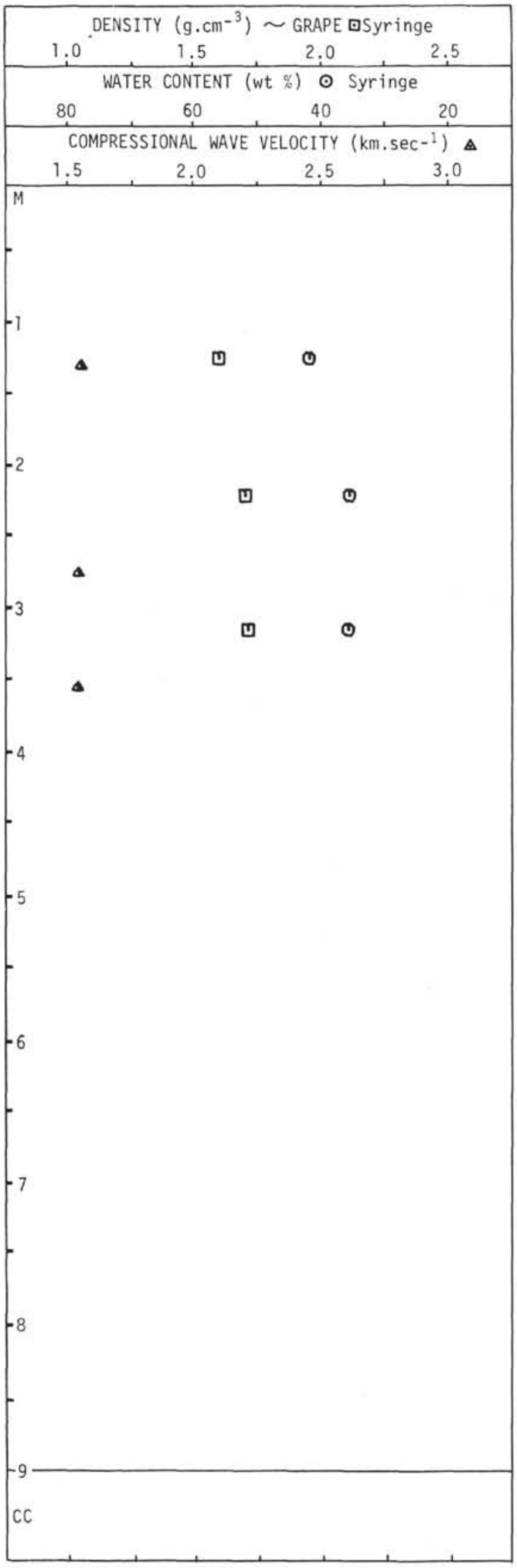




For Explanatory Notes, see Chapter 1

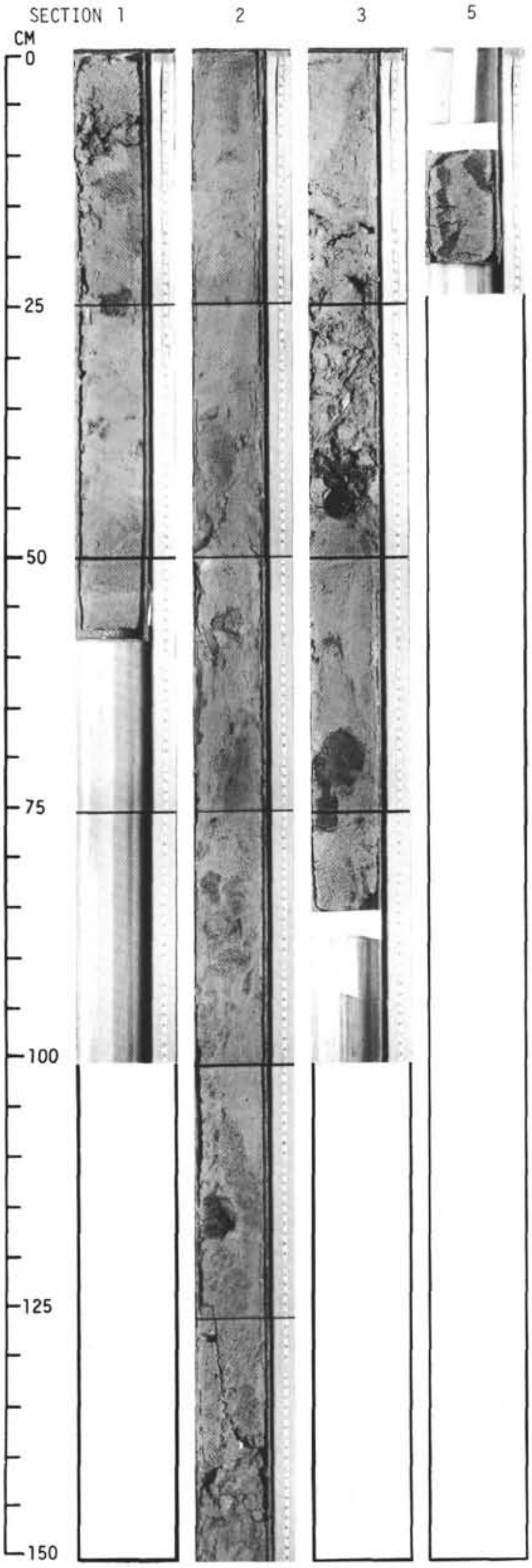
348-4

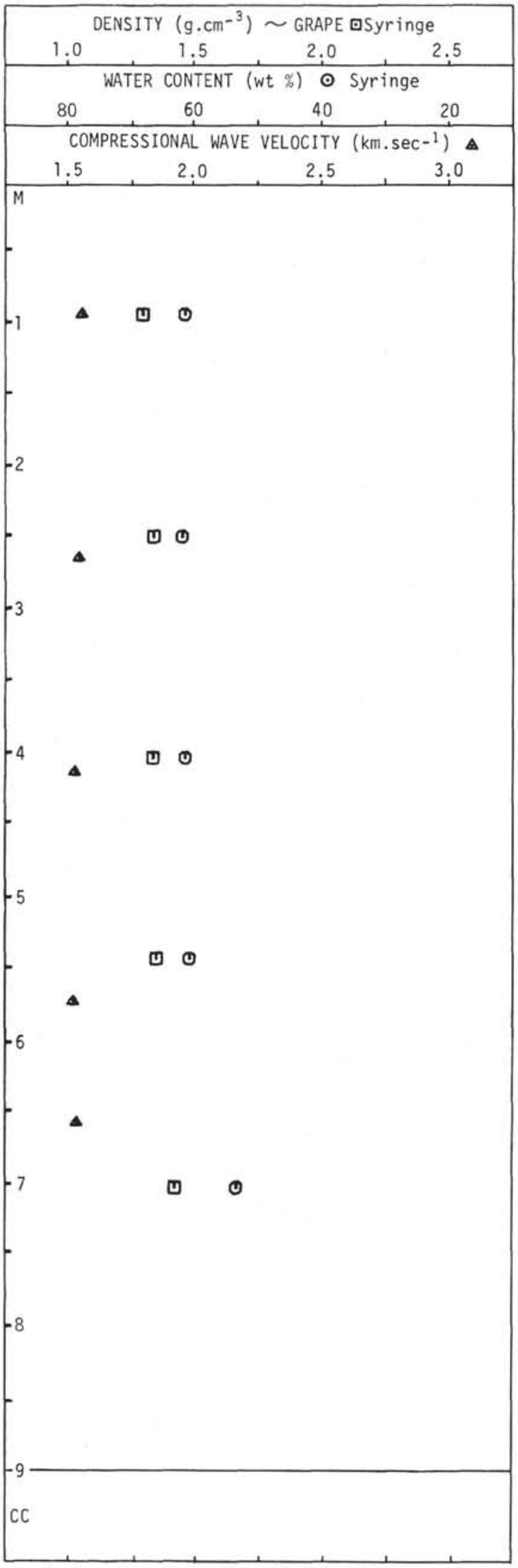




For Explanatory Notes, see Chapter 1

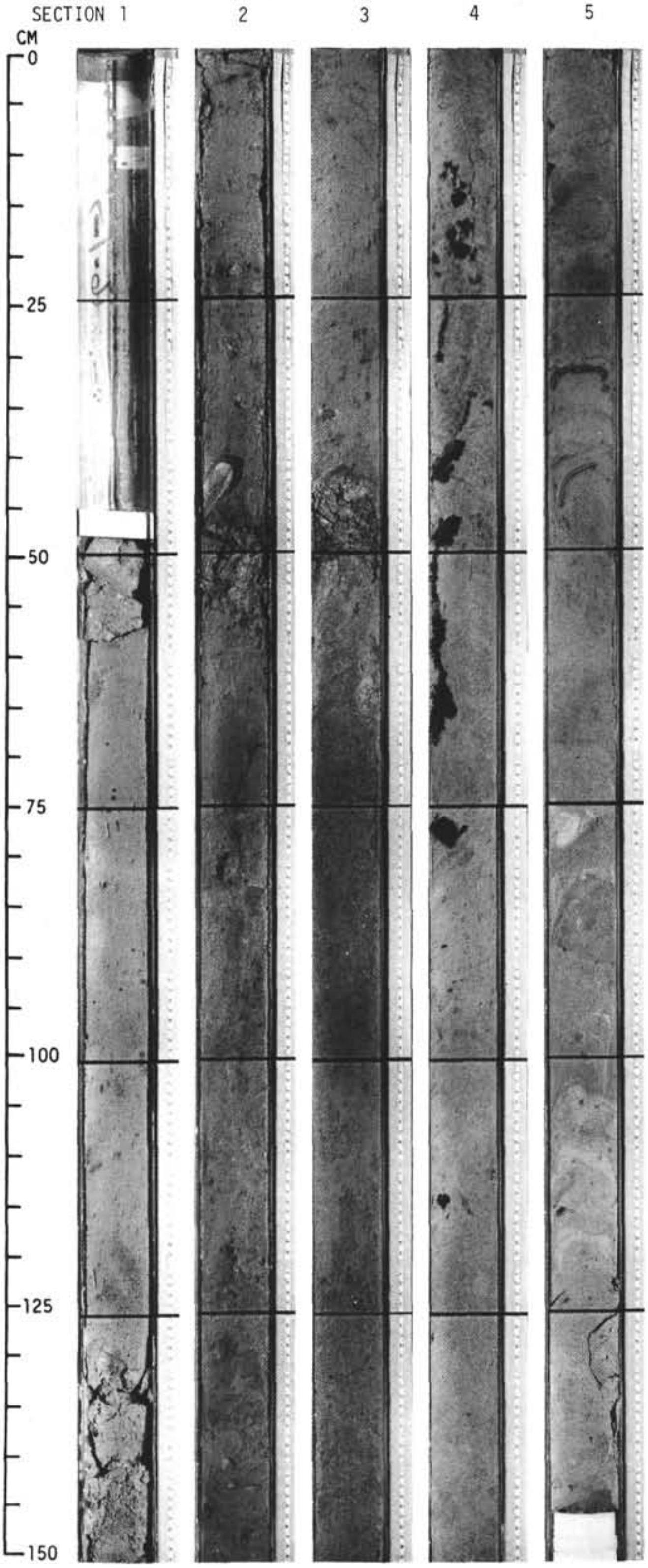
348-5

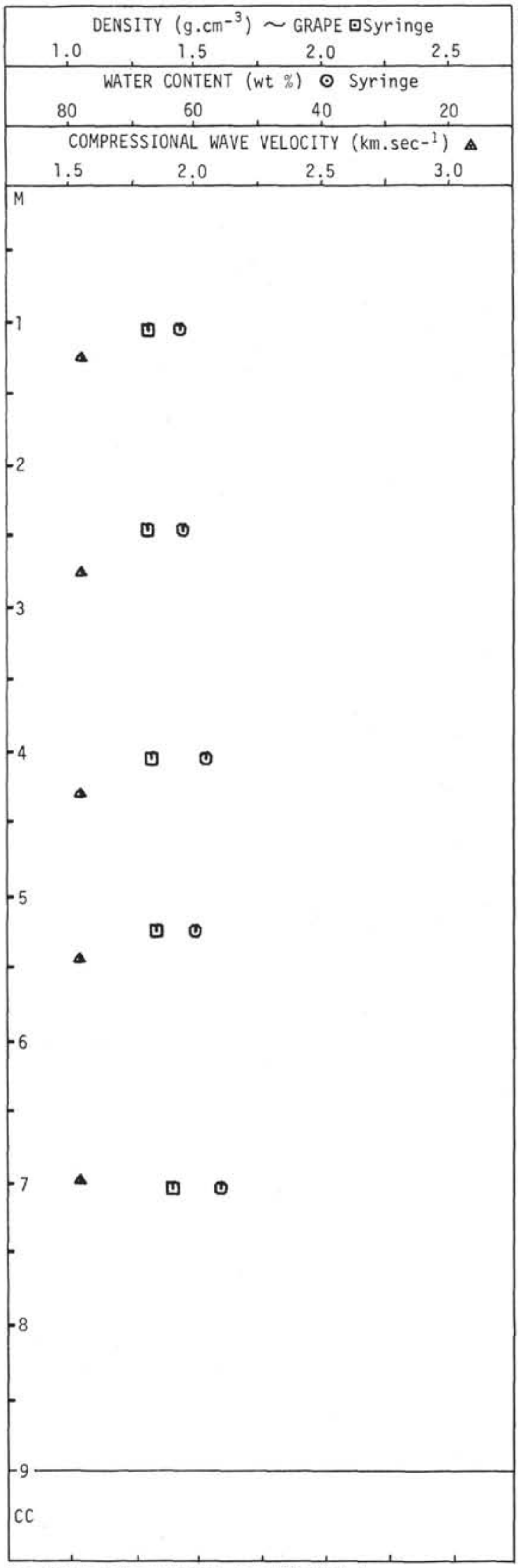




For Explanatory Notes, see Chapter 1

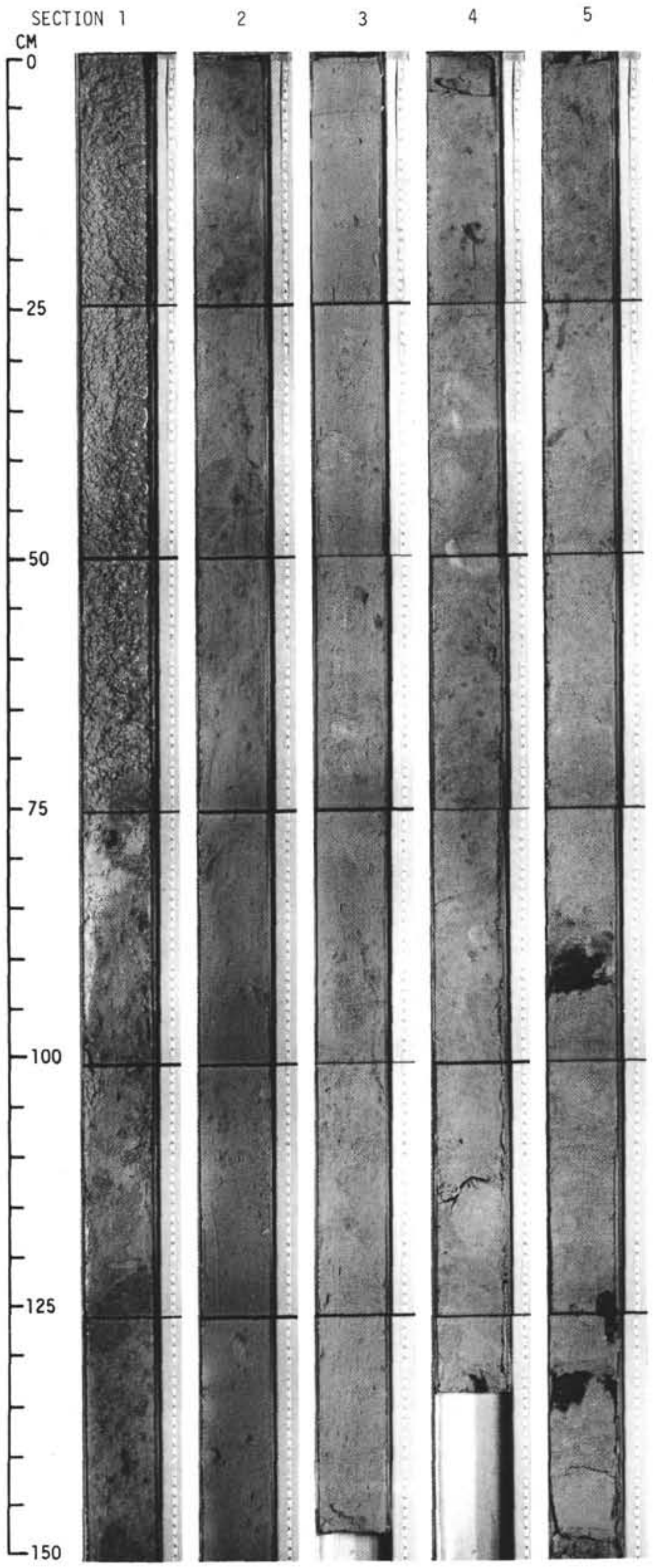
348-6

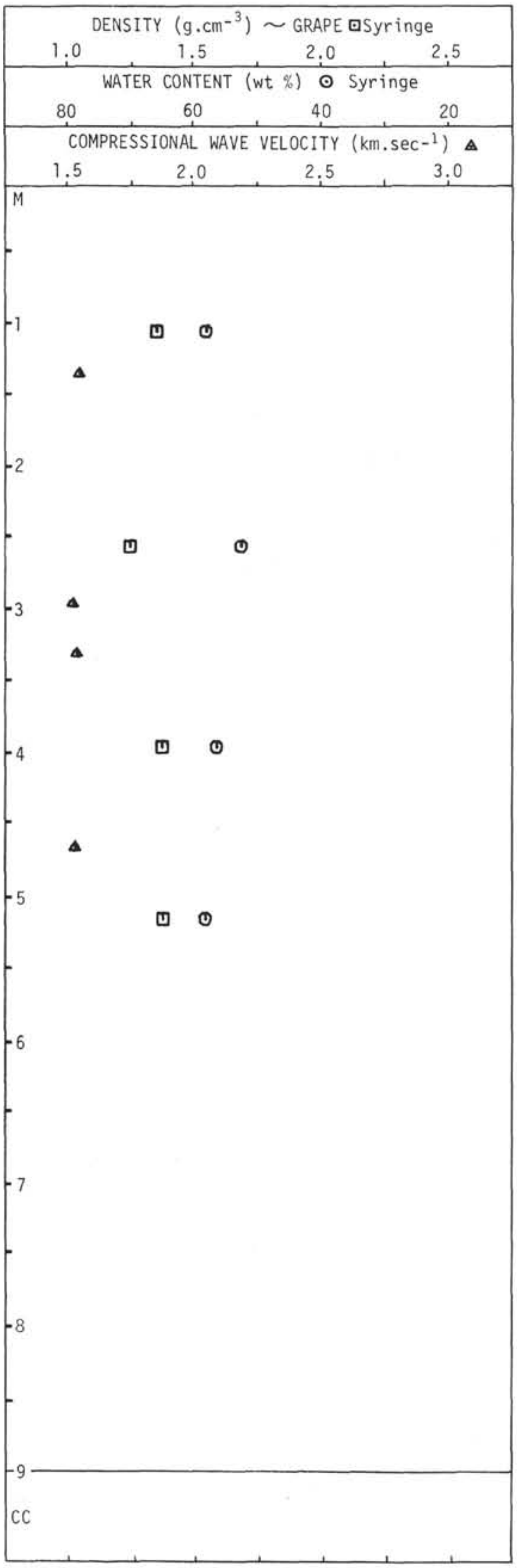




For Explanatory Notes, see Chapter 1

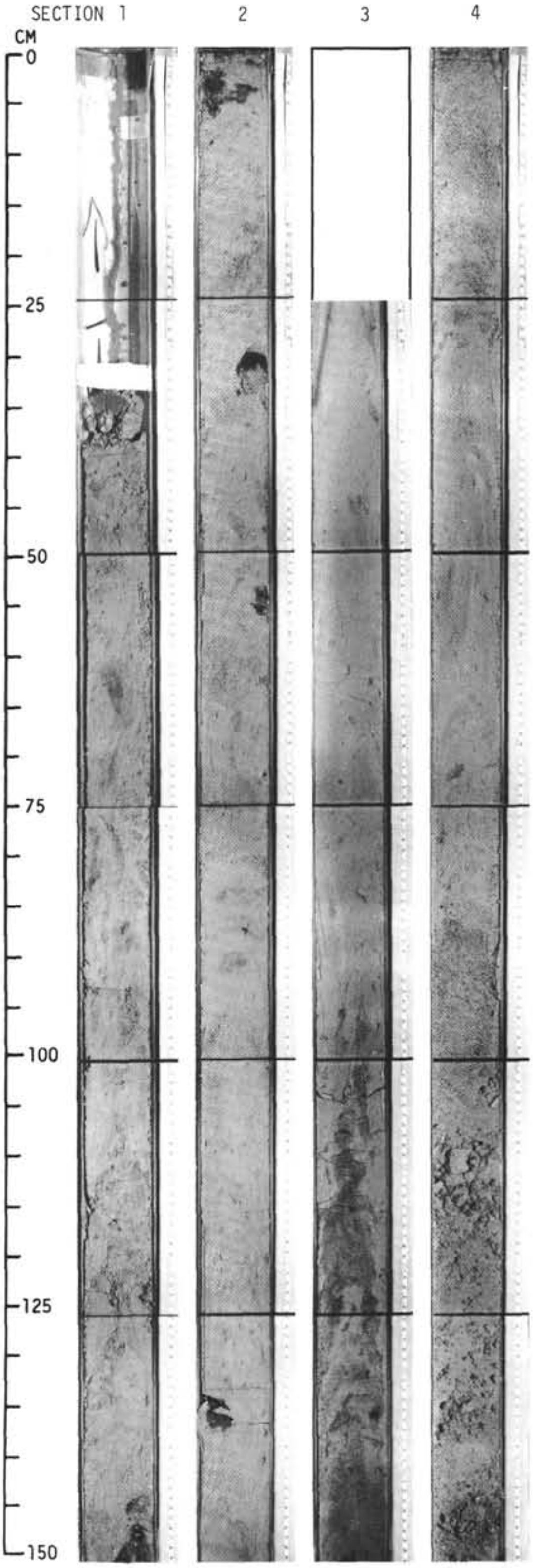
348-7



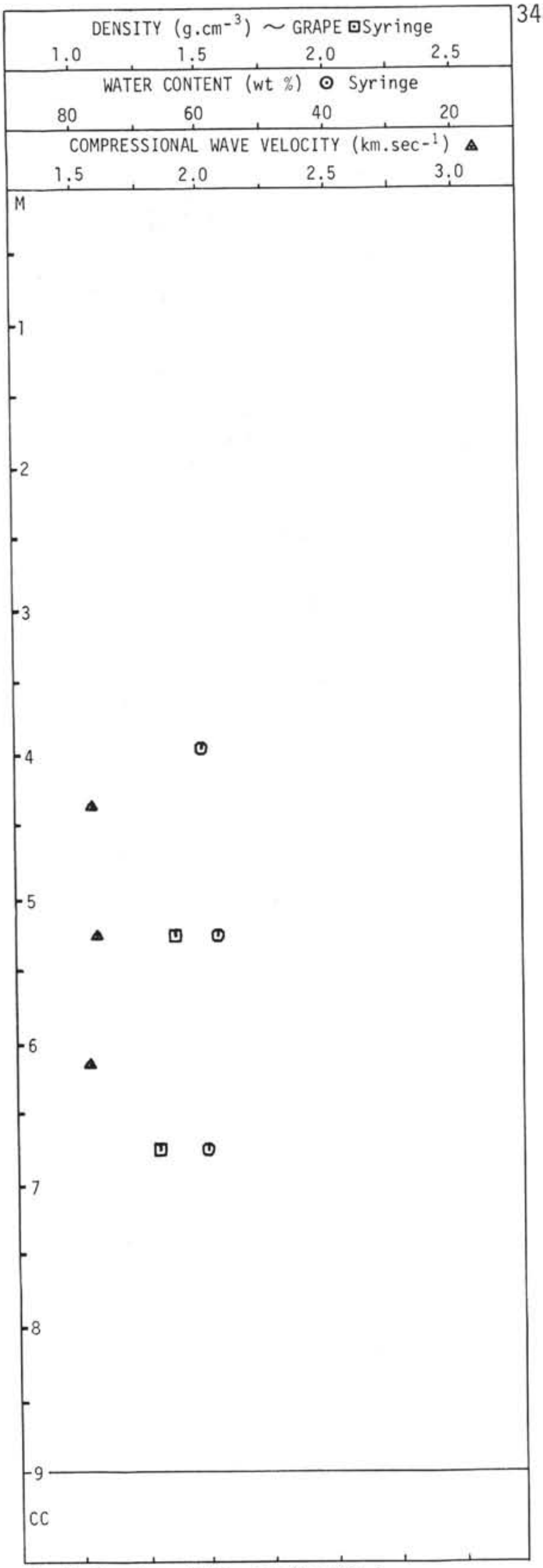


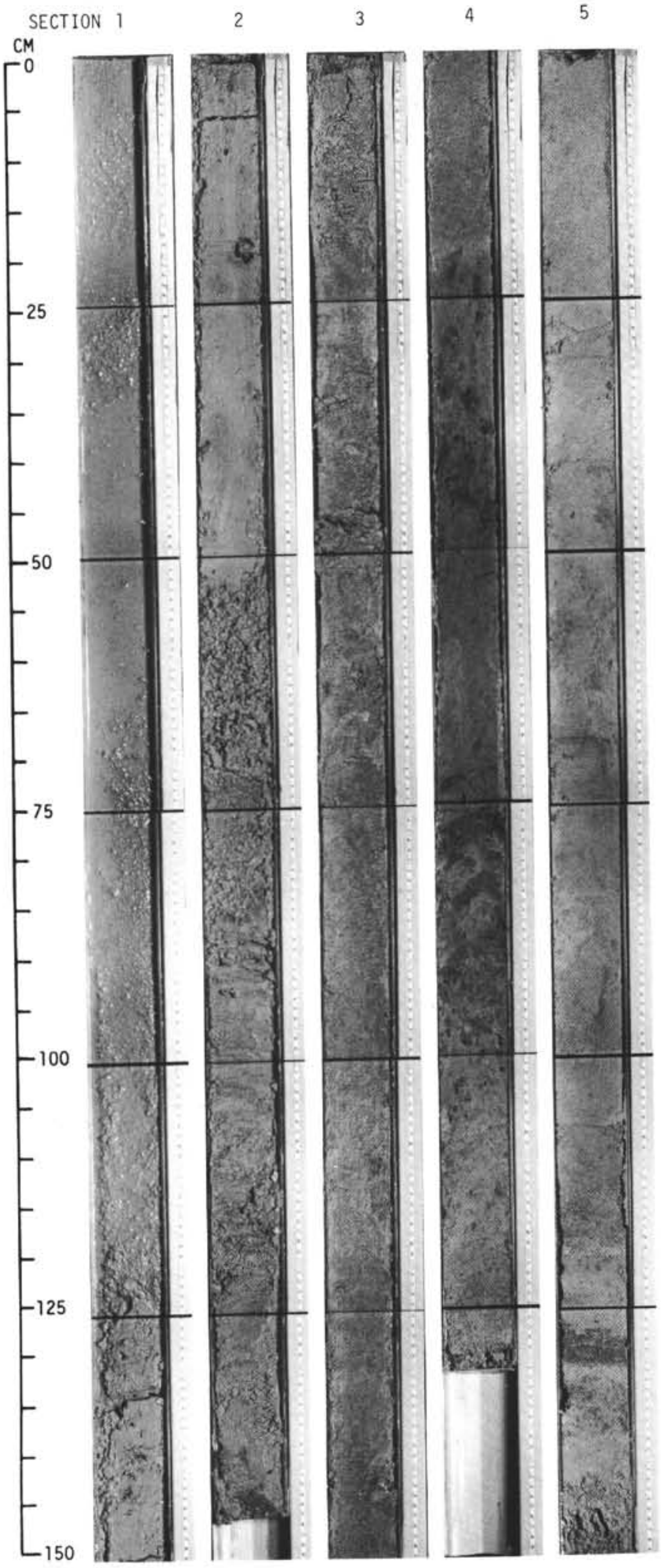
For Explanatory Notes, see Chapter 1

348-8



348-9





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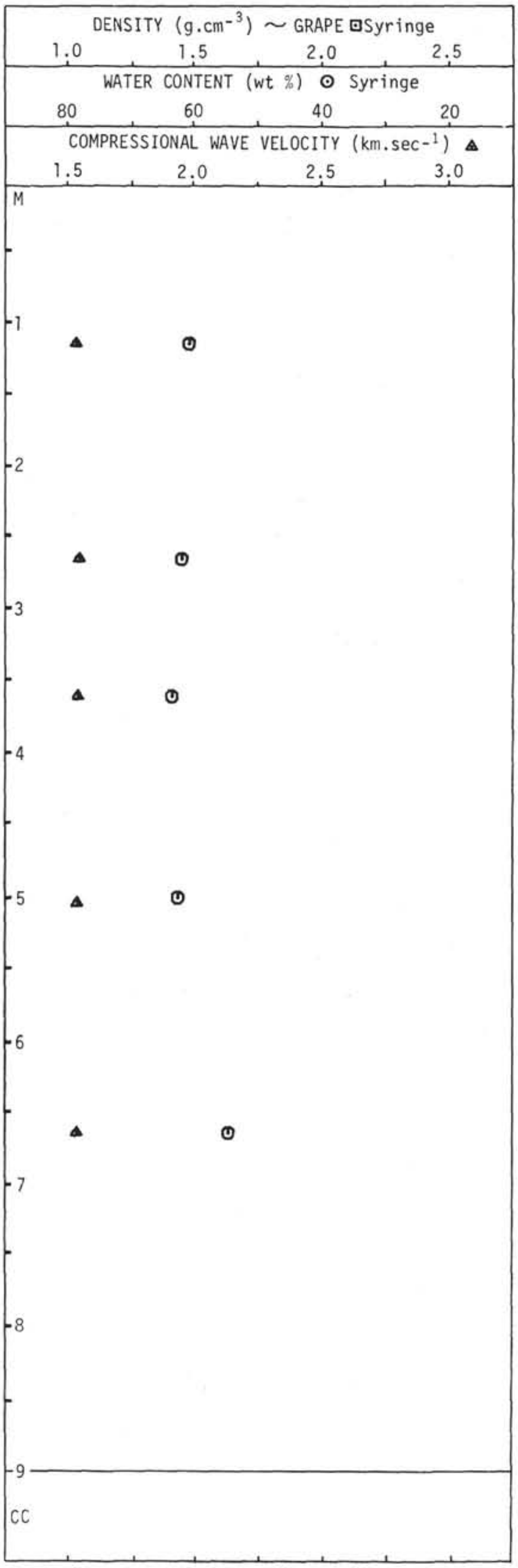

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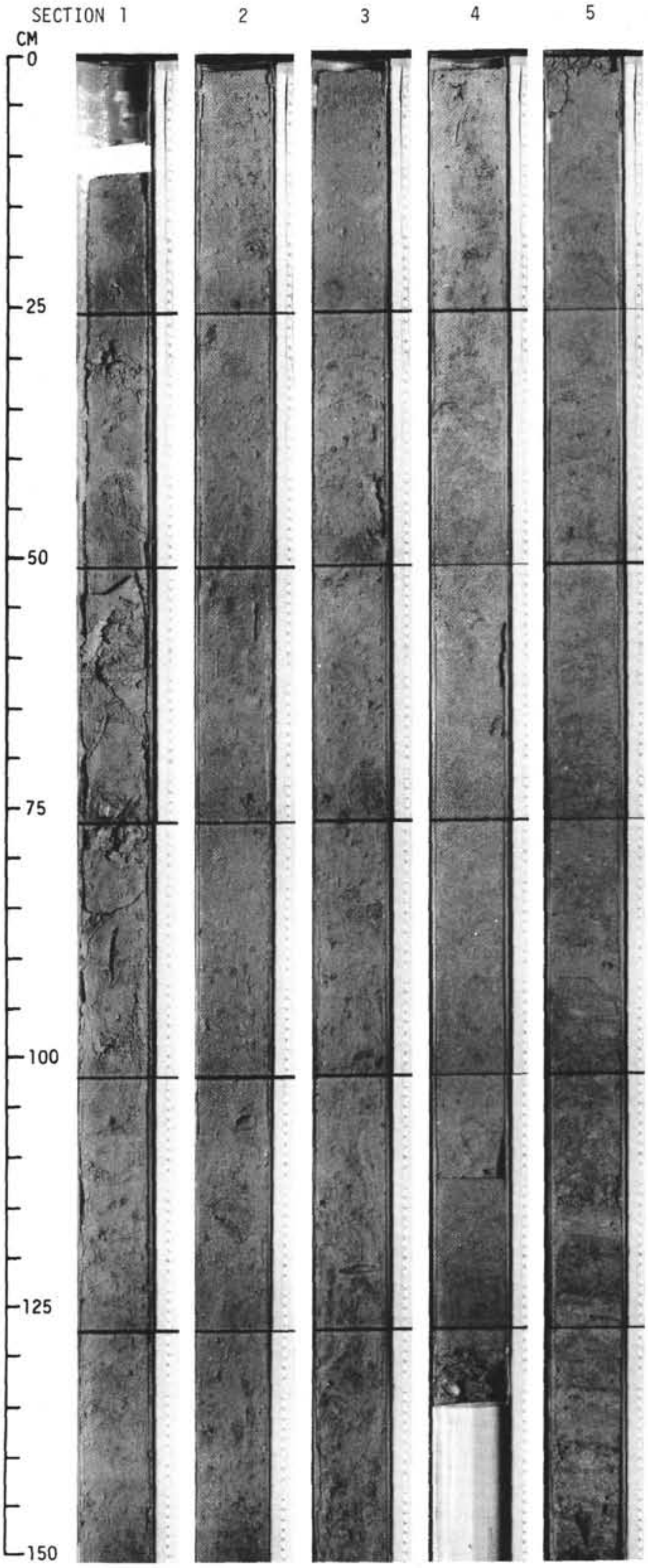

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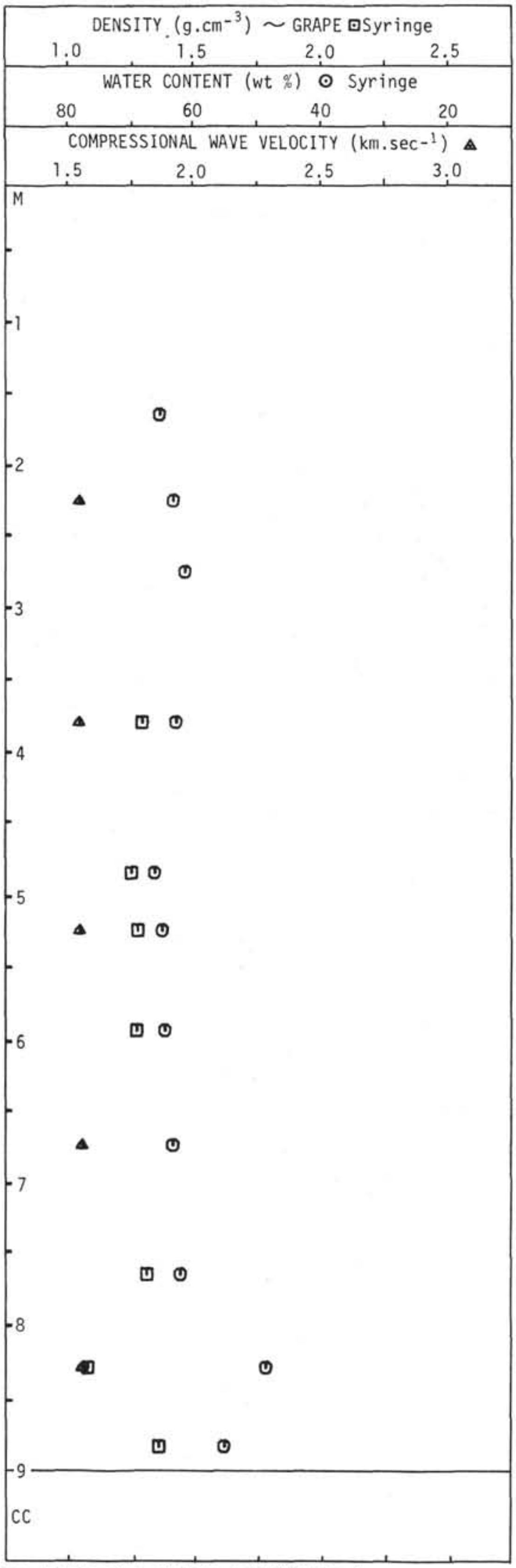

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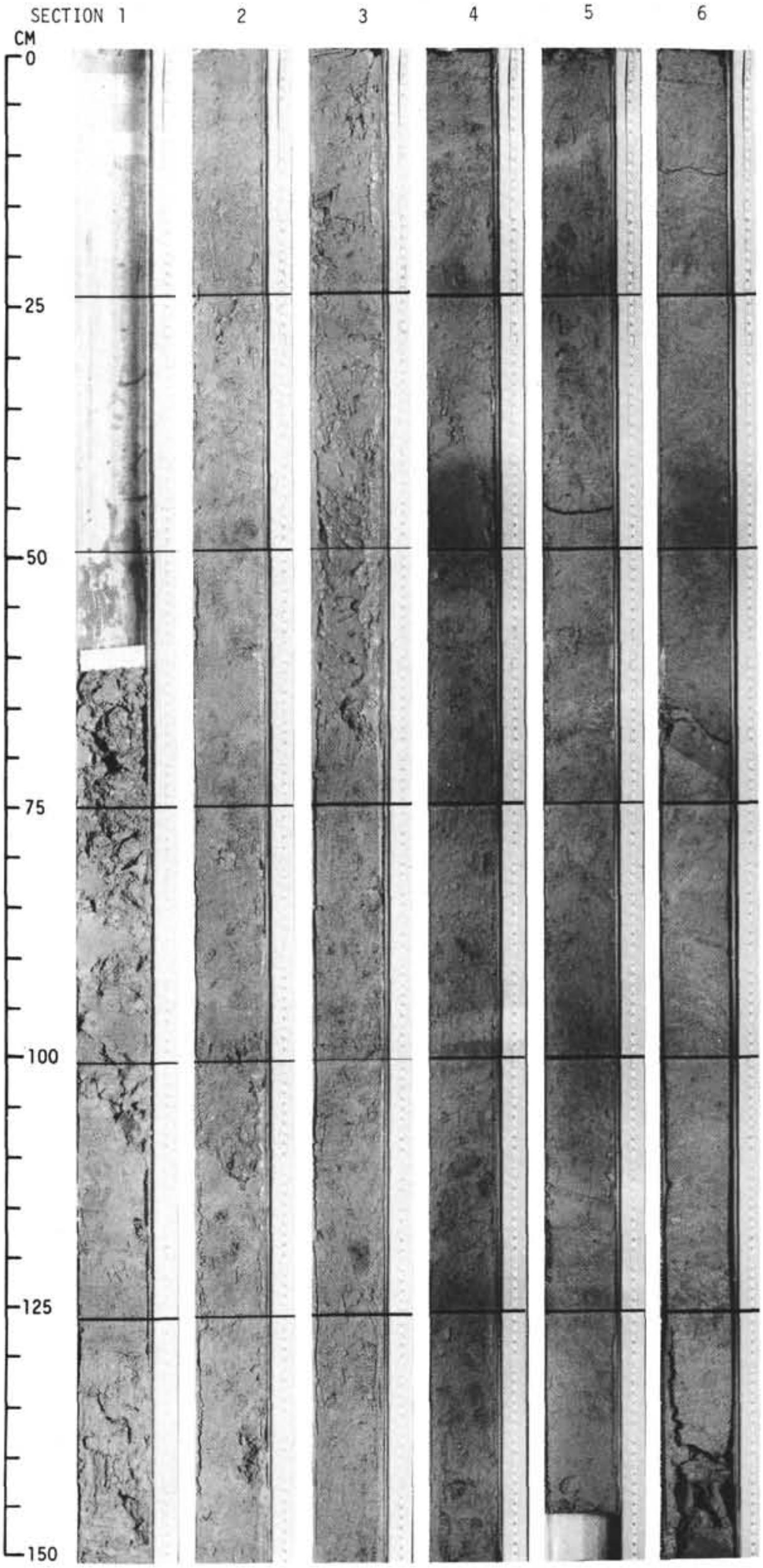

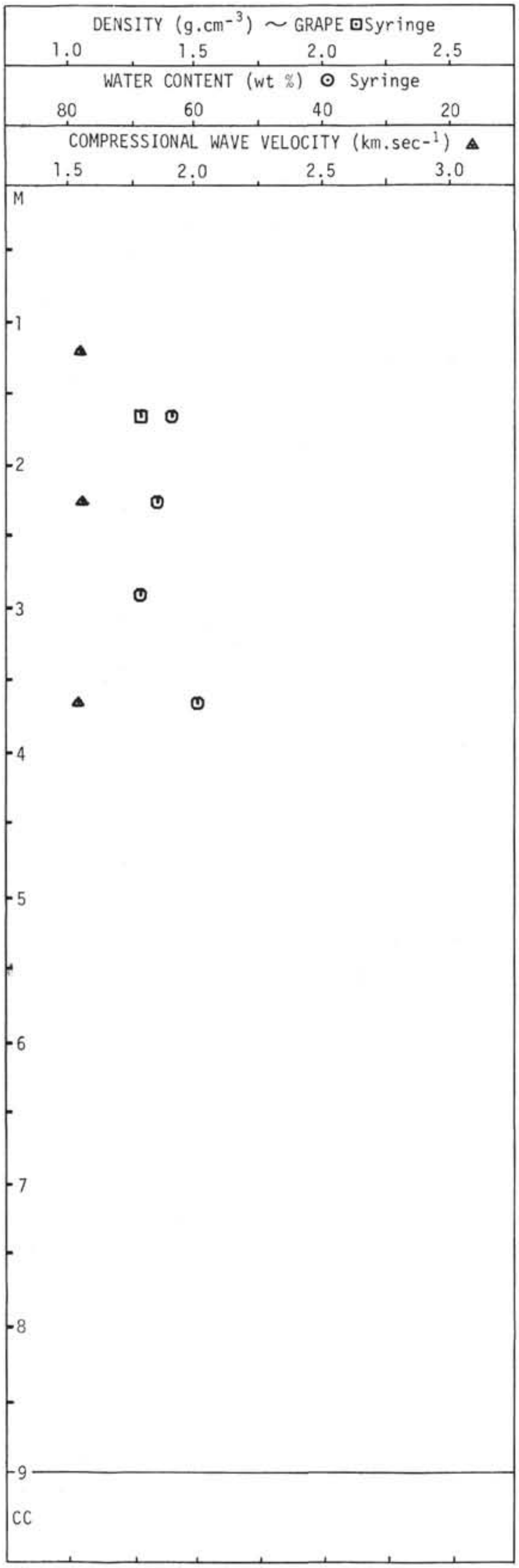

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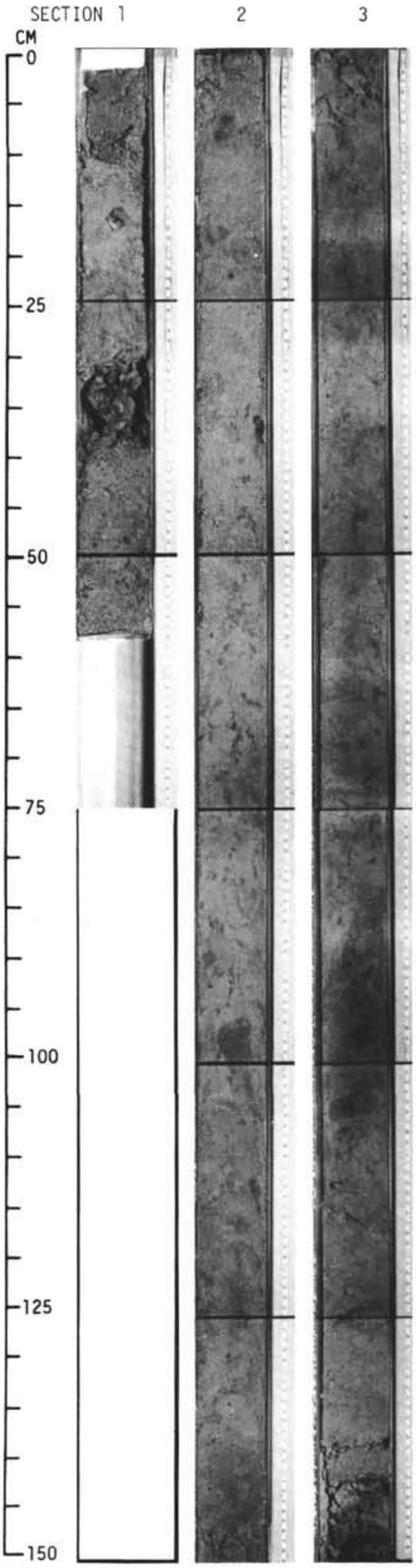

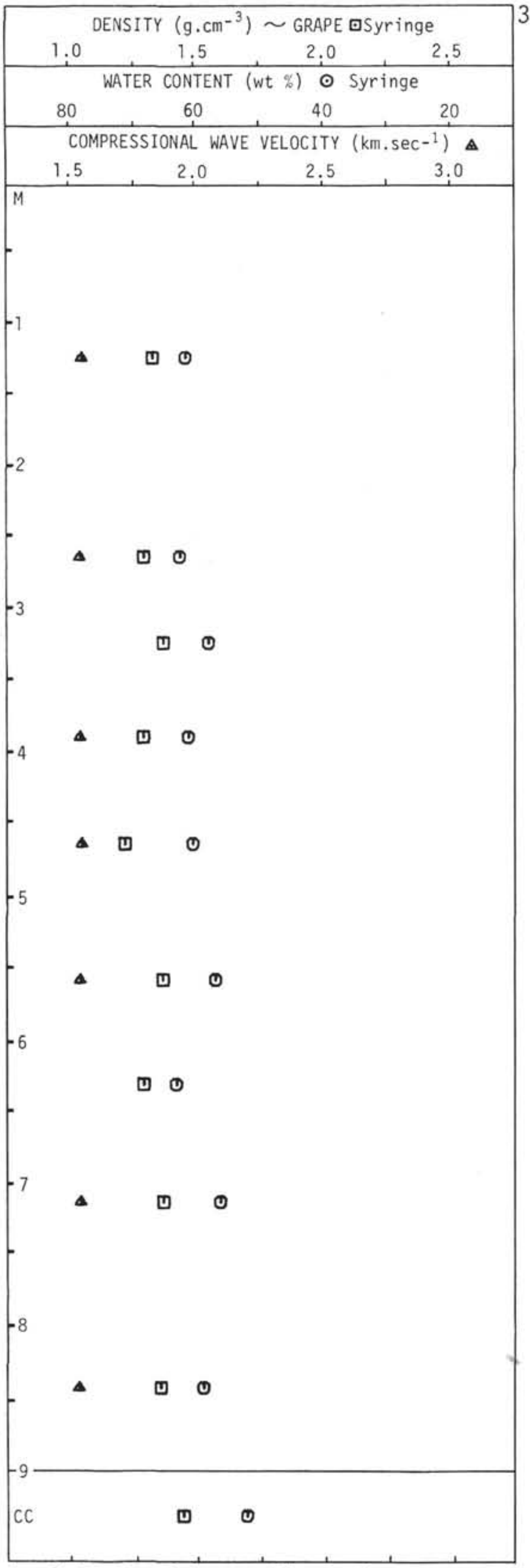

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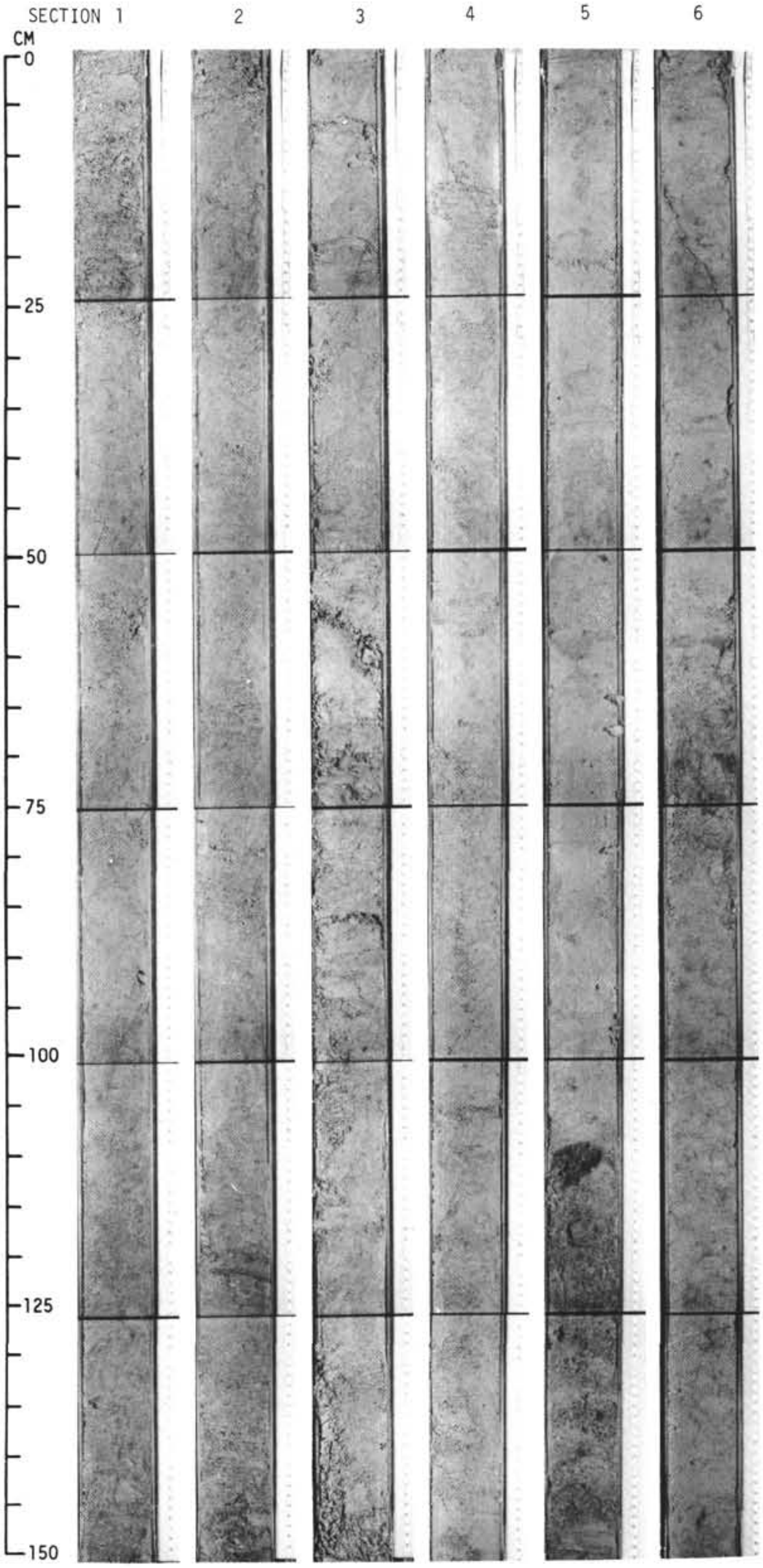

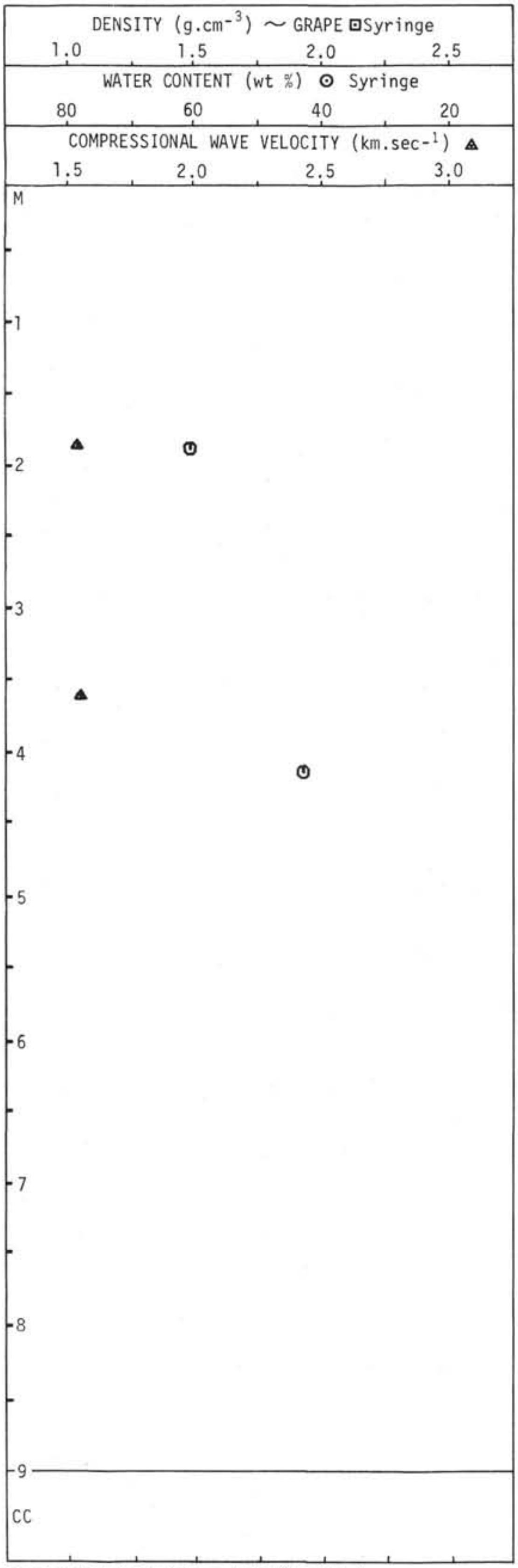

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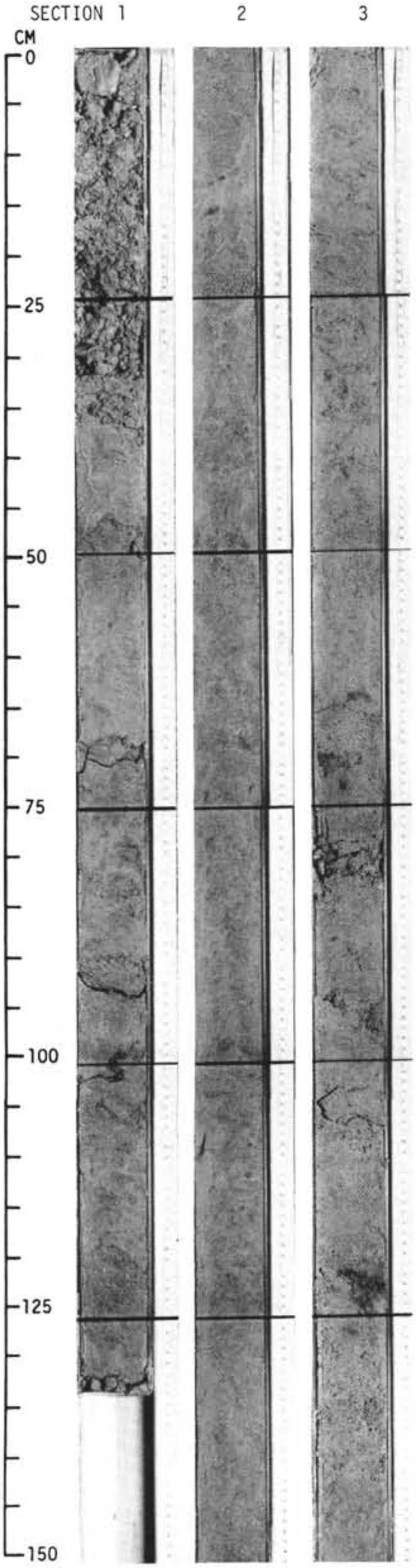

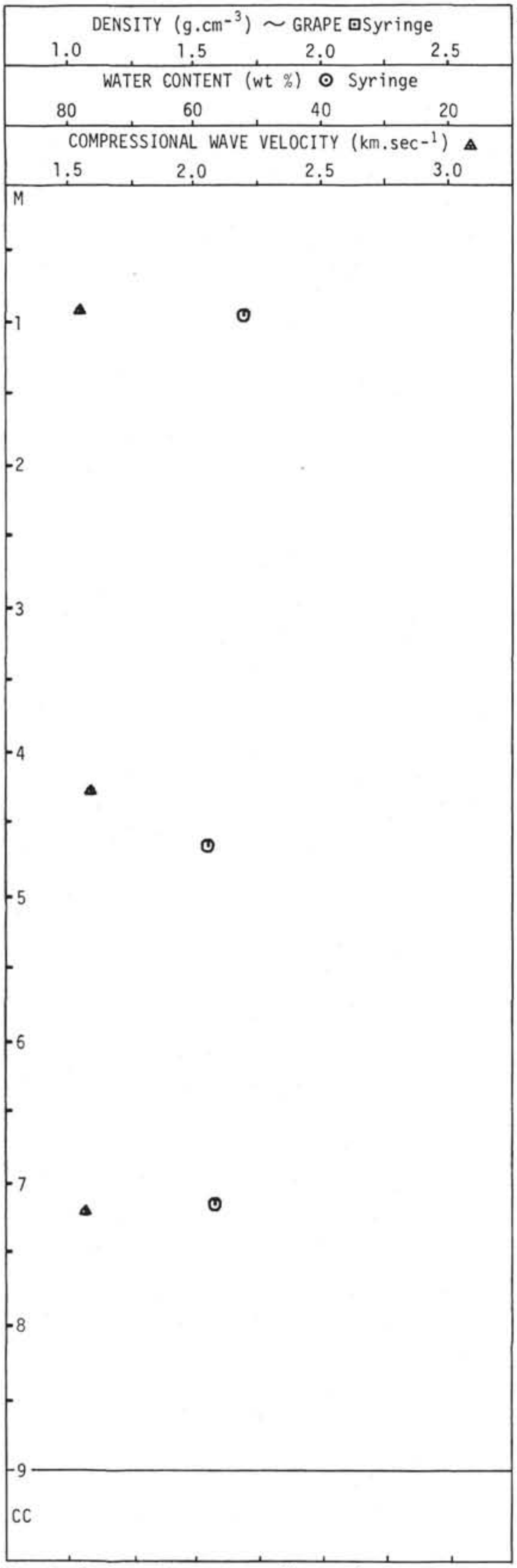

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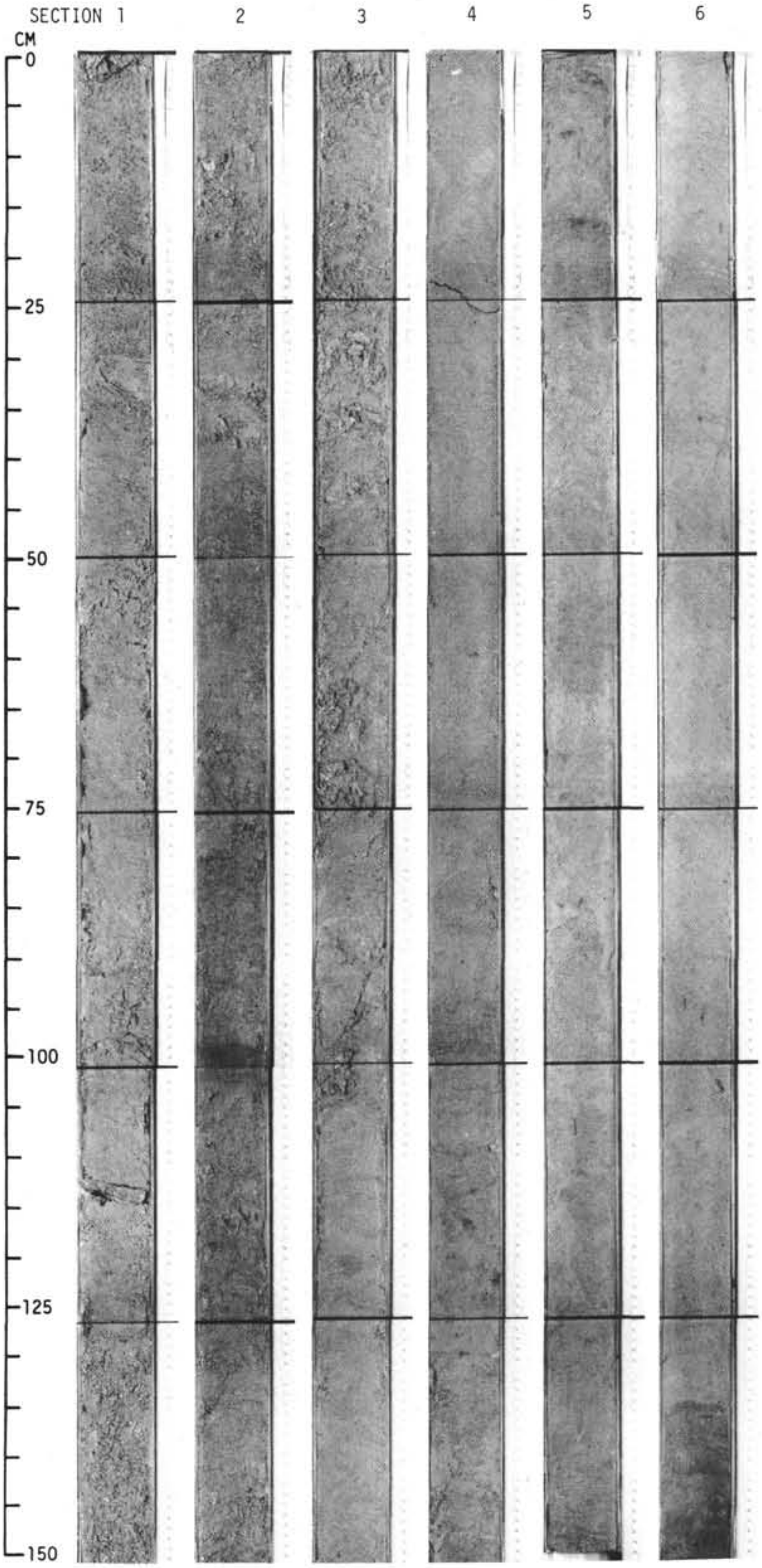

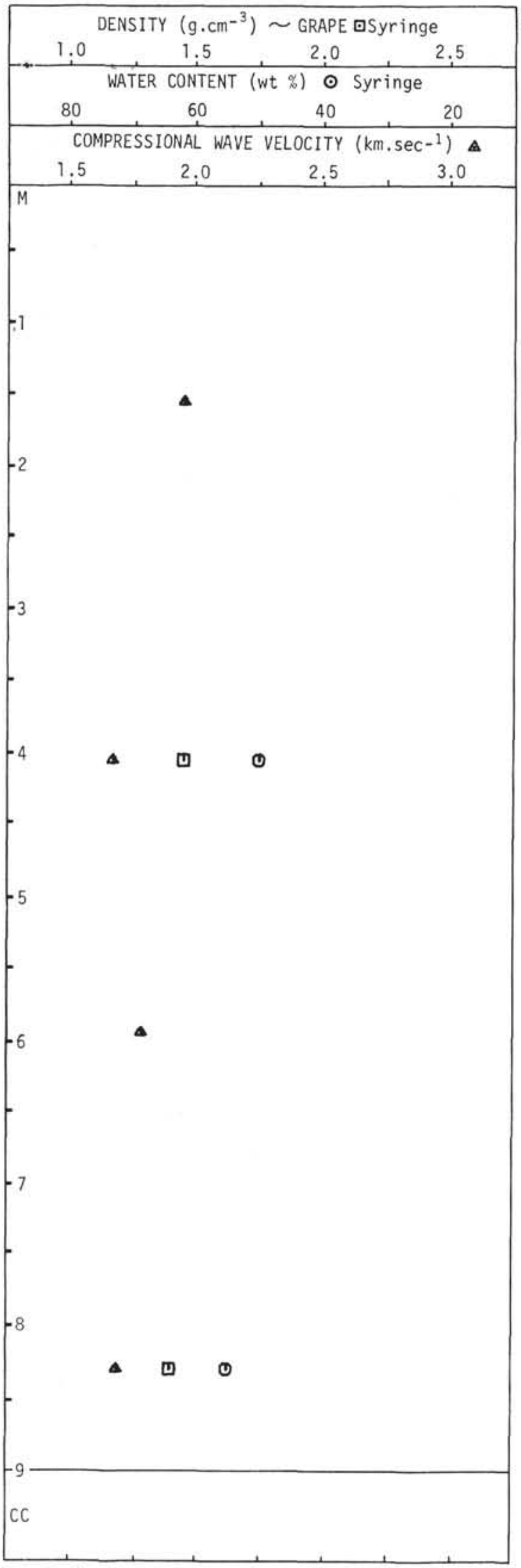

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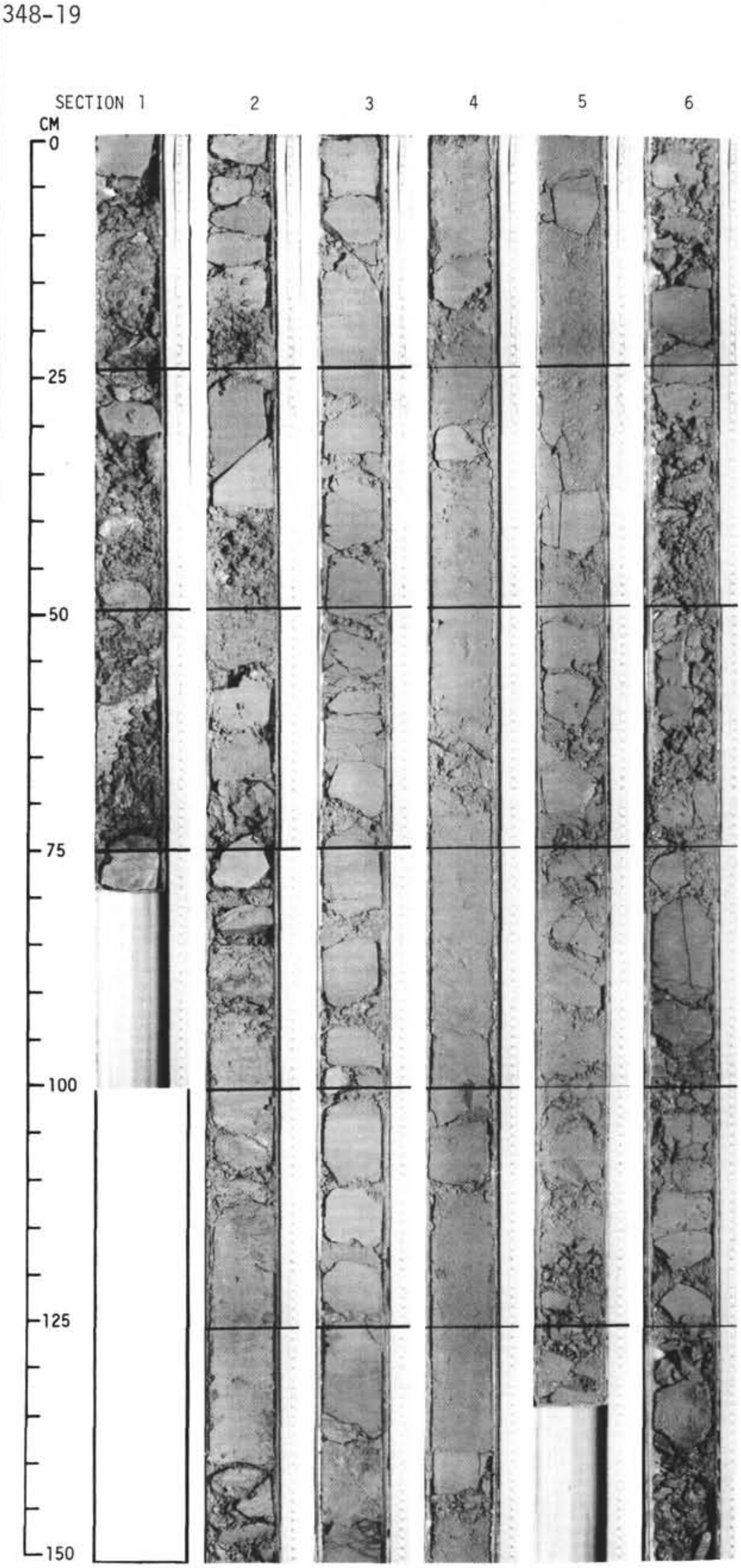

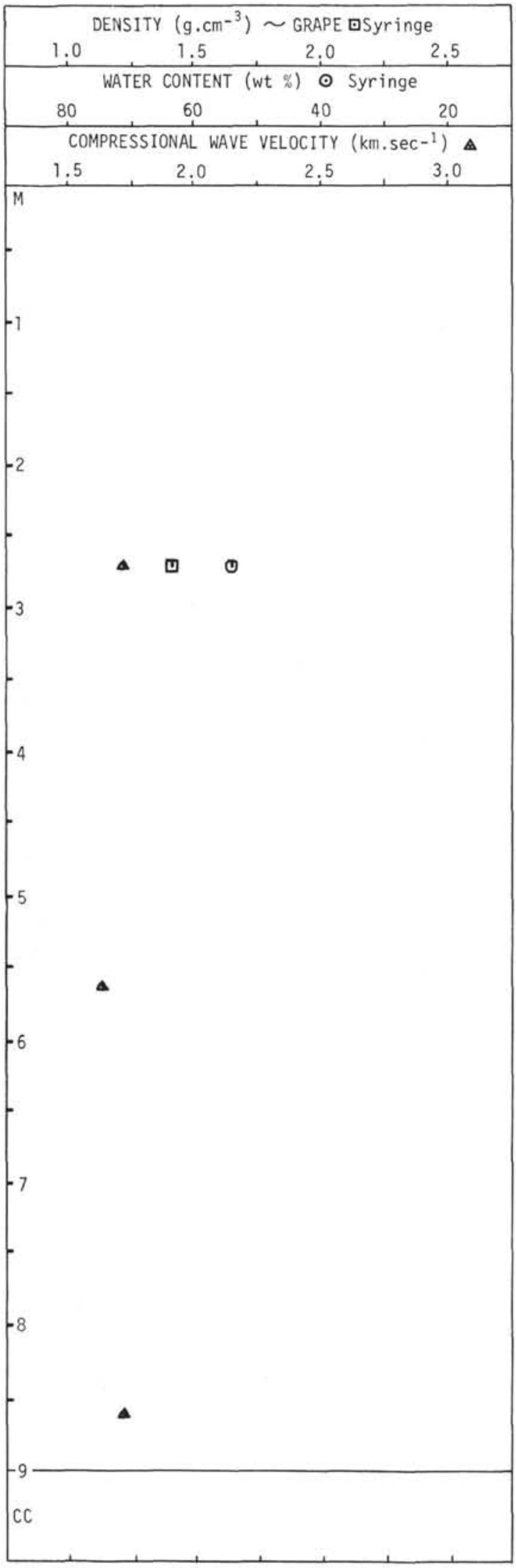

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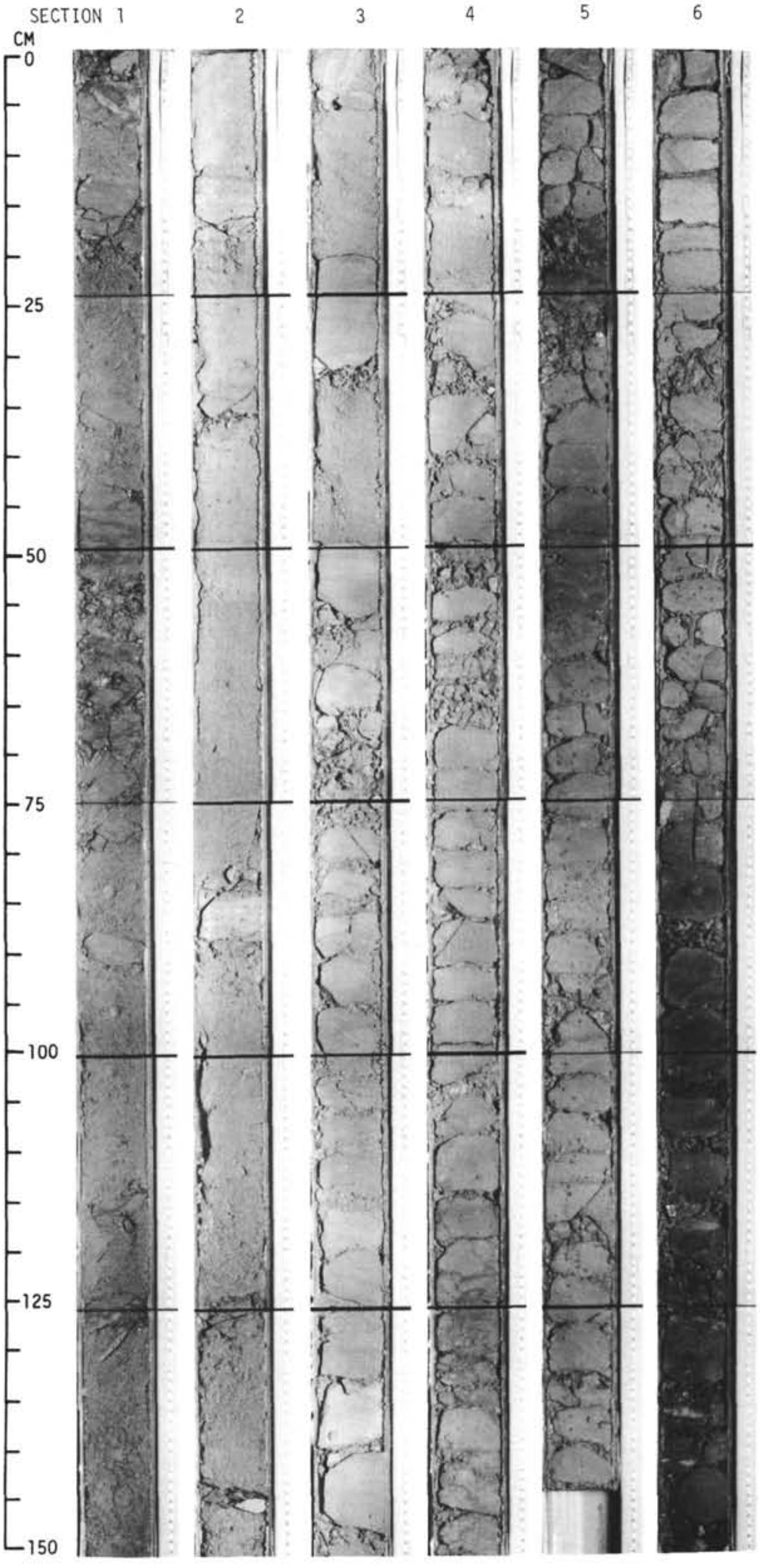

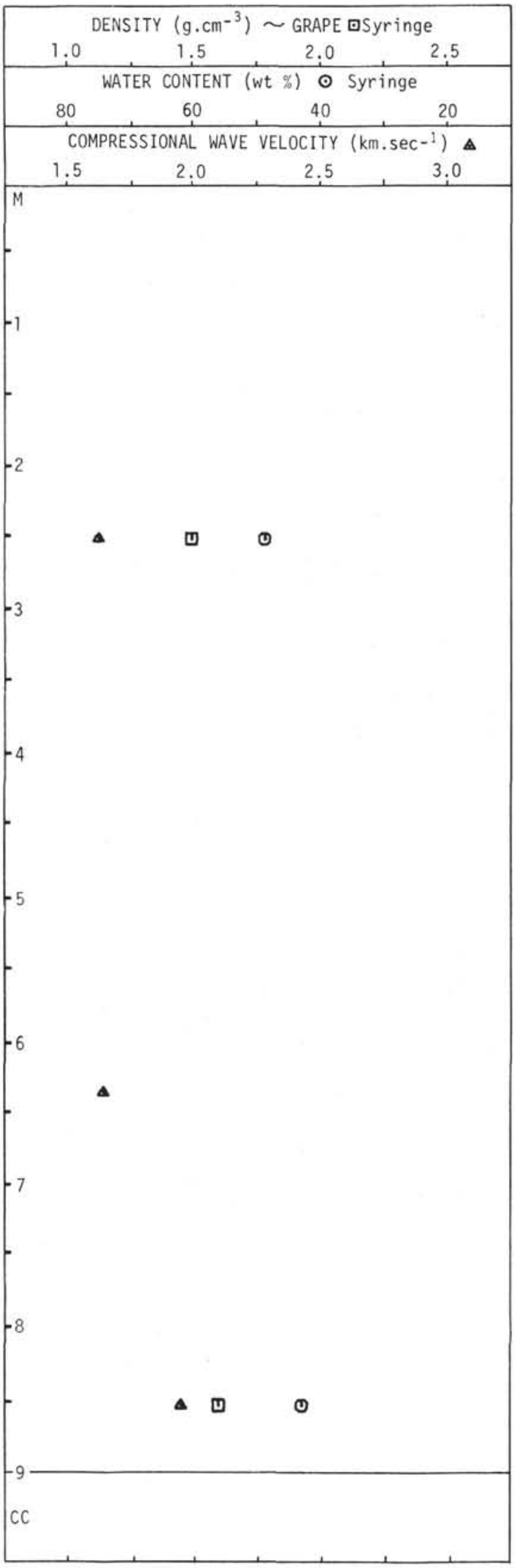

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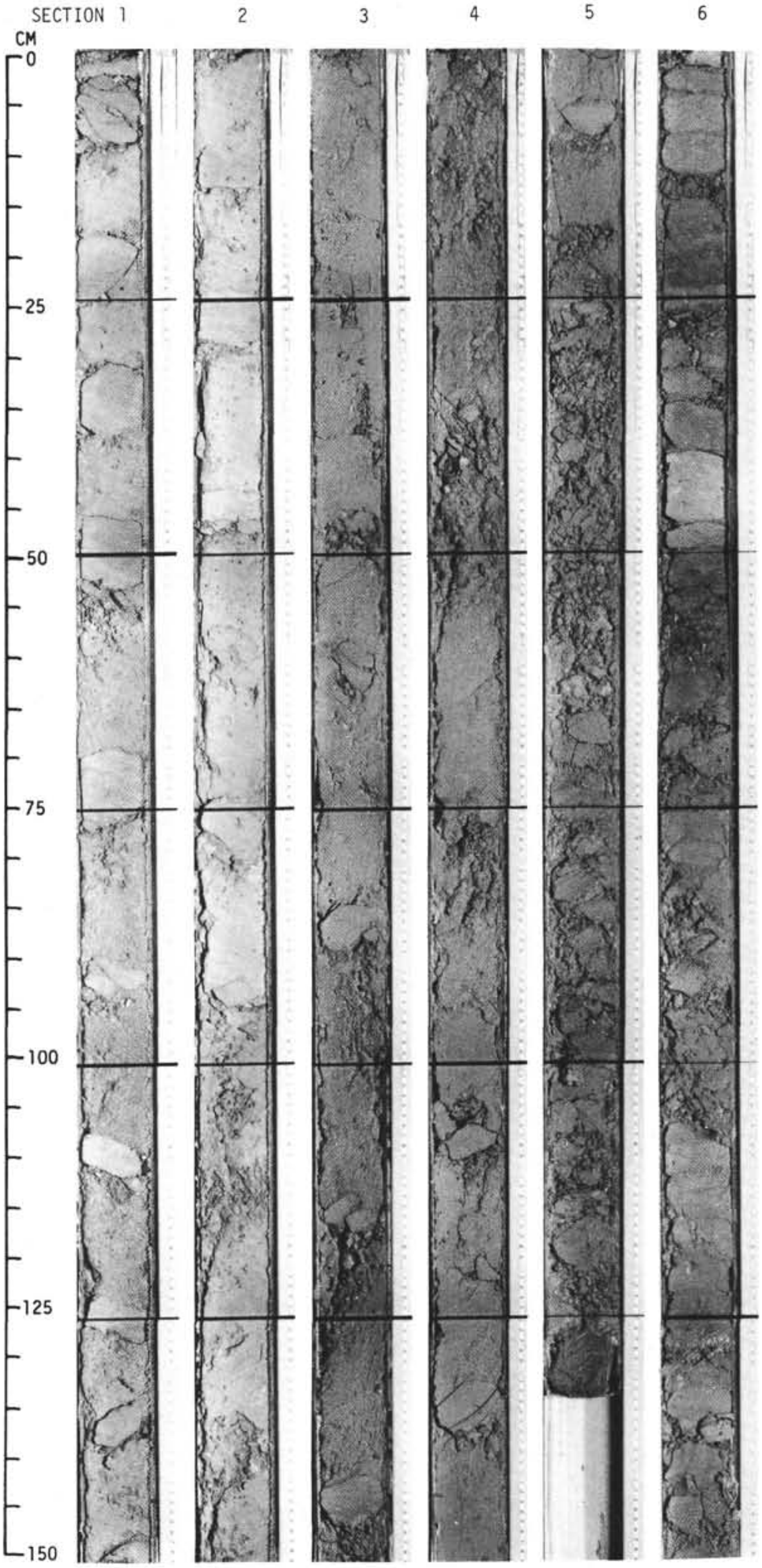

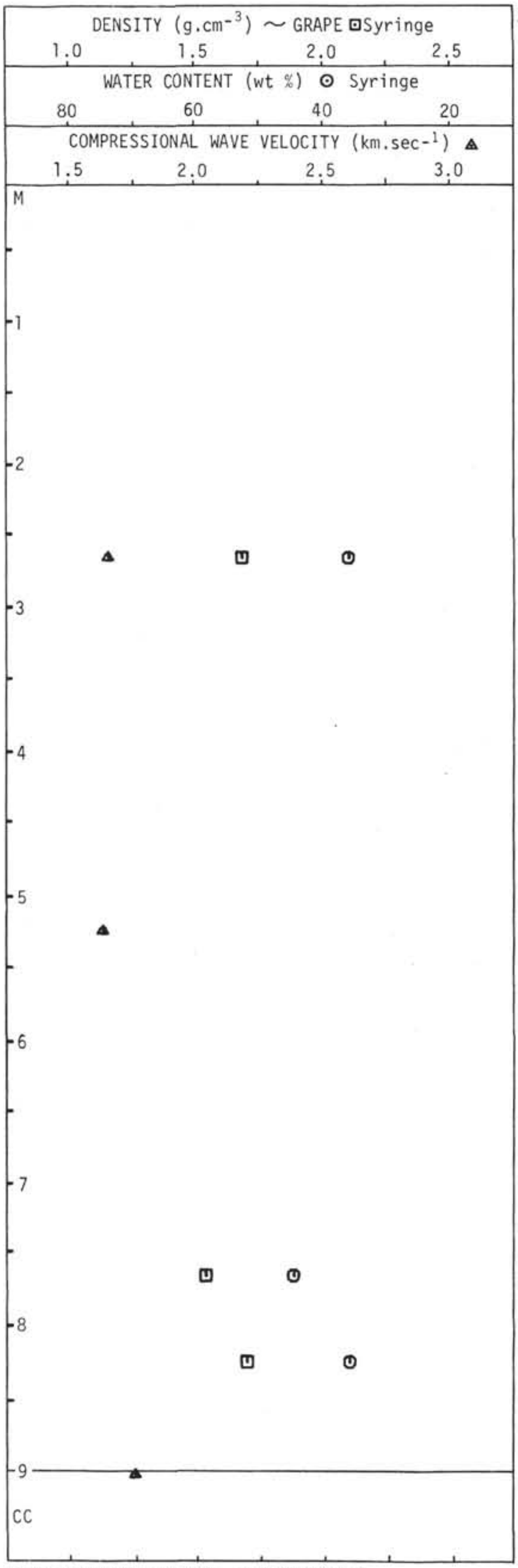

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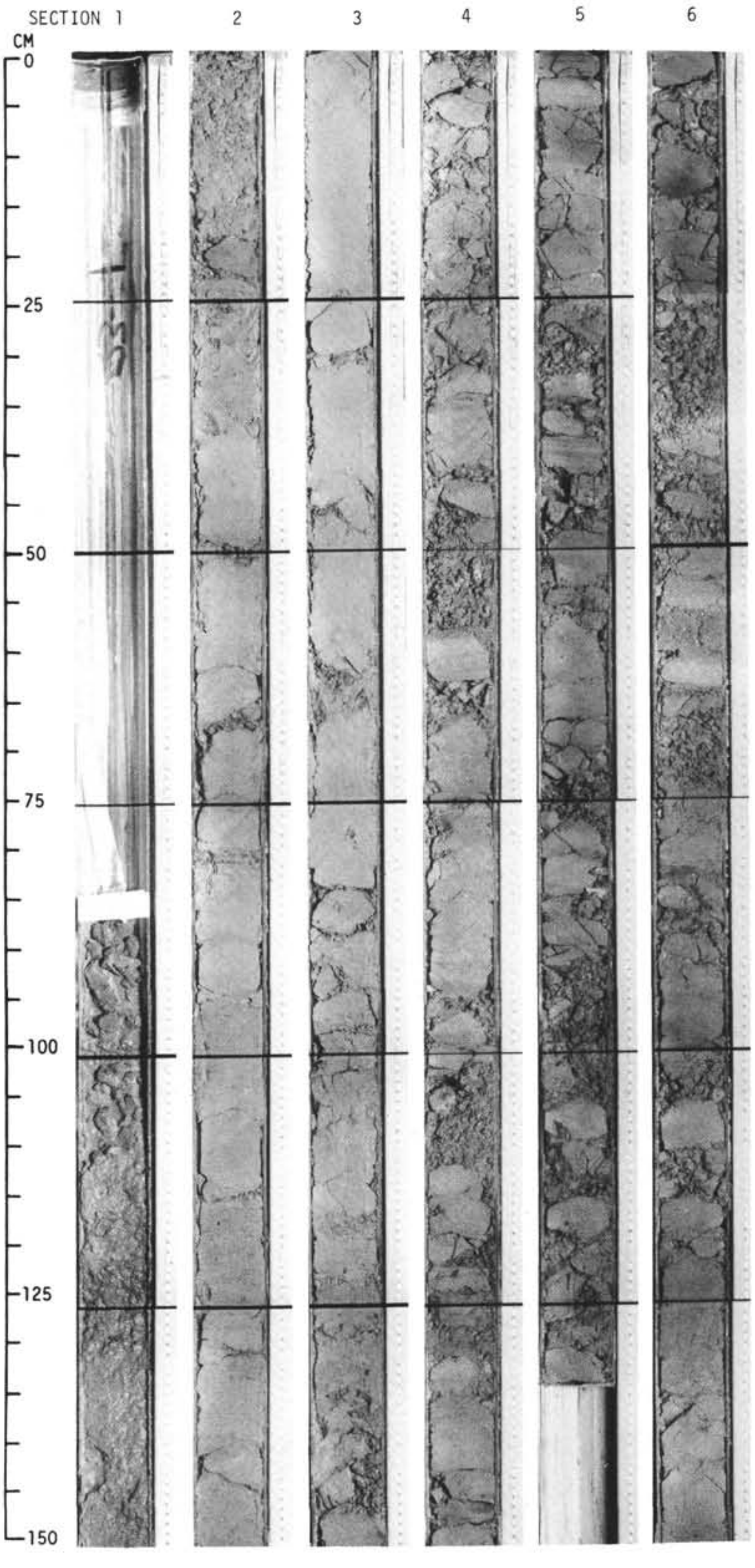

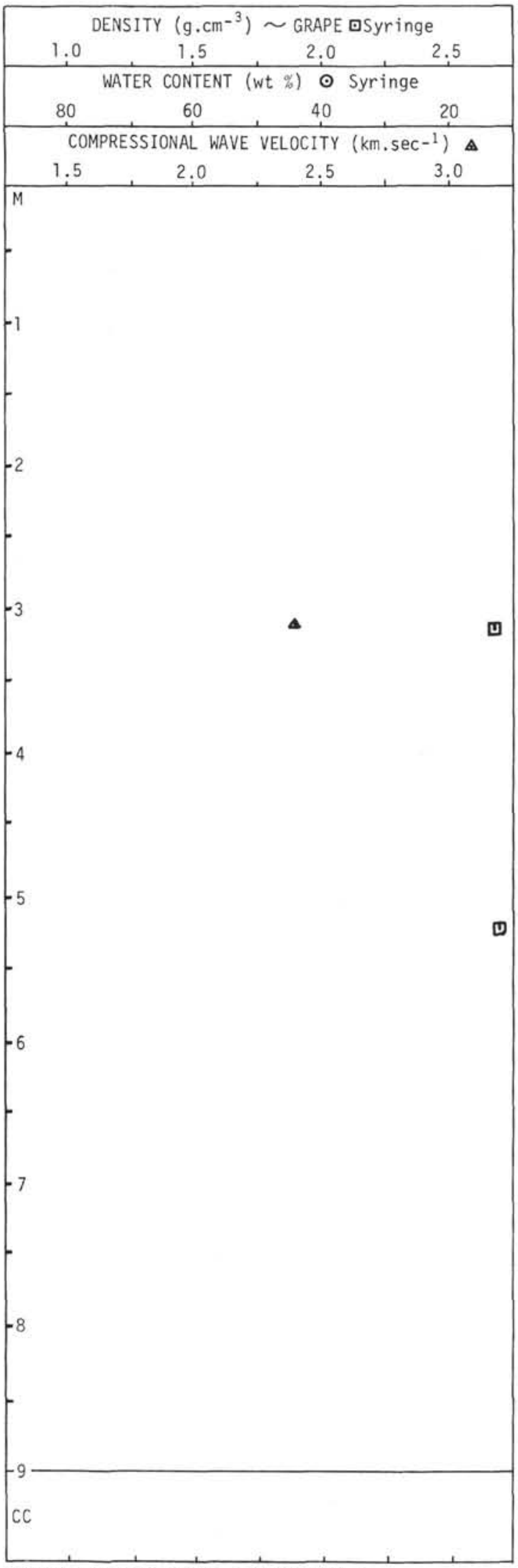

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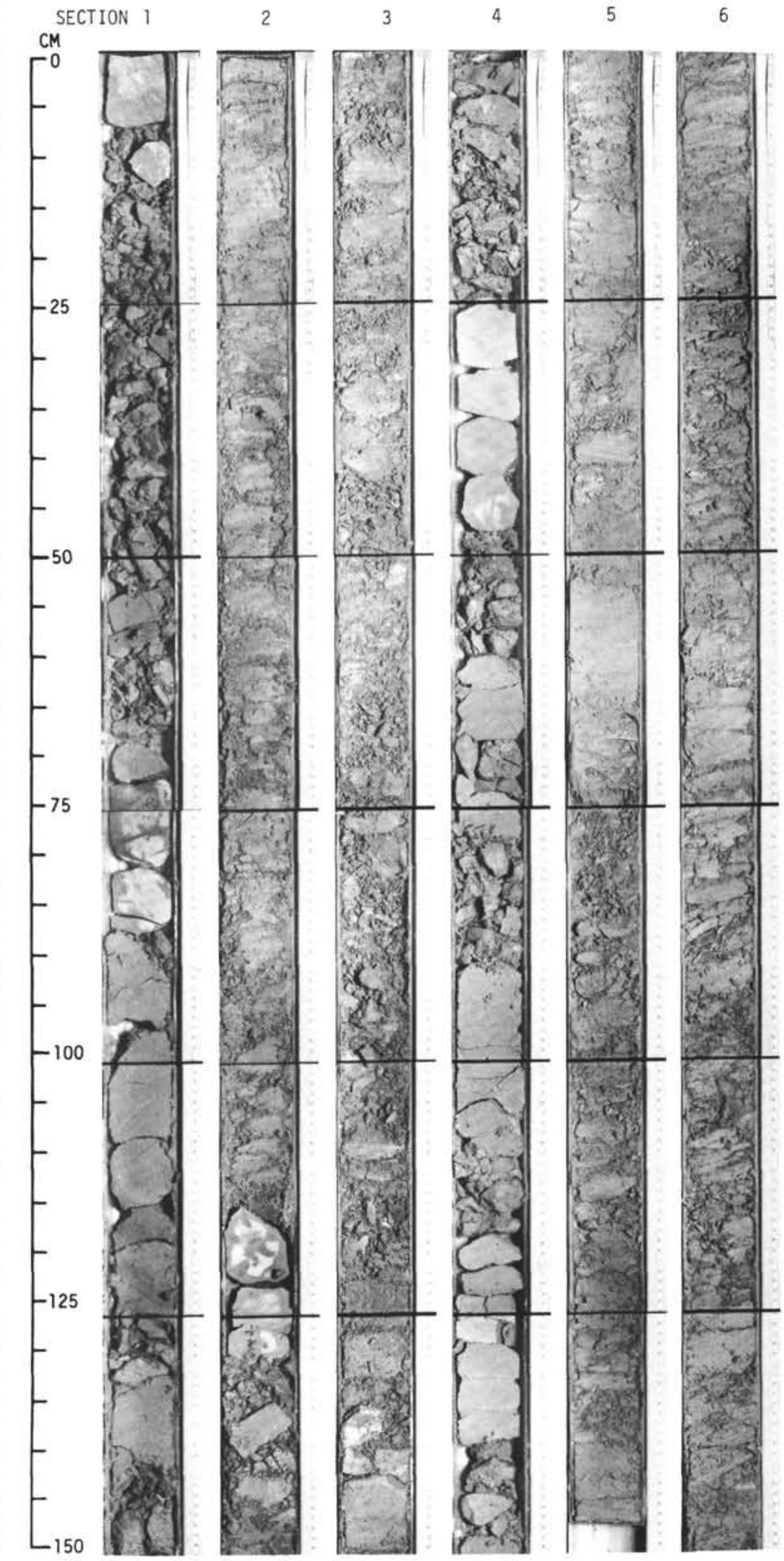

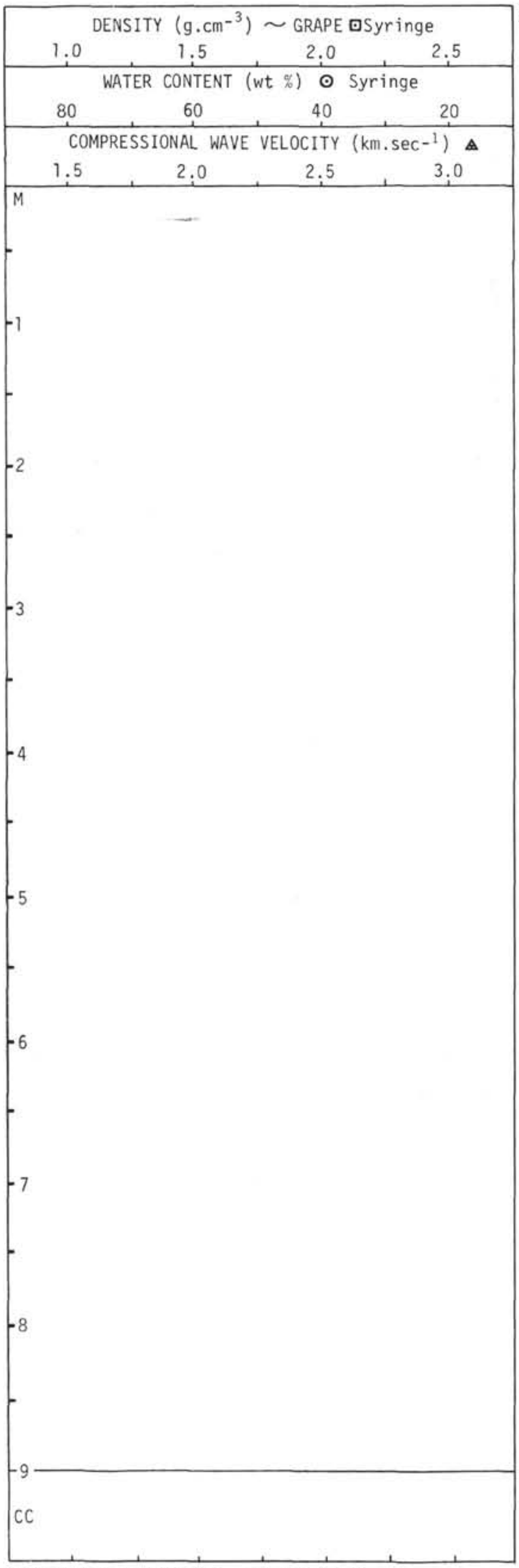

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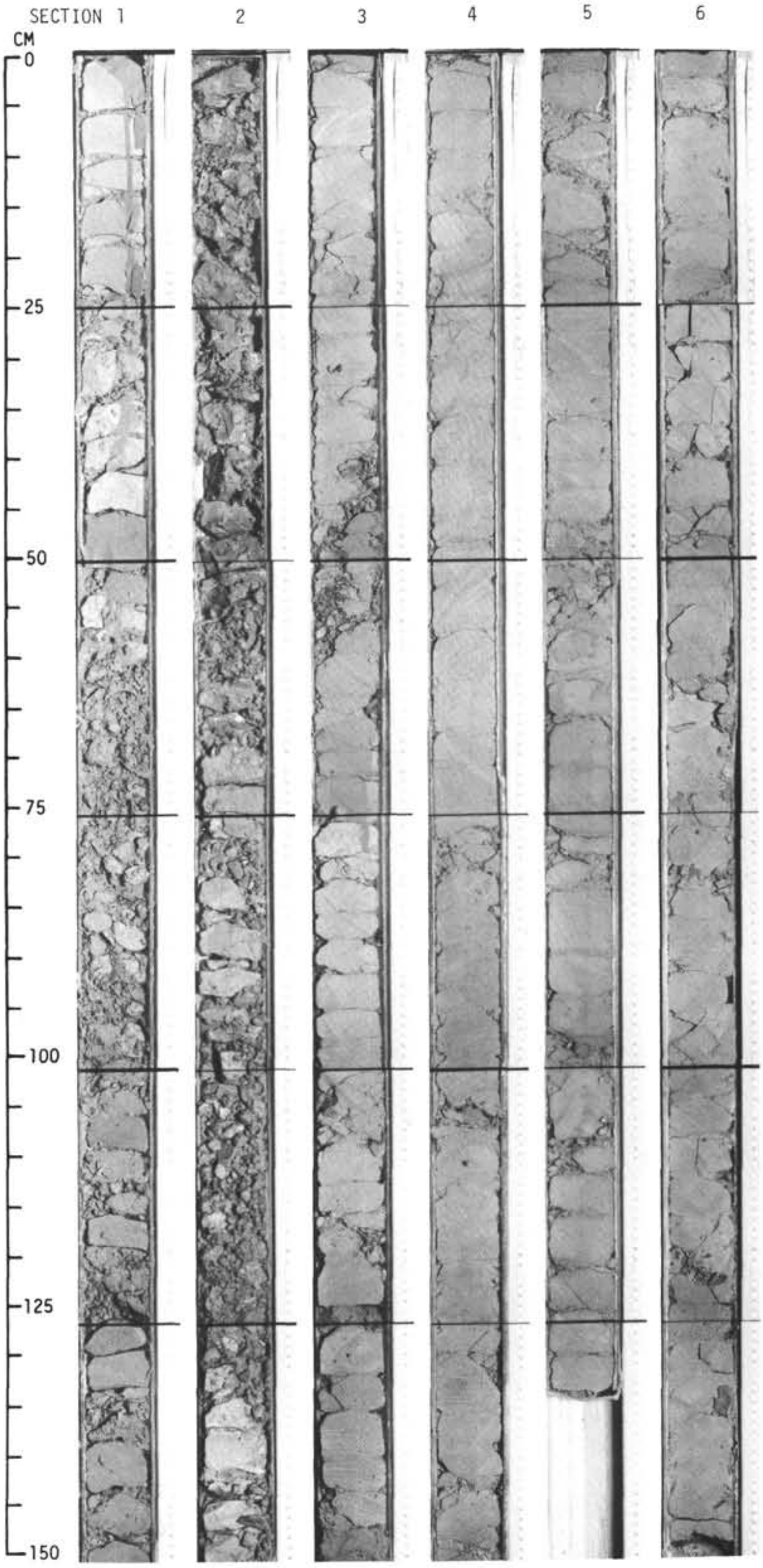

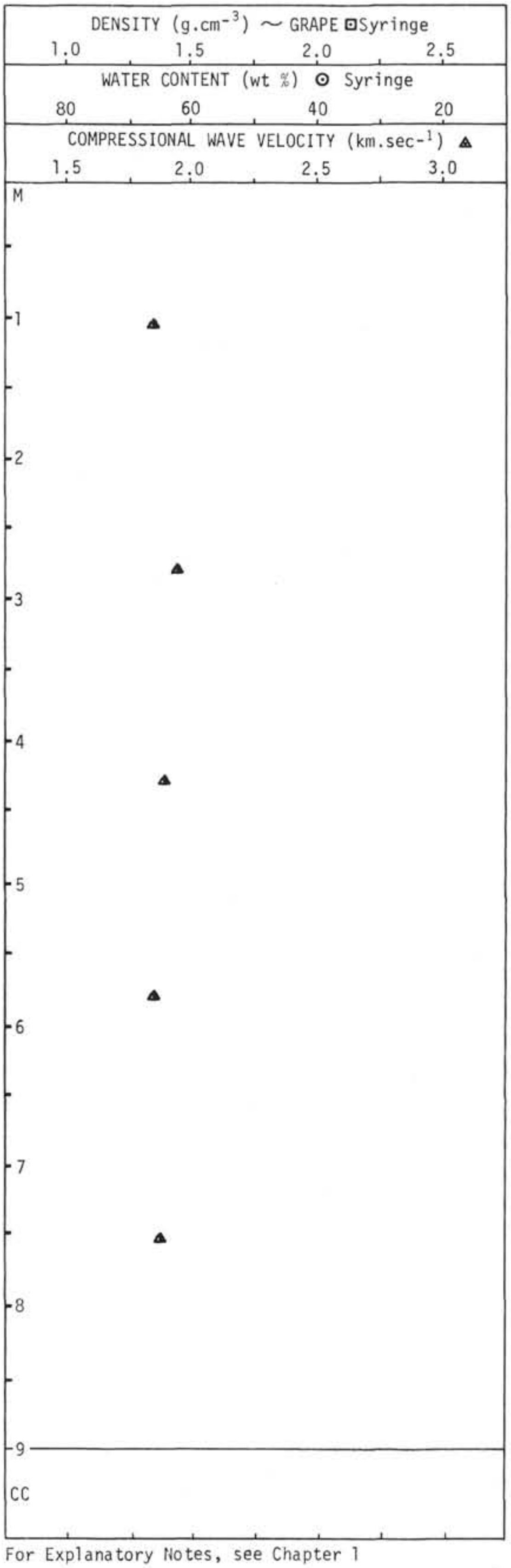

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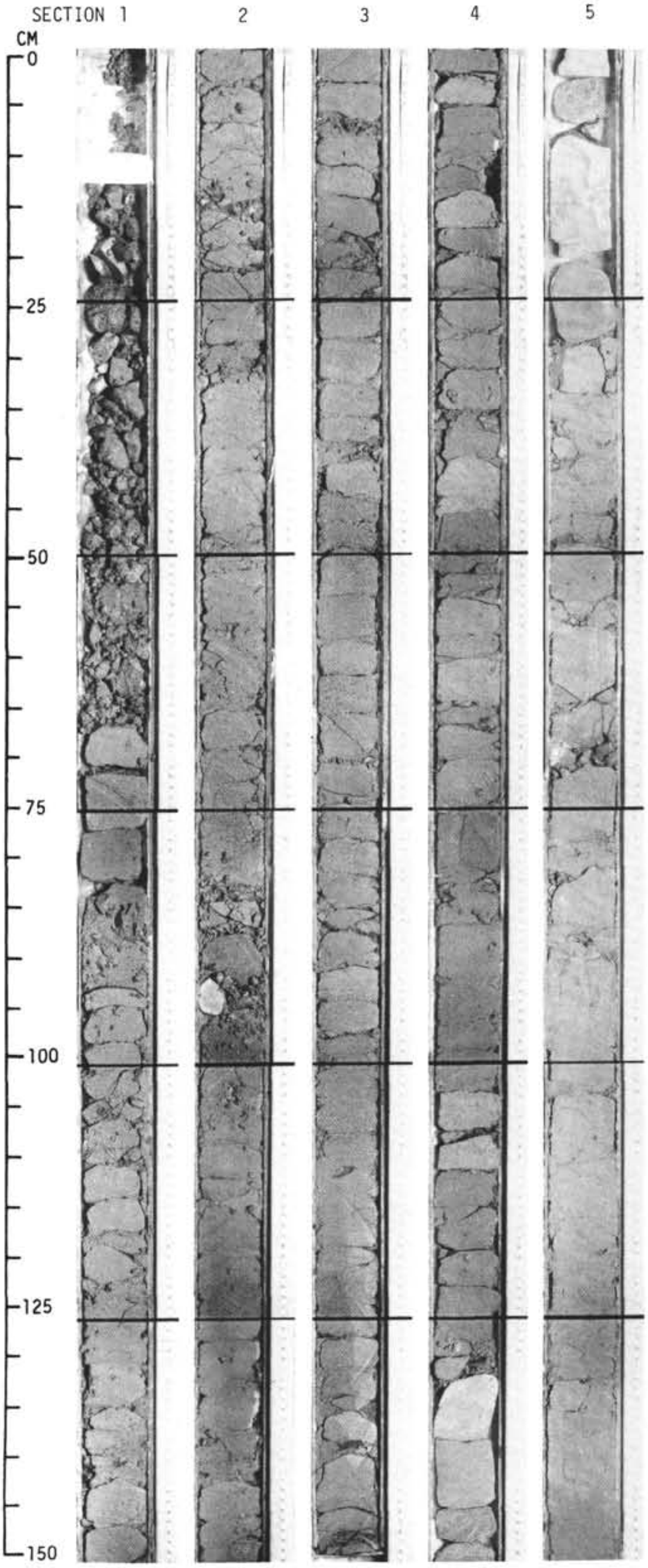

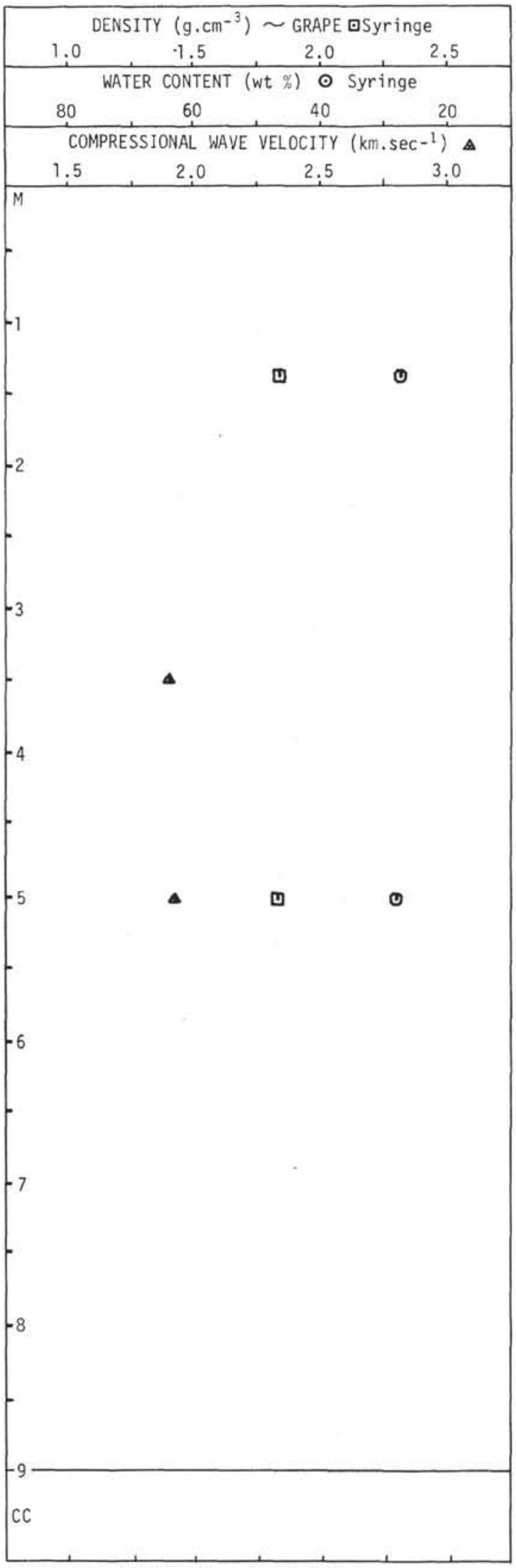

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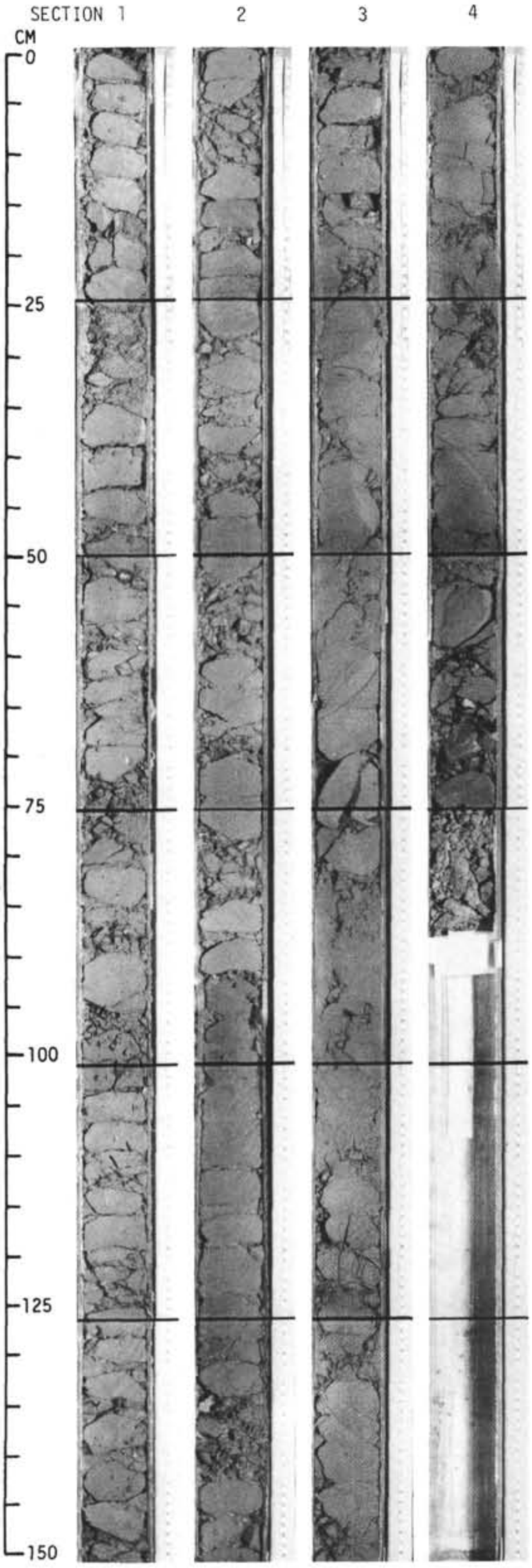

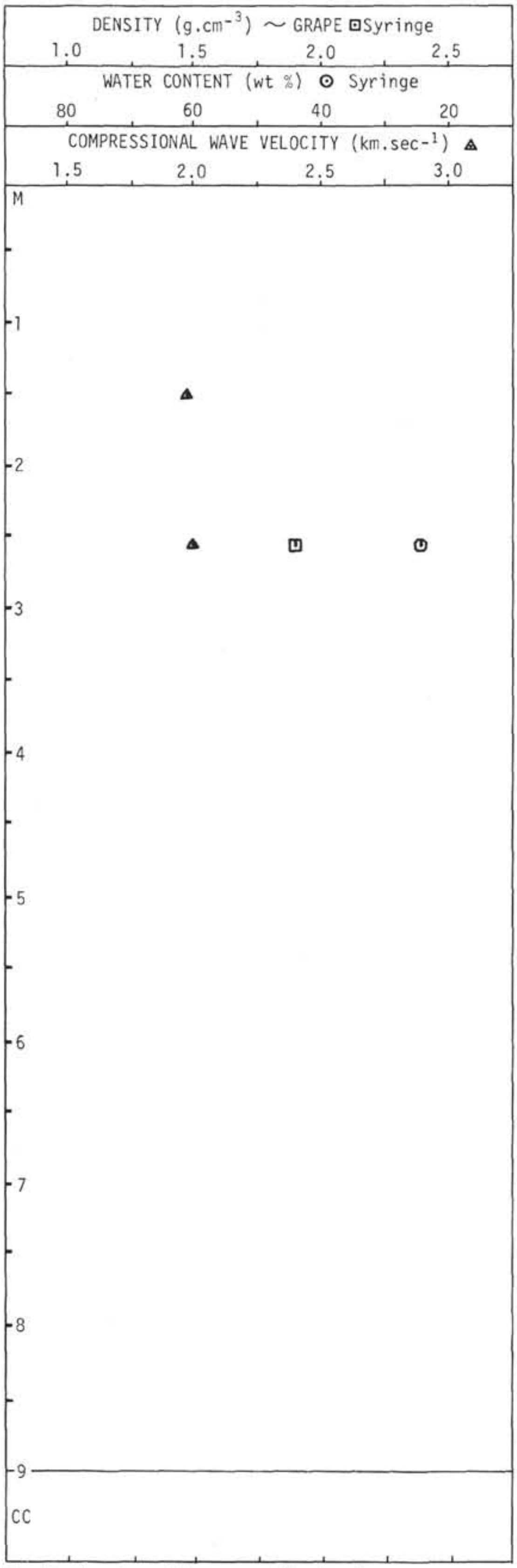

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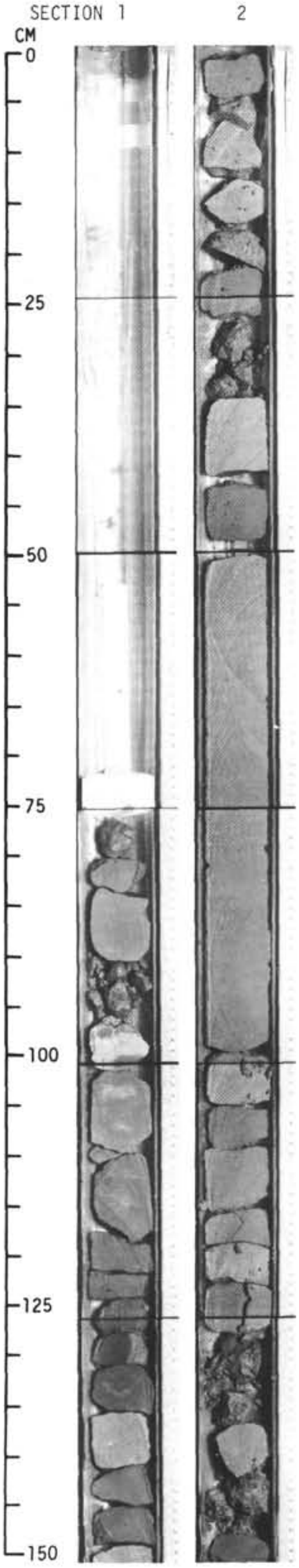

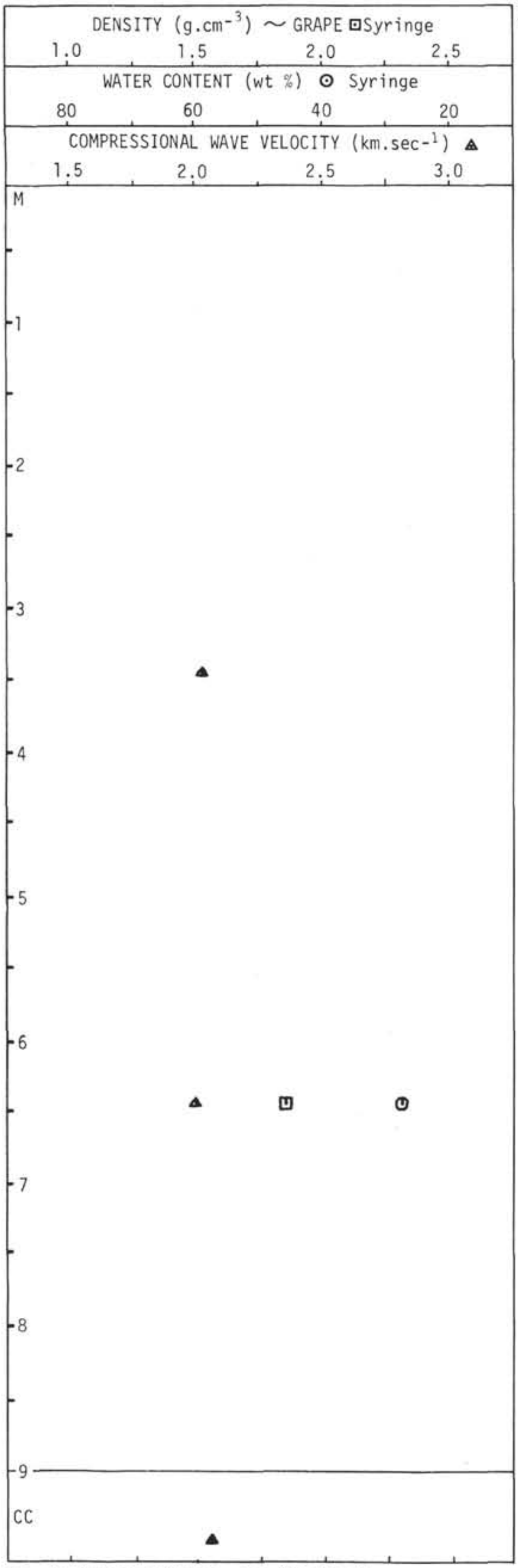

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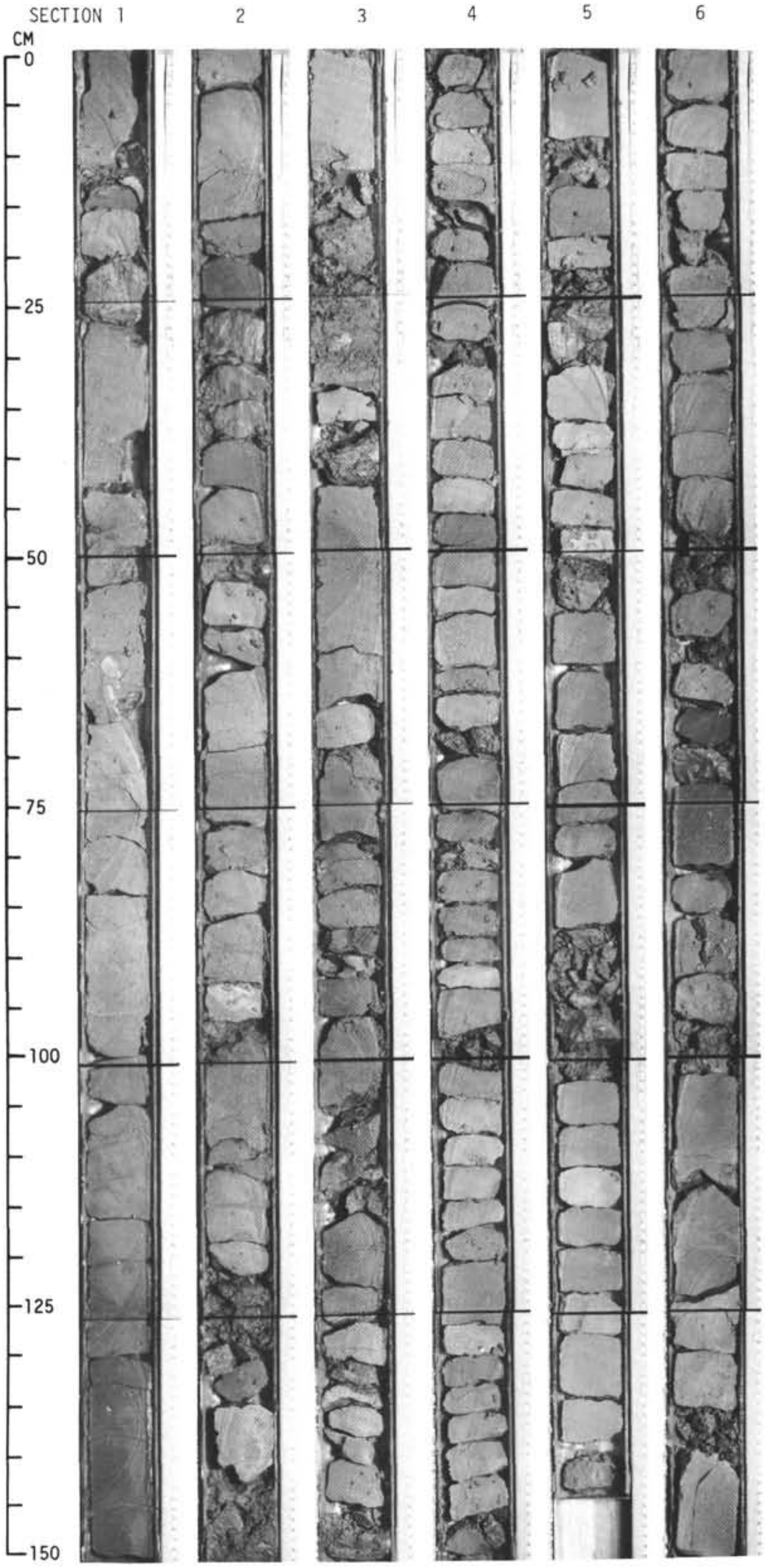

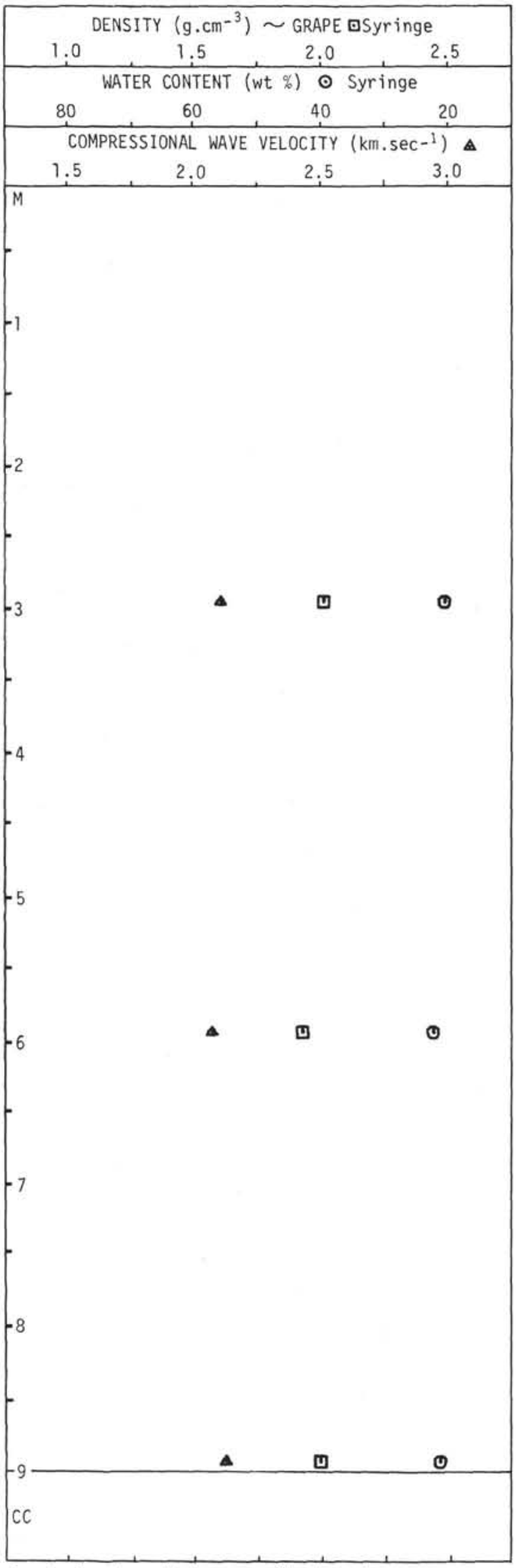

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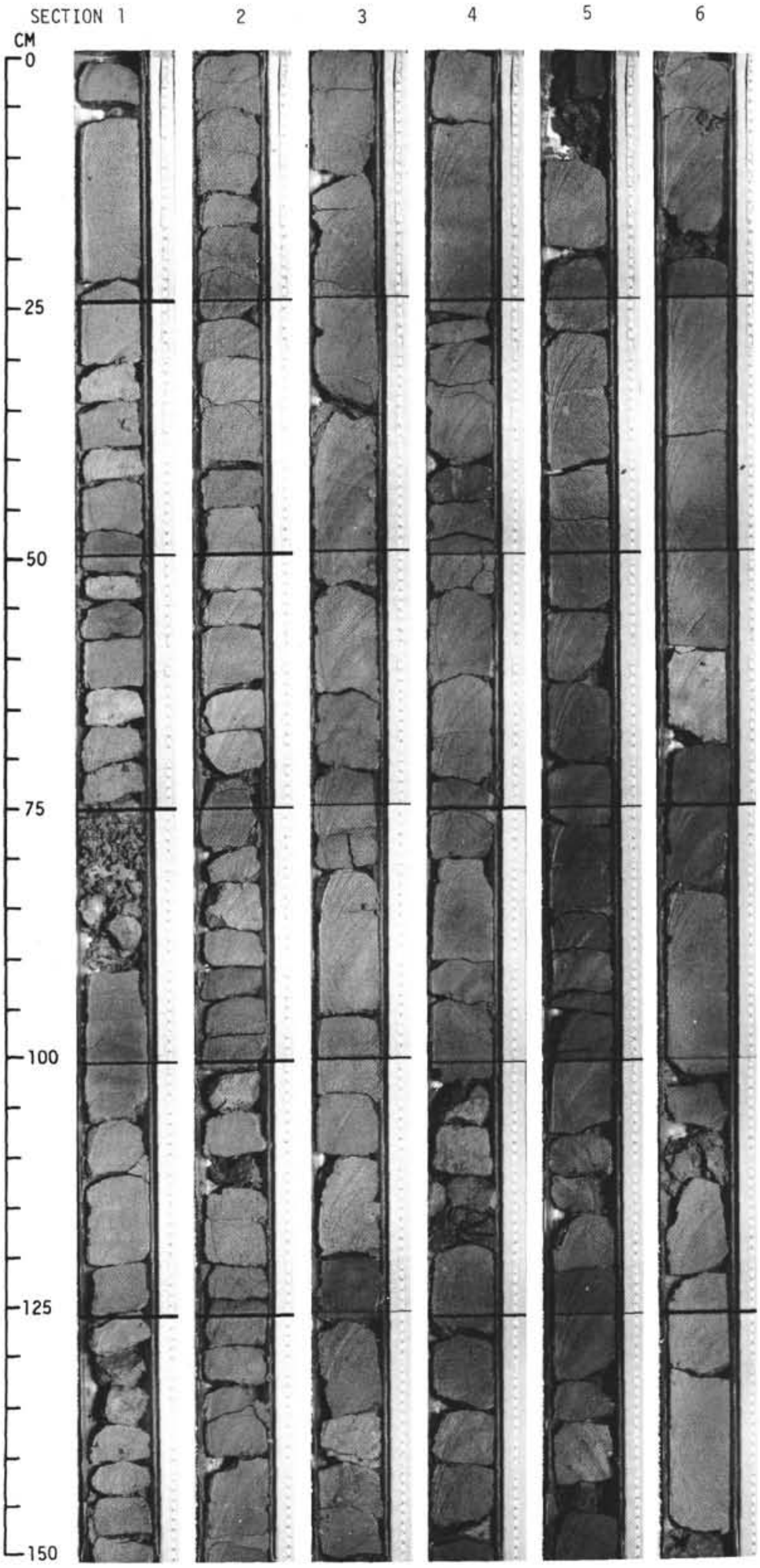

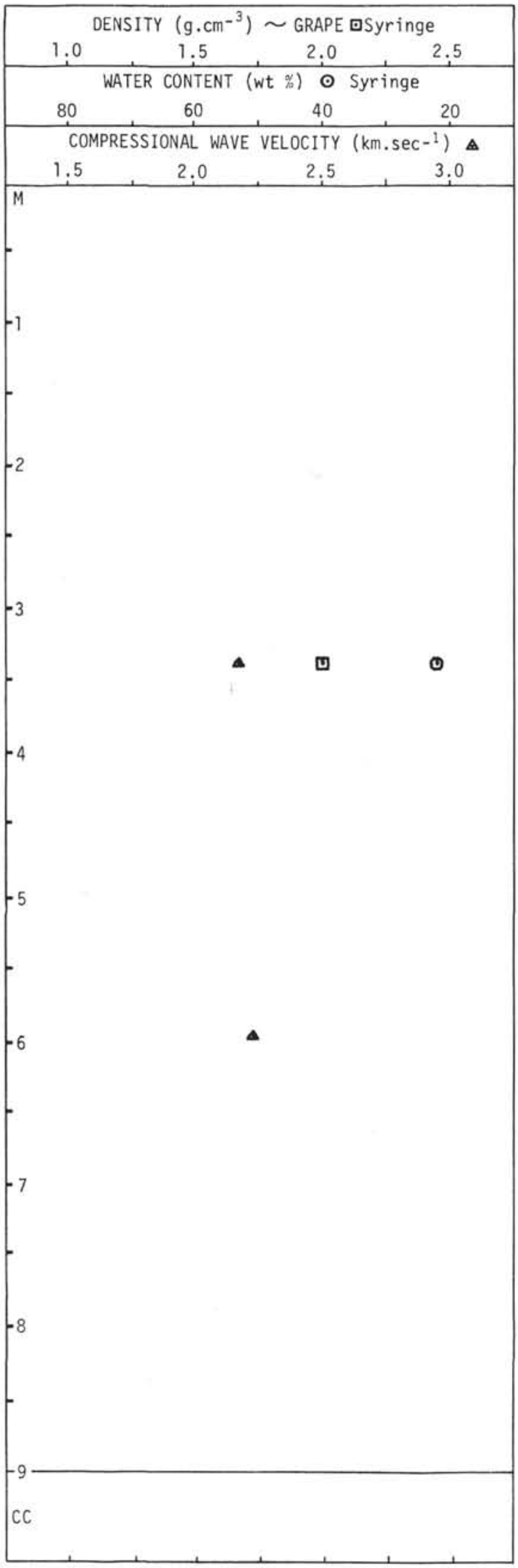

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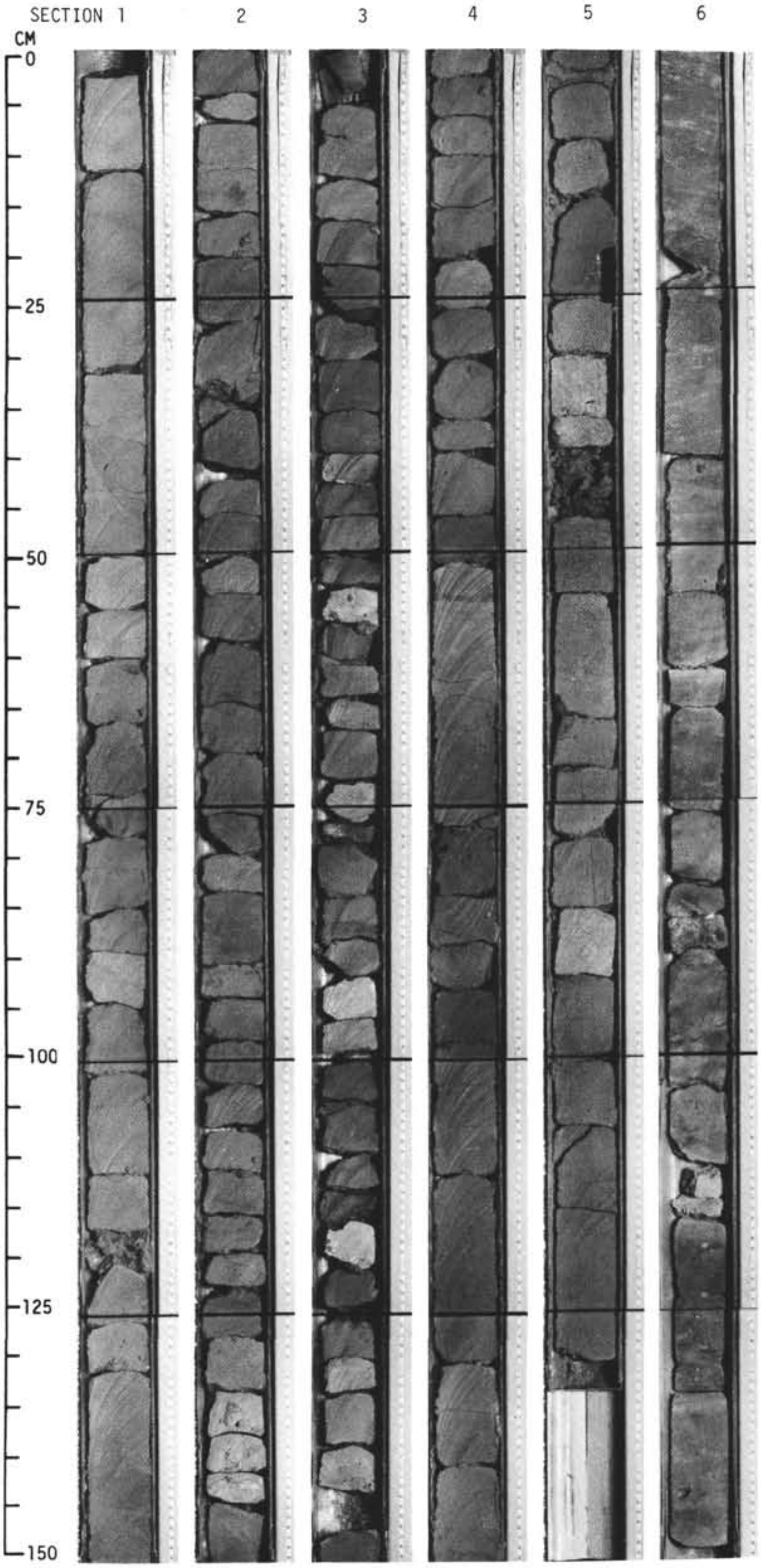

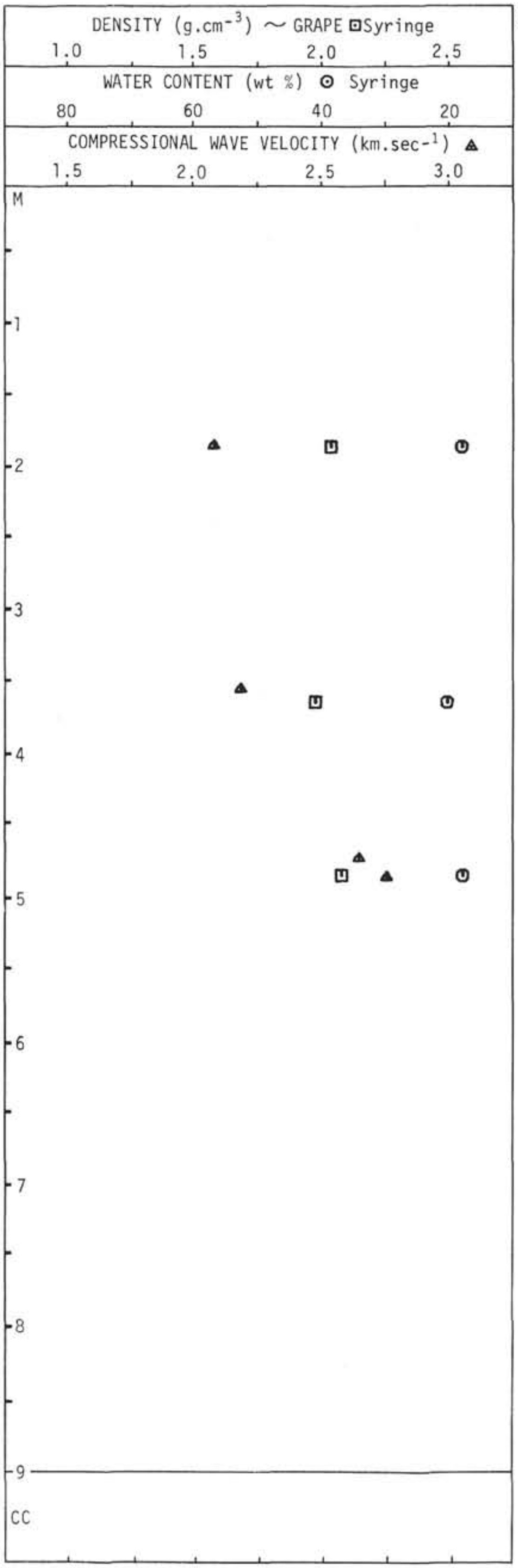

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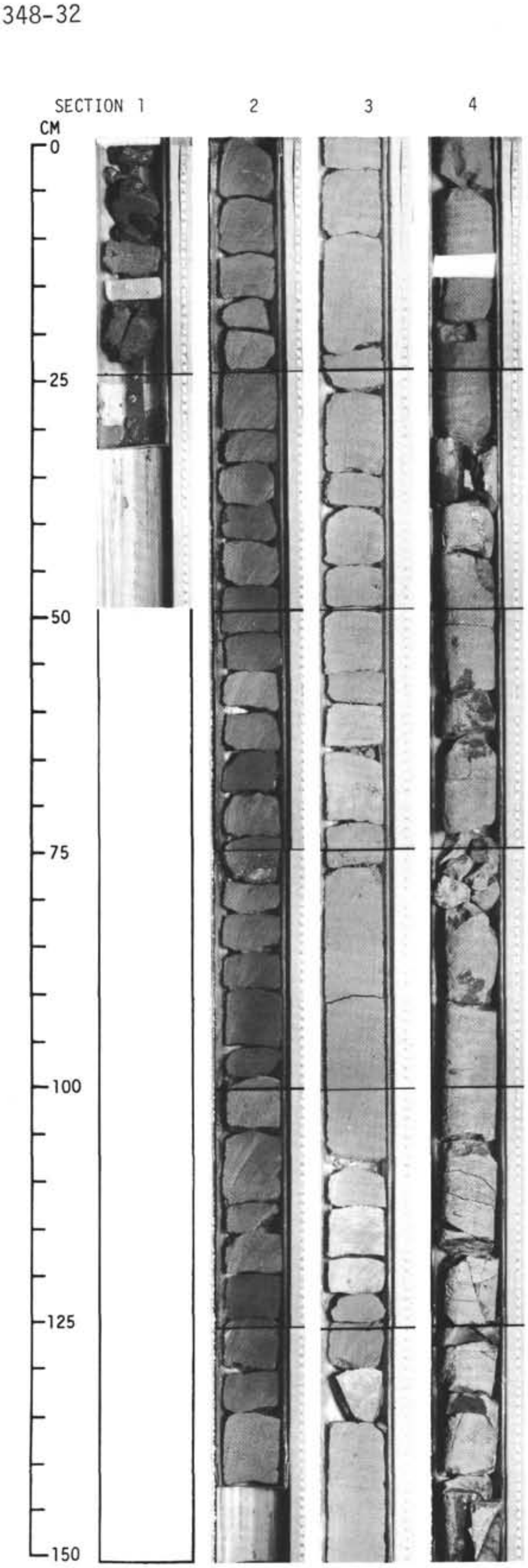

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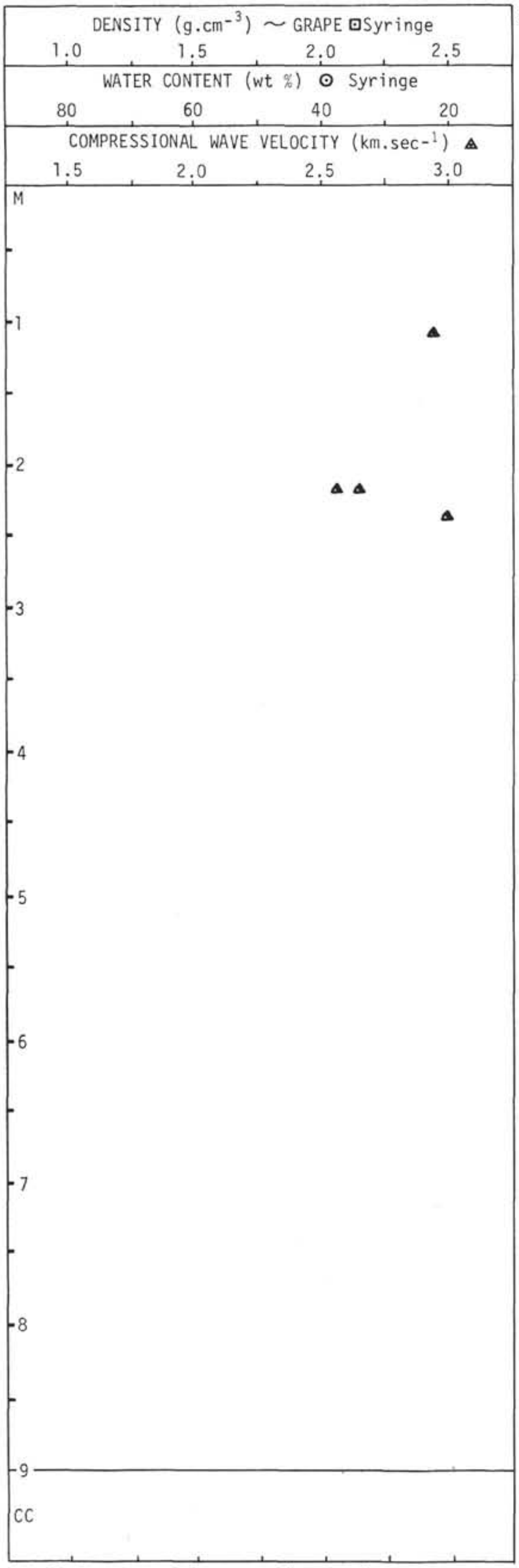

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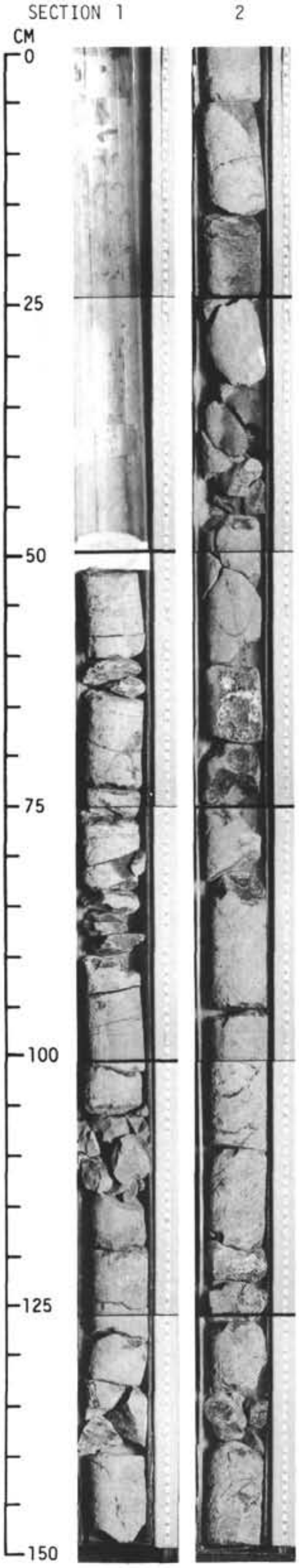

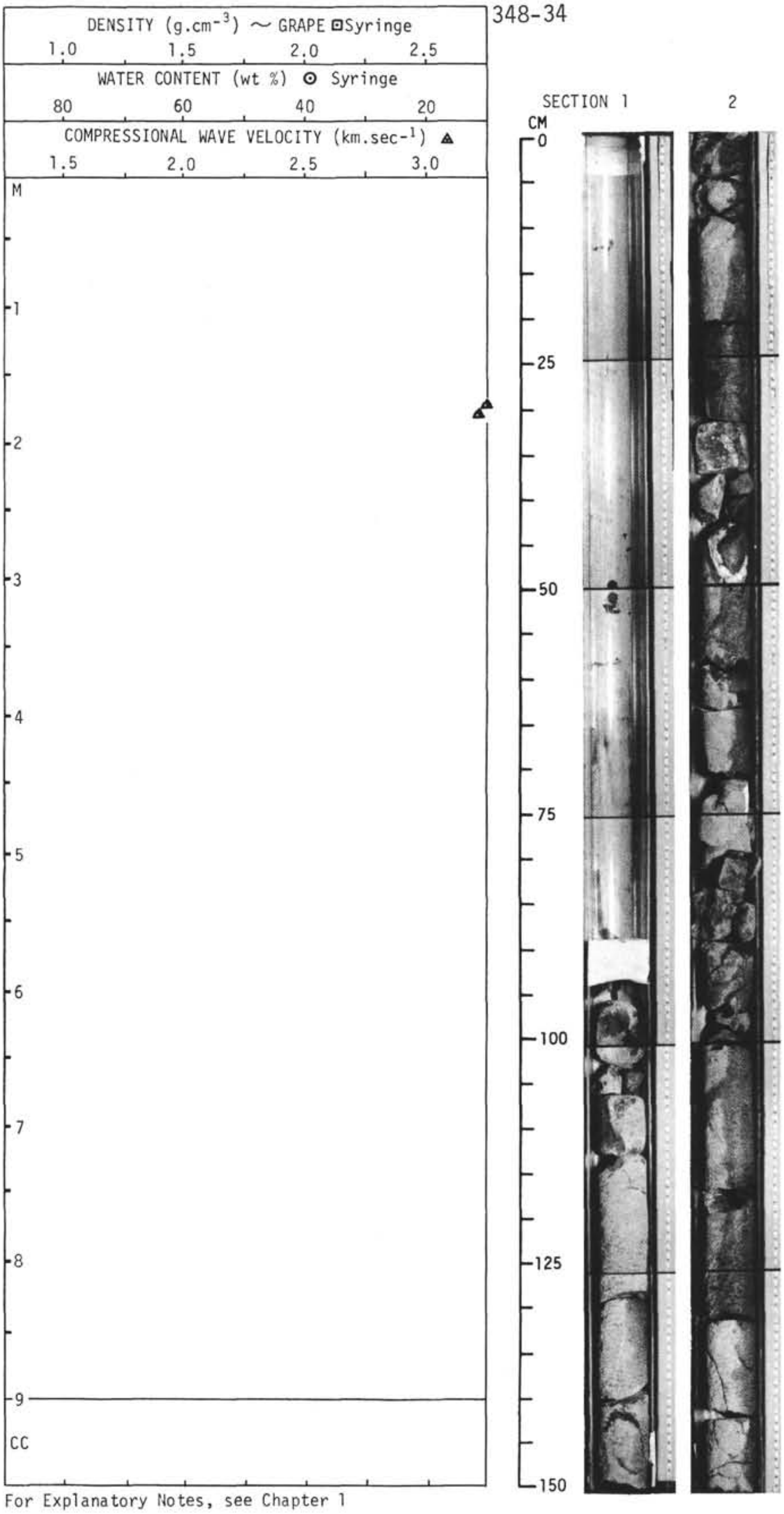

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