4. SITES 338-343

The Shipboard Scientific Party[1]
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SITE DATA, SITE 338

Position: 67°47.11′N; 05°23.26′E

Water depth (from sea level): 1297.0 corrected meters (echo sounding)

Bottom Felt at: 1315.0 meters (drill pipe)

Penetration: 437.0 meters

Number of Cores: 45

Number of Holes: 1

Total Length of Cored Section: 427.5 meters

Total Core Recovered: 209.0 meters

Percentage of Core Recovery: 48.8%

Oldest Sediment Cored:
Depth below sea floor: 408.0 meters
Nature: Sandy mud/mudstone
Age: Early Eocene (Core 42)
Measured velocity: 2.1 km/sec

Basement:
Depth below sea floor: 400.8 meters (drilled)
Nature: Basalt with diabasic texture
Age: K/Ar-46 m.y. (middle Eocene)

Principal Results: A nearly complete section of Tertiary sediments was recovered. The dominant component in the Miocene, Oligocene, and upper and lower Eocene sediments is diatomaceous ooze. Lower Eocene sediments included a large component of sandy muds, deposited over a basalt basement. The age of the basalt determined radiometrically and paleontologically from the overlying sediments is in rough agreement with the age predicted from the sea-floor spreading type magnetic anomalies.

SITE DATA, SITE 339

Position: 67°12.65′N; 06°17.05′E

Water Depth (from sea level): 1262.0 corrected meters (echo sounding)

Bottom Felt at: 1276.0 meters (drill pipe)

Penetration: 108.0 meters

Number of Holes: 1

Number of Cores: 12

Total Length of Cored Section: 108.0 meters

Total Core Recovered: 50.4 meters

Percentage of Core Recovery: 46.7%

Oldest Sediment Cored:
Depth below sea floor: 108.0 meters
Nature: Diatomaceous ooze
Age: Early or middle Oligocene (Core 12)
Measured velocity: ≅2.0 km/sec

Principal Results: This site was on a diapir on the Inner Vøring Plateau. About 75 meters of "glacial" sediments overlie disturbed lower or middle Oligocene diatomaceous oozes. The latter is believed to constitute the diapiric material.

SITE DATA, SITE 340

Position: 67°12.47′N; 06°18.38′E

Water Depth (from sea level): Est. 1206/1217 corrected meters (echo sounding)

Bottom Felt at: 1244.0 meters (drill pipe)

Penetration: 104.5 meters

Number of Holes: 1

Number of Cores: 11

Total Length of Cored Section: 104.5 meters

Total Core Recovered: 67.2 meters

Percentage of Core Recovery: 64.3%

Oldest Sediment Cored:
Depth below sea floor: 104.5 meters
Nature: Diatomaceous ooze
Age: Late Eocene (Core 11)
Measured velocity: ≅1.57 km/sec

Principal Results: This site, about 2200 ft from Site 339, was located on a topographically steeper part of the diapir.

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This difference in location reduced the thickness of the overlying "glacial" sediments to 5 or 10 meters. The remaining 95 meters was in upper Eocene diapiric material. This material, which consists of diatomaceous oozes, is greatly disturbed.

SITE DATA, SITE 341

Position: 67°20.10′N; 06°06.64′E

Water Depth (from sea level): 1439.0 corrected meters (echo sounding)

Bottom Felt at: 1443.5 meters (drill pipe)

Penetration: 456.0 meters

Number of Holes: 1

Number of Cores: 34

Total Length of Cored Section: 313.5 meters

Total Core Recovered: 213.9 meters

Percentage of Core Recovery: 68.2%

Oldest Sediment Cored:
Depth below sea floor: 456.0 meters
Nature: Transitional biogenic siliceous (diatomite)
Age: Middle Miocene (Core 34)

Principal Results: At this site, a thick sequence (323 m) of "glacial" sediments, overlies middle Miocene sediments. The thick "glacial" sequence included allochthonous material of Miocene, Oligocene, and Pliocene sediments, presumably obtained by slumping and erosion from nearby diapiric bodies. Also included were Pleistocene sediments containing shallow water benthonic fauna. The Miocene diatomaceous oozes contained methane and traces of ethane. Soluble hydrocarbons were detected in the middle Miocene sediments, and further penetration was stopped.

SITE DATA, SITE 342

Position: 67°57.04′N; 04°56.02′E

Water Depth (from sea level): 1303.0 corrected meters (echo sounding)

Bottom Felt at: 1316.0 meters (drill pipe)

Penetration: 170.5 meters

Number of Holes: 1

Number of Cores: 8

Total Length of Cored Section: 75.5 meters

Total Core Recovered: 49.8 meters

Percentage of Core Recovery: 65.9%

Oldest Sediment Cored:
Depth below sea floor: 151.5 meters
Nature: Diatomaceous oozes
Age: Early Miocene (Core 6)
Measured velocity: 1.59 km/sec (Core 5)

Basement:
Depth below sea floor: 153.2 meters (drilled)
Nature: Holocrystalline basalt
Age: K/Ar-44 to 46 m.y. (middle Eocene)

Principal Results: This site is located on the Vøring Plateau on the landward side of the Vøring Plateau escarpment. The results are very similar to those from Site 338, except that the Eocene sediments are missing, and lower Miocene sediments rest directly on basaltic basement.

SITE DATA, SITE 343

Position: 68°42.91′N; 05°45.73′E

Water Depth (from sea level): 3131.0 corrected meters (echo sounding)

Bottom Felt at: 3165.0 meters (drill pipe)

Penetration: 284.0 meters

Number of Holes: 1

Number of Cores: 16

Total Length of Cored Section: 132.0 meters

Total Core Recovered: 59.3 meters

Percentage of Core Recovery: 44.9%

Oldest Sediment Cored:
Depth below sea floor: 282.0 meters
Nature: Turbidites, muds, sandy muds
Age: Early Eocene (Core 16)

Basement:
Depth below sea floor: 251.3 meters (drilled)
Nature: Highly altered basalt
Age: K/Ar-30 m.y. (late Oligocene)

Principal Results: This site is located at the eastern margin of the Lofoten Basin, at the foot of the Vøring Plateau. It lies on a well-developed magnetic lineation which has been identified as anomaly 23 on the Heirtzler time scale. The hole penetrated 253 meters of sediment, of which 108 meters were "glacial." The interval from 108 to 146 meters was washed, and middle Eocene sediments lie below this interval. Thus, any post-Eocene Tertiary sediments are either absent, or have a total thickness less than 38 meters. The "glacial" sediments consist of varying percentages of terrigenous sediments (muds, sandy muds, and fine sands), and biogenic oozes (principally nannoplankton). The upper part of the lower Eocene is dominated by biogenic oozes, while the lowest 50 meters is almost completely terrigenous, with turbidites being present. The underlying basalt is highly altered.

BACKGROUND AND OBJECTIVES, SITES 338-343

Introduction

Sites 338 and 343 were located on or very close to the Vøring Plateau (Figure 1). This plateau is a prominent feature of the Norwegian continental margin. Its top is nearly flat at a depth of about 700 fathoms (1300 m). To the north, it slopes down to the Lofoten Basin and to the southwest to the Jan Mayen Fracture Zone and the Norway Basin. The steepest part of both the northern and the southwestern slopes lies between 1000 and 1500 fathoms (1800 and 2700 m). To the southeast, there is a more gentle slope up to the continental margin off Norway.

Structurally the Vøring Plateau is divided into two parts by a buried southwest-northeast escarpment, the Vøring Plateau Escarpment (Talwani and Eldholm, 1972). The Outer Vøring Plateau lies on the seaward side of the escarpment: the Inner Vøring Plateau lies on the landward side.

Acoustic basement is shallow under the Outer Vøring Plateau and forms a ridge which slopes down to the northwest. The crest of the ridge is at its shallowest between 67° and 68°N, the subbottom depth to the ridge being less than 0.5 km. The ridge crest plunges to

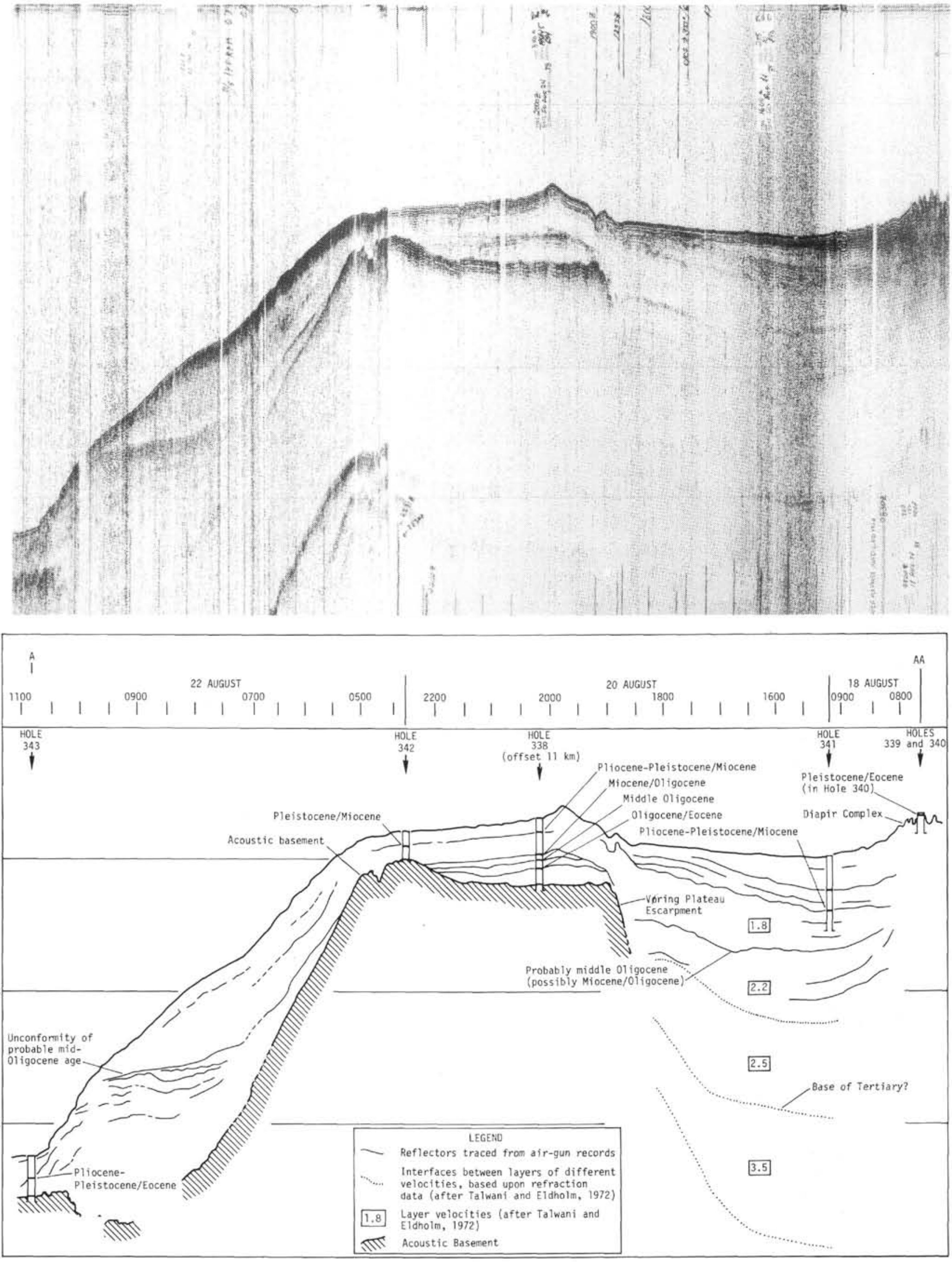

Figure 1. *Profiler record, Sites 338-343 (Vøring Plateau).*

the northeast and to the southwest beyond these latitudes.

The magnetic field, the gravity field, and the pattern of sedimentation are also substantially different on either side of the escarpment. The magnetic field is smooth on the landward side of the escarpment. On the seaward side, it is characterized by lineated anomalies. The free-air gravity anomalies have positive values of about 50 mgal seaward of the escarpment. They are generally negative landward of the escarpment, and in places more negative than -30 mgal. Therefore a pronounced gravity gradient exists across the escarpment.

On the Outer Vøring Plateau, the sediment cover is thinner than on the Inner Vøring Plateau. Except in the northeast and western parts of the Outer Vøring Plateau, the total sediment thickness is less than 1 km. The sediment has low seismic compressional velocities (from seismic refraction measurements), and Talwani and Eldholm (1972) believe it to be Tertiary or younger in age.

On the Inner Vøring Plateau, the sediment thickness is much greater. Seismic reflection profiles are unable to obtain reflections from basement. A number of short sonobuoy seismic refraction profiles are also unable to obtain the depth to basement, although sediment thicknesses of at least about 4 km are indicated. From a longer crustal refraction profile, Hinz (1972) concluded that the depth to a horizon with velocity 6 km/sec (which is presumably basement) is 7 km. On the basis of a number of sonobuoy refraction profiles in the area, Talwani and Eldholm (1972) have presented a generalized picture of the sedimentary layering. Subparallel layers with velocities of 1.8, 2.2, 2.5, 3.5, and 4.4 km/sec exist. The first three layers are probably Tertiary in age, the 3.5 km/sec layer is probably Mesozoic in age, and the 4.4 km/sec layer is Mesozoic, or possibly even Paleozoic in age. Thus in striking contrast with the sediments west of the escarpment, those lying east of the escarpment are much thicker and presumably extend to a much greater age.

Diapirism

A number of diapiric structures have been detected over the thick sedimentary section of the Inner Vøring Plateau (defining Inner as the part lying east of the escarpment). The tops of these diapirs often extend above the general level of the sea bed by as much as 150 meters. Some diapirs appear to outcrop; however, more often they are covered with a small thickness of layered Recent sediments. A core taken on *Vema* cruise 27 on one of these diapiric structures that nearly outcrop, obtained material of late Eocene age (Bjørklund and Kellogg, 1972).

Objectives

Drilling at Sites 338 and 343 was aimed at resolving various problems related to the Vøring Plateau which have an application to the genesis of all continental margins. A principal question is the nature and age of basement. The depth to basement is too large for the drill string to reach on the landward side of the escarpment. However, on the seaward side it is within reach. Holes at Sites 338, 342, and 343 were designed to reach basement. Site 343 lies over a well-developed magnetic lineation which has been identified as anomaly 23. The identification of magnetic anomalies at Sites 342 and 338 is less clear, but they apparently lie on sea floor with an age older than that of anomaly 24. Site 343 lies at the foot of the Vøring Plateau in the Lofoten Basin, while Sites 338 and 342 lie on top of the basement high seaward of the Vøring Plateau Escarpment. The differences in the nature and age of basement at these three locations is of great interest.

Comparison of the sedimentary sections at Sites 338, 341, and 342 would be of great interest. If the cores from Site 338 represent a complete sedimentary sequence seaward of the escarpment, as the reflection profiler records appear to suggest, the difference between these cores, and those obtained at Site 341, which lies landward of the escarpment and also appears from reflection records to have a complete sequence, would give us information about the influence of the escarpment on sedimentary processes. If we compare the reflection records at Sites 338 and 342, a basal layer present at Site 338 is missing at Site 342. This basal layer is missing at other points on the outer Vøring Plateau where the basement forms a peak. The nature of the missing section will again give us information about the past sedimentary environment of the Outer Vøring Plateau.

Holes at Sites 339 and 340 were specifically designed to pierce the diapirs. They were expected to provide information about the nature of the diapiric material, as well as any other old sediments that the diapir may have brought up with it to the surface.

Sites 338 and 341, where more or less continuous coring was planned through the Pleistocene, were expected to yield information both about the onset of glaciation, as well as the details of the glacial record.

OPERATIONS, SITE 338

Approach to Site 338

The approach was from the southwest on heading 057° and at normal speed. At 1610Z, the heading was altered to 067°, and the speed decreased to 6 knots. During this time, *Glomar Challenger* was on the seaward side of the Vøring Plateau Escarpment, and traveling nearly parallel to it. The course was altered at 1746Z to 117° in order to cross the escarpment. At 1907Z, the course was altered to 320° to recross the escarpment, and it was recrossed at about 1930Z (Figure 2). At about 2045Z, the first prominent subbottom reflector appeared to split into two, and the uppermost began to shallow rapidly giving the appearance that it would outcrop. However, since it was hoped to also sample the overlying layer, the course was altered to 250° at 2114Z. On this course, the split in the subbottom horizon decreased and the overlying layer thickened again. The 13.5-kHz beacon was dropped at 2128Z. *Glomar Challenger* continued on same course and speed until 2143Z, at which time a Williamson turn was made and the gear was pulled in. The ship maneuvered to occupy the position of the beacon drop (Figure 3).

Drilling Operations

The same type bit and BHA, as employed at Sites 336 and 337, with the inclusion of the formation tester was used. After flushing the drill string clean, continuous

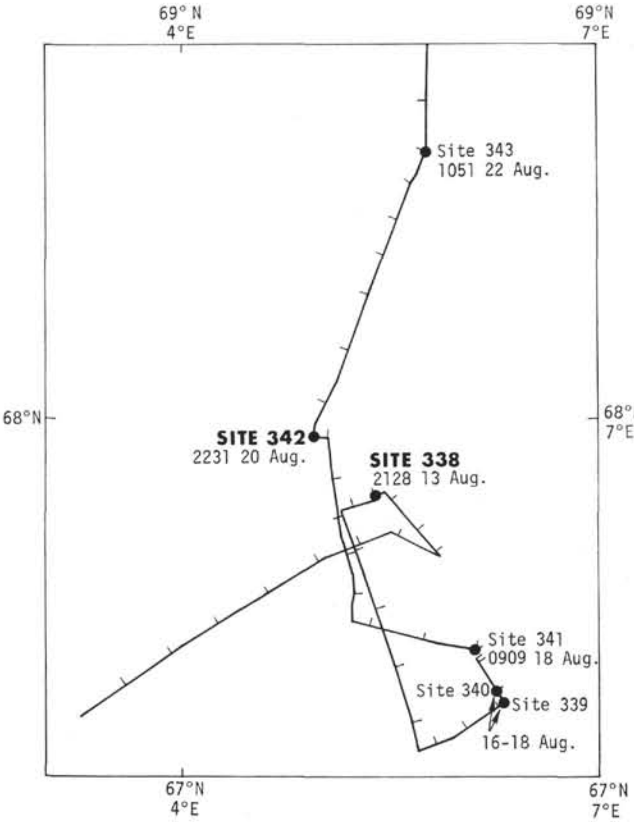

Figure 2. *Track chart, Sites 338 and 342.*

coring commenced from the sea bed located at 1315 meters (drill pipe measurement).

After the initial five cores (47 m which averaged some 11.5 m/hr AROP and with 50% recovery), the merits of the core/wash technique were assessed; however, it was decided to continuously core the hole.

Occasional poor recoveries (1400/1419 m) were attributed to the sand-like consistency of some intervals; and, in some instances, to the plasticity of the material, which readily extruded through the core catcher and plastic sock. Recoveries from 1419 meters to 1581 meters averaged 52%. From 1581 to basement at 1716.8 meters recoveries fluctuated between 3% and 100%, averaging 54%. Recoveries from basement (1716.8 to 1752 m) averaged 40%, with an AROP of 3.4 m/hr. Overall recovery was 208.7 meters from 427.5 meters cored, or 48.8% (Table 1).

Hole conditions remained clean and stable during the whole operation. Two temperature surveys were successfully run at 1391 meters and 1495.5 meters. No evidence of hydrocarbons was encountered, although there was evidence of nitrogen. The hole was abandoned according to the relevant safety regulations at 0815 hr, 16 August. *Glomar Challenger* was underway for Site 339 at 1330 hr, 16 August with a detour over Site 338 for corroborative seismic data.

OPERATIONS, SITES 339 AND 340

Approach to Sites 339 and 340 and Site Survey

On completion of drilling at Site 338, it was decided to run a sonobuoy, in a direction roughly parallel to the strike of the escarpment. The ship got underway at 1230Z at 145 rpm on course 075°. A Williamson turn was started at 1248Z and completed at 1300Z, at which time the ship was steady on course 255°. A first sonobuoy malfunctioned, and a second sonobuoy was dropped at 1305Z. At 1318Z, the beacon was on the starboard beam at 1097.5 m (3600 ft).

At 1418Z, the sonobuoy profile was completed, speed was increased to 210 rpm, and the course altered to 164°. The ship was now headed across the escarpment, which was crossed shortly after 1500Z. At 1862Z, the speed was reduced to 145 rpm and the heading altered to 057°. From an earlier *Vema* crossing along the same azimuth, it was known that two diapiric ridges would be encountered, and it had been decided to core on the eastern one. *Glomar Challenger* crossed the western diapir peak before 2100Z, and then crossed over a valley to the second diapir ridge (Figure 4). The 16-kHz beacon was dropped at 2110Z, not on the peak of the second (eastern) ridge, but some distance further east of it at a greater depth. The ship continued on the same course for about 15 min, the gear was then retrieved, and the ship maneuvered to return to the site of the beacon drop (Figure 5).

Site 340 was on the same diapir ridge as 339, about 2200 feet along the azimuth from Site 339. The same beacon was used for both stations. Site 340 was estimated to be on the steep slope just east of the peak of the eastern diapir ridge (Figure 5). The PDR showed several side echoes, and the best depth estimate is made from the drill pipe length.

Drilling Operations, Site 339

The same type bit and BHA as previously employed was run, without the RFT (Recoverable Formation Tester). After flushing the drill string clean, continuous coring commenced from the sea bed at 1276 meters (drill pipe measurement).

Initial penetration rates were higher than predicted conditions suggested. From spudding at 0345 hr, 17 August, overall AROP (average rate of penetration) to total depth at 1384 meters was 13.5 m/hr, fluctuating between 12.7 and 16. Core recoveries varied from 24% to 91%, averaging 52.5% (Table 2). The average was low due to a completely empty barrel (1350.5-1360 m).

Because this site was located in a diapiric structure and limited to a nominal 100 meters maximum penetration, strict core monitoring measures were enforced for safety/control; core-catcher samples were immediately assessed for salinity prior to coring ahead, and core samples were checked for fluorescence and other warning signs of hydrocarbon/structural hazards. No evidence of hydrocarbons was encountered.

The hole, which remained clean throughout, was filled with barite mud according to relevant abandonment regulations. The bit was pulled some 200 meters above the sea bed level by 1400 hr, and *Glomar Challenger* commenced moving towards Site 340 at 1330 hr, 17 August.

Drilling Operations, Site 340

Glomar Challenger moved 600.6 meters (1970 ft) northwest of Site 339 to Site 340, 17 August. At 1615 hr

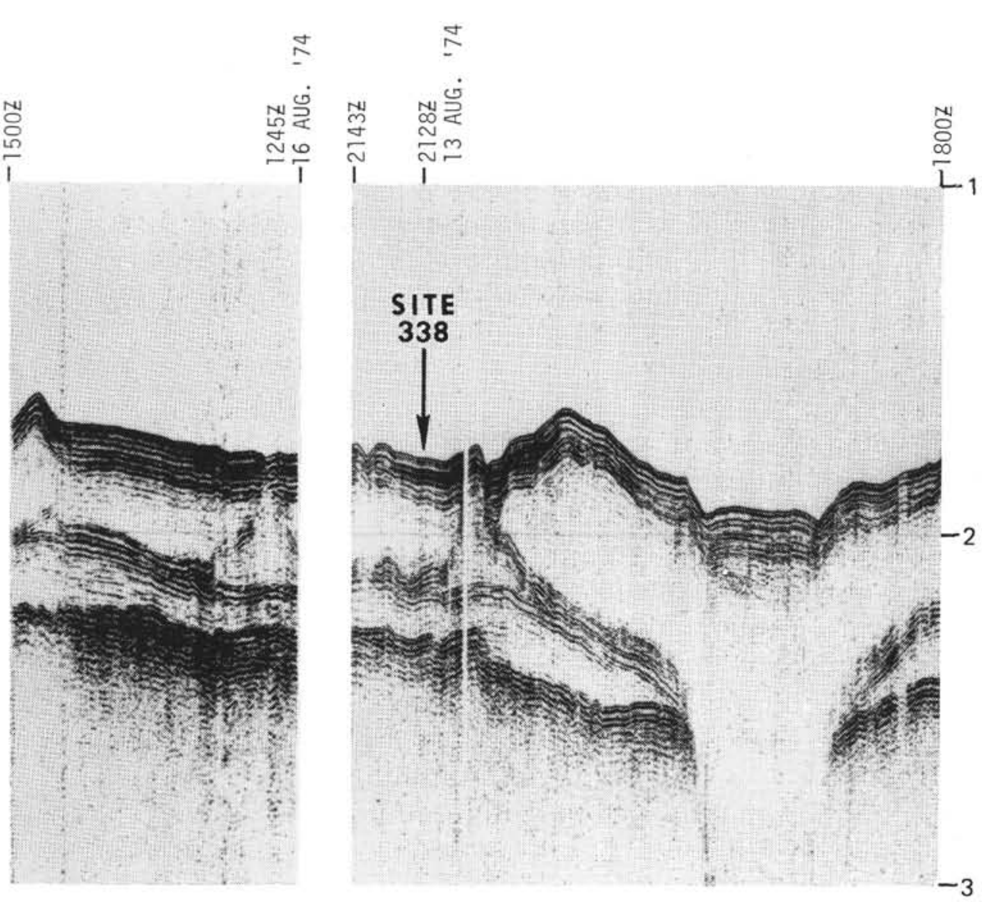

Figure 3. *Profiler record, Site 338.*

the BHA assembly was run down to sea bed, which was located at 1244 meters (drill pipe measurement).

Continuous coring commenced at sea bed (1244 meters) and continued to the final depth of 1348.5 meters, with generally good recoveries over the 104.5 meters cored, averaging 64.3% in the relatively uniform clay formation (Table 3). Coring was interrupted twice by loss of hydraulic power to the power swivel and coring reel due to the electric motor circuits being tripped off the switchboard.

Because this site, like Site 339, was located on a diapiric structure, and limited to a nominal 100 meters maximum penetration, core monitoring measures were enforced for safety/control. No evidence of hydrocarbons was encountered.

The hole, which remained clean throughout, was filled with barite mud to meet the relevant abandonment regulations. The bit was pulled above the sea bed at 0445 hr, 18 August, and *Glomar Challenger* departed for Site 341 at 0748 hr.

OPERATIONS, SITE 341

Approach to Site 341 from Site 340

The ship left Site 340 at 0648Z on course 140°. The underway geophysical gear was streamed at 0703Z. A Williamson turn was started and completed at 0715.5Z, at which time the ship was steady on course 328°. At 0734.5Z, the beacon was abeam to port at 609.8 meters (2000 ft) (Figure 4). A first beacon was dropped at 0927Z, but it was judged that the subbottom layering was not clear, so a second beacon was dropped at 1009Z. The ship continued on the same speed and course until 1029Z, when the gear was pulled in, and the ship maneuvered to reoccupy to site of the beacon (Figure 1).

Drilling Operations

The same bit/BHA assembly as previously employed at Site 340 was run. After flushing the drill stem, the sea bed was tagged at 1443.5 meters (drill pipe measurement) at 1615 hr, 18 August. It was decided to include the RFT, complete with circulating sub, in the string as the significant thickness of sediments could possibly provide the formation competence for a functional evaluation test.

Continuous coring was undertaken for 105.5 meters, from 1443.5 meters to 1557.5 meters. The core/wash technique was adopted from 1557.5 to 1833 meters. Between 1548 and 1681 meters, occasional poor core recoveries were experienced. At 1549 meters, persistent plugging required the premature pulling of the core to regain circulation through the string.

Continuous coring recommenced from 1833.0 meters (389.5 penetration) and continued to total depth at 1899.5 meters. From the 34 cores cut totaling 313.5 meters, there was a recovery of 213.9 meters or 68.2 (Table 4).

TABLE 1
Coring Summary, Site 338

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	14	0725	1315.0-1324.5	0-9.5	9.5	6.3	66.3
2	14	0825	1324.5-1334.0	9.5-19.0	9.5	5.0	53.0
3	14	0910	1334.0-1343.5	19.0-28.5	9.5	5.0	53.0
4	14	1005	1343.5-1353.0	28.5-38.0	9.5	5.5	58.0
5	14	1055	1353.0-1362.5	38.0-47.5	9.5	8.0	84.2
6	14	1215	1362.5-1372.0	47.5-57.0	9.5	3.5	37.0
Washed			1372.0-1381.5	57.0-66.5			
7	14	1303	1381.5-1391.0	66.5-76.0	9.5	0.3	3.0
8	14	1500	1391.0-1400.5	76.0-85.5	9.5	4.8	51.0
9	14	1545	1400.5-1410.0	85.5-95.0	9.5	1.2	12.6
10	14	1633	1410.0-1419.5	95.0-104.5	9.5	2.2	23.0
11	14	1720	1419.5-1429.0	104.5-114.0	9.5	5.8	57.0
12	14	1810	1429.0-1438.5	114.0-123.5	9.5	3.4	35.8
13	14	1910	1438.5-1448.0	123.5-133 0	9.5	8.7	91.6
14	14	1955	1448.0-1457.5	133.0-142.5	9.5	4.6	48.1
14	14	2030	1457.5-1467.0	142.5-152.0	9.5	8.0	84.0
16	14	2105	1467.0-1476.5	152.0-161.5	9.5	6.2	64.7
17	14	2145	1476.5-1486.0	161.5-171.0	9.5	5.3	55.8
18	14	2220	1486.0-1495.5	171.0-180.5	9.5	2.8	29.5
19	15	2400	1495.5-1505.0	180.5-190.0	9.5	7.0	73.6
20	15	0105	1505.0-1514.5	190.0-199.5	9.5	6.4	67.4
21	15	0155	1514.5-1524.0	199.5-209.0	9.5	2.5	26.3
22	15	0255	1524.0-1533.5	209.0-218.5	9.5	9.5	100
23	15	0345	1533.5-1543.0	218.5-228.0	9.5	9.5	100
24	15	0435	1543.0-1552.5	228.0-237.5	9.5	9.0	94.7
25	15	0530	1552.5-1562.0	237.5-247.0	9.5	1.9	20.0
26	15	0635	1562.0-1571.5	247.0-256.5	9.5	7.2	75.8
27	15	0720	1571.5-1581.0	256.5-266.0	9.5	7.3	76.8
28	15	0800	1581.0-1590.5	266.0-275.5	9.5	2.1	22.1
29	15	0855	1590.5-1600.0	275.5-285.0	9.5	4.3	45.3
30	15	0945	1600.0-1609.5	285.0-294.5	9.5	8.0	84.0
31	15	1030	1609.5-1619.0	294.5-304.0	9.5	2.5	26.3
32	15	1135	1619.0-1628.5	304.0-313.5	9.5	9.5	100
33	15	1224	1628.5-1638.0	313.5-323.0	9.5	9.0	94.7
34	15	1315	1638.0-1647.5	323.0-332.5	9.5	0.3	3.2
35	15	1415	1647.5-1657.0	332.5-342.0	9.5	1.9	20.0
36	15	1530	1657.0-1666.5	342.0-351.5	9.5	0.3	3.2
37	15	1605	1666.5-1676.0	351.5-361.0	9.5	3.1	32.6
38	15	1700	1676.0-1685.5	361.0-370.5	9.5	1.2	12.6
39	15	1800	1685.5-1695.0	370.5-380.0	9.5	2.4	25.3
40	15	1900	1695.0-1704.5	380.0-389.5	9.5	1.4	14.7
41	15	1943	1704.5-1714.0	389.5-399.0	9.5	2.1	22.1
42	15	2130	1714.0-1723.5	399.0-408.5	9.5	2.6	28.4
43	16	0150	1723.5-1733.0	408.5-418.0	9.5	5.0	52.0
44	16	0535	1733.0-1742.5	418.0-427.5	9.5	4.0	42.1
45	16	0805	1742.5-1752.0	427.5-537.0	9.5	2.4	24.7
Total			1752.0	437.0	427.5	209.0	48.8

As the hole was deepened beyond 1500 meters, the initial faint trace of methane gas became increasingly strong and persistent. At 1557 meters and as warranted thereafter, tests to identify the presence of clathrates were made. However, there were negative results. Strict core monitoring and continuous coring from 400 meters below sea bed were enforced for safety control. From 1880 meters, there was increasing evidence of methane gas and possible soluble hydrocarbons. Accordingly, it was decided to terminate coring and seal the hole. Up to this point, hole condition remained good, and there was no repetition of the fill experienced at 1549 meters.

The hole was abandoned according to regulations by emplacing 40 bbl of 1.8 S.G. cement slurry to fill the hole from the bottom at 1899.5 meters to 1779.5 meters, using the balanced cementing technique. The bit was slowly pulled back 123.5 meters to 1776 meters, and the drill string and annulus circulated clean. Finally, a 120-bbl barite mud plug was emplaced to completely fill the hole from 1776 meters to sea bed at 1443.5 meters. The drill string was pulled slowly out of the hole to ensure proper plug deposition and to avoid any swabbing tendency. The bit was clear of the sea bed by 1225 hr, 20 August.

Glomar Challenger was underway for Site 342, an additional site on the schedule, by 1510 hr, 20 August.

OPERATIONS, SITE 342

Approach to Site 342 from Site 341

The ship left Site 341 at 1410Z on course 105° at 145 rpm. Gear was streamed, and a Williamson turn commenced at 1424Z and completed at 1435Z at which time

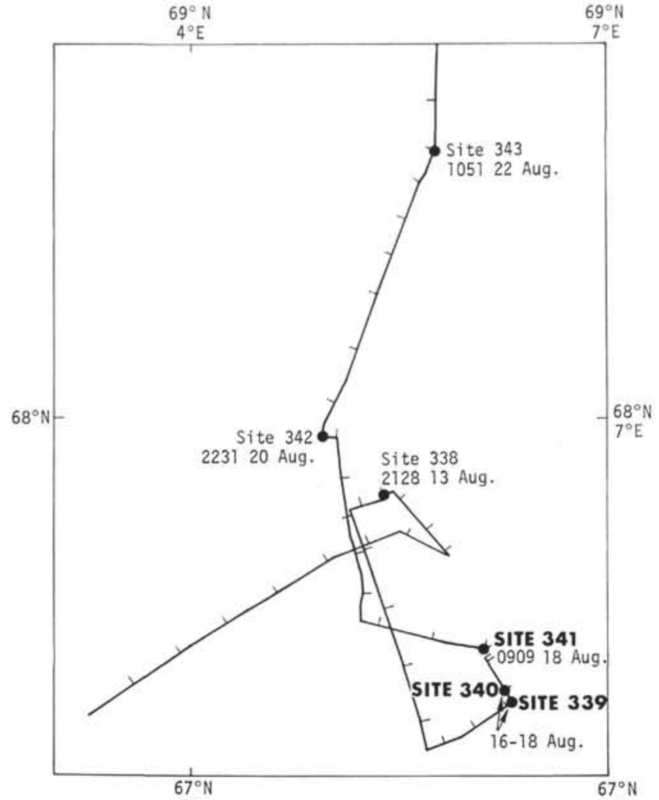

Figure 4. *Track chart, Sites 339, 340, and 341.*

the ship was steady on course 285° (Figure 6). The beacon was passed at 1459Z at a distance of 1371.9 meters (4500 ft) on the port beam; the speed was increased to 210 rpm. At 1720Z, the speed was reduced to 145 rpm, and the course altered to 351°. The ship was now traveling in a direction nearly perpendicular to that of the escarpment. A further change in heading to 340° was made at 1835Z, and the escarpment was crossed a few minutes later.

Since the objective at this site was to get as shallow a depth as possible to basement and since earlier profiles had indicated that basement was shallow to the west, course was altered at 2200Z to 270°. Basement shallowed and the beacon was dropped at 2231Z. The ship continued on the same course and speed until 2241Z, when the gear was pulled, and the ship maneuvered to occupy a position over the beacon (Figure 7).

Drilling Operations

A 13.5-kHz beacon was dropped at 2231 hr, 20 August. After testing the beacon, *Glomar Challenger* was locked on target by the usual procedure. The same bit and BHA, including the Lynes RFT (Retrievable Formation Tester) was run, and the hole spudded at 0530 hr, 21 August.

After taking the initial core to confirm sea bed at 1316 meters (drill pipe measurement), the technique of washing and recovering occasional control cores was adopted from 1316 to 1439 meters. Continuous coring was adopted to total depth at 1486.5 meters; AROP to

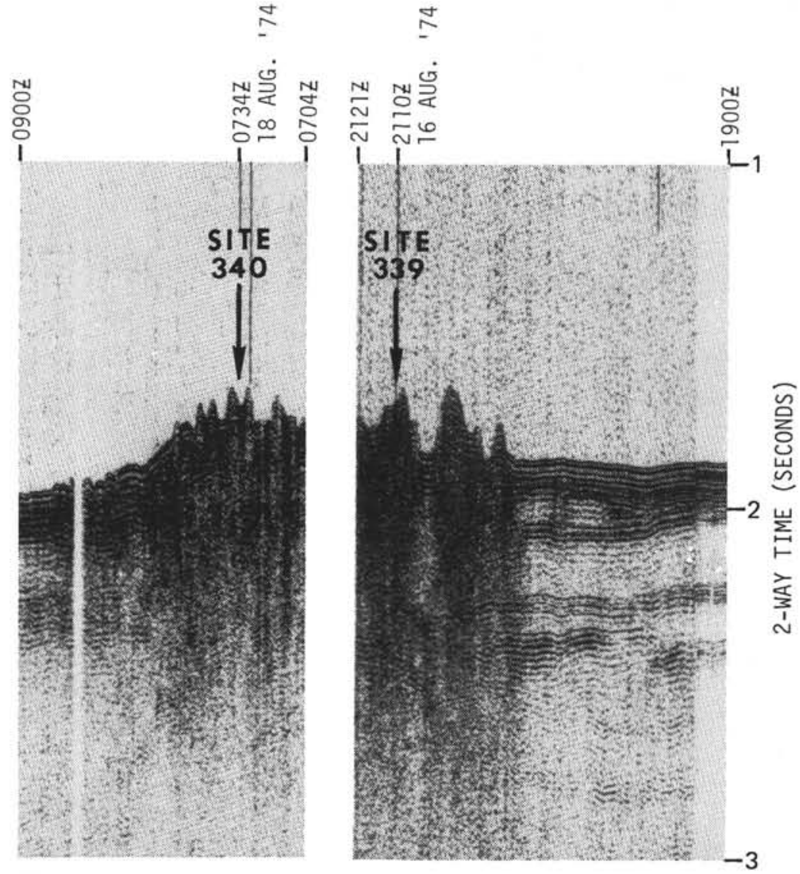

Figure 5. *Profiler record, Sites 339-340.*

TABLE 2
Coring Summary, Site 339

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	17	0415	1276.0-1284.0	0-8.0	8.0	7.3	91.0
2	17	0500	1284.0-1293.5	8.0-17.5	9.5	5.7	60.0
3	17	0545	1293.5-1303.0	17.5-27.0	9.5	5.0	52.6
4	17	0620	1303.0-1312.5	27.0-36.5	9.5	5.1	53.7
5	17	0655	1312.5-1322.0	36.5-46.0	9.5	2.3	24.2
6	17	0745	1322.0-1331.5	46.0-55.5	9.5	5.5	57.9
7	17	0830	1331.5-1341.0	55.5-65.0	9.5	3.7	39.0
8	17	0915	1341.0-1350.5	65.0-74.5	9.5	7.5	78.9
9	17	1000	1350.5-1360.0	74.5-84.0	9.5	0.0	0
10	17	1045	1360.0-1369.5	84.0-93.5	9.5	3.8	40.0
11	17	1130	1369.5-1379.0	93.5-103.0	9.5	1.0	10.5
12	17	1250	1379.0-1384.5	103.0-108.0	5.0	3.5	70.0
Total			1384.5	108.0	108.0	50.4	46.7

TABLE 3
Coring Summary, Site 340

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	17	1710	1244.0-1253.5	0-9.5	9.5	7.0	73.7
2	17	1740	1253.5-1263.0	9.5-19.0	9.5	4.4	46.3
3	17	1835	1263.0-1272.5	19.0-28.5	9.5	6.8	71.6
4	17	1915	1272.5-1282.0	28.5-38.0	9.5	5.4	56.8
5	17	1950	1282.0-1291.5	38.0-47.5	9.5	2.8	29.5
6	17	2225	1291.5-1301.0	47.5-57.0	9.5	4.0	42.1
7	17	2350	1301.0-1310.5	57.0-66.5	9.5	7.5	78.9
8	18	0040	1310.5-1320.0	66.5-76.0	9.5	7.2	75.8
9	18	0140	1320.0-1329.5	76.0-85.5	9.5	7.7	81.0
10	18	0235	1329.5-1339.0	85.5-95.0	9.5	6.3	66.3
11	18	0350	1339.0-1348.5	95.0-104.5	9.5	8.1	85.3
Total			1348.5	104.5	104.5	67.2	64.3

top of the basalt at 1467.5 meters was 8.8 m/hr and through the basalt 2.7 m/hr. Recovery from this 47.5-meter interval was 28.4 meters or 59.7%; overall AROP was 12.8 m/hr, and total core recovery 66% (Table 5).

No evidence of any hydrocarbon or other gasses was encountered in the hole, and it was abandoned according to the relevant safety regulations. The BHA was retrieved above the sea bed by 2345 hr, 21 August, and *Glomar Challenger* was underway for Site 343 by 0515 hr, 22 August.

OPERATIONS, SITE 343

Approach to Site 343 from Site 342

The ship got underway at 0415Z on course 024°. The underway geophysical gear was streamed, and at 0434Z the speed was increased to 210 rpm. *Glomar Challenger* approached Site 343 on 22 August, after steaming 49.7 n mi in 6 hr, 41 min at an average of 7.4 knots from Site 342. At 0716Z, the speed was reduced to 145 rpm, and the beacon was dropped at 1051Z. The ship continued on the same course and speed until 1206Z, at which time the gear was pulled in, and the ship maneuvered to reoccupy the position over the beacon (Figures 8, 9).

Drilling Operations

A 16-kHz beacon was dropped at 1051 hr, and *Glomar Challenger* dynamically positioned in the normal manner. A 6 to 8 ft swell persisted during the move, and probably would be present during the Site 343 operating phase. The same type bit and BHA, with an additional longstroke bumper sub above the lowermost drill collars, was run.

An initial successful core was taken with the pinger/piston core barrel from 3165 to 3168 meters with a 67% recovery. This was the first occasion it could be employed for acquiring an undisturbed sea bed sample, comparing the pinger/drill pipe depth with the PDR (3165 vs 3141 m), and proving its functional efficiency.

After taking a standard 9.5-meter core below the depth cored by the piston corer (Core 2), the technique of washing and recovering occasional control cores was adopted (from 3177.5 to 3358 m). Continuous coring was adopted to total depth at 3449 meters. AROP to top of the basalt at 3416 meters, was 7.9 m/hr and through the basalt 4.9 m/hr.

After 2 meters penetration into basement, the core (Core 12) was prematurely recovered (3417 m) to preserve and retrieve the sediment/basalt contact. The subsequent core (Core 13) jammed in the inner barrel after coring 7.5 meters. Four hours were required before finally dislodging it, allowing further basalt cores to be taken to final depth (3449 m). The overall AROP was 11.7 m/hr; total core recovery from 132 meters cored was 59 meters or 44.9% (Table 6).

TABLE 4
Coring Summary, Site 341

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	18	1640	1443.5-1453.0	0-9.5	9.5	9.5	100
2	18	1720	1453.0-1462.5	9.5-19.0	9.5	4.3	45.3
3	18	1755	1462.5-1472.0	19.0-28.5	9.5	6.0	63.2
4	18	1835	1472.0-1481.5	28.5-38.0	9.5	3.2	33.7
5	18	1925	1481.5-1491.0	38.0-47.5	9.5	8.8	92.6
6	18	2010	1491.0-1500.5	47.5-57.0	9.5	4.3	45.3
7	18	2055	1500.5-1510.0	57.0-66.5	9.5	7.2	75.8
8	18	2135	1510.0-1519.5	66.5-76.0	9.5	9.5	100
9	18	2225	1519.5-1529.0	76.0-85.5	9.5	5.5	57.9
10	18	2312	1529.0-1538.5	85.5-95.0	9.5	8.5	89.5
11	19	0010	1538.5-1548.0	95.0-104.5	9.5	4.7	81.0
12	19	0055	1548.0-1549.0	104.5-105.5	1.0	1.0	100
13	19	0245	1549.0-1557.5	105.5-114.0	8.5	8.2	
Washed			1557.5-1567.0	114.0-123.5			
14	19	0410	1567.0-1576.5	123.5-133.0	9.5	0.2	2.0
Washed			1576.5-1586.0	133.0-142.5			
15	19	0545	1586.0-1595.5	142.5-152.0	9.5	0.2	2.0
Washed			1595.5-1605.0	152.0-161.5			
16	19	0700	1605.0-1614.5	161.5-171.0	9.5	1.5	16.8
Washed			1614.5-1624.0	171.0-180.5			
17	19	0830	1624.0-1633.5	180.5-190.0	9.5	2.2	23.2
Washed			1633.5-1643.0	190.0-199.5			
18	19	0945	1643.0-1652.5	199.5-209.0	9.5	1.1	11.6
Washed			1652.5-1662.0	209.0-218.5			
19	19	1100	1662.0-1671.5	218.5-228.0	9.5	0.8	8.4
Washed			1671.5-1681.0	228.0-237.5			
20	19	1320	1681.0-1690.5	237.5-247.0	9.5	9.5	100
Washed			1690.5-1700.0	247.0-256.5			
21	19	1502	1700.0-1709.5	256.5-266.0	9.5	9.5	100
Washed			1709.5-1719.0	266.0-275.5			
22	19	1630	1719.0-1728.5	275.5-285.0	9.5	1.4	14.7
Washed			1728.5-1738.0	285.0-294.5			
Washed			1738.0-1747.5	294.5-304.0			
23	19	1745	1747.5-1757.0	304.0-313.5	9.5	8.0	84.2
24	19	1915	1757.0-1766.5	313.5-323.0	9.5	9.6	100
Washed			1766.5-1776.0	323.0-332.5			
25	19	2040	1776.0-1785.5	332.5-342.0	9.5	9.5	100
Washed			1785.5-1795.0	342.0-351.5			
26	19	2140	1795.0-1804.5	351.5-361.0	9.5	9.6	100
Washed			1804.5-1814.0	361.0-370.5			
27	19	2255	1814.0-1823.5	370.5-380.0	9.5	9.5	100
Washed			1823.5-1833.0	380.0-389.5			
28	20	0001	1833.0-1842.5	389.5-399.0	9.5	9.6	100
29	20	0110	1842.5-1852.0	399.0-408.5	9.5	9.5	100
30	20	0230	1852.0-1861.5	408.5-418.0	9.5	9.5	100
31	20	0345	1861.5-1871.0	418.0-427.5	9.5	7.5	79.0
32	20	0510	1871.0-1880.5	427.5-437.0	9.5	9.5	100
33	20	0610	1880.5-1890.0	437.0-446.5	9.5	9.5	100
34	20	0730	1890.0-1899.5	446.5-456.0	9.5	9.5	100
Total			1899.5	456.0	313.5	213.9	68.2

No evidence of any hydrocarbons or other gases was encountered, and the hole was abandoned according to the relevant safety regulations. The BHA was retrieved above the sea bed by 0830 hr, 24 August. *Glomar Challenger* let out profiling gear and was underway for Site 344 by 1350 hr, 24 August.

LITHOLOGY, SITE 338

Hole 338 was drilled through an almost unbroken lower Eocene to Quaternary succession overlying basaltic basement to the west of the Vøring Plateau. This has proved to be the most complete Tertiary record drilled during the course of Leg 38. Total sedimentary thickness is 401.8 meters, and a total of 194.9 meters of sediment was recovered. Nine sedimentary units were identified (Table 7, Figures 10, 11).

Unit Descriptions

Unit 1

Unit 1 consists of a sequence of interbedded muds, sandy muds, and calcareous oozes, together with coarser presumably ice-rafted material. Sandy muds, commonly light olive-gray and with occasional pebbles of metamorphic rocks (up to 3.5 cm in diameter), predominate at the top of the unit, and grade

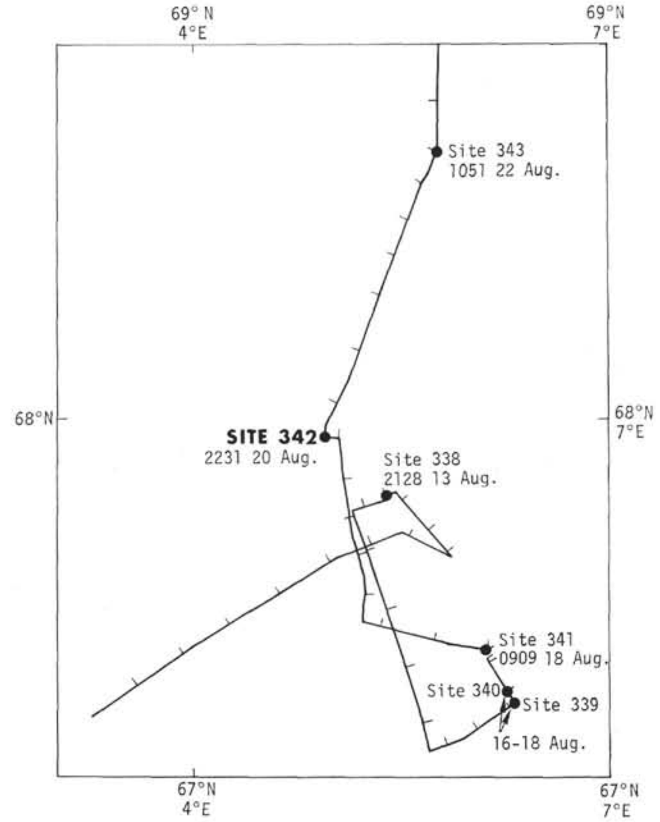

Figure 6. *Track chart, Site 342.*

downwards into a darker colored, light olive-gray, finer grained mud with pebbles, and then to an olive-gray clay through Core 3. The bulk of Cores 3 and 4 consists, respectively, of calcareous mud and muddy calcareous ooze. Minor layers of nannofossil ooze and muddy calcareous ooze are present in Cores 2 and 5. A volcanic ash streak was noted in Core 4, Section 4, and the lowest pebble, consisting of gneiss, is in Core 5, Section 5.

Smear slides show that, in general, the sediments outside the ooze layers are poorly sorted, some of the sandy muds in Cores 1 and 2 having approximately equal proportions of sand, silt, and clay. Many of the larger sand grains consist of compound grains of a red matrix quartz sandstone, which are also reported from other holes on the Vøring Plateau. Nannofossils are nearly ubiquitous (10%-20%) in a majority of samples, and reach >90% in some of the calcareous horizons.

The only identifiable sedimentary structures are some mottles seen in Core 5, Section 6, and some color layering, perhaps representing lithological variations, in Cores 2 and 3. This limited distribution may, however, reflect the considerable amount of core deformation present.

The precise base of the unit cannot be identified as it coincides with a 9.5-meter uncored interval between 57 and 66.5 meters.

Unit 2

The greater part of the sediment column, from ~61 to 285 meters, consists of late Eocene to late Miocene pelagic siliceous oozes. Variations in terrigenous and calcareous nannofossil content, however, permit a fourfold subdivision.

Subunit 2A is distinguished from Unit 1 and Subunit 2B by its higher terrigenous content and appears to be intermediate in composition between the overlying calcareous muds and underlying diatom ooze. The dominant lithology is a muddy diatom ooze, consisting of some 65%-70% siliceous components, including diatoms (40%-60%), Radiolaria (10%-15%), and sponge spicules (5%-10%), with up to 30% clay minerals, 3% to 5% quartz, and subordinate quantities of mica, opaques, glauconite, and volcanic glass. However, the glass increases to 10% within a diatomaceous ashy mud layer in Sample 10-2, 104 cm. A layer of clay (unproven by sampling) has been recorded in Core 9, Section 1.

For the most part the subunit appears structureless, although some mottles and possible clasts are recorded, which may have resulted from the intense drilling deformation.

Subunit 2B (Table 7) is a distinctive green colored diatom ooze with subordinate layers of muddy diatom ooze in Cores 11, 15, 17, and 19, and calcareous diatom ooze in Core 15, Section 4. Through much of the subunit, the total pelagic siliceous component exceeds 70%, with the lowest proportion of terrigenous components (down to a minimum of 3%) in Cores 12 to 14 and 16, inclusive. A single sample, 14-3, 147 cm, has up to 30% opaque, circular spheres, typically less than 0.01 mm in diameter, which may represent a form of volcanic lapillae. The presence of these spheres is also noted in Sample 11-4, 134 cm, at which point there is some 7% glauconite. Core 15, Section 4 contains streaks of both calcareous diatom ooze, with 15% calcareous nannofossils, and muddy diatom ooze, with 41% clay. Interbedding is noticeable in Cores 15 and 19, but otherwise the sediments are massive with no sedimentary structures apart from some mottling in Core 16. The oozes are extremely soft, and deformation is moderate to intense.

The upper part of the subunit grades into the overlying subunit 2A through an extensively mottled zone (1 m thick) in Core 10, Section 2. The lower boundary has been established at an increase in proportion of calcareous nannofossils in Core 19, Section 4, and this corresponds to an increase in sediment competency.

Subunit 2C (Table 7) is of middle Oligocene age. It is a continuation of the dominantly siliceous oozes seen in the previous two subunits, but is characterized by a significant proportion of calcareous nannofossils and interbedded clay layers. A plot of the relative proportions of terrigenous, pelagic siliceous, and pelagic calcareous components (Figure 11) shows that biogenic carbonate (predominantly calcareous nannofossils, with up to 5% authigenic carbonate) increases somewhat erratically from about 15% in Core 19 to 20% in Core 20, 70% in Core 22, 80% in Cores 23 and 24, and reaches a maximum of 95% in Core 25, below which it vanishes. Between the nannofossil-rich layers, the muddy siliceous oozes continue, but with a considerable proportion (up to 36%) of clay. Cores 19 to 21 contain interbedded calcareous diatom oozes and muddy diatom oozes, with a volcanic ash horizon at Sample 20-3, 55. In Cores 22 to 25 the increase in carbonate

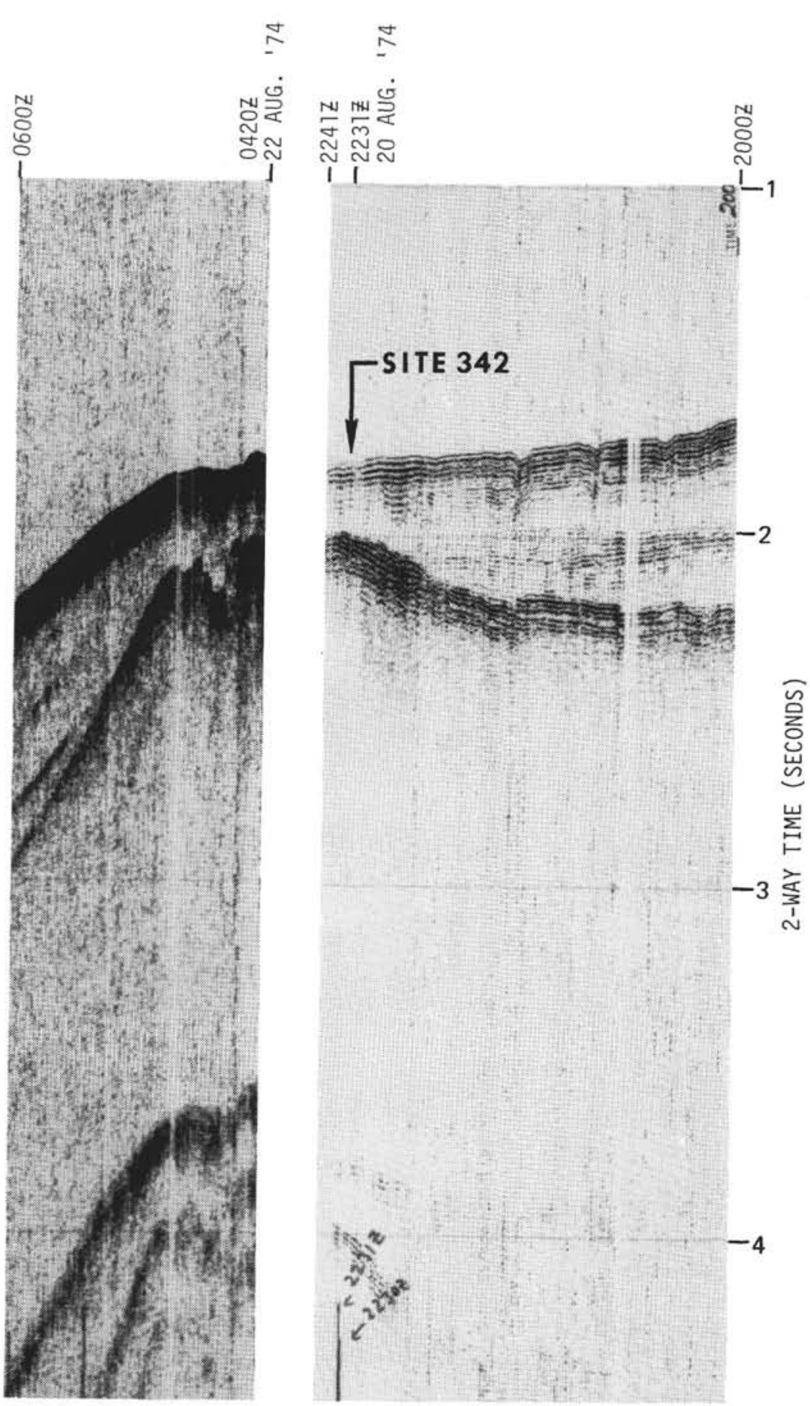

Figure 7. *Profiler record, Site 342.*

content results from the presence of a number of nannofossil ooze layers. Core 24 includes a high proportion of mud, with up to 80% clay minerals, and includes a number of muddy ash and ashy nannofossil ooze layers. The upper part of Core 26 (down to the base of the subunit) is also dominantly clay, which may represent a devitrified ash.

Colors are dominantly greenish-gray, with mottling in Cores 20 to 23 and color banding in Cores 23 to 25, with layers varying in thickness from a few centimeters to over a meter, and color variations from light olive-gray to black. Much of the subunit is bioturbated with prominent *Chondrite*-type burrows in Cores 19 and 20. Core deformation is moderate to slight, and there is an abrupt increase in sediment competency at the top of Core 23, Section 4.

Subunit 2D includes the remainder of the pelagic oozes from Core 26, Section 2 to Sample 29, CC, and represents a return to noncalcareous muddy diatom ooze (Cores 26 and 27) and diatom ooze (Cores 28 and 29). The subunit consists of diatoms (25% to 50%, rising to 60%-80% in Cores 28 and 29), with subordinate quantities of Radiolaria and sponge spicules. Clay mineral content drops from about 30% to 10%-20%

TABLE 5
Coring Summary, Site 342

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	21	0605	1316.0-1325.0	0-9.0	9.0	9.4	100
Washed			1325.0-1353.5	9.0-37.5			
2	21	0710	1353.5-1363.0	37.5-47.0	9.5	5.8	61.0
Washed			1363.0-1401.0	47.0-85.0			
3	21	0840	1401.0-1410.5	85.0-94.5	9.5	6.2	65.3
Washed			1410.5-1439.0	94.5-123.0			
4	21	0940	1439.0-1448.5	123.0-132.5	9.5	3.2	31.6
5	21	1040	1448.5-1458.0	132.5-142.0	9.5	8.5	89.5
6	21	1145	1458.0-1467.5	142.0-151.5	9.5	5.2	54.7
7	21	1520	1467.5-1477.0	151.5-161.0	9.5	6.4	
8	21	1950	1477.0-1486.5	161.0-170.5	9.5	5.1	53.7
Total			1486.5	170.5	75.5	49.8	65.9

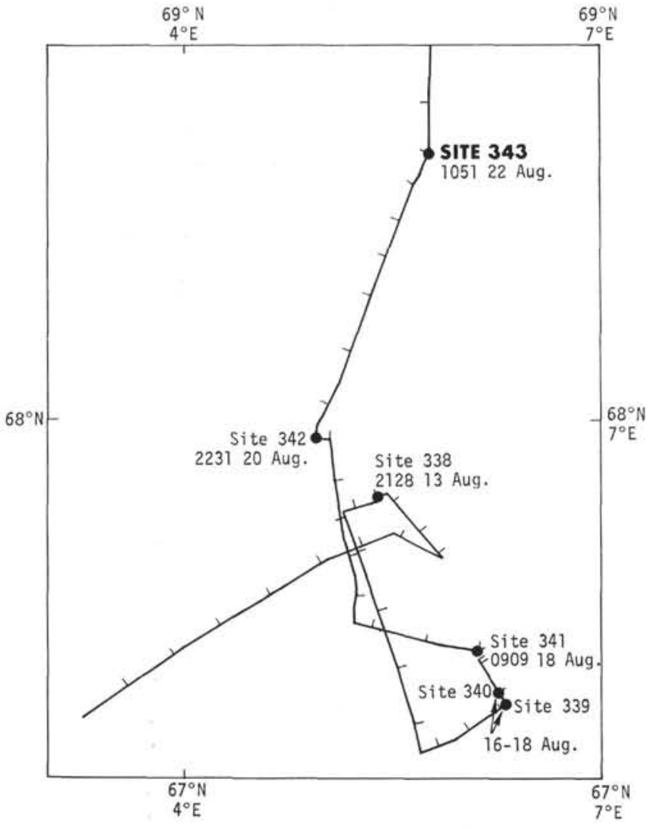

Figure 8. *Track chart, Site 343.*

over the same interval. Volcanic ash and siliceous ash layers up to 30 cm thick and with a maximum of 67% of volcanic glass are present in Cores 27 and 28. Stratification is apparent in Cores 26 to 28, with fine laminations in Core 29. Mottling is present in all cores, and bioturbation in Cores 28 and 29 with common *Zoophycos* burrows in Core 29, Section 2. The sediments are firm to competent and indurated in Core 29, Section 3. Drilling deformation is moderate to slight.

Unit 3

In marked contrast to the overlying oozes, Unit 3 consists almost exclusively of terrigenous muds and sandy muds of early Eocene age.

Subunit 3A is a distinctive sequence which has an abrupt contact with Unit 2 at the top of Core 30, but appears to grade into the underlying muds of Subunit 3B at the base of Core 31, Section 1. It consists essentially of a greenish-black glauconitic sandy mud, which is semi-indurated, especially at the top of Core 30. Below Core 30, Section 2, the deposit includes an increasing number of clay clasts, and below Core 30, Section 4, it is finer grained, becoming a sandy mud and then a mud. Much of the deposit is mottled and possibly bioturbated.

A basal dark gray fragmented section is composed of dark green to black angular to subrounded claystone clasts (up to 1.5 cm in diameter), initially in a sandy matrix (in Core 30, Section 6) and below that in mud. This is present in the lower 10 cm of Core 30, Section 6, and continues through Core 31, Section 1.

Examination of smear slides, thin sections, and heavy mineral separations confirms the predominance of glauconite grains, up to 2 mm in diameter and set in a clay matrix. The glauconite appears to be replacing both microfossils (diatoms) and fecal pellets (see White, this volume). Small angular to subhedral crystals of broadly twinned and zoned basic plagioclase (labradorite?) are fairly common and range from 0.1 to 1 mm in length. In addition, there are rare quartz grains, greenish mica flakes, prisms of pleochroic olive-brown amphibole 0.1 to 0.2 mm long, black crystals of pyroxene up to 0.5 mm long, and an octahedron of magnetite about 0.1 mm in diameter. Rounded lithic grains are present in variable quantities. These include a structureless mudstone and altered trachytic lavas, some with obvious feldspar laths, and others with many clear microlites. The clay matrix, dominantly montmorillonite, includes small subhedra of a colorless mineral, probably a zeolite (natrolite?). This glauconitic unit is barren of fossils and is undated.

Poor recovery in several cores restricts the description of Subunit 3B, but from the data available it would appear distinct enough to merit separate consideration. It consists principally of thinly stratified olive-gray mud, locally sandy in Core 32 and calcareous in Cores 34 and 36. The mud typically consists of 40% to 70% clay minerals with a fairly constant composition of 30%-40% montmorillonite, 40%-45% illite, and 20%-25% chlorite/kaolinite. In addition are 3% to 7% quartz

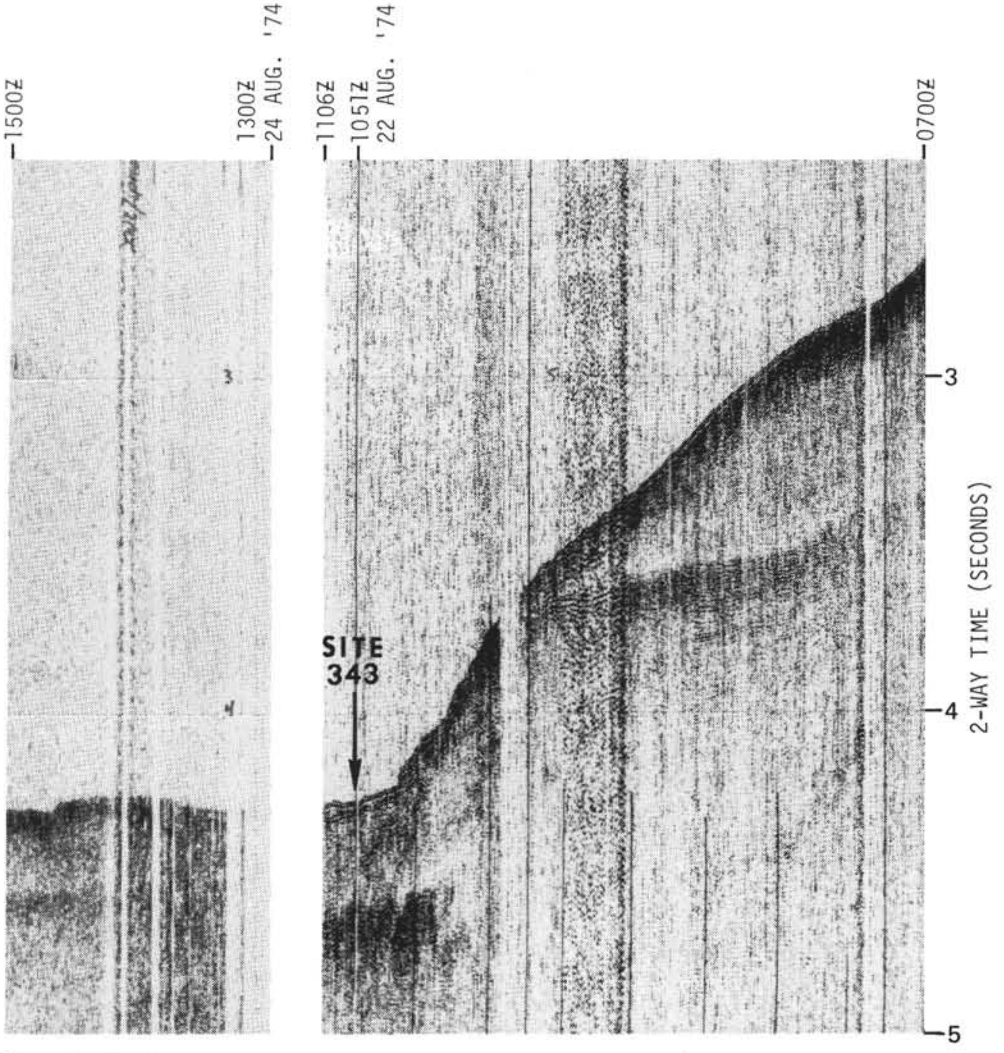

Figure 9. *Profiler record, Site 343.*

and feldspar (up to 30% in one sandy mud in Core 32), trace amounts to a few percent each of opaques, heavy minerals, mica, volcanic ash, glauconite, and zeolites, and up to 80% authigenic carbonate. A zeolitic pellety mudstone with numerous(?) fecal pellets up to 1 mm in diameter is present in Core 31, Section 2. A zeolitic clay with 80% zeolites and about 20% clay, which may consist of devitrified ash, is present in Core 34, Section 2. Mineral grains include green, slightly pleochroic, amphibole, much angular quartz, altered feldspar, white brown, and green micas (chlorite?). Lithic grains up to 1 mm long are abundant in Sample 34, CC, and consist of highly calcitized finely vesicular lava. Mottling and bioturbation is extensive, with either *Chondrites*, *Helminthoida*, or rind burrows in a majority of cores. Deformation is slight.

Subunit 3C continues to the base of the dominantly terrigenous succession at 400.85 meters. It appears to consist almost exclusively of brownish-gray sandy mud, although core recovery in these five cores is low (about 20%). The mud is relatively characterless, but has a variable sand content ranging from an 80-cm-thick band of brownish-black sandy mudstone in Core 39, Section 2, to silts and silty sands in Core 39, Section 3. Variable quantities of mica and secondary carbonate cement are also present. In Core 39, Section 2, a carbonate cemented layer is present consisting of about 15 cm of hard gray calcareous mudstone, which may be of concretionary origin. Bioturbation is commonly observed throughout the more muddy intervals, otherwise no sedimentary or other structures were observed.

In smear slides, the deposit consists of four main components: quartz grains (25% to 50%), clay minerals (15% to 40%), lithic fragments (7%-40%), and opaque grains (2%-25%). The relative proportions of these change down the sequence, quartz and clay decreasing from values of ca. 50% and 30% (+), respectively, in Cores 37 and 38, to 25%-30% and 15%-20% in the cores immediately above basement. The proportion of lithic and opaque fragments increases proportionately, from 7% and 2%-4%, respectively, in Cores 37 and 38 to approximately 30% and 15%-25% in Cores 41 and 42. Secondary quantities of volcanic glass (1%-2%), glauconite (1%), mica (2%-3%), heavy minerals (2%-4%), and feldspar (5%-7%) are present in nearly uniform quantities throughout these cores. The limestone

TABLE 6
Coring Summary, Site 343

Core	Date (August 1974)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	23	0115	3165.0-3168.0	0-3.0	3.0	2.0	66.7
2	23	0235	3168.0-3177.5	3.0-12.5	9.5	6.0	53.1
Washed			3177.5-3215.5	12.5-50.5			
3	23	0430	3215.5-3225.0	50.5-60.0	9.5	8.6	90.5
Washed			3225.0-3263.0	60.0-98.0			
4	23	0645	3263.0-3272.5	98.0-107.5	9.5	6.2	65.3
Washed			3272.5-3310.5	107.5-145.5			
5	23	1025	3310.5-3320.0	145.5-155.0	9.5	6.6	69.5
Washed			3320.0-3358.0	155.0-193.0			
6	23	1225	3358.0-3367.5	193.0-202.5	9.5	0.9	9.5
7	23	1335	3367.5-3377.0	202.5-212.0	9.5	5.3	55.8
8	23	1450	3377.0-3386.5	212.0-221.5	9.5	4.3	45.3
9	23	1600	3386.5-3396.0	221.5-231.0	9.5	2.6	27.4
10	23	1710	3396.0-3405.5	231.0-240.5	9.5	3.2	33.7
11	23	1822	3405.5-3415.0	240.5-250.0	9.5	2.2	23.2
12	23	1955	3415.0-3417.0	250.0-252.0	2.0	2.3	100
13	24	0130	3417.0-3424.5	252.0-259.5	7.5	2.7	36.0
14	24	0325	3424.5-3434.0	259.5-269.0	9.5	0.4	4.0
15	24	0455	3434.0-3443.5	269.0-278.5	9.5	2.5	26.3
16	24	0700	3443.5-3449.0	278.5-284.0	5.5	3.5	64
Total			3449.0	284.0	132.0	59.3	44.9

TABLE 7
Lithologic Summary, Site 338

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
1	Light olive-gray to olve-gray interbedded muds, sandy muds, and calcareous oozes, with pebbles	0-~61	~61	0-28.5 – Pleistocene 28.5-57 Plio-Pleistocene
2A	Olive-black to olive-gray structureless muddy diatom ooze	~61-97.6	~36.6	Middle Miocene – middle/late Miocene
2B	Dusky yellow-green to olive-gray diatom ooze	97.6-185.1	87.5	Middle Oligocene – middle Miocene
2C	Greenish-gray interbedded calcareous diatom ooze and muddy diatom ooze	185.1-249.8	64.7	Middle Oligocene
2D	Dusky yellow-green stratified diatom ooze and muddy diatom ooze	249.8-285	35.2	Late Eocene
3A	Greenish-black glauconitic sandy mud and mud	285-296	11	Undated
3B	Thinly stratified olive-gray mud, locally sandy, calcareous or zeolitic	296-~348	~52	Early Eocene
3C	Brownish-gray sandy mud	~348-400.85	~52.85	Early Eocene
3D	Lithified basalt breccia and sandy limestone including basalt fragments	400.85-401.8	0.95	Undated

bands are composed of local concentrations of authigenic carbonate. Clay mineral content is more variable than in the overlying subunit, but the most noticeable feature is an increase in montmorillonite from less than 30% in Core 39, Section 1 to over 80% in Core 42, Section 1, with a corresponding decrease in the other components. A detailed study of Sample 39-2, 102 cm shows much angular quartz with rare feldspar set in a base of greenish-brown clay. There are also what appear to be clasts of dark brown mudstone and small (0.3 mm maximum) fragments of fine-grained altered trachytic lava, together with a few grains of

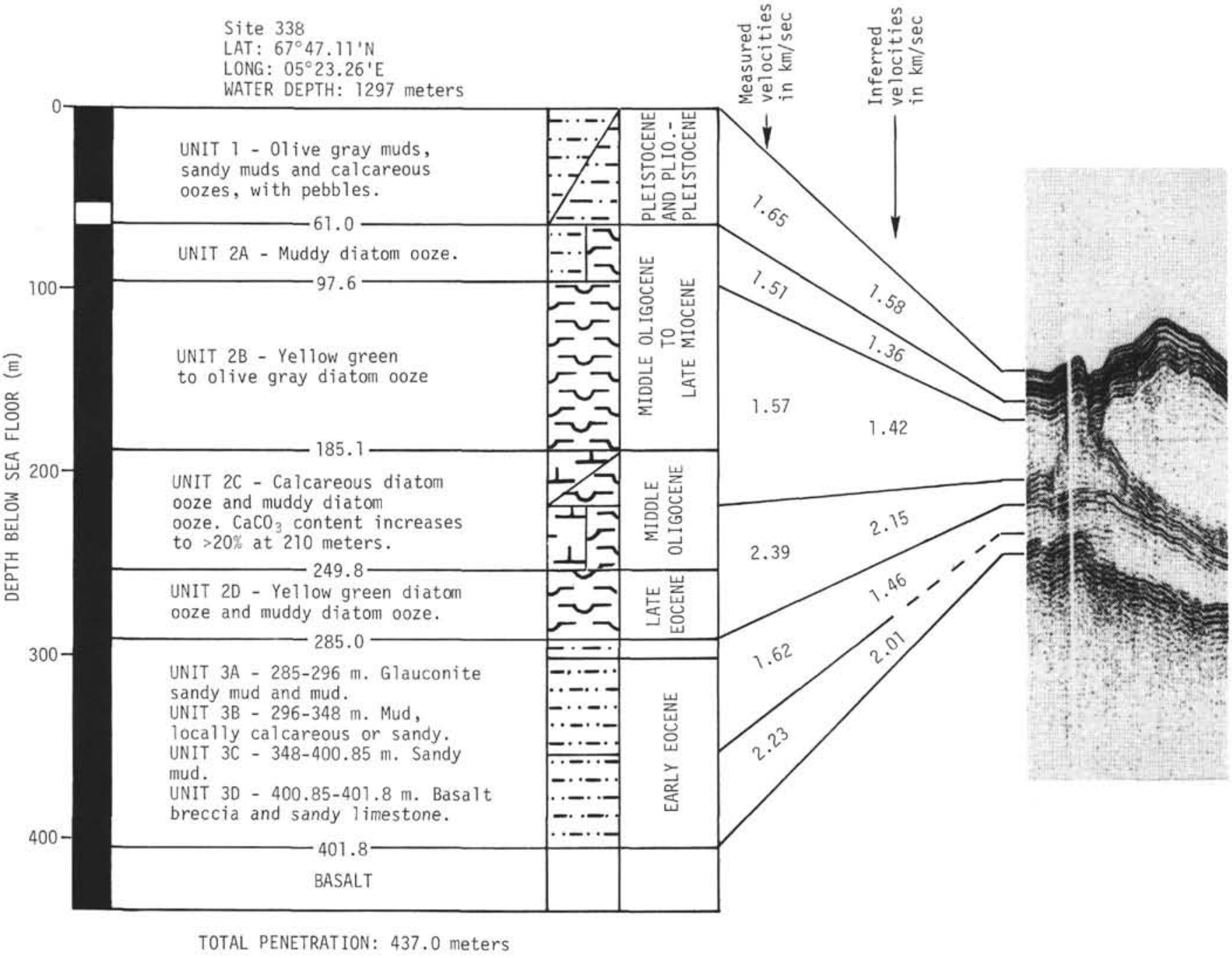

Figure 10. *Lithologic column and seismic profile, Site 338.*

volcanic glass, biotite, and glauconite. Basalt fragments are also reported in slides from Cores 40 to 42.

Subunit 3D consists of a quasisedimentary unit overlying the basaltic basement. In ascending order from the basalt, this unit consists of about 60 cm of lithified brecciated basalt including fragments of fine-grained brownish-black basalt, which decrease upwards in size, cemented by a green-gray chlorite-calcite matrix. This is overlain by 4 cm of white fibrous calcite and dark green chlorite, and finally 32 cm of dark gray, fine-grained sandy limestone, consisting of basalt fragments (50%) and quartz grains (10%), set in a calcite cement. A majority of the basalt fragments is highly altered, principally to calcite.

Interpretations

Site 338 was drilled just to the east of the crestline of a basement high lying to the west of the Vøring Plateau Escarpment. It is suggested that the sediments recovered provide evidence for the progressive subsidence of the outer part of the Vøring Plateau with respect to sea level throughout the Tertiary.

The lithified basaltic breccia and sandy limestone immediately overlying basement are presumably derived from the immediately underlying basalt. The sandy limestone appears to have been deposited in a subaqueous environment, but otherwise the nature of the weathering or erosive process responsible for the breccia is not clear. Of interest is the very considerable difference in lithification between these sediments and those of the overlying Subunit 3C. This appears to be directly related to the amount of calcite cement in Subunit 3D. It is conceivable that the absence of calcite in Subunit 3C indicates a hiatus of unknown length between the times of deposition of Subunits 3C and 3D. Alternatively, this contrast could be explained by compositional differences in the constituent sediments.

Comparison of Site 338 with Site 342 and airgun profiles in this area indicates that the dominantly sandy muds of Unit 3 do not form a continuous layer overlying basaltic basement, but are absent on the crests of three basement highs (one drilled at Site 342) lying to the west of the escarpment. The Unit 3/Unit 2 boundary represents a very considerable change in sedimentation pattern, with terrigenous sedimentation below, pelagic sedimentation above. It is also relevant to note that glauconitic sandy muds of Subunit 3A must have formed in response to some significant

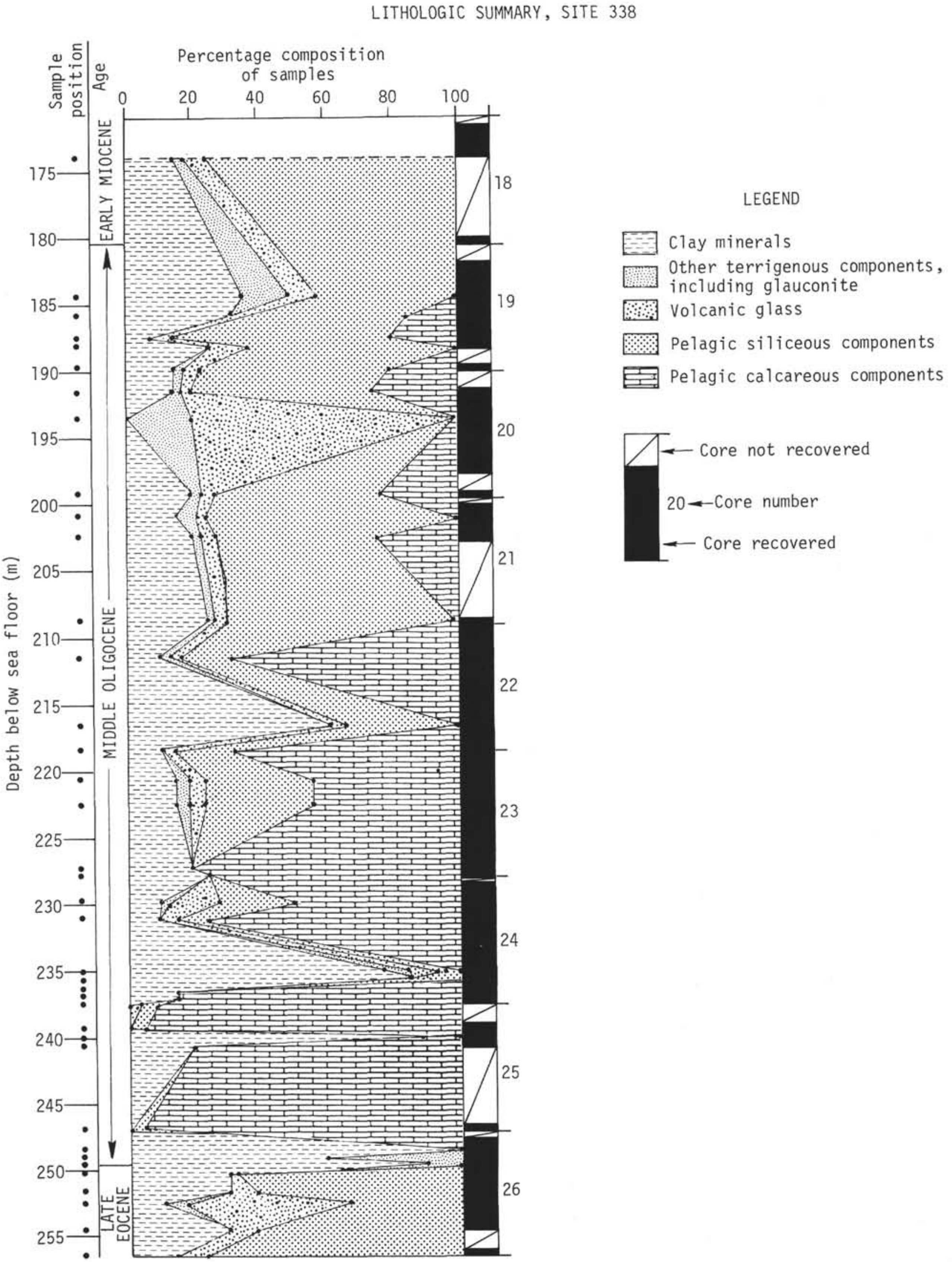

Figure 11. *Lithologic summary, Site 338. Relative proportions of terrigenous, pelagic siliceous, and pelagic calcareous components through the middle Oligocene section (based on smear-slide estimates).*

change in the environmental conditions at about the middle Eocene.

It is suggested that these observations can best be explained by proposing, first, that at least a proportion of the Eocene deposits of Unit 3 are derived from erosion of the (basaltic) basement highs. Such erosion could be subaerial or submarine, but would imply that the basement immediately west of the escarpment lay at or about sea level during the early Eocene. Subsidence of this ridge during middle Eocene times could produce the change in environmental conditions responsible for the glauconitic sands seen in Subunit 3A. Removal of the local source of terrigenous material would permit pelagic sedimentation to be dominant throughout the late Eocene to Miocene. An alternative explanation attributes the terrigenous sediments of Subunits 3B and 3C to transport by currents from some unknown source within the restricted ocean of Eocene times. However, this does not satisfactorily explain the abrupt change in sediment pattern at the Unit 3/Unit 2 boundary, the absence of sediment over the basement highs, or the very considerable difference in Eocene sediments as recorded between Site 338 and Sites 339/340, some 75.9 km to the southeast.

The dominantly pelagic oozes of Subunits 2C and 2D are also missing at Site 342. This can be explained by nondeposition or subsequent erosion, but it is convenient to link this to the subsidence hypothesis already discussed. Sinking of the basement ridge beneath active erosion level during the middle Eocene would remove the source of terrigenous material, and permit deposition of pelagic oozes at Site 338 from the late Eocene. However, only limited subsidence of the ridge would have inhibited deposition of pelagic material at Site 342, leaving a hiatus until further subsidence permitted eventual sedimentation during the Miocene.

Pelagic sedimentation continued until the middle Miocene (top of Subunit 2B). The overlying Subunit 2A, dated as middle to late Miocene, consists of a biogenic siliceous ooze with up to 35% terrigenous components. It is suggested that this incursion of terrigenous material may be related to the onset of glacial conditions, although there is, at present, an absence of confirmatory paleontological and paleomagnetic data. Unit 1 is considered to have been deposited by glacial processes.

LITHOLOGY, SITE 339

Hole 339 was the first of two holes to be drilled on a diapir-like structure within the Vøring Plateau basin and was continuously cored to a depth of 108 meters. It penetrated the diapir through a shallow saddle lying some 73 meters below the crest. Three sedimentary units were recorded (Table 8, Figure 12).

Unit Descriptions

Unit 1

Subunit A (Table 8) consists almost entirely of calcareous mud and mud. This mud is soft and consists principally of clay-size particles (30%-70%), quartz and feldspar (5%-35%), and calcium carbonate (up to 50%) which includes both nannofossils and authigenic carbonate (both locally up to 30%). Calcium carbonate content (as estimated from smear slides) generally increases upwards, varying from 2% to 10% in Cores 4 to 6, 15% to 25% in Core 3, 45% in Core 2, and a maximum of 50% (marly calcareous ooze) in Sample 1, CC. Occasional layers and patches of diatomaceous mud and muddy diatom ooze are present in Cores 5 and 6.

Proportion of sand-size grains averages 2%-5%, with locally high values of 40% and 45% in layers of sandy mud and sandy silt in Cores 3 and 5, respectively. Throughout the subunit, structureless zones alternate with thinly (<1 cm) color-layered zones. A well-defined syn-sedimentary fold is present within such a stratified zone at Sample 4-4, 130.

In addition to the sandy layers in Cores 3 and 5 (about 5 cm thick), other subordinate lithologies include clay balls or clasts, which are common in Cores 4 and 5, patches of (?) carbonaceous matter in Core 2, Section 4, and scattered ash patches in Core 6, Section 4. Bioturbation is recorded from Cores 2, 3, and 5 with *Chondrites* recognizable in Cores 3 and 5, and mottling in Cores 5 and 6. Pebbles were recorded only from Core 6, Section 3 and Core 6, Section 4. Drilling deformation is generally moderate, but is intense in Core 1 and through much of Core 6.

Subunit B consists of an interstratified mixture of the overlying "glacial" muds and underlying siliceous oozes, individual layers ranging from 0.2 to 2 meters in thickness. Primary sedimentary components are as described in Subunit A and Unit 2, but locally there appears to have been almost complete mixing between the two. Pebbles are present in Sections 8-2, 8-3, and 8-5; the largest, of granitic composition (2 cm in diameter), is reported from Sample 8-5, 20. Drilling deformation is moderate to intense throughout.

The top of the virtually continuous sequence of diatom ooze comprising Unit 2 is taken as Sample 9, CC. However, as this was the only sample recovered from Core 9, the boundary between Units 1 and 2 has been arbitrarily placed midway between Cores 8 and 9, CC, at 79 meters.

Unit 2

Unit 2 consists essentially of a greenish-gray to pale green diatom ooze composed principally of diatoms (55%-80%), with subordinate quantities of radiolarians (5%-10%), sponge spicules (5%-10%), and clay minerals (15%-20%), together with trace quantities to a few percent of detrital components including mica, quartz, and opaque grains. The variations in composition appear to be random, although in Core 10, Section 1 and Core 11, Section 1 the composition is locally a diatomaceous mud with up to 75% clay minerals, and a complementary drop in biogenic components. Calcium carbonate content is less than 3%. Drilling deformation is intense in all cores except in Core 11, but otherwise no sedimentary structures are apparent. Hydrogen sulfide gas was recorded from all sections of Core 10.

Interpretations

General comments concerning the nature and time of formation of the diapir are given in the Site 340 Report, and a more detailed comparison of the Tertiary

TABLE 8
Lithologic Summary, Sites 339 and 340

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
Site 339				
1A	Soft sandy calcareous mud with pebbles	0-57	57	Pleistocene
1B	Interstratified sandy mud with pebbles, and diatom ooze	57-~79	~22	Plio-Pleistocene
2	Diatom ooze and diatomaceous mud	~79->108	>29	Early to mid-
Site 340				
1	Moderate brown to olive-gray sandy mud, with some pebbles	0-10	10	Pleistocene
2	Virtually homogeneous yellow-green diatom ooze	10->104.5	>94.5	Mixed middle and late Eocene

sediments at the two sites is discussed in Caston (this volume). The Oligocene oozes represented by Unit 2 need not, of course, be typical of the complete Oligocene succession within the Vøring basin, neither are they likely to represent a conformable sequence. They may nevertheless be taken as representative of the composition of the oozes deposited during the early to mid-Oligocene. This indicates that pelagic sedimentation was probably dominant within the basin during this time, with a moderate terrigenous contribution (up to 30%), which is considerably higher than the very low terrigenous proportion (maximum 15%) recorded in the Eocene oozes at Site 340.

LITHOLOGY, SITE 340

Site 340 was the second of two sites drilled on a diapiric-like structure standing ~150 meters above the surrounding sea floor. This particular site drilled into the side of the diapir some 30 meters below the summit. It was successful in avoiding the thickness of Pleistocene encountered in the previous hole (339), and passed immediately into sediments of Eocene age, which are the oldest recovered from the Vøring Plateau basin. The sediments penetrated can be lithologically subdivided into two units, which are summarized in Figure 12 and Table 8.

Unit Descriptions

Unit 1

Unit 1 consists of approximately 10 meters of unconsolidated very soft sandy mud. The uppermost sediments are coarse grained, with from 15% to 20% sand, which rapidly drops to 3%-5% at the base of Core 1. Pebbles, with a maximum diameter of 2 cm, and presumably ice rafted, are reported from Core 1, Section 2

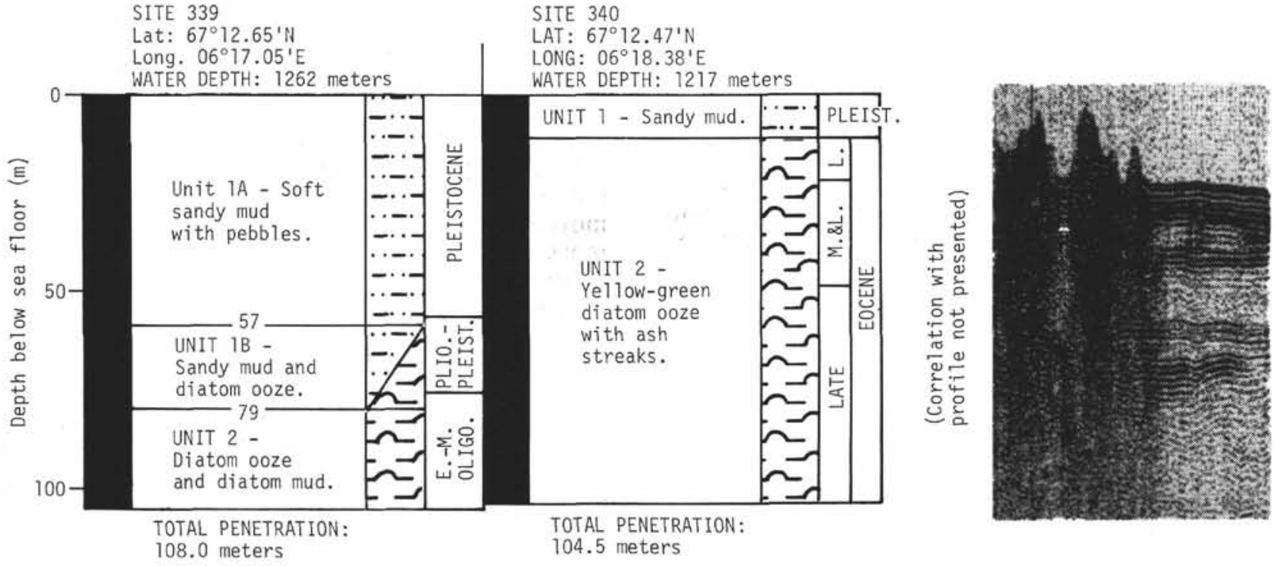

Figure 12. *Lithologic column and seismic profile, Sites 339 and 340.*

and Core 1, Section 5. With the exception of color banding from Core 1, Section 3 to Core 1, Section 5, which is commonly 10 cm thick and perhaps represents depositional layering, no sedimentary structures are visible. Coring deformation throughout the unit is moderate, except for considerable flowage up the core barrel in Core 1, Section 1 and Core 1, Section 2.

Smear slides indicate that the mud is composed principally of clay minerals (45%-78%), quartz and feldspar (up to 27%), authigenic carbonate (5%-10%), and nannoplankton (5%-10%), with subordinate quantities of heavy minerals (1%-3%), opaque grains (2%-5%), and diatoms (2%-5%), together with traces of volcanic glass, glauconite, and sponge spicules.

Isolated patches of Eocene diatom ooze are present from Samples 1-5, 90 cm to 1-5, 110 cm; at 1-5, 150 cm, and 1, CC. The lower contact of Unit 1 is gradational, from Samples 2-1, 30 cm to 2-1, 70 cm, although this is possibly a result of drilling deformation.

Unit 2

Unit 2 consists of dusky yellow-green, firm but unconsolidated, diatom ooze of mixed middle and late Eocene age. It is commonly mottled, and, although deformation (which may or may not be wholly attributable to drilling) is moderate to intense throughout, color banding, from yellow-green to light olive-gray and presumably of original depositional origin, is locally preserved. Some thin (<5 cm) greenish-black volcanic ash streaks were recorded in Sections 3-2, 4-3, and 8-5, some clay balls in Core 2, Section 2. The presence of pyrite was noted in Cores 10 and 11. A 1-cm-diameter pebble was found within the ooze at Sample 9-3, 24 cm.

The ooze is composed dominantly of diatoms (65%-90%), with some radiolarians (5%-20%) and sponge spicules (3%-10%). Up to 15% of the clay is locally present in samples from Cores 4 to 7 and in Core 10. X-ray diffraction results show that this clay, together with the small quantities recorded in other cores, consists mainly of montmorillonite. Volcanic glass is present throughout the ooze, ranging in amount from a "background" of from 1% to 5% in the majority of samples to 75%-95% in the ash streaks. The bulk of the ash consists of clear, well-formed glass shards, may of which have a fluted appearance and some of which have opaque inclusions. A minority are pale brown in color. Only occasional quartz grains have been recorded. The deposit is thus almost wholly of pelagic origin, with a very low proportion of terrigenous components.

Interpretations

The glacial-marine sediments of Unit 1 are extremely thin in comparison with those penetrated at Sites 339 (also on the diapir) and 341 (an undisturbed section). This is presumably because Site 340 penetrated the side slope of the diapir upon which either only a restricted thickness of glacial-marine sediments was deposited, or from which quantities of previously deposited sediments had slumped or otherwise eroded.

Because the Eocene diatom oozes were drilled within a diapir, and are presumably not in situ, they are not necessarily typical of the complete Eocene succession within the Vøring basin. Neither are they likely to represent a continuous sequence, although preservation of presumed original layering indicates that individual "blocks" of ooze, retaining a certain amount of their original structure, were carried up within the diapir core.

There is no reason to doubt, however, that the composition of the diatom ooze is not representative of the oozes as originally deposited in the Vøring Plateau basin. This indicates that a very low proportion of terrigenous material was being deposited in the basin in middle and late Eocene times.

There is no evidence favoring salt tectonics in the diapir formation. The sedimentary evidence indicates that the Eocene oozes represent the diapiric material, and that they underwent upward vertical movement through the overlying sedimentary section, presumably as a result of plastic(?) flow due to changes in sediment physical properties (i.e., water content and overburden pressures). The oozes of Oligocene (Site 339) and Miocene age (Site 341—within the "glacial" section), which also appear to be in anomalous stratigraphic positions, may have been carried passively up by the upward movement of the Eocene age material, or may have themselves contributed to the development and growth of the diapir.

The most obvious question raised by these two short holes (339 and 340) drilled in the diapir field is why Site 339 passed through "glacial" muds into Oligocene oozes, whereas at Site 340, only 600 meters away to the southwest, oozes of Eocene age immediately underlie a thin "glacial" cover. A possible explanation, supported by profiler evidence (Figure 5), is that Site 340 was located more centrally in the diapir field, thus penetrating the older Eocene oozes which form the core of the feature, whereas the younger Oligocene sediments are perhaps present as an encircling arc or rim surrounding the Eocene core.

The diapirs appear to be located immediately above a structural high in the (?)pre-Tertiary, and it is suggested that this feature may have been responsible for some tectonic deformation within the overlying strata. This deformation may have provided zones of weakness along which the diapir could develop. Date of the present diapir formation is not known. However, on the basis of displaced Miocene oozes within the "glacial" sediments at Site 341 it is suggested that the diapiric movements commenced in post-Miocene times. That movement may have continued through the Pleistocene is implied by the presence of this allochthonous Miocene material within the Pleistocene at Site 341.

A certain amount of post-Pleistocene movement may also have occurred. Talwani and Eldholm (1972) illustrate a profiler record across the diapir field which suggests that the diapir core material is exposed or virtually exposed at the surface of the sea bed at the crest of at least one diapir. This was confirmed by Bjørklund and Kellogg (1972) who cored one diapir, and recorded only 160 cm of post-Eocene sandy mud overlying Eocene ooze. Virtual absence of Pleistocene and/or Holocene deposits can be explained by nondeposition, deposition, and subsequent erosion, or by post-

Pleistocene upward movement of the diapir punching through the remaining Pleistocene cover. Nondeposition is difficult to explain unless relatively strong currents are present, and if the Pleistocene was deposited and later eroded, it poses the question as to why the soft Eocene oozes were also not eroded. Post-Pleistocene movement of the diapir is, therefore, the most satisfactory explanation for these observations.

LITHOLOGY, SITE 341

Site 341 was planned as a stratigraphic test within the deep sedimentary basin lying to the east of the Vøring Plateau Escarpment. The site is located 17 km northwest of the diapir field, at a point where reflectors were apparent on the airgun profile to a depth of 1.1 sec below sea bed (Figure 13). Three principal sedimentary units have been recognized (Table 9). Because the middle part of the hole from Cores 13 to 27 was not continuously cored, determination of some unit boundaries is approximate.

Unit Descriptions

Unit 1

Because of the presence of a block of allochthonous siliceous ooze within this unit, it is convenient to divide the sediments into three subunits.

Subunit 1A (Table 9) consists of mud and calcareous mud, initially dark yellowish-brown on the sea bed and in Core 1, Section 1, passing down through moderate brown to olive-gray in Core 1, Section 2. From 25% to 35% authigenic carbonate and calcareous nannoplankton are typically present in a majority of samples throughout the subunit, with over 90% in nannofossil ooze layers in Samples 1-5, 150 cm, and 3, CC. Although dominantly olive-gray, considerable color banding is present within the less sandy Cores 1 and 4, with layers of from 15 to 40 cm in thickness. In general, proportion of sand is less than 10%. Pebbles are recorded in Cores 1 to 3, with maximum diameters of 2 cm, including one of Cretaceous chalk in Sample 1-6, 70 cm.

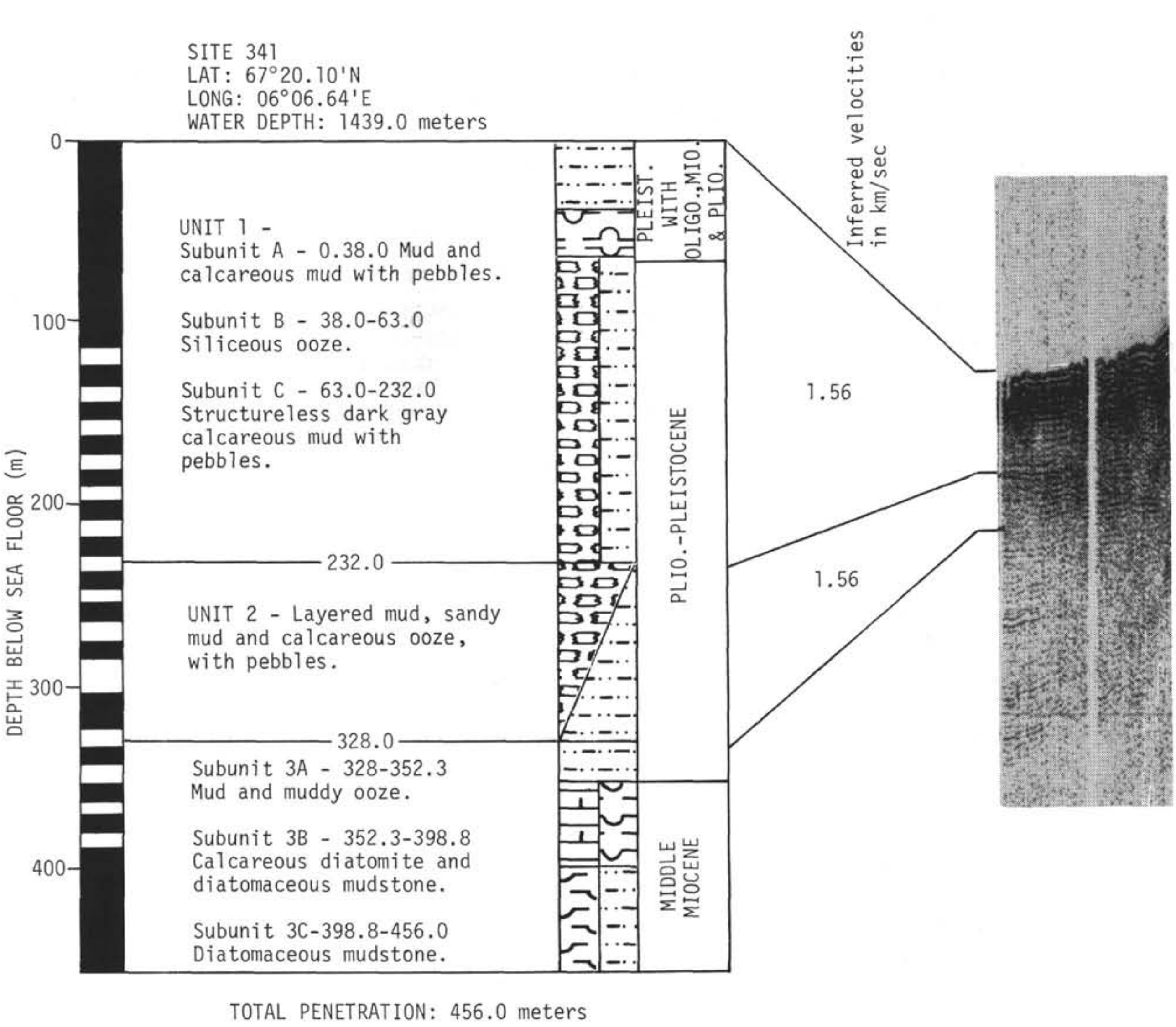

Figure 13. *Lithologic column and seismic profile, Site 341.*

TABLE 9
Lithologic Summary, Site 341

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
1A	Dark yellowish-brown to olive-gray mud and calcareous mud with pebbles	0-38	38	Pleistocene, mixed with Oligocene, Miocene and Pliocene
1B	Dusky yellow-green pelagic siliceous ooze	38-63	25	
1C	Structureless dark gray calcareous mud with pebbles	63-~232	~169	Plio-Pleistocene
2	Olive-gray to dark greenish-gray layered mud, sandy mud and calcareous ooze, with pebbles	~232-~328	~96	Plio-Pleistocene
3A	Thinly stratified dark greenish-gray to dusky yellow-green mud and muddy ooze	~328-352.3	~24.3	Middle Miocene to Plio-Pleistocene
3B	Massive brownish-gray to dark greenish-gray calcareous diatomite and calcareous diatomaceous mudstone	352.3-398.8	46.5	Middle Miocene
3C	Massive dark greenish-gray (above Core 31-3) to olive-black diatomaceous mudstone	398.8->456	>57.2	Middle Miocene

Drilling deformation is intense throughout the greater part of the subunit.

Subunit 1B consists of diatom, siliceous, and calcareous siliceous oozes of from Oligocene to Pliocene age, which have well-defined layers (5 to 60 cm thick), presumably representing original stratification. Composition includes diatoms (20%-50%), Radiolaria (5%-20%), sponge spicules (10%-30%), clay minerals (0%-20%), and quartz/feldspar (1%-12%). Up to 5% of the quartz grains are sand sized. Dominant color of the ooze is dusky yellow-green with shades of green and gray in the layers. The base of the subunit appears to be gradational in Core 7, Section 1 to Core 7, Section 3, with increasing downward proportions of clay, although greenish colors continue to Sample 7-4, 120 cm. The basal boundary has been somewhat arbitrarily established at Sample 7-4, 120 cm, the top of a thick dark gray mud sequence.

Subunit 1C, below the oozes, consists of an almost structureless sequence of dark gray calcareous mud, which lightens very slightly below Core 13. Mud content includes from 30% to 65%, typically from 45% to 55% clay, 10% to 35% quartz and feldspar, and a total of less than 5% for glauconite, heavy minerals, and opaque grains. Calcium carbonate is present in every sample up to 30%, composed of authigenic carbonate and calcareous nannofossils normally in proportions of 2:1. Sand content is usually below 15%, except for a local maxima of 20% in a calcareous sandy mud at Sample 8-5, 70 cm. Many sand-size grains consist of particles, up to 1 mm in diameter, of a heavy mineral rich quartz sandstone with a distinctive brown matrix; these are also present, to a lesser extent, in Subunit 1A. In Cores 12 and 13, small proportions (less than 10%) of biogenic siliceous components are reported.

Pebbles are present scattered throughout the subunit, including mica schists in Sections 9-3, 9-4, 10-5, and 10-6, and granite (4 cm diameter) in Core 11, Section 4. Drilling deformation is generally moderate to intense.

The base of the subunit has been placed midway between the base of Core 19(at 228 meters) and the top of Core 20 (237.5 m), which is the uppermost core of a distinctively different lithology.

Unit 2

This unit is distinguished from Subunit 1C by the prominent olive-gray to dark greenish-gray banding, corresponding to interbeds of mud, sandy mud, calcareous mud, and calcareous ooze. Color bands range in thickness from 1 to 5 cm in Cores 20 and 21, to 5 to 65 cm in Core 24. Colors commonly grade upwards within individual beds from dark gray to olive-gray. This is especially apparent in a 70-cm-thick turbidite sequence in Core 21, which includes graded beds (1-2 cm) with basal fine sand and even small pebbles (<5 mm diameter). There are few other sedimentary structures, apart from a zone of mud rip-ups in Core 21, Section 5.

The muds are generally similar in composition to those of Subunit 1C, but beds of calcareous ooze and marly calcareous ooze in Cores 20, 21, and 23 contain up to 95% calcium carbonate. Up to 5% lithic fragments are present in samples from Cores 23 and 24 and include recognizable chert and shale.

Pebbles are present throughout the unit, with a maximum diameter of 4 cm, and include quartz, quartzite, and possibly basalt. A distorted ash bed is present in Sample 20-3, 125 cm, and pyrite is present as worm-like burrow infill (5 mm × 1 mm), in Core 23, Section 4, and as nodules up to 1 cm in diameter in Core 24. The mud is very stiff, becoming mudstone by Core 23, and is locally fissile. Drilling deformation is slight. The base of the unit has been placed midway between Sample 24, CC (323 m) and the top of Core 25 (332.5 m), which are muddy siliceous oozes, although still of Plio-Pleistocene age.

Unit 3

Unit 3 consists of a relatively structureless sequence of diatomaceous mudstones, muddy diatomites, calcareous diatomites, and calcareous diatomaceous mudstones. The different sediment types result from variation in the relative proportions of the terrigenous, siliceous biogenic, and calcareous biogenic components.

Figure 14 is a graphical presentation of this variation throughout the unit, based upon smear-slide data. However, the accuracy of the diagram is directly related to the spacing of the samples, and, particularly where there are no cores, the sediment composition shown is merely an interpolation between two adjacent samples. Good core recovery means that the picture shown is fairly accurate from Cores 28 through 34, but is less reliable in the upper part of the unit. The diagram suggests a subdivision into three subunits.

Subunit 3A consists only of Core 25, and the uppermost 80 cm or so of Core 26. It appears to consist of sediments gradational in composition between those of Unit 2 and Subunit 3B, the dominant lithology being very thinly stratified dark greenish-gray to dusky yellow-green mud. It includes quantities of siliceous biogenic material increasing downunit from 4% in Core 25, Section 2 to nearly 20% at Sample 25, CC. Up to 15% glauconite is locally present in Core 25. The muds are faintly mottled and bioturbated with recognizable *Zoophycos*. Drilling deformation is slight.

Subunit B extends from Samples 26-1, 50 cm to Core 28-6, 150 cm and is dominantly a calcareous diatomite/calcareous diatomaceous mudstone, with subordinate quantities of diatomaceous mud, muddy diatomite, chalk, and siliceous chalk. The oozes are massive, with gradational color contacts between dominantly brownish-gray, olive-gray, and dark greenish-gray layers, presumably representing gradational compositional boundaries. Figure 14 shows that the subunit is characterized by a fairly low terrigenous content (generally less than 40% including both clay and other minerals), typically 20%-30% carbonate, and 40%-50% biogenic siliceous material. The carbonate is dominantly calcareous nannofossils with less than 10% authigenic carbonate, whereas the siliceous ooze consists primarily of diatoms (15%-45%), Radiolaria (3%-5%), and sponge spicules (7%-20%). A distinct nannoplankton chalk bed is present in Core 26, Section 2, and there is an increase in the proportion of clay minerals and terrigenous components in Core 28.

Bioturbation is ubiquitous, with abundant *Zoophycos* and *Helminthoida* burrows. Because of the lithified or partially lithified nature of the sediment, drilling deformation is only slight, and some synsedimentary faults are recognizable in the oozes of Core 26, Section 1.

Subunit 3C is present from the base of Core 28 to Sample 34, CC, and consists of massive, lithified, undeformed diatomaceous mudstone with a fairly constant composition, except for a single 40-cm-thick band of calcareous diatomite in Core 29, Section 2.

The proportion of clay and other terrigenous components increases through Core 29 to remain at 50%-60% for the remainder of the subunit. Composition of the clays, as shown by X-ray diffraction, varies little, with 25%-39% illite, 25%-44% montmorillonite, 15%-20% kaolinite, and 13%-18% chlorite. The siliceous ooze component consists principally of diatoms, and also remains constant at 30%-35%; thus the principal variable is the proportion of calcareous nannofossils, which reaches a high of 36% in the calcareous diatomite layer, but which then varies from 1% to 10% through Cores 30 to 33, dropping ultimately to zero at the base of Core 34. Extensive bioturbation is present throughout, with recognizable *Chondrites*, *Zoophycos*, and *Helminthoida* burrows in Core 33. Colors from Cores 29 to 31, Section 2 are predominantly dark greenish-gray to grayish-olive, but below Core 31, Section 3 brown coloration, including olive-black, brownish-black, and brownish-gray, is dominant. This is attributed to oil staining. Weight percent of organic carbon (as determined by DSDP and Phillips Petroleum) remains below 1% throughout the greater part of Site 341, but rises above that figure in Cores 30-34 inclusive, with a maximum of 2.41% in Core 32, Section 5.

Interpretations

This site has by far the greatest thickness (~328 m) of "glacial" sediments recorded on the Vøring Plateau, contrasting with approximately 61 and 86 meters, respectively, at Sites 338 and 342. Although the base was not reached, and dates are at present imprecise, the thickness of middle Miocene oozes present in the lower part of Site 341 (>128 m) is at least two to three times the thickness of those sediments of equivalent age at Site 338. This implies: (1) that the pre-Miocene (and probably pre-Tertiary) configuration of the present plateau originally consisted of a linear deep-water basin lying to shoreward of, and bounded to the northwest by, a major positive relief feature forming the Vøring Plateau Escarpment, and that the history of the area has been the gradual infilling of this basin throughout the Tertiary, or (2) that the Escarpment represents a fault that has been active throughout the Tertiary, permitting the basin to subside at a greater rate than the crust to the northwest.

Evidence from seismic records suggests that the latter mechanism has operated, although this does not discount the possibility of an original difference in relief (see Caston this volume).

The "raft" of allochthonous Oligocene to Pliocene ooze found within the "glacial" sediments (Subunit 1B) is approximately 31 meters thick. It is possible that this may represent a large glacial "erratic" carried into position by ice rafting. However, as this is a pelagic, presumably deep-water ooze, it is difficult to envisage it in a situation where it could have been exposed to ice activity, even at periods of lower sea level, unless tectonically lifted to some shallow water area. The location of Site 341, only 17 km away from the diapir zone, however, suggests an alternative mechanism, which attributes the presence of the ooze to upward movement within the diapir during the Pleistocene, and subse-

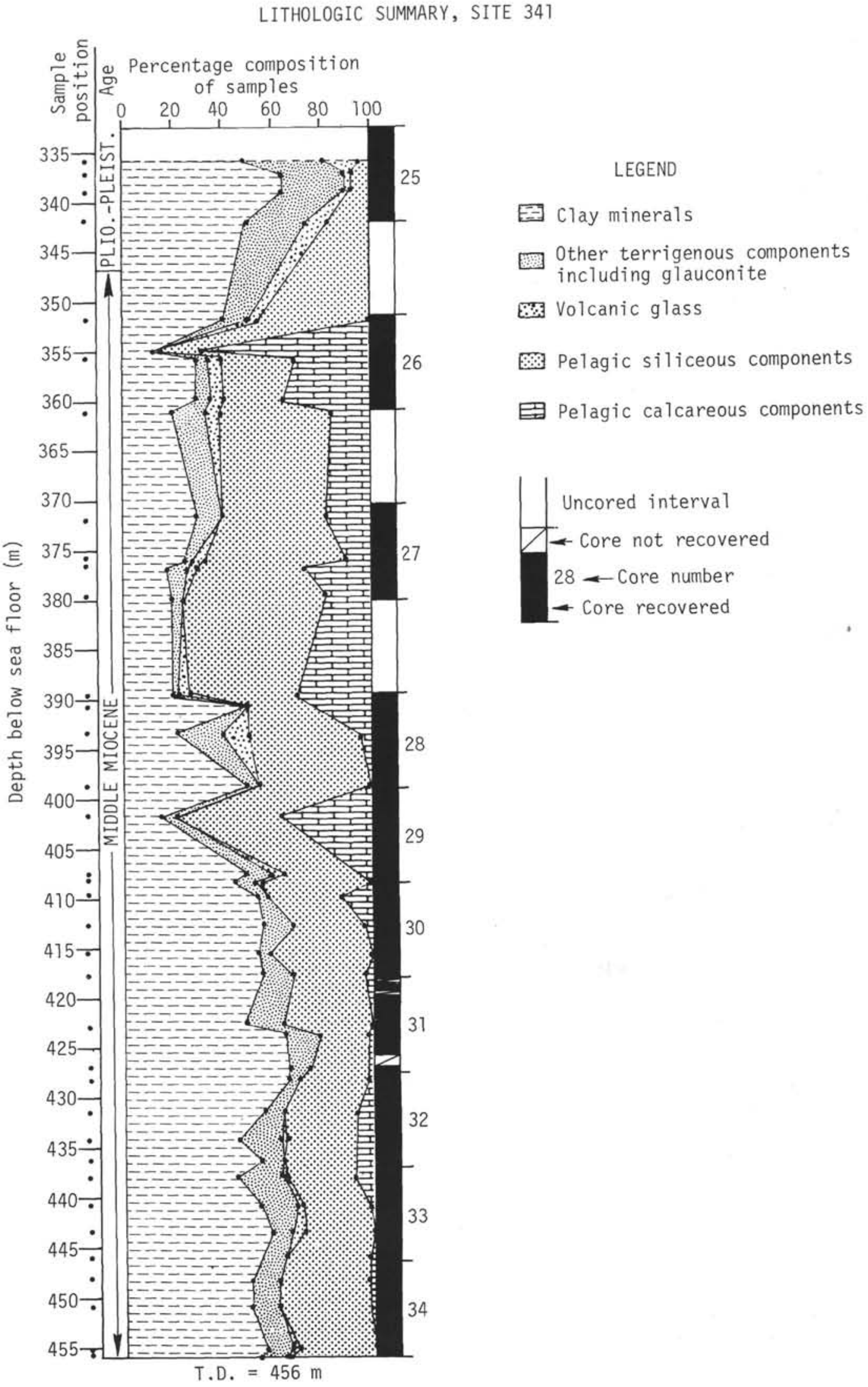

Figure 14. *Lithologic summary, Site 341. Relative proportions of terrigenous, pelagic siliceous, and pelagic calcareous components through the middle Miocene section (based on smear-slide estimates).*

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quent downslope movement to its present position. This, fairly considerable, amount of displacement could perhaps indicate the period of maximum diapiric activity.

LITHOLOGY, SITE 342

Site 342 was drilled about 46 km to the northwest of Site 338 in the same water depth, but at a point where the underlying basement was at a shallower depth below sea bed. From the airgun profile (Figure 7) it was apparent that the lowermost layers penetrated by Site 338 appeared to thin out against this basement "high," and were nonexistent on top. This was confirmed by Site 342 which passed from "glacial" muds through siliceous oozes of early Miocene age and into basaltic basement at 153.2 meters.

Two principal sedimentary units have been recognized, the second of which has been divided into three subunits. Since only the lowest 30 meters of sediment were continuously cored, determination of the true thicknesses of subunits 2A and 2B must necessarily be approximate (Table 10, Figure 15).

Unit Descriptions

Unit 1

Only two full cores were cut in this unit, thus the lithology described may not be fully representative of the sediments penetrated. The uppermost 80 cm of Core 3 consists of clay with pebbles and has thus been included within Unit 1, the boundary with Unit 2 being drawn at a depth of 85.8 meters, the top of the underlying dominantly siliceous ooze and muddy siliceous ooze sequence.

Unit 1 consists of olive-gray to brownish-gray, locally calcareous, terrigenous mud and sandy mud with pebbles throughout. Pebbles, up to 3 cm in diameter were observed in Sections 1-6, 2-3, and 3-1. Although drilling deformation is moderate to intense, an apparent original stratification is preserved through much of the unit, and this includes very thin color banding or laminae in Core 2, Section 3 and Core 2, Section 4, with individual beds averaging about 10 cm in thickness. Two graded beds are present in Core 1, Section 4 and Core 1, Section 6, the latter being 50 cm thick and consisting of brownish-gray sandy mud at the base, grading

TABLE 10
Lithologic Summary, Site 342

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
1	Olive-gray to brownish-gray locally calcareous pebbly mud and sandy mud	0-85.8	85.8	Early Miocene to Pleistocene
2A	Interstratified mud and sponge spicule mud with some nannoplankton ooze	85.8-~92.5	~6.7	Early Miocene
2B	Grayish-olive diatom ooze	~92.5-141	~48.5	Early Miocene
2C	Diatomaceous mud, becoming sandy glauconitic mud immediately above basalt	141-153.2	12.2	Early Miocene

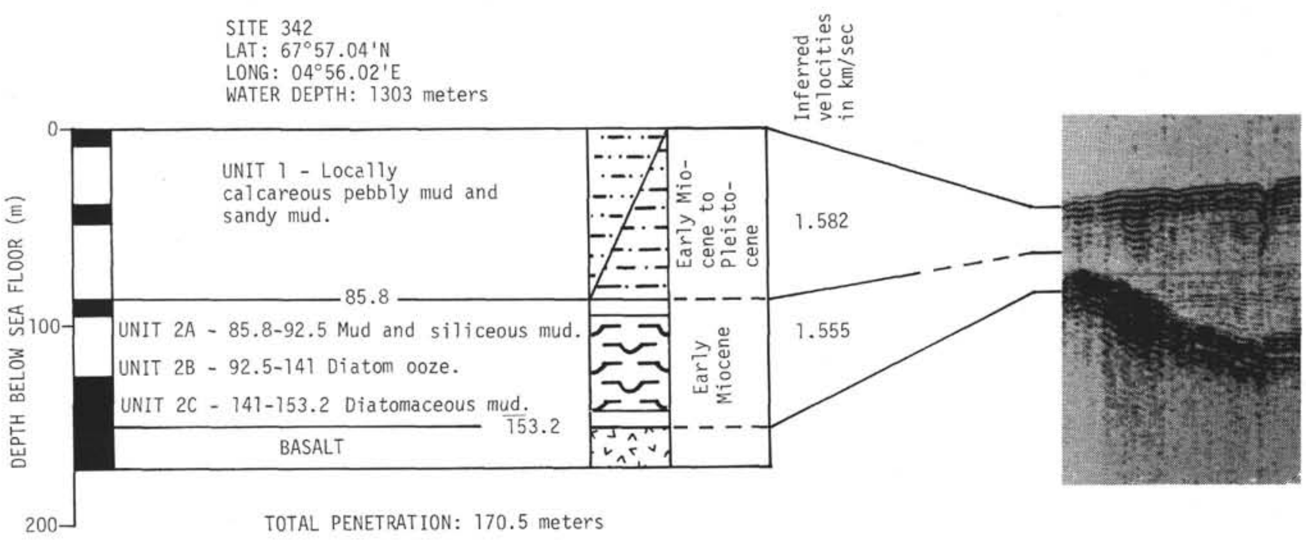

Figure 15. *Lithologic column and seismic profile, Site 342.*

upward to pale olive clay through laminations of intermediate colors. A thin streak of nannoplankton ooze is present in Core 1, Section 6, and calcite fragments and/or authigenic carbonate are present in many smear slides.

Unit 2

Unit 2 consists essentially of a siliceous ooze which becomes increasingly muddy and impure both towards the base (Core 6), and towards the top (Core 3), thus forming the basis for a threefold subdivision.

Subunit 2A (Table 10) appears to be little more than a few meters thick, the approximate Subunit 2A/2B boundary being drawn at 92.5 meters, midway between the base of Core 3, Section 4 and Sample 3, CC. However, it is possible that the true boundary lies somewhere in the uncored interval between Cores 3 and 4. The subunit consists of interstratified olive-gray and brownish-gray terrigenous mud, and lighter colored sponge spicule mud, with streaks of nannoplankton ooze in Samples 3-3, 80 cm and 3-3, 115 cm, and a volcanic ash layer, with abundant pyrite, at Sample 3-3, 38 cm. It appears to represent a gradational zone between the overlying "glacial" muds of Unit 1, and the underlying biogenic oozes of Subunit 2B. Although deformation is moderate to intense, stratification is recognizable, and there is a progressive increase in the proportion of biogenic material down the core, with a corresponding decrease in clay content. The siliceous material consists mainly of sponge spicules (7%-10%) with subordinate quantities of diatoms (2%-5%) and Radiolaria (1%-2%). No sedimentary structures were recorded.

Subunit 2B consists almost entirely of grayish-olive diatom ooze of early Miocene age. However there is a 28.5-meter coring gap between Cores 3 and 4. Thus, the composition of only the lower 18 meters or so is known. The base of the subunit at 141 meters has been selected midway between two samples, the lower (at Sample 5, CC) marking the top of the more terrigenous basal sediment identified as Subunit 2C. (See Caston, this volume.)

The diatom ooze consists largely of diatoms (52%-82%) with subordinate quantities of other biogenic siliceous debris including Radiolaria (5%-10%), sponge spicules (7%-18%), and up to 4% of silicoflagellates, together with a "background" of from trace amounts to a few percent of volcanic glass, quartz grains, heavy minerals, and opaque grains. In two samples, a clay mineral content of 10% and 20%, respectively, was recorded, and a narrow zone of ashy diatom ooze, with 20% volcanic glass shards, was noted in Sample 4-1, 90 cm. Drilling deformation is intense throughout, and apart from a certain amount of color layering, little original structure is recognizable.

Subunit 2C comprises the basal 12.2 meters of the section, and represents the more terrigenous deposits immediately overlying basaltic basement, the proportion of nonbiogenic components increasing steadily downwards to a maximum of 86% in Sample 6, CC, at which point the sediment is a sandy glauconitic mud. The composition and relative proportions of the pelagic ooze remains much as in the preceding subunit, while the terrigenous material consists primarily of an increase in clay-size particles (to a maximum of 60%), two layers with volcanic glass content exceeding 20%, and, in the basal Sample 6, CC maxima both of opaque grains (20%) and glauconite (10%). Quartz and feldspar, on the other hand, decrease from 2% to 3% in Cores 5 and 6, Section 1 to only trace amounts in the lower sections of Core 6. Drilling deformation is again intense, and little original structure remains except for some mottling, including balls or clasts consisting of pyrite-coated volcanic ash, in Core 6, Section 2 and Core 6, Section 3.

LITHOLOGY, SITE 343

Site 343 was drilled in deep water (3131 m) at the base of the Vøring Plateau slope on the edge of the Lofoten Basin at a point where a rather irregular basement "high" was clearly identifiable on the profiler record at a depth of 0.3 sec (Figure 9). Only "glacial" and Eocene age sediments were recovered, although, as the hole was not continuously cored above 193 meters, it is possible that preglacial sediments might have been present between Cores 4 and 5. The sediments are divisible into five units (See Table 11 Figure 16).

Unit Descriptions

Unit 1

Cores 1 through 4 consist of dark yellowish-brown to dark greenish-gray terrigenous mud and sandy mud, locally calcareous, with thin streaks of fine to very fine sand or silt. Below Core 2, Section 3 are a number of horizons of muddy biogenic ooze, principally nannoplankton ooze, although a narrow band of radiolarian diatom ooze is reported from Sample 35, 80 cm, and these increase in number with depth. Great variations in composition are recorded, with sand percentages varying from 3% to 65%, and nannoplankton up to 70%. A patch of volcanic ash is noted in Core 1, CC. X-ray diffraction analyses show that illite is the dominant mineral in Core 2 with percentages of 40% and 50% in two samples, whereas montmorillonite is the most obvious clay component (74%) in the radiolarian-diatom ooze in Sample 3-5, 81 cm, and kaolinite/chlorite (56%) in the marly nannofossil ooze in Sample 4-3, 19 cm.

Pebbles are present throughout the unit, but are particularly abundant in Cores 1 and 4. Rock types represented include igneous (? basalt) and metamorphics (up to 3.5 cm), although the majority are generally less than 0.5 cm in diameter.

Muds are structureless and massive in Core 1, becoming thinly stratified in Cores 2 and 3 and clearly layered in Core 4, with interbeds of terrigenous and transitional biogenic sediments. Core 4 is also clearly bioturbated with *Chondrites* and *Helminthoida* burrows. The sediment is generally very soft with intense deformation. Because of coring gaps, the Unit 1-2 boundary has been arbitrarily placed at the midpoint between Cores 4 and 5.

Unit 2

Unit 2 is identified in Cores 5 and 6 only, and little is known about the latter because of poor recovery (less

TABLE 11
Lithologic Summary, Site 343

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
1	Dark yellowish-brown to dark greenish-gray mud, locally calcareous, with pebbles	0-~126.5	~126.5	Plio-Pleistocene to Pleistocene
2	Dusky yellow-green muddy diatom ooze with volcanic ash layers	~126.5-202.5	~76.0	Middle Eocene
3A	Olive-black to dark greenish-gray thinly-stratified mud	202.5-250	47.5	Early Eocene
3B	Turbidite sequence composed of mud and glauconite mud	250-253	3	Early Eocene
4	Olive-gray mud and sandy mud, locally calcareous and glauconitic	~261.2-283	~21.8	Early Eocene

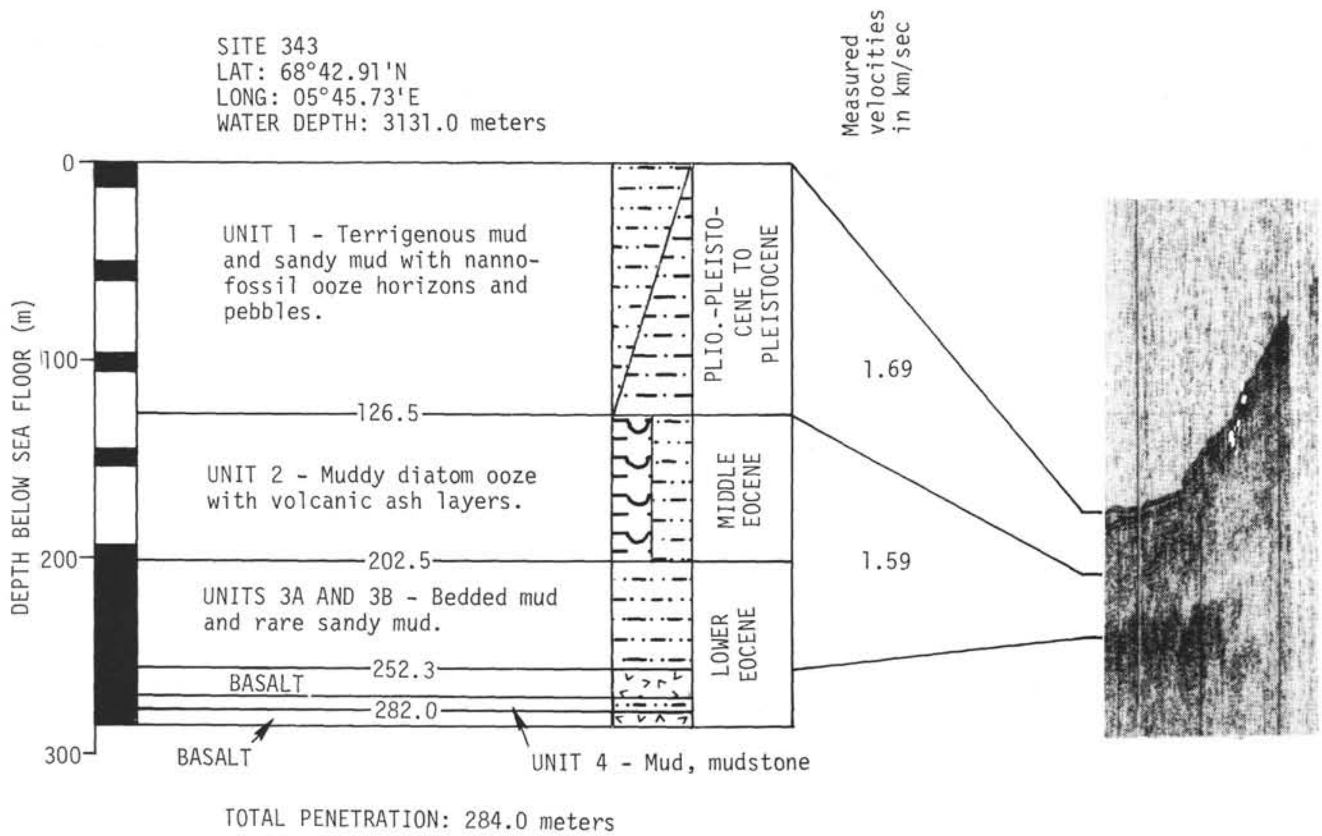

Figure 16. *Lithologic column and seismic profile, Site 343.*

than 0.7 m). It is distinguished from the overlying "glacial" sediments both by an absence of pebbles and a predominance of biogenic ooze.

The uppermost 70 cm, down to Sample 5-2, 42 cm, is composed of mud, but below the dominant sediment is a muddy diatom ooze with diatoms (40%-60%), Radiolaria (5%-15%), sponge spicules (5%-10%), volcanic ash (0%-10%), clay minerals (10%-25%), and other terrigenous components (5%-20%). Considerable diversity is apparent in the sediment types noted, with several thin layers (maximum thickness 20 cm) of volcanic ash or diatomaceous muddy ash in Core 5, Section 4 and Core 5, Section 6, a thin streak of nannofossil ooze in Sample 5-4, 148 cm, and narrow bands of sandy mud or muddy silt in Samples 5-2, 115 cm and 5-4, 147 cm. The nannofossils are almost wholly altered to authigenic carbonate. A single X-ray diffraction analyses at Sample 5-2, 74 cm indicated that montmorillonite was again the dominant clay mineral (63%) within the diatomaceous oozes.

The muds in the upper two sections are variegated and range in color from olive-gray to light olive-gray, whereas the oozes are fairly massive and commonly dusky yellow-green in color. Some bioturbation is present in Core 5, Section 1 and Core 5, Section 3, with recognizable *Chondrite* burrows in the latter.

The Unit 2-Unit 3 boundary is placed at the base of Core 6 where there is a return to entirely argillaceous sediments in the latter unit.

Unit 3

Unit 3 is subdivided into two subunits—Subunit A consisting of bedded muds down to Sample 11, CC (250 m), and Subunit B, which consists of a detailed turbidite sequence immediately overlying basalt.

Subunit 3A (Table 11) consists of olive-black to dark greenish-gray mud and rare sandy mud. This is thinly stratified, especially in Cores 10 and 11, where colors are variegated. The greater part of the mud consists of clay minerals; X-ray diffraction analyses suggest that illite is the dominant mineral (43%-56%), and that kaolinite/chlorite generally increases down the unit (from 12% at Core 8, Section 1 to 38% at Core 11, Section 2) at the expense of montmorillonite (down from a maximum of 58% at Core 7, Section 1 to 16%), but these generalizations are based upon only a few measurements. Other terrigenous components make up from 18% to 47%, including a maximum of 25% quartz/feldspar in one silty horizon, and up to 40% opaques (possibly volcanic lapillae) elsewhere. Volcanic glass, which is commonly (?) devitrified, is typically present from trace amounts to 5%, but locally reaches 80% to 100% in ash layers common in Cores 7 and 11. Biogenic content is low, less than 7%, except in an altered nannofossil ooze streak in Sample 7-1, 32 cm, but fecal pellets and mud "blebs" are recorded from the mud in a number of smear slides. A large (5 cm in diameter) pyrite nodule was found in Sample 8-2, 5 cm, and more pyrite is present elsewhere in Cores 8 and 9.

Subunit 3B includes only Core 12, Section 1 and Core 12, Section 2. Core 12, Section 2 consists of a well-developed and lithified turbidite sequence with 11 identifiable units within a total of 120 cm. These include at least one complete and several partial Bouma sequences, with well-displayed examples of basal erosion, graded bedding, cross bedding, and parallel stratification. Conglomerate pebbles, up to 2.5 cm in diameter, are composed of mudstone and/or decomposed chloritized (?) basalt. Sand and silt-size grains appear also to be composed principally of this material, and smear slides show that quartz/feldspar are present in quantities of less than 5%. Glauconite is present in significant amounts varying from 2% to 25%, the latter present in association with (and possibly replacing) a volcanic ash at Core 12-2, 61 cm. X-ray diffraction results show an abrupt increase in montmorillonite to nearly 80% at Core 12, Section 2.

Unit 4

Unit 4 has been distinguished principally on the basis of its stratigraphic position between two basalt layers, although superficially it is fairly similar in composition to the previous unit. It consists essentially of olive-gray mud with intercalated sandy ashy mud, muddy silt, calcareous mud, and glauconitic mud horizons. Clay content, identified as predominantly montmorillonite by X-ray diffraction analyses, ranges from 36% in a muddy silt to 72%, volcanic glass from 0 to 40%, and glauconite from 0 to 25%. Of significance are up to 30% authigenic carbonate (locally 93% in a carbonate vein at Sample 16-2, 30 cm), some fragments of which have a fibrous appearance suggesting possible derivation from shell material, and a high proportion of terrigenous components, ranging from 12% to 56%. This material consists of quartz grains (locally up to 40%), mica, heavy minerals, and up to 20% of opaques and some lithic fragments. As in Unit 3, glauconite appears to be locally replacing volcanic ash and some opaque grains.

The mud is faintly bedded in Cores 15 and 16, Section 1, with some poorly developed graded bedding. Bioturbation is possibly responsible for some mottling seen in Core 15, Section 2. Core 16, Section 2 and Core 16, Section 3 are extensively brecciated and veined by chlorite and calcite. A large porphyritic andesite pebble is present at Sample 15-2, 140 cm. Drilling deformation is locally intense.

Interpretations

The lowest Eocene age sediments cored, those of Unit 4, are fairly fine grained, are poorly sorted, and have features suggesting that they were deposited perhaps in relatively deep water, but adjacent to a shallow-water environment. This would explain the significant proportion of quartz grains, mica flakes, and other detrital components together with the andesite pebble (rolled down a slope?) and the authigenic carbonate, some of which looks as if it is an alteration product after (?) molluscan shell debris. The turbidite sequence of Subunit 3B supports the idea that Site 343 lay at or near the base of a paleo slope during the early Eocene. However, this unit has a consistently finer grain size with a much lower proportion of detrital components, perhaps implying that the primary depositional area of the turbidite material was by this time cut off from a direct "continental" source.

Throughout Subunit 3A time the site area continued to receive quantities of essentially hemipelagic muds and occasionally sandy muds, although there is no indication here of sediment deposition via turbidity currents. These sediments were succeeded in the middle Eocene (Unit 2) by muddy siliceous oozes, suggesting that at this time the source of terrigenous clay particles was becoming less significant.

The evidence thus suggests that soon after the onset of sedimentation in the early Eocene Site 343 lay at or near the base of a paleo slope, and that the time span represented by Units 4 through 2 saw a progressive decrease in the amount of terrigenous sediment deposited at the site. Coupled with evidence from Sites 338 and 342, this can best be explained in terms of continued subsidence of the margin.

An important question concerns the reason for the considerable hiatus (middle Eocene to Plio-Pleistocene) between the ages of the sediments seen in Units 2 and 1, respectively. It is of course possible that sediments younger than middle Eocene were present in the uncored 38-meter interval between Cores 5 and 4. Nevertheless, assuming sedimentation rates comparable either with the Eocene at Site 343, or at least with those seen in other holes to the west of the Vøring Plateau Escarpment, this thickness is totally insufficient to account for the potential thickness of mid-Eocene to Pliocene age sediments. The hiatus may be explained by referring to the *Glomar Challenger* profile from Sites 342 to 343 (Figure 1). This shows that a wedge of sediments thickening downslope and equated with the Eocene to mid-Oligocene of Site 338 extends down the side of the Vøring Plateau. Just before Site 343, this wedge abruptly thins, suggesting that deposition was inhibited, or that sediments might even have been eroded, by a contour or bottom current flowing around the base of the plateau. The extent of the lower featheredge of this wedge is not clear on the profiler records, but it appears to extend as far as Site 343, in which case it would be represented by Subunit 3B to Unit 2 inclusive, the single identifiable reflector marking the upper surface of this wedge equating with the Unit 1-Unit 2 boundary. If the current's activity continued throughout the Tertiary, this would explain the continued nondeposition of sediments until the anomalous events of the glacial period were responsible for deposition of the uppermost 126 meters

A further interesting question posed by the results of Site 343 concerns the relationship of the uppermost basalt layer to overlying and underlying sediments. The latter is of course not seen, but the contact of Unit 3B above the basalt—the base of the turbidite layer with a basal conglomerate of mudstone clasts—is clearly of sedimentary origin, thus strongly suggesting that this basalt layer at least was extrusive, and not still intruded into an existing sedimentary sequence. This observation has yet to be reconciled with the conclusions drawn from a petrographic study of the igneous rocks, which suggests that all sedimentary rocks in contact with the basalt have been thermally metamorphosed, and that the basalts are therefore intrusive sills.

IGNEOUS PETROGRAPHY-PETROLOGY, SITE 338

General Description

Rocks of acoustic basement at Site 338 were penetrated at 401.8 meters. Four cores (42, 43, 44, 45) contained 12.3 meters. The upper part of the section (Core 42, Section 2) is represented by a brownish-black breccia and sandstone, with round and angular fragments of altered weathered basalt cemented by a calcite-chlorite-hydrogoethite matrix. It may represent the remainder of an eluvial horizon similar to the lower part of the reddish claystone bed recovered from Hole 336. The thickness of the breccia at Site 338 is about 1 meter. The upper part of eluvial horizon probably was eroded, and then redeposited as a sediment series.

Petrography

The igneous rocks are represented by homogeneous, nearly holocrystalline basalt with diabasic, subophitic, microintersertal, and rare pilotaxitic texture, medium and fine crystalline. The framework consists of twinned plagioclase laths (0.1-0.5 mm long). Small euhedral olivine phenocrysts are pseudomorphic and replaced by chlorite, iddingsite, and goethite. The high olivine content (up to 20%) allows the classification of an olivine basalt (Samples 42-2, 144-147 cm and 44-3, 48-51 cm). It is interesting that olivine basalt is usually enriched by a glassy matrix (up to 20%). There are the intratelluric phenocrysts and glomeroporphyritic plagioclase clusters (An 62-69 [5%-12%]), from 0.5 × 1.0 to 3 × 4 mm. There are also euhedral clinopyroxene phenocrysts (2%-3%) 0.2-0.5 mm long.

The section contains two beds of basalt enriched in amygdules (10%-12%), 1-10 mm diameter. They are found in Samples 43-4, 115-133 cm and 44-2, 75-83 cm. The amygdules are round to ellipsoidal, and filled by white calcite, gray-green smectite. There are rare irregular cavities (from 10 × 20 to 20 × 60 mm), filled by gray-green smectite and chlorite (?).

The basalt is highly altered. Chloritization, calcification and albitization (?) are observed throughout. Olivine is completely replaced by chlorite, iddingsite, and goethite. Plagioclase is partially replaced by smectite, calcite, and zeolite. Around the plagioclase grains there is thin rim of newly formed albite (?). Clinopyroxene, in a few places, is replaced by leucoxene (?).

There are numerous veins of smectite and calcite (0.1 to 5 cm thick) with rare pyrite also observed. Slickensides and mylonitization have broken the basalt.

Summary

The basalt of Site 338 is nearly holocrystalline without (or with small number) a glassy matrix, contains alterations products, and possibly represents a dike or sill.

IGNEOUS PETROGRAPHY-PETROLOGY, SITE 342

General Description

Cores 7 and 8 from Hole 342 contained 11.5 meters of basalt. In the upper portion of Core 7, Section 1, drill pebbles of altered, weathered (?), and mylonitized basalt were found. Below this, there is nearly 1 meter of medium light gray to medium light dark gray basalt, with traces of oxidation. Still lower, the color of basalt gradually changes to medium dark and grayish-black.

Rare fissures and veins intersect the basalt. On the walls of the fissures, dark green chlorite is present. Veins (1-5 mm thick) are filled by white calcite, green and dark-green chlorite, and rare pyrite. In a few cores (Sections 7-3, 8-4), the fissures and veins contain small needle-shaped crystals, which are probably zeolite (near isotropic, $N \ll 1.572$).

There are cavities, vesicles, and amygdules. The walls of the cavities and vesicles contain green chlorite, white calcite, and sometimes calcite crystals. The amygdules are often filled by dark green chlorite, and rarely by calcite.

The basalt contains irregular disseminations of copper (0.05-1.0 mm). The cupreous basalt is very similar to the basalt in which copper is not present.

Probably the copper represents "xenocrysts" taken by a magma from depth. There are also xenoliths of feldspathic rocks with biotite.

Petrography

The basalt of Site 342 is nearly holocrystalline, fine to medium grained, and porphyritic. It is generally fresh in appearance except in the upper part, and in the narrow altered zones near fractures. The textures are subdiabasic, intersertal, and subophitic. The framework consists of twinned plagioclase laths (An 60-65, 0.5-1.0 mm long). Augite and plagioclase are present in subophitic intergrowths. Between the augite and plagioclase are magnetite, green chlorite, and smectite.

Phenocrysts (up to 20%) are represented by plagioclase, very rare olivine, and rare clinopyroxene. Plagioclase phenocrysts and glomeroporphyritic clusters, and augite-plagioclase aggregates (2-4 mm) are common.

Plagioclase (An 54-58) usually is fresh, without traces of secondary alteration. Its grains are polysynthetically twinned. Sometimes on the periphery and in the cleavage surfaces of the plagioclase phenocrysts there is relic glass and finely crystallized pyroxene grains. Clinopyroxene (augite) phenocrysts (0.2-0.5 mm) have irregular short prismatic grains arranged separately, or as small aggregates. Some clinopyroxene grains have a slight violet color that indicates the alkaline type of mineral (titanaugite) and basaltic magma.

The basalt is slightly altered. Smectite, chlorite, and rare calcite was observed.

Summary

The basalt (diabase-basalt) of Site 342 petrographically is similar to basalt recovered from Site 338, but the magma from Site 342 has a more alkaline composition, confirmed by the presence of titanaugite. Small amounts of glass and nearly holocrystalline rock indicate a thick flow or dike (sill) character for Site 342 basalt.

IGNEOUS PETROGRAPHY-PETROLOGY, SITE 343

General Description

Sections 12-2, 12-4, 13-1, 13-2, 14-1, 16-3 from Site 343 contain five basalt horizons. Between these horizons (probably sills), sedimentary rocks including limestone, claystone, and siltstone are present. The sedimentary rocks are present in the metamorphic aureole of the basalt sills, and have been thermally metamorphosed. The limestone (marble) has an aphanitic and granoblastic texture with rare, included basalt fragments, and phosphatic micronodules. There are also round, recrystallized remnants which probably are algae growths.

The claystone and siltstone contain angular and round basaltic fragments, feldspar, quartz, and sheets of muscovite and biotite. There is evidence of slight dolomitization. Rare pyrite concretions (5 × 4 cm) were also observed. The sedimentary rocks are generally hard, while the basalt is soft, and over a few intervals has been converted into black clayish matrix material.

The fresh basalt is grayish-black to dark gray and contains white calcite veins, and amygdules filled by dark green smectite, chlorite, pyrite, and calcite. In few places, the rock is intersected by slickensides and fissures, with a black, clayish chloritized mass on their walls.

Petrography

The basalt has microporphyritic, hyaloophitic, subophitic, and subdiabasic textures. Near the contacts with the sedimentary rocks,the basalt has a very fine grained, and variolitic texture. In the middle parts of the sills, the basalt is fine to medium grained, and nearly holocrystalline. The basalt framework consists of altered skeletal plagioclase laths (0.2-0.5 mm). The maximum extinction angle ($\perp$ 010) from 27° (Sample 13-2, 5-8 cm) to 32° (Sample 16-3, 144-147 cm) indicates the plagioclase is andesine (An 47) and labradorite (An 56). Inside the laths is a nearly isotropic mass, which is probably the remnants of devitrified glass. Interstitial areas between the plagioclase laths are filled by calcite-chlorite-smectite aggregates, and rarely by augite. Chloritized devitrified glass also is present in interstitial openings. Microphenocrysts and phenocrysts (5%-15%) are replaced by chlorite, leucoxene, and calcite. The phenocryst form indicates that they were formerly olivine, pyroxene, and plagioclase. Some plagioclase phenocrysts have well-developed zonations underlined by secondary minerals. Peripheral zone is thin, clean, and transparent. Maximûm extinction angle of 25° ($\perp$ 010) indicates andesine (An 45). Skeletal crystals of an opaque mineral may possibly be ilmenite. There are also magnetite and pyrite crystals.

The amygdules (0.1-2 mm) and vesicles (1-3 mm) are regularly filled by pyrite, chlorite-smectite, and calcite. Some places (Sample 16-3, 144-147 cm) have high content of amygdules (up to 30%). The viens (0.1-3 mm) have a chlorite-calcite composition with later deposited pyrite. The following stages are proposed for the origin of secondary minerals: (1) pyrite; (2) chlorite and smectite; (3) calcite; (4) pyrite.

Summary

Rocks of acoustic basement at Site 343 probably represent basaltic sills, with slightly metamorphic limestone, siltstone, and claystone. The basalt of Site 343 is very highly altered, with chloritization being observed. Secondary alterations make it very difficult to recognize the primary mineral composition. This basalt probably contained plagioclase (30%-45%), clinopyroxene (35%-45%), and olivine (5%-20%). It appears to represent a type midway between typical oceanic tholeiites, and alkalic plateau basalt. This is supported by the low basic nature of the plagioclase.

GEOCHEMISTRY OF BASALTS (H.R AND F.-J.E) SITES 338, 342, AND 343

The discussion concerning the geochemistry of the basalts from the three sites on the outer part of the Vøring Plateau northwest of the Vøring Plateau Escarpment is summarized in this section. It was expected that the character of the basalts would give important suggestions about the oceanic or continental character of the Outer Vøring Plateau and the initial opening of the Norwegian Sea in the early Eocene.

The degree of alteration of the basalts from Site 338 (total H_2O: 2.63%-3.88%; 100 $FeO/FeO + Fe_2O_3$ = 58.4), and from Site 342 (total H_2O: 1.64%-3.95%; 100 $FeO/FeO + Fe_2O_3$ = 61.0) is low enough for geochemical characterization. The highly altered basalts from Site 343 with extensive carbonatization and formation of smectite-minerals prevents a thorough discussion of the analytical geochemical results. No major differences in geochemistry were found in the basalt sequences within each of the three separate holes (Tables 12-15).

The normative composition of Site 338 basalts (ferric iron calculated as $TiO_2 + 1.5$) shows an olivine tholeiite character of these rocks, which is not changed if iron is fixed to 1.5% Fe_2O_3. The basalts of Site 342 are even quartz normative tholeiites or olivine tholeiites, depending on the calculation of ferric iron.

There are, however, decisive differences concerning the absolute element concentration (Tables 12 to 15). Site 338 basalts have the lowermost crystallization index of all sites (FeO/MgO = 1.15), an average Al_2O_3 content = 16.0, which is quite normal for ocean floor basalts, and very low contents of K_2O (0.11%), TiO_2 (1.07%), and P_2O_5 (0.08%). From the element concentrations, a very high normative color index and normative An content fo plagioclase and a low differentiation index results.

On the other hand, the basalt from Site 342 shows the most developed iron enrichment of all sites together, with higher alkali concentrations. We observe a very high K_2O (average 0.52%), TiO_2 (average 2.45%), P_2O_5 (average 0.25%), and a lower CaO (average 10.26%) contents in comparison to Site 338. A lower normative anorthite content in the plagioclase and a rather high differentiation index indicate a change in the overall composition from Site 342 to Site 338.

PHYSICAL PROPERTIES, SITE 338

Bulk Density, Porosity, and Water Content

Corrected GRAPE bulk density section averages clearly show differences in this physical property and outline a gross stratigraphy based upon density. Four sedimentary units are shown and average density values displayed in Table 16.

Excellent correspondence exists between the sediment types and bulk density. Unit 1 is primarily a highly deformed mud and sandy mud which has been quite deformed. Units 2 and 3 are pelagic, consisting primarily of diatom and radiolarian siliceous oozes, with some mixing of calcareous nannofossil ooze and show low densities and high water contents, due to excessive voids caused by the tests. Unit 3 has been considered separately as it exhibits a peculiar trend in that a density gradient exists through several cores. Most obvious is the interval between the nearly continuous section occupied by Cores 22-24. Maximum density is present at the top of Core 22, and decreases linearly to the base of Core 24. Core deformation is not considered responsible for this trend because (1) each plotted point represents a smoothed average of corrected density values taken 1 cm apart, (2) core log descriptions show slight deformation through this interval, (3) core deformation, when present, is greatest toward the top of each core which would result in decreased density values and increased water contents toward the top, the reverse of this situation, and (4) Unit 2, composed of the same sediment types, does not exhibit these patterns. The lowermost section of Core 24 is primarily a terrigenous clay, and the successively higher cores are alternating calcareous and siliceous pelagic deposits. Recrystallization in Cores 22 and 23 may have occurred to increase the density and decrease the porosity in this upper portion.

Unit 4, composed of semi-indurated terrigenous deposits of mudstone and sandy mudstone, shows a sharp increase in density which remains relatively constant to the basalt found in Core 42, Section 2.

Rock chip samples of indurated sediments provide an independent estimate of bulk density, porosity, and water content (Table 17).

Sonic Velocity

Cores 1-6 show increasing velocities to Core 3, then a decrease through Cores 4-6, but still higher velocity than succeeding cores. This unit reflects the high density values seen in Figure 17. Lower, very consistent values are seen in Cores 7-23, consisting predominantly of calcareous and siliceous oozes.

A sharp change back to low velocity sediments occurs in Core 28, Section 4, continuing to the base of Core 35. Following this, a high velocity unit is again seen (Cores 36-42), immediately above the basalt basement. Velocities decrease from about 2.4 km/sec to less than 2.0 km/sec immediately above the basalt. This decrease is probably due to operational difficulties as the lowermost sediments were composed of loosely consolidated conglomerates and difficult to measure.

Table 18 presents mean values and standard deviations of sonic velocities which characterize each group of cores.

Shear Strength

Measurements of shear strength were limited to Cores 1-3 in which terrigenous clays and muds were present. Cores 1-3 showed deformation from intense to moderate, but the clay units appeared uniform and homogenous. Plastic flowage had taken place in many places, yet the internal cohesion seemed little altered.

Figure 18 shows the increase in shear strength observed in Cores 1 and 2. Values range from 0.045 TSF (44.65 g/cm^2). These values correspond favorably with the range of shear strengths from cores from the same area.

Core 2 clearly shows the effect of disturbance on shear strength. The low value was taken from a segment of the core that was very obviously disturbed. The two higher values were taken from undisturbed material.

Values for unconfined compression ranged between 0.25 TSF (248.04 g/cm^2) to 2.5 TSF (2480.41 g/cm^2), with maximum values occurring below Core 7. Several units of extremely high compressive strength were observed to also be units possessing high sonic velocities (Cores 24-26 and Core 37).

TABLE 12
Analyses of Site 338 Basalts

	43-2, 115-118 cm RF 9809	43-3, 53-56 cm RF 9810	43-3, 99-102 cm RF 9811	43-4, 54-57 cm RF 9812	43-4, 100-103 cm RF 9813	44-3, 91-94 cm RF 9817	45-1, 127-130 cm RF 9818	45-2, 56-59 cm RF 9819
SiO_2	47.00	47.54	47.03	47.89	46.50	47.28	48.16	47.74
TiO_2	1.09	1.10	1.01	1.10	1.02	1.10	1.10	1.09
Al_2O_3	16.38	16.61	15.83	16.03	16.76	15.81	15.18	15.36
Fe_2O_3	4.03	3.60	3.90	3.54	4.21	4.33	4.23	4.43
FeO	5.51	5.63	5.94	5.94	4.94	5.14	5.93	6.34
MnO	0.13	0.11	0.12	0.15	0.16	0.26	0.23	0.22
MgO	7.89	7.80	8.83	7.95	8.53	8.21	7.95	7.60
CaO	11.28	11.77	10.33	12.00	10.55	11.09	11.74	12.08
Na_2O	2.21	2.27	2.27	2.09	2.26	2.29	2.20	2.06
K_2O	0.13	0.09	0.08	0.10	0.09	0.17	0.09	0.08
H_2O_{tot}	2.94	2.94	3.88	2.90	3.23	3.30	2.83	2.63
SO_3	0.00	0.02	0.01	0.00	0.02	0.01	0.00	0.00
P_2O_5	0.08	0.09	0.08	0.08	0.09	0.09	0.08	0.08
Total	98.67	99.57	99.31	99.77	98.36	99.08	99.72	99.71
C.I.P.W. Norms[a]								
Qz	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Or	0.80	0.55	0.50	0.61	0.56	1.05	0.55	0.49
Ab	19.57	19.90	20.16	18.28	20.14	20.27	19.25	17.99
An	35.98	36.12	34.39	35.20	37.20	33.84	32.34	33.47
Di	17.78	19.15	15.20	20.80	13.92	18.62	22.14	22.65
Hy	15.45	14.26	13.04	17.28	15.76	15.29	17.78	17.04
Ol	4.14	3.68	5.67	1.59	6.27	4.57	1.69	2.16
Mt	3.93	3.91	3.82	3.90	3.85	3.94	3.90	3.88
Il	2.17	2.16	2.01	2.16	2.04	2.19	2.16	2.14
Ap	0.20	0.22	0.20	0.20	0.23	0.22	0.20	0.20
Pr	0.00	0.04	0.02	0.00	0.04	0.02	0.00	0.00
Norm.Plag.An	64.77	64.48	63.04	65.82	64.88	65.54	62.69	65.04
Diff.Ind.	20.37	20.45	20.65	18.89	20.70	21.32	19.80	18.48
Norm.C.I.	43.66	43.43	44.96	45.92	42.10	44.85	47.87	48.06

[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 13
Trace Elements of Site 338 Basalts

	RF 9809	RF 9810	RF 9811	RF 9812	RF 9813	RF 9817	RF 9818	RF 9819
Sr	1.39	141	136	140	143	135	128	124
Nb	10	5	<3	9	3	7	4	<3
Zr	62	61	54	62	54	62	62	61
Y	21	21	16	21	11	19	24	24
Ni	97	94	101	93	92	83	86	78
Co	47	47	52	42	45	48	54	54
V	277	276	260	284	262	312	311	309
Zn	75	73	72	76	74	84	93	82
Cu	55	56	86	104	128	170	156	117
Cr	352	367	323	369	341	212	218	206
Ce	8	28	16	22	8	26	13	36
Sc	43	44	45	49	46	55	54	54

PHYSICAL PROPERTIES, SITE 339

Bulk Density, Porosity, and Water Content

Figure 19 presents the sectional averages of corrected GRAPE bulk density with depth. Two distinctly different sedimentary units are seen. Cores 1-8 comprise a unit of relatively high density sediment, ranging between 1.63-2.23 g/cc. A section of low-density sediment is present in Core 7, but makes up a minor part of this high density unit. Cores 9-12 show an abrupt and

TABLE 14
Analyses of Site 342 Basalts

	7-1, 146-148 cm	7-2, 137-140 cm	7-4, 113-116 cm	7-5, 126-129 cm	8-1, 135-138 cm	8-2, 65-68 cm	8-3, 84-87 cm	8-4, 73-76 cm	8-4, 127-130 cm
	RF 9847	RF 9848	RF 9850	RF 9851	RF 9852	RF 9853	RF 9854	RF 9855	RF 9856
SiO_2	48.47	48.43	48.33	48.46	48.01	48.89	48.18	47.25	48.38
TiO_2	2.43	2.53	2.37	2.51	2.41	2.42	2.43	2.51	2.44
Al_2O_3	15.39	15.49	13.85	14.69	14.33	14.13	14.04	14.04	14.11
Fe_2O_3	5.92	3.83	4.58	4.63	6.50	3.99	4.38	6.27	3.99
FeO	6.26	7.29	8.58	6.98	6.07	8.47	8.65	7.40	8.82
MnO	0.15	0.14	0.17	0.14	0.19	0.17	0.18	0.16	0.18
MgO	4.36	5.28	5.75	5.70	5.35	5.81	6.09	5.56	5.93
CaO	10.37	10.75	9.99	10.46	9.88	10.59	10.54	9.09	10.64
Na_2O	2.96	2.91	2.64	2.81	2.66	2.60	2.65	2.38	2.69
K_2O	0.94	0.48	0.38	0.57	0.77	0.38	0.36	0.48	0.35
H_2O_{tot}	2.08	2.01	2.40	2.15	3.10	2.08	1.86	3.95	1.64
SO_3	0.02	0.03	0.00	0.00	0.00	0.00	0.05	0.00	0.02
P_2O_5	0.35	0.25	0.23	0.26	0.23	0.22	0.22	0.23	0.22
Total	99.70	99.42	99.27	99.36	99.50	99.75	99.63	99.32	99.41
C.I.P.W. Norms[a]									
Qz	1.45	2.08	2.69	2.07	2.16	3.15	1.49	3.77	1.81
Qr	5.70	2.91	2.32	3.47	4.73	2.30	2.18	2.98	2.12
Ab	25.71	25.28	23.08	24.48	23.41	22.53	22.96	21.17	23.29
An	26.62	28.52	25.64	26.55	25.89	26.38	25.96	27.55	25.98
Di	19.51	19.80	19.64	20.31	19.20	21.12	21.29	14.97	21.64
Hy	9.54	9.83	15.63	11.63	13.40	13.47	15.03	17.88	14.03
Ol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mt	5.85	6.00	5.80	5.99	5.90	5.82	5.83	6.11	5.84
Il	4.74	4.93	4.65	4.91	4.76	4.71	4.73	5.01	4.74
Ap	0.85	0.61	0.56	0.63	0.57	0.53	0.53	0.57	0.53
Pr	0.04	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.04
Norm. Plag. An	50.87	53.01	52.63	52.03	52.52	53.94	53.07	56.55	52.73
Diff. Ind.	32.87	30.26	28.09	30.01	30.31	27.98	26.63	27.93	27.21
Norm. C.I.	40.53	41.22	46.28	43.46	43.82	45.65	47.43	44.54	46.83

TABLE 15
Trace Elements of Site 342 Basalts (ppm)

	RF 9847	RF 9848	RF 9850	RF 9851	RF 9852	RF 9853	RF 9854	RF 9855	RF 9856
Sr	232	232	200	214	193	208	208	168	206
Nb	22	17	13	10	15	15	16	13	19
Zr	174	168	164	171	164	167	158	168	160
Y	46	34	42	44	44	40	32	37	35
Ni	76	81	85	128	109	79	80	91	90
Co	47	52	54	78	57	49	52	55	57
V	343	367	337	358	343	354	343	345	356
Zn	147	129	130	139	123	126	122	140	130
Cu	110	182	252	198	273	228	179	129	250
Cr	182	195	167	190	189	189	179	203	186
Ce	48	40	39	33	43	48	35	39	45
Sc	48	50	41	50	41	49	44	48	43

distinct change in bulk density. The low density and high water content is characteristic of diatom ooze. Table 19 presents the means and standard deviations, based on section averages.

Bulk density, porosity, and water content were also measured on selected rock chip samples (Table 20). Average values for each rock chip sample are slightly lower than the values obtained by the GRAPE, even after corrections. Inasmuch as the determinations are made directly on the rock in the rock chip method, the data are considered to possess a high level of reliability. GRAPE values may be inaccurate, depending on the grain density chosen to use in corrections.

Shear Strength

Shear strength increases from 0.02 TSF (19.84 g/cm²) in Core 1 to 0.117 TSF (116.14 g/cm²) in Cores 2-4, with an extreme value of 0.190 TSF (188.60 g/cm²) pre-

TABLE 16
GRAPE Density (Section Means and Standard Deviations), Site 338

Unit	Core	$\bar{x}$	s	n
1	2-6	1.877	0.094	14
2	8-21	1.365	0.054	27
3	22-29	1.427	0.081	23
4	30-42	1.901	0.148	21

TABLE 17
Bulk Density, Porosity, Water Content – Rock Chip, Site 338

Unit	Sample (Interval in cm)	W (%)	Porosity (%)	Density (g/cc)
2	15-1, 100-101	61.56	79.93	1.30
	15-4, 85-86	59.27	78.44	1.32
	15-5, 40-41	59.56	78.59	1.32
	17-3, 95-96	62.30	79.64	1.28
	19-1, 75-76	59.35	78.90	1.33
	19-5, 80-81	60.58	78.20	1.29
	19-5, 130-131	59.11	78.46	1.33
	20-3, 45-46	53.30	74.13	1.39
3	22-4, 53-54	48.06	71.61	1.49
	23-3, 40-41	49.97	71.34	1.43
	24-2, 70-71	59.84	79.91	1.33
	24-4, 70-71	60.63	80.48	1.33
	24-6, 60-61	53.24	76.88	1.44
	25-2, 42-43	55.98	77.82	1.39
	26-1, 127-128	49.62	73.05	1.47
	26-2, 80-81	19.85	51.08	2.04
	26-5, 130-131	64.51	80.78	1.25
	27-2, 82-83	59.94	77.69	1.30
	27-3, 40-41	61.03	79.29	1.30
	27-4, 147-148	60.04	77.72	1.29
	29-2, 90-91	63.97	81.10	1.27
4	30-4, 90-91	44.44	65.57	1.47
	32-2, 119-120	30.34	55.10	1.81
	32-4, 120-121	46.15	70.82	1.53
	32-6, 115-116	34.05	59.17	1.74
	33-2, 147-148	31.25	55.65	1.78
	33-4, 147-148	32.64	57.50	1.76
	33-6, 138-139	31.09	55.53	1.79
	36-1, 120-121	1.10	2.97	2.70
	37-2, 58-59	33.46	58.39	1.74
	39-2, 110-111	30.52	54.40	1.78
	40-1, 142-143	23.21	44.08	1.90
	41-2, 80-81	29.03	52.35	1.80

sent at 124 cm. The rate of increase in shear strength decreases in Core 3 to practically zero, with only one value exceeding previous values. The sediments of these three cores were soft, plastic mud. Deformation was most intense in Core 1, becoming moderately deformed in Core 2. Core 3 was again intensely deformed, perhaps attributing to the lessening in shear strength increase observed. Values from Core 4 continued to show increased shear strength with depth. Values associated with the lowest, least-disturbed segment of core are believed most reliable. Consequently, a line connecting these points should define the pattern of shear strength increase with depth. (It is convenient to ignore the extreme value from the base of Cores 2-4.) The line so drawn should give the maximum shear strength to be expected in the sediments. Values falling to the left of the line probably represent a disturbed, or remolded

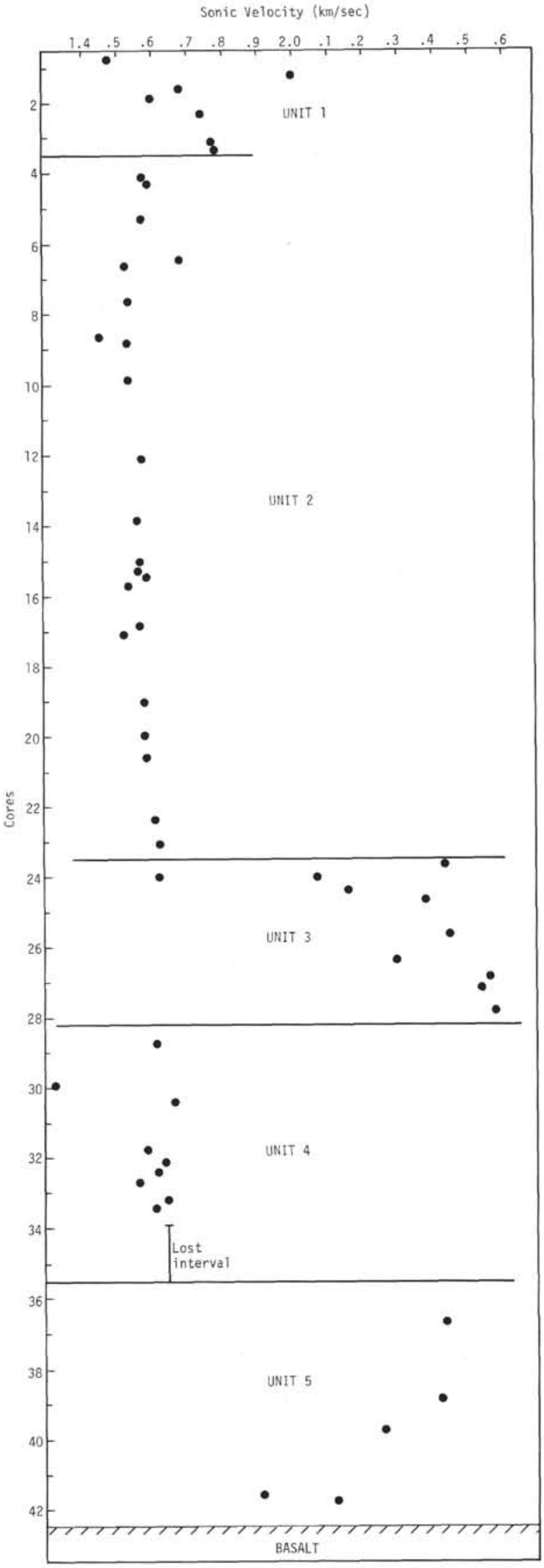

Figure 17. *Sonic velocity profile, Site 338.*

TABLE 18
Sonic Velocities – Means and Standard Deviations, Site 338

Core	$\bar{x}$	s	n
1-6	1.593	0.138	13
7-23	1.558	0.430	23
24-28	2.456	0.669	19
29-35	1.692	0.223	19
36-42	2.605	1.103	9

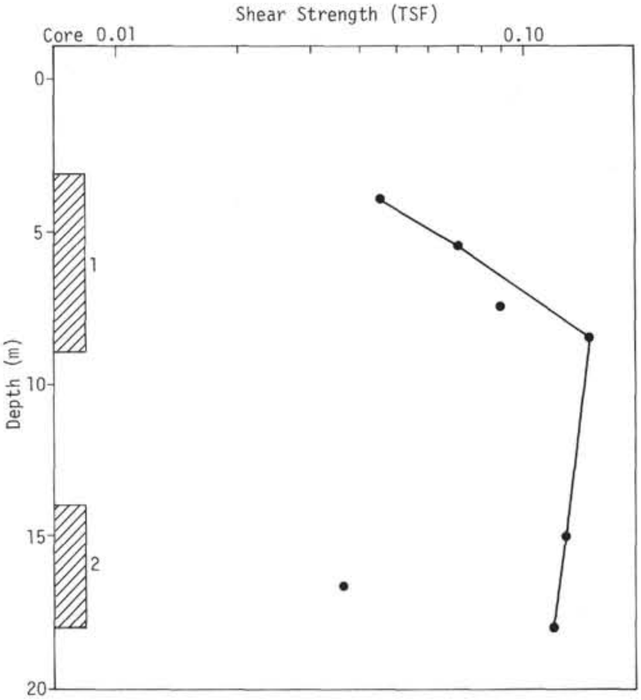

Figure 18. *Shear strength profile - Cores 1 and 2, Site 338.*

value. Carrying this assumption a step farther, it may be possible to determine the sensitivity of the sediments. Sensitivity (Terzaghi, 1944) measures the loss of strength when the sediment is remolded; the higher the sensitivity, the greater the loss of strength in the remolded condition.

$$S_t = \frac{\text{undisturbed strength}}{\text{remolded strength}}$$

Using the classification of Rosenquist (1953) and determining sensitivity from Figure 20 it is seen that S_t values for Cores 1-4 vary between 1.10 and 1.71—slightly insensitive. The percentage of undisturbed strength lost in the remolded state may range between 0 to 50%. This is significant in that it enables a quantitative assessment of the effects of drilling deformation and core disturbance to be made on shear strength. Table 21 shows the calculations based on Figure 20.

Sonic Velocity

Sonic velocities were much greater at this site for the same type of sediment at Site 338. The lowest velocity recorded was 1.85 km/sec in Core 8. The "glacial" section shows velocities, often in excess of 2.0 km/sec (Figure 19). In previous cores these sediments seldom possessed velocities greater than 1.7 km/sec. Low velocities are normally found with low density sediments, i.e., oozes. However, Cores 9-12 continue to show excessively high velocities.

It is believed the higher velocity observed through the entire sediment column is due to vertical stresses from below, generated by diapiric movement. Sound velocity is dependent upon the elastic constants of the medium through which the sound is traveling. "Stretching" of the sediments over the rising diapir has affected these constants, increasing the velocity of sound.

The fact that the most recent sediments exhibit higher than expected velocities indicates that movement is taking place at present times.

PHYSICAL PROPERTIES, SITE 340

In general, the sediments from this site possessed unusually low values of bulk density. The entire sediment column below Core 1 was composed of variously lithified Eocene diatom and radiolarian oozes. Bulk density in Core 1 averaged 1.797 g/cc. A sharp discontinuity existed between Core 1 and Core 2, Section 1. The section average was 1.269 g/cc. Bulk density values ranged from as low as 1.161 g/cc to 1.370 g/cc with an average value of 1.278 g/cc.

GRAPE porosity remained very high below Core 1, with a range of 79.67% to 92.52% and an average of 84.97%. Syringe water contents averaged 71.19% below Core 1.

Shear Vane

A few vane tests were made in Core 1, a sandy mud. Values generally increased with depth to 0.120 TSF (119.06 g/cm²) from 0.056 TSF (55.56 g/cm²) in Core 1, Section 1. The core was moderately disturbed, but the base of the core should represent a reasonably good value. Cores 2 to 11 were pelagic siliceous oozes, quite noncohesive. No further measurements of shear strength were made.

Sonic Velocity

Several reasonably distinct sedimentary units seemed to be defined acoustically in this rather monotonous sedimentary sequence. Relatively high velocities were found through Cores 1 to 3, Section 1, ranging between 1.490 to 1.966 km/sec, averaging 1.836 km/sec. Velocities tended to decrease to 1.539 km/sec in Core 10, Section 2. A sharp increase was observed in Sections 2, 3, and 4 of Core 10, attaining a velocity of 2.0 km/sec. In Core 10, Section 5 and to the remainder of the hole, velocity again dropped to a constant 1.55 km/sec. No apparent reason exists for the velocity increase seen in Core 10.

PHYSICAL PROPERTIES—SITE 341

Bulk Density, Porosity, and Water Content

Data interpretation is difficult at this site inasmuch as considerable disturbance occurred to the sediment

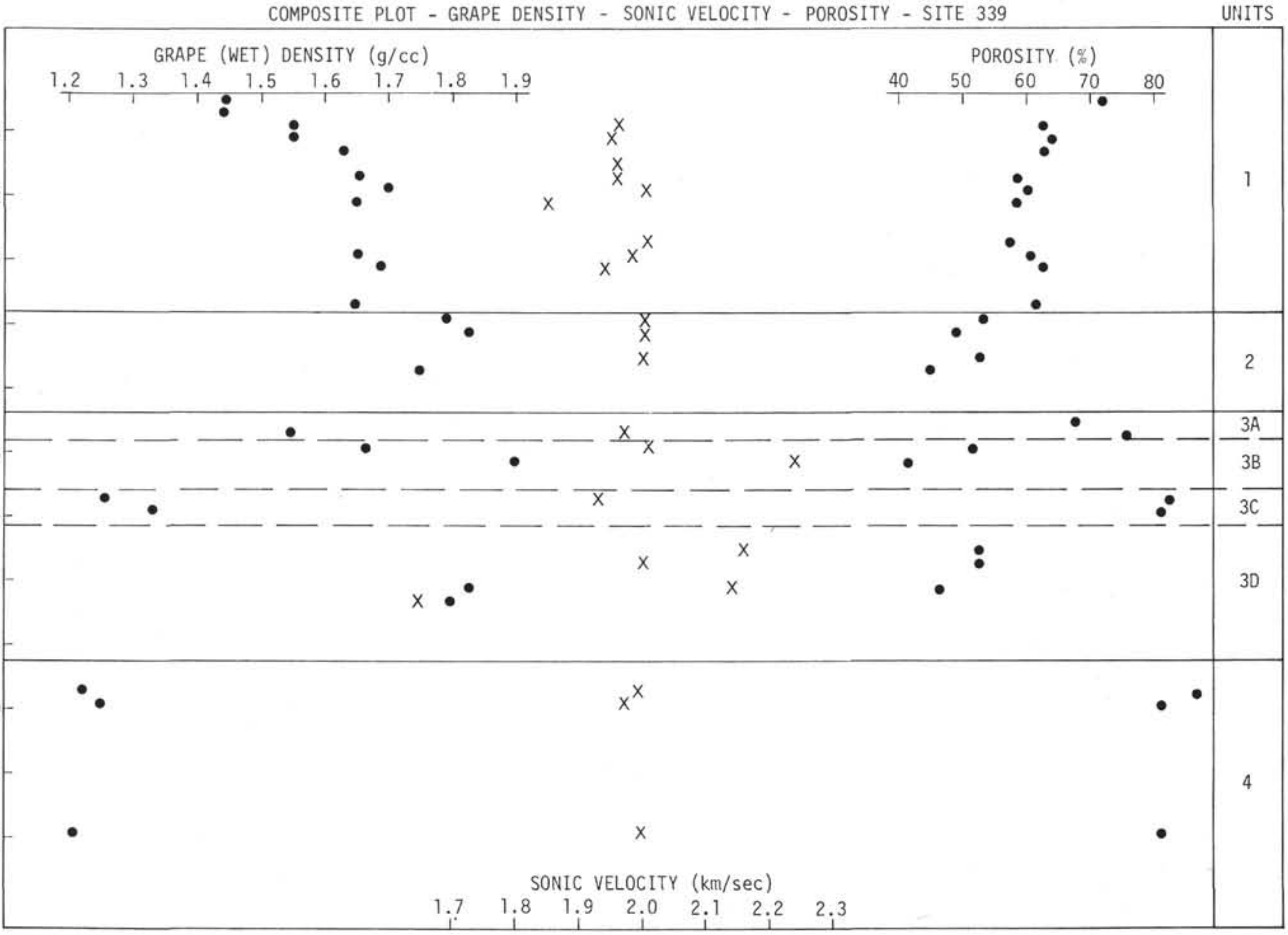

Figure 19. *Density and velocity profile, Site 339.*

fabric of many of the cores due to the ebullition of dissolved gases. GRAPE density values are available for all cores recovered below Core 5; however, due to the increasing quantities of gas, the measurements are unlikely to be representative of in situ conditions. Average GRAPE densities and porosities are presented for Cores 1-5 (Table 22).

Sonic Velocity

Sonic velocities were measured at least once on each core section until Core 6. From this point downward it was not possible to measure velocity due to extremely high signal attenuation. This phenomena is a response to the gas content of the sediment.

Surficial sediments showed higher speeds (1.65 km/sec), which decreased to approximately 1.54 km/sec after the first 10 meters. Slightly higher velocities were observed in Cores 4 and 5, but no relationship to sediment bulk properties is apparent.

Shear Strength

The "Torvane" provided estimates of shear strength in the terrigenous sediments of Cores 1-4. Shear strength increased from 0.03 TSF (29.76 g/cm²) at the base of Core 2, Section 2, to a maximum of 0.139 TSF (137.91 g/cm²) at the base of Core 3, Section 4, then decreased slightly and erratically in Core 4 (Figure 21). The rate of increase in strength with depth was quite rapid through Core 1, then decreased in rate to its maximum value in Core 2, Section 4. In applying the test for sensitivity, described in Site Report 339 (this volume), the value for only three points ranges between 1.25 and 1.78. The sediment is classed as slightly insensitive (Rosenquist, 1953).

PHYSICAL PROPERTIES, SITES 342/343

Due to the closeness of the two sites, the physical properties of the sediments will be discussed together. Coring was not continuous at either site, consequently no complete stratigraphic column can be reconstructed.

Bulk Density, Porosity, and Water Content

In general, sediments below 50 meters at Site 343 are more dense than those at Site 342, being richer in clay and terrigenous components (i.e., quartz, feldspar, and heavy minerals). The density ranges between 1.830 and 2.220 g/cc. At Site 342, density ranges between 1.255 and 1.607 g/cc through the same depths. Water contents and porosities are also very high at Site 342, being those associated with siliceous oozes.

On the other hand, the "glacial" section at both sites compare fairly closely. Sediments from Site 343 appear to be coarser, and bulk density increases toward the base of the section to a maximum of 2.297 g/cc. In the

TABLE 19
GRAPE Density and Porosity of Sedimentary Units, Site 339

	Bulk Density		Porosity	
Core	$\bar{x}$	s	$\bar{x}$	s
1-8	1.846	0.159	51.55	9.43
9-12	1.324	0.032	82.37	1.83

TABLE 20
Bulk Density, Porosity, and Water Content of Selected Rock Chips, Site 339

Sample (Interval in cm)	W(%)	η	ρ
3-2, 130-131	34.78	59.97	1.72
3-3, 40-41	37.00	61.73	1.67
3-3, 120-121	35.77	60.70	1.70
3-3, 150-151	34.82	59.77	1.72
3-4, 40-41	35.69	61.00	1.71
3-4, 140-141	39.06	64.70	1.66
4-2, 30-31	44.79	69.13	1.54
4-2, 120-121	29.71	53.87	1.81
4-3, 30-31	30.88	54.87	1.78
4-4, 30-31	25.15	48.27	1.92
4-4, 120-121	26.80	50.40	1.88
5-1, 98-99	29.09	53.10	1.82
5-2, 30-31	22.93	44.40	1.94
5-2, 120-121	24.04	46.03	1.91
6-1, 105-106	38.06	68.07	1.79
6-2, 62-63	56.77	76.27	1.34
6-3, 150-151	28.57	51.83	1.81
6-4, 70-71	20.78	41.80	2.01
7-2, 44-45	63.78	82.30	1.29
7-3, 100-101	65.05	80.90	1.24
8-1, 69-70	30.18	53.13	1.76
8-2, 40-41	29.77	52.77	1.77
8-4, 41-42	24.29	46.80	1.93
10-2, 110-111	74.32	87.00	1.17
10-3, 80-81	67.26	81.63	1.21
12-3, 71-72	67.61	82.10	1.21

more clay-rich sediments at Site 342, density ranges between 1.912 and 2.032 g/cc. Porosities are higher at Site 342 (average 44.15%), whereas at Site 342 they are lower (average 30.75%).

Sonic Velocity

Sonic velocity at Site 342 showed little variation, except for the initial sediments of Core 1. A slight decrease in velocity occurred between the "glacial" and mid-Miocene, increasing slightly through the Miocene section to its maximum value (1.594 km/sec).

On the other hand, considerably more variation was seen at Site 343. Velocities in the "glacial" section ranged between 1.534 to 1.836 km/sec. The Eocene sediments showed greater variability (due to the presence of several thin well-indurated units), but its average velocity remained lower than the overlying glacial deposits. Table 23 shows the mean velocity and standard deviations.

Shear Strength

Core 1 from Site 342 showed an increase in shear strength from 0.028 TSF (27.78 g/cm^2) at the surface, to 0.11 TSF (109.14 g/cm^2) at its base. Figure 22 shows the shear strength profile. A line connecting the least-disturbed portions of each section indicates the rate and magnitude of strength increase with depth. Several values show greater strength than predicted by the line. These values may have been affected by the occasional pebble noted in the core. The lowest value of shear strength occurred in the most deformed portion of the core and may reflect this disturbance. However, the remainder of the core below Section 1 showed only slight or moderate disturbance.

The sensitivity (S#), as determined in the manner described for Site 339, ranges between 1.13 and 1.59 for the three points beneath the line. This allows the sediment to be classified as "slightly insensitive" (Rosenquist, 1953), and presumes a loss of strength due to disturbance to range between 0 to 50%.

Cores 1 and 2 from Site 343 were so intensely deformed that no meaningful shear strength measurements could be made.

GEOCHEMISTRY

Inorganic Geochemistry

Interstitial water data from the sediments of Sites 338 to 343 will be found in Tables 24 (338), 25 (339 and 340), 26 (341), and 27 (342 and 343).

Results of special salinity studies at Sites 339, 340, and 341 are found in Table 28.

Organic Geochemistry

Dissolved Gas in Tertiary Sediments at Site 338

As was the case at Site 337 interstitial dissolved gas was encountered during the coring of Site 338, and the gas pockets were sampled in the manner described in the report for Site 337.

No hydrocarbon gas components were detected at Site 338, which is not surprising in light of the thin column of pelagic sediments that overlies basaltic basement. The compositions of gas pockets that were sampled are presented in Table 29. These data show that the gas consists only of carbon dioxide, in addition to the air that was present. The composition of dissolved gas at this site is similar to the gas analyzed at Site 337, and probably is of a similar origin, and represents the diagenetic product of processes occurring within the sediments. Based on the lithologic character of the Tertiary sediments and the composition of the gas, it seems unlikely that organic diagenesis has proceeded to any great extent at this locality.

Sites 339 and 340

Neither the presence of gas nor hydrocarbons was detected at Site 339 or Site 340.

Shipboard Analysis of Dissolved Gas in Tertiary Cores from Site 341

As in the case of previous sites, interstitial gas also was encountered at Site 341. Dissolved gas first became evident in the Pleistocene section at a depth of 50.5 meters and persisted throughout the hole to total depth

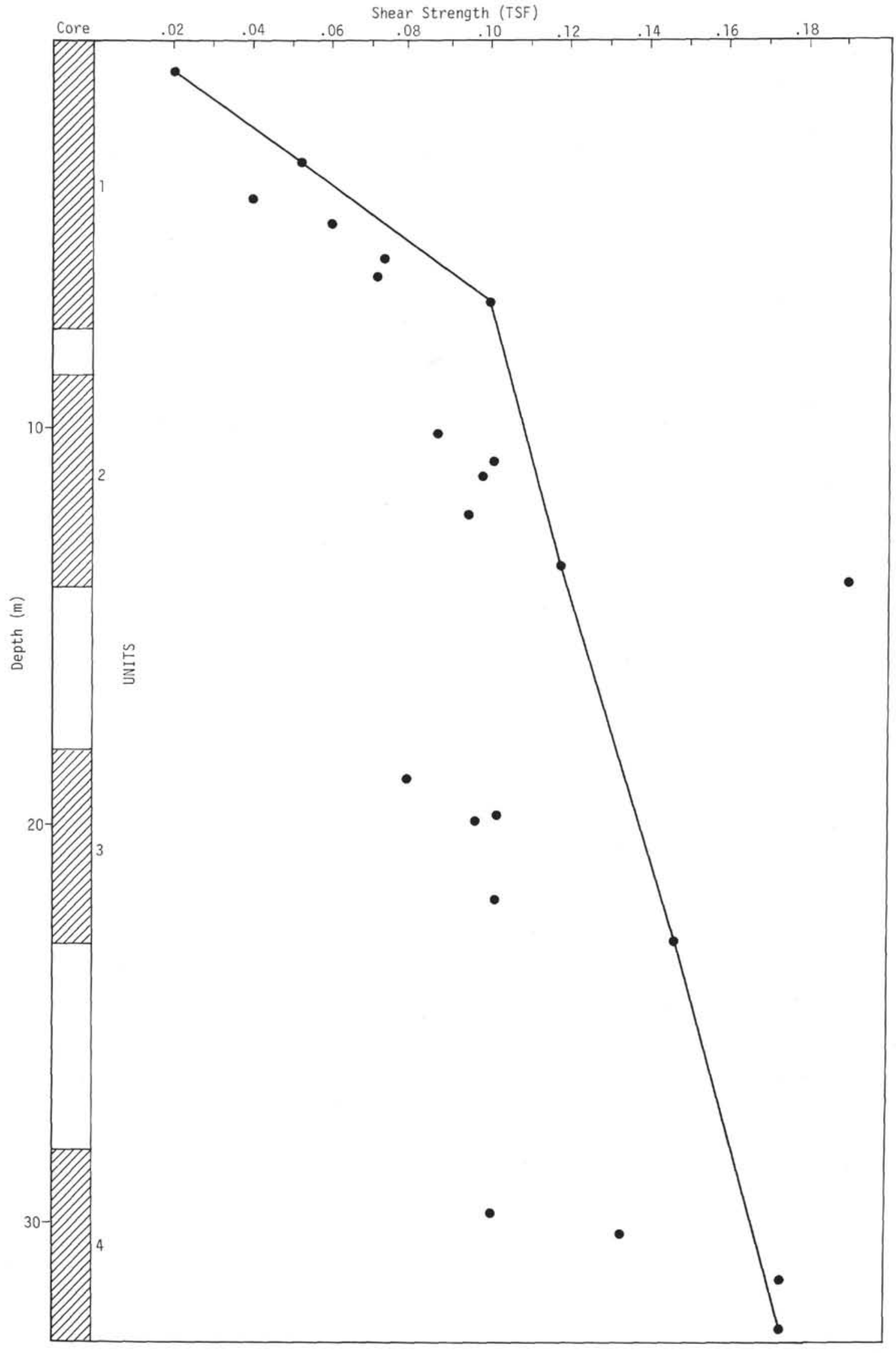

Figure 20. *Shear strength profile, Site 339.*

TABLE 21
Shear Strength and Sensitivity
of Cores 1-4, Site 339

Core-Section	Remold	Pred.	s
1-3	0.04	0.065	1.63
1-4	0.06	0.074	1.23
1-4	0.073	0.084	1.15
1-5	0.072	0.092	1.28
2-2	0.086	0.108	1.26
2-2	0.100	0.110	1.10
2-3	0.097	0.112	1.15
2-3	0.093	0.114	1.23
3-2	0.078	0.133	1.71
3-2	0.102	0.136	1.33
3-2	0.096	0.137	1.43
3-4	0.100	0.142	1.42
4-2	0.100	0.164	1.64
4-3	0.133	0.166	1.25

TABLE 22
Average GRAPE Density and
Porosity – Cores 1-5, Site 341

	Density		Porosity	
Core	$\bar{x}$	s	$\bar{x}$	s
1	1.742	0.053	57.71	3.15
2	1.912	0.021	47.81	1.07
3	1.645	0.049	63.36	2.02
4	1.750	0.025	57.23	1.53
5	1.540	0.131	64.37	3.37

of 456 meters in middle Miocene strata. Gas pockets formed in nearly every core recovered below a depth of 50 meters, and in several instances the pressure was sufficient to extrude 1 or 2 cm of sediment from the core liner. Gas sampling and analysis was carried out in the manner described earlier, and an attempt was made to obtain a gas sample from each and every core to monitor compositional trends with depth, sediment type, and stratigraphy. In addition, the core-catcher samples were examined under a fluoroscope.

Component composition of 15 gas samples recovered from the Pleistocene and Plio-Pleistocene, and 9 from the middle Miocene at Site 341 are provided in Table 30. It is significant that, with but one exception in the Plio-Pleistocene section, all samples contained methane, and nearly all gas samples recovered from the Miocene contained trace quantities of ethane, i.e., >0.004 mol%. Preliminary evidence suggests organic diagenesis is not far advanced in the Pleistocene and that very little soluble hydrocarbons have been generated. The methane content of the Pleistocene section probably approaches 100 mol% in the sediment interstices, and probably has been generated from organic matter present in the sediment. Although conclusive evidence is lacking, the Pleistocene may be somewhat undercompacted, with interstitial fluid pressures exceeding grain-to-grain pressures. Existence of such a pressure regime would diminish the effectiveness of diagenetic processes and retard migration of pore fluids into the Pleistocene from underlying stratigraphic units.

Trace quantities of ethane found beneath the Plio-Pleistocene section suggest that organic diagenesis is somewhat further advanced in the Miocene than in the Pleistocene, and that diagenesis is related to depth of burial and/or increasing geothermal gradient. Supporting this interpretation is the fact that the 33-cc sample recovered from a depth of 446.5-447 meters (Miocene) had a bright yellow pin-point fluorescence and a strong petroliferous odor and appeared to contain soluble hydrocarbons in the sediment interstices. Because of these facts, coring at Site 341 was terminated. (See Operations section.)

Some 7 or 8 hr after the coring operation was terminated the final core recovered from the site had been split and described. At that time, it became apparent that Cores 30 through 34 (408.5 through 456 m) all had a petroliferous odor which was especially evident in Core 33, and it was concluded that this entire interval probably contained some quantity of soluble hydrocarbons in the interstices of the middle Miocene sediments. It is emphasized that absolutely no quantity of free or liquid petroleum was detected nor recovered from this particular site.

The origin and nature of this soluble hydrocarbon material will be identified and geochemically characterized. Preliminary data suggest it probably was generated in situ within the Miocene section. The fact that interstitial gas from the Miocene contained trace quantities of ethane, as well as methane and more carbon dioxide than gas from the Pleistocene suggests that organic diagenesis, which is proceeding in the Miocene, is more advanced than in the Pleistocene section.

Sites 342 and 343

Neither the presence of gas nor hydrocarbons was detected at Sites 342 or 343.

BIOSTRATIGRAPHY, SITE 338

Biostratigraphic Summary

Glacial sediments were present in Cores 1 through 6 (0.0-57.0 m). They are barren of siliceous microfossils. Nannofossils and *Globigerina pachyderma* (sinistral) are more or less abundant. Reworked Cretaceous and Paleogene nannofossils, pollen, and dinoflagellates are present in differing amounts. The Miocene sediments (Core 7 to Core 18, 66.5-180.5 m) are rich in siliceous microfossils, while calcareous nannoplankton is missing.

The middle Oligocene (Core 19 to Core 26, 180.5-249 m) is characterized by the presence of nannofossils and planktonic foraminifera as well as by siliceous fossils. The upper Eocene (Core 26, Section 2 to Core 29, 249-285 m) is determined by diatoms, silicoflagellates, radiolarians, and siliceous foraminifera, while calcareous foraminifera and nannofossils are absent.

No fossils were found in Cores 30 and 31. The early Eocene was determined by nannoplankton and foraminifera from Cores 32 to 42 (304-400 m) overlying basalt. The assemblages of both fossil groups are comparable with those from northern Europe and Rockall Bank. This sequence is characterized by reworked, ther-

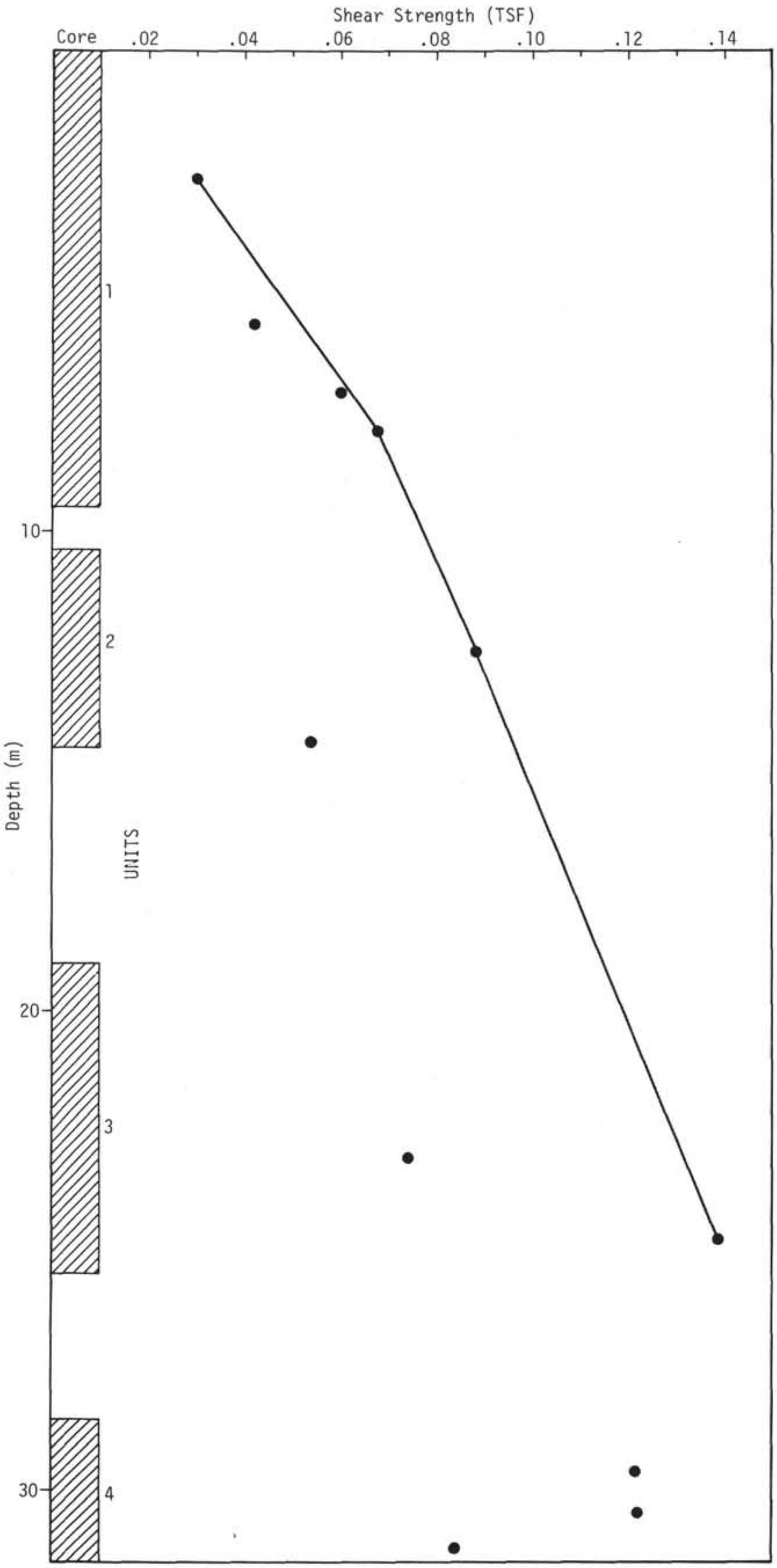

Figure 21. *Shear strength profile, Core 1-4, Site 341.*

TABLE 23
Average Sonic Velocity of Sediment Units, Sites 342 and 343

	$\bar{x}$	s	n
Site 342			
Glacial	1.555	0.089	10
Mid-Miocene	1.569	0.020	9
Site 343			
Glacial	1.715	0.084	22
Eocene	1.597	0.169	24

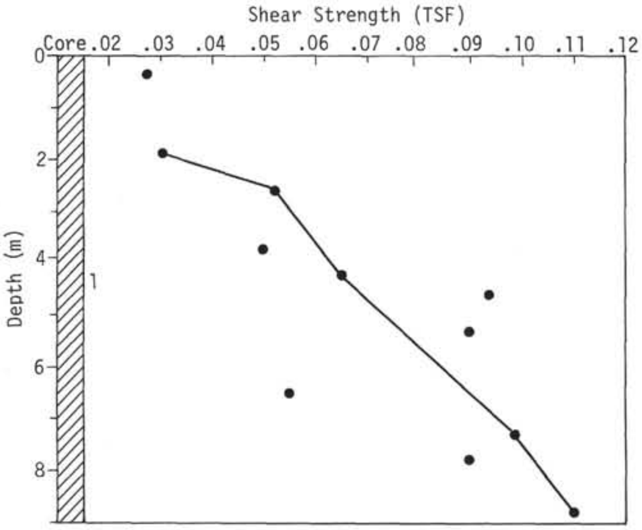

Figure 22. *Shear strength Core 1, Site 342.*

mally altered plant debris. A distinct change in the amount of pollen and dinoflagellates can be observed in the uppermost part of the lower Eocene, indicating a change from a probable near-shore to a more open ocean environment.

Together with radiolarians, the "microfossils" Anellotubulata were found in several samples. They are also present at Sites 344, 348, and 349 (see Bjørklund, this volume).

Foraminifera—338

"Glacial," Cores 1 through 6

The fauna of all samples is dominated by left-coiling *Neogloboquadrina pachyderma. Globigerina bulloides* and *G. quinqueloba* are the only other planktonic species observed and they are only rarely present. *N. pachyderma* coiling direction varies between 96% and 98.5% sinistral.

The benthonic fauna has a low diversity, only few species are present among which one or two are clearly dominant. However, at different levels, different species are dominant, mostly *Cibicides wuellerstorfi*, but in some samples *Melonis zaandamae, Bulimina aculeata, Islandiella teretis*, or *Elphidium incertum* (s.s. and *clavatum*) are the most abundant form. Samples with *E. incertum* as the dominant species also have abundant ice-rafted material, and the species may be displaced from shallower depth. Apart from the species mentioned, a few lagenids and miliolids are found.

From Core 3 down, the effects of carbonate dissolution become conspicuous; many test fragments are found, complete specimens have a chalky appearance and the percent of benthonics increases up to 35%. The ice-rafted material contains mainly quartz, but also contains fragments of metamorphic and sedimentary rock, lignite, and Cretaceous *Inoceramus* prisms. Unfortunately the base of the "glacial" section was not recovered in the cores.

Middle and Upper Miocene, Cores 7 through Sample 11-3, 100 cm (dated by silicoflagellates)

No age-diagnostic foraminifera were found in these cores, but a characteristic arenaceous foraminiferal fauna makes it a distinguishable unit. Only three species are present: *Martinotiella communis, Spirosigmoilinella* sp., and *Spirolocammina* sp. *Martinotiella* is consistently present in the samples until 11-3, 55-57 cm, and consistently absent from the next sample (11-3, 130-132 cm) downward. The two other forms continue into the next lower unit. Although the range of *M. communis* is known to be Oligocene-Recent elsewhere, the species is the characteristic arenaceous element of many middle Miocene deposits in northwest Europe. Our best estimate was that this unit is of middle Miocene age. It seems that the local range of this fossil can be successfully used for correlation within the Greenland-Norway Sea.

The very small wash residues contain siliceous microfossils (radiolarians, diatoms), fecal pellets, fish remains, some pyrite, and volcanic glass. Cores 10 and 11 also have glauconite grains.

Lower Miocene, Sample 11-3 100 cm through Core 18 (dated by silicoflagellates)

This interval differs from the one above by the absence of *Martinotiella communis* and near-absence of *Spirolocammina. Spirosigmoilinella* sp. is consistently present, at some levels associated with *Karreriella siphonella.* Sample 16, CC yielded a few corroded, undeterminable calcareous specimens which indicate that deposition was about at CCD (in seven additional samples of the core, no other calcareous remains were found).

Oligocene, Cores 19 through 25

Sample 19, CC has a quite diverse, somewhat corroded calcareous benthonic Oligocene microfauna with *Turrilina alsatica, Angulogerina gracilis tenuistriata, Sphaeroidina bulloides*, as its most characteristic elements. Also present are: *Gyroidina girardana, G. soldanii, Melonis affinis, Nonionella lobsanensis, Pullenia quinqueloba, Cassidulina subglobosa, Lagena* spp., *Fissurina* spp., *Oolina* spp., *Dentalina* sp., *Cibicides tenellus, Spirosigmoilinella* sp., and *Spirolocammina* sp. As at Site 336, this fauna is typical for northwest European (Belgium, Germany, Holland, Denmark) Oligocene. Three planktonic foraminiferal specimens were found, one *Globigerina* cf. *G. prae-*

TABLE 24
Summary of Shipboard Geochemical Data, Site 338

Sample (Interval in cm)	Subdepth (m)	*p*H	Alkalinity (meq/k)	Salinity (°/oo)	Ca++ (mmoles/1)	Mg++ (mmoles/1)
Surface Seawater	–	8.21	2.44	35.2	10.29	53.52
1-3, 140-150	4.5	7.72	5.02	35.2	10.40	53.78
4-3, 144-150	40.5	7.48	7.87	35.8	11.57	48.62
8-3, 142-150	80.5	7.16	7.43	35.2	16.95	44.18
11-3, 140-150	108.5	7.17	5.52	35.2	17.41	45.53
14-2, 144-150	136.0	7.18	6.30	35.2	17.67	45.35
19-3, 144-150	185.0	7.45	5.21	35.5	22.61	41.49
23-0, 42-50	218.5	7.65	5.25	35.5	25.61	39.95
26-1, 140-150	248.5	–	4.60	34.1	28.92	43.20
30-4, 144-150	291.0	8.42	1.67	34.9	34.31	32.25
35-1, 138-150	334.0	7.75	1.75	35.8	29.65	40.40
37-1, 137-150	353.0	7.78	1.33	35.2	33.03	–
42-1, 143-150	400.5	8.17	1.00	35.2	44.76	31.24

TABLE 25
Summary of Shipboard Geochemical Data, Sites 339 and 340

Sample (Interval in cm)	Subdepth (m)	*p*H	Alkalinity (meq/kg)	Salinity (°/oo)	Ca++ (mmoles/1)	Mg++ (mmoles/1)
Surface Seawater		8.24	2.37	34.4	10.34	52.97
Site 339						
1-4, 144-150	6.0	7.74	6.35	35.2	10.03	50.17
3-3, 144-150	21.5	7.72	8.13	33.0	8.17	46.76
6-3, 140-150	50.5	7.46	14.47	29.7	7.34	37.47
8-3, 144-150	69.5	7.74	11.08	30.0	7.60	37.57
12-2, 142-150	106.0	7.59	11.50	29.7	8.12	39.44
Site 340						
2-2, 144-150	12.5	8.00	4.04	35.2	11.27	52.98
5-1, 144-150	39.5	7.65	4.13	35.2	11.12	52.41
10-4, 144-150	91.5	7.77	3.70	35.2	11.22	53.10

TABLE 26
Summary of Shipboard Geochemical Data, Site 341

Sample (Interval in cm)	Subdepth (m)	*p*H	Alkalinity (meq/kg)	Salinity (°/oo)	Ca++ (mmoles/1)	Mg++ (mmoles/1)
Surface Seawater		8.21	1.91	35.2	10.49	53.69
2-2, 144-150	12.5	7.77	8.28	33.3	7.40	48.32
7-4, 144-150	72.5	7.56	9.36	33.0	6.96	43.92
12-5, 144-150	113.0	7.35	5.49	33.0	8.71	41.30
17-1, 138-150	163.0	7.53	4.47	33.6	9.53	40.34
20-4, 142-150	243.5	7.85	7.23	31.6	6.61	26.20
23-5, 143-150	311.5	8.01	11.42	32.2	7.17	20.45
27-5, 144-150	377.5	–	26.08	33.0	9.09	25.95
32-5, 124-130	434.0	7.35	26.50	32.4	10.34	22.32

bulloides, one *G.* cf. *G. ampliapertura*, and one *G. ciperoensis*. If the determinations had been based on more material and were more certain, the assemblage would be characteristic for the lower (and middle) Oligocene.

The top of this unit with calcareous fossils lies between Samples 19-5, 50-52 cm and 19-5, 140-142 cm; its base is between 26-2, 47-49 cm and 26-2, 113-115 cm. The small wash residues have siliceous microfossils (radiolarians, diatoms, and sponge spicules).

Upper and Middle Eocene, Cores 26 through 31

Below Sample 25-2, 113-115 cm calcareous fossils disappear. However, the arenaceous foraminiferal fauna is diagnostically different from above, *Spiroplectammina spectabilis* (small specimens) replacing *Spirosigmoilinella* sp. In northwest Europe, *S. spectabilis* ranges throughout the Eocene and Paleocene, but has never been recorded from the Oligocene. It seems practical and justifiable to use the top of its occurrence at the Leg 38 sites as marking the top of the Eocene.

TABLE 27
Summary of Shipbaord Geochemical Data, Sites 342 and 343

Sample (Interval in cm)	Subdepth (m)	pH	Alkalinity (meq/kg)	Salinity ($^{\circ}/_{\circ\circ}$)	Ca++ (mmoles/1)	Mg++ (mmoles/1)
Site 342						
Surface seawater		8.20	2.38	35.2	10.73	53.66
1-4, 144-150	6.0	7.60	4.46	35.2	10.63	51.02
2-3, 144-150	42.0	7.77	7.46	34.4	10.88	44.92
3-3, 144-150	89.5	7.52	5.76	34.6	13.45	53.13
4-1, 124-130	124.3	7.48	4.60	34.9	19.20	40.50
Site 343						
Surface seawater		8.22	2.38	34.5	10.37	52.87
1-1, 144-150	1.5	7.38	3.13	35.5	10.93	51.59
3-4, 144-150	56.5	7.50	8.23	35.2	12.89	49.71
4-2, 144-150	104.0	7.41	8.37	34.9	15.55	46.32
5-5, 122-128	152.8	7.73	5.09	35.2	23.51	44.21
7-2, 144-150	205.5	7.66	1.03	35.5	36.19	34.06
–	252.0[a]	–	–	–	–	–
15-2, 123-130	271.8	7.41	0.37	36.6	53.90	25.06

[a] Basalt contact, clay underlying.

The very small wash residues have some radiolarians, diatoms, and sponge spicules. Many samples are barren. A change is present between 29-3, 138-140 cm and 29, CC below which many wash residues have ash and clear, angular feldspar (?) grains. Some levels have common fish remains, and/or fecal pellets.

Lower Eocene, Cores 32 through 37

Sample 31, CC belongs with the unit described above, whereas the highest sample of Core 32 (32-0, 7-9) is different in having fine sand, some ash, and some calcareous benthonic foraminifera. Lower core-catcher samples yielded a diverse, early Eocene benthonic foraminiferal fauna, characterized by lagenids (*Lenticulina cultrata, Lenticulina decorata, Lenticulina* spp., *Dentalina* spp., *Nodosaria latejugata*) and stilostomellids (a.o. *Stilostomella spinulosa*). Some of the other species found are: *Haplophragmoides* sp.,, *Ammodiscus* sp., *Spiroplectammina spectabilis, Textularia plummerae, Citharina* sp., *Bulimina cacumenata, Turrilina brevispira, Chilostomelloides eocenica, Quadrimorphina paleocenica, Melonis affinis, Pullenia quinqueloba, Anomalinoides anomalinoides, Cibicides* spp., *Cancris subconicus, Eponides* sp., and others. One specimen of *Aragonia aragonensis* was found. The best-preserved and most diverse fauna was collected from Core 34. The recovery consisted of a bucket of sediment water from the core barrel when it came on deck.

Planktonic foraminifera are practically absent, and the few present are small and of a basic globigerina morphology; they have not yet been studied with the SEM, and a specific determination is not really justified. Tentative names given are: *Globigerina linaperta, G. velascoensis, G. turgida*, and *G. inaequispira*. An assemblage that would support the early Eocene age assignment is based on the benthonic fauna.

Apart from the foraminifera, the washed residues contain skeletal remains of pelecypods (thin-shelled), gastropods, echinoids, crustaceans, and fish.

TABLE 28
Special Salinity Studies, Sites 339, 340, and 341[a]

Core	Depth (m)	S($^{\circ}/_{\circ\circ}$)
Site 339		
1	8.0	35.2
2	17.5	33.3
3	27.0	31.9
4	36.5	31.6
5	46.0	29.4
6	55.5	28.9
7	65.0	28.9
8	74.5	30.0
9	84.0	29.7
10	93.5	28.9
11	103.0	27.5
12	108.0	28.6
Site 340		
1	9.5	35.2
2	19.0	35.2
3	28.5	34.4
4	38.0	35.2
5	47.5	35.8
6	57.0	35.8
7	66.5	35.8
8	76.0	35.5
10	91.5	35.2
Site 341		
27	389.5	33.0
28	399.0	32.8
29	408.5	32.4
30	418.0	33.0
31	427.5	33.0
32	437.0	32.4
33	446.5	33.0
34	456.0	33.0

[a] Core-catcher samples.

TABLE 29
Shipboard Analysis of Gas Pockets in Cores From DSDP Leg 38, Site 338

Core-Section	Interval (cm)	As Sampled in Liner[a]	
		Air	CO_2
2-2	70	100.0	<0.01
6-5	145	100.0	<0.01
24-4	0	99.96	0.04
37-1	0	99.75	0.25

[a] In Mol %.

Lower Eocene?, Cores 38 through 41

Few specimens of benthonic foraminifera *Lenticulina* sp. and one of *Cibicides* sp. were found in Samples 40, CC and 41, CC. All other samples are barren. Perhaps the most time-significant record in the cores is an obvious increase of ash in the wash residues from Sample 39, CC down (next higher sample is 39-2, 86-88 cm). This might be comparable with the lowermost Eocene ash reported from the North Sea and surrounding areas.

Nannoplankton—338

Quaternary sediments were recovered in Cores 1 through 6 (0-57 m). Sediments contain only few nannoplankton, except for some nannofossil ooze layers. Reworked species of the Cretaceous and Eocene are common in some samples. The increase of reworked species is associated with an increase of ice-rafted material. The section from Sample 1-1, top to Sample 1-2, 124-125 cm belongs to the *Emiliania huxleyi* Zone (NN 21) of the Quaternary with the following species: *Emiliania huxleyi, Cyclococcolithus leptoporous, Coccolithus pelagicus, Helicosphaera carteri, Syracosphaera pulchra, Gephyrocapsa ericsonii.*

From Sample 1-4, 106-107 cm to Sample 3-2, 133-134 cm, the same assemblage is present, but without *Emiliania huxleyi.* This part belongs to the *Gephyrocapsa oceanica* Zone (NN 20). Very few specimens of *Pseudoemiliania lacunosa* were found in Sample 3-3, 96-97 cm and Sample 5-2, 98-99 cm, and together with *Gephyrocapsa ericsonii* indicating a Quaternary age. *Gephyrocapsa ericsonii* is also present in Sample 6, CC. Core 7 to Sample 19-4, 85-86 cm (66.5-187.5 m) are barren of nannoplankton.

The nannoplankton assemblage of the middle or upper Oligocene is present in Sample 19-2, 123-124 cm to Sample 26-1, 86-87 cm (187.5-248 m). Nannofossils are slightly etched in some samples. The assemblage consists of *Dictyococcites dictyodus, Coccolithus abisectus, Discolithina desueta, Cyclococcolithus floridanus, Reticulofenestra clatrata, Discoaster deflandrei, Coccolithus pelagicus, Sphenolithus moriformis, Reticulofenestra lockeri, Helicosphaera euphratis, Helicosphaera recta,* and *Chiasmolithus altus.*

Sample 26-2, 109-110 cm to Sample 31, CC (248-304 m) are without nannoplankton. From Sample 32-1, 60-61 cm (304 m) a nannoplankton assemblage of lower Eocene (NP 12) was observed. The nannofossil content is low, and they are restricted to some horizons. The following species were observed: *Discolithina pulcher, Discolithina fimbriata, Zygolithus dubius, Cyclococcolithus luminis, Imperiaster obscurus, Braarudosphaera bigelowi, Toweius eminens, Micrantholithus mirabilis,*

TABLE 30
Shipboard Analysis of Dissolved Gas in Tertiary Cores from Site 341

Stratigraphic Age	Depth (m) Below Mud Line	Sample (Interval in cm)	As Sampled in Liner			
			Air	Carbon Dioxide	Methane	Ethane
Pleistocene[b]	50.5	6-2, 0	98.23	0.10	1.77	–
	74.0	8-4, 150	99.62	0.10	0.28	–
	80.5	9-2, 150	90.56	0.03	9.41	–
	83.0	9-4, 150	94.98	0.02	5.00	–
	93.0	10-4, 150	83.27	0.11	16.62	–
Pliocene-Pleistocene	110.5	12-3, 150	94.27	0.08	5.65	–
	163.9	16-1, 90	100.00	<0.01	–	–
	183.6	17-2, 10	63.08	<0.01	36.92	–
	226.0	19-6, 0	86.49	<0.01	13.51	–
	243.5	20-5, 150	42.54	0.03	57.43	–
	246.5	20-6, 150	57.58	0.11	42.31	–
	256.5	21-0, 10	68.41	<0.01	31.59	–
	277.0	22-1, 0	86.68	<0.01	13.32	–
	318.0	24-3, 0	69.68	<0.01	30.32	–
	342.9	25-6, 140	68.95	1.05	30.00	<0.004
	354.5	26-2, 0	57.82	2.69	39.49	<0.004
	370.5	27-0, 0	75.18	0.58	24.24	<0.004
	398.5	28-6, 0	95.15	0.08	3.97	–
Middle Miocene	403.5	29-3, 0	39.47	3.45	57.08	0.02
	417.5	30-6, 0	98.22	0.71	1.07	<0.004
	427.0	31-6, 0	87.57	0.80	11.63	<0.004
	436.5	32-6, 0	92.30	0.94	6.76	–
	446.0	33-6, 0	65.65	1.74	32.61	<0.004
	455.5	34-6, 0	98.79	0.53	0.68	<0.004

Markalius inversus, Discoasteroides kuepperi, Coccolithus pelagicus, Zygolithus protenus and only few specimens of *Chiasmolithus solitus* (32-1, 60-61 cm), *Discoaster lodoensis*, and *Marthasterites tribrachiatus* (Sample 33, CC). Below Sample 33, CC nannofossils are very rare. In Sample 42-1, 69-70 cm *Zygolithus dubius* was still found which has its first occurrence in the *Marthasterites tribrachiatus* Zone (NP 12) of the lower Eocene.

Diatoms—338 (H.-J.S.)

Diatoms are rare to abundant and moderately to well preserved in the interval from Cores 8 through 29. The following interval-sample-zones were observed: Interval ? to Sample 8-2, 10 cm-*Actinocyclus ingens* Zone (?); interval Samples 8-2, 58 cm to 8-4, 85 cm-*Nitzschia* sp. 8 Zone (?); interval Samples 8, CC to 9-1, 135 cm-*Sceptroneis caducea* Zone (base 13 m.y.); interval Samples 9, CC to 10-1, 135 cm-*Coscinodiscus plicatus* group Zone (13-13.6 m.y.); interval Samples 10-2, 55 cm to 11-2, 85 cm-*Denticula hyalina* Zone (top 13.6-base ?); interval Samples 11-3, 5 cm to 12-3, 90 cm-*Rhizosolenia bulbosa* Zone (top ?-base 19.5 m.y.); interval Samples 13-1, 55 cm to 13, CC-*Thalassiosira fraga* Zone (?); interval Samples 14-1, 20 cm to 15-1, 20 cm-*Nitzschia maleinterpretaria* Zone (?); interval Samples 15-1, 95 cm to 16-2, 10 cm-*Coscinodiscus vigilans* Zone (?); interval Samples 16-4, 67 cm to 16, CC-*Rhizosolenia norwegica* Zone (?); interval Samples 17-2, 46 cm to 17, CC-*Synedra jouseana* Zone (?); interval Samples 18-1, 50 cm to 19-3, 40 cm-*Pseudodimerogramma elegans* Zone (assuming the Miocene/Oligocene boundary occurs at the base, a tentative absolute age of 22.7 to 23.8 m.y. can be given to the base of this zone); interval Samples 19-3, 140 cm to 19-5, 135 cm-*Coscinodiscus praenitidus* Zone (?); interval Samples 19, CC to 20, CC-*Thalassiosira irregulata* Zone (?); interval Samples 21-1, 67 cm to 22-2, 115 cm-*Pseudodimerogramma filiformis* Zone (?); interval Samples 22-3, 22 cm to 24-2, 86 cm-*Sceptroneis pupa* Zone (?); interval Samples 24-1, 35 cm to 26-2, 109 cm-"Interval Zone"-(not dated on the basis of diatoms, the coccolith biostratigraphy (Müller, this volume) reveals a late Oligocene age NP 24 = *Sphaerolithus distentus* Zone approximate age 24-29 m.y. after Berggren, 1972a); interval Samples 26-3, 34 cm to 28-2, 30 cm-*Coscinodiscus oblongus* Zone (late Eocene age 37.5 - younger 43 m.y.); interval Samples 28-2, 133 cm to 29-3, 130 cm-*Triceratium barbadense* Zone (late Eocene).

Radiolarians—338

At this site, an almost complete recovery of the sediments from the Recent to late Eocene was obtained. Based on radiolarian occurrences, the sediment column could be divided into three units.

Unit 1 (Cores 1 through 6, CC) is characterized by the absence of radiolarians, but with a high content of ice-rafted material. In Sample 2, CC a relatively poor faunal assemblage of reworked middle(?) Eocene was obtained.

Unit 2 (Cores 7 through 29) is characterized by a relatively rich radiolarian fauna ranging from late Miocene to late Eocene. This unit has a high Miocene (Cores 7 through 17, CC) species diversity, which is also the case for the Eocene (Cores 26-3, 67-69 cm through 29, CC). The Oligocene (Cores 18-1, 110-112 cm through 24-3, 62-64 cm) is characterized by fewer species and a relatively high percentage of Trissocyclidae.

The radiolarian fauna obtained from this site did not have the key species which is the base for lower latitude radiolarian zonation.

Traces of *Stichocorys diploconus, Cyrtocapsella tetrapera*, and *Cannartus violina* were found at a few horizons. *Cannartus violina* has the shortest time range, with its first occurrence near the bottom of the *Calocycletta virginis* Zone (early Miocene), being extinct in the *Brachyospyris alata* Zone (early middle Miocene). Only one specimen of *Cannartus violina* was found in Core 10, CC. However, *Cyrtocapsella tetrapera* was found in Core 17, CC, and as this species ranges from the upper part of *Lychnocanium bipes* Zone, which contains the Miocene-Oligocene boundary, Core 17, CC belongs to the lower part of the early Miocene.

Sample 7, CC is characterized by a high occurrence of *Hexalonche* sp. A, which is correlated with the *Hexalonche* sp. A maximum at Site 348 in Sample 15-2, 30-32 cm (late Miocene) and Samples 31-5, 17-19 cm through 31, CC at Site 341.

Anellotubulates were recovered from different horizons in this site. As there was no reworked Cretaceous material in the Tertiary part of this site, it is believed that the anellotubulates have been deposited or produced in these horizons, or as recent work suggests, produced during sample preparation.

Silicoflagellates—338

Sample 7, CC to Sample 8-2, 58-59 cm (76-79 m) belong to the *Mesocena circulus* Zone including the upper part of the middle Miocene and the upper Miocene. The assemblage consists of *Distephanus crux, Mesocena circulus, Mesocena apiculata, Distephanus speculum, Mesocena diodon*, and *Cannopilus hemisphaericus*. Sample 8-3, 70-71 cm to Sample 11-4, 85-86 cm (79-106.5 m) contain the assemblage of the *Corbisema triacantha* Zone. The species are the same described from the *Mesocena circulus* Zone without *Mesocena circulus* and with *Corbisema triacantha*, and *Distephanus longispinus*.

The *Naviculopsis navicula* Zone of the lower Miocene was determined from Sample 12-2, 5-6 cm to Sample 17-4, 85-86 cm (117-167.5 m) indicated by the presence of *Naviculopsis navicula* and *Naviculopsis quadratum*. Other species are: *Distephanus crux, Distephanus speculum, Corbisema triacantha, Distephanus longispinus, Cannopilus hemisphaericus, Mesocena apiculata*, and few specimens of *Naviculopsis lata, Pseudorocella barbadiensis*, and *Mesocena elliptica*. *Distephanus crux* and *Dictyocha* sp. are abundant in most of the samples.

Sample 18-1, 50-51 cm to Sample 19-2, 10-11 cm (171 m) belong to the *Naviculopsis lata* Zone of the upper Oligocene/lower Miocene. The assemblage is the same described from the *Naviculopsis navicula* Zone minus *Naviculopsis navicula*. *Naviculopsis lata* becomes more frequent, and *Naviculopsis biapiculata* and *Naviculopsis ponticula* were observed in this zone.

From Sample 19-2, 85-86 cm to Sample 24-4, 37-38 cm (185-234 m) the *Naviculopsis biapiculata* Zone was determined with the following species: *Distephanus speculum, Distephanus crux, Cannopilus hemisphaericus, Mesocena apiculata, Dictyocha hexacantha*, and *Naviculopsis ponticula.* Silicoflagellates are less common in the nannofossil ooze and disappear in Sample 24-4, 144-145 cm to Sample 26-1, 67-68 cm (234-248 m).

The *Dictyocha quadria* Zone, defined by the first occurrence of *Mesocena apiculata* to the last occurrence of *Dictyocha quadria* was determined from Sample 26-2, 109-110 cm to Sample 26-5, 30-31 cm (249-254.5 m), with *Naviculopsis ponticula, Dictyocha quadria, Mesocena apiculata, Dictyocha hexacantha, Distephanus speculum*, and *Dictyocha frenguellii.*

The assemblage below consists of the same species minus *Mesocena apiculata.* This part also belongs to the upper Eocene (*Corbisema bimucronata* Zone). The sediments below Core 29 are barren of silicoflagellates.

Palynology—338 (S.B.M.)

Dinocysts

Fairly good to excellent cyst assemblages were obtained from most samples taken from Core 8 and below. These were more closely studied than assemblages from other sites, and the zonation suggested by cyst ranges at Site 338 has been applied to other sites (Figure 23). Seven cyst-zones were distinguished, with further subzones in three of them. (For further details see Manum, this volume.)

The cyst assemblages are rather species poor in samples from Cores 33 and below, and reworked terrestrial plant debris and indigenous pollen and spores have a severe dilution effect on the cysts present. From Cores 33 to 30 the situation changes rapidly.

Sections 24-5, 25-2 and 26-2 yielded virtually barren cyst preparations. This interval is noticeable for marking the most drastic change observed in the composition of the cyst flora throughout the hole, serving to separate cyst Zones III and IV. From this interval up to Core 20, Section 2, number of cysts decreases relative to pollen, and while some samples are good, others are barren (23-5, 22-5, 22-2, 20-5). This interval (24-2 to 20-2) has a distinctive assemblage composition referred to as cyst Zone III. The top of Zone III (in 20-2) is marked by an influx of *Lejeunia* spp. and a few other species not seen elsewhere at Site 338, probably reflecting an environmental event of fair dimension. From Core 20, Section 2 upwards to the "glacial" cores, the samples yielded generally good cyst preparations with no indication of events of a magnitude comparable to the two described above.

Debris, Reworked Material

Reworked, thermally altered terrestrial plant debris has a severe dilution effect on indigenous palynomorphs in all samples studied from Core 42, Section 2 up to Core 32, Section 5, and then disappears through the following two cores. Reworked debris resembles maceration residues which may be obtained from humic coals. Relatively few reworked spores and pollen are present. They are rather undiagnostic of age and show slight to moderate thermal alteration. A few reworked cysts of (mid-) Upper Cretaceous age are present.

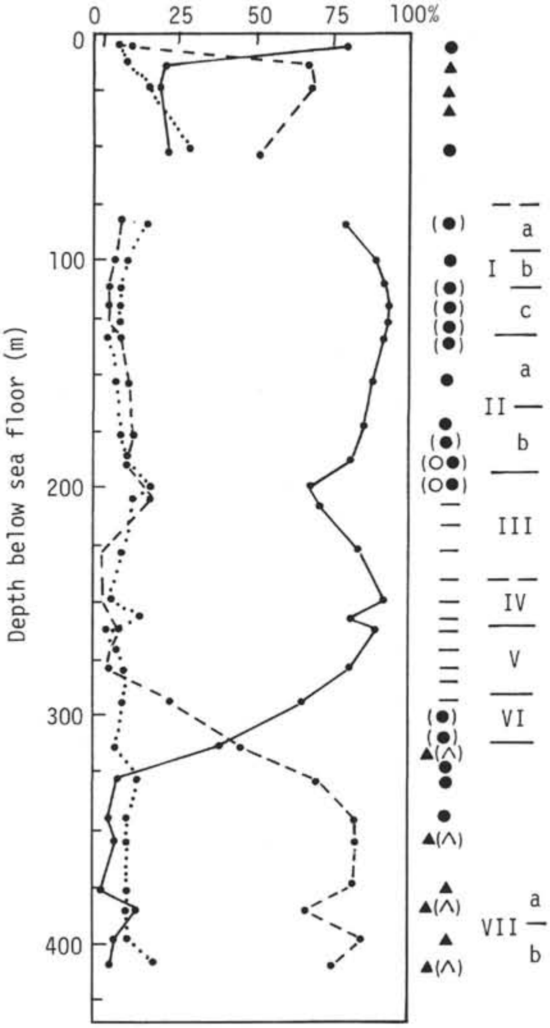

Figure 23. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation, Site 338. — dinocysts; – –pollen and spores; excl. saccates; ··· saccate pollen; terrestrial plant debris: mixed cuticular and tracheidal;* ▲ *altered (dark color);* ∧ *unaltered; sorted, tracheidal mainly* ● *carbonized (opaque);* ○ *noncarbonized; – no recognizeable debris; ( ) debris present but not; dominating in prep. residue; symbol only: debris dominating.*

The debris suggests that erosion of Upper Cretaceous deltaic or lagoonal deposits, probably containing coal seams, took place in the Eocene in the vicinity of the Vøring Plateau.

Among reworked material (never dominant) in Core 17, Section 2 to Core 8, Section 2, there is a small assemblage of slightly to moderately altered pollen and spores suggestive of a Paleocene/Eocene source. From Core 6, Section 5 upwards, the reworked material is derived from a variety of sources, ranging in age from Lower Cretaceous (spores, cysts, thermal alteration moderate) to Paleocene-Eocene (pollen, thermal alteration slight, and unaltered cysts).

BIOSTRATIGRAPHY—339

Biostratigraphic Summary

"Glacial" sediments (Pliocene to Pleistocene) mixed with underlying siliceous ooze in the lower part were encountered from Cores 1 through 8, containing nannoplankton and planktonic foraminifera. Reworked nannofossils, pollen, and dinoflagellates are present in different amounts. The underlying siliceous ooze (Core 9 to Core 12, 74.5-108 m), is of late Eocene age, with abundant, well-preserved, and diversified diatom, silicoflagellate, dinoflagellate and radiolarian assemblages, and sponge spicules. Some fish debris was also observed.

Foraminifera—339

"Glacial," Cores 1 through 8

Left-coiling *Neogloboquadrina pachyderma* is the dominant form in these cores. The low diversity benthos has *Islandiella teretis* (mostly) or *Cibicides wuellerstorfi* (at one level) as the dominant form. Other species present are *Dentalina* sp., *Bulimina aculeata*, *Melonis zaandamae*, and rare miliolids. From Core, Section 3 down, the effect of carbonate dissolution is strong and the samples are poor in microfauna, Cores 7 and 8 being nearly barren of calcareous fossils.

An exception to the above is Sample 3, CC. Here *Bulimina aculeata* is the dominant benthonic, and the planktonic foraminiferal fauna is warmer than any encountered at previous sites; 20% of *N. pachyderma* coils dextrally and three other species are present, *Globigerina bulloides*, *G. quinqueloba*, and *Globorotalia inflata*. This would have been a most interesting "glacial" section to study climatic changes if it were not that the cores have been highly disturbed by the drilling, and possibly also by diapirism.

The ice-rafted material in the wash residues of Cores 1 through 8 consists of quartz and other sand grains, rock fragments (metamorphic and sedimentary), lignite, Cretaceous Inoceramus prisms, and rare macrofossil fragments. Samples 7-2, 23-25 cm, 7, CC, 8-3, 120-122 cm, and 8-4, 80-82 cm have in addition an abundance of siliceous microfossils (Sample 8-4, 80-82 also has some white gypsum[?] crystals), which is absent again in Samples 8-5, 90-92 cm and 8, CC.

Oligocene, Cores 9 through 12 (as dated with silicoflagellates)

Washed residues of Cores 9 through 12 are strikingly different from the above and consist entirely of siliceous microfossils (radiolarians, diatoms, and spicules), and some fish remains with, at a few levels, very fine volcanic glass. The total absence of siliceous foraminifera could be used as very weak evidence for an Oligocene age; Miocene siliceous oozes in the area always yield *Martinotiella communis*, and Eocene oozes have *Spiroplectammina spectabilis*.

Nannoplankton—339

"Glacial" sediments were recovered in Cores 1 to 8 (0-74.5 m). The lower part of this sequence is mixed with the underlying siliceous ooze of Miocene and Eocene age. Core 1-1, top to probably Sample 2-2, 96-97 cm (0-10 m) belongs to the *Emiliania huxleyi* Zone (NN 21) with *Emiliania huxleyi*, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, *Gephyrocapsa ericsonii*, and very few specimens of *Syracosphaera pulchra* and *Helicosphaera carteri*. Reworked species are more or less abundant. The assemblage of Samples 2-3, 72-73 cm and 4-4, 98-99 cm (10-33 m) consists mainly of *Coccolithus pelagicus* and *Gephyrocapsa ericsonii* and belongs to the *Gephyrocapsa oceanica* Zone (NN 20).

In Sample 4, CC and Sample 6-2, 128-129 cm (36.5-49 m) few specimens of *Pseudoemiliania lacunosa* (small) were observed. This part may belong to the *Pseudoemiliania lacunosa* Zone (NN 19). The sediments of Core 6, Section 3 through Core 8 (49.0-74.5 m) are a mixture of "glacial" sediments and the underlying siliceous oozes.

In Sample 6-3, 39-40 cm a few slightly etched nannofossils were found (*Coccolithus pelagicus*, *Reticulofenestra pseudoumbilica*) together with silicoflagellates of middle Miocene.

An Eocene silicoflagellate assemblage is present in Sample 7-2, 20-21 cm and Sample 7-2, 83-84 cm with only few specimens of *Coccolithus pelagicus* and *Reticulofenestra umbilica*. Sample 7-3, 61-62 cm is abundant in nannoplankton with *Reticulofenestra pseudoumbilica*, *Helicosphaera carteri*, *Coccolithus pelagicus*, *Cyclococcolithus leptoporous*, *Braarudosphaera bigelowi*, *Sphenolithus abies*, *Discolithina japonica*, and *Discolithina* sp. together with a mixed silicoflagellate assemblage of Miocene and Eocene species. In Sample 7-3, 102-103 cm and 8-1, 20-21 cm Eocene silicoflagellates are present together with Pleistocene nannofossils (*Gephyrocapsa ericsonii*, *Cyclococcolithus leptoporus*). In Sample 8, CC only *Coccolithus pelagicus* was found with many reworked species of the Cretaceous and Eocene. Below this level sediments are barren of nannoplankton.

Diatoms—339 (H.-J. S.)

The biogenic siliceous sequence contained a well-preserved, diverse diatom assemblage with good index fossils such as *Coscinodiscus oblongus* (found only in the upper part and placing Sample 6-2, 60-62 cm into the *Coscinodiscus oblongus* Zone of late Eocene age). *Triceratium barbadense* was observed in Samples 6-2, 60 cm and 7-2, 70 cm, and places Sample 7-2, 70 cm into the *Triceratium barbadense* Zone of late Eocene (?). Due to the fact that the base of this zone was not defined at Site 338, the following age determination is exclusively based on the occurrence of species at Site 338 and Site 339.

Triceratium barbadense is absent in samples below Core 8, and new species were observed, which were not found at Site 338, such as *Pseudorutilaria monomembranacea* and *Coscinodiscus oligocaenicus*. This places Samples 10-12, 80 cm to 12-2, 10 cm lower into the "middle" Eocene section than those samples from Site 338, Core 29. No diatoms were observed in samples from the "glacial" sequence. Due to poor biostratigraphic zonation and age determination, no sedimentation rates have been calculated.

Radiolarians—339

Based on the occurrence of radiolarians, two units could be identified.

Unit 1 (Cores 1, CC through 8, CC) is characterized by being barren of radiolarians, except for the interval 7, CC through 8-3, 80-82 cm, which has a rich and well-preserved reworked late Eocene fauna with *Lophocorys norvegiensis* and *Calocyclas talwanii.*

Unit 2 (Cores 9, CC through 12, CC) has a high species diversity, good preservation, but *L. norvegiensis* and *C. talwanii* are missing. However, species not present in the section recovered at Site 338 are present in this unit, and it is assumed that the faunal assemblage recovered from Site 339 has a stratigraphic position below the stratigraphy position at Site 338.

Since this hole was drilled on the top of the diapir, it is questionable how valuable this may be from a stratigraphic point of view. It is likely that disturbances have taken place during diapirism.

Silicoflagellates—339

Siliceous ooze is intercalated in Quaternary sediments probably due to slumping. In Sample 6-3, 39-40 cm, a lower Miocene assemblage is present, and in Core 7, upper Eocene to lower Oligocene, comparable with those observed in the siliceous ooze recovered in Sample 9, CC to Sample 12, CC (84-108 m). Most important species of this assemblage are: *Corbisema triacantha, Corbisema spinosa, Naviculopsis foliacea, Mesocena apiculata, Corbisema hastata, Naviculopsis biapiculata*, and *Corbisema bimucronata*. This section belongs to the *Naviculopsis biapiculata* Zone of late Eocene to middle Oligocene age.

Palynology—339 (S.B.M.)

Dinocysts

Core 12, Section 2 and Core 10, Section 2 have good cyst assemblages. Dominating species are *Phthanoperidinium* spp. (*P. amoenum*, plus *P. resistente* and *P.* sp. I, both unknown from Site 338), *Deflandrea phosphoritica*, and *Thalassiophora pelagica*, comparable with cyst Zone V of Site 338. However, since *Wetzeliella* spp. and *Deflandrea* sp. I are present, this may suggest a transitional position between V and VI (Figure 24).

Cores 8 to 5 also contain assemblages of Zones V to VI composition; in Core 6, Section 2 and Core 7, Section 2 they are virtually repetitions of the Core 10, Section 2 sample.

Debris, Reworked Material

Core 10, Section 2 and Core 12, Section 2 have minor amounts of carbonized tracheidal matter. From Core 8, Section 5 upwards, reworked terrestrial debris (mainly tracheidal) is prominent. In reworked spores and pollen, two, sometimes three, grades of thermal alteration may be distinguished (unaltered, slightly to moderate, and moderate). Reworked palynomorphs are not very age diagnostic, but appear to be derived from Lower Cretaceous to early Tertiary (predominantly Cretaceous).

In Core 2, Section 2, a change is observed in the composition of reworked fossils suggesting an early Tertiary origin. Here unaltered early Tertiary cysts are present associated with slightly to moderately altered pollen and spores of corresponding age, indicating lower Tertiary sources of different diagenetic histories.

BIOSTRATIGRAPHY—340

Biostratigraphic Summary

The entire sequence (104 m) recovered at this site is characterized by being a late to middle Eocene diatom ooze, without calcareous fossils, except for Core 1 which is a mixture of Pleistocene and late Eocene sediments. The Eocene sequence is strongly disturbed either by drilling and/or diapirism.

Foraminifera—340

"Glacial," Core 1

Left-coiling (96% in 1, CC) *Neogloboquadrina pachyderma* dominates the foraminiferal fauna. Two other planktonic species, *Globigerina quinqueloba* and *G. bulloides*, are very rare. The benthonic fauna is nearly exclusively made up by *Islandiella teretis*, *Melonis zaandamae* being the only other species (rarely) observed. The wash residues with this fauna and ice-rafted material are "pure" until Sample 1-5, 81-83 cm.

Mixed "Glacial" and Eocene, Cores 1 and 2

The mixed section is present from 1-5, 90 cm until a level between Samples 2-1, 50-52 cm and 2-1, 140-142 cm. From the latter sample down, only siliceous Eocene was found. The mixed nature of the section is evident from the additional presence of abundant radiolarians, spicules, diatoms, and *Spiroplectammina spectabilis.*

Eocene, Cores 2 through 11

Spiroplectammina spectabilis is not present in all Eocene samples. Most others have *Bathysiphon* sp. and some have, in addition, *Haplophragmoides* sp. The erratic presence and absence of the fossils support the observations made on the distribution of silicoflagellates and radiolarians, that various levels of the Eocene are mixed. No lower Eocene forms have been noticed. The absence of calcareous fossils, like that at Sites 338 and 339, indicates that the Vøring Plateau was below the carbonate compensation surface (CCS) during the late and middle Eocene.

Nannoplankton—340

Nannofossils were only found in Core 1. The assemblage belongs to the *Emiliania huxleyi* Zone (NN 21) with *Emiliania huxleyi, Coccolithus pelagicus, Gephyrocapsa ericsonii*, and *Cyclococcolithus leptoporus.* In the lower part of this core, Quaternary sediments are mixed with underlying siliceous ooze.

Diatoms—340 (H.-J. S.)

"Glacial" sediments (~10 m thick) are directly underlain by a late Eocene biogenic siliceous ooze, which is greatly disturbed. Due to this disturbance, the

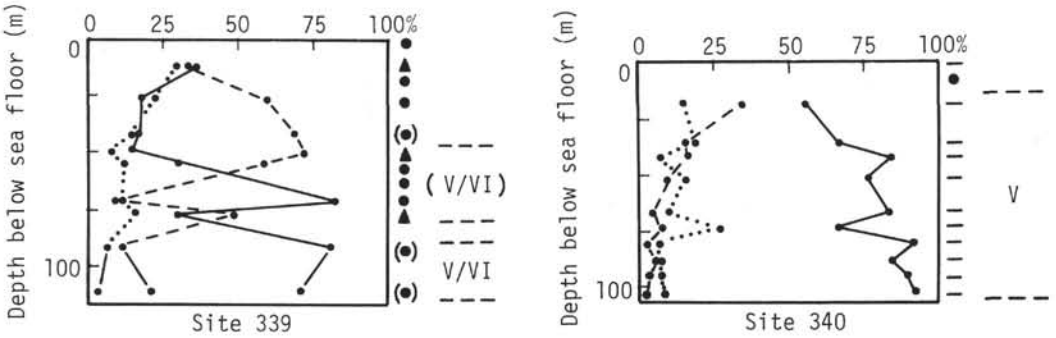

Figure 24. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation, Sites 339 and 340. – dinocysts; -- pollen and spores; excl. saccates; ··· saccate pollen; terrestrial plant debris: mixed cuticular and tracheidal; ▲ altered (dark color); Λ unaltered; sorted, tracheidal mainly · carbonized (opaque); noncarbonized; – no recognizable debris; () debris present but not dominating in prep. residue; symbol only: debris dominating.*

biostratigraphic interpretation is tentative here. Orientation of samples presented here includes various reversals within the Eocene section and was placed in descending order by the presence of index fossils such as *Coscinodiscus oblongus, C. oligocaenicus, Navicula bendaensis, Pseudorutilaria monomembranacea, Sceptroneis* spp., and *Triceratium barbadense.*

Coscinodiscus oblongus Zone	*Triceratium barbadense* Zone
9-2, 60-62 cm	7-2, 100-102 cm
9-5, 60-62 cm	7-3, 65- 67 cm
10-6, 60-62 cm	7-5, 60- 62 cm
11-2, 60-62 cm	8-5, 60- 62 cm
11-5, 60-62 cm	3-2, 60- 62 cm
2-2, 60-62 cm	3-5, 40- 42 cm

and samples 5-2, 60-62 cm, 6-5, 50-52 cm, 10-2, 60-62 cm into an unzoned interval below the interval at Site 338, Core 29.

Radiolarians—340

The well-preserved faunal assemblage recovered in Sample 1, CC through 11, CC differs from that obtained at Site 339. The major difference is the presence of *Calocyclas talwanii* throughout, while *Lophocorys norvegiensis* is present only in 8, CC-9, CC, where it is abundant. Also, *Spongopyle spiralis* is present. The general faunal assemblage would date the sediments as late Eocene, but stratigraphically above the sequence recovered from Site 339. However, not much attention should be paid to the stratigraphic interpretations from within Site 339 or 340. This is especially true for Site 340, which contains a reversed zonation.

Silicoflagellates—340

Silicoflagellates are present from Core 1, Section 4 to Sample 11, CC (6-106.5 m). The assemblages indicate a middle to late Eocene age. The sequence is mixed probably due to diapiric activities in this area. It is possible to recognize three units (A-C) with typical assemblages. Units B (Core 1 to Core 3, Section 1 and Core 6 to Core 8, Section 5) and C (Sample 8, CC to Sample 11, CC) belong to the *Corbisema bimucronata* Zone with the following species: *Corbisema triacantha, Distephanus crux, Naviculopsis ponticula, Mesocena apiculata, Dictyocha quadria, Dictyocha spinosa, Corbisema bimucronata, Naviculopsis foliacea*, and *Corbisema* cf. *hastata.* Unit C (Sample 8, CC to Sample 11, CC) probably represents the youngest part of this zone.

Unit A (Sample 3, CC to Sample 5, CC) is intercalated in Unit B, and probably belongs to the *Naviculopsis foliacea* Zone of the middle Eocene with: *Mesocena oamaruensis, Naviculopsis ponticula, Distephanus speculum*, and *Corbisema spinosa*, whereas *Dictyocha quadria* is missing.

Palynology—340 (S.B.M.)

Dinocysts

Good cyst assemblages were obtained from all cores except Core 1, Section 5 which is the only sample with noteworthy amounts of terrestrial plant debris. Cyst assemblages in Cores 11 to 2 show little variation, and are dominated by *Phthanoperidinium amoenum*, cf. *Gonyaulacysta giuseppei, Leptodinium incompositum, Meiourogonyaulax* sp., plus infrequent *Deflandrea phosphoritica, Thalassiphora pelagica, Cyclonephelium*, and *Wetzeliella* spp. This composition compares with cyst Zone V of Site 338 (Figures 23, 24).

While Core 1, Section 2 appears to have a thoroughly indigenous cyst flora closely resembling that of 339-10-2 and 12-2 (Zones V to VI), and has no reworked material, Core 1, Section 5 contains reworked material and a few cysts of early Tertiary age, but different from those present in the cores below.

Debris, Reworked Material

Terrestrial plant debris in Core 1, Section 5 consists almost entirely of carbonized tracheidal matter, with a few corroded spores (thermal alteration slight to moderate) suggestive of a Cretaceous age.

BIOSTRATIGRAPHY—341

Biostratigraphic Summary

A thick Pliocene to Pleistocene sequence (Cores 1 to 25, 0-342 m) can be subdivided into four units by nannoplankton and foraminifera. Diatoms, silicoflagellates, and radiolarians are missing within this sequence; they are present only in displaced siliceous ooze of early late Miocene age, encountered in Cores 4 to 7. Pollen and diverse plant debris dominate this sequence, with the exception of Cores 5 to 7, where a high increase of reworked dinoflagellates compared to the amount of pollen can be obsered.

Dinoflagellates are also abundant in the early late to middle Miocene sediments (Core 26 to Core 34, 351-456 m) rich in siliceous microfossils (diatoms, silicoflagellates, archaeomonads, radiolarians, siliceous foraminifera, and sponge spicules). Calcareous microfossils are restricted to some horizons. In some of these nannofossils are etched, indicating that most of the Miocene was deposited near the CCD.

Foraminifera—341

The cores from this site yielded a fascinating foraminiferal faunal succession that reflects significant geologic events not only allowing for an understanding of the local Vøring Plateau late Cenozoic geologic history but also for speculations on the origin of the ice ages.

"Glacial," Pleistocene, Cores 1 through 19

The "glacial" *Neogloboquadrina pachyderma* Zone with ice-rafted material (quartz and fragments of metamorphic rocks) consists of three distinct benthonic foraminiferal assemblage zones which will be referred to as Subzones A-C. Subzone A has the normal Arctic deep water benthonic fauna; Subzone B has the same fauna as A, plus reworked Tertiary siliceous benthos; Subzone C has the same fauna as A, but it is outnumbered by additional Arctic shallow water forms.

Subzone A, Core 1 through Sample 4-2, 86-88 cm

The foraminiferal fauna is dominated by the planktonic, sinistrally coiling *Neogloboquadrina pachyderma.* At this site, the species shows such a spectacular range of morphologic variations and so many "abnormal" specimens occur that we used the term "genetic desperados" as shipboard characterization of these faunas although the phenomenon most likely is the result of peculiar environmental conditions. Rare specimens of *Globigerina bulloides* and *G. quinqueloba* are present in most samples.

A few levels, however, are quite different: the washed residues contain very little ice-rafted material and are more like a normal foraminiferal ooze. Sample 3, CC is from such a level. Here eight planktonic forms are found. *N. pachyderma* still is dominant but only 61% is sinistrally coiling (or 81% if larger, globular chambered specimens are distinguished as *N. incompata*) as opposed to 100% in 1, CC and 98% in 2, CC. *G. bulloides* s.s. is abundant and *Globorotalia inflata, G. quinqueloba*, and *G. bulloides cariacoensis* are common, whereas *Globigerinita glutinata, Orbulina universa*, and *Globorotalia hirsuta* are rare. The assemblage suggests that the surface water at that time was as warm as today or warmer; that is in terms and criteria of Bé and Tolderlund (1971): subarctic (8 species present) to transitional (presence of *G. hirsuta* and *O. universa*), or about 10°C. The presence of *G. cariacoensis* and *G. hirsuta* ascertain the Pleistocene (by all definitions) age of this core.

The benthonic fauna has the usual low diversity. *Cibicides wuellerstorfi* or *Islandiella teretis* are dominant in most samples, but in some samples *Eponides umbonatus* or *Pullenia bulloides dominate*. Other forms present are *Melonis zaandamae, Elphidium incertum*, and some miliolids. The benthonic fauna of the warm sample (3, CC) is somewhat more diverse, here *Bulimina aculeata* is the dominant form and in addition to the species mentioned above, several species of *Lenticulina, Buccella, Cancris*, and *Fissurina* were found. In several samples of Core 1 *Recurvoides turbinatus* and *Reophax curtus* are common; this is the first core where the "glacial" sediments yielded a substantial arenaceous constituent.

Subzone B, Sample 4, CC through Core 7

The same fauna as subzone A, but empoverished and the washed residues are mixed with Eocene radiolarians, Oligocene (?) (*Angulogerina gracilis?*), and Miocene (*Martinotiella communis, Spirosigmoilinella* sp., *Spirolocammina* sp.) foraminifera and some Arctic, shallow water elements. *N. pachyderma* is small, compact, and practically 100% sinistral. *G. bulloides* is rare. Quite some washed residues largely consist of redeposited siliceous ooze material and have a small ice-rafted contribution only.

Subzone C, Core 8 through Sample 19, CC

More than any of the above, the washed residues of this subzone largely consist of fine and coarse terrigenous material, mainly quartz and fragments of metamorphic rocks. Sinistral *N. pachyderma* dominates the foraminiferal fauna, but is hard to find among the clastics. Despite the scarcity of the fauna, *G. bulloides* is found and warmer water species sporadically occur (*Globigerinoides triloba* in 12, CC and *G. inflata* in 19, CC).

Benthonic foraminifera outnumber the plankton in this subzone. The same deep water benthos as in subzone A is found but it is rare. More common are species from shallower depths: *Elphidium incertum clavatum* and *E. incertum incertum* dominate; other species are *Nonion labradoricum, Hyalinea balthica, Angulogerina angulosa, Islandiella norcrossi, Buccella frigida, Cassidulina crassa, Cibicides lobatulus*, and miliolids. This assemblage is considered to be redeposited. The common presence of fragments of gastropod shells, oysters, and other thick-walled pelecypods is further evidence for redeposition of shallow water sediments. Sample 13, CC yielded *Lithothamnium* fragments. The base of subzone C lies between Samples 19, CC and 20-1, 50-52 cm; the boundary is quite conspicuous because of the sudden drop in amount and size of terrigenous grains below it.

"Glacial" Plio-Pleistocene, Core 20 through Sample 25-2, 125-127 cm

This unit is characterized by the presence of sinistral *Neogloboquadrina atlantica* and ice-rafted terrigenous material, plus Cretaceous *Inoceramus* prisms. The ice-rafted quartz grains and fragments of metamorphic rocks are not as abundant and coarse as above and in many samples are present in minor amounts or just as a few grains. Three subzones can be distinguished: subzone D with common *N. pachyderma* and relatively few *N. atlantica*; subzone E practically barren; subzone F with *N. atlantica* dominant and *N. pachyderma* present.

Adhering to a young Plio-Pleistocene boundary concept (1.85 m.y.), one would draw the boundary at the top of this unit (top of *N. atlantica*, Poore and Berggren, 1975a,b); adhering to an old-boundary (2.8 m.y.) concept one might draw it between subzones E and F.

Subzone D, Cores 20 through 22, CC

Of the 18 samples examined from this subzone, three are barren (21-3, 6-8 cm; 21-4, 104-106 cm; 21-6, 47-49 cm) and their fairly large washed residues entirely consist of ice-rafted sand, mainly fine with some coarse grains. The washed residues of Samples 20-3, 55-57 cm and 20-5, 55-57 cm, on the other hand, are oozes with only some ice-rafted material. A third type of washed residue is very small, has very little and fine ice-rafted material, some pyrite, and practically no fauna. The composition of other samples is somewhere in between these extremes.

The fauna, if present, shows signs of dissolution. Planktonic specimens generally are small. *N. pachyderma* always dominates (99%, 100%, 90% sinistral in Samples 20, CC, 21, CC and 22, CC, respectively). Larger specimens with a more open umbilicus can be classified as *N. atlantica* although the distinction is not always clear; other species present in the richer samples are *G. quinqueloba, G. bulloides, G. glutinata* and one specimen of *G.* sp. cf. *G. inflata. G. quinqueloba* is of "Pliocene size" ($x = 268\ \mu$m, cf. Asano et al, 1968). The benthonic fauna is as in subzone A of the above unit. In Core 20 *Islandiella teretis* and/or *Cibicides wuellerstorfi* dominate, among the few others present are *Melonis zaandamae, Pullenia bulloides, P. quinqueloba*, and rare miliolids. Cores 21 and 22 have practically no benthonic fauna (rare *I. teretis* only) and the planktonic specimens are very small.

Subzone E, Cores 23 and 24

Of the 16 samples examined from this subzone, eight are barren. The fauna of the others is strongly affected by carbonate dissolution and mainly consists of the resistant *I. teretis* and *M. zaandamae.* The rare, small planktonic forams are *N. pachyderma* and *G. quinqueloba.* Washed residues show a similar variation in relative abundance of ice-rafted material as in subzone D, but with a higher frequency of the third type. Pyrite is present in all samples and can be abundant. Strictly speaking Sample 25-0, 17-19 cm should be classified in this subzone; however it is considered contaminated with uphole material.

Subzone F, Core 25 through Sample 25-2, 125-127 cm

All seven samples of this subzone have glauconite; the upper two are barren but the others have large, sinistral *N. atlantica* and less conspicuously *N. pachyderma.* The benthonic fauna is as above but has in addition large nodosarids (mostly fragments). Pyrite is a common constituent of the washed residues most of which have some sand-size quartz. The carbonate dissolution effect is stronger than in subzone D but not as strong as in subzone E.

Mio-Pliocene, Samples 25-3, 8-10 cm through 25, CC

This part of the section is characterized by the absence of calcareous fossils, the absence of terrigenous (ice-rafted) material, and the presence of glauconite. Other constituents of the washed residues are pyrite, sponge spicules, and volcanic glass.

Subzone G

The six upper samples of this unit (25-3, 8-10 cm through 25-4, 83-85 cm) are barren.

Subzone H

The eight lower samples of this unit (25-4, 137-139 cm through 25, CC) have the siliceous foraminifera *Martinotiella communis, Spirosigmoilinella* sp., and *Spirolocammina* sp. Drawing the Miocene-Pliocene boundary for practical biostratigraphic reasons at the top of the *Martinotiella* fauna would be in agreement with the silicoflagellate age assignment. However, a more significant "facies" boundary would be at the base of this unit, below which calcareous foraminifera are present again and glauconite is absent.

Upper and Middle Miocene, Cores 26 through 34

Practically all samples (including the lowest) of this interval yielded the siliceous arenaceous assemblage *M. communis, Spirosigmoilinella* sp., and *Spirolocammina* sp. Age determinations on other siliceous microfossil groups suggest that the lower Miocene was not reached at Site 341. This is consistent with the presence of the *Martinotiella* assemblage which at other sites also does not range below the middle Miocene. Most washed residues have some pyrite; some have volcanic ash. At several levels sculptured or smooth archaeomonads are abundant. Fish remains were found in some core-catcher samples.

All levels suffered carbonate dissolution and the size of the washed residues is minimal. However, dissolution is not always total. In Cores 26 and 27 some calcareous foraminifera are preserved and at most levels planktonic species are present. In Cores 28, 29 and the upper two sections of Core 30 some levels still have a few plankton specimens, but from Core 30, Section 3 through Core 32 only the odd calcareous specimen is found and all 20 samples of Cores 33 and 34 are barren of calcareous fossils.

Despite its scarcity, the planktonic fauna has the potential for further age determination. A very preliminary investigation shows that dextral *N. atlantica* is present from the top of Core 26 down to 27-4, 20-22 cm which indicates a late Miocene age. Other forms in this interval are *Neogloboquadrina acostaensis* (dextral), *N. pachyderma*, and small *Globigerina* spp. Rare dextral specimens in Core 28 may also be *N. acostaensis.* From Core 29 down the *N. acostaensis*-like specimens are sinistral and one might draw the Messinian-Tortonian boundary between Cores 28 and 29 (Zachariasse, 1975). Scattered small specimens of the *Globorotalia mayerisiakensis* plexus occur from Core 30, Section 3 down indicating that this part of the section is of middle Miocene age.

The relict calcareous benthonic foraminiferal fauna has *Pullenia bulloides, Melonis zaandamae, Eponides* *umbonatus*, and from Core 28 down small *Uvigerina* sp. as its most common specimens. Others present are *Eggerella* sp., *Triloculina* sp., *Pyrgo* sp., Nodosaridae, *Fissurina* sp., *Laticarinina* sp., Cibicidae. This fauna is different from the "glacial" one and especially the consistent absence of *Islandiella teretis* is significant.

Nannoplankton—341

"Glacial" sediments were encountered in Cores 1 to 25 (0-335.5 m). The sequence can be subdivided into four units.

Unit 1: Core 1 to Core 3 (0-28.5 m) with Quaternary species: *Coccolithus pelagicus, Gephyrocapsa ericsonii*, and a few specimens of *Helicosphaera carteri, Syracosphaera pulchra, Cyclococcolithus leptoporous. Emiliania huxleyi* was observed from Core 1-1, top to Sample 2-1, 112-113 cm. Nannofossils are rare, enriched only in the nannofossil ooze layers. Reworked species of the Cretaceous and Tertiary are generally common in all samples except those from the nannofossil ooze.

Unit 2: Sample 4, CC to Sample 7, CC (28.5-66.5 m), a siliceous ooze with silicoflagellates and nannofossils of middle/late Miocene age. These sediments are intercalated in the Quaternary sequence. A few reworked nannofossils of the Cretaceous and Eocene were also found.

Unit 3: In Core 8 to Sample 19, CC (66.5-228 m) autochthonous nannofossils are rare: *Coccolithus pelagicus, Cyclococcolithus leptoporus, Pseudoemiliania* cf. *lacunosa*. The high amount of reworked Cretaceous and Eocene species corresponds to an increase of ice-rafted material.

Unit 4: In Cores 20 to 25 (237.5-342 m) well-preserved nannofossils are common with: *Coccolithus pelagicus, Gephyrocapsa* sp., *Cyclococcolithus leptoporus, Helicosphaera carteri, Discolithina japonica*, and *Pseudoemiliania lacunosa*. This part of the profile may belong to the lower Quaternary or upper Pliocene.

In Cores 26 to 33 (351.5-446.5 m), the nannoplankton assemblage consists of *Coccolithus pelagicus, Reticulofenestra pseudoumbilica, Discolithina japonica, Helicosphaera carteri*, and a few species of *Sphenolithus abies* indicating a Miocene to early Pliocene age. Nannofossils are restricted to several nannofossil ooze layers intercalated in siliceous sediments. In some layers, they are etched.

Diatoms—341 (H.-J.S.)

Sample 4-2, 101-103 cm contained a diversified diatom assemblage with *Rhizosolenia barboi* and *Thalassiosira oestrupii*, and is tentatively placed into the *Rhizosolenia barboi* Partial Range Zone, dated as 1.8-2.5 m.y. B.P. The diatom assemblage of this sample is very close to the Assemblage 1 being defined on present-day surface sediment material within the CLIMAP program and covers the area north of the Iceland-Faeroe Ridge to approximately 70° N characterized by the northward flow of the Gulf Stream.

The displaced block of biogenic diatomaceous ooze represented in Samples 5-2, 105-107 cm through 7-5, 82-84 cm contained a well-preserved diatom assemblage with index species such as *Coscinodiscus flexuosus, Denticula punctata, Mediaria splendida, Coscinodiscus endoi, Goniothecium tenue* and places this block into the *Nitzschia* sp. 8.

The next unit directly overlain by the "glacial" sequence consists of transitional biogenic siliceous ooze, primarily diatomite, and covers the interval from 328 to 456 and deeper (uncored) meters. Cores 26 through 29 are placed into the *Nitzschia* sp. 8 Range Zone which has an approximate early late Miocene age (10 m.y. B.P.). Core 30 is placed into the *Coscinodiscus plicatus* group Partial Range Zone, which has a tentative age of approximately 13.5-13 m.y. B.P. Cores 31-34 are placed into the *Denticula hyalina* Partial Range Zone, which has not been absolutely dated, but is still in the middle Miocene and is younger than 15 m.y. No fresh water diatoms were observed, but reworked older species of Eocene and Oligocene age were found in all diatomaceous samples. Displaced shallow water marine-benthonic species were found only in the block within the "glacial" sequence. No facies change was observed in the lower diatomaceous sequence.

Radiolarians—341

Based on radiolarian occurrences, three units could be recognized.

Unit 1 (Samples 1, CC through 24, CC) consisted mainly of ice-rafted material and was barren of radiolarians. Within this unit, however, in Samples 3, CC through 7, CC, there were reworked Miocene and Eocene radiolarian faunas, with *Calocyclas talwanii* and *Lophocorys norvegiensis* as the most typical species.

Unit 2 (Samples 25, CC through 30, CC) is characterized by a rich siliceous microfossil assemblage of good preservation. None of the zones as defined from Site 338 was recognized, and the presence of *Antarctissa whitei* and a *Triceraspyris* sp., very similar to *T. antarctica*, but larger, indicates that this unit is younger than the *Lithomelissa scigi* Zone (late Miocene).

Unit 3 (Samples 31-5, 17-19 cm through 34, CC) contains a good radiolarian fauna of good preservation, except in Samples 34-2, 41-42 cm through 34, CC, where there is a decrease in both species diversity and preservation. Samples 31-5, 17-19 cm through 31, CC are characterized by a *Hexalonche* sp. A maximum, which corresponds to Sample 7, CC at Site 338, and with Sample 15-2, 30-32 cm at Site 348, indicating a late Miocene age. *Lophocorys norvegiensis* are present in Samples 25, CC, 26, CC, 28, CC, 29, CC, 32, CC, and 33, CC, which indicates that redeposition of late Eocene sediments has taken place.

Silicoflagellates—341

Silicoflagellates observed in the siliceous ooze, which is intercalated in Quaternary sediments of Samples 4, CC to Core 7, CC (38-66.5 m), indicate middle Miocene age and represent displaced material.

In Core 25, only sponge spicules, some diatoms, and archaeomonads were found. The silicoflagellate assemblage of Sample 25, CC to Sample 34, CC (342-456 m) consists of the following species: *Distephanus crux, Mesocena diodon, Distephanus speculum, Cannopilus hemisphaericus, Mesocena circulus, Mesocena* *elliptica, Mesocena apiculata*, and *Dictyocha* cf. *fibula* indicating a middle to late Miocene age (*Mesocena circulus* Zone). Archaeomonads are common in some samples.

Palynology—341 (S.B.M.)

Dinocysts

Cysts are frequent in Cores 34 to 25. A rich assemblage very similar to that from 338-8-2 (Zone Ia) is present in Sections 33-2 and 32-2. A poor Zone Ia assemblage is present in Section 33-5, and that of Section 34-3 is undiagnostic. The assemblages in Core 31, Section 5 and higher cores are different, apparently representing younger Miocene sediments than Section 338-8-2 (Figures 23, 25).

Debris, Reworked Material

Only small amounts of tracheidal matter are present in cores up to Core 21. Higher cores are dominated by terrestrial palynomorphs and diverse plant debris, with the exception of Sections 7-2 to 5-5, which have good and thermally unaffected Zones IV-V (in 7-2) and Zone II cysts (in 6-2 and 5-5), reflecting sources of allochthonous sediments at these points. This change in allochthonous material source is also well reflected in the cyst-pollen curves.

Material in the other cores appears to be mainly of early Tertiary source, and slightly thermally altered.

BIOSTRATIGRAPHY—342

Biostratigraphic Summary

Cores 1 and 2 (0-47 m) belong to the Quaternary with planktonic foraminifera (*Globigerina pachyderma*, left coiling, dominant) and calcareous nannofossils. Reworked Cretaceous and Eocene pollen, dinoflagellates, and nannoplankton are present. Late early Miocene to middle Miocene sediments were encountered in Cores 3 to 5 (85-142 m) with diatoms, silicoflagellates, archaeomonads, radiolarians and sponge spicules, and some siliceous foraminifera. Core 6 belongs to the lower Miocene based on diatoms and silicoflagellate assemblages, while the radiolarian assemblage yields a middle Miocene age.

Foraminifera—342

Glacial, Cores 1 through 2 (3-1, 50-52 cm)

Left-coiling *Neogloboquadrina pachyderma* dominates the foraminiferal fauna (97.5% and 100% sinistral in 1, CC and 2, CC, respectively). *Globigerina quinqueloba* and *G. bulloides* are very rare. Benthos is relatively rare. *Islandiella teretis* is the dominant species in most samples, but some have more *Cibicides wuellerstorfi*. Rare other species are *Melonis zaandamae, Bulimina aculeata, Eponides umbonatus, Pullenia quinqueloba*, lagenids, and polymorphinids. A varying amount of ice-rafted quartz and rock fragments occurs in all samples; rare lignite and *Inoceramus* prisms were found. Sample 1-3, 60-62 cm is practically an ooze whereas the washed residue of other samples from Core 1 consists of 20% to 50% forams. Core 2 is considerably poorer, even having some barren levels; more fragments and relatively more benthos suggest stronger carbonate dissolution. Sample 3-1, 50-52 cm has the same fauna (very rare) and washed residue as above. However, the coring was not continuous and the "glacial" material at the top of Core 3 could very well be downhole contamination.

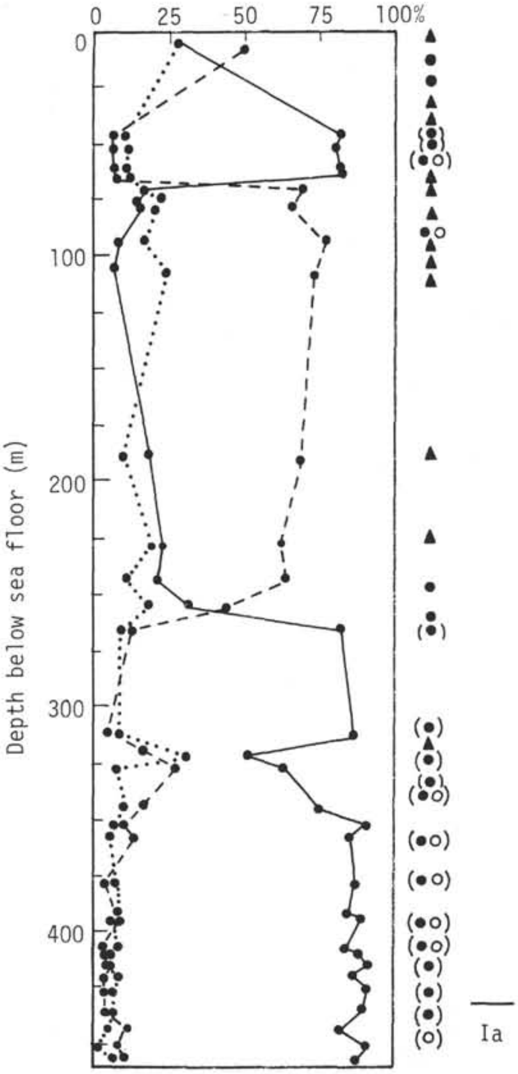

Figure 25. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation, Site 341 (as established for 338). — dinocysts; – – pollen and spores; excl. saccates; ··· saccate pollen; terrestrial plant debris: mixed cuticular and tracheidal; ▲ altered (dark color); ʌ unaltered; sorted, tracheidal mainly ● carbonized (opaque); ○ noncarbonized; – no recognizable debris; () debris present but not dominating in prep. residue; symbol only: debris dominating.*

Pliocene (?), Samples 3-1, 130-132 cm through 3-2, 120-122 cm

The upper samples of this core have practically no fauna, only very few specimens of *Spirosigmoilinella* sp. and *Karreriella siphonella* were found in the washed residues that largely consist of volcanic glass and some sponge spicules. Since it overlies the *Martinotiella* Zone, this part of the section may be of early Pliocene age.

Upper and Middle Miocene, Core 3, Section 3 through Core 5

Sample 3-3, 55-57 cm has *Martinotiella communis* and some corroded calcareous foraminifera (Cibicidae, *Lagena, Fissurina, Pullenia bulloides*). This is the only sample with calcareous tests, but from here down *Martinotiella* is consistently present often with *Spirosigmoilinella* sp., *Spirolocammina* sp., and very rare *Karreriella siphonella.* The washed residues have radiolarians, diatoms, and at a few levels volcanic glass. At other sites, the *Martinotiella* zone was found to be of late-middle Miocene age; the age assignment also here would agree with the determination based on silicoflagellates.

Lower Miocene (?), Core 6

From the highest sample of Core 6 (6-2, 55-57 cm) down *Martinotiella* is absent. Most samples are barren, but some have rare *Spirosigmoilinella* sp. The washed residues look quite different from above consisting of glauconite with some or abundant volcanic glass. The absence of *Martinotiella* suggests a pre-middle Miocene age which would be in agreement with the conclusions based on other fossil groups.

Nannoplankton—342

Nannoplankton are present in Cores 1 and 2 (0-47 m). The assemblage belongs to the Quaternary with the following species: *Coccolithus pelagicus, Cyclococcolithus leptoporus, Gephyrocapsa ericsonii, Helicosphaera carteri*, and *Emiliania huxleyi.* Reworked Cretaceous and Eocene nannofossils were found in most samples. Sediments of the lower part of the profile are barren of nannoplankton (85-151.5 m).

Diatoms—342 (H.-J.S.)

"Glacial" muds were recovered in Cores 1 and 2, late early Miocene siliceous ooze in Cores 3 to 6 above basaltic basement. Diatoms were found in high abundance and good preservation in the siliceous ooze and containe7 few age-diagnostic species: *Bruniopsis mirabilis, Coscinodiscus lewisianus, Cymatosira biharensis, Opephora gemmata, Rhaphoneis parallelica, R. wicomicoensis, Rhizosolenia bulbosa, Thalassiosira fraga.* The range of the above species allowed the following zonation: Cores 3 to 5 belong to the *Rhizosolenia bulbosa* Partial Range Zone, and Core 6 belongs to the *Thalassiosira fraga* Partial Range Zone. Both zones are of late early Miocene age (base of *Rhizosolenia bulbosa* Zone dated as 19.5 m.y. B.P.).

Reworked older species of Eocene to Oligocene age were observed in Samples 3-2, 70-72 cm; 5-2, 60-62 cm; and 6-2, 70-72 cm. Displaced fresh water species (*Melosira islandica*) were found only in Sample 6-2, 70-72 cm, and displaced shallow water benthonic species (*Diploneis* species) were found in Core 5.

Radiolaria—342

Core 1 through Sample 2, CC consisted of "glacial" sediments barren of radiolarians. Middle Miocene sediments in Samples 3-2, 50-52 cm through 5, CC, corresponded to the upper part of the *Actinomma holtedahli* Zone. Because of washing, the glacial/nonglacial boundary was missed. *Cyrtocapsella tetrapera* was present in Sample 3, CC, in a high enough density so species identification is good. As *C. tetrapera* is not a native species in the Norwegian Sea, it is most likely that *C. tetrapera* was transported by currents, when its population in the North Atlantic was at its maximum in middle Miocene. This age is supported by the silicoflagellate assemblage. It is reasonable to conclude because of the occurrence of *C. tetrapera*, that Sample 3, CC at this site corresponds in time with Samples 10-1, 115-117 cm through 11-1, 145-147 cm at Site 338.

A change in the radiolarian assemblage occurs between Samples 5, CC and 6-3, 130-132 cm. The fauna present in Samples 6-3, 130-132 cm through 6, CC is very similar to the fauna in the lower part of the *Actinomma holtedahli* Zone, indicating an upper early Miocene age.

Silicoflagellates—342

Silicoflagellates are common in Samples 3-1, 95-96 cm to 6, CC (85-151.5 m). The assemblage of Sample 3-1, 95-96 cm to Sample 3-4, 45-46 cm consists of *Distephanus crux, Mesocena diodon*, and *Distephanus speculum.*

From Sample 3-4, 145-146 cm to Sample 5-6, 115-116 cm *Distephanus longispinus, Cannopilus hemisphaericus*, and *Mesocena apiculata* are present, while *Mesocena diodon* is missing. This part of the profile belongs to the *Dictyocha triacantha* Zone of the lower Miocene to middle Miocene.

The sequence from Sample 6-2, 30-31 cm to Sample 6-4, 65-66 cm belongs to the *Naviculopsis navicula* Zone of the lower Miocene. In Samples 6-4, 115-116 cm and 6, CC *Naviculopsis navicula* was not observed. This part of the profile may belong to the *Naviculopsis lata* Zone of upper Oligocene to lower Miocene.

Palynology—342 (S.B.M.)

Dinocysts

Core 6, Section 2 to Core 4, Section 1 gave workable assemblages assigned to Zones IIa to Ia-b. Core 6, Section 2 is the richest, containing the following Zone IIa species (besides more long-ranging species): *Leptodinium* spp. II and cf. IV, *Batiacasphaera baculata, Thalassiphora delicata, Pentadinium* cf. *taeniagerum*, and Dinocyst sp. I., *Cannophaeropsis* sp. III.

Core 5, Section 5 to Core 4, Section 2 are assigned to Zone Ic since they lack *L.* sp. II, *L.* sp. IV, and *C.* sp. I, while *T. delicata, Apteodinium spiridoides* (Gocht), and *A.* cf. sp. B persist. Core 4, Section 1 lacks the three last mentioned species, giving a poor Zone Ia-b assemblage, without species differentiating these two subzones (Figure 26).

Core 3, Section 2 has a completely different and apparently indigenous assemblage of very few species, none of which are known from the pre-"glacial" cores of Site 338.

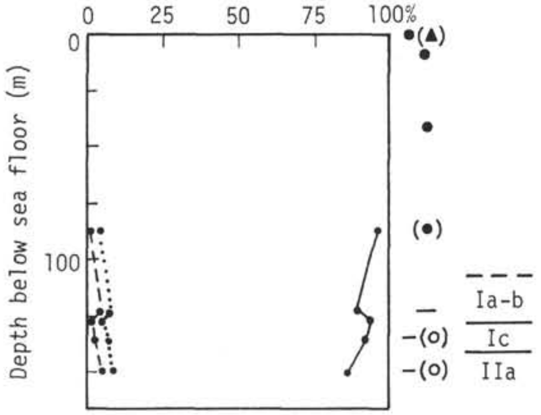

Figure 26. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation, Site 342 (as established for 338). — dinocysts;- -pollen and spores; excl. saccates; ··· saccate pollen; terrestrial plant debris: mixed cuticular and tracheidal;* ▲ *altered (dark color);* ∧ *unaltered; sorted, tracheidal mainly* ● *carbonized (opaque);* o *noncarbonized; – no recognizable debris; () debris present but not dominating in prep. residue; symbol only: debris dominating.*

Debris, Reworked Material

In Core 6, Section 2 to Core 4, Section 2 scattered noncarbonized tracheidal fragments are present. Core 4, Section 1 lacks recognizable debris, while Core 3, Section 2 marks a distinct change in debris content. Core 1 has very scattered reworked pollen and cysts (*Classopollis classoides, Gonyaulacysta hadra*), which, when taken in combination, suggest a Lower Cretaceous age.

BIOSTRATIGRAPHY—343

Biostratigraphic Summary

Quaternary sediments were recovered in Cores 1 to 4 (0-107.5 m) with nannoplankton and planktonic foraminifera. Cores 3 and 4 are characterized by benthonic foraminifera of a shallow water environment, fragments of thick-shelled pelecypods, and bryozoa. Also the presence of siliceous ooze in Core 3, Section 5 indicates displaced material. Reworked Cretaceous and Paleogene nannofossils, pollen, and spores are present.

In Core 5, Section 2 a middle Miocene diatom assemblage was found (see Schrader, this volume), while Core 5, Section 3 to Core 6 belong to the early Eocene based on diatom, silicoflagellate, and dinoflagellate assemblages. The early Eocene was also determined in Cores 7 to 16 by nannofossils and foraminifera. This sequence is also rich in plant debris and pollen, while siliceous microfossils are missing.

Foraminifera—343

"Glacial," Cores 1 through 5, Section 1

The upper cores are characterized by *Neogloboquadrina pachyderma* (93%, 98%, 100%, and 100% left-coiling in Samples 1, CC, 2, CC, 3, CC, and 4, CC, respectively) and by the abundance of terrigenous material (ice-rafted quartz and rock fragments).

Subzone A, Cores 1 and 2

Both core-catcher samples have a well-preserved Pleistocene (by all standards) planktonic fauna with in addition to the dominating *N. pachyderma, Globigerina bulloides, G. cariacoensis, G. quinqueloba*, and *Globorotalia inflata*. This is a subarctic assemblage comparable to the one living here today (Bé and Tolderlund, 1971; Kellogg, 1974). The rare benthos has an even lower diversity than at previous sites: large *Pyrgo* spp. and *Cibicides wuellerstorfi* are practically the only forms present. Foram tests make up between 50% and 10% of the washed residue, except for Samples 1-1, 0-40 cm and 2-3, 68-70 cm which are oozes with less than 10% terrigenous grains.

Subzone B, Cores 3 and 4

The rare microfauna is quite different from above. *N. pachyderma* is the only planktonic species found. The benthos is more abundant than the plankton and of shelf origin (a fat *Cibicides* sp., *Elphidium incertum inflatum, Buccella inusitata*). Rounded and angular fragments of thick-shelled pelecypods and bryozoa among the partly well rounded clastics are further evidence for the displaced nature of the material (turbidites). The washed residues have fragments of sedimentary rocks including white chalk?, brown chert, and lignite. Cretaceous *Inoceramus* prisms are not rare and one cast of a Paleozoic ostracode was found.

Subzone C, Core 5-1

The washed residue of the only sample from this section (5-1, 132-134 cm) consists of ice-rafted sand with *N. pachyderma* and some larger radiolarians. No benthos was found. Since this core was taken after drilling without coring, the top of the core could be caved uphole material.

Miocene, Core 5, Section 2

The two samples of Core 5, Section 2 (50-52 and 135-137 cm) both yielded *Martinotiella communis* and *Spirosigmoilinella* sp., a late-middle Miocene assemblage as dated at the other sites. The upper sample also has some quartz grains and radiolarians, which probably is contamination from uphole. The lower sample has some volcanic glass.

Upper Eocene, Sample 5-3, 45-47 cm

This sample of Core 5 has very fine quartz, volcanic glass, and abundant pyrite. Badly preserved and pyritic casts of small nodosarids and stilostomellids are common and some specimens were found of *Lenticulina cultrata* and a "smoothly ribbed" *L. decorata* suggesting a late Eocene age (Bettenstaedt et al., 1962, p. 347).

Middle Eocene, Samples 5-3, 110-112 cm through 6-1, 120-122 cm

All six samples from this interval have the siliceous arenaceous *Spiroplectammina spectabilis* as the only foraminifera. Diatoms, radiolarians, and spicules constitute the rest of the small washed residues. The middle Eocene age is based on silicoflagellates.

Lower Eocene, Sample 6, CC through Core 16

Only a few specimens of planktonic foraminifera were found; they are small and have an unkeeled, basic globigerine morphology; most were provisionally classified as *G. linaperta.* In searching for these rare forms *N. pachyderma* was found as a contaminant in many samples. The benthonic foraminiferal fauna is better preserved and more common. Arenaceous species mostly dominate in the upper cores (7 through 12); *Cyclammina* sp., *Haplophragmoides* sp., *Recurvoides* sp., *Bathysiphon* sp., *Ammodiscus* sp., *Textularia plummerae*, and *Spiroplectammina spectabilis.* The latter two range throughout the section.

The calcareous benthos has been affected to various degrees by carbonate dissolution; many fragments and broken specimens are present. *Cancris* sp. cf. *mauryae* is by far the most conspicuous form, and apparently quite resistant to dissolution because it is in several samples the only calcareous form preserved. Others are small stilostomellids, *Lenticulina* sp., *Gyroidina* sp., *Pullenia* sp., *Quadrimorphina paleocenica, Chilostomelloides eocenica.* From Sample 10-1, 120-122 cm down an *Osangularia* sp. and *Stilostomella spinulosa* are regularly present. Cores 15 and 16 differ in having less arenaceous forms.

Except for Core 15, ash is present in most residues. Fish remains, pyrite, and pyritized diatoms are common.

Our preliminary interpretation is that the upper cores compare with the northwest German Eocene 2 and 3 (Ypresian), whereas the lower cores (15 and 16) may be equivalent with the northwest German Eocene 1 (Ypresian and upper Paleocene).

Nannoplankton—343

Quaternary sediments were recovered in Core 1 to Core 4 (0-107.5 m). Core 1 belongs to the *Emiliania huxleyi* Zone (NN 21) with an assemblage of *Coccolithus pelagicus, Emiliania huxleyi, Gephyrocapsa ericsonii, Cyclococcolithus leptoporus*, and very few specimens of *Syracosphaera pulchra* and *Helicosphaera carteri.* Reworked species of the Cretaceous and Eocene are more or less frequent. Some nannofossil ooze layers are present in Core 2, abundant in *Coccolithus pelagicus* and *Gephyrocapsa ericsonii.* Reworked species were only sporadically observed in these layers. In Core 3, Section 5 a thin layer of siliceous ooze is intercalated, probably displaced by slumping. Sample 4-3, 80-81 cm (98-107.5 m) still contains Quaternary species.

In Sample 5-3, 40-41 cm (145.5-155 m) few specimens of poorly preserved *Discolithina pulcheroides* and *Micrantholithus* sp. were observed, indicating an Eocene age. From Samples 5-3, 100-101 cm to 7-1, 10-11 cm (150-203.5 m) nannoplankton is missing.

Sample 7-1, 95-96 cm contains *Imperiaster obscurus, Zygolithus dubius*, and *Micrantholithus mirabilis* which give an early Eocene age (NP 12). This assemblage is present in Core 7 through Core 16 (204-284 m) together with *Cyclococcolithus luminis, Braarudosphaera bigelowi, Discolithina pulcher, Coccolithus pelagicus, Discoaster lodoensis*, and *Chiasmolithus solitus* were found in Samples 8, CC and 15-2, 105-106 cm. Nannofossils are rare in the Eocene sediments and are slightly etched.

Diatoms—343 (H.-J.S.)

Well-preserved diatom assemblages were only recovered from Cores 5 and 6. They contained a flora different from all other Leg 38 material and dated only by comparison with the well-known Cementstein flora of Mors, Jutland, which has been placed into the early Eocene. An early Eocene age was also assigned to this core by silicoflagellate studies (Martini and Müller, this volume). Because of this single occurrence, no further biostratigraphic investigation was made.

Sample 343-5-2, 140-142 cm contained a well-preserved diverse middle Miocene diatom assemblage with *Denticula hustedtii, Mediaria splendida, Denticula punctata, Pseudodimerogramma elongata, Rhaphoneis parallelica, Goniothecium tenue*, and *Bruniopsis mirabilis.* Displaced shallow water benthonic diatom species or displaced fresh water diatoms were not observed.

A drastic change is composition, and slightly in preservation, was found to occur between Samples 5-6, 110 cm to 6-1, 128 cm; the flora changes from diverse to nearly monotonic composition.

Silicoflagellates—343

Silicoflagellates were found in Sample 3-5, 84-85 cm, a siliceous ooze which is intercalated into Quaternary sediments. The assemblage consists of *Corbisema triacantha, Dictyocha frenguellii, Dictyocha* cf. *fibula*, and *Corbisema* cf. *hastata.* From Sample 5-3, 100-101 cm to Sample 6-1, 128-129 cm (149.5-194 m) an assemblage is present consisting of *Distephanus speculum, Corbisema spinosa, Naviculopsis foliacea, Dictyocha rotundata, Dictyocha* cf. *fibula, Corbisema apiculata, Dictyocha deflandrei, Dictyocha frenguellii, Naviculopsis* cf. *minor*, probably belonging to the early middle Eocene (*Naviculopsis minor* Zone).

Palynology—343 (S.B.M.)

Dinocysts

Cores 16 to 8 gave poor cyst assemblages of low stratigraphic value but comparable with Zone VIIa of Site 338. Core 7, Section 2 contains a rich cyst population, completely dominated by a deflandroid species not seen at Site 338, and otherwise no zone-diagnostic species. The assemblages in Cores 7 and below are all considered to have been controlled by near-shore conditions. Core 5, Section 2 has a good cyst assemblage quite distinct from those below, mostly containing species not used for zonation, plus a few species not seen at Site 338. A correlation with Zone V of Site 338 is suggested by the occurrence of *Psaligonyaulax* cf. *simplicia, Leptodinium* sp. I, *Deflandrea phosphoritica*, and *Systematophora ancyrea* (Figures 23, 27).

Core 4, Section 2 and higher cores have no stratigraphically diagnostic cyst assemblages.

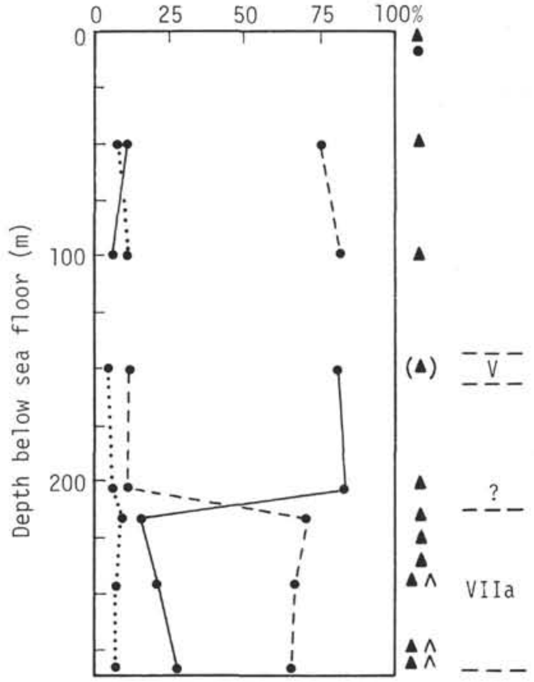

Figure 27. *Relative palynomorph abundance, palynodebris composition, and dinocyst zonation, Site 343.* —— *dinocysts;* – – *pollen and spores; excl. saccates;* ··· *saccate pollen; terrestrial plant debris: mixed cuticular and tracheidal;* ▲ *altered (dark color);* ∧ *unaltered; sorted, tracheidal mainly* ● *carbonized (opaque);* ○ *noncarbonized;* – *no recognizable debris;* ( ) *debris present but not dominating in prep. residue; symbol only: debris dominating.*

Debris, Reworked Material

Reworked material in Cores 16 to 5 is undiagnostic of age. In Cores 1 to 4, the age suggested by spores and pollen is not older than Cretaceous, and they appear mostly to be of Upper Cretaceous to early Tertiary origin.

SUMMARY AND CONCLUSIONS, SITES 338-343

Summary

"Glacial" Sediments

The thicknesses of "glacial" sediments at the various sites in the vicinity of the Vøring Plateau are as follows:

Site 343—	≅108 meters
Site 342—	47 meters
Site 338—	57 meters
Site 341—	≅323 meters
Site 339—	75 meters
Site 340—	≅ 9 meters

Of these sites, the base of the "glacial" was not observed (due to washing) at Sites 343, 342, and 338. Hence, the actual thicknesses can be somewhat higher.

Lithologically, the "glacial" consists of an almost exclusively terrigenous sequence of interbedded sandy muds and clays. There is evidence of ice-rafted material, including pebbles, while occasional biogenic oozes are found.

Paleonotologically, one obtains the impression of low population and low diversity of species. Siliceous sediments, apart from older reworked fauna, are completely absent in the "glacial." Nannoplankton exist with generally low diversity, and are seldom very abundant. The relatively high portion of reworked nannoplankton from the Cretaceous and the Eocene, especially within sediments rich in ice-rafted material, is remarkable.

Planktonic foraminifera indicate generally cold water conditions as exemplified by the left-coiling *G. pachyderma*. The benthonic fauna also generally show a low diversity of species and an arctic deep-water environment. Sporadically warmer water incursions are indicated by warmer water fauna. Shallow water benthonic foraminifera are also present, which have been deposited by ice rafting, or some other means of transportation. The section at Site 341 from 66 to 228 meters (Cores 8 through 19) is a good example of such shallow water fauna.

It might also be noted, that there are some completely barren sections with the Pliocene. An example is the section lying between 47.5 and 66.5 meters at Site 338.

Apart from the more ubiquitous reworked Eocene and Cretaceous nannofossils, the "glacial" sections at the sites on the Inner Vøring Plateau contain allochthonous material probably derived from the diapirs in this area. The section lying between 28.5 and 66.5 meters at Site 341 contains a mixture of Eocene, Oligocene, and Miocene fossils. At Sites 339 and 340, which are located on diapirs, the base of the "glacial" sediments is mixed with Eocene and Miocene material.

The varying thicknesses of the "glacial" sediments at the different sites represent different average rates of sedimentation. Assuming the base of the "glacial" to lie at 3 m.y., the average rate of sedimentation at Site 338 is about 2 cm/1000 yr. The same rate is probably also representative for Site 342. The "glacial" sediments have been partially removed from Sites 339 and 340 because of underlying diapiric activity, hence the sediment thicknesses here cannot be used to calculate average rates of sedimentation. It is noticed, however, that the rate of sedimentation is considerably higher (more than 10 cm/1000 yr) at Site 341 than at Site 338. A small part of the increase can be attributed to the presence of allochthonous Eocene through Miocene sediments here probably derived from the nearby diapiric structures. Also noted is a very large thickness (66 to 228 m) of sediments characterized by shallow water fauna. The section at Site 338 has not been examined in enough detail to determine if a corresponding section, with shallow water fauna, is also represented there. If it is not, it would seem that a large part of the extra thickness of "glacial" sediments at Site 341 is attributed to the presence, near the base of the section, of material which has been transported there from shallow water. In any event, the Vøring Plateau Escarpment is undoubtedly responsible in some way for the disparity of the thickness of glacial sediments at these two nearby sites. The reflection profiler records (Figure 3) in this area show a wedge of sediments corresponding to the "glacial" time, which thins out in the direction of the escarpment.

The "glacial" sediments are also somewhat thicker at Site 343 than at Site 338. We note that shallow water fauna are also present at Site 343, which lies at the foot of the Vøring Plateau.

Miocene

Miocene sediments were recovered from Sites 342, 338, and 341. An attenuated section may have been present at Site 343 during an interval that was washed rather than cored. The section at Site 338 appears to be complete. The upper Miocene is missing at Site 339. Coring was stopped while in the middle Miocene at Site 341, hence no further information is available about the lower Miocene at this site.

By and large, biogenic siliceous oozes form the largest part of the Miocene sediments. Sediments that are terrigenous in origin are also present in varying amounts, and occasional ash layers are also present.

Calcareous fossils are generally absent or badly dissolved. An exception to this is the top part of the Miocene (351 to 380 m at Site 341), in which calcareous foraminifera are present. A possible explanation is that most of the deposition during Miocene times was just below CCD. In Messinian (late Miocene) times, during the sea level fall of 200 meters, the sea bottom was above CCD, which accounts for the preservation of calcareous fossils during this small time interval. Siliceous fossils—Radiolaria, silicoflagellates, etc.—are commonly found in the Miocene sediments.

As for "glacial" sediments, the Miocene sedimentation seems to have been nearly identical at the adjacent Sites 338 and 342 on the Outer Vøring Plateau. However, the rate of sedimentation during the upper Miocene, appears to have been about three times higher at Site 341 than at Site 338. Undoubtedly, the presence of the escarpment is in some way responsible for this. However, since the sediments are principally pelagic, the difference in the rates cannot be attributed simply to a damming effect by the escarpment.

Oligocene

Oligocene sediments were recovered only from Site 338. They are probably present at Site 341, but lie below the level to which coring was carried out. An attenuated section may be present at Site 343 during an interval that was washed rather than cored. They are absent at Site 342, where Miocene sediments directly overlie basement, a point that will be discussed later.

At Site 338, where the entire Oligocene section (from about 150 to 270 m) is presumably present, the sediments are dominantly composed of biogenic oozes, with varying amounts of terrigenous material. The oozes are generally siliceous, containing siliceous foraminifera, diatoms, silicoflagellates, and Radiolaria. Calcareous fossils are generally absent, except in the 180 to 247 meter interval, where nannoplankton and calcareous foraminifera are present. In the lower part of this interval (228 to 247 m), siliceous fossils are completely absent. It is interesting that a sudden increase in seismic velocity occurs at about 228 meters, together with an apparent increase in competence(?). The increase in velocity persists to about 270 meters.

Eocene

Eocene sediments are found at Sites 343 and 338. At Sites 339 and 340, Eocene sediments are found as part of the diapiric material. There is some question about the age of what has been called upper Eocene(?) at Site 343. Assuming that this age is correct, there appears to be good resemblance in the sediment types comprising the Eocene at Sites 343 and 338. The younger sections are predominantly biogenic oozes, while the lower part of the section (lower Eocene) consists mainly of terrigenous sands and clays, with minor biogenic components.

The upper Eocene contains siliceous foraminifera, Radiolaria, and silicoflagellates. Calcareous fossils are absent. The middle Eocene at Site 338 is barren, while the lower Eocene contains calcareous fossils, some nannoplankton, and more abundant benthonic foraminifera that resemble the Ypresian fauna of northwest Germany. Pollen, spores, and dinoflagellates are also found in the lower Eocene section. At the top of the lower Eocene, in the interval of Cores 30 to 33 there is a very rapid change in the relative abundances of dinocysts versus pollen and spores. The latter predominate in cores below 33.

Diatomaceous oozes form the major part of the upper and middle Eocene sediments comprising the diapirs at Sites 339 and 340. The sediments are jumbled up, being mixed at the top with "glacial" sediments, and at Site 340, there is a reversal within the Eocene sediments. Middle Miocene sediments are sandwiched between two layers of upper Eocene sediments.

Contact with Basalt, Nature and Age of Basement

At Site 343, conglomerate pebbles composed of mudstone and claystone and chloritized basalt overlie the basalt. The top layer of basalt (253 to 269 m) is probably a sill. Sediments lie between 269 and 282 meters, and consist of mud and rock fragments which are chloritized and calcitized. Basalt underlies this sediment sandwich. The basalt at this site is highly altered, with extensive chloritization and carbonatization.

At Site 342, there is a 4.5-meter coring gap between the last recovered sediments and the top of the basalt. The lowest sediment conisists of a Miocene (or perhaps latest Oligocene) biogenic siliceous ooze, and it is clear from other information (reflection profiling) that there is a hiatus between the sediments and the underlying basalt. The basalt at this site is generally fresh in appearance. It is fine and medium grained, porphyritic, and it appears to be alkalic in composition. Traces of metallic copper are found in the basalt. At Site 338, fine-grained sandy limestone overlies about 76 cm of basalt breccia with chlorite/calcite cement. The fauna in the sandy limestone (also in the breccia?) is early Eocene.

The basalt is holocrystalline without a glassy matrix and is considerably altered. Chloritization, calcitization, and albitization are observed throughout.

The petrology and geochemistry of the basalts from Sites 338, 342, and 343 are discussed in several papers in this report (Kharin; Raschka and Eckhardt; Ridley et al.; Schilling; as well as others). Age determination results by the potassium argon method are summarized by Kharin et al. (this volume).

The radiometric ages determined for Sites 338, 342, and 343 are, respectively, 46.6 ±2.5 m.y., 44 m.y., and 28.5 ±2 m.y. At Site 338, the oldest sediments found which are deposited over the basalt are earliest Eocene in age; an estimate of 53 m.y. can be made. At Site 342 the oldest sediments recovered were of early Miocene age (or perhaps late Oligocene) and are considerably younger in age than the underlying basement. The sediments of Oligocene age at Site 338 are clearly absent in reflection seismic profiler record at Site 342 (Figures 1, 7), hence the difference in age between basement and overlying sediments is as expected. At Site 343 the oldest sediments are of early Eocene age, and the much younger radiometric age can probably be attributed to considerable alteration of the basalt. One can conclude that at Sites 338, 342, and 343 the basement is early Eocene in age although the radiometric ages are 6 or 7 m.y. younger for basement at Sites 338 and 342 and almost 25 m.y. younger for Site 343. The ages obtained paleontologically are roughly in agreement with the ages obtained from magnetic anomalies. Site 343 is located on anomaly 23 and Sites 338 and 342 are on ocean floor presumably somewhat older than anomaly 24, but younger than 25 (see Figure in site survey chapter). On the Heirtzler et al. (1968) time scale the age for anomaly 23 is 58 m.y., for anomaly 24 it is 60 m.y., and for anomaly 25 it is 60 m.y. But the Heirtzler time scale gives ages that are too old by perhaps 5 to 7 m.y. in the early Tertiary (Sclater et al., 1974; Larson and Pitman, personal communication), which would bring the magnetic ages in rough coincidence with paleontological ages.

Hydrocarbons

Gas was encountered in the cores at Site 338 and 341. However, the gas in the cores at Site 338 contained no hydrocarbons; free nitrogen was the dominant component, with carbon dioxide occurring in lesser amounts. The situation was different in the cores at Site 341. Gas pockets formed in virtually every core recovered below a depth of 50 meters. All but one sample contained methane, and nearly all gas samples from the Miocene contained traces of ethane. Methane content increased rapidly below 183 meters in the Pleistocene, and decreases below 343 meters in the Miocene. Miocene cores below 400 meters have a strong petroliferous odor, and appear to contain interstitial soluble hydrocarbons whose quantity seems to increase with increasing depth. For a further discussion see Morris (Chapter 24, this volume). Coring at Site 341 was suspended at 456 meters, and the hole was plugged.

Shore-based organic geochemical studies have not indicated the presence of anomalously high concentration of lipids. Erdman and Schorno (this volume) believe that, while the core samples are rich in organic matter, petroleum genesis appears to be at only a very early stage. Other organic geochemists (Hood et al., this volume; Hunt, this volume) believe that none of the samples analyzed are potential sources for significant oil accumulations.

One sample of Eocene age at Site 339, which has obviously been brought up by diapiric activity, was found by Erdman and Schorno (this volume) to have a high proportion of lipids—"comparable to those for source rocks for many petroleum accumulations." This result would suggest that if there is petroleum potential on the Vøring Plateau, it is underneath the Inner Vøring Plateau at depths not reached by the drilling on Leg 38.

Discussion

Origin of Vøring Plateau

The Vøring Plateau, a relatively flat (at about 1200 m) submarine plateau, is a prominent feature of the continental slope off Norway, and its origin has been a subject of considerable speculation. The Vøring Plateau Escarpment (Talwani and Eldholm, 1972), which is a buried escarpment trending roughly northeast, divides the Vøring Plateau into an inner and an outer part. The inner part of the Vøring Plateau contains a large thickness of sediments, perhaps up to 8 km, which may extend into the Mesozoic, or even perhaps into the Paleozoic. Talwani and Eldholm (1972) believe the inner part of Vøring Plateau to be a subsided continental area. From seismic refraction measurements, Hinz (1972) believes that the underlying crust is intermediate in character, since neither typically continental nor typically oceanic crustal velocities are obtained.

The outer part of the Vøring Plateau contains only a thin layer (0.5 to 2 km) of low velocity sediments. Talwani and Eldholm (1972) interpret these sediments as Tertiary, and the underlying prominent reflector as oceanic basement. In their view, therefore, the Vøring Plateau Escarpment defines the ocean-continent boundary. Three important observations tend to substantiate this view. One, that linear magnetic anomalies are present on the Vøring Plateau, which apparently continue into well-identified anomalies in the Lofoten Basin. Secondly, this reflector continues westward into the oceanic basement of the Norway Basin and Lofoten Basin. Thirdly, refraction measurements give a velocity of about 5 km/sec for the prominent reflector, which is typical for basement. Earlier single-channel seismic reflection results showed no reflectors below this prominent reflector which was reached by drilling at Sites 338 and 342, but recent multichannel reflection results (Hinz, personal communication; Montadert, personal communication) show underlying layered reflectors resting on "true basement." The area where the subbasaltic reflectors exist is generally confined to a limited area between anomaly 24 and the escarpment. Our interpretation is that these subbasaltic reflectors probably represent pyroclastic sediments deposited rapidly and that true basement is not significantly older than the overlying basalt.

If the above interpretation is correct, the drilling results substantiate the view advanced by Talwani and Eldholm (1972) that the Vøring Plateau Escarpment represents the ocean-continent boundary, and the Outer Vøring Plateau is oceanic in origin. The age of the opening of the Norwegian Sea is earliest Eocene.

Nature of Sediments on the Vøring Plateau

It appears that the Vøring Plateau Escarpment has had a major effect on the sediment distribution on the Vøring Plateau. Not only has it acted as a dam for terrigenous sediments brought in from land by turbidity currents, etc., but the fact that pelagic biogenic oozes, as in the upper Miocene, are much thicker on the Inner Vøring Plateau suggests that current activity on top of the ridge underlying the Outer Vøring Plateau reduced the amount of pelagic sedimentary deposits on it. Upper Miocene sediments are about 3-4 times thicker at Site 341 than they are at Site 338. If the value of 2 km for the total thickness of the Tertiary sediments obtained by Talwani and Eldholm (1972) near Site 341 is accepted, the total Tertiary column is about 5 times thicker at Site 341 than at Site 338. This suggests that the importance of the Vøring Plateau Escarpment as far as sediment distribution is concerned has been maintained throughout the Tertiary.

Some other points of interest can be noted about the sediments. The basal Eocene found at Sites 343 and 338 is notably terrigenous in composition. Turbidites, sands, and sandy muds prevail. This situation is in some contrast to the remainder of the Tertiary sequence found at any of the Vøring Plateau sites. Although terrigenous sediments are found throughout the Tertiary, they are seldom as dominant as in the basal Eocene. There are at least two possible explanations for this. One is that in the early Eocene when the initial opening of the Norwegian Sea had just started, there was a large amount of tectonic activity. Emergence and erosion could supply terrigenous sediment. An objection to this idea is that there is no apparent cause for the sudden stoppage of terrigenous sedimentation. A more plausible suggestion is that these lower Eocene sediments came from the erosion of the crestal part of the Vøring Plateau basement ridge (see location of Site 342, Figure 1) itself when it was above sea level. When it subsided sufficiently below sea level, this erosion stopped. This hypothesis nicely explains the ponding of Eocene sediments between the locations of Sites 342 and 338. However, the presence of quartz grains in these sediments is not easily explained if they are obtained by weathering of basalt. Itualso suggests that the Vøring Plateau has subsided about 1450 meters since Eocene time.

We notice that hiatuses in sedimentation exist at Sites 342 and 343. We can explain the absence of Eocene and Oligocene sediments at Site 342 by invoking initial emergence, and then possible nondeposition and erosion even when submerged under shallow water due to current activity. At Site 343 it is more difficult to suggest reasons for the absence of sediments. Perhaps bottom currents in this location at the foot of the Vøring Plateau were responsible in part for the absence of sediments.

Diapirism

On a diapir cored by a piston core from *Vema* in 1970 (Talwani and Eldholm, 1972), Eocene fauna was identified (Bjørklund and Kellogg, 1972). The question remained whether the Eocene sediments merely represented material on the top of the diapir, or themselves constitute the diapiric material. We were able to, for safety reasons, core only about 100 meters into the diapirs at two locations. Only middle and upper Eocene fauna was encountered. At Site 340, stratigraphic order of the sediments was disturbed (including a reversal). Biogenic oozes constructed the Eocene material, and it seems reasonable to suppose that the Eocene sediments constitute the diapiric material.

Displaced Miocene, Oligocene, and Eocene fauna found within a section of the Pleistocene at Site 341 suggest that the older sediments have been obtained from the high-standing diapirs by erosion and slumping. One can extrapolate this observation, suggesting that this section of the Pleistocene was a principal time of diapirism. Some diapirs are now covered by flat-lying undisturbed Pleistocene sediments, suggesting that they are at present not rising. Others outcrop, or are covered only by a very thin veneer of sediments. This suggests either continued activity at present, or the possibility that no sedimentation has occurred on the steep diapirs, either due to increased current activity or because of erosion through slumping or otherwise.

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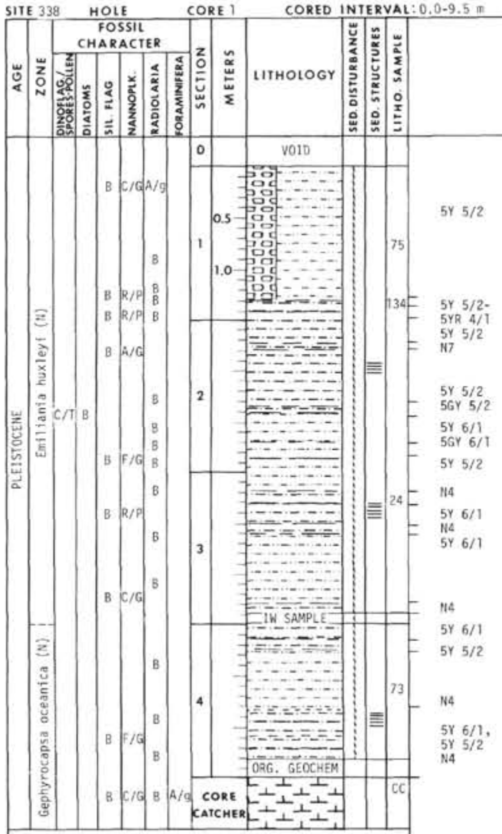
SITE 338 HOLE CORE 1 CORED INTERVAL: 0.0-9.5 m



LITHOLOGIC DESCRIPTION

Colors in grays: light olive (5Y 5/2), brownish (5YR 4/1), light gray (N7), greenish (5GY 6/1), medium dark (N4), light olive (5Y 6/1). Generallv soft, deformed sandy mud, and mud, interstratified, with scattered sand grains, fine pebbles. Clayey when pebbles absent. Stratification improves to Sec. 4 (5-10 cm). Some interbedded oozes.

MAJOR LITHOLOGIES

a) SANDY MUD (Smears 1-134, 3-24)

20-30% Sand	40-45% Quartz
17-35% Silt	5% Feldspar
35-63% Clay	TR- 2% Mica
	0- 1% Heavy minerals
	3% Opaques
	0- 5% Volcanic glass
	35-63% Clay minerals
	TR- 1% Glauconite
	3- 7% Authigenic carbonate

b) MUD (Smear 4-73)

10% Sand	25% Quartz
30% Silt	5% Feldspar
60% Clay	1% Mica
	2% Heavy minerals
	1% Opaques
	1% Volcanic glass
	62% Clay minerals
	TR% Glauconite
	3% Authigenic carbonate

c) CALCAREOUS MUD (Smear 1-75)

12% Sand	15% Quartz
32% Silt	5% Feldspar
55% Clay	1% Heavy minerals
	1% Opaques
	TR% Volcanic glass
	55% Clay minerals
	TR% Glauconite
	15% Authigenic carbonate
	1% Foraminifera
	7% Nannofossils

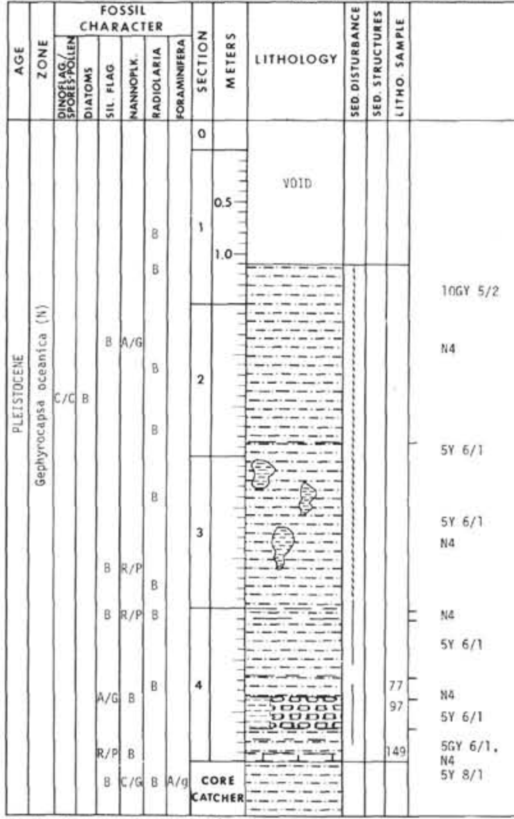
MINOR LITHOLOGY

NANNOFOSSIL OOZE (Smear CC)
5% Quartz
TR% Mica
2% Opaques
25% Clay minerals
7% Authigenic carbonate
1% Foraminifera
60% Nannofossils

Carbon-Carbonate (DSDP)
1-132 (0.9, 0.5, 3)
3-78 (1.8, 0.2, 13)

Grain Size (DSDP)
4-60 (5.4, 24.2, 70.4)

SITE 338 HOLE CORE 2 CORED INTERVAL: 9.5-19.0 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: grayish-green (10GY 5/2), medium dark gray (N4), light olive gray (5Y 6/1), greenish-gray (5GY 6/1), yellowish gray (5Y 8/1). Intensely deformed, causing streaking. Random distribution of sand grains, clay clasts, pebbles (gneiss, 3.5 cm) in Sec. 3.

MAJOR LITHOLOGIES

a) SANDY MUD (Smear 4-77)

40% Sand	60% Quartz
37% Silt	7% Feldspar
23% Clay	TR% Mica
	3% Heavy minerals
	2% Opaques
	23% Clay minerals
	TR% Glauconite
	5% Authigenic carbonate
	TR% Nannofossils

b) MUDDY CALCAREOUS OOZE (Smear 4-97)

10% Silt	5% Quartz
90% Clay	TR% Heavy minerals
	35% Clay minerals
	30% Authigenic carbonate
	30% Nannofossils

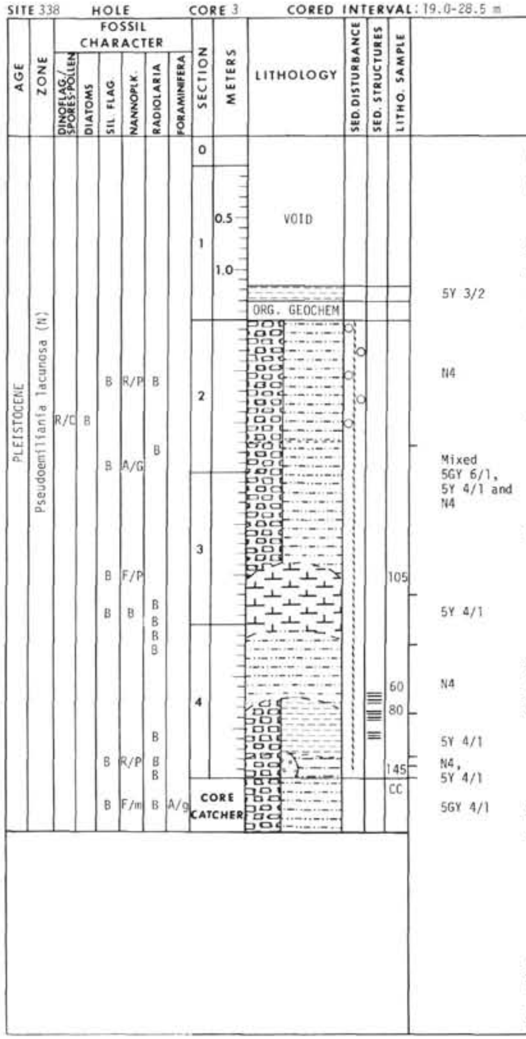
MINOR LITHOLOGY

NANNOFOSSIL OOZE (Smear 4-149)
5% Quartz
TR% Heavy minerals
TR% Opaques
2% Authigenic carbonate
7% Foraminifera
86% Nannofossils

Carbon-Carbonate (DSDP)
3-119 (1.9, 0.3, 13)

Grain Size (DSDP)
4-55 (8.2, 27.3, 64.6)
4-65 (34.0, 31.2, 34.8)

SITE 338 HOLE CORE 3 CORED INTERVAL: 19.0-28.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2), dark gray (N4), greenish-gray (5GY 6/1), olive gray (5Y 4/1). Pebble zones throughout. Intense deformation, bedding improves in Sec. 4, especially at base.

MAJOR LITHOLOGIES

a) CALCAREOUS MUD (Smear CC)
7% Sand 10% Quartz
18% Silt 5% Feldspar
75% Clay TR% Mica
TR% Opaques
55% Clay minerals
20% Authigenic carbonate
TR% Foraminifera
10% Nannofossils

b) CALCAREOUS CLAY (Smear 4-80)
2% Quartz
1% Mica
TR% Heavy minerals
57% Clay minerals
30% Authigenic carbonate
10% Nannofossils

c) CALCAREOUS ASH (Smear 4-145)
7% Quartz
TR% Mica
TR% Heavy minerals
40% Opaques - Ash?
18% Clay minerals
15% Authigenic carbonate
20% Nannofossils

d) MUD (Smear 4-60)
10% Sand 20% Quartz
20% Silt 3% Feldspar
69% Clay TR% Mica
1% Heavy minerals
1% Opaques
1% Volcanic glass
69% Clay minerals
5% Authigenic carbonate

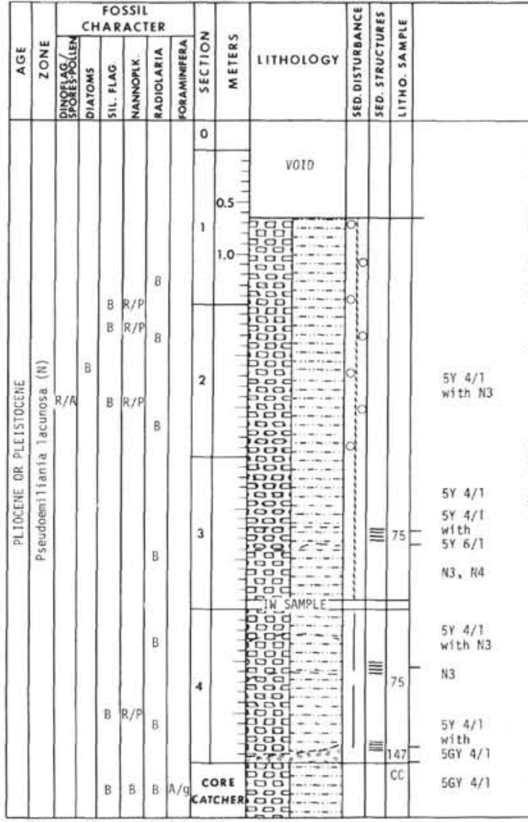
MINOR LITHOLOGY

NANNOFOSSIL OOZE (Smear 3-105)
5% Quartz
10% Authigenic carbonate
81% Nannofossils
3% Sponge spicules
1% Foraminifera
TR% Opaques, Volcanic glass

Carbon-Carbonate (DSDP)
2-105 (1.1, 0.8, 2)

Grain Size (DSDP)
2-100 (14.7, 33.5, 51.8)

SITE 338 HOLE CORE 4 CORED INTERVAL: 28.5-38.0 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Drilling breccia to intense deformation (Secs. 1-3). Moderate in Sec. 4. Colors: olive gray (5Y 4/1), dark gray (N3), light olive gray (5Y 6/1), medium dark gray (N4), dark green gray. Generally very mixed with 1 cm dark gray (N3) bands in Sec. 4. Pebbles (1-2 mm) noted in Sec. 3.

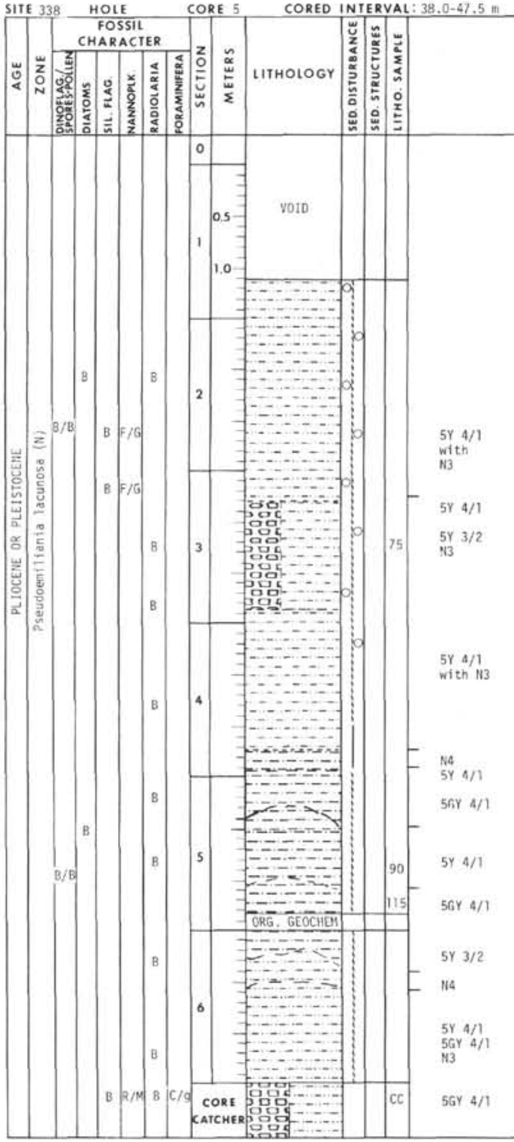
MAJOR LITHOLOGY

MUDDY CALCAREOUS OOZE (Smears 3-75, 4-75, 4-147, CC)
5% Sand 5- 7% Quartz
10% Silt TR% Heavy minerals
85-90% Clay TR- 1% Opaques
0-15% Volcanic glass
32-35% Clay minerals
0-TR% Glauconite
25-50% Authigenic carbonate
20% Nannofossils

Carbon-Carbonate (DSDP)
4-129 (1.9, 0.2, 14)

Grain Size (DSDP)
4-147 (2.1, 34.2, 63.7)

SITE 338 HOLE CORE 5 CORED INTERVAL: 38.0-47.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), dark gray (N3), olive gray (5Y 3/2), medium dark gray (N4), dark green gray (5GY 4/1). Intense deformation-drilling breccia, with complete in core mixing. Some streaking by (N4). Pebbles scattered in Secs. 3, 4, and 5 (inc. 10 mm gneissic pebble).

MAJOR LITHOLOGIES

a) CALCAREOUS MUD (Smears 3-75, CC)

3- 5% Sand	3- 6% Quartz
15-30% Silt	TR- 2% Feldspar
67-80% Clay	TR% Heavy minerals
	0- 1% Opaques
	55-75% Clay minerals
	0- 1% Glauconite
	0- 1% Zeolite
	15-20% Authigenic carbonate
	0- 1% Foraminifera
	5-15% Nannofossils

b) SANDY MUD (Smears 5-90, 5-115)

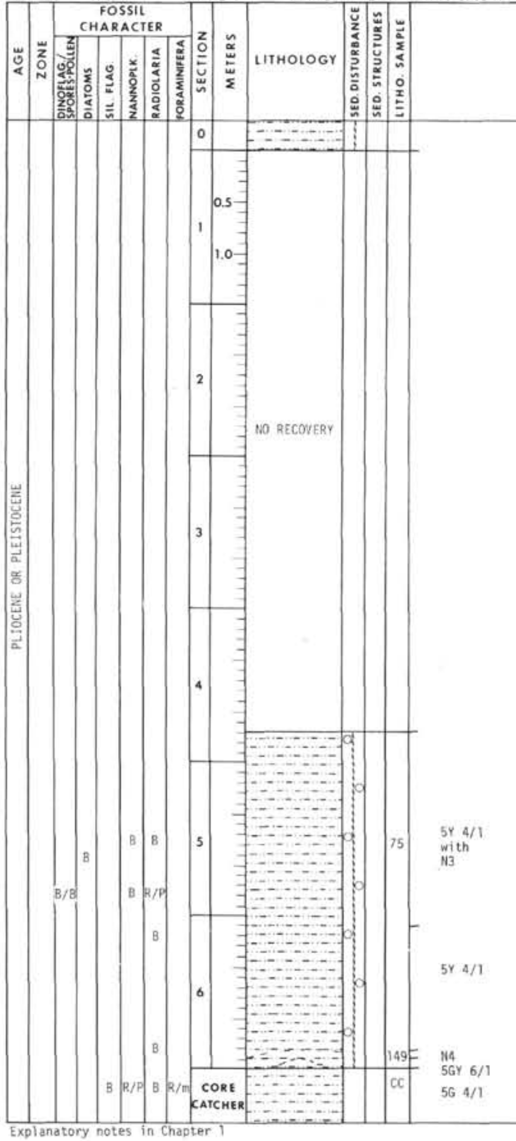
10-15% Sand	15-20% Quartz
15-20% Silt	2- 5% Feldspar
70-75% Clay	TR- 1% Mica
	2- 3% Heavy minerals
	50-70% Clay minerals
	3-10% Opaques
	0- 2% Glauconite

Carbon-Carbonate (DSDP)
5-86 (0.3, 0.2, 1)

Carbon-Carbonate (PP)
5-5 (top) (0.45, 0.12)
5-5 (bottom) (0.25, 0.09)

Grain Size (DSDP)
1-130 (5.3, 11.0, 83.7)
5-28 (21.2, 35.7, 43.1)

SITE 338 HOLE CORE 6 CORED INTERVAL: 47.5-57.0 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), dark gray (N3), medium dark gray (N4), minor greenish-gray (5GY 6/1). Intense deformation - breccia. Yields color mottling.

MAJOR LITHOLOGY

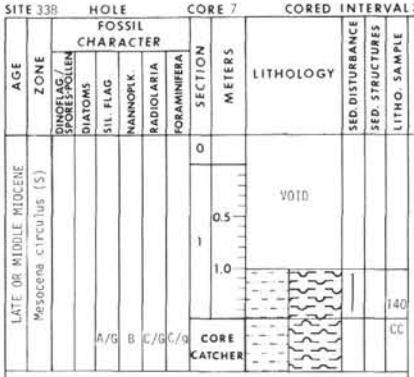
MUD (Smears 5-75, 6-149, CC)

12% Sand	20% Quartz
18% Silt	3% Feldspar
70% Clay	1% Mica
	2% Heavy minerals
	2% Opaques
	1% Volcanic glass
	70% Clay minerals
	TR% Authigenic carbonate

Carbon-Carbonate (DSDP)
5-50 (0.3, 0.2, 1)

Grain Size (DSDP)
6-120 (11.7, 28.9, 59.5)

SITE 338 HOLE CORE 7 CORED INTERVAL:66.5-76.0 m



LITHOLOGIC DESCRIPTION

5Y 2/1 -
5Y 4/1

5Y 2/1

Olive black (5Y 2/1), olive gray (5Y 4/1). Moderate deformation.

MAJOR LITHOLOGY

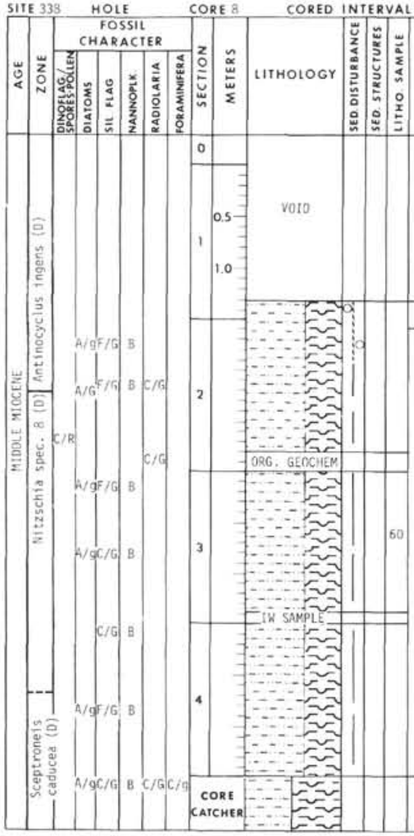
MUDDY DIATOM OOZE (Smears 1-140, CC)
1- 5% Sand
5-25% Silt
74-90% Clay

X-Ray (BP)
1-122
18 Mont.
45 Ill.
21 Kaol.
17 Chlo.

5% Quartz
1% Mica
1% Opaques
1% Volcanic glass
30% Clay minerals
TR% Glauconite
40% Diatoms
10% Radiolarians
10% Sponge spicules
1% Silicoflagellates

Carbon-Carbonate (DSDP)
1-105 (1.4, 1.3, 1)

SITE 338 HOLE CORE 8 CORED INTERVAL:76.0-85.5 m



LITHOLOGIC DESCRIPTION

5Y 4/1 -
5Y 2/1

5Y 2/1
with
5GY 4/1

5Y 2/1

5Y 2/1

Colors: olive black (5Y 2/1), olive gray (5Y 4/1). Intense to moderate deformation.

MAJOR LITHOLOGY

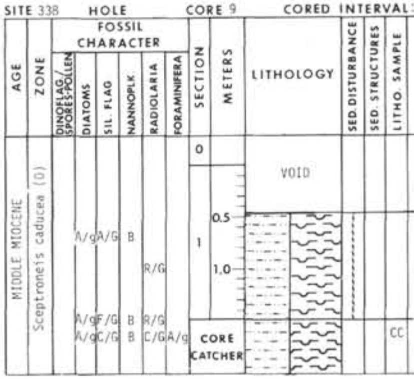
MUDDY DIATOM OOZE (Smears 3-60, CC)
5% Sand
20% Silt
75% Clay

3% Quartz
3% Opaques
2% Volcanic glass
25% Clay minerals
TR% Glauconite
40% Diatoms
15% Radiolarians
10% Sponge spicules

Carbon-Carbonate (PP)
8-3 (top) (1.36, 0.04)
8-3 (bottom) (2.11, 0.04)

X-Ray (BP)
4-80
16 Mont.
38 Ill.
22 Kaol.
24 Chlo.

SITE 338 HOLE CORE 9 CORED INTERVAL:85.5-95.0 m



LITHOLOGIC DESCRIPTION

5Y 2/1

5Y 2/1

Olive black (5Y 2/1), intense deformation, massive.

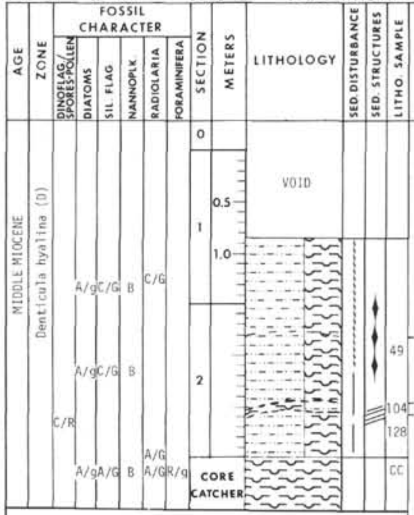
MAJOR LITHOLOGY

MUDDY DIATOM OOZE (Smear CC)
5% Silt
95 Clay

X-Ray (BP)
1-80
20 Mont.
47 Ill.
20 Kaol.
13 Chlo.

5% Quartz
1% Opaques
1% Volcanic glass
27% Clay minerals
TR% Glauconite
50% Diatoms
10% Radiolarians
5% Sponge spicules
1% Silicoflagellates

SITE 338 HOLE CORE 10 CORED INTERVAL: 95.0-104.5 m



LITHOLOGIC DESCRIPTION

5Y 2/1

5YR 2/1

5GY 5/2

10Y 4/2

Olive gray (5Y 2/1), brownish gray (5YR 4/1), dusky yellow green (5GY 5/2). Intense-moderate deformation, mottled colors (subhorizontal), some bioturbation.

MAJOR LITHOLOGIES

a) MUDDY DIATOM OOZE (Smears 2-49, 2-128)
3- 5% Quartz
0- 3% Mica
0- 1% Opaques
10-15% Volcanic glass
29-37% Clay minerals
TR- 1% Glauconite
30% Diatoms
10% Radiolarians
7-15% Sponge spicules
1- 2% Silicoflagellates

b) DIATOM OOZE (Smear CC)
5% Quartz
TR% Mica
2% Opaques
7-10% Volcanic glass
10% Clay minerals
2% Glauconite
50-60% Diatoms
5-10% Radiolarians
15-20% Sponge spicules
2- 5% Silicoflagellates

MINOR LITHOLOGY

DIATOMACEOUS ASHY MUD (Smear 2-104)
35% Sand
29% Silt
36% Clay

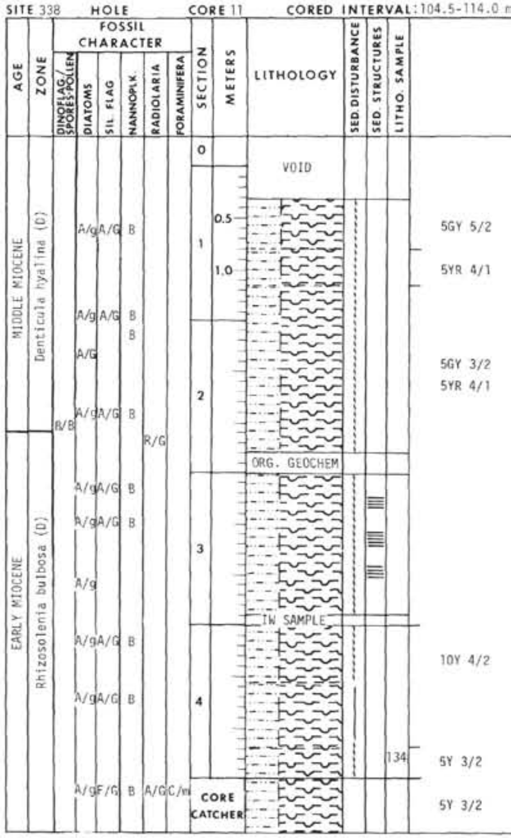
X-Ray (BP)
2-128
27% Mont.
44% Ill.
17% Kaol.
12% Chlo.

3% Quartz
20% Opaques
10% Volcanic glass
36% Clay minerals
1% Glauconite
15% Diatoms
3% Radiolarians
10% Sponge spicules
2% Silicoflagellates

Grain Size (DSDP)
2-122 (9.4, 28.9, 61.8)

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 11 CORED INTERVAL: 104.5-114.0 m



LITHOLOGIC DESCRIPTION

Colors: dusky yellow green (5GY 5/2), brownish gray (5YR 4/1), grayish olive (10Y 4/2), olive gray (5Y 3/2). Generally intensely deformed. Some bedding in Sec. 3.

MAJOR LITHOLOGY

MUDDY DIATOM OOZE (Smear 4-134)

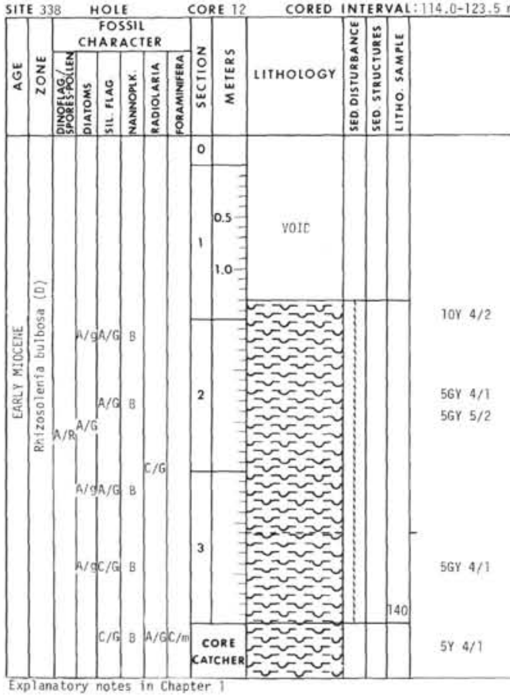
5%	Quartz
2%	Feldspar
TR%	Mica
5%	Opaques
3%	Volcanic glass
10%	Clay minerals
7%	Glauconite
51%	Diatoms
5%	Radiolarians
10%	Sponge spicules
2%	Silicoflagellates

Carbon-Carbonate (PP)
11-2 (top) (0.90, 0.03)
11-2 (bottom) (0.80, 0.04)

X-Ray (BP)
4-133

22%	Mont.
48%	Ill.
15%	Kaol.
15%	Chlo.

SITE 338 HOLE CORE 12 CORED INTERVAL: 114.0-123.5 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive (10Y 4/2), dark green gray (5GY 4/1), dusky yellow green (5GY 5/2). Intense deformation.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 3-140)

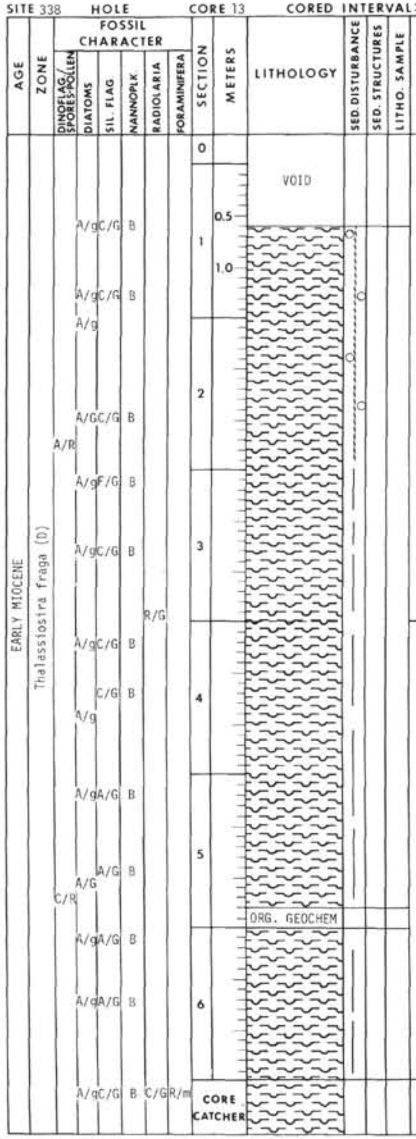
2%	Quartz
TR%	Mica
3%	Opaques
3%	Volcanic glass
10%	Clay minerals
TR%	Glauconite
TR%	Authigenic carbonate
68%	Diatoms
3%	Radiolarians
10%	Sponge spicules
1%	Silicoflagellates

X-Ray (BP)
3-70

19%	Mont.
51%	Ill.
17%	Kaol.
13%	Chlo.

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 13 CORED INTERVAL:123.5-133.0 m



LITHOLOGIC DESCRIPTION

Colors: light olive gray (5Y 5/2), dark greenish-gray (5GY 4/1). Generally intense deformation with moderate in Secs. 3-6.

MAJOR LITHOLOGY

DIATOM OOZE

Carbon-Carbonate (DSDP)
5-50 (1.1, 0.9, 2)

Carbon-Carbonate (PP)
13-5 (top) (1.37, 0.04)
13-5 (bottom) (1.07, 0.02)

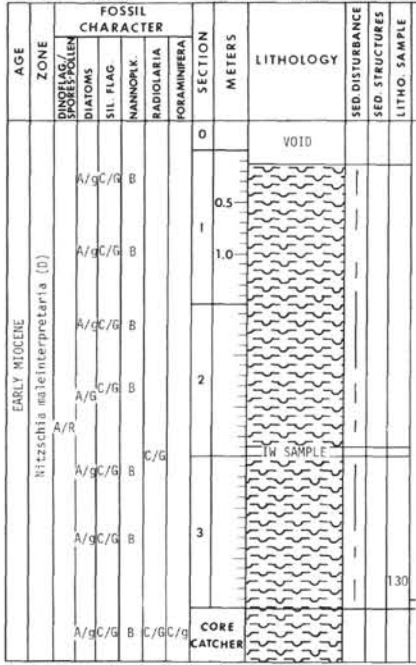
X-Ray (BP)
4-70
15% Mont.
59% Ill.
12% Kaol.
14% Chlo.

5GY 4/1

5Y 5/2

5Y 4/1

SITE 338 HOLE CORE 14 CORED INTERVAL:133.0-142.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), slight grayish-olive green (5GY 3/2). Slight moderate deformation.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 3-130)

1%	Quartz
2%	Opaques
76%	Diatoms
10%	Radiolarians
10%	Sponge spicules
1%	Silicoflagellates

Grain Size (DSDP)
3-58 (0.2, 26.7, 73.1)

5Y 4/1

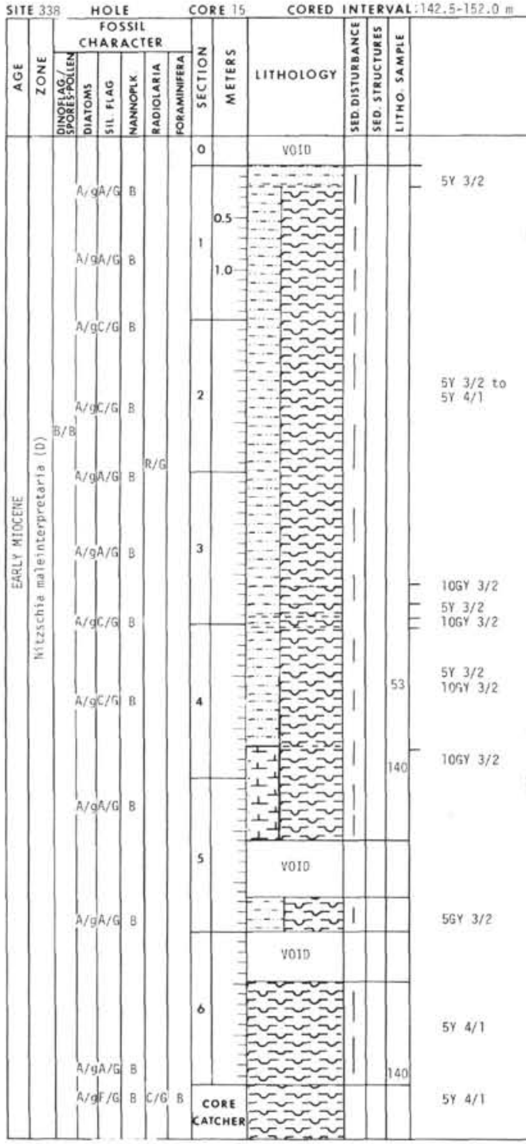
X-Ray (BP)
3-89
32% Mont.
44% Ill.
13% Kaol.
12% Chlo.

5GY 3/2

5Y 4/1

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 15 CORED INTERVAL:142.5-152.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2), (5Y 4/1), dusky yellow green (10GY 3/2), grayish olive green (5GY 3/2). Some interbedding Secs. 3 and 4. Slight-moderate deformation.

MAJOR LITHOLOGIES

a) DIATOM OOZE (Smear 6-140)

1%	Quartz
1%	Mica
5%	Volcanic glass
19%	Clay minerals
3%	Authigenic carbonate
2%	Nannofossils
50%	Diatoms
7%	Radiolarians
10%	SPonge spicules
2%	Silicoflagellates

b) MUDDY DIATOM OOZE (Smear 4-53)

2%	Quartz
1%	Mica
1%	Opaques
5%	Volcanic glass
41%	Clay minerals
35%	Diatoms
7%	Radiolarians
7%	Sponge spicules
1%	Silicoflagellates

c) CALCAREOUS DIATOM OOZE (Smear 4-140)

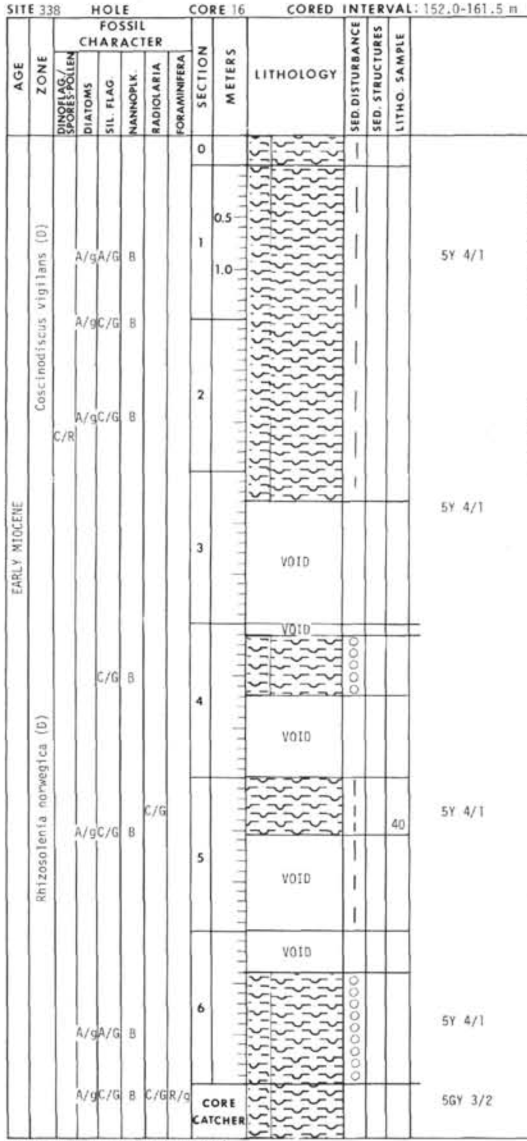
TR%	Heavy minerals
TR%	Volcanic glass
15%	Nannofossils
66%	Diatoms
10%	Radiolarians
7%	Sponge spicules
1%	Silicoflagellates

Carbon-Carbonate (DSDP)
3-75 (1.4, 1.2, 2)

X-Ray (BP)
6-79

28%	Mont.
36%	Ill.
36%	Kaol., Chlo.

SITE 338 HOLE CORE 16 CORED INTERVAL: 152.0-161.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), dusky olive green (5GY 3/2). Moderate-slight deformation to breccia in Secs. 4 and 6. Color mottling throughout.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 5-40)

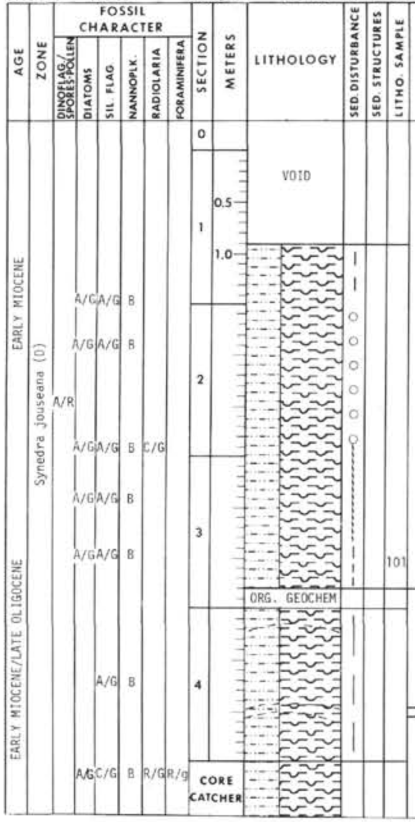
10%	Sand	18%	Clay minerals
15%	Silt	2%	Authigenic carbonate
75%	Clay	60%	Diatoms
		7%	Radiolarians
		10%	Sponge spicules
		TR%	Quartz, Mica, Opaques, Volcanic glass, Glauconite

X-Ray (BP)
6-79

40%	Mont.
25%	Ill.
19%	Kaol.
16%	Chlo.

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 17 CORED INTERVAL: 161.5-171.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), medium dark gray (N5), dark green gray (5GY 4/1); medium dark gray layers in Sec. 4. Breccia to slight/moderate deformation.

MAJOR LITHOLOGY

MUDDY DIATOM OOZE (Smear 3-101)
TR% Quartz
TR% Mica
30% Opaques
1% Volcanic glass
15% Clay minerals
TR% Glauconite
38% Diatoms
5% Radiolarians
10% Sponge spicules
1% Silicoflagellates

Carbon-Carbonate (DSDP)
4-39 (1.4, 1.1, 2

Carbon-Carbonate (PP)
17-5 (top) (1.50, 0.03)
17-5 (bottom) (1.51, 0.02)

X-Ray (BP)
4-79
40% Mont.
20% Ill.
21% Kaol.
19% Chlo.

5Y 4/1

N5

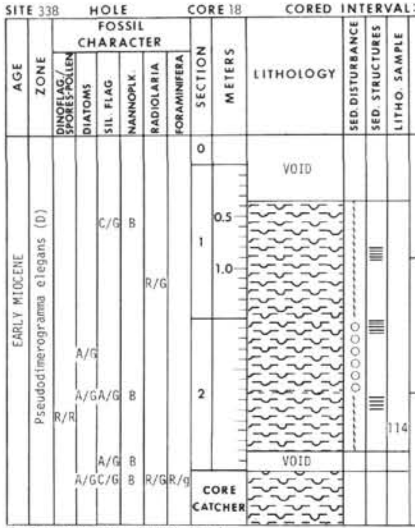
5Y 4/1

N5

5Y 4/1
5GY 4/1

5Y 5/2

SITE 338 HOLE CORE 18 CORED INTERVAL: 171.5-180.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1) (5Y 3/2). Intense deformation to drilling breccia. Possibly very thin stratification, generally massive.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 2-114)
0- 5% Quartz
0- 5% Feldspar
15% Clay minerals
5% Authigenic carbonate
60% Diatoms
5% Radiolarians
0- 5% Sponge spicules
3% Silicoflagellates

Carbon-Carbonate (DSDP)
1-79 (0.8, 0.7, 1)

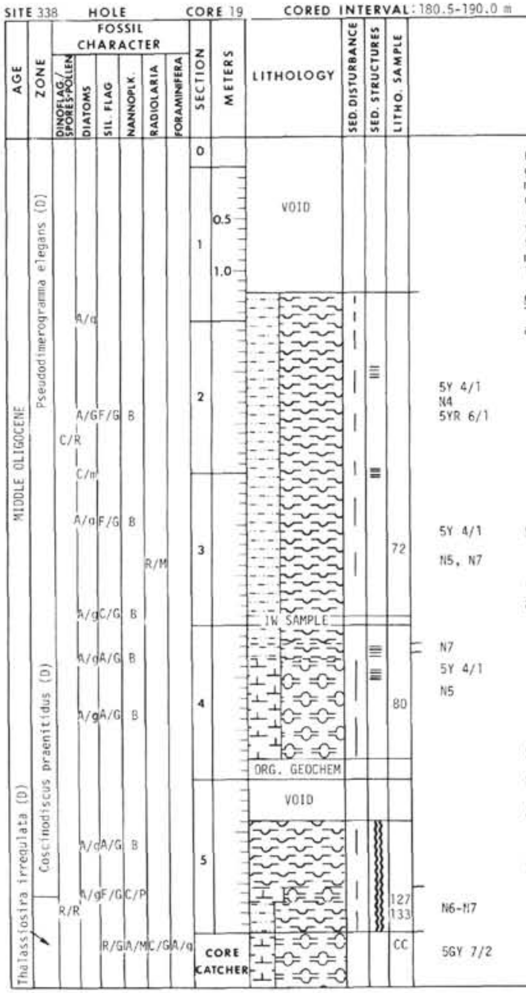
X-Ray (BP)
2-129
34% Mont.
24% Ill.
25% Kaol.
16% Chlo.

5Y 4/1

5Y 3/2

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 19 CORED INTERVAL: 180.5-190.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), medium dark gray (N4), light brownish-gray (5YR 6/1), medium gray (N5), light gray (N7), light olive gray (5Y 6/1), grayish yellow green (5GY 7/2). Laminated to very thinly stratified, multicolored layers, soft. Local hard/firm intervals (1-5 cm) in Sec. 4, more massive in Sec. 5. Chondrite burrows (135-141 cm) in Sec. 5.

MAJOR LITHOLOGIES

a) MUDDY DIATOM OOZE/DIATOMACEOUS MUD (Smears 3-72, 5-133)

0- 2% Sand	TR- 3% Quartz
10% Silt	0- 2% Feldspar
90% Clay	TR- 1% Mica
	2% Opaques
	7-10% Volcanic glass
	26-36% Clay minerals
	TR- 7% Glauconite
	30-40% Diatoms
	5-10% Radiolarians
	5-10% Sponge spicules
	1- 2% Silicoflagellates

b) CALCAREOUS DIATOM OOZE SILICEOUS OOZE (Smears 4-80, 5-127, CC)

0- 5% Sand	TR% Quartz
10-15% Silt	TR% Mica
80-90% Clay	0- 2% Opaques
	2- 5% Volcanic glass
	7-32% Clay minerals
	0- 5% Authigenic carbonate
	15% Nannofossils
	25-50% Diatoms
	5-10% Radiolarians
	10-15% Sponge spicules
	1- 2% Silicoflagellates

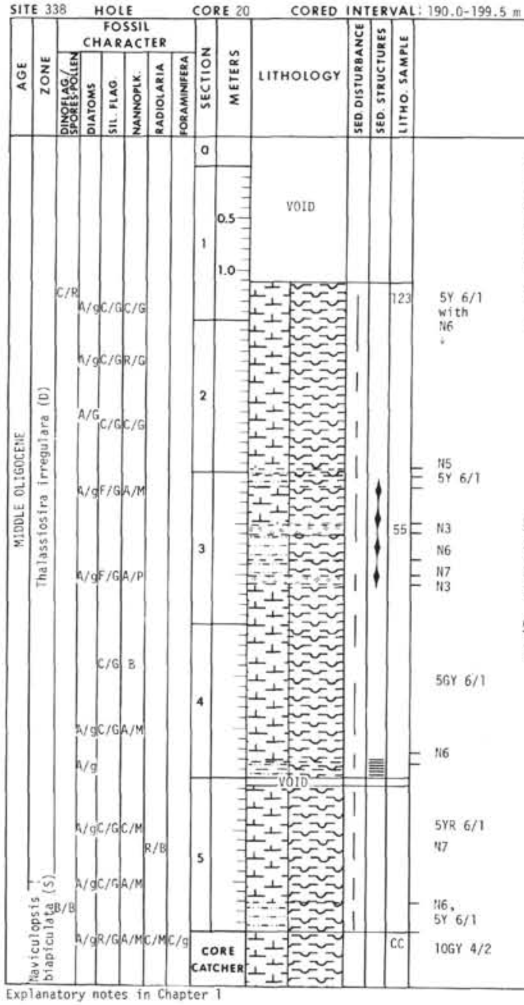
Carbon-Carbonate (DSDP)
1-137 (1.0, 0.8, 2)
5-73 (0.6, 0.6, 0)

Carbon-Carbonate (PP)
19-4 (top) (0.40, 0.06)
19-4 (bottom) (0.07, 0.63)

Grain Size (DSDP)
5-75 (2.5, 20.3, 77.1)

X-Ray (BP)
5-119
49 Mont.
42 Ill.
9 Kaol., Chlo.

SITE 338 HOLE CORE 20 CORED INTERVAL: 190.0-199.5 m



LITHOLOGIC DESCRIPTION

Colors: light olive gray (5Y 6/1), medium light gray (N6), medium gray (N5), light gray (N7), dark gray (N3), greenish-gray (5GY 6/1), light brownish-gray (5YR 6/1). Slight-moderate deformation. Thinly stratified, locally mottled (bioturbation?); intense bioturbation (chondrites) in Sec. 3.

MAJOR LITHOLOGY

NANNOFOSSIL DIATOM OOZE (Smears 1-123, CC)

5-10% Sand	TR- 3% Quartz
30% Silt	1- 2% Mica
60% Clay	0- 1% Heavy minerals
	2- 5% Volcanic glass
	15-20% Clay minerals
	0- 1% Glauconite
	0- 2% Opaques
	20% Nannofossils
	30% Diatoms
	5-15% Radiolarians
	10% Sponge spicules
	2% Silicoflagellates

MINOR LITHOLOGY

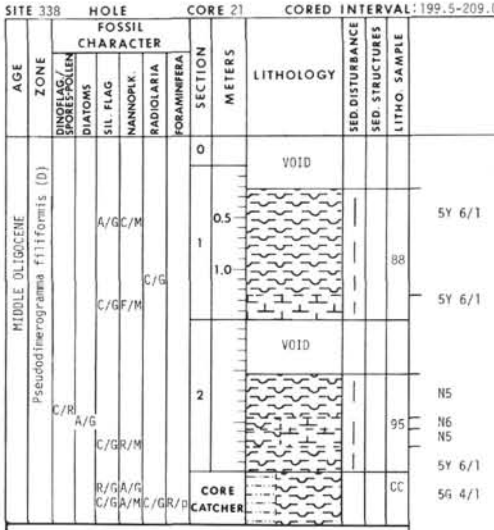
VOLCANIC ASH (Smear 3-55)

70% Sand	0- 5% Feldspar
15% Silt	20% Opaques
15% Clay	80% Volcanic glass

Carbon-Carbonate (DSDP)
1-142 (1.2, 0.4, 7)
5-75 (0.9, 0.5, 3)

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 21 CORED INTERVAL: 199.5-209.0 m



LITHOLOGIC DESCRIPTION

Colors: light olive gray (5Y 6/1), medium gray (N5), medium light gray (N6). Slight deformation. Intercalated nannofossil oozes.

MAJOR LITHOLOGIES

a) DIATOM OOZE (Smear 1-88)

2- 3% Sand	5% Quartz
3- 7% Silt	TR- 2% Feldspar
90-95% Clay	5-15% Clay minerals
	5% Opaques
	0- 2% Foraminifera
	TR% Nannofossils
	60% Diatoms
	7% Radiolarians
	7% Sponge spicules
	2% Silicoflagellates

b) CALCAREOUS DIATOM OOZE (Smear 2-95)

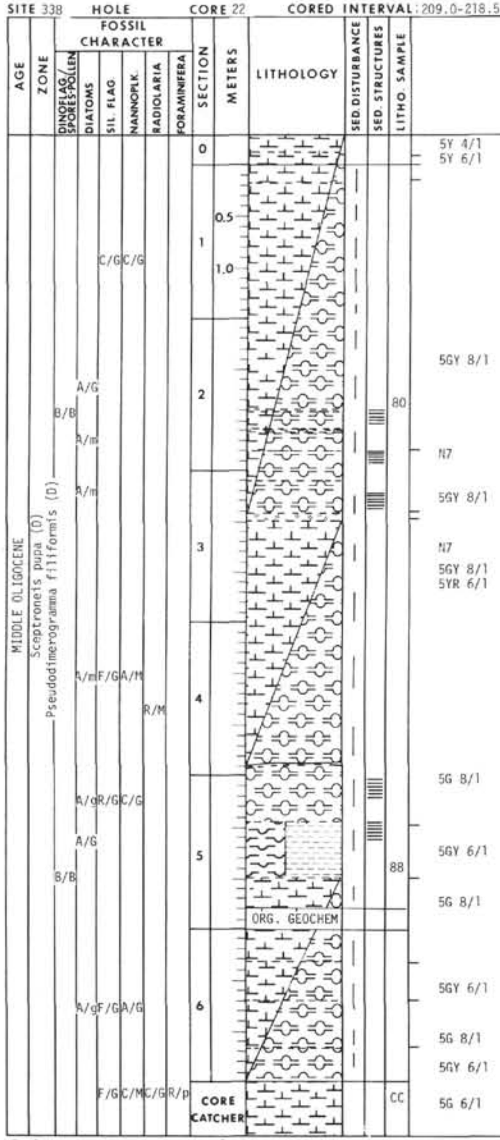
1% Quartz
TR% Mica
1% Opaques
5% Volcanic glass
20% Clay minerals
5% Authigenic carbonate
20% Nannofossils
30% Diatoms
7% Radiolarians
10% Sponge spicules
TR% Silicoflagellates

c) MUDDY DIATOM OOZE (Smear CC)

TR% Mica
1% Opaques
5% Volcanic glass
25% Clay minerals
1% Nannofossils
40% Diatoms
10% Radiolarians
15% Sponge spicules
3% Silicoflagellates

Carbon-Carbonate (DSDP)
1-125 (0.3, 0.0, 3)

SITE 338 HOLE CORE 22 CORED INTERVAL: 209.0-218.5 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Olive gray (5Y 4/1), light olive gray (5Y 6/1), greenish gray (5G 6/1), light greenish gray (5GY 8/1), light gray (N7), light brownish gray (5YR 6/1). Light greenish-gray (5G 8/1). Slight deformation, laminated, thinly stratified, pyrite laminations (Secs. 2 and 4), bioturbation (Secs. 3 and 6).

MAJOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smears 2-80, CC)

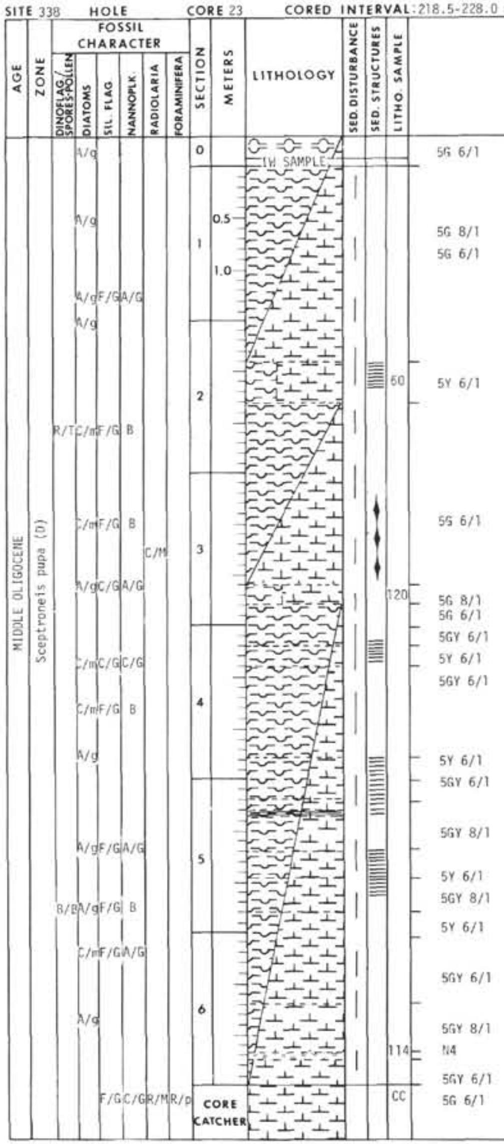
5% Sand	0- 1% Quartz
10% Silt	0-TR% Feldspar
85% Clay	3% Volcanic glass
	10% Clay minerals
	0- 2% Foraminifera
	65-70% Nannofossils
	5% Diatoms
	5% Radiolarians, Sponge spicules

b) DIATOMACEOUS CLAY (Smear 5-88)

10% Silt	TR% Quartz
90% Clay	0- 1% Mica, Heavy minerals, and Opaques
	60% Clay minerals
	15% Diatoms
	7% Radiolarians
	10% Sponge spicules
	2% Silicoflagellates

Carbon-Carbonate (DSDP)
1-74 (5.7, 0.4, 44)
4-85 (2.0, 0.5, 13)
6-138 (0.4, 0.5, 0)

Carbon-Carbonate (PP)
22-5 (top) (0.18, 4.40)
22-5 (bottom) (0.21, 3.50)



LITHOLOGIC DESCRIPTION

Colors: greenish gray (5G 6/1), light greenish-gray (5G 8/1), light olive gray (5Y 6/1), greenish gray (5GY 6/1), light greenish-gray (5GY 8/1). Laminated, thinly stratified with gradational color contacts. Soft through Sec. 3 with slight deformation. Color mottling common. Bioturbation in Sec. 3, subhorizontal. Core firm from Sec. 4.

MAJOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smear CC)

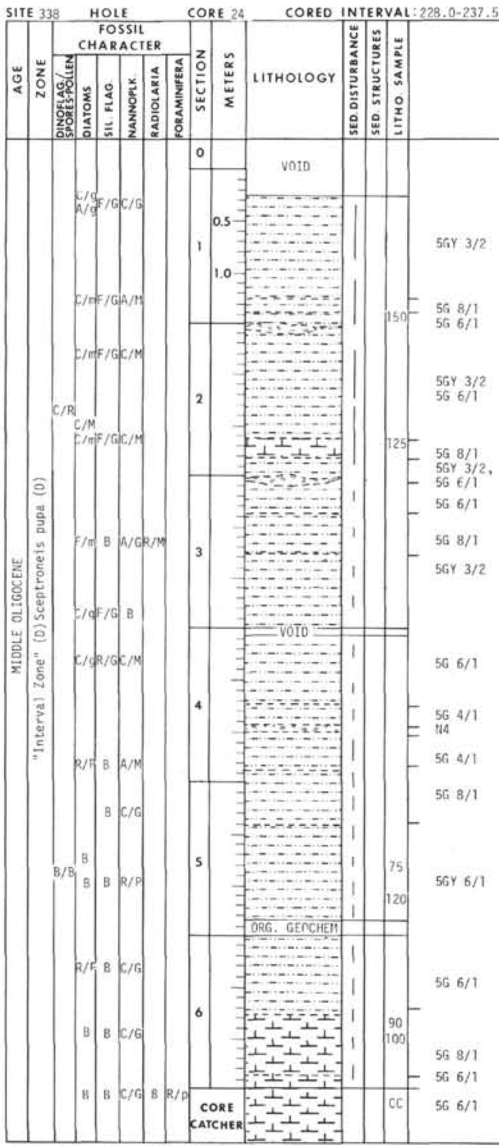
1- 5% Sand	1% Feldspar
9-15% Silt	1% Mica
80-90% Clay	20% Clay minerals
	48% Nannofossils
	30% Diatoms, Radiolarians, Sponge spicules

b) SILICEOUS NANNOFOSSIL OOZE (Smears 2-60, 3-120)

1% Sand	15% Clay minerals
2% Silt	44% Nannofossils
97% Clav	15% Diatoms
	10% Sponge spicules
	7% Radiolarians

Carbon-Carbonate (DSDP)
1-73 (4.3, 0.2, 34)
6-107 (4.7, 0.2, 38)

X-Ray (BP)
2-102
P Mont. (MXL?)
TR Ill.
A Kaol., Chlo.



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: gray olive green (5GY 3/2), light greenish gray (5G 8/1), greenish gray (5G 6/1), brownish black (5YR 2/1), dark greenish-gray (5G 4/1). Stiff, firm to semilithified, 10-50 cm bedding. Moderate to slight deformation with internal brecciation. Color mottling common.

MAJOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smears 2-125, 6-90, 6-100, CC)
TR- 1% Quartz
TR% Feldspar
10-15% Clay minerals
0- 3% Volcanic glass
0- 1% Foraminifera
76-90% Nannofossils
0- 5% Siliceous fossils

b) MUD (Smear 5-120)

3- 5% Sand	1- 2% Quartz
15-1 % Silt	TR% Feldspar
80% Clay	0- 1% Mica, Heavy minerals
	0- 8% Volcanic glass
	70-80% Clay minerals
	5-10% Sponge spicules
	0- 1% Glauconite
	TR- 5% Diatoms

MINOR LITHOLOGY

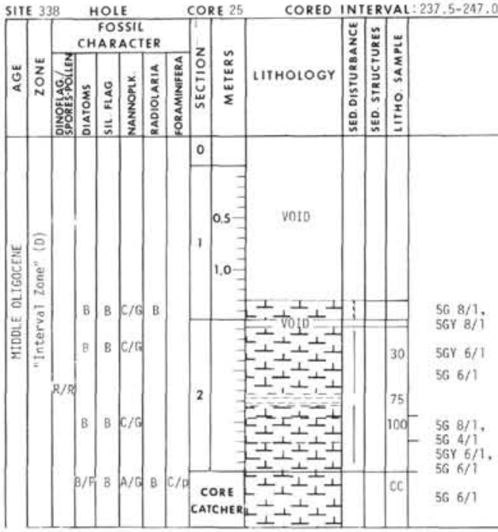
ASHY NANNOFOSSIL OOZE (Smear 1-150)
1% Quartz
2% Opaques
TR% Heavy minerals
15% Volcanic glass
10% Clay minerals
50% Nannofossils
7% Diatoms
5% Radiolarians
10% Sponge spicules

Carbon-Carbonate (DSDP)
3-60 (6.1, 0.1, 50)

Carbon-Carbonate (PP)
24-5 (top) (0.11, 0.03)
24-5 (bottom) (0.08, 0.08)

Grain Size (DSDP)
2-10 (6.0, 35.3, 58.7)

SITE 338 HOLE CORE 25 CORED INTERVAL: 237.5-247.0 m



LITHOLOGIC DESCRIPTION

Colors: light greenish-gray (5GY 8/1), light green gray (5G 8/1). Firm, alternating stiff/soft zones, moderate to slight deformation.

MAJOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smears 2-30, 2-100, CC)

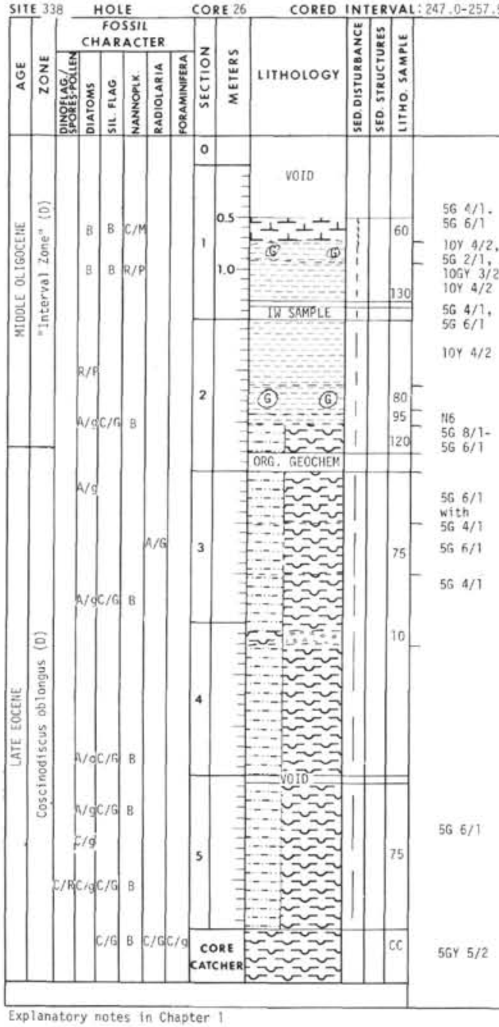
100% Clay	TR% Quartz
	TR% Heavy minerals, Opaques
	0-10% Clay minerals
	1- 3% Foraminifera
	78-90% Nannofossils
	1- 5% Sponge spicules

b) CLAY (Smear 2-75)

100% Clay	1% Opaques
	88% Clay minerals
	1% Zeolites
	6% Siliceous debris
	2% Quartz

Grain Size (DSDP)
2-19 (0.2, 19.8, 80.1)

SITE 338 HOLE CORE 26 CORED INTERVAL: 247.0-257.5 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: dusky yellow green (5GY 5/2), greenish gray (5G 4/1), green gray (5G 6/1), white (N9), light green gray (5G 8/1). Glauconite zone in Sec. 1 (70-90). Slight-moderate deformation with color mottling. Firm with stiff zones start in Sec. 3.

MAJOR LITHOLOGIES

a) MUDDY DIATOM OOZE (Smears 2-120, 3-75, 5-75)

TR- 1% Quartz
TR% Mica
TR% Heavy minerals
1- 7% Volcanic glass
30% Clay minerals
40-50% Diatoms
10-15% Radiolarians
7% Sponge spicules

b) CLAY (Smears 1-130, 2-95) (Devitrified ash?)

TR% Quartz
TR% Mica
90-98% Clay minerals

c) GLAUCONITIC (40% at 2-80)

MINOR LITHOLOGIES

a) DIATOM OOZE (Smear CC)

2% Sand	1% Quartz
10% Silt	1% Heavy minerals
88% Clay	7% Volcanic glass
	15% Clay minerals
	TR% Glauconite
	51% Diatoms
	10% Radiolarians
	15% Sponge spicules

b) DIATOMACEOUS VOLCANIC ASH (Smear 4-10)

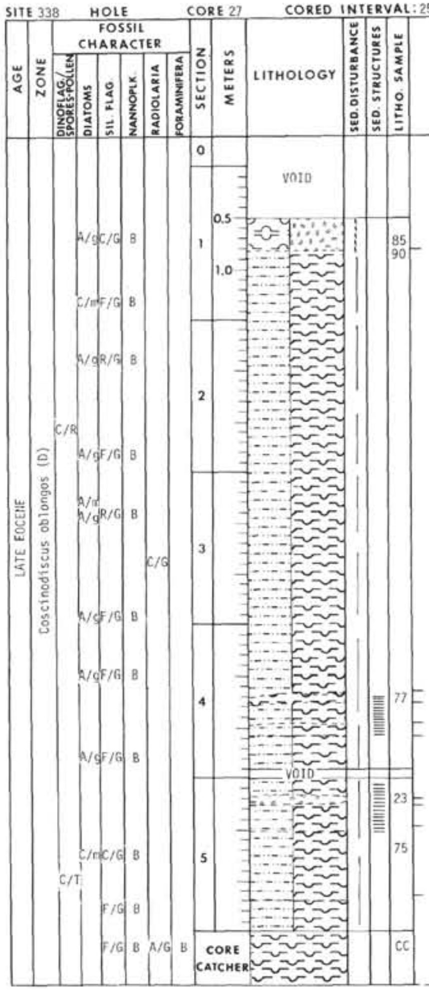
5% Quartz
2% Opaques
50% Volcanic glass
10% Clay minerals
24% Diatoms
7% Radiolarians
2% Sponge spicules

Carbon-Carbonate (DSDP)
3-140 (0.1, 0.1, 0)

Carbon-Carbonate (PP)
26-2 (top) (0.14, 0.04)
26-2 (bottom) (0.10, 0.06)

Grain Size (DSDP)
3-80 (3.5, 40.6, 55.9)

SITE 338 HOLE CORE 27 CORED INTERVAL: 257.5-266.0 m



5G 6/1-
5G 4/L
5GY 4/1
5Y 4/1
5Y 2/1,
5Y 6/4
5GY 4/1
5Y 2/1,
5Y 6/4
5GY 4/1
10YR 2/2
10YR 2/2
10Y 4/2
10YR 2/2
10Y 4/2-
5Y 4/1
N3
10Y 4/2
5GY 6/1
5Y 4/1
10Y 4/2

LITHOLOGIC DESCRIPTION

Colors: greenish gray (5G 6/1), dark green gray (5G 4/1), dark greenish-gray (5GY 4/1), olive gray (5Y 4/1), olive black (5Y 2/1), dusky yellow (5Y 6/4), dusky yellow brown (10YR 2/2). Firm, with moderate deformation, internal breccia, 5-20 mm. Stratification, patchv mottling. Stiffens in Sec. 3.

MAJOR LITHOLOGIES

a) MUDDY DIATOM OOZE (Smear 1-90)

0- 5% Sand	1% Quartz
15-20% Silt	TR% Mica
80% Clay	1% Opaques
	10% Volcanic glass
	30% Clay minerals
	TR% Glauconite
	38% Diatoms
	10% Radiolarians
	10% Sponge spicules

b) DIATOM OOZE (Smears 4-77, 5-75, CC)

TR% Quartz
3% Volcanic glass
5-10% Clay minerals
TR% Glauconite
65-70% Diatoms
15% Radiolarians
3- 7% Sponge spicules
TR- 1% Silicoflagellates

MINOR LITHOLOGIES

a) SILICEOUS ASHY MUD (Smear 1-85)

2% Quartz
7% Opaques
30% Volcanic glass
31% Clay minerals
15% Diatoms
10% Radiolarians
5% Sponge spicules

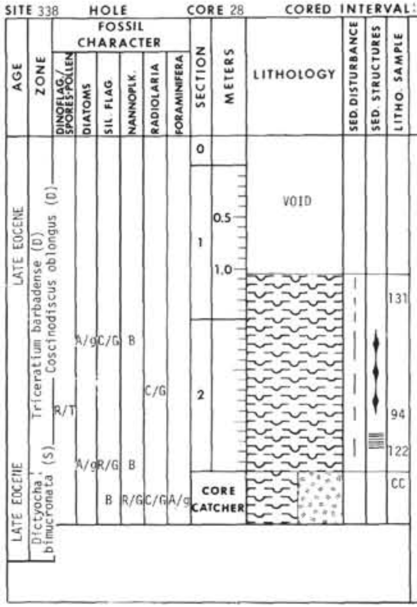
b) VOLCANIC ASH (Smear 5-23)

82% Sand	15% Quartz
8% Silt	67% Volcanic glass
10% Clay	10% Clay minerals
	5% Diatoms
	3% Sponge spicules

Carbon-Carbonate (DSDP)
5-89 (0.6, 0.5, 1)

Grain Size (DSDP)
2-120 (3.7, 55.2, 41.1)

SITE 338 HOLE CORE 28 CORED INTERVAL: 266.0-275.5 m



5GY 3/2

LITHOLOGIC DESCRIPTION

Colors: Sec. 1 dusky yellow green (5GY 5/2), olive gray (5Y 4/1), light olive (5Y 6/1), olive black (5Y 2/1), medium greenish-yellow (10Y 7/4). Sec. 2 light olive gray (5Y 5/2), grayish olive green (5GY 3/2). Slight deformation, mottling (partly bioturbation), thin stratification.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 1-131, 2-95, 2-122)

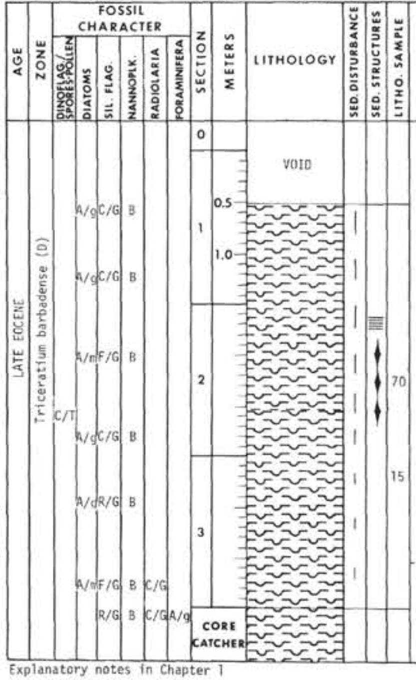
TR% Quartz
0- 1% Opaques
0-15% Volcanic glass
10-20% Clay minerals
TR% Glauconite
46-70% Diatoms
10-15% Radiolarians
5- 7% Sponge spicules

MINOR LITHOLOGY

DIATOMACEOUS VOLCANIC ASH (Smear CC)

TR% Quartz
TR% Opaques
45% Volcanic glass
20% Clay minerals
TR% Glauconite
20% Diatoms
10% Radiolarians
5% Sponge spicules

SITE 338 HOLE CORE 29 CORED INTERVAL: 275.5-285.0 m



Explanatory notes in Chapter 1

5GY 5/2
5Y 5/2
5GY 6/1

LITHOLOGIC DESCRIPTION

Color: dusky yellow green (5GY 5/2), light olive gray (5Y 5/2). Slight deformation, with competent and indurated towards Sec. 3. Burrows (Zoophycus) common 30-80 cm (Sec. 2), finely laminated, Sec. 2.

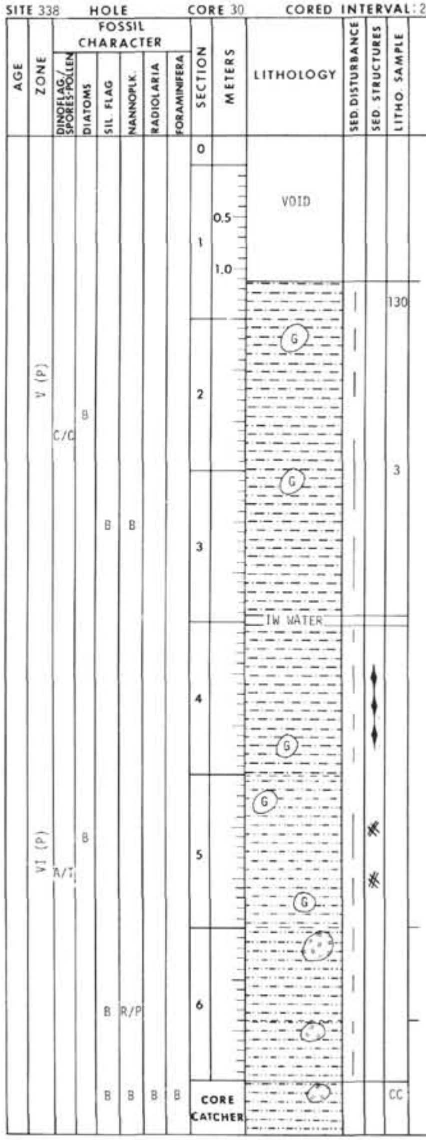
MAJOR LITHOLOGY

DIATOM OOZE (Smears 2-70, 3-15, CC)

TR% Quartz
0- 7% Volcanic glass
10-20% Clay minerals
TR% Glauconite
60-80% Diatoms
7-12% Radiolarians
3- 7% Sponge spicules
TR% Silicoflagellates

X-Ray (BP)
3-24
P Mont. (MXL.)
TR Ill.
A Kaol., Chlo.

SITE 338 HOLE CORE 30 CORED INTERVAL: 285.0-294.5 m



LITHOLOGIC DESCRIPTION

5G 2/1

5GY 3/2

5GY 3/2

Greenish black (5G 2/1), olive green (5GY 3/2), greenish (5GY 4/1), dusky yellow green (10GY 3/2), dark gray (N3), olive black (5Y 2/1). Slight to moderate deformation.

Sec. 1 Semi-indurated glauconite sand
Sec. 2 Semi-indurated glauconite sand (muddy)
Sec. 3 Very poor sorting, clay clasts
Sec. 4 Clay clasts to 20 cm, bioturbation
Sec. 5 Finer grained, silt, semi-horizontal, flat clasts
Sec. 6 Color change, finer grained

MAJOR LITHOLOGY

GLAUCONITIC SANDY MUD (Smears 1-130, 3-3)

50-70% Sand	7-10% Quartz
16-20% Silt	0- 3% Feldspar
5-34% Clay	0- 1% Mica
	TR- 3% Heavy minerals
	25% Opaques
	15-34% Clay minerals
	25-50% Glauconite

MINOR LITHOLOGIES

a) ?MUDDY VOLCANIC ASH (Smears 6-145, CC)

50% Sand	3% Quartz
20% Silt	70% Opaques
30% Clay	30% Clay minerals
	TR% Glauconite

b) ?VOLCANIC ASH (Smear 6-80)

70% Sand	7% Quartz
17% Silt	70% Opaques (Ash)
13% Clay	13% Clay minerals
	5% Glauconite
	5% Zeolites

Carbon-Carbonate (DSDP)
4-61 (0.2, 0.2, 0)

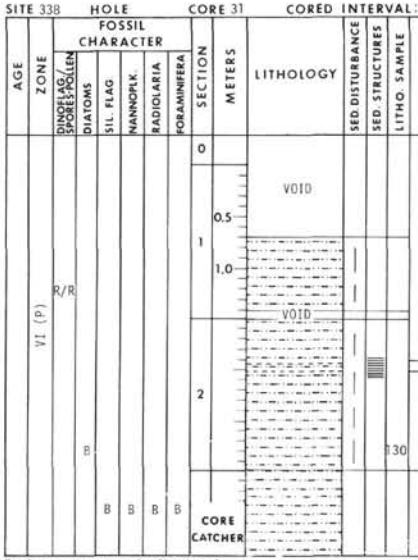
Carbon-Carbonate (PP)
30-5 (top) (0.44, 0.02)
30-5 (bottom) (0.41, 0.02)

Grain Size (DSDP)
4-70 (20.1, 15.8, 64.1)

X-Ray (BP)
2-106
P Mont.
TR Ill.
A Kaol., Chlo.

5-1
P Mont.
TR Ill.
A Kaol., Chlo.

SITE 338 HOLE CORE 31 CORED INTERVAL: 294.5-304.0 m



LITHOLOGIC DESCRIPTION

5YR 2/1

N3

5B 5/1
with
5Y 4/1

5GY 2/1

Colors: brownish black (5YR 2/1), dark gray (N3), medium bluish-gray (5B 5/1), olive gray (5Y 4/1). Slight deformation, mottled. Bedding (colors) in Sec. 2.

MAJOR LITHOLOGY

MUD (Smears 2-130, CC)

5% Sand	1- 3% Quartz
15-35% Silt	5-10% Feldspar
60-75% Clay	1- 2% Mica
	1- 2% Heavy minerals
	66-70% Clay minerals
	5-10% Opaques
	5-15% Glauconite
	0- 5% Zeolites

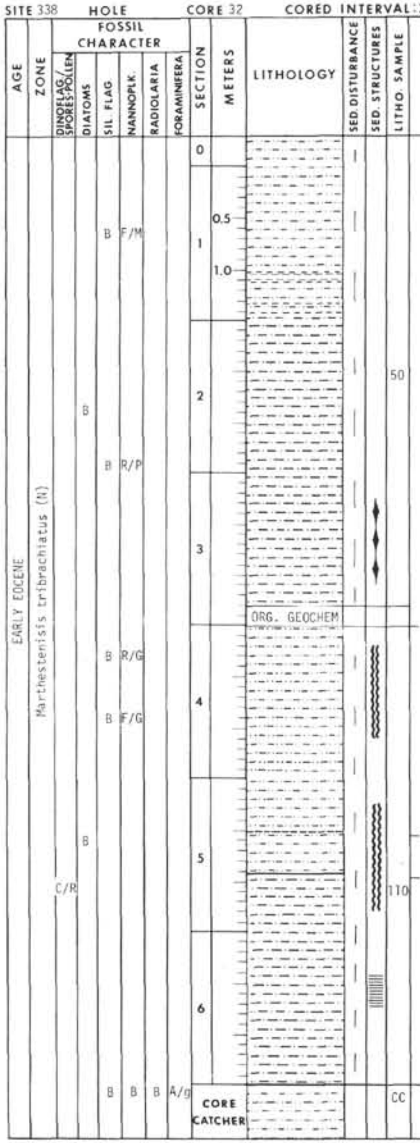
Carbon-Carbonate (DSDP)
1-80 (0.4, 0.4, 0)

Grain Size (DSDP)
2-143 (5.8, 50.1, 44.1)

X-Ray (BP)
2-128
43% Mont
35% Ill.
22% Kaol., Chlo.

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 32 CORED INTERVAL:304.0-313.5 m



LITHOLOGIC DESCRIPTION

5Y 4/1

5G 4/1
with
5Y 4/1

5Y 4/1

5Y 4/1
with N3

5G 4/1

5Y 3/2

Colors: olive gray (5Y 4/1), dark green gray (5G 4/1), dark gray (N3). Slight deformation. Burrows in Sec. 3. Chondrites in Sec. 4 - 3-8 mm; x-section, faint color difference; also thin stratification (8-10 mm); Sec. 5. Thin stratification (8-27 mm), prominent burrows (1 cm rind burrows), parallel bedding; Sec. 6 as above.

MAJOR LITHOLOGY

SANDY MUD (Smears 2-50, 5-110, CC)

10-20% Sand	20-25% Quartz
20-40% Silt	3- 5% Feldspar
30-60% Clay	TR- 5% Mica
	1- 2% Heavy minerals
	5-15% Opaques
	30-60% Clay minerals
	0-1% Glauconite
	1- 2% Sponge spicules
	3-15% Authigenic carbonate

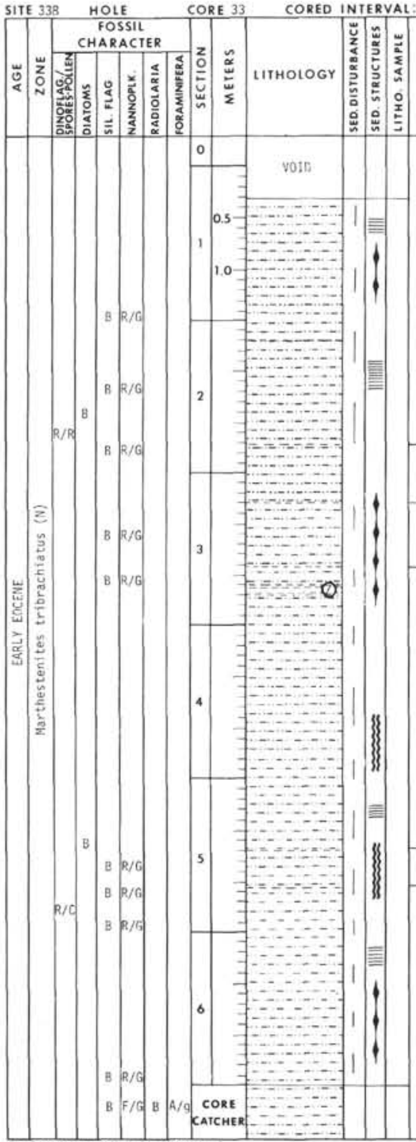
Carbon-Carbonate (DSDP)
4-27 (0.7, 0.6, 2)

Carbon-Carbonate (PP)
32-3 (top) (0.43, 0.13)
32-3 (bottom) (0.59, 0.17)

Grain Size (DSDP)
5-134 (4.5, 48.4, 47.2)

X-Ray (BP)
2-86
42% Mont.
38% Ill.
6% Kaol.
14% Chlo.

SITE 338 HOLE CORE 33 CORED INTERVAL: 313.5-323.0 m



LITHOLOGIC DESCRIPTION

5Y 4/1
with N3

5Y 4/1

5Y 4/1
N6
5Y 4/1

N3 with
5Y 4/1
5Y 4/1

5Y 2/1

Colors: olive gray (5Y 4/1), olive black (5Y 2/1), dark gray (N3), medium light gray (N6). Slight deformation. Sec. 1 - faint layering, 3 x 6 mm burrows; Sec. 2 - thinly stratified, faint mottling; Sec. 3- 3-15 mm laminae, mottling, Chondrite burrows in 1.5 to 2 cm dark clays; Sec. 4 - mottling prominent at 29, 40-44, 50-53, 66-68 and 79-83 cm (Chondrites) burrows; Sec. 5 - thin stratified, Helminthoidea at 48-52 cm; Sec. 6 - thin stratification, burrows.

MAJOR LITHOLOGY

MUD

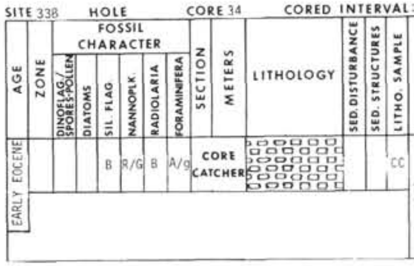
Carbon-Carbonate (DSDP)
4-50 (0.5, 0.4, 1)

Grain Size (DSDP)
4-127 (14.0, 49.3, 36.7)

X-Ray (BP)
CC
28% Mont.
45% Ill.
8% Kaol.
19% Chlo.

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 34 CORED INTERVAL:323.0-332.5 m



LITHOLOGIC DESCRIPTION

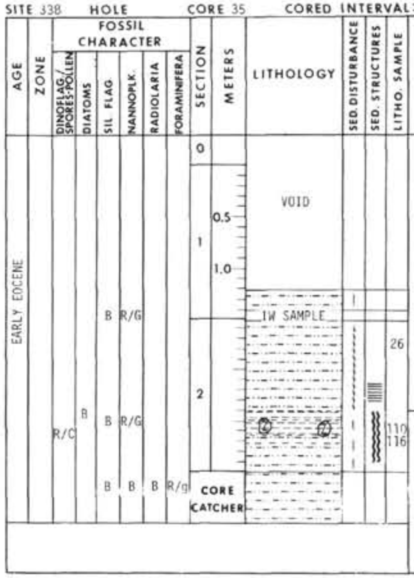
5Y 2/1 Core catcher only: olive black (5Y 2/1).

X-Ray (BP)
CC
33% Mont.
38% Ill.
29% Kaol., Chlo.

CALCAREOUS OOZE (SANDY) (Smear CC)
14% Clay minerals
3% Quartz, Feldspar
3% Opaques
80% Authigenic carbonate

CC
81% Mont.
19% Ill.
TR% Kaol., Chlo.

SITE 338 HOLE CORE 35 CORED INTERVAL: 332.5-342.0 m



LITHOLOGIC DESCRIPTION

Olive black (5Y 2/1), intense deformation to 90 cm in Sec. 2, slight to 150 cm. 0-90 cm, Sec. 2 - massive, with drilling breccia, with fragments of lithified mud; 90-150 cm, laminated to thinly stratified, burrowing (Chondrite).

MAJOR LITHOLOGY

MUD (Smears 2-26, 2-116)
7% Sand 30% Quartz
10-40% Silt 7% Feldspar
50-80% Clay 3% Heavy minerals
2% Opaques
1% Volcanic glass
50-80% Clay minerals
1% Zeolites
3% Mica

5Y 4/1

X-Ray (BP)
2-86
30% Mont.
46% Ill.
24% Kaol., Chlo.

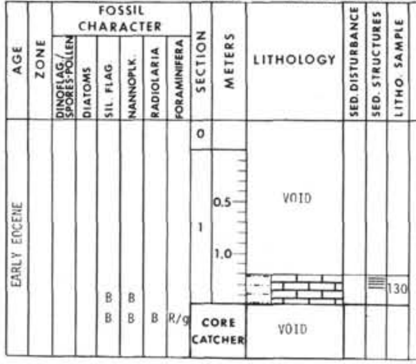
MINOR LITHOLOGY

ZEOLITIC CLAY (Smear 2-110)
10% Silt 1% Opaques
90% Clay 20% Clay minerals (Devitrified ash)
79% Zeolites

5Y 2/1

Carbon-Carbonate (DSDP)
2-45 (0.6, 0.4, 1)

SITE 338 HOLE CORE 36 CORED INTERVAL: 342.0-351.5 m



LITHOLOGIC DESCRIPTION

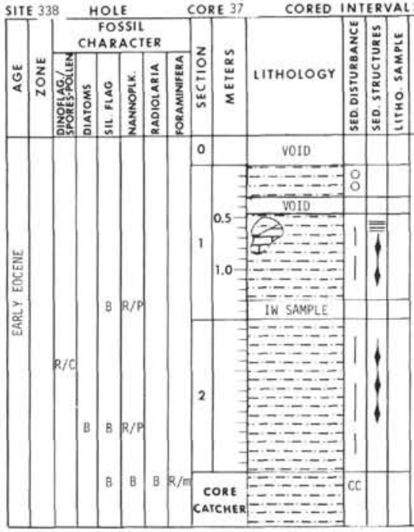
Colors: brownish black (5YR 4/1) and brownish gray (5YR 2/1) laminated, thinly stratified. Locally burrowed (Helminthoida), calcite veins.

LIMESTONE (Smear 1-130)
2% Sand 1% Quartz
88% Silt 2% Opaques
10% Clay 20% Clay minerals
77% Carbonate

5YR 4/1

X-Ray (BP)
CC
TR% Mont. (MXL?)
55% Ill.
45% Kaol., Chlo.

SITE 338 HOLE CORE 37 CORED INTERVAL:351.5-361.0 m



LITHOLOGIC DESCRIPTION

Colors: olive black (5Y 2/1), brownish gray (5YR 4/1). Slight deformation, soft, slightly deformed, micaceous, very thinly stratified, laminated. Partly burrowed (chondrites). Local pyrite modules up to 1.5 cm locally.

MAJOR LITHOLOGY

SANDY MUD (Smear CC)
30% Sand 50% Quartz
33% Silt 7% Feldspar
37% Clay 3% Heavy minerals
2% Opaques, Mica
37% Clay minerals

5YR 4/1

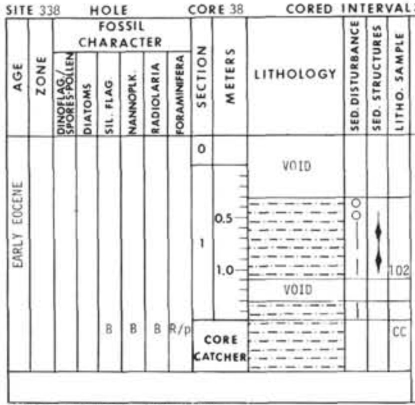
Carbon-Carbonate (DSDP)
2-64 (0.7, 0.5, 2)

Grain Size (DSDP)
1-115 (18.5, 57.5, 24.0)

X-Ray (BP)
2-108
18 Mont.
58 Ill.
2 Kaol.
22 Chlo.

5Y 2/1

SITE 338 HOLE CORE 38 CORED INTERVAL:361.0-370.5 m



LITHOLOGIC DESCRIPTION

Colors: brownish gray (5YR 4/1), massive, possibly bioturbated, soft with some clay fragments.

MAJOR LITHOLOGY

MUDDY SAND (Smears 1, 102, CC)
40% Sand 40-50% Quartz
30% Silt 7-10% Feldspar
30% Clay 2- 3% Mica
2- 4% Heavy minerals
2- 4% Opaques
1- 2% Volcanic glass
30% Clay minerals
TR% Glauconite
2- 3% Authigenic carbonate
7% Lithics

5YR 4/1

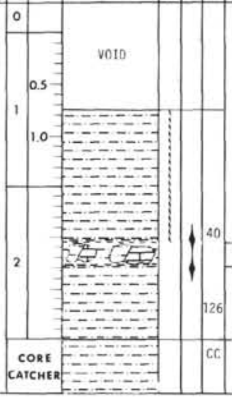
X-Ray (BP)
1-49
83% Mont.
11% Ill.
3% Kaol.
3% Chlo.

5Y 4/1

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 39 CORED INTERVAL: 370.5-380.0 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA
EARLY EOCENE		R/C		B	B	B	B



LITHOLOGIC DESCRIPTION

Color: brownish gray (5YR 4/1). Intense deformation to 55 cm, Sec. 2. Hard calcareous concretionary mudstones 55-75 cm, Sec. 2 - one massive (N3) others (N5, N7) with clasts, bioturbation.

MAJOR LITHOLOGY

5YR 4/1 SANDY MUD (Smear 2-40)

10-35% Sand 10-50% Quartz
20-40% Silt 5-10% Feldspar
20-70% Clay 3% Heavy minerals
0-10% Opaques
TR% Volcanic glass
TR-10% Glauconite
42-77% Clay minerals
2- 3% Authigenic carbonate

N3 with N5, N7

(Becomes muddy sand in Sec. 2 at 75-150 cm and CC).

5YR 2/1

Carbon-Carbonate (DSDP)
2-110

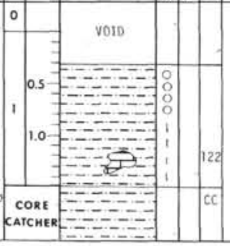
X-Ray (BP)
1-129
28% Mont.
55% Ill.
6% Kaol.
11% Chlo.

5Y 2/1

Grain Size (DSDP)
2-135 (31.0, 37.6, 31.4)

SITE 338 HOLE CORE 40 CORED INTERVAL: 380.0-389.5 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA
EARLY EOCENE		R/A		B	B	B	R/P



LITHOLOGIC DESCRIPTION

Color: brownish gray (5YR 4/1). Silt content increases toward base of section. Firm, massive.

MAJOR LITHOLOGY

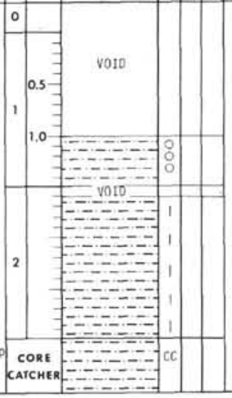
MUDDY SAND (Smears 1-122, CC)
50-60% Sand 25-50% Quartz
25-30% Silt 5% Feldspar
15-25% Clay 0- 5% Mica
2- 4% Heavy minerals
7-10% Opaques
15-25% Clay minerals
2% Volcanic glass
7-40% Lithics

X-Ray (BP)
1-63
76% Mont.
11% Ill.
5% Kaol.
8% Chlo.

5YR 4/1

SITE 338 HOLE CORE 41 CORED INTERVAL: 389.5-399.0 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA
EARLY EOCENE		T/C		B	R/G	B	R/P



LITHOLOGIC DESCRIPTION

Drilling breccia of mudstone in Sec. 1 with rounded calcareous clasts (3 cm). Brown gray (5YR 4/1) to yellow gray (5Y 8/1). Scattered 3 cm pyrite clasts.

MUDDY SAND (Smear CC)
50% Sand 30% Quartz
30% Silt 7% Feldspar
20% Clay 2% Heavy minerals
20% Clay minerals
30% Lithics
2% Volcanic glass
5% Opaques
1% Glauconite

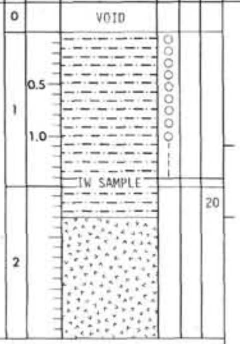
5YR 4/1

X-Ray (BP)
2-75
66% Mont.
25% Ill.
3% Kaol.
6% Chlo.

5YR 2/1

SITE 338 HOLE CORE 42 CORED INTERVAL: 399.0-408.5 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA
EARLY EOCENE		T/C		B	R/P		



LITHOLOGIC DESCRIPTION

Drilling breccia brownish gray (5YR 4/1) to 110 cm; mud/mudstone: 110-150 - mud/silt/sand, massive. Sec. 2 - sandy mud (5YR 4/1) no breccia, not weathering zone.

5Y 4/1 MUDDY SAND (Smear 2-20)
65% Sand 25% Quartz
20% Silt 5% Feldspar
15% Clay 2% Heavy minerals
20% Opaques
15% Clay minerals
20% Lithics
3% Authigenic carbonate
1% Glauconite

X-Ray (BP)
1-82
82% Mont.
13% Ill.
2% Kaol.
3% Chlo.

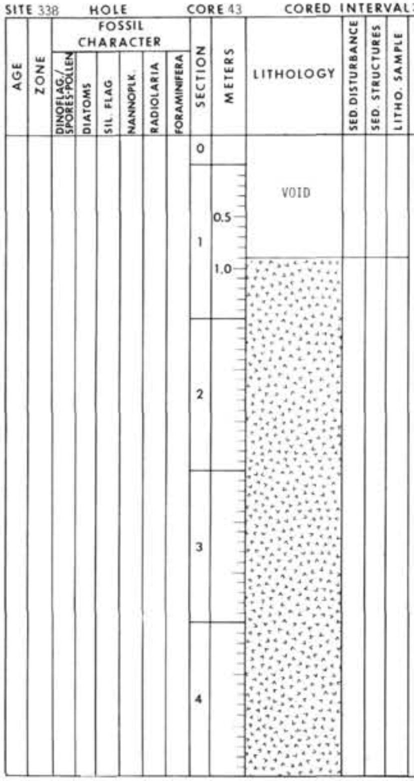
5Y 4/1

BASALT

N3 (25-50 cm) dark gray (N3) aphyric fine-grained basalt and brownish-black sandstone; (50-60 cm) calcite-chlorite vein; (60-125 cm) conglomerate-breccia with angular and round fragments of brownish-black (2YR 2/1) weathered basalt ferruginious on surface. Size 1-5 cm, cemented by green-gray chlorite-calcite matrix; (125-150 cm) brownish-black to dark-gray amygdaloidal phyric basalt with altered olivine phenocrysts (to 20%).

Explanatory notes in Chapter 1

SITE 338 HOLE CORE 43 CORED INTERVAL: 408.5-418.0 m



LITHOLOGIC DESCRIPTION

BASALT

Thin Sections: altered chloritized basalt (dolerite) with plagioclase, clinopyroxene (euhedral) phenocrysts and plagioclase glomeroporphyritic clusters (2 x 3 mm).

Thin Sections: altered chloritized plagioclase basalt (dolerite?), doleritic texture. Plagioclase, clinopyroxene phenocrysts, plagioclase glomeroporphyritic clusters (3 x 4 mm).

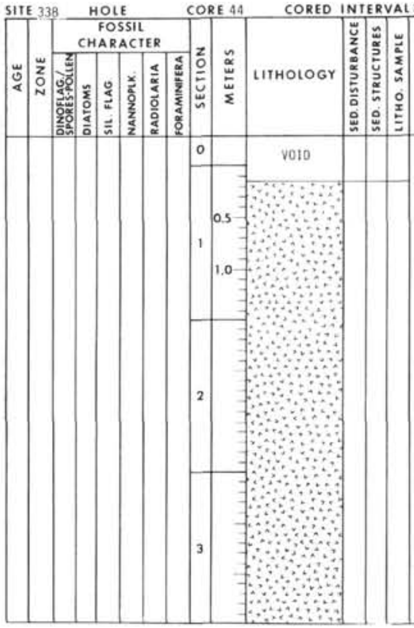
Sec. 1 (90-150 cm) dark gray chloritized amygdaloidal basalt with altered olivine, plagioclase and clinopyroxene phenocrysts; round amygdules filled by white calcite and dark green chlorite, rare thin calcite veins.

Sec. 2 phyric basalt with altered olivine, pyroxene, plagioclase phenocrysts and calcite-chlorite amygdules. Abundance of white calcite amygdules, vein of calcite with chlorite. Smectite(?)-chlorite inclusion at 50-60 cm, with slickensides with black chlorite noted below 80 cm.

Sec. 3 dark gray (N3) to greenish-black (5G 2/1) phyric basalt with plagioclase and clinopyroxene phenocrysts and calcite-chlorite amygdules. Calcite vein (at 25 cm) with chlorite vesicles from 40-50 cm, chlorite inclusions noted from 100-125 cm, and chloritization noted below 125 cm.

Sec. 4 (0-100 cm) aphyric to sparsely phyric and amygdaloidal basalt with plagioclase, pyroxene and altered olivine phenocrysts. Veins of calcite with chlorite and vesicles with calcite; (100-150 cm) - amygdaloidal basalt, calcite amygdules.

SITE 338 HOLE CORE 44 CORED INTERVAL: 418.0-427.5 m



LITHOLOGIC DESCRIPTION

BASALT

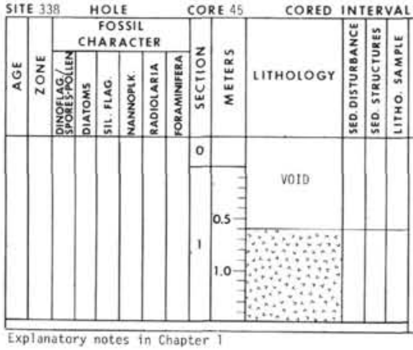
Thin Section: chloritized with chloritized plagioclase phenocrysts, chlorite amygdules and veins, chlorite amygdules.

Sec. 1 (15-75 cm) drill pebbles of very fine-grained chloritized basalt with calcite and chlorite on fissure walls and cavities; (75-150 cm) phyric basalt with rare phenocrysts of altered olivine, plagioclase and clinopyroxene. Small round amygdules of chlorite and calcite, calcite veins with chlorite.

Sec. 2 (10-150 cm) dark gray (N3) to olive black (5Y 2/1) massive basalt, to aphyric to sparsely phyric basalt. Rare round white calcite amygdules (2-10 mm). Chlorite amygdules, calcite veins and slickensides.

Sec. 3 (0-20 cm) drill pebbles of aphyric basalt, calcite veining; (20-150 cm) phyric basalt with phenocrysts of altered olivine, clinopyroxene and plagioclase glomeroporphyritic clusters. Cavities noted with chlorite and calcite.

SITE 338 HOLE CORE 45 CORED INTERVAL: 427.5-437.0 m



LITHOLOGIC DESCRIPTION

BASALT

Sec. 1 (60-150 cm) massive phyric basalt with phenocrysts of altered olivine, plagioclase and clinopyroxene. Calcite-chlorite veins, plus rare small calcite-chlorite amygdules, slickenside surfaces.

Sec. 2 phyric basalt is similar to Sec. 1 with chlorite veins, slickensides, calcite amygdules, and chloritization noted on slickenside surfaces.

Explanatory notes in Chapter 1

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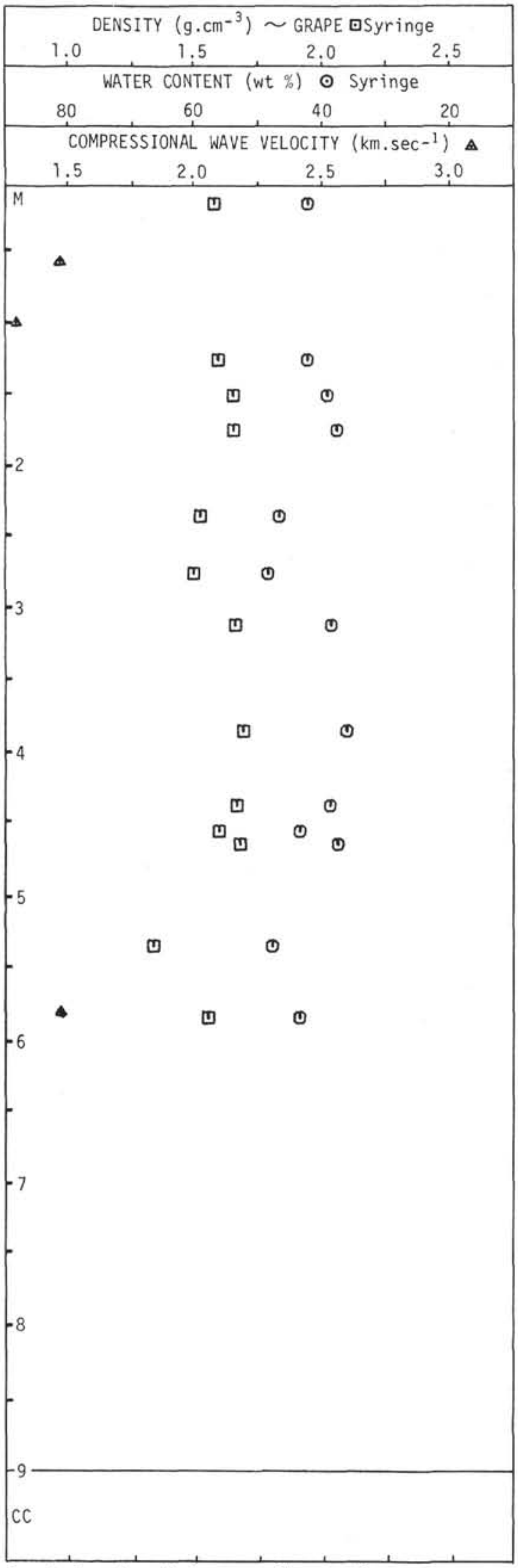
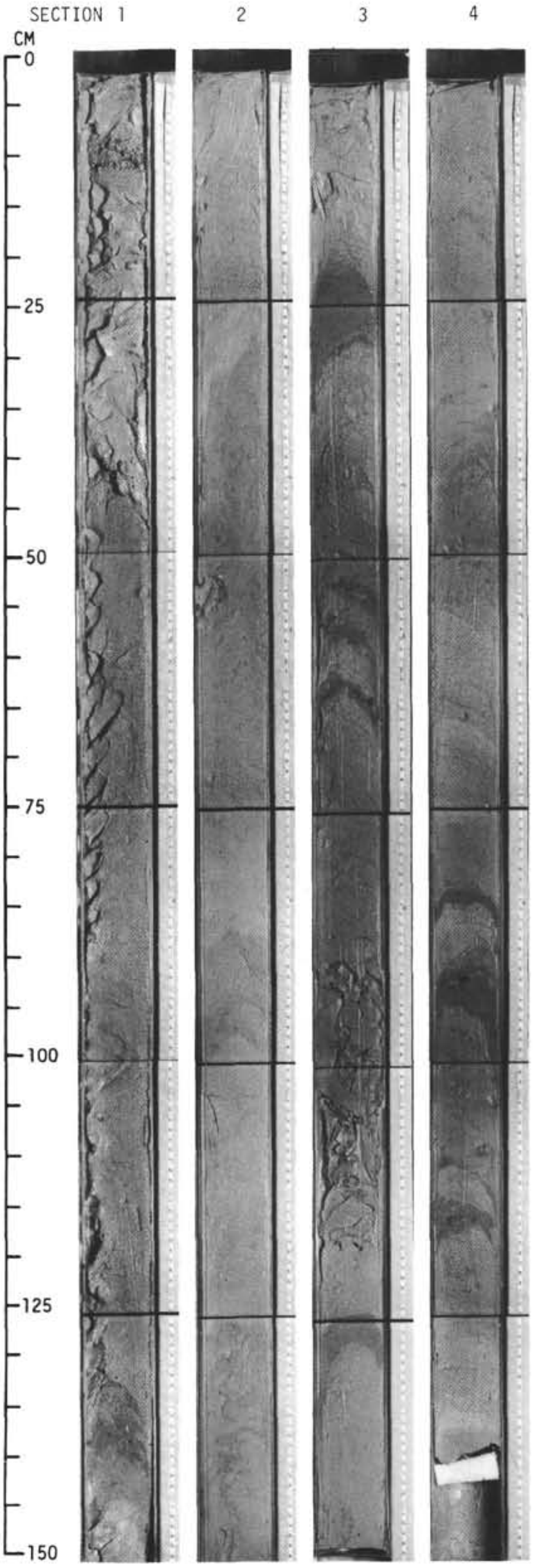
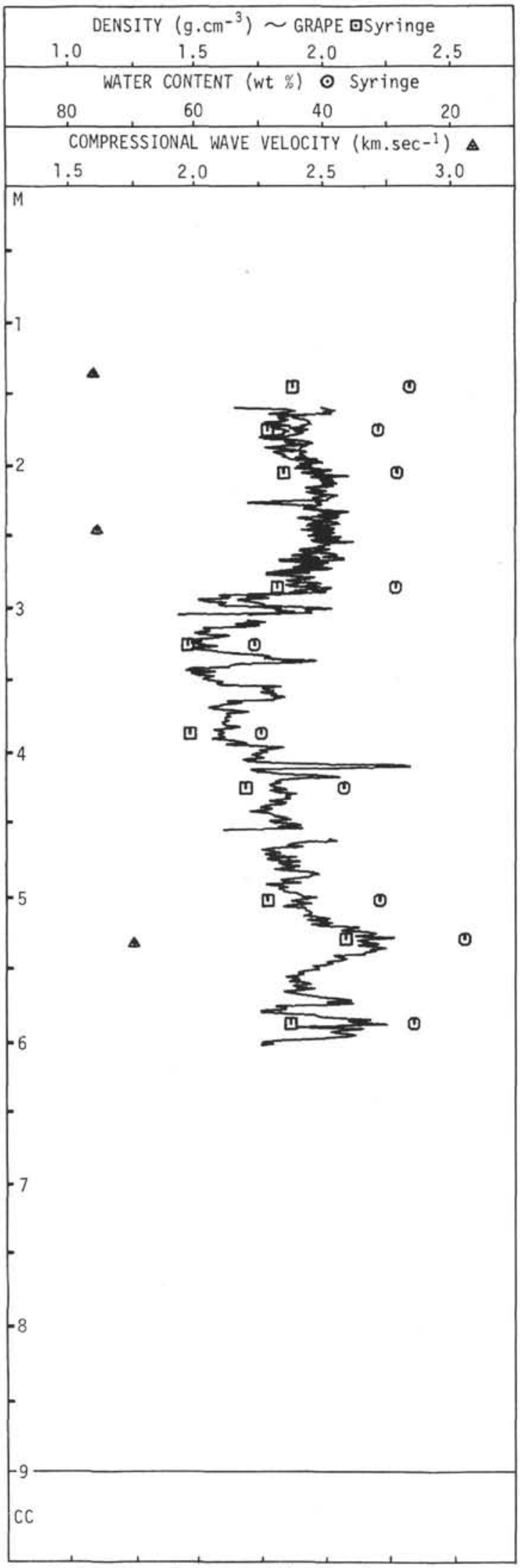


For Explanatory Notes, see Chapter 1





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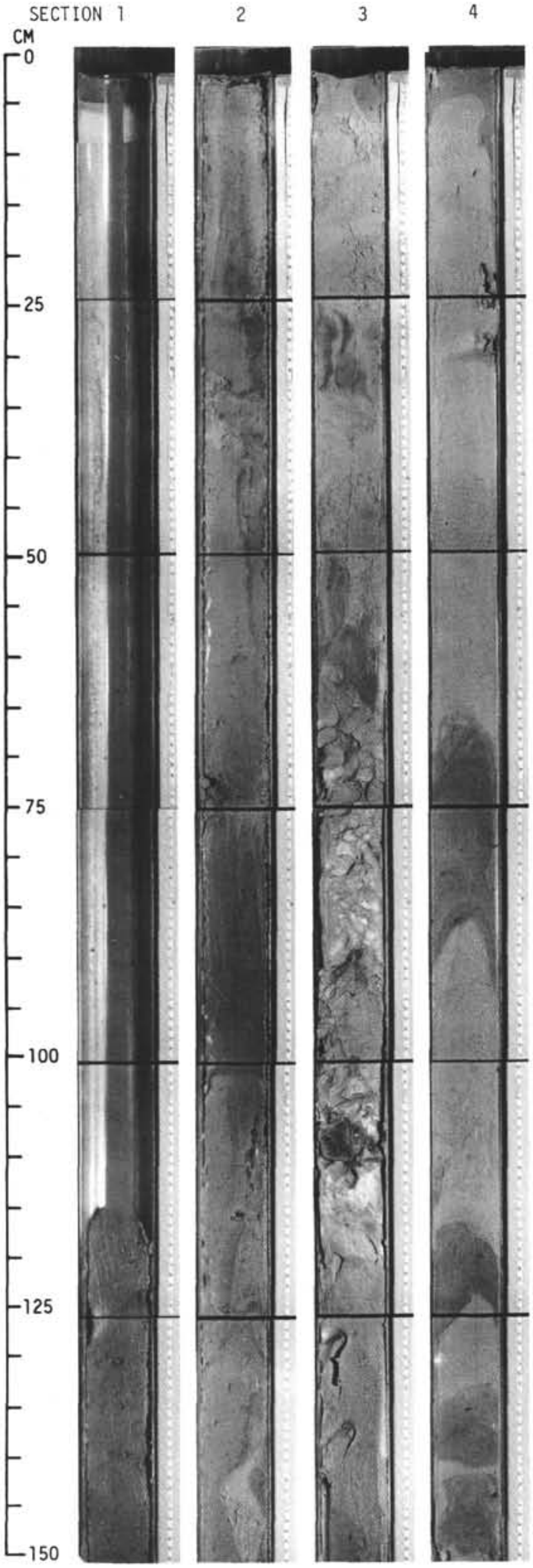

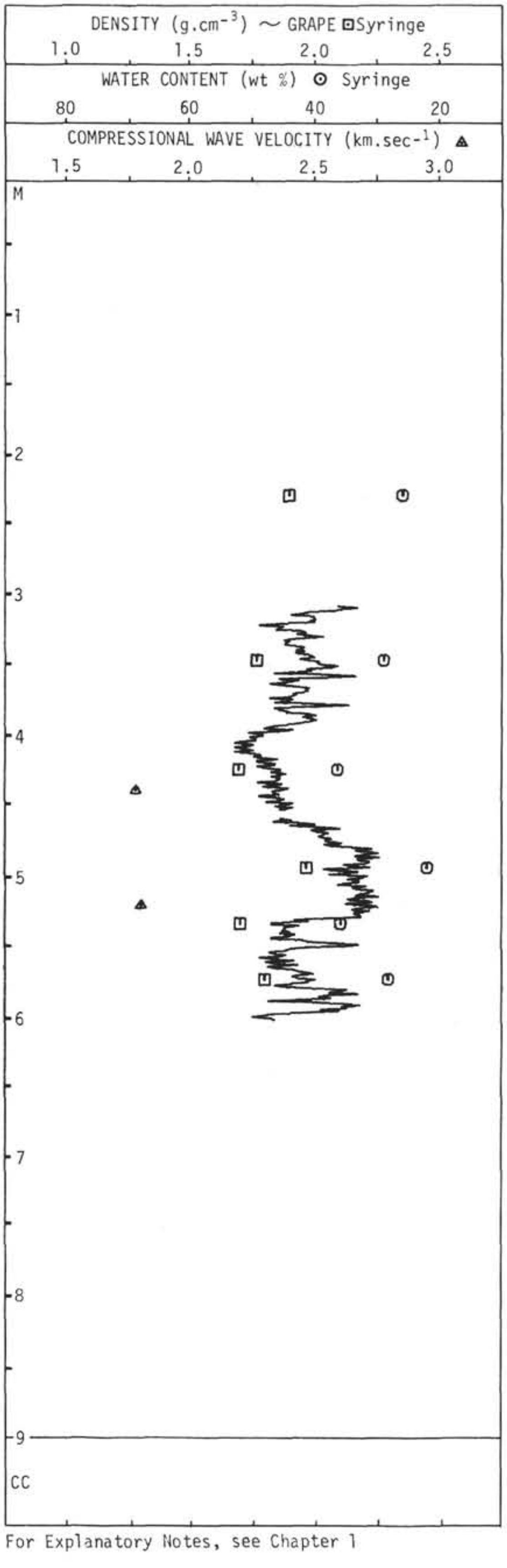

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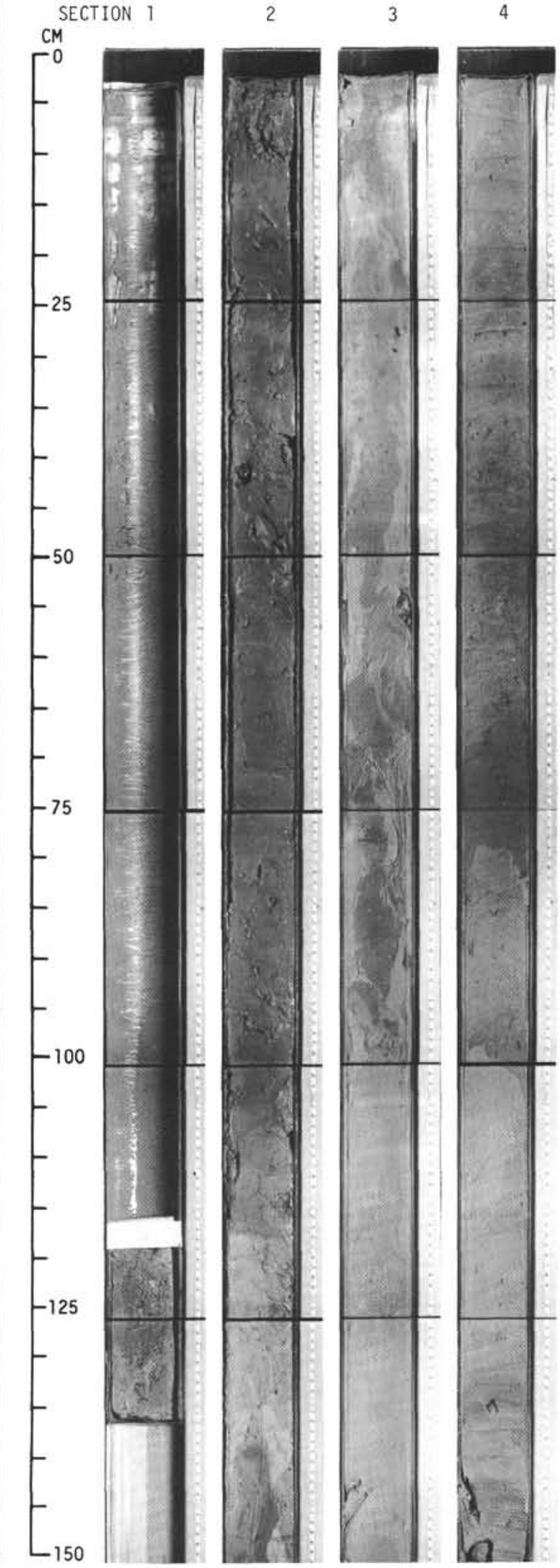

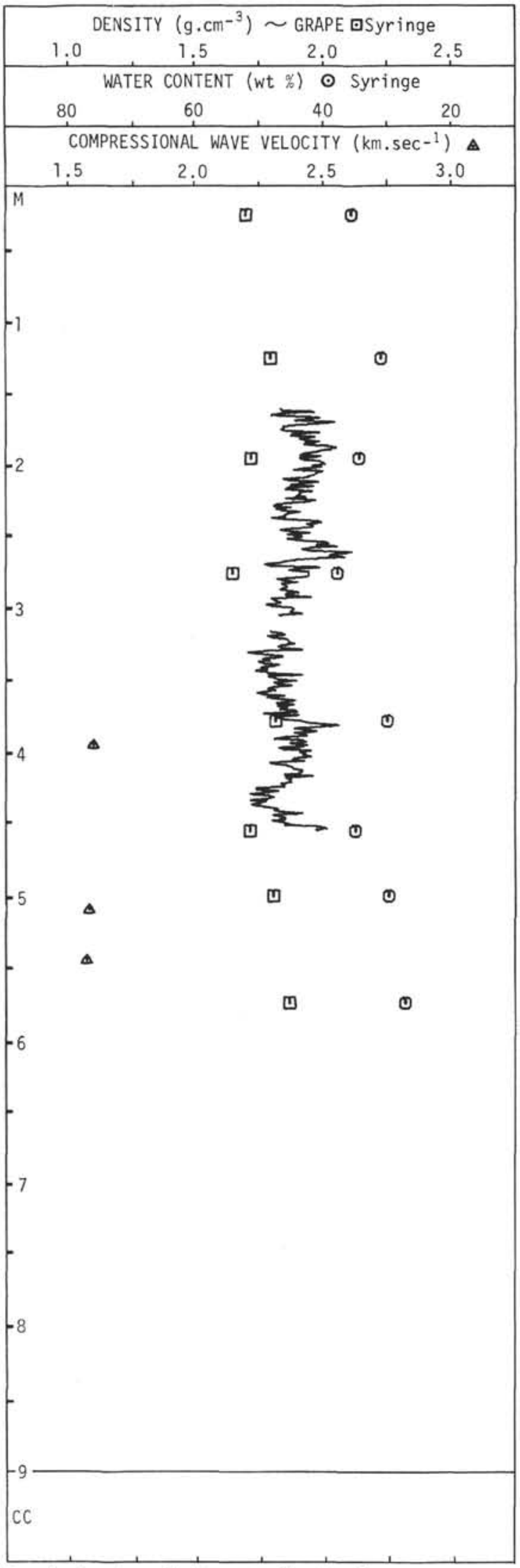

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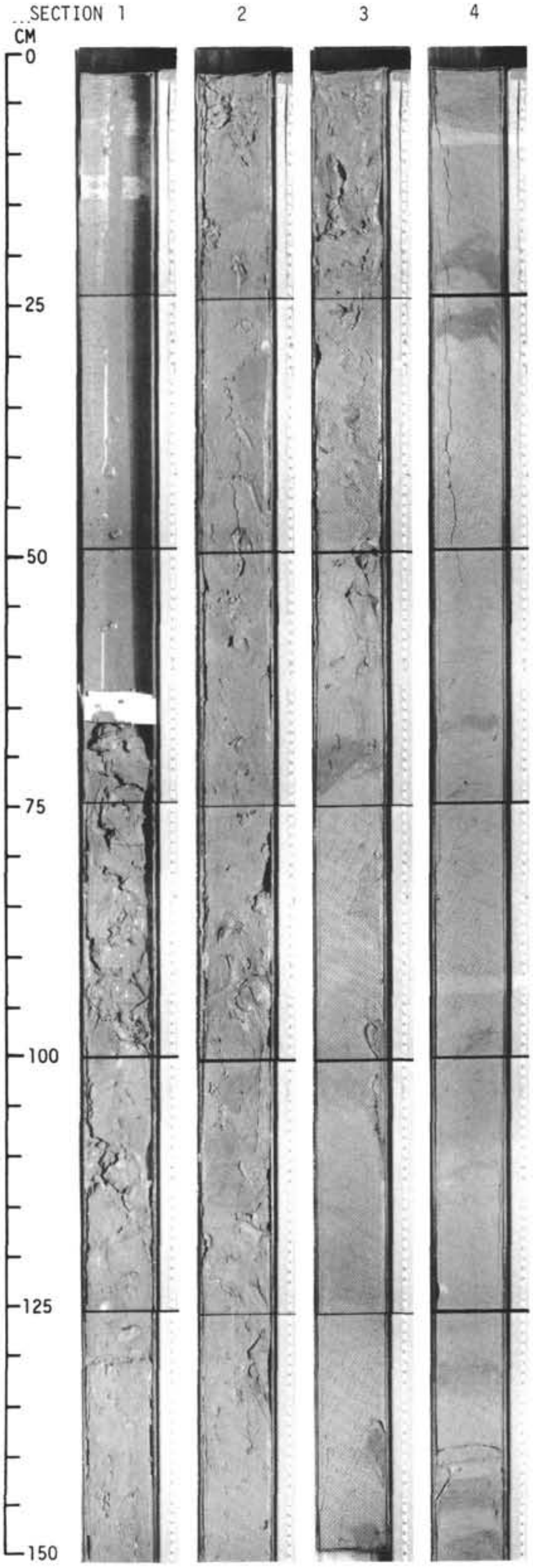

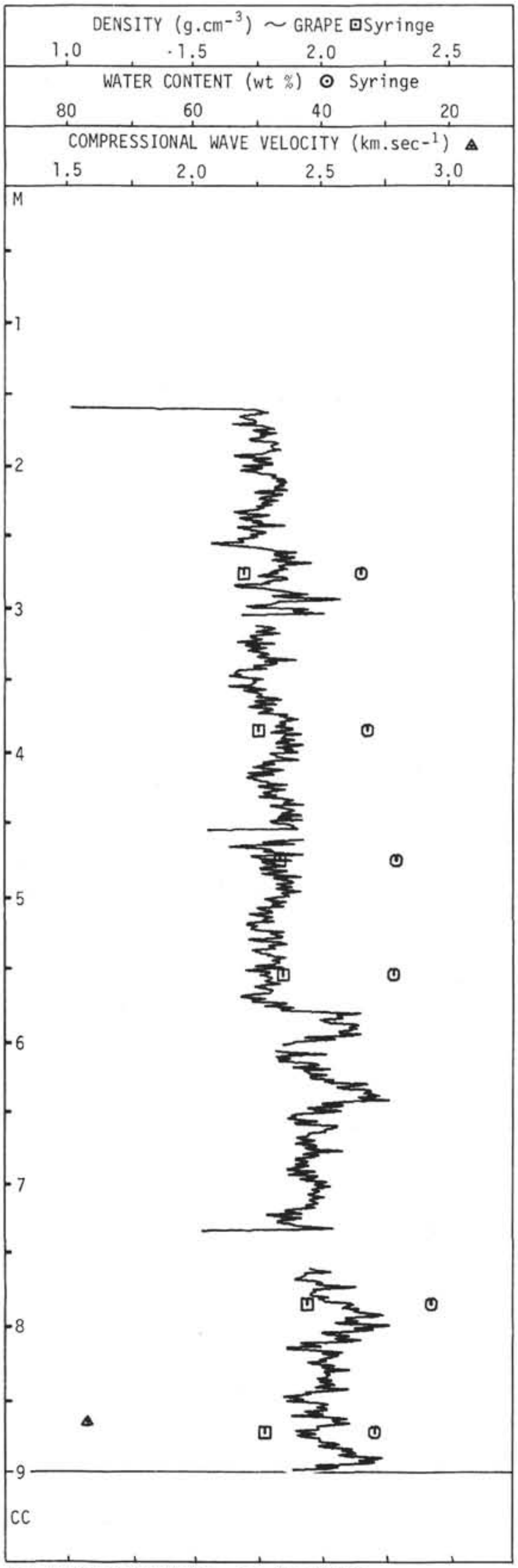

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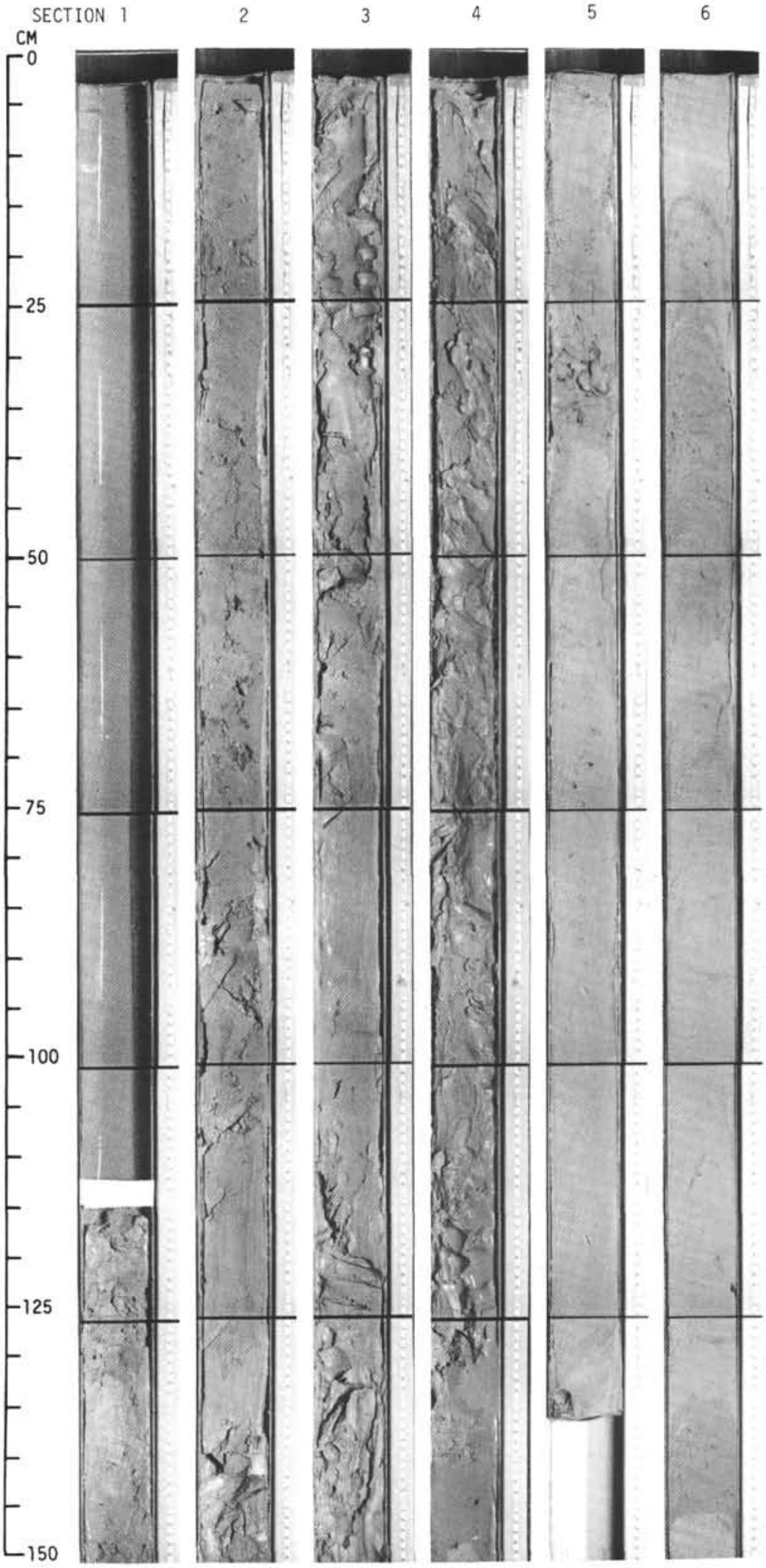

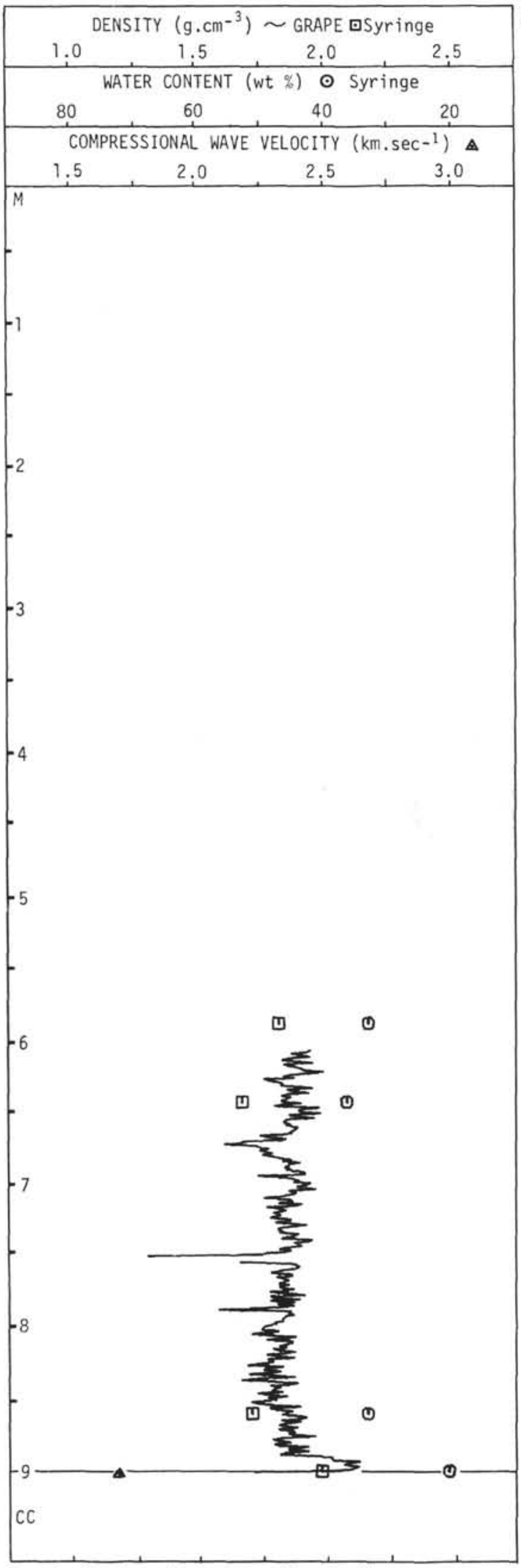

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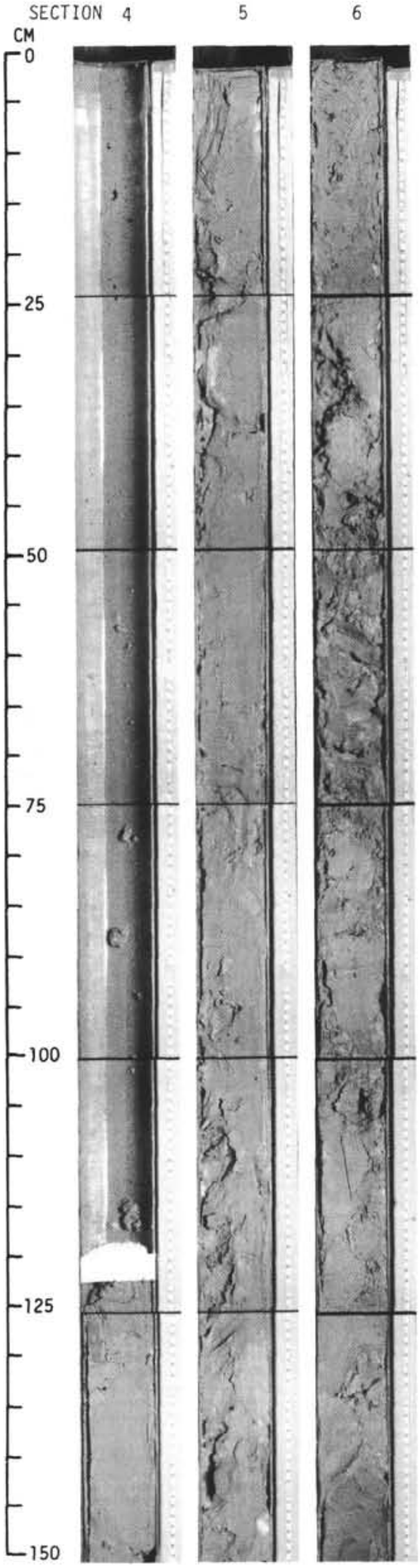

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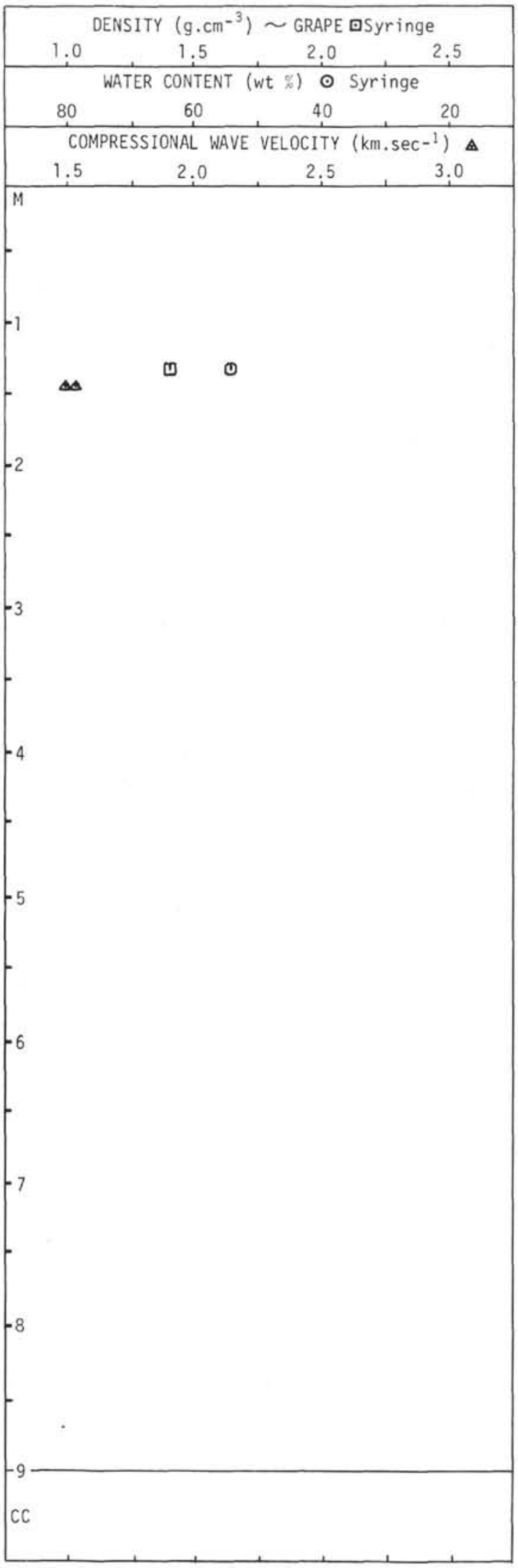

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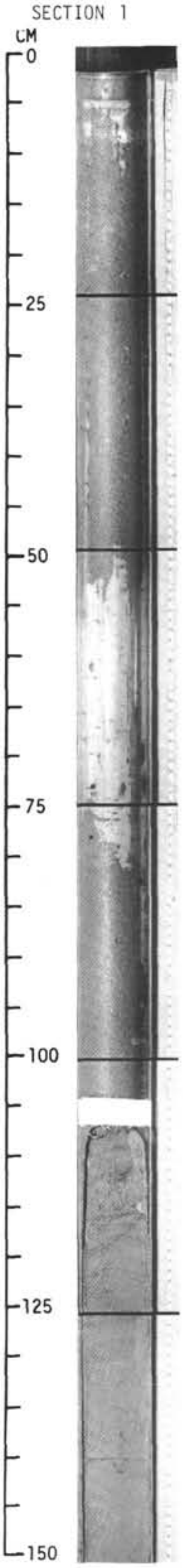

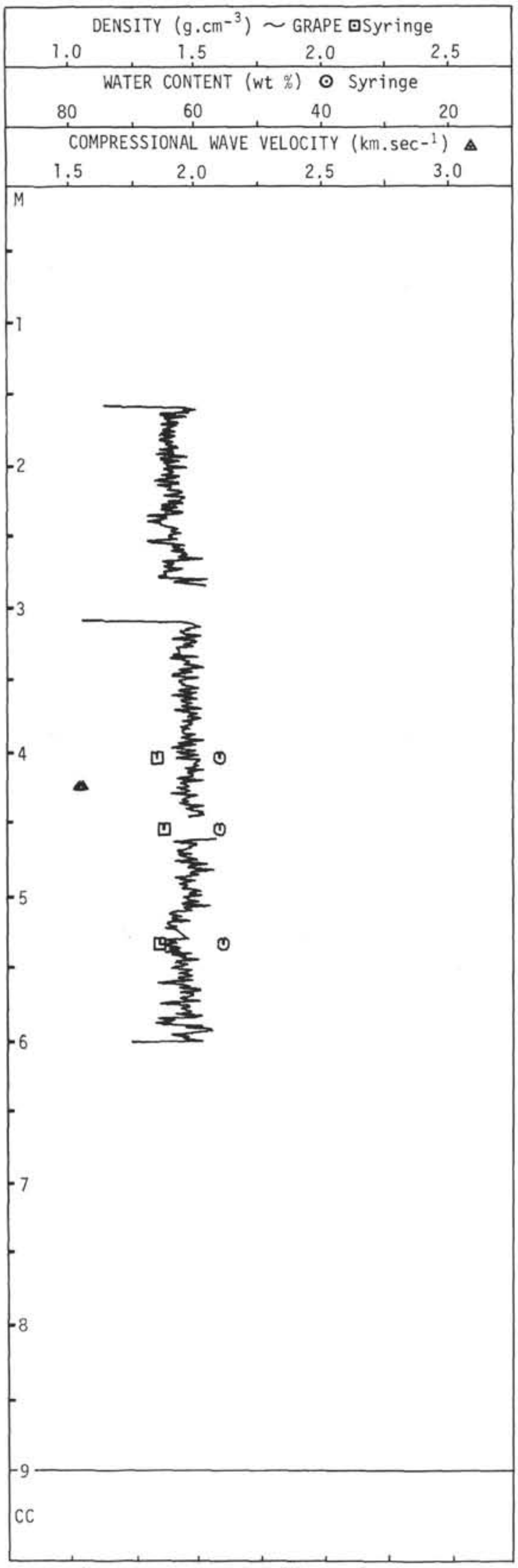

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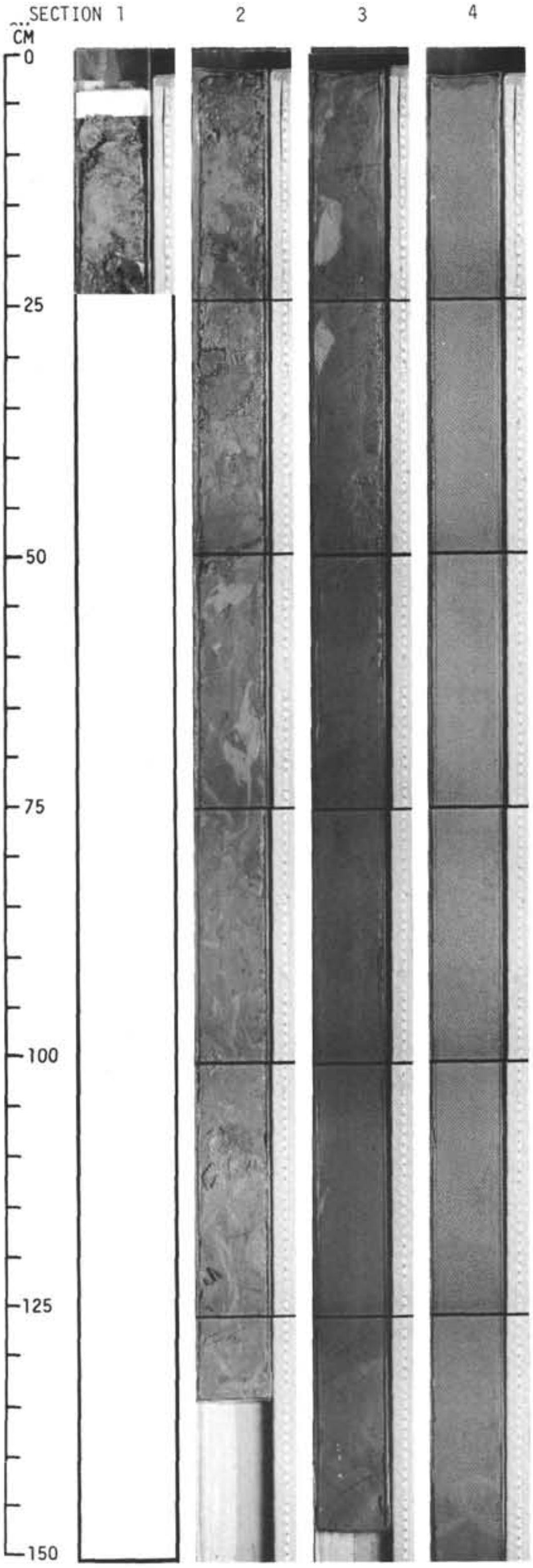

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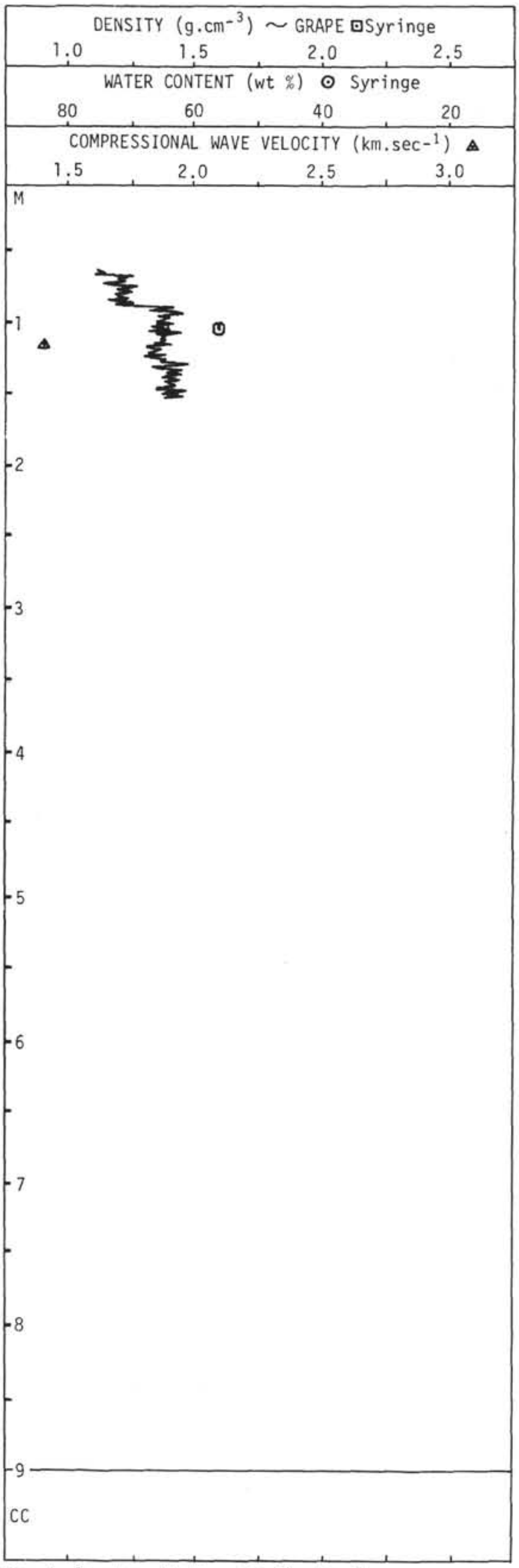

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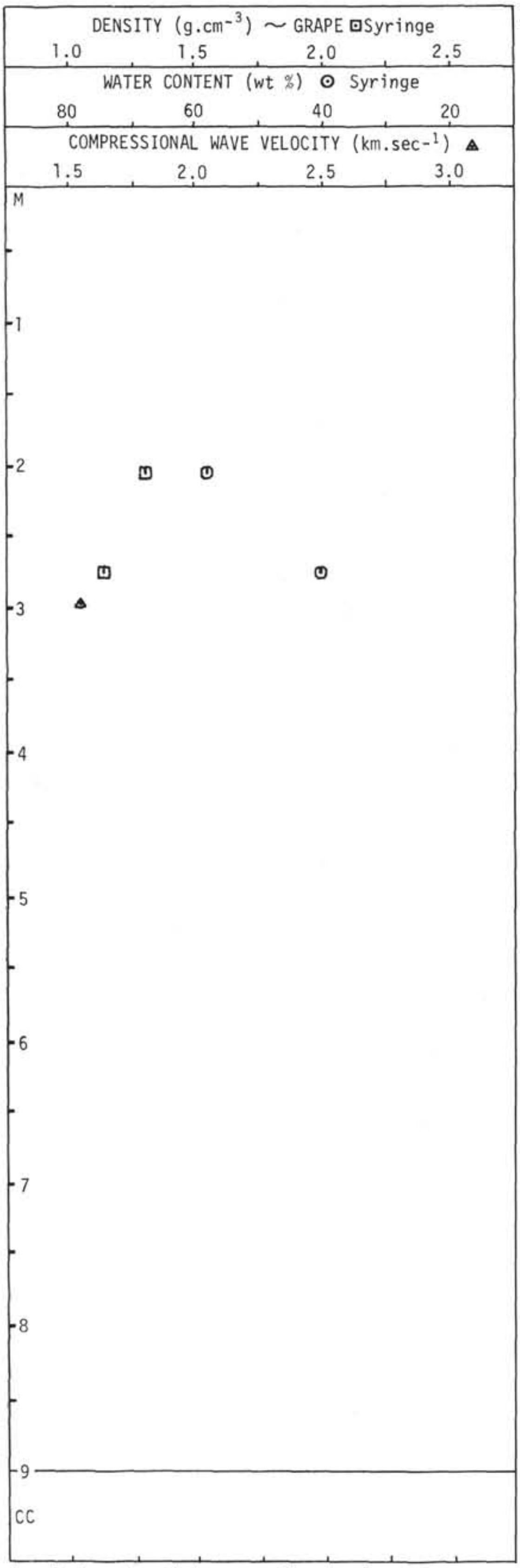

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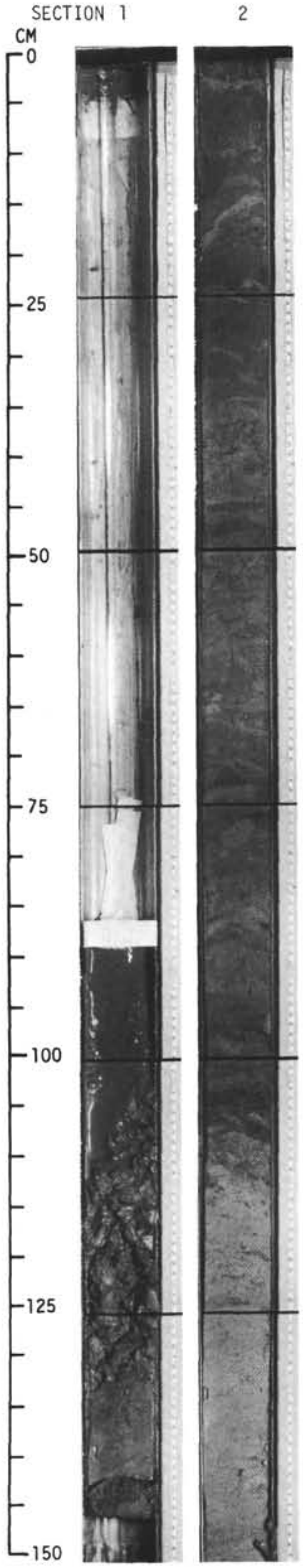

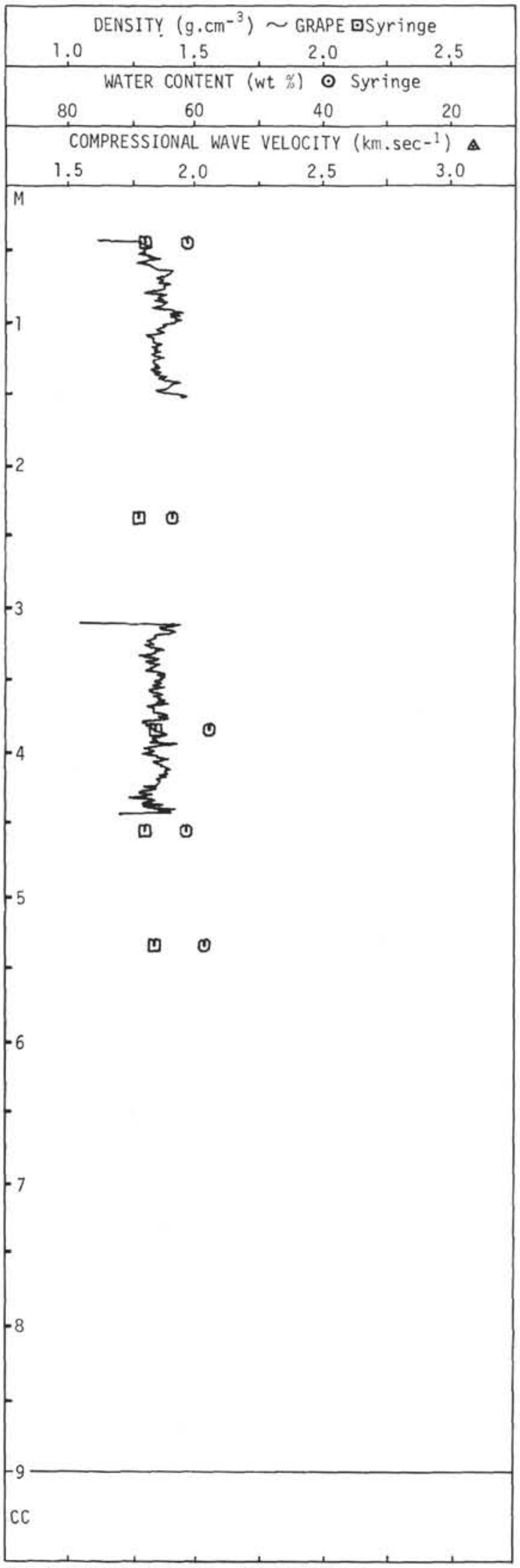

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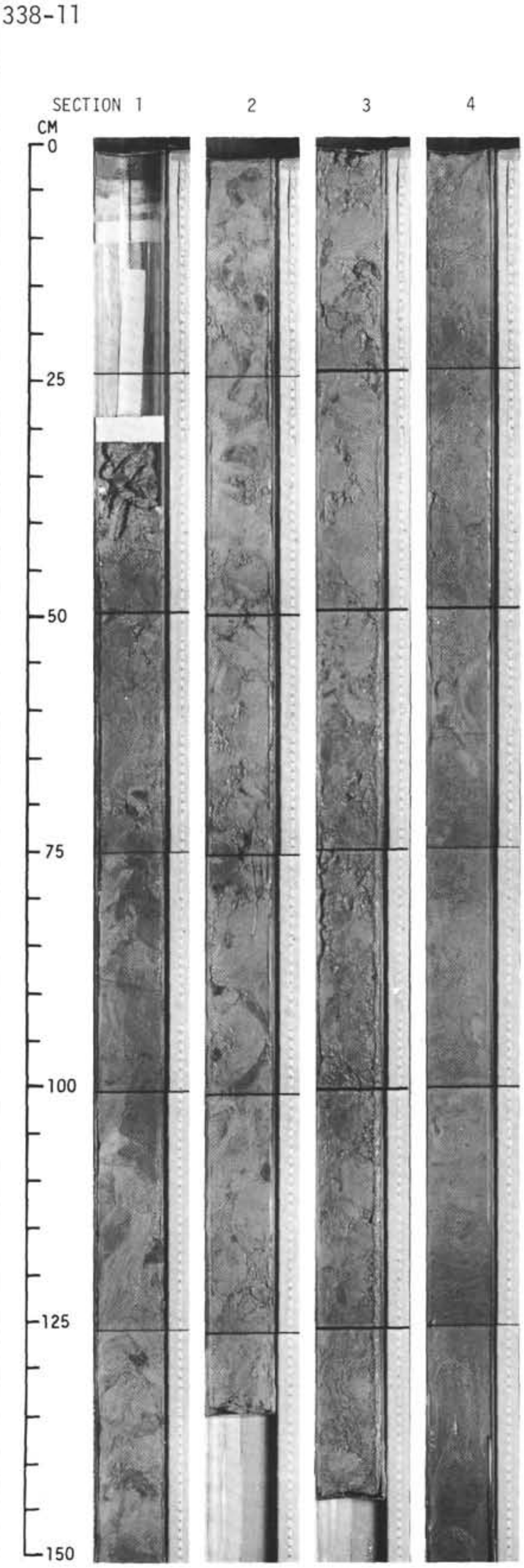

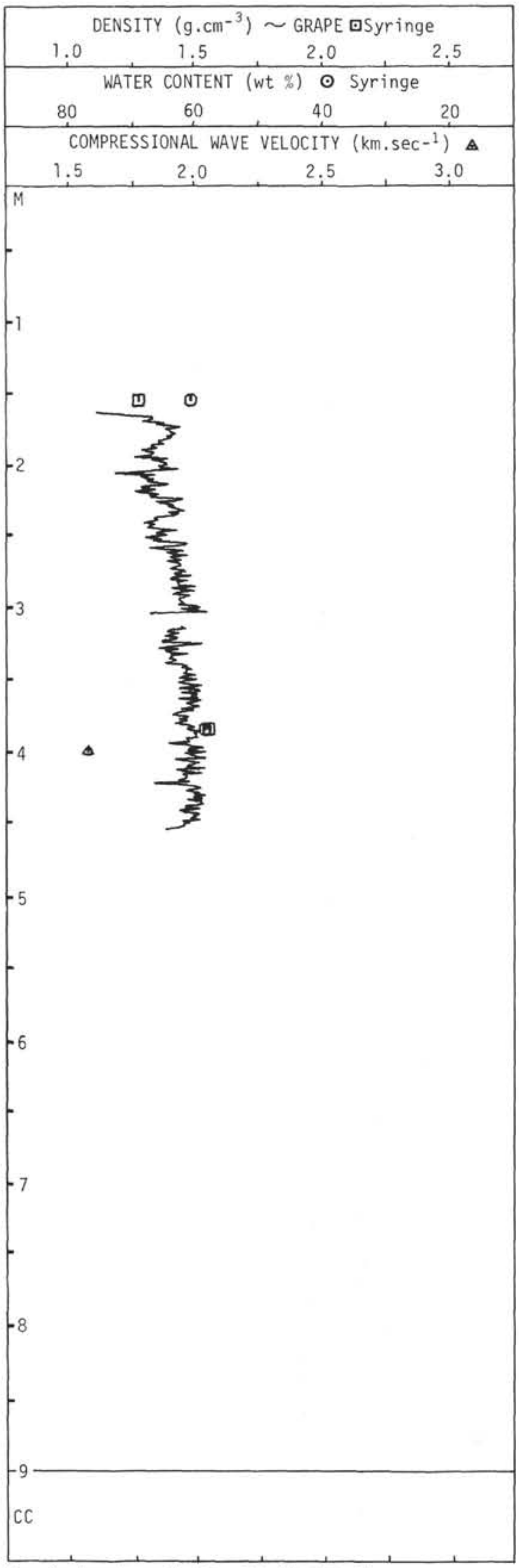

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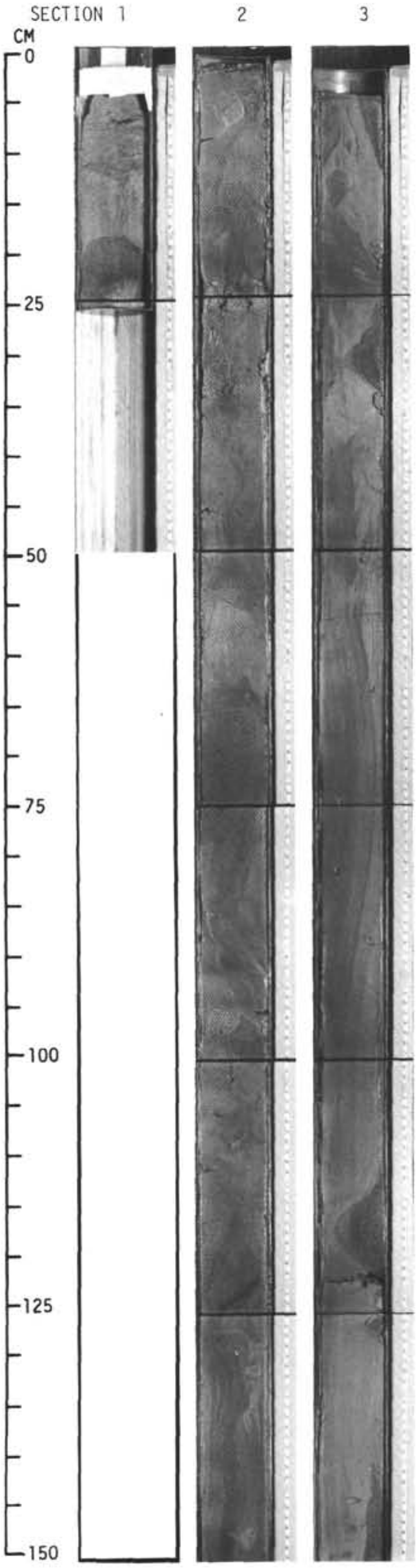

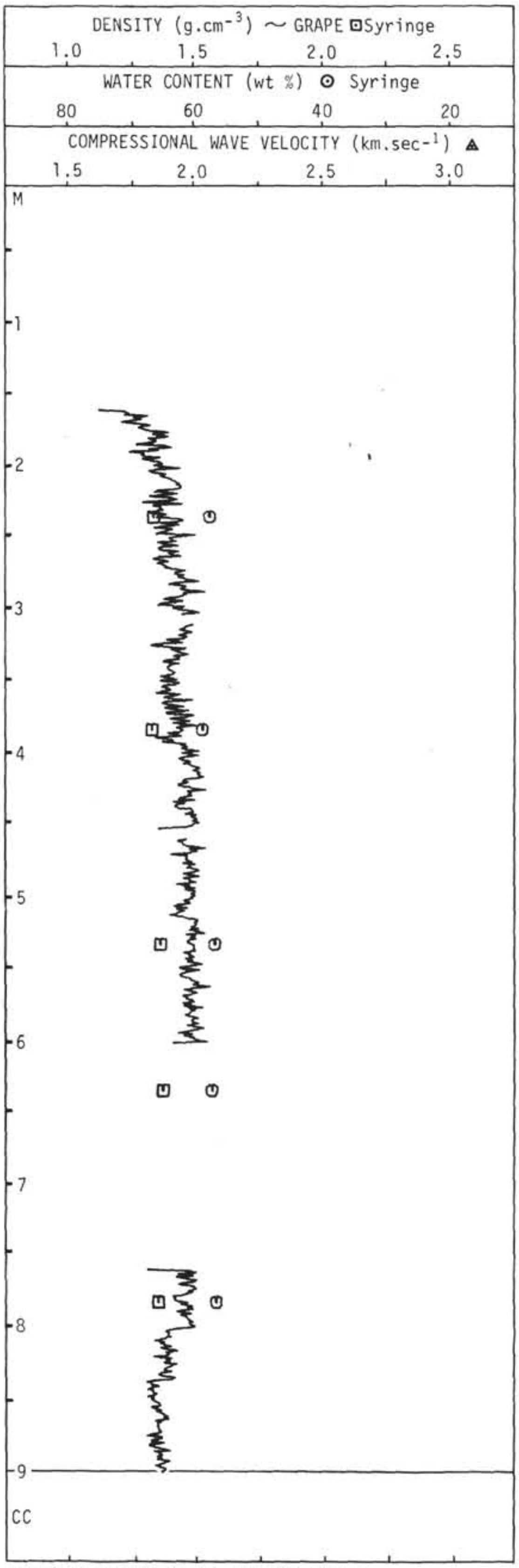

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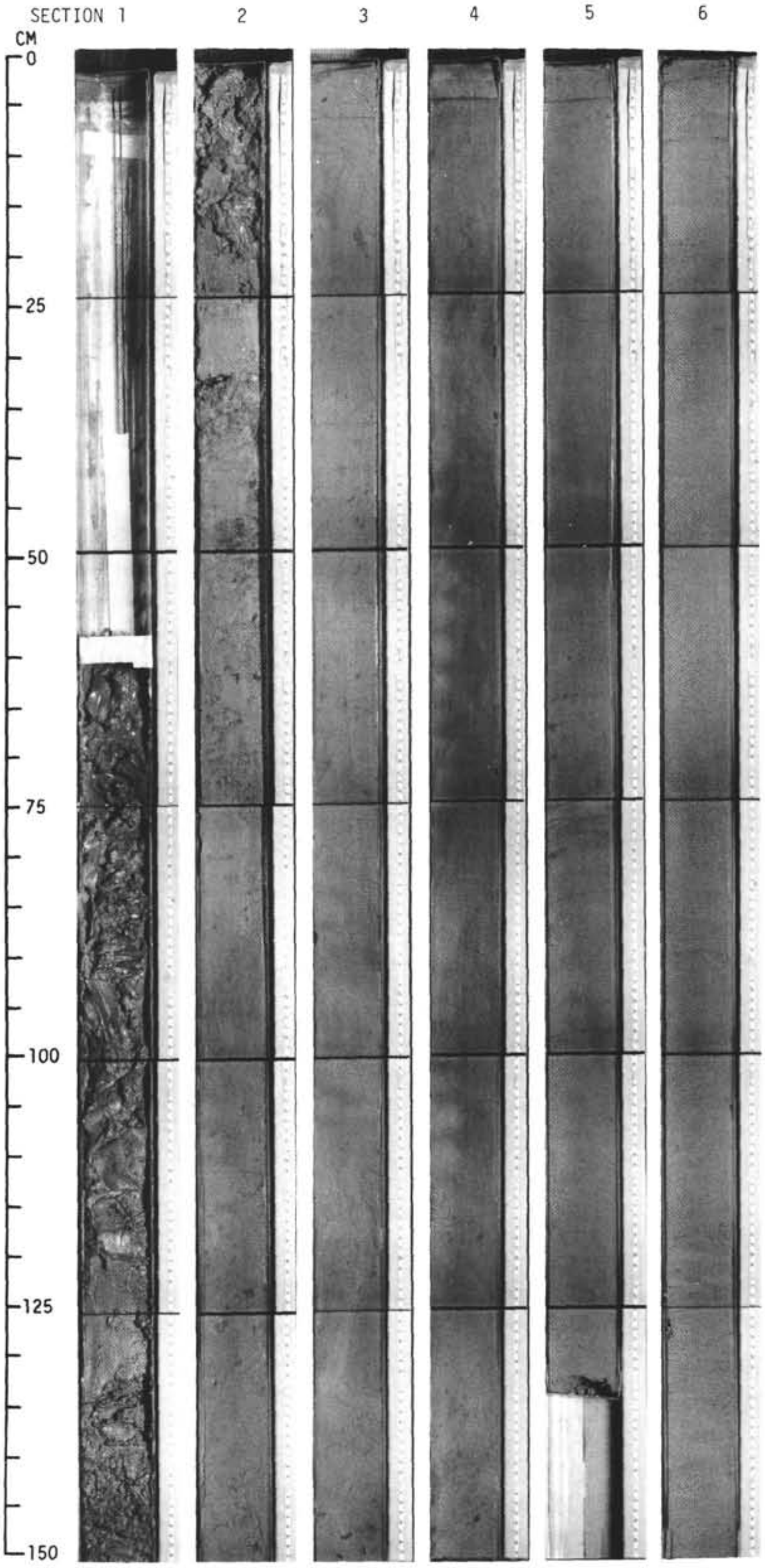

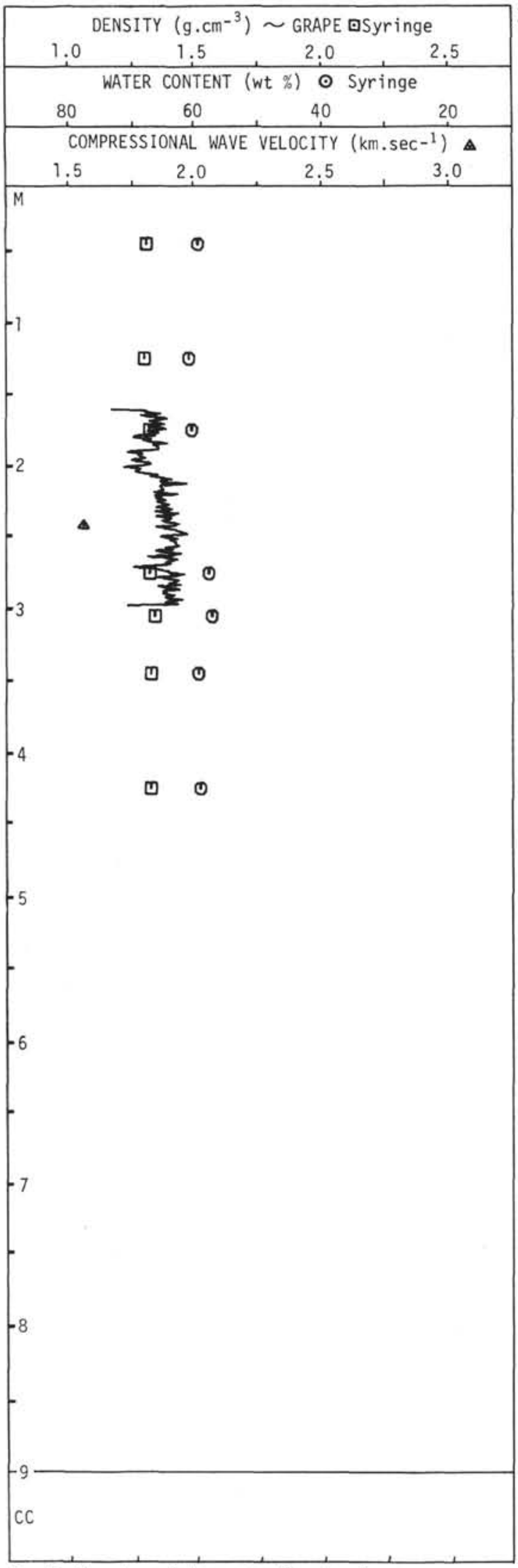

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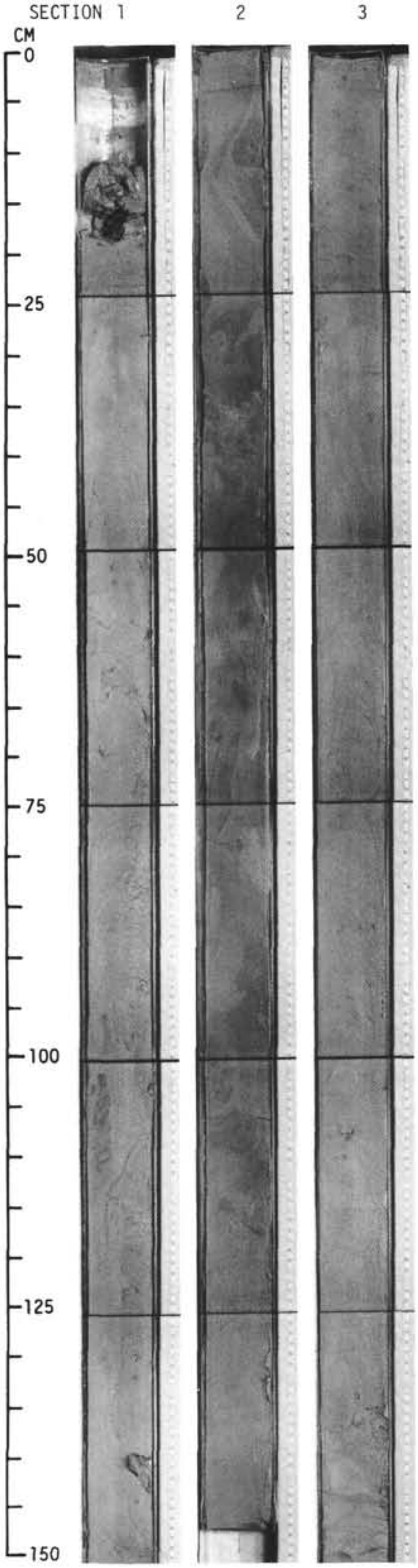

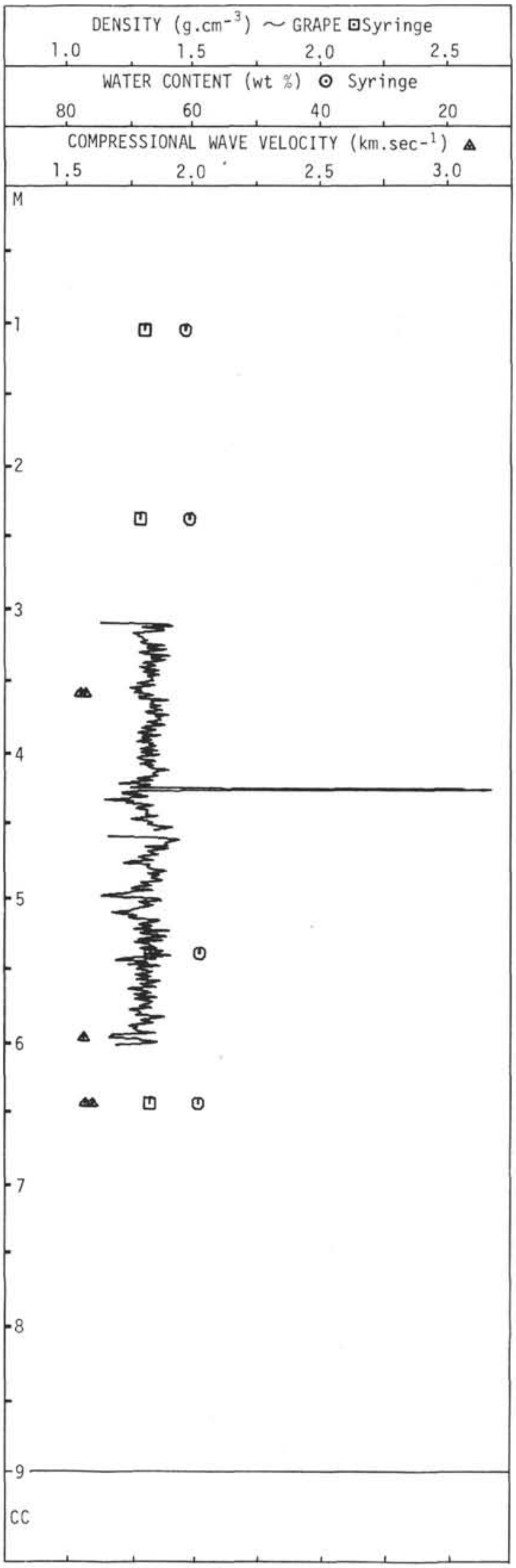

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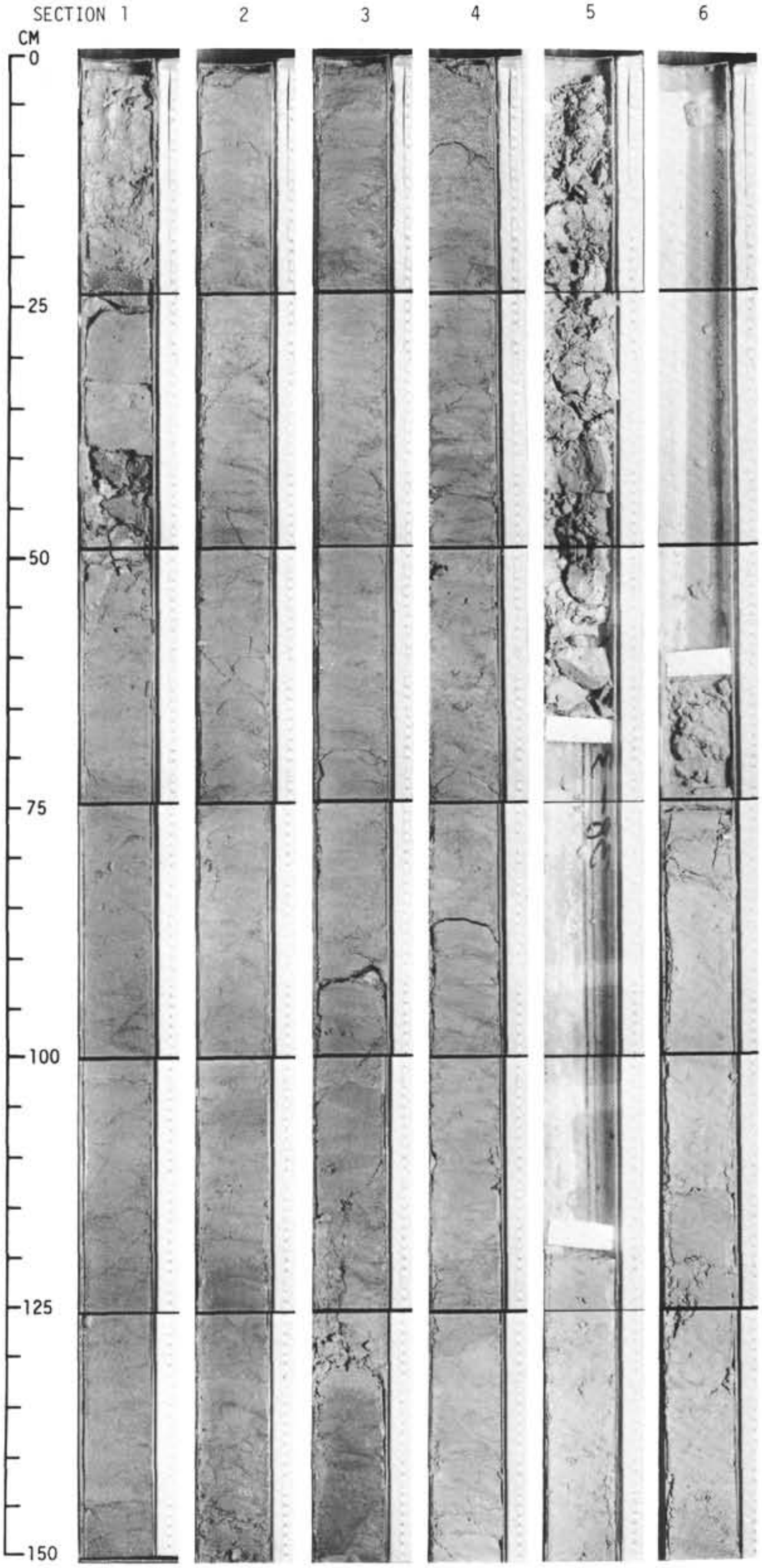

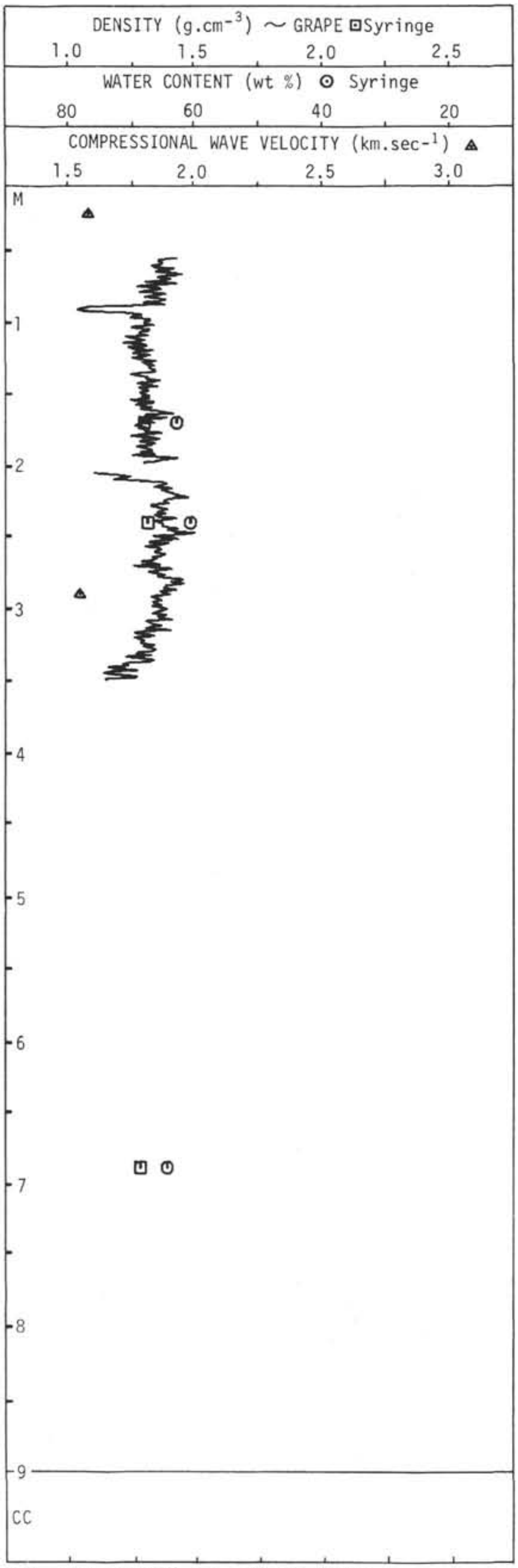

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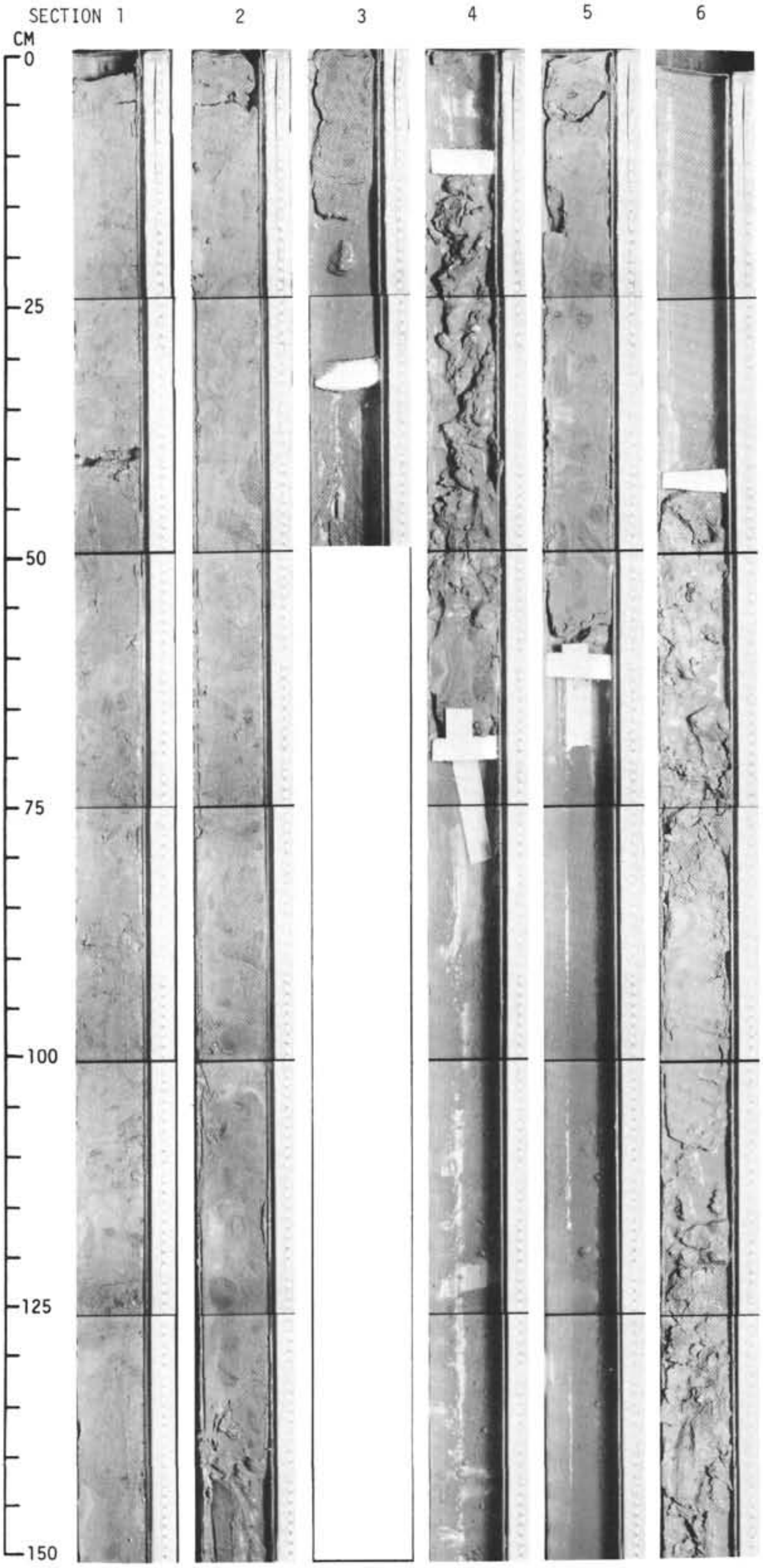

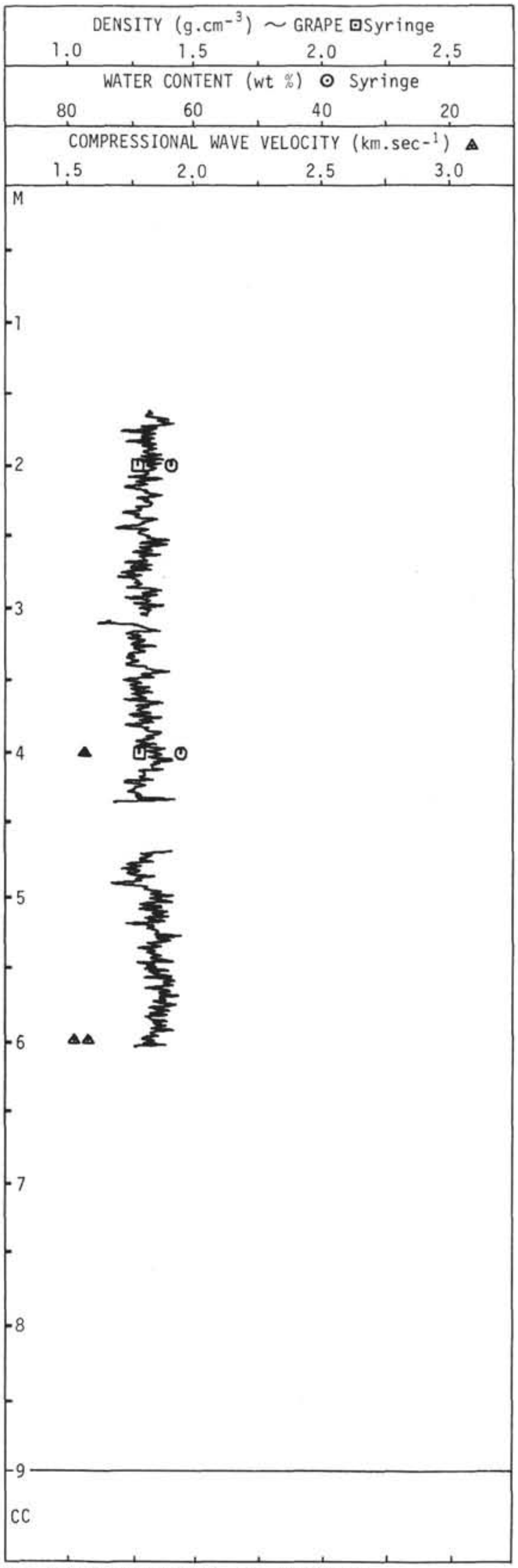

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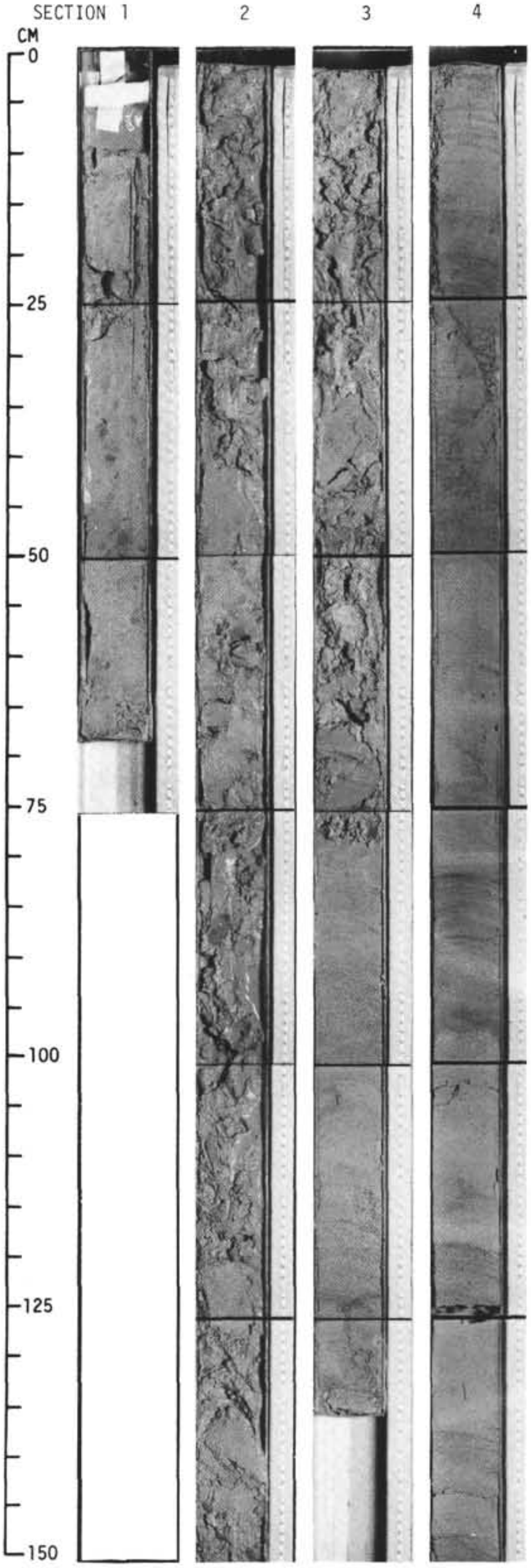

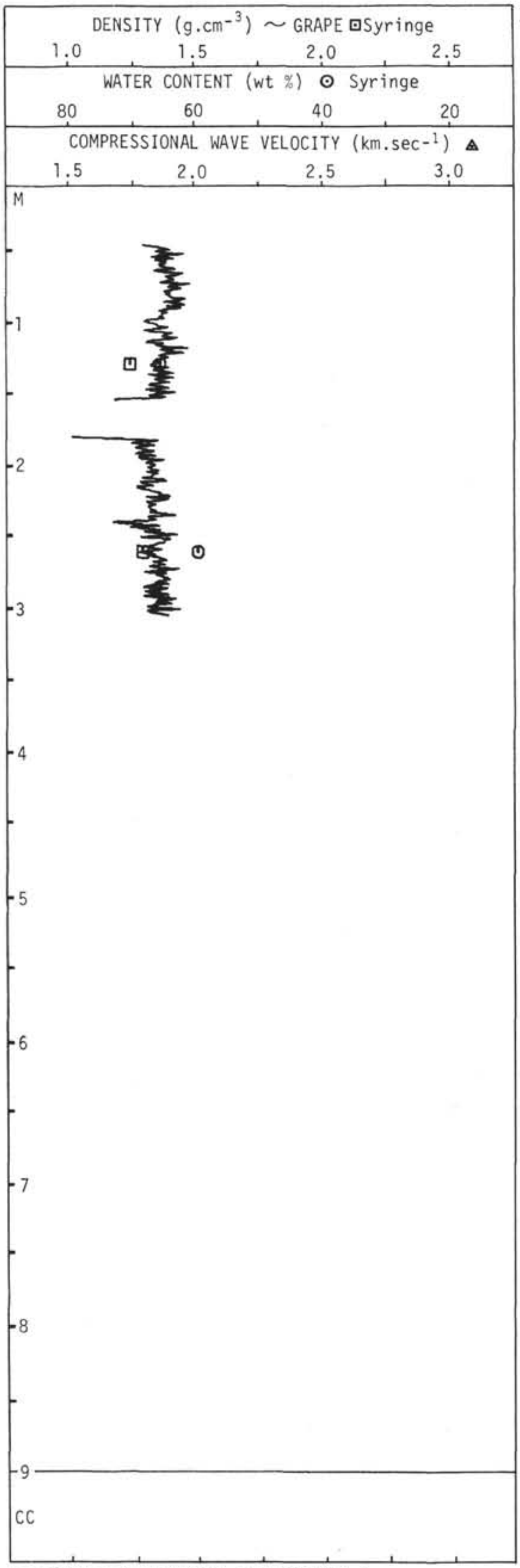

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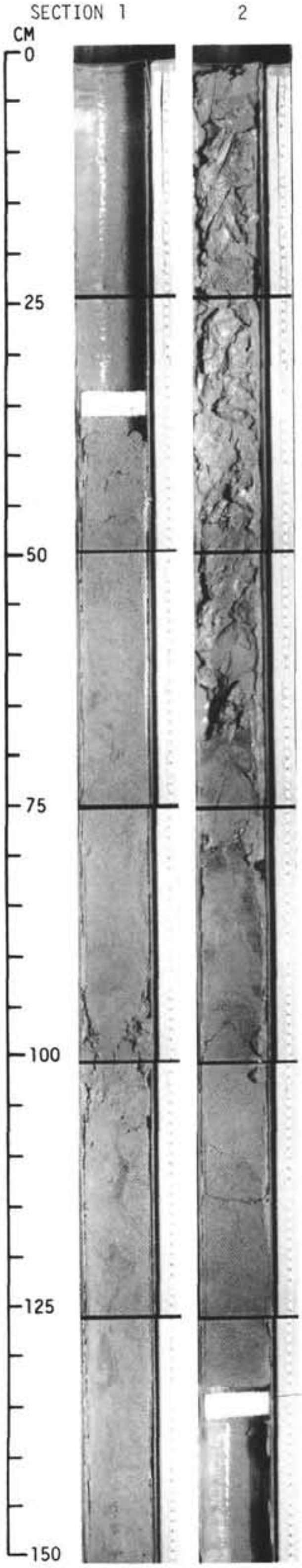

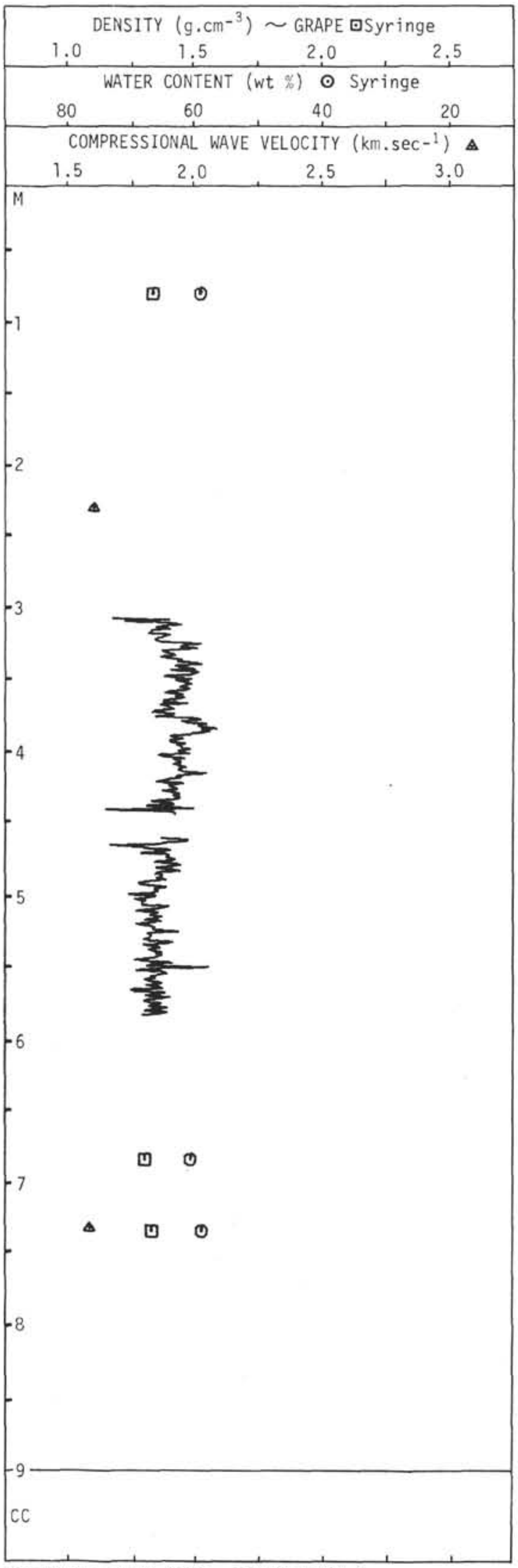

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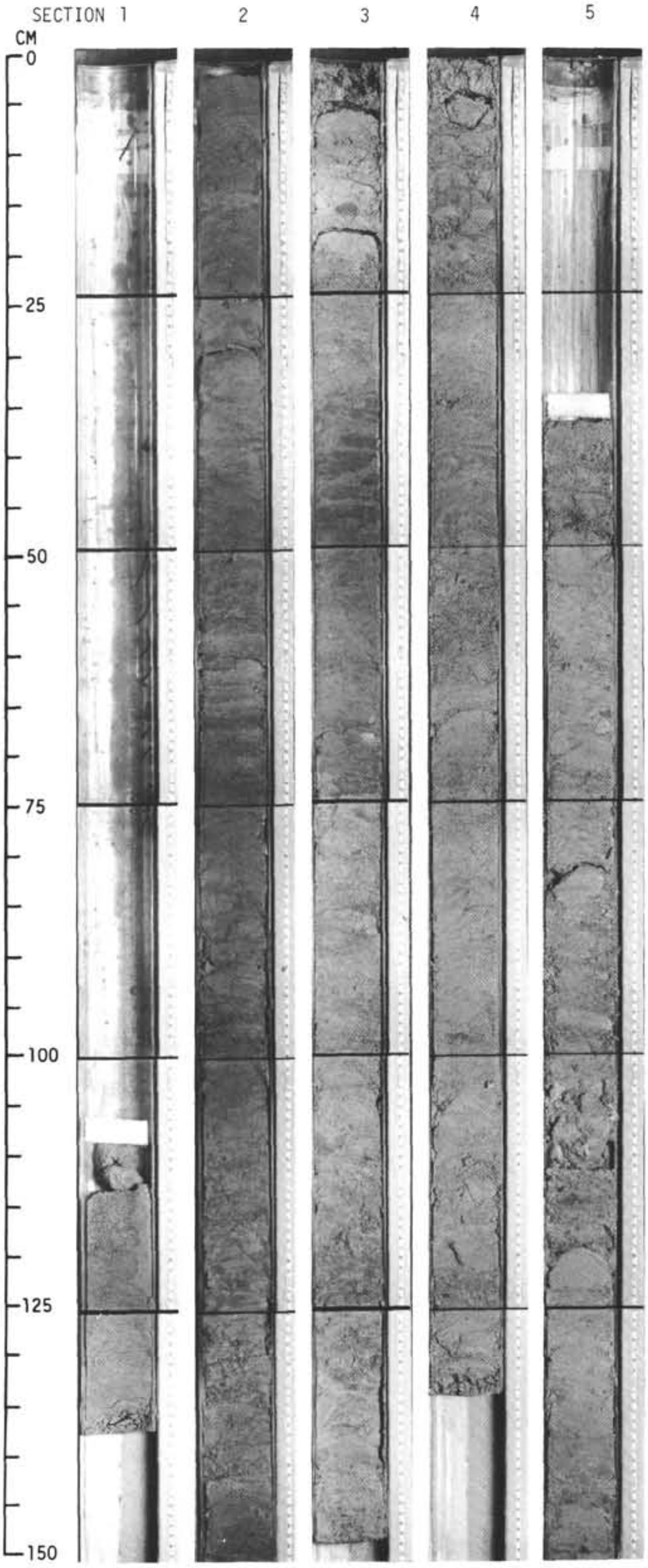

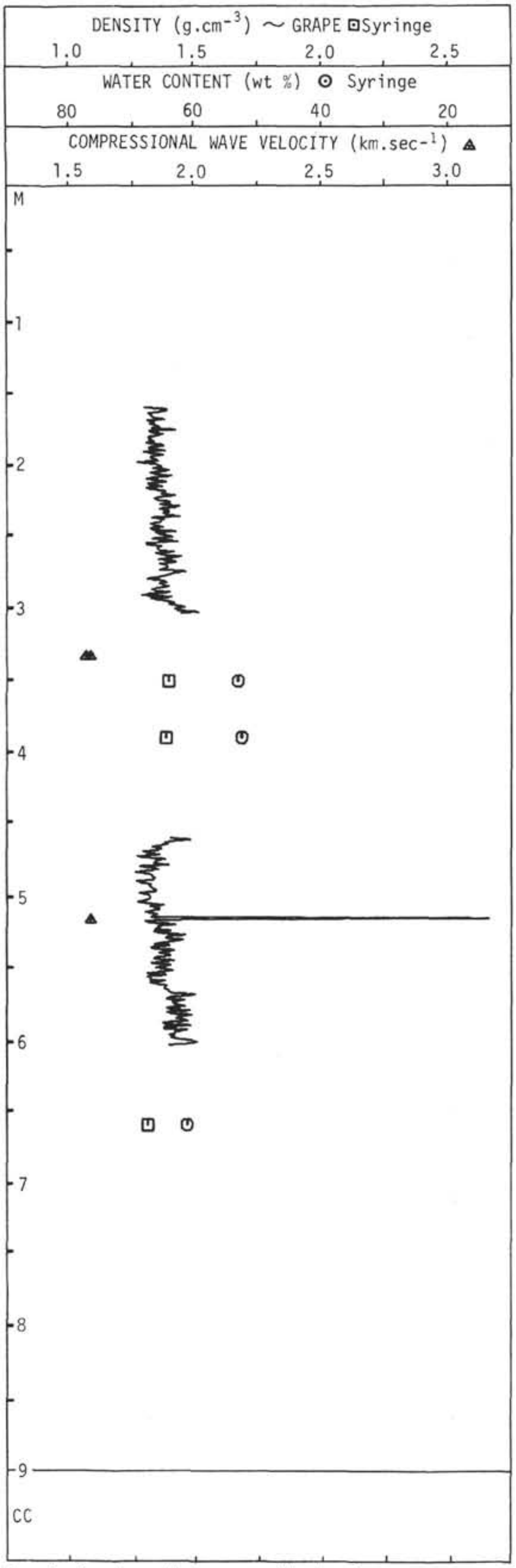

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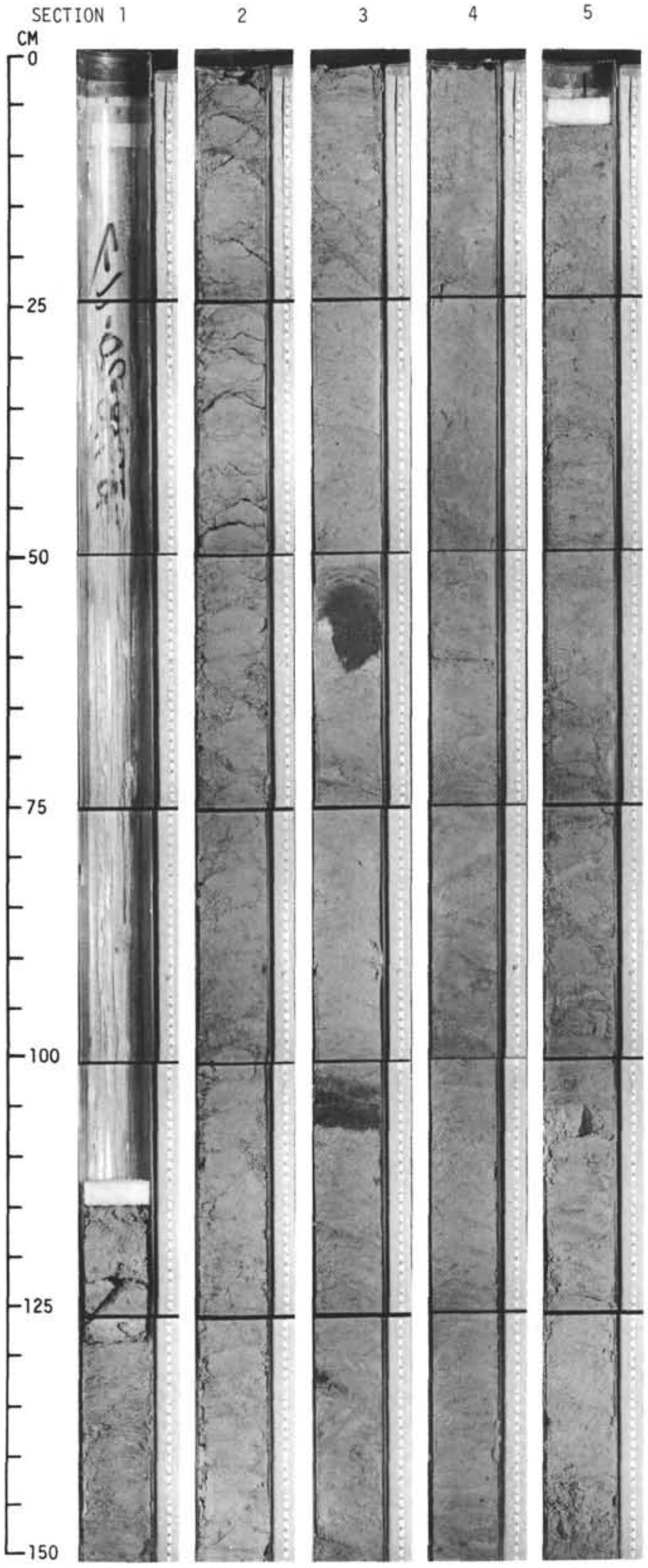

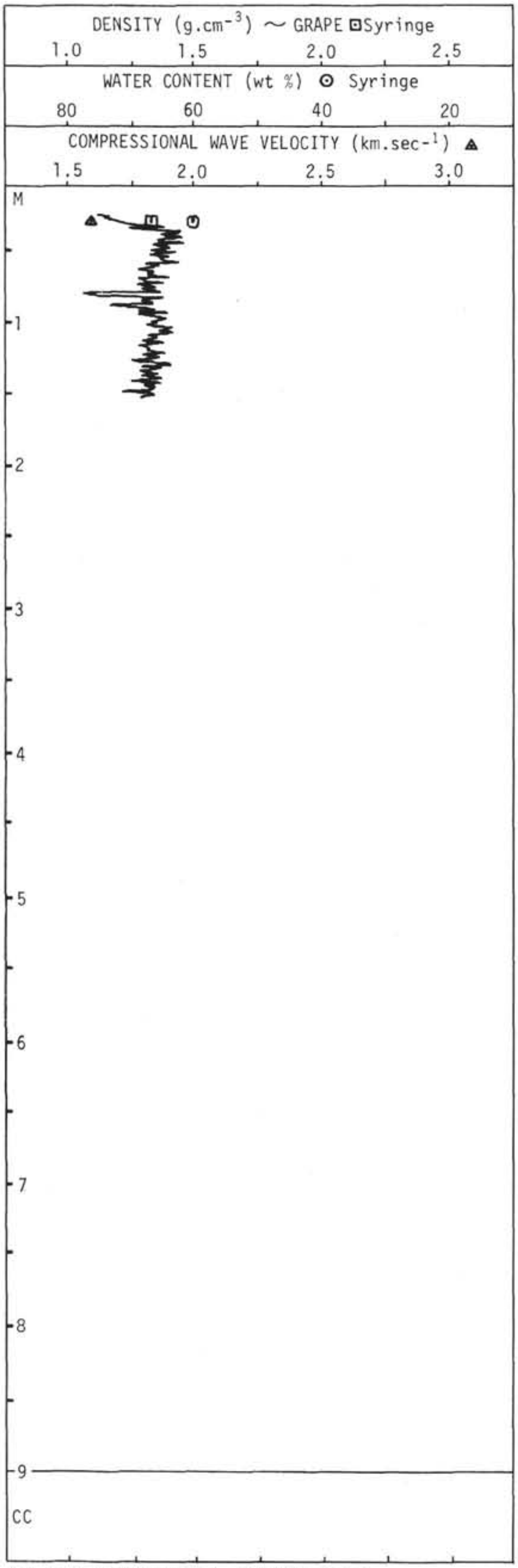

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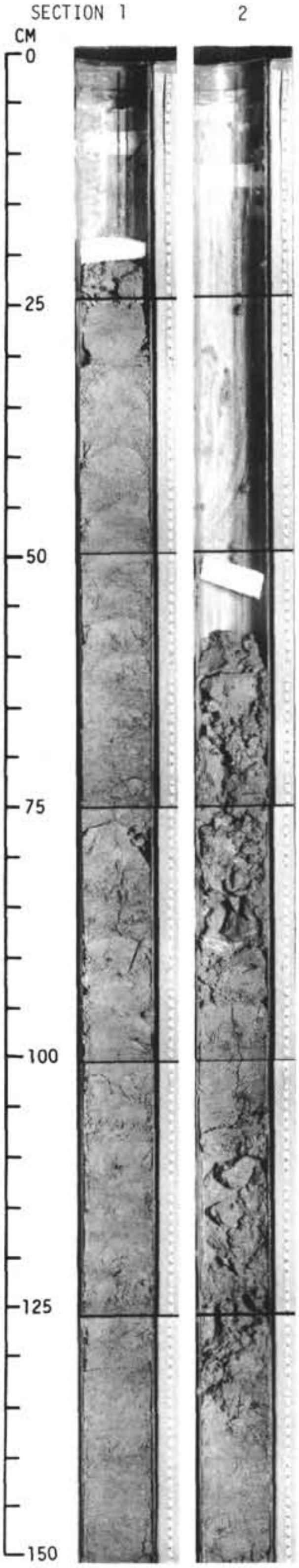
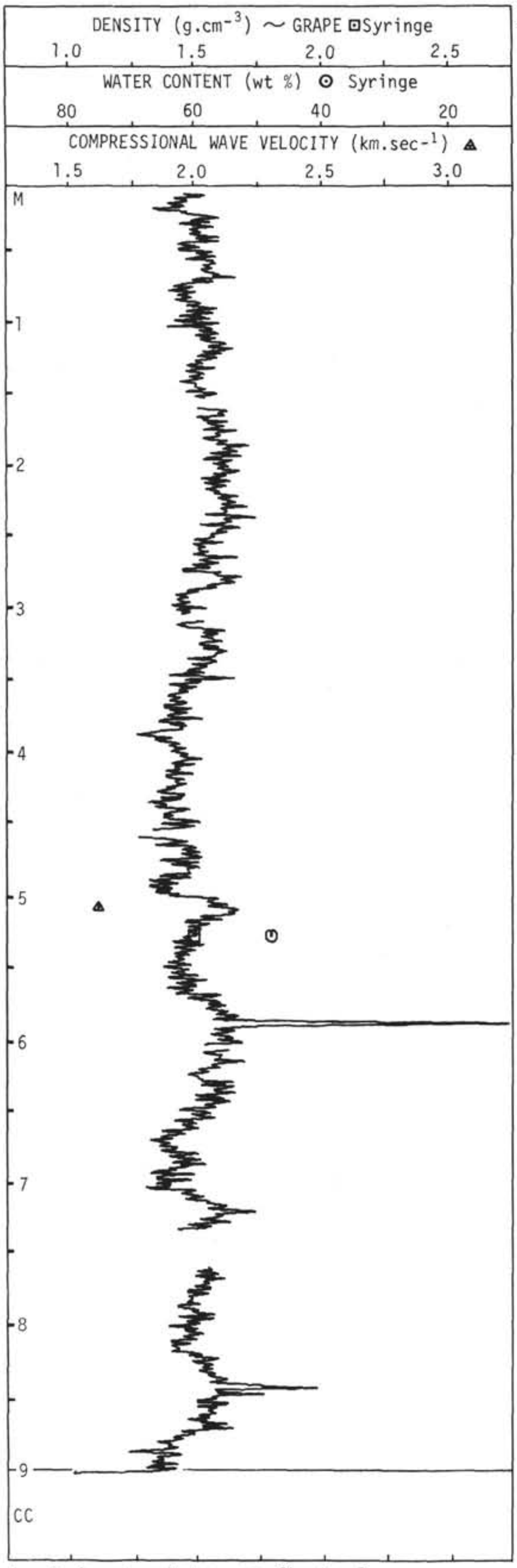
338-21





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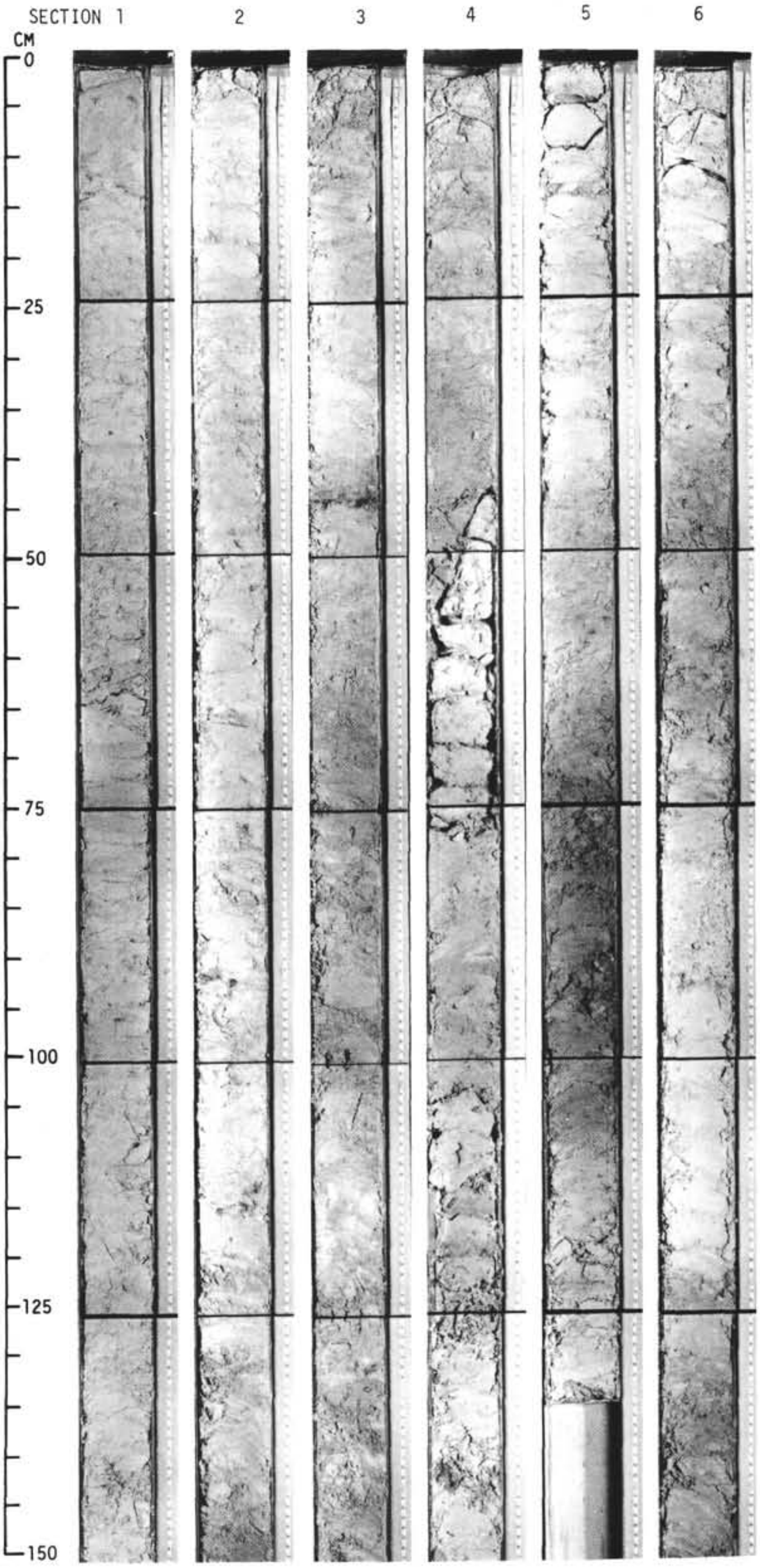

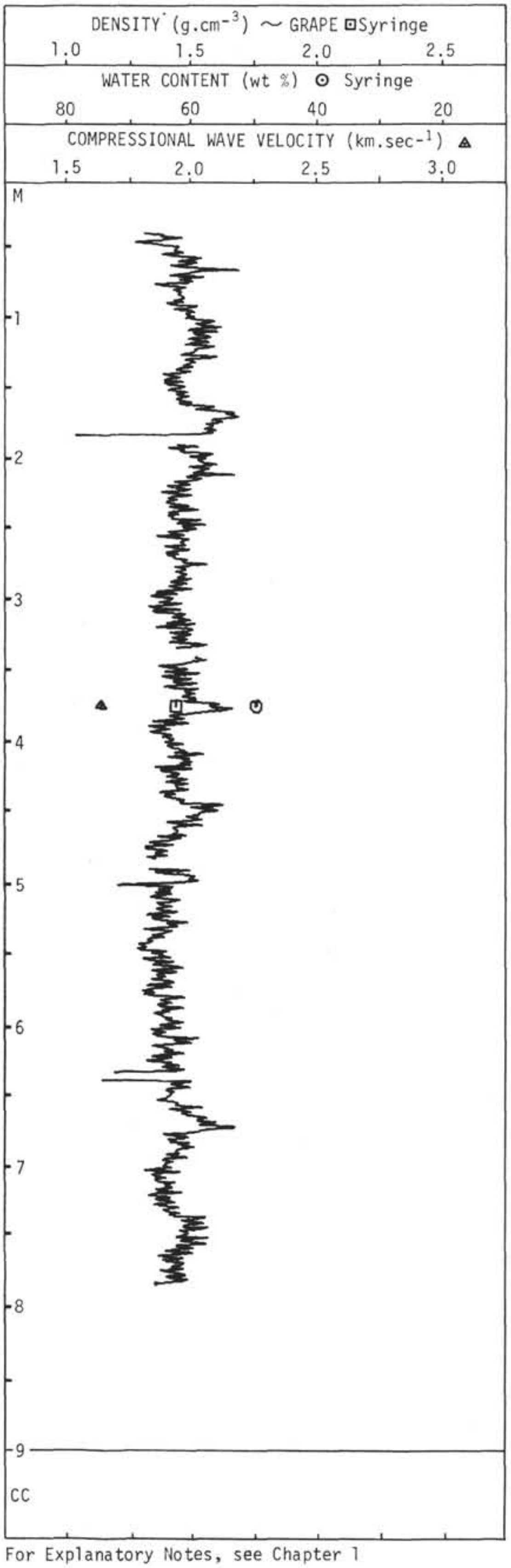

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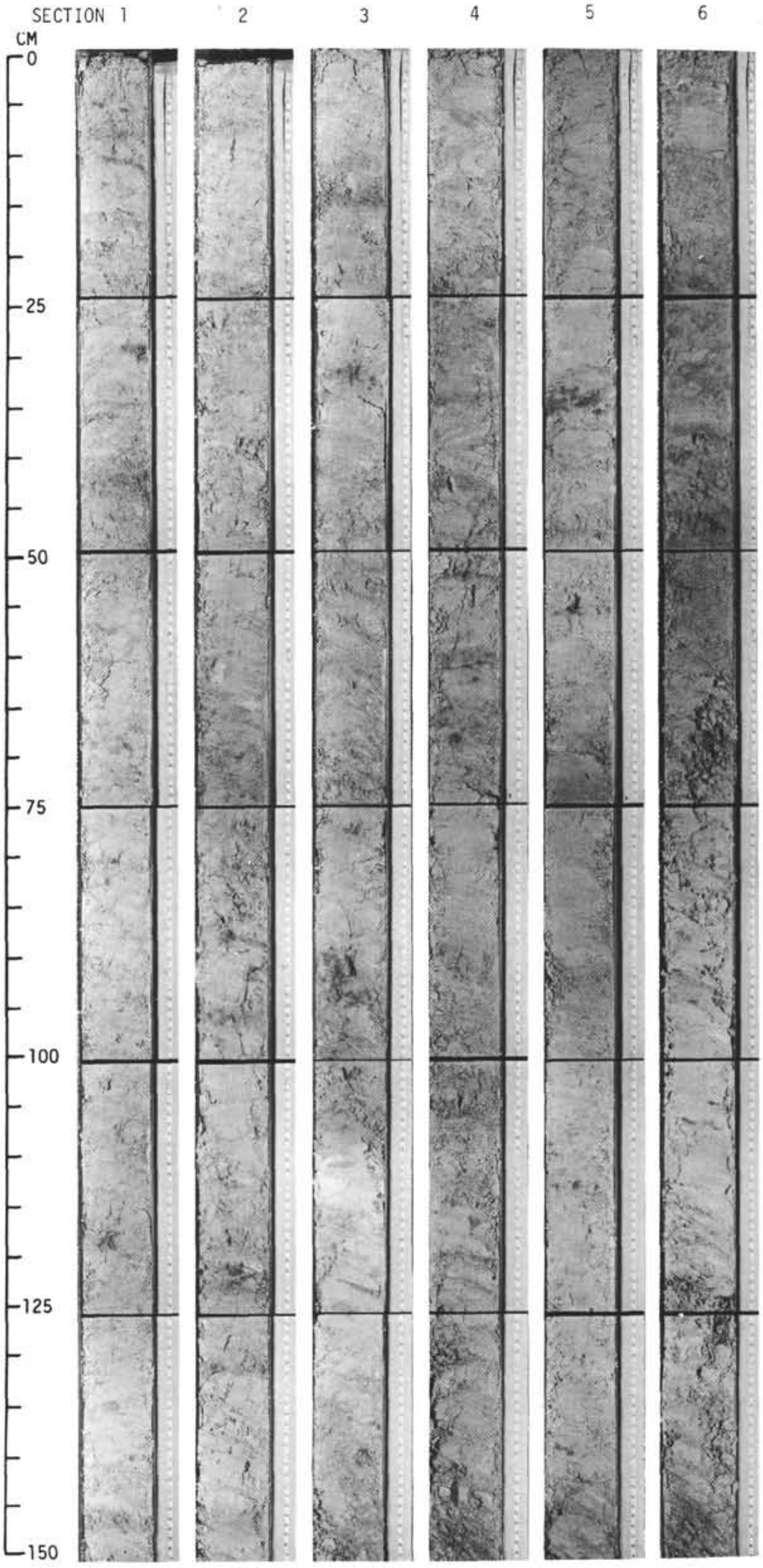

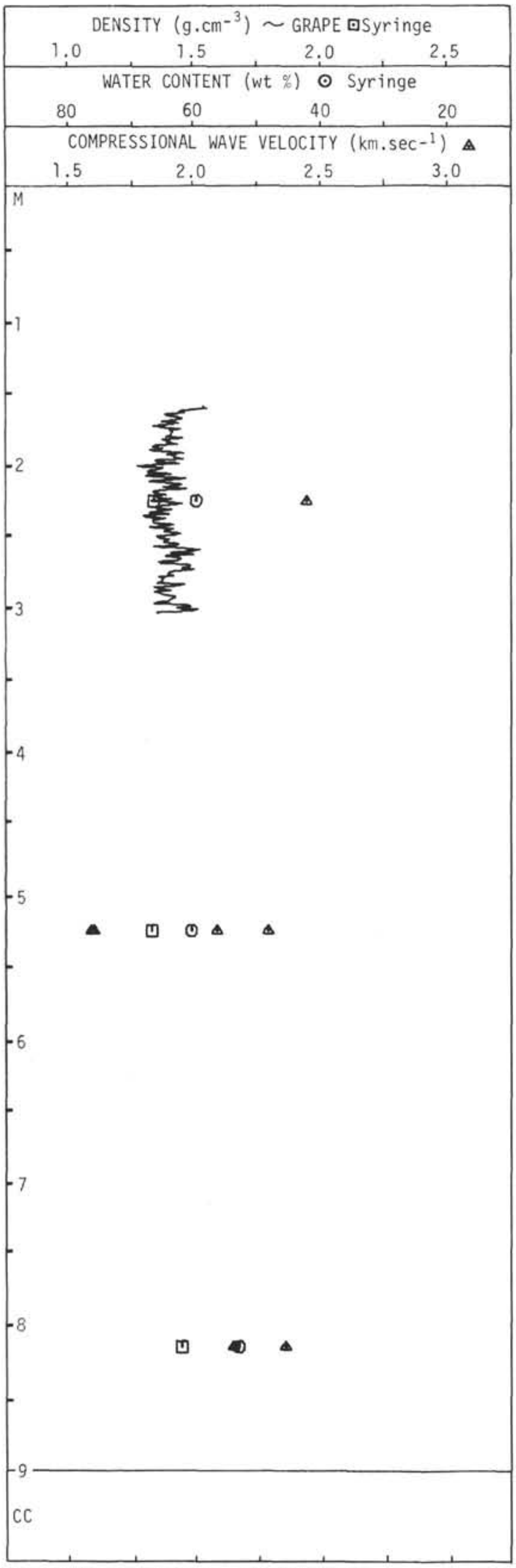

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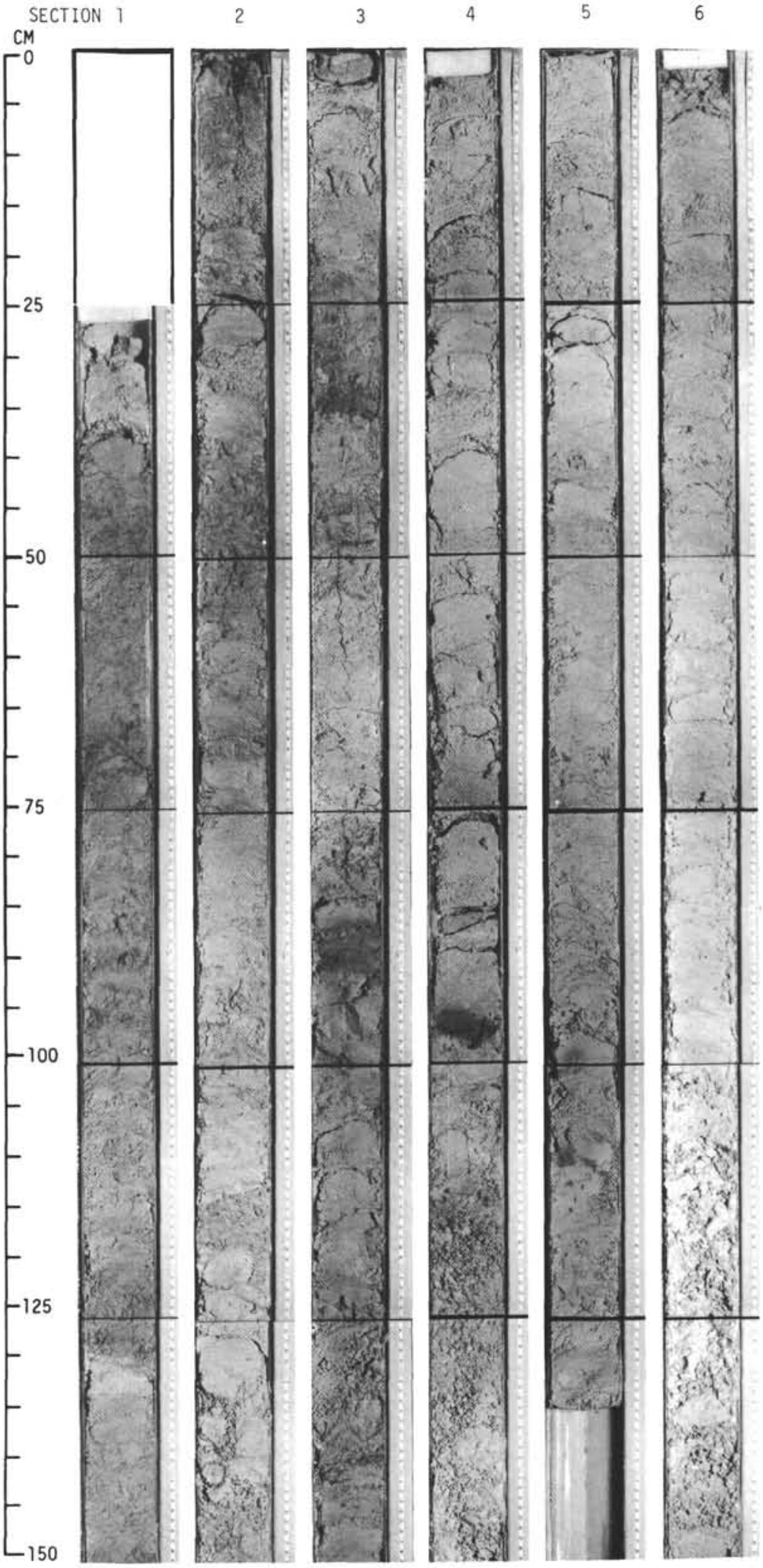

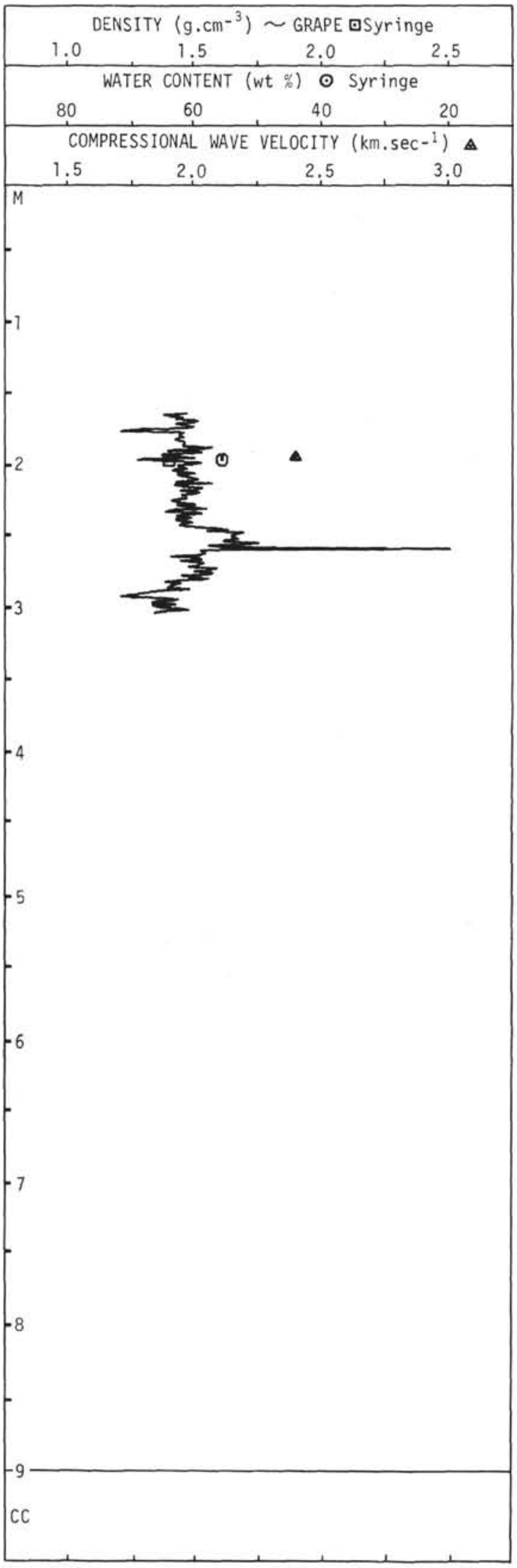

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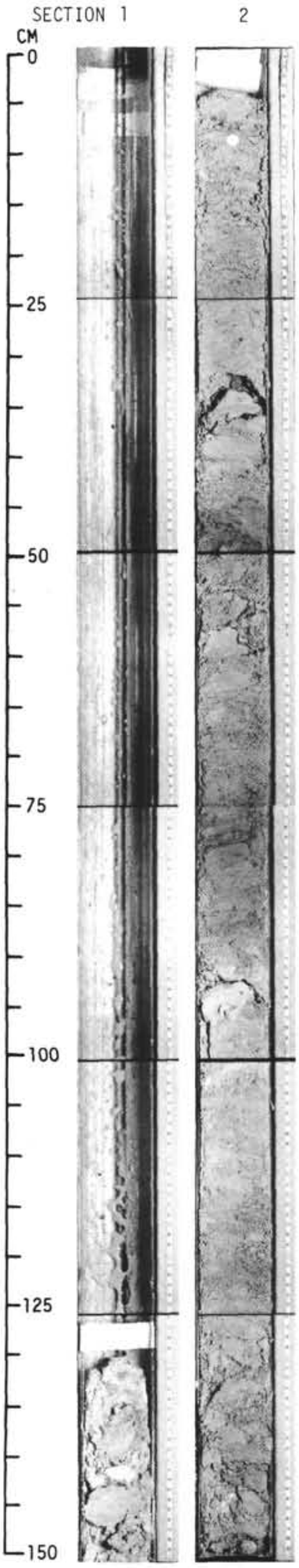

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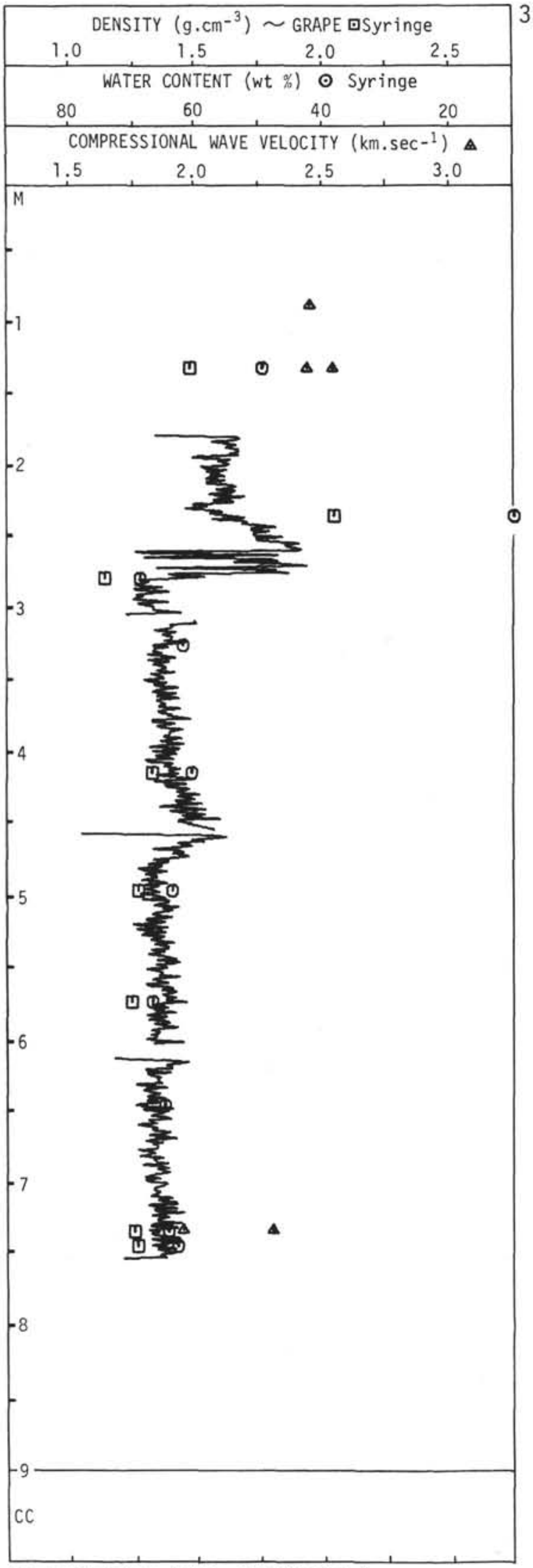

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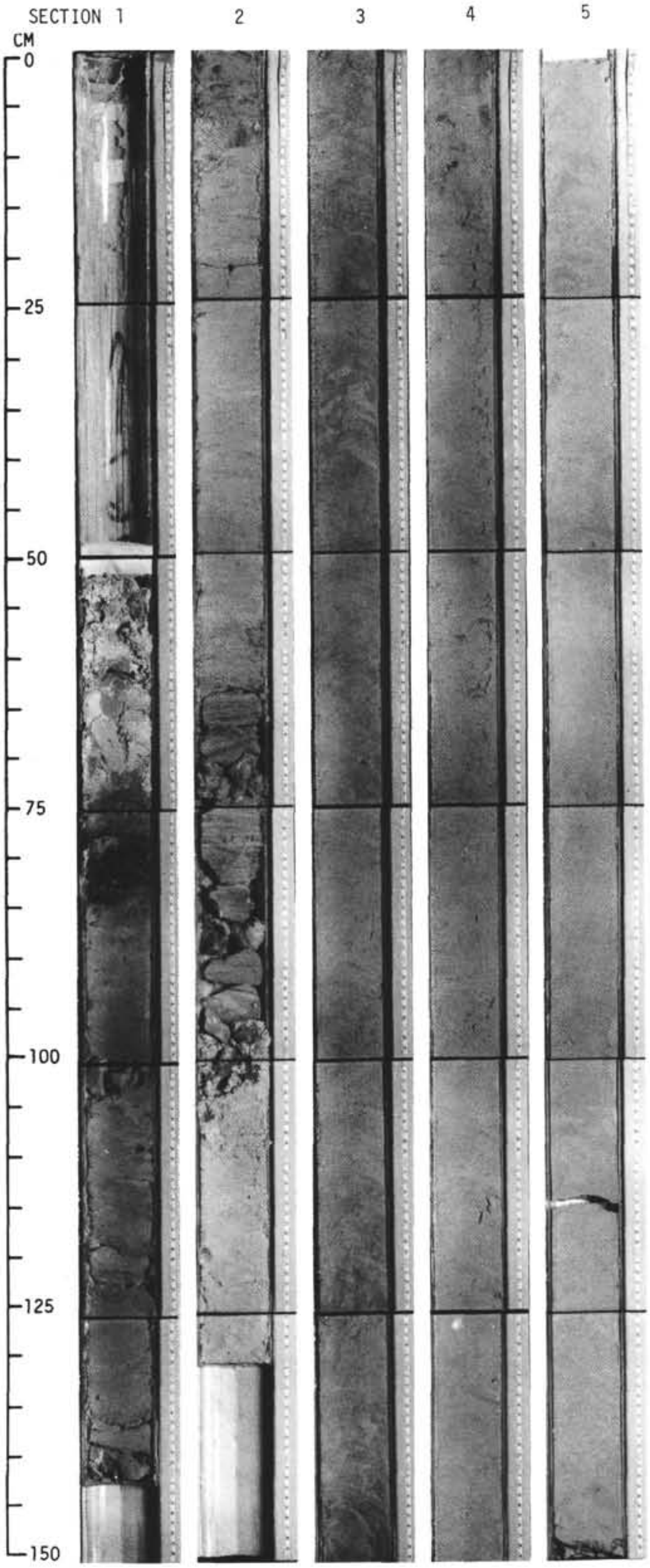

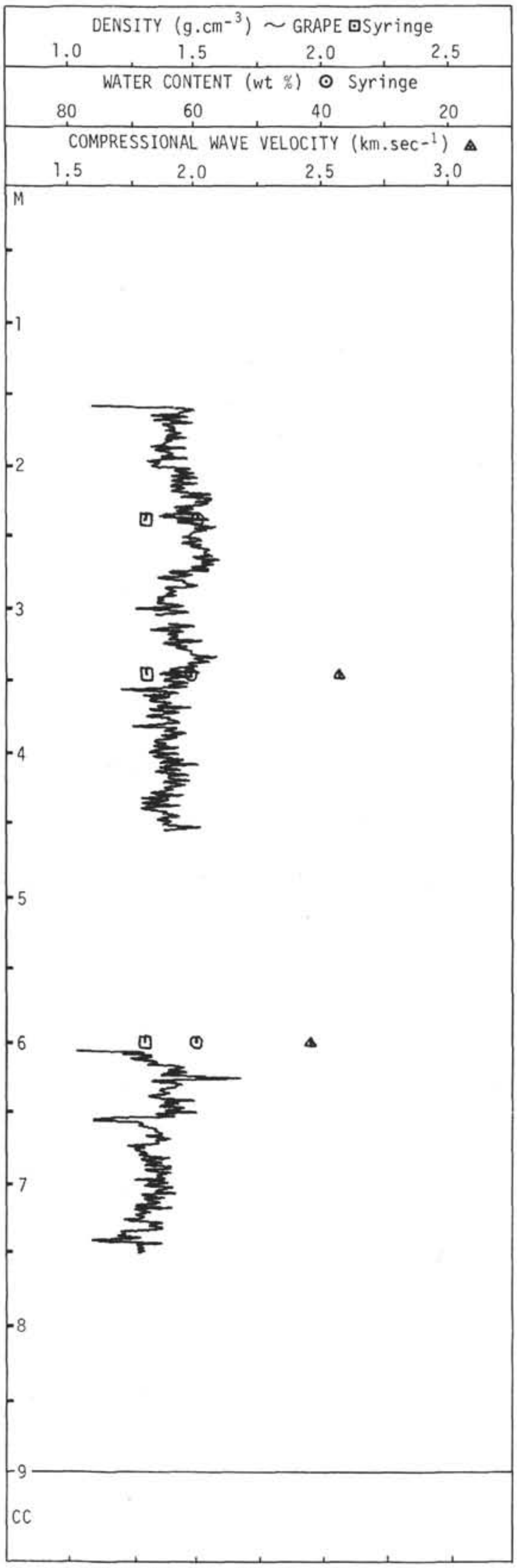

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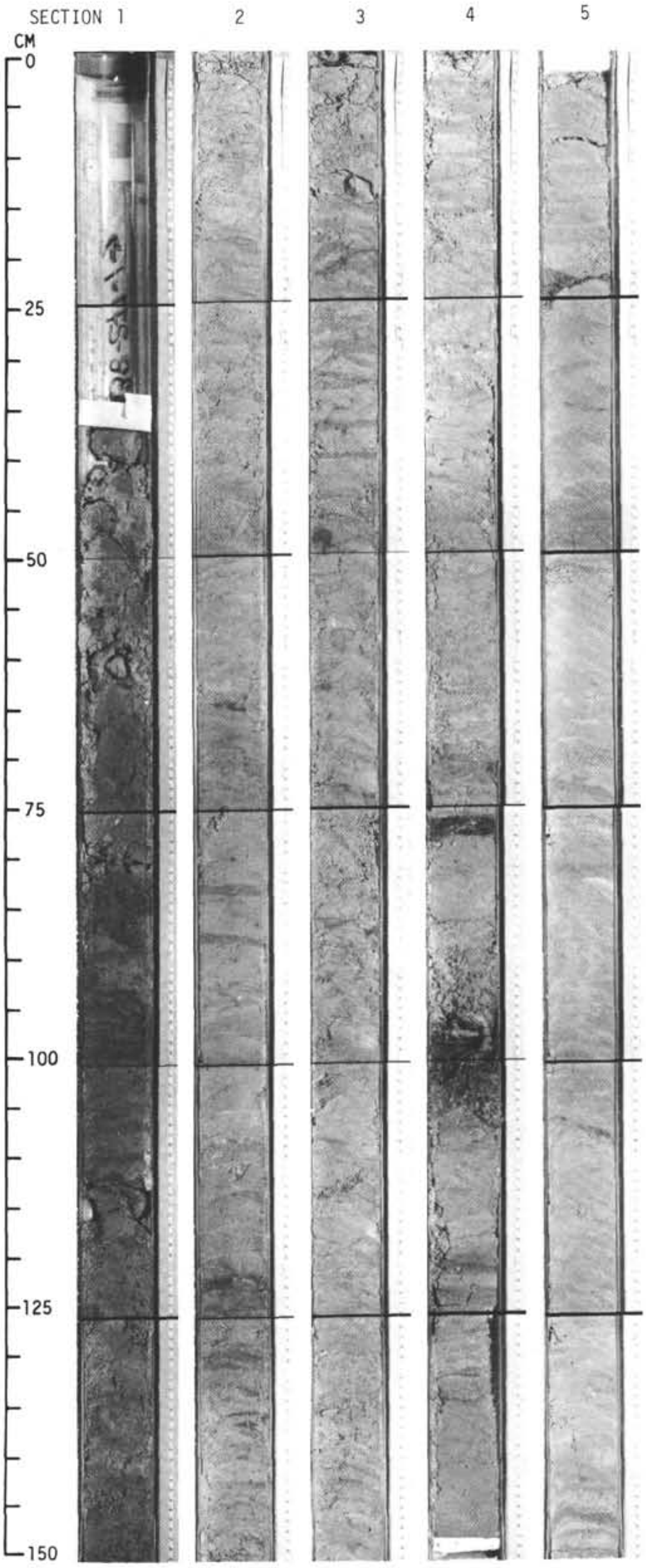

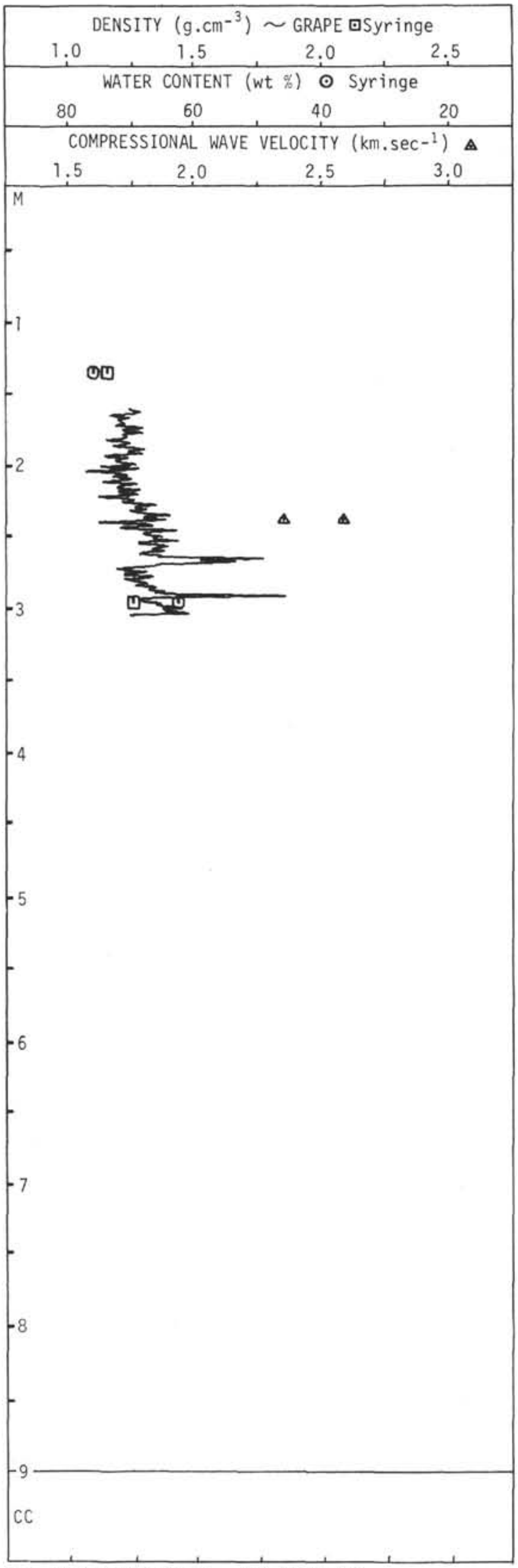

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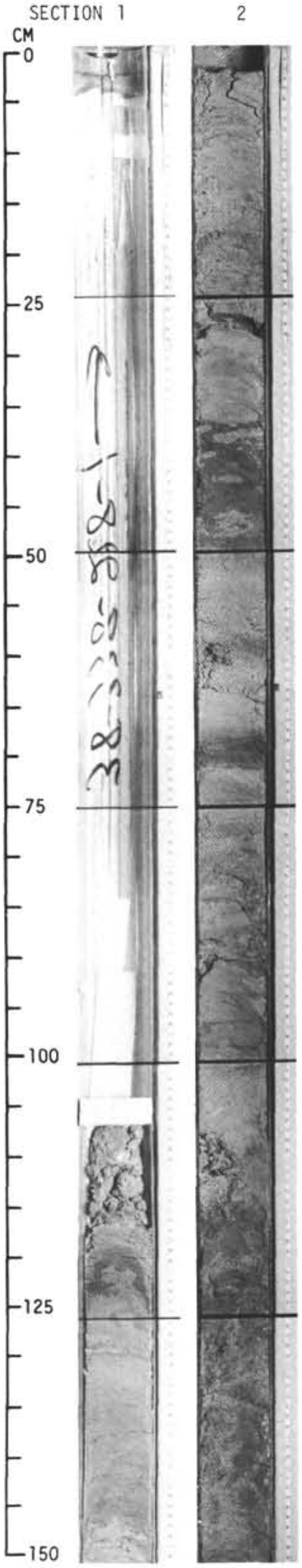

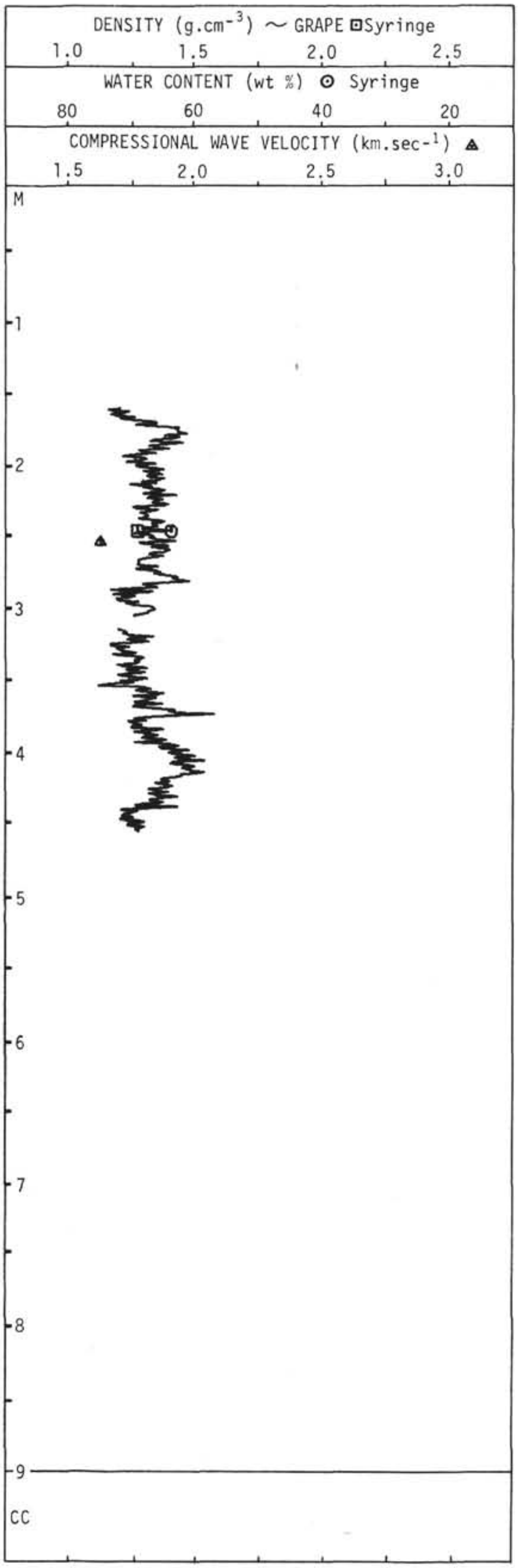

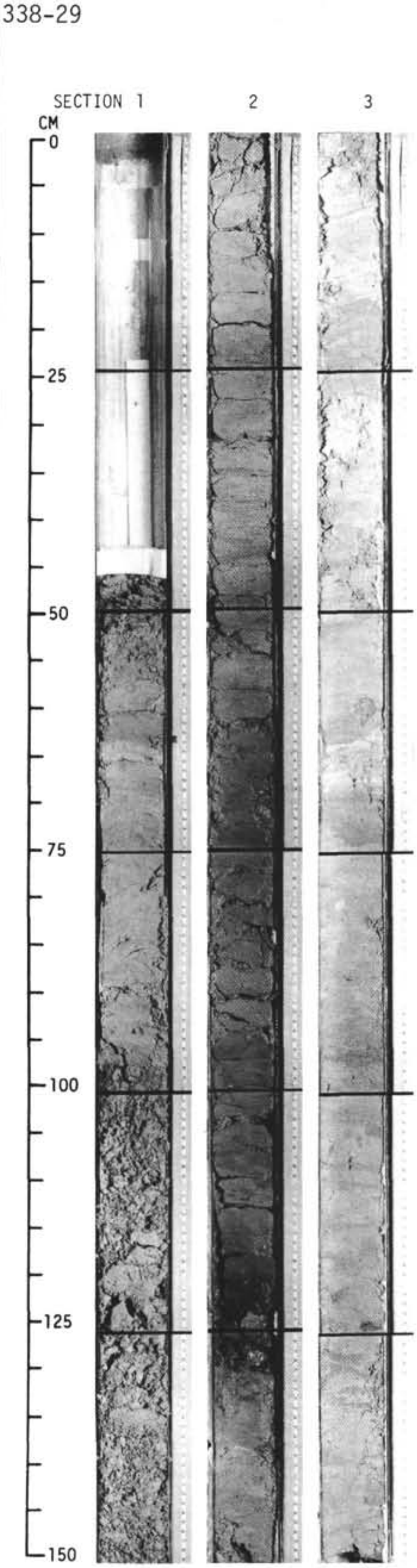

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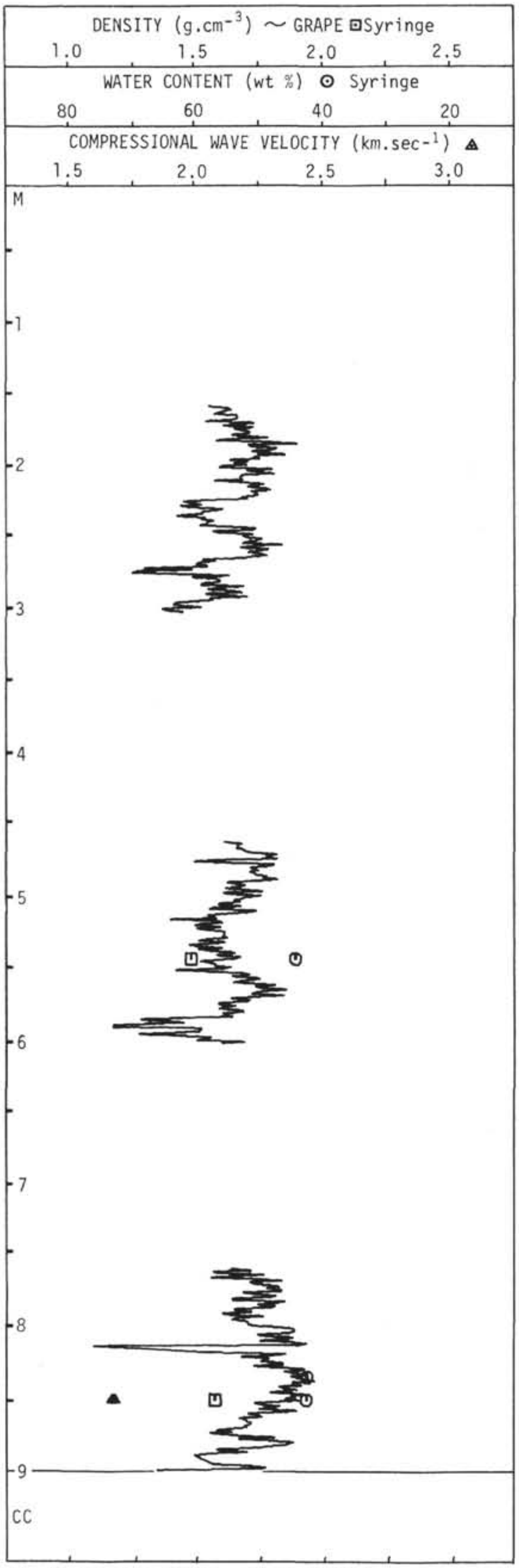

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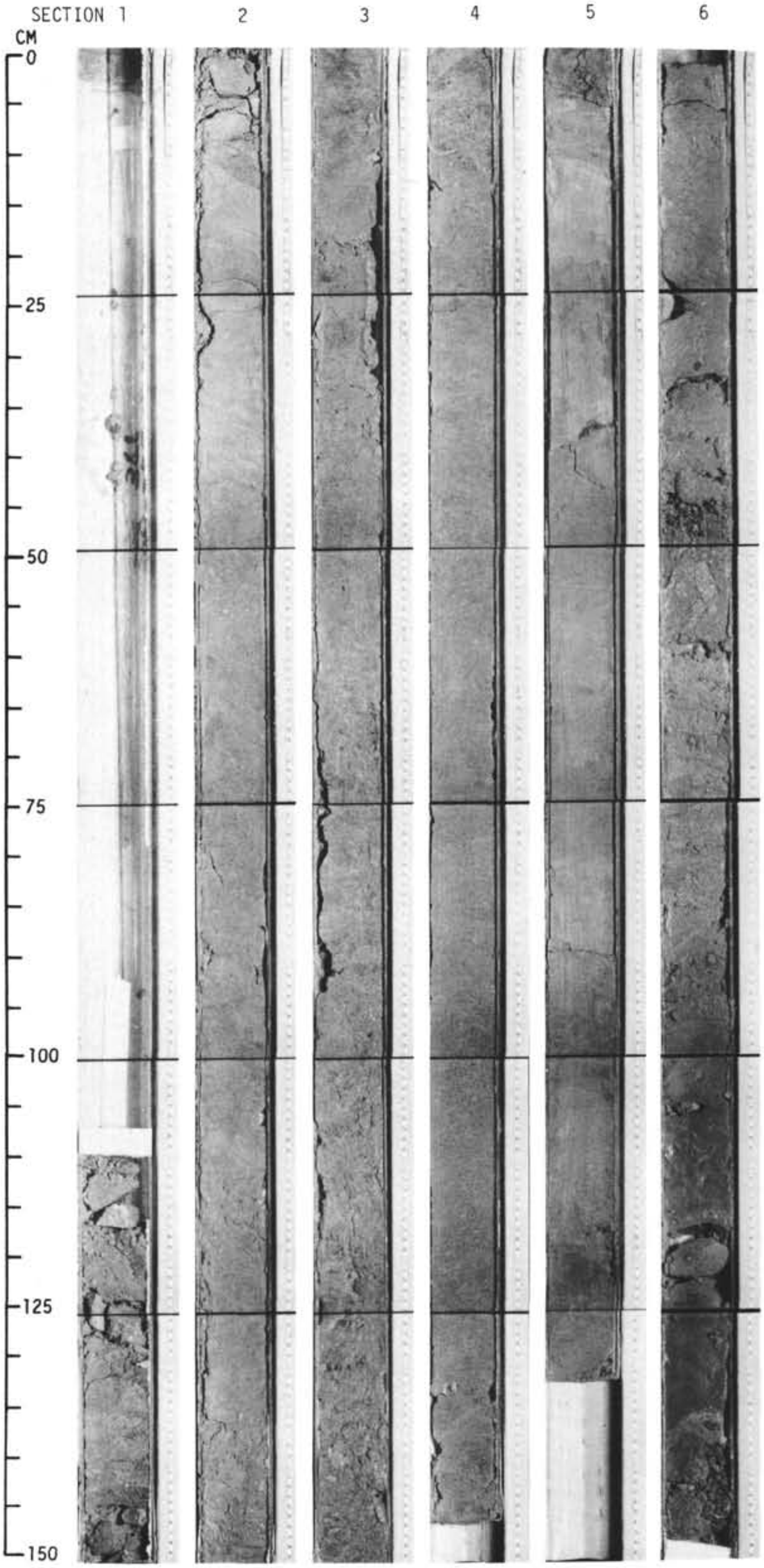

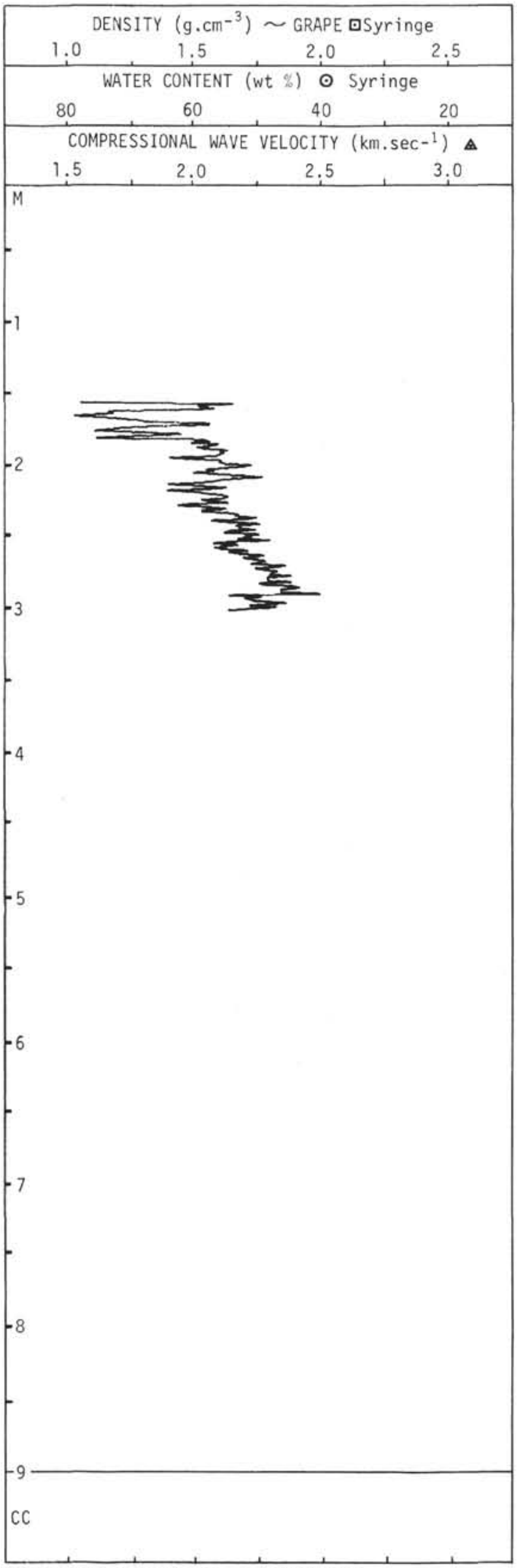

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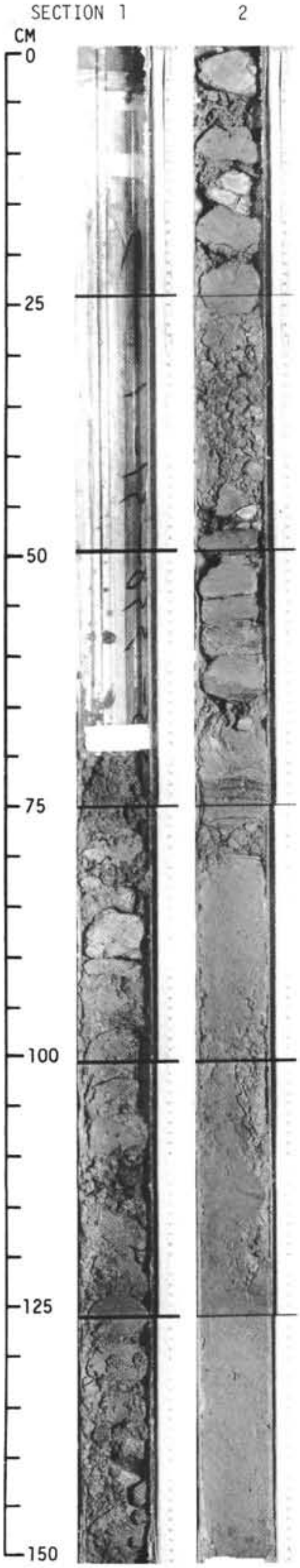

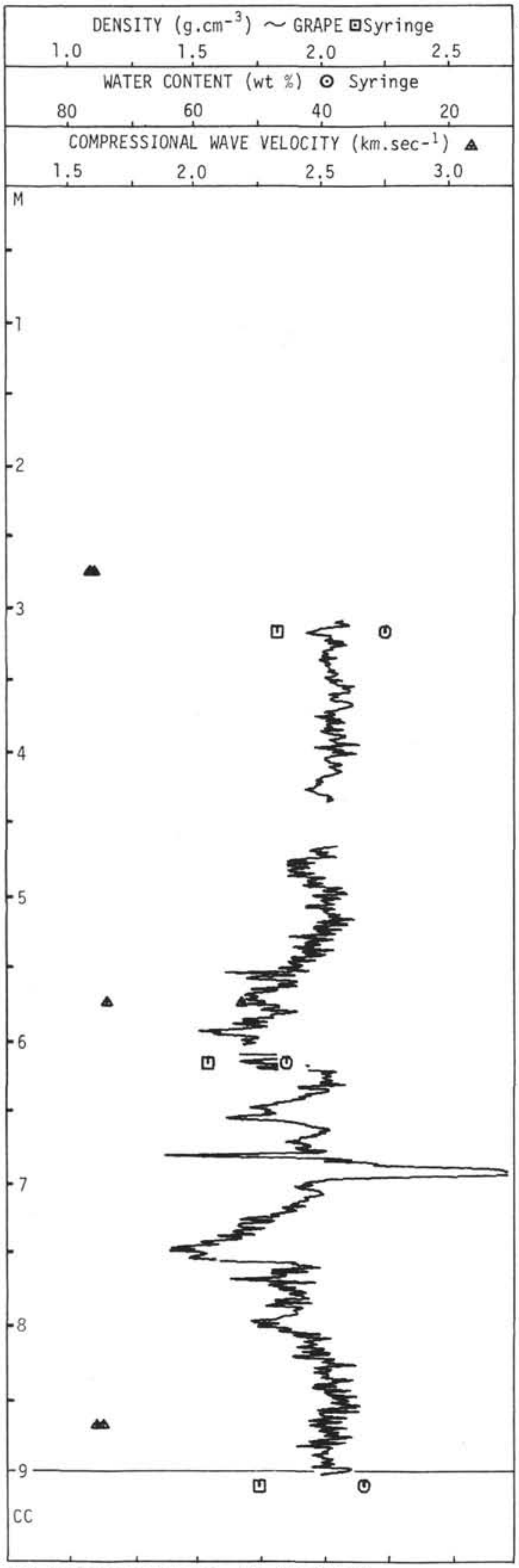

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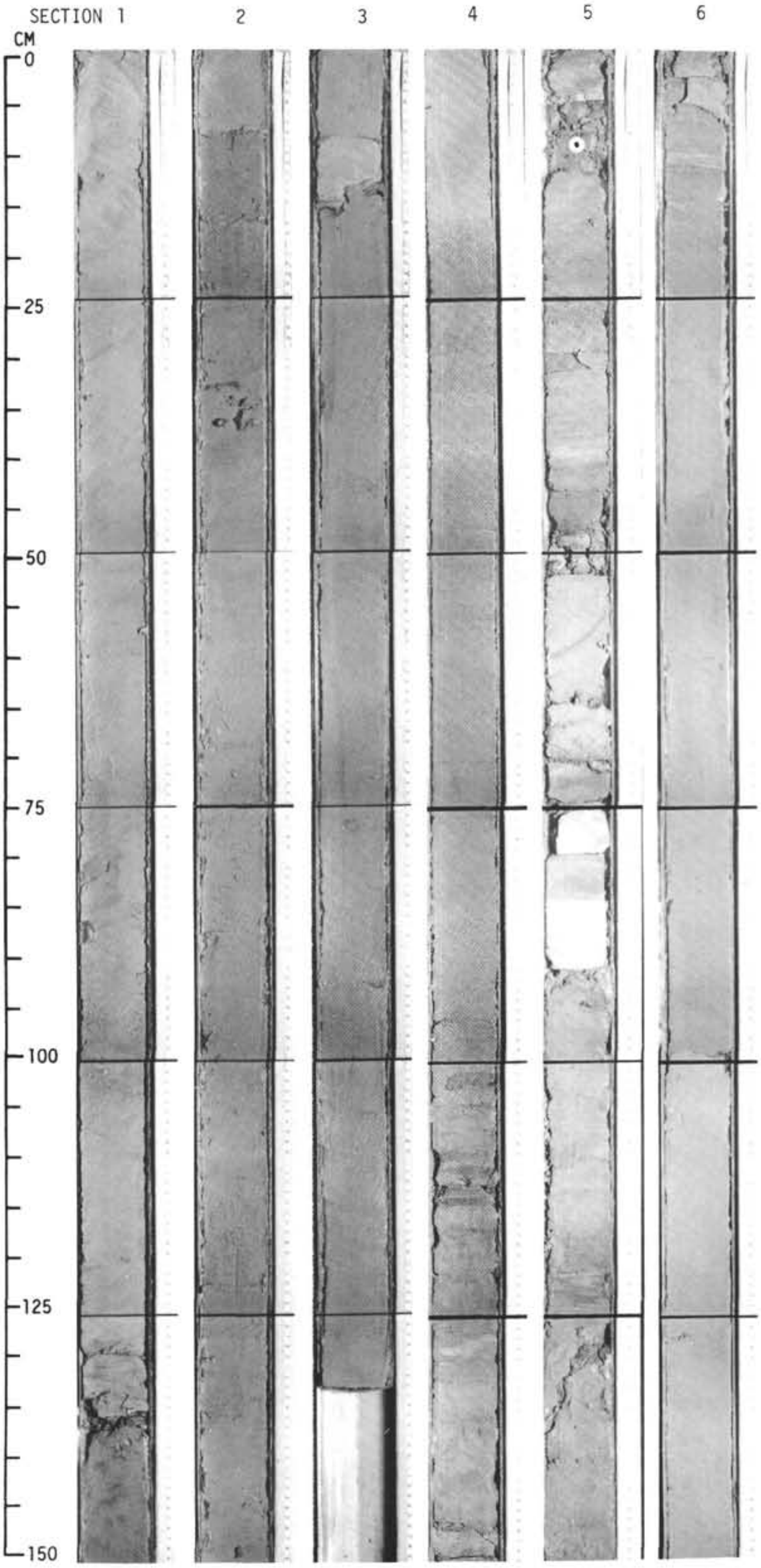

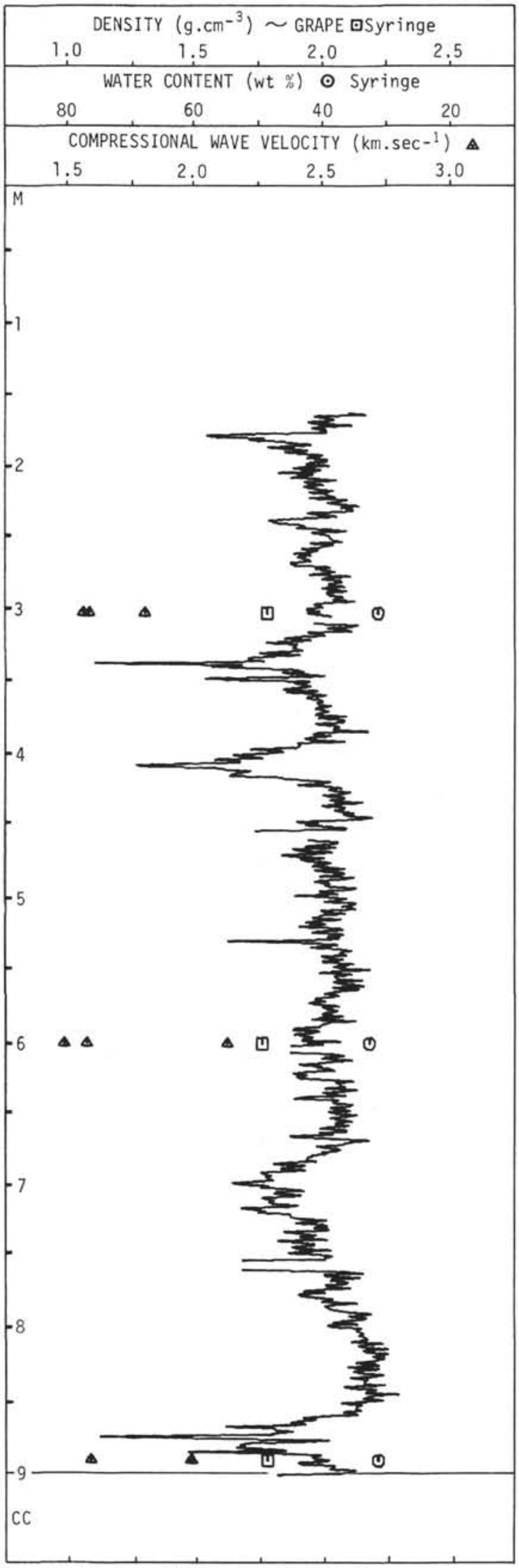

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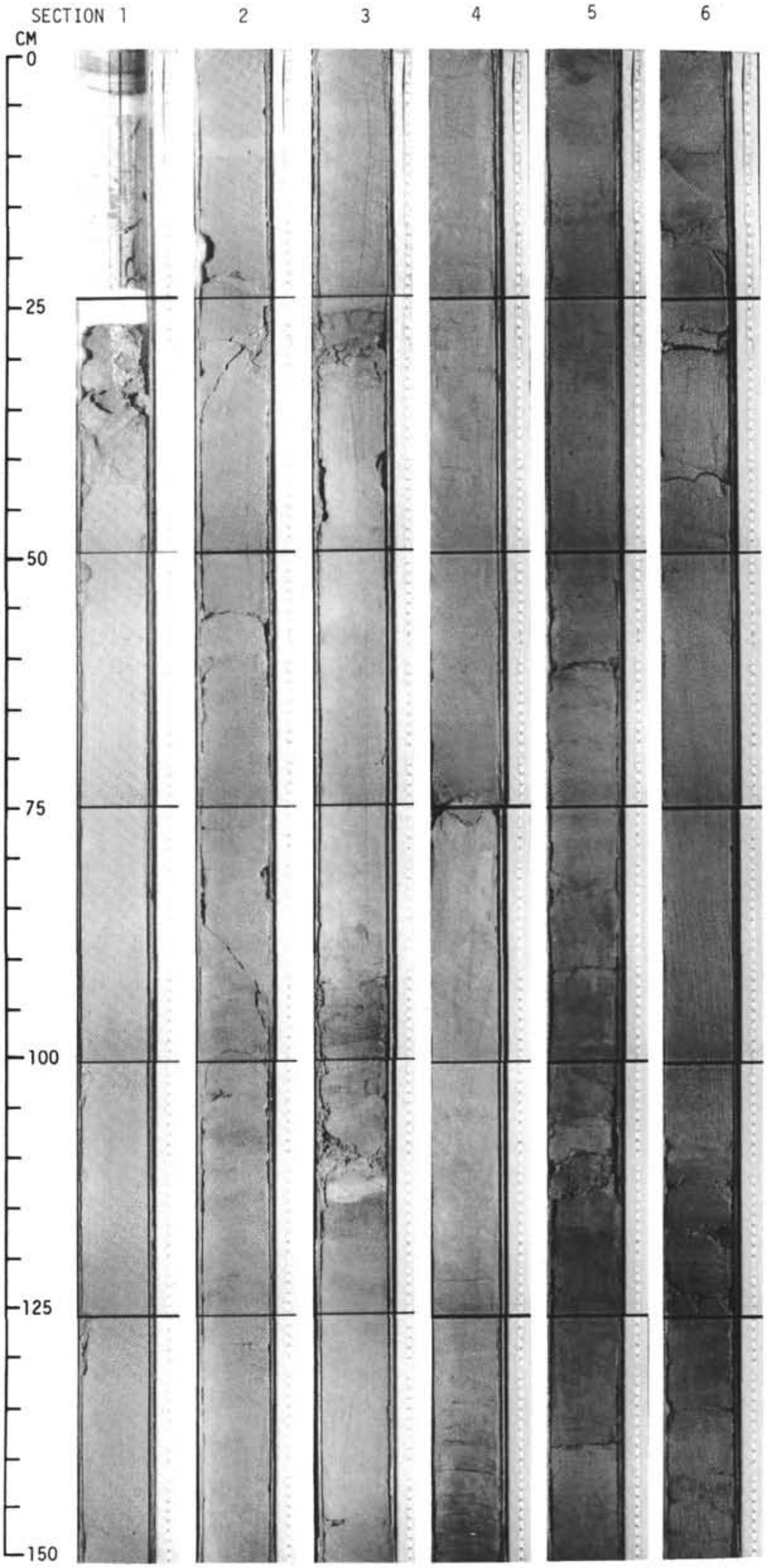

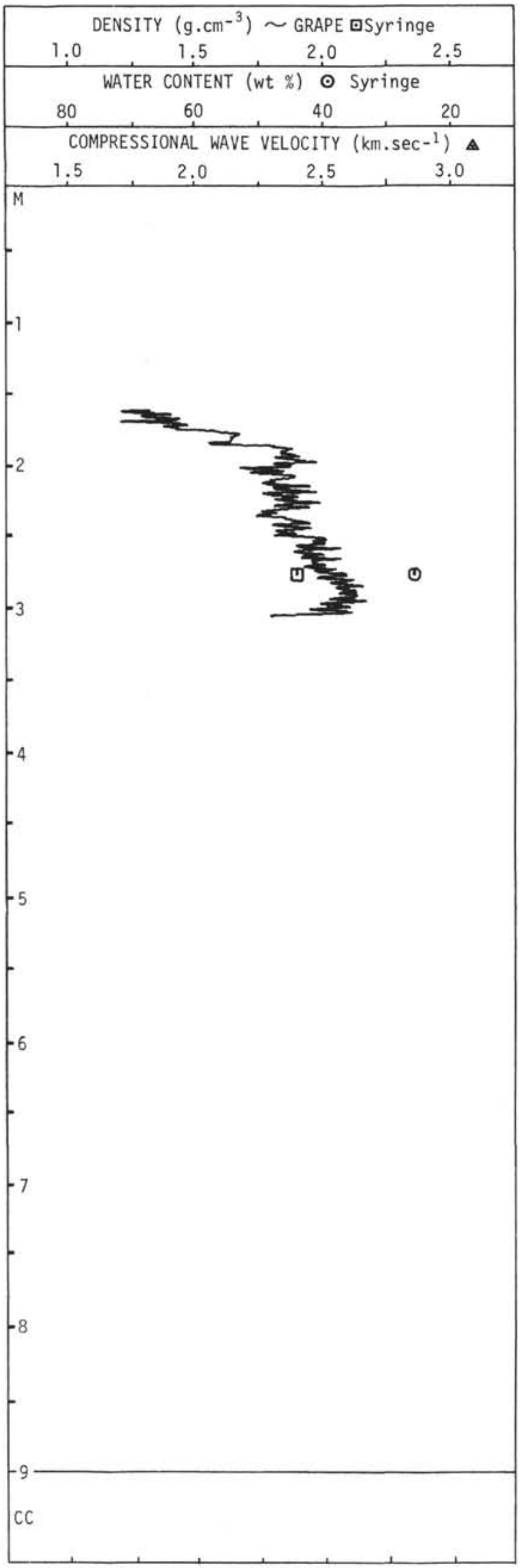

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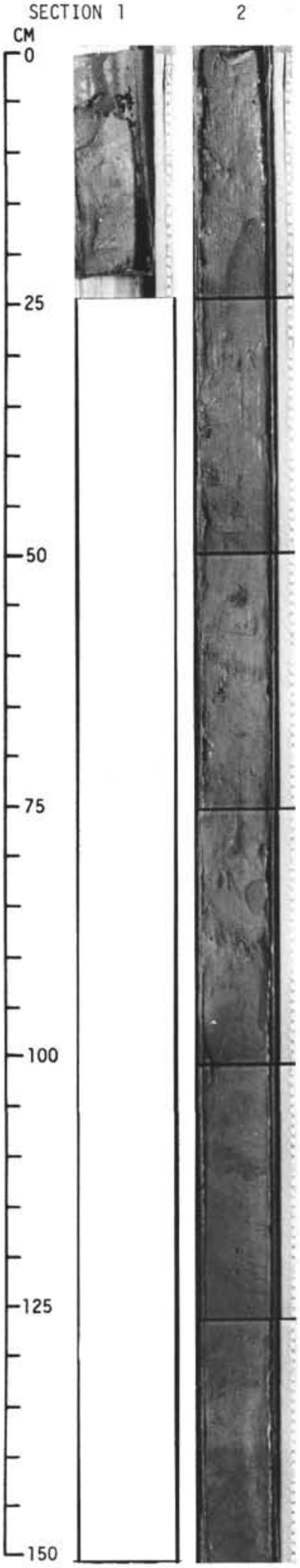

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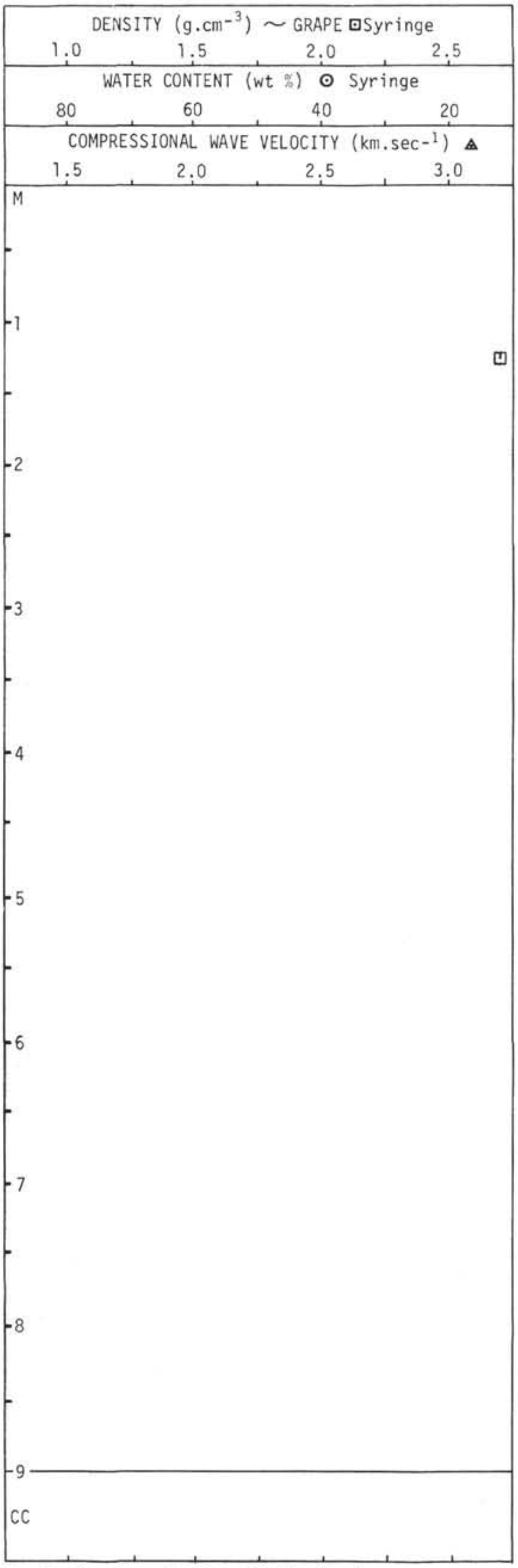
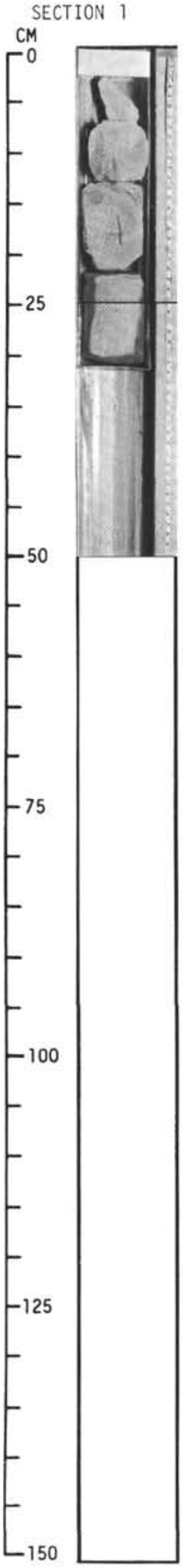
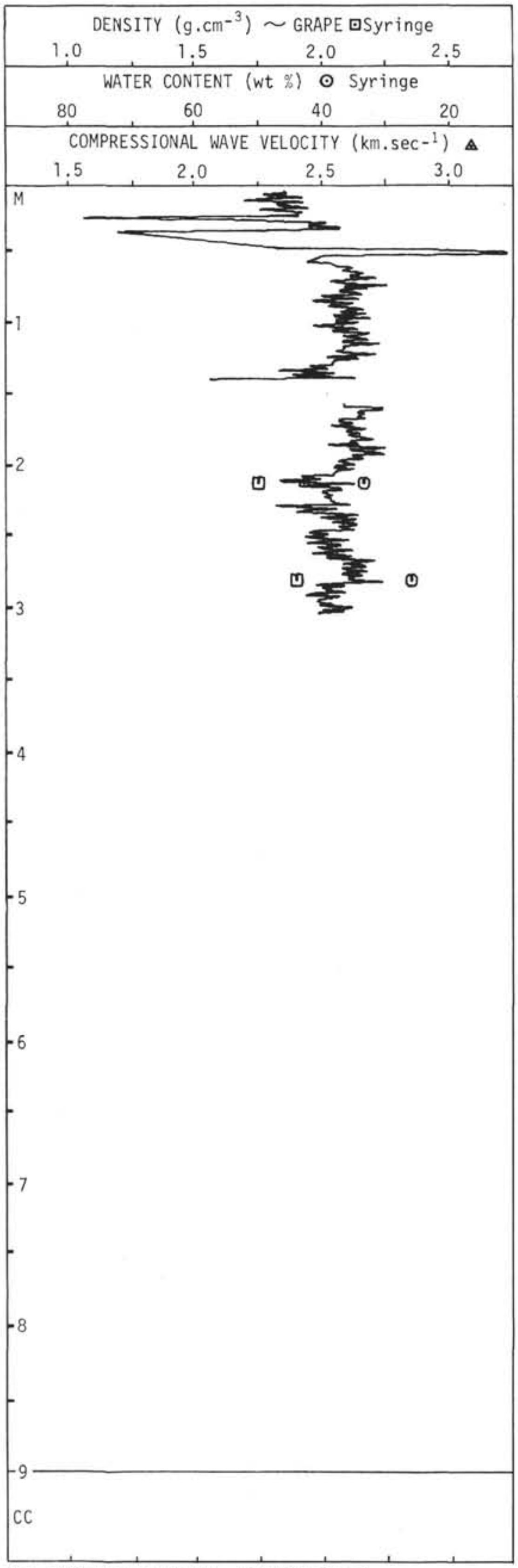


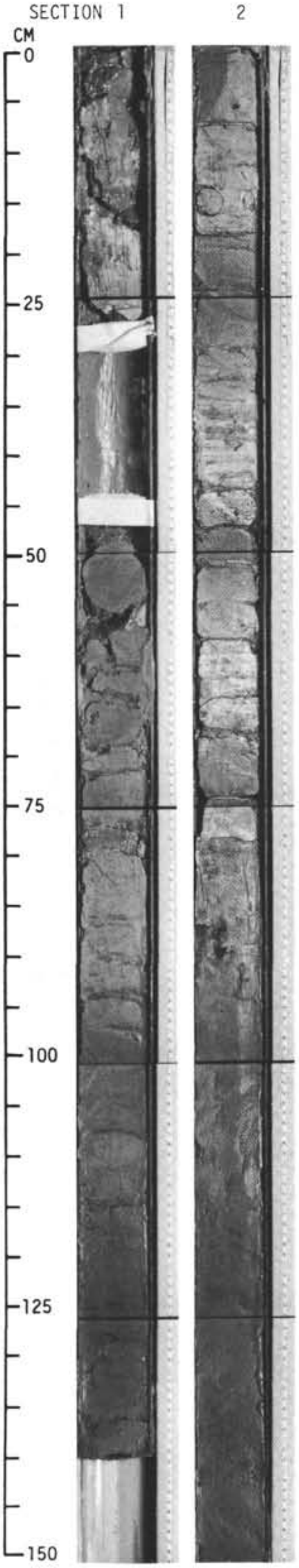
For Explanatory Notes, see Chapter 1

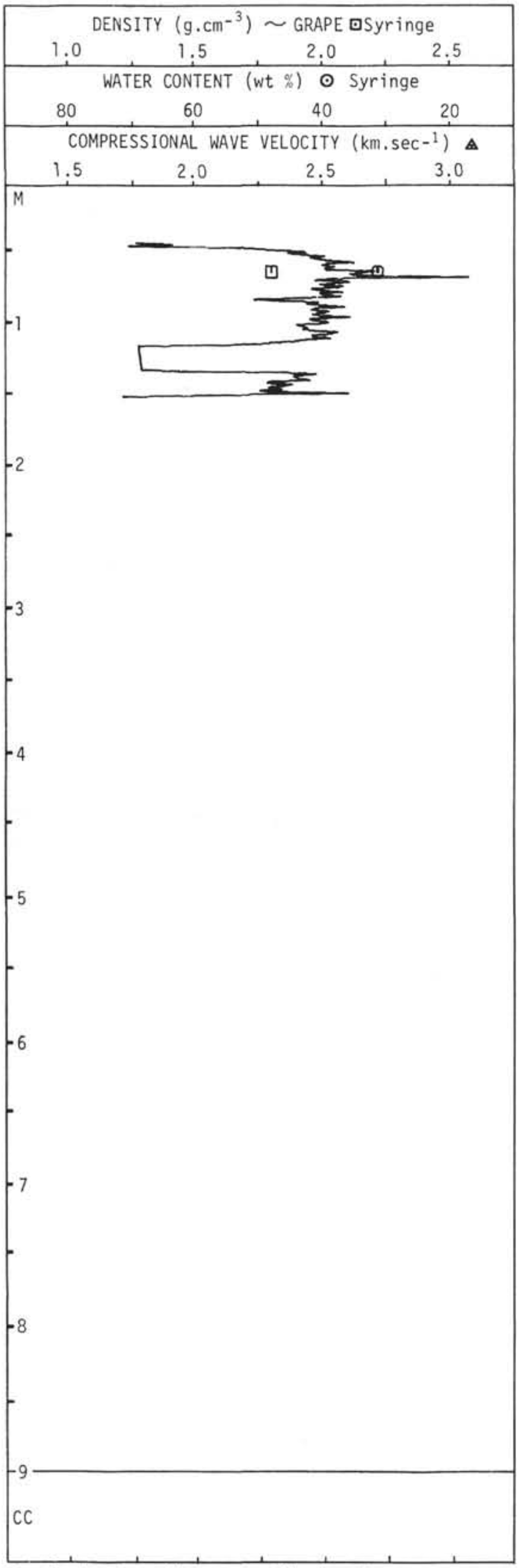




For Explanatory Notes, see Chapter 1

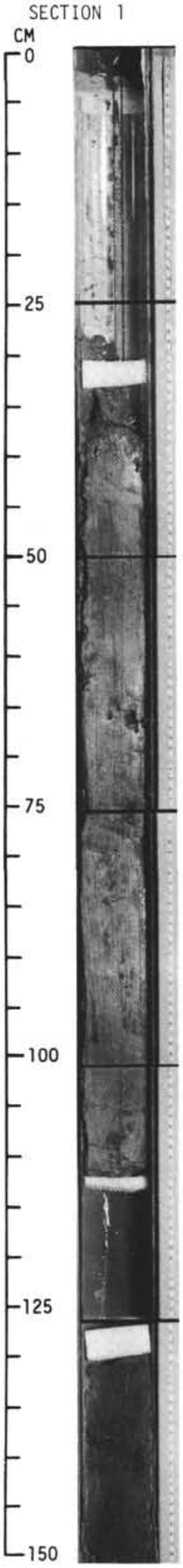
338-37

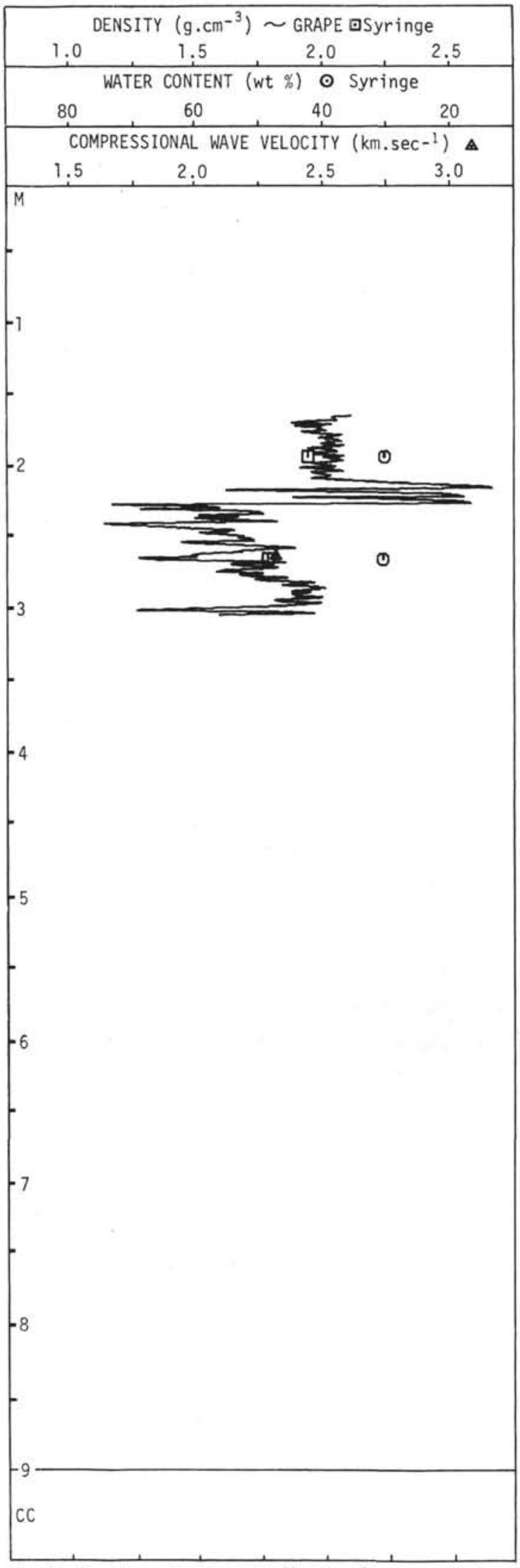




For Explanatory Notes, see Chapter 1

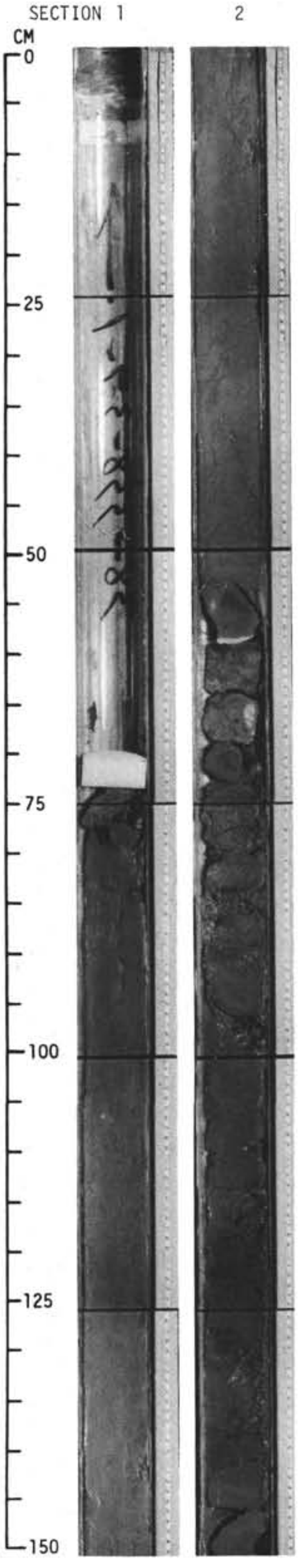
338-38

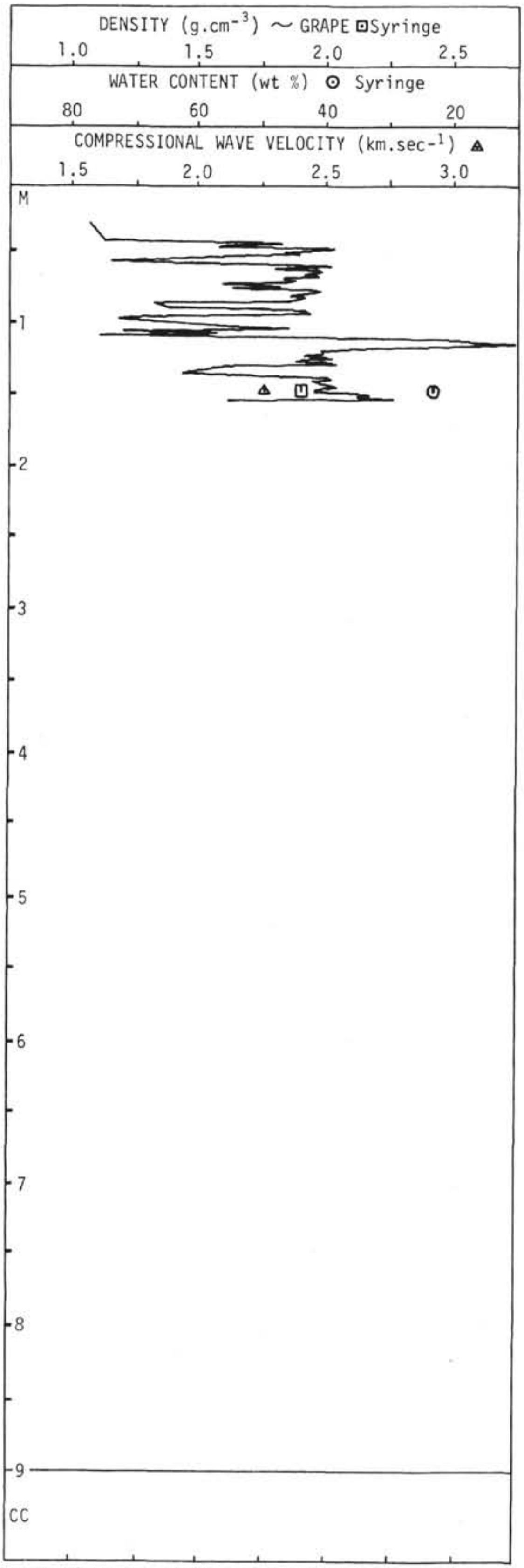




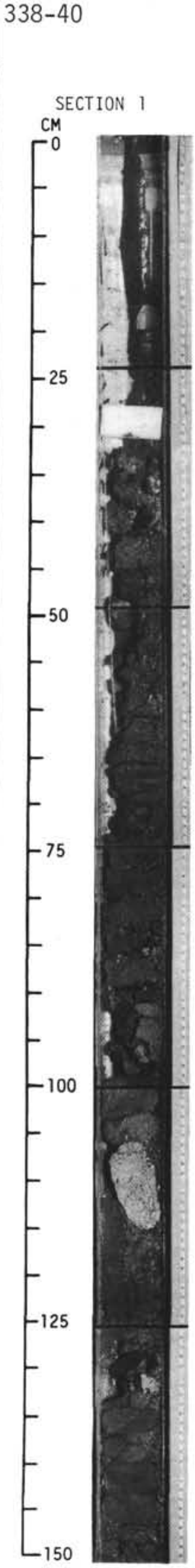
For Explanatory Notes, see Chapter 1

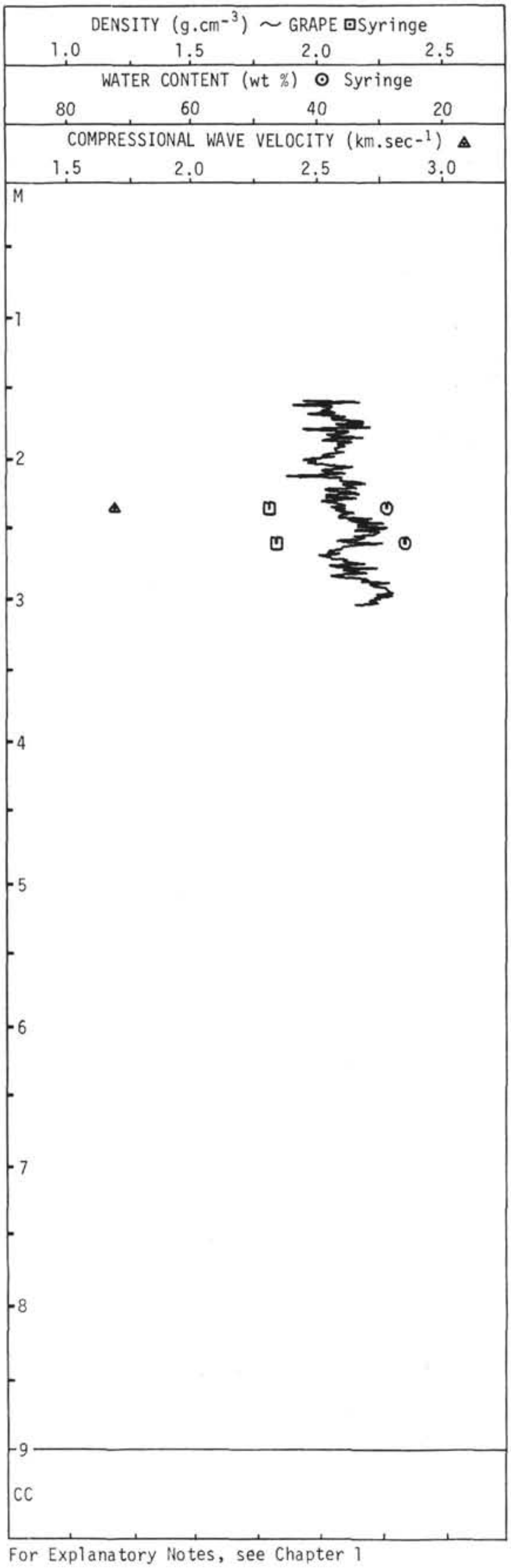
338-39





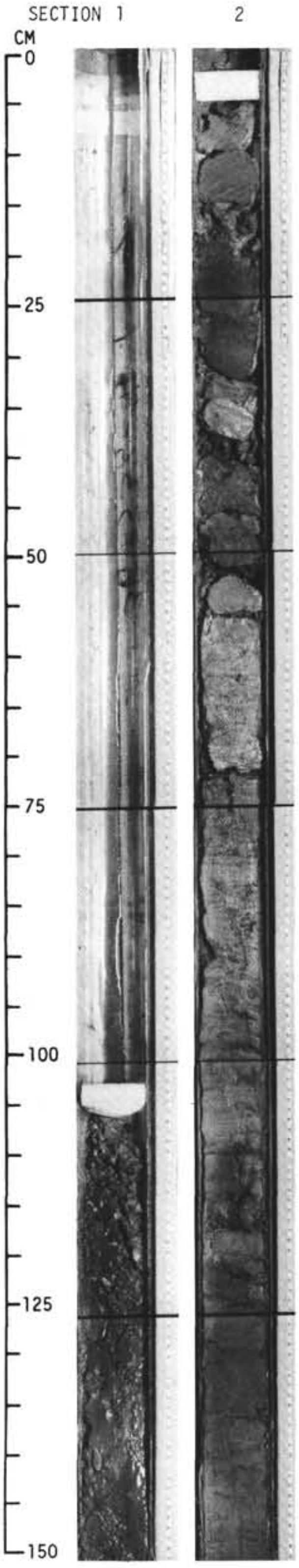
For Explanatory Notes, see Chapter 1



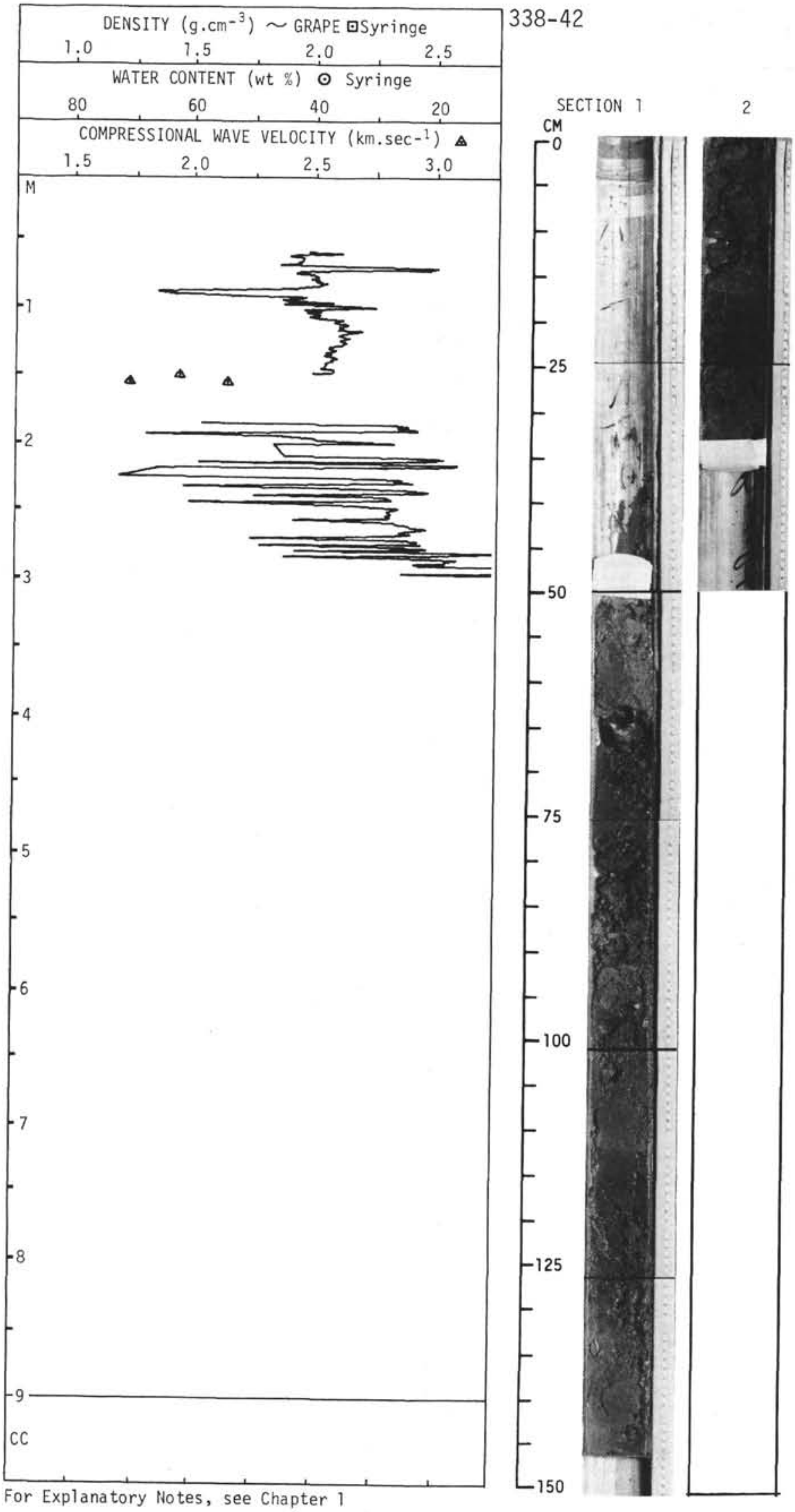


For Explanatory Notes, see Chapter 1

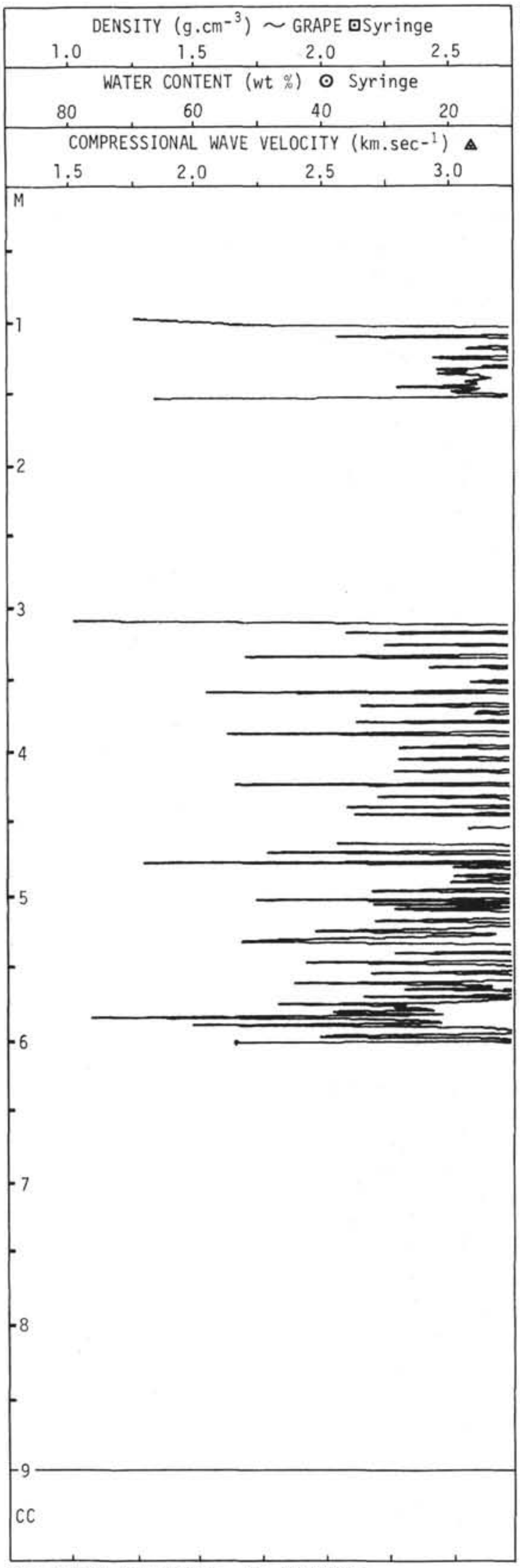
338-41



338-42

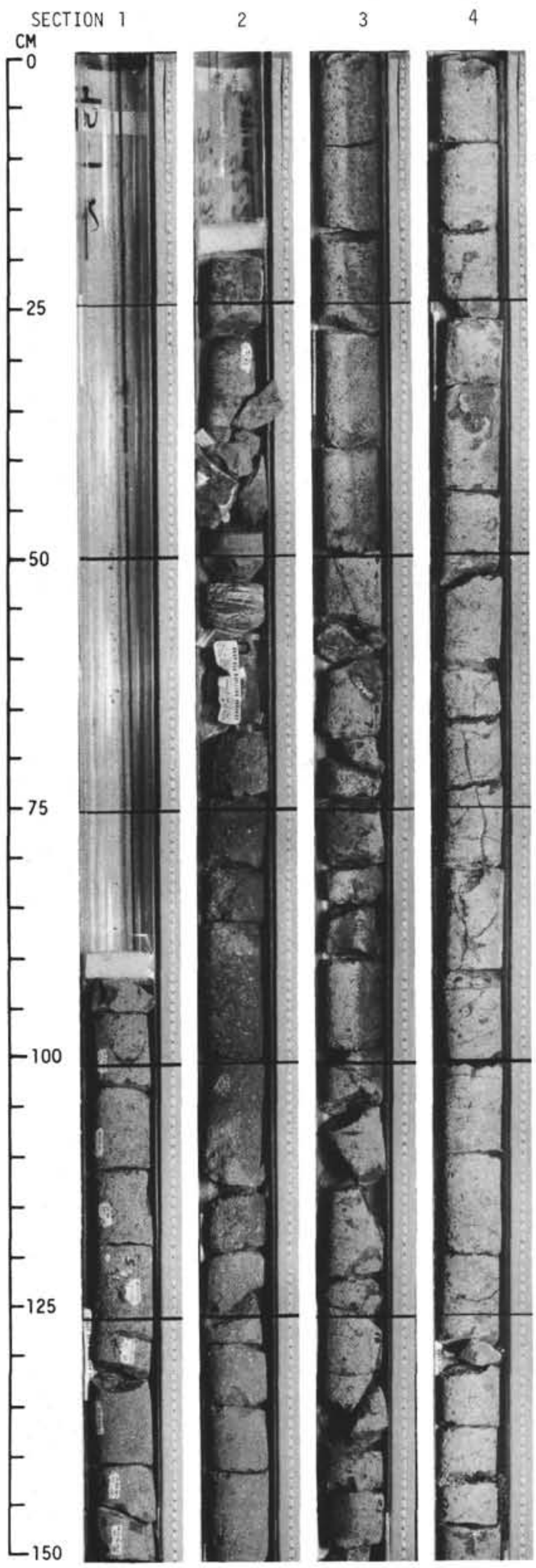


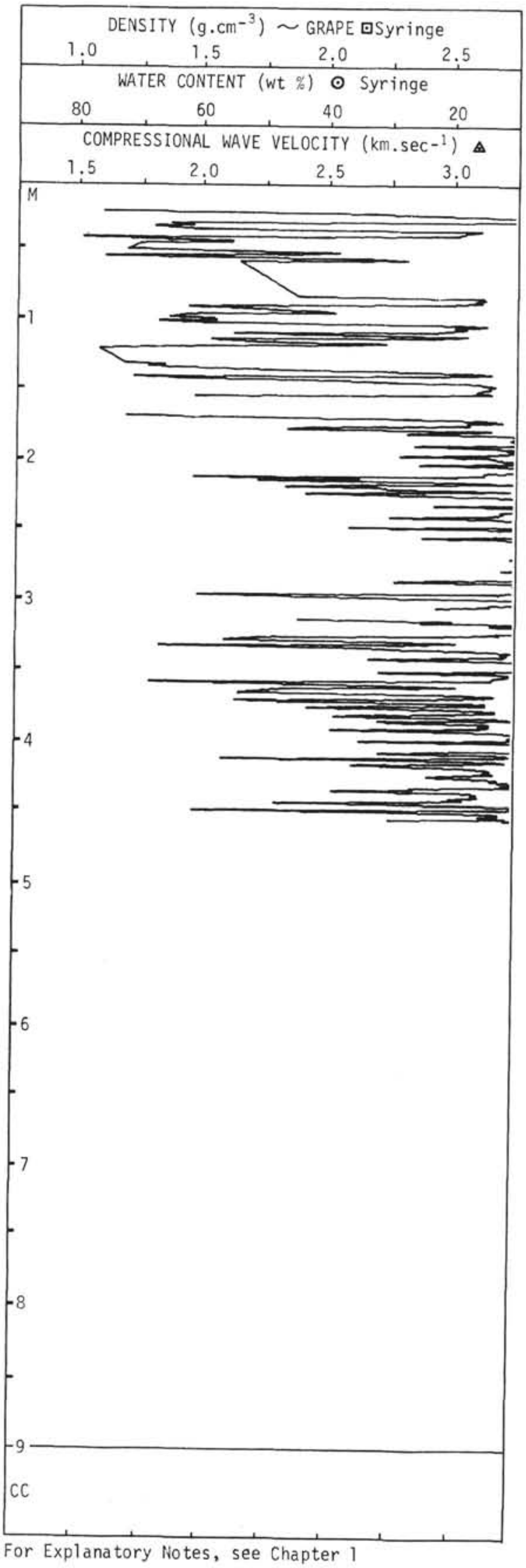
For Explanatory Notes, see Chapter 1



For Explanatory Notes, see Chapter 1

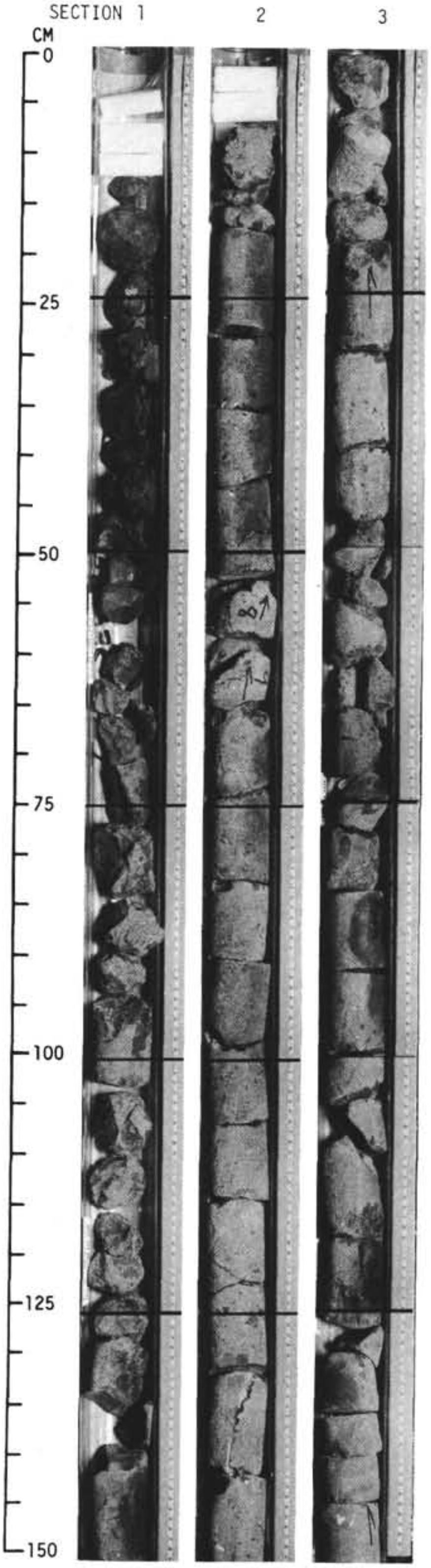
338-43

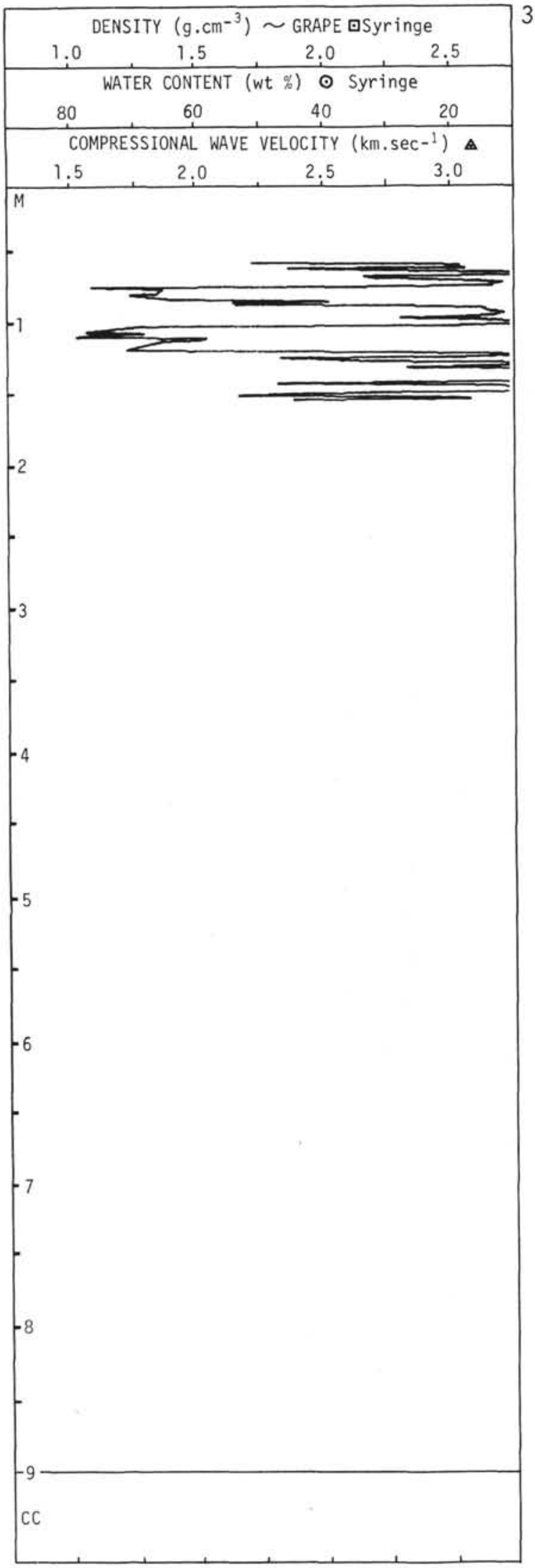




For Explanatory Notes, see Chapter 1

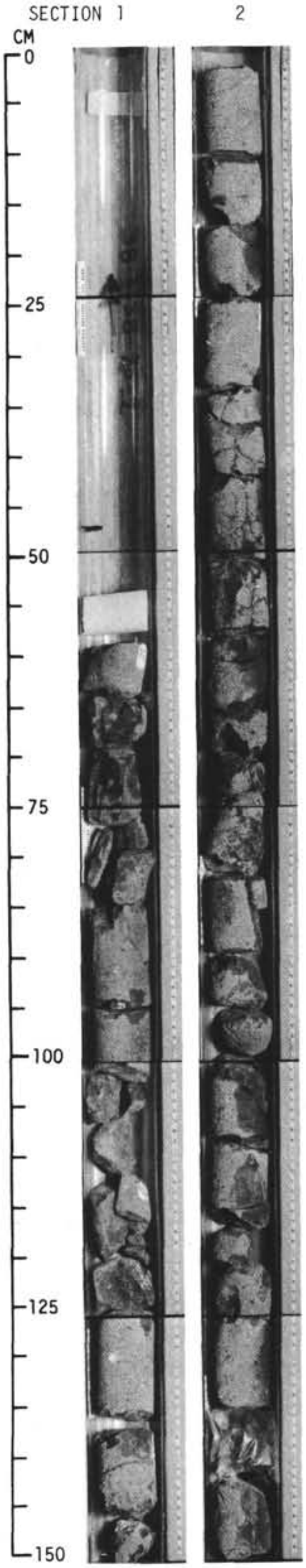
338-44



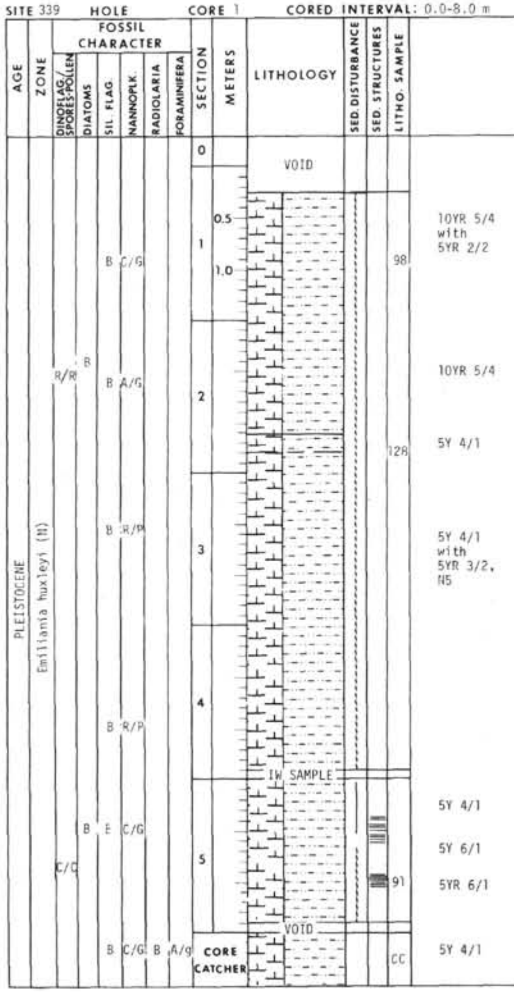


For Explanatory Notes, see Chapter 1

338-45



SITE 339 HOLE CORE 1 CORED INTERVAL: 0.0-8.0 m



LITHOLOGIC DESCRIPTION

Colors: moderate yellow brown (10YR 5/4), dusky brown (5YR 2/2), olive gray (5Y 4/1), pale brown (5YR 3/2), medium gray (N5) light olive gray (5Y 6/1), light brownish-gray (5YR 6/1). Intense deformation, massive, soft. Sec. 2 - sharp contact to overlying unit. Color patches and streaking throughout. Sec. 5 - thin stratified with dark green gray streaks (5GY 4/1).

MAJOR LITHOLOGY

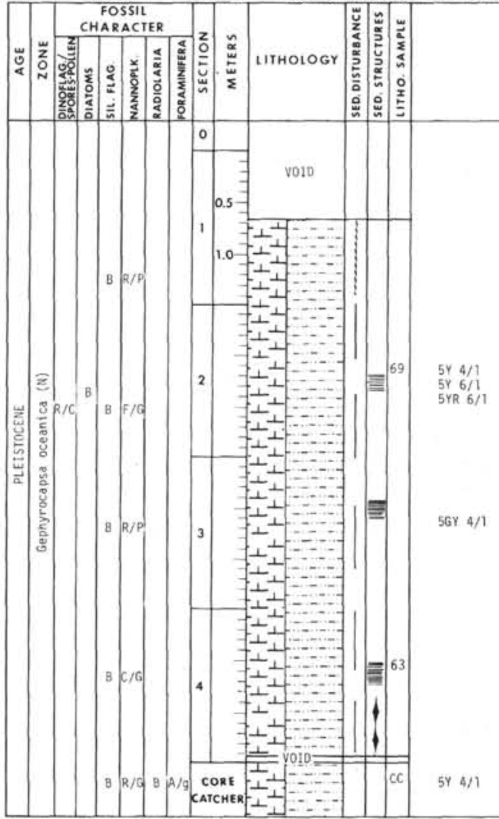
CALCAREOUS MUD AND MARLY CALCAREOUS OOZE (Smears 1-98, 2-128, 5-91, CC)

3- 5% Sand	7-20% Quartz
10-30% Silt	5-10% Feldspar
70-85% Clay	0- 2% Mica
	TR- 5% Heavy minerals
	35-52% Clay minerals
	TR- 3% Opaques
	TR% Volcanic glass
	TR- 1% Glauconite
	0- 5% Lithics
	0- 1% Radiolarians
	0- 2% Sponge spicules
	15-30% Authigenic carbonate
	5-30% Nannofossils
	TR- 2% Foraminifera
	0- 5% Diatoms

Carbon-Carbonate (DSDP)
5-100 (2.1, 0.5, 14)

Grain Size (DSDP)
1-146 (18.5, 29.2, 52.3)
3-146 (12.1, 24.6, 63.3)

SITE 339 HOLE CORE 2 CORED INTERVAL: 8.0-17.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), light olive gray (5Y 6/1), light brownish-gray (5YR 6/1). Intense to moderate deformation. Massive, soft with thin stratification in Secs. 2, 3, and 4 with dark greenish-gray (5GY 4/1) laminae. Sec. 4 has local patches of carbonaceous material, possibly some bioturbation, and light gray strata (1-2 cm).

MAJOR LITHOLOGY

CALCAREOUS MUD (Smears 2-69, 4-63, CC)

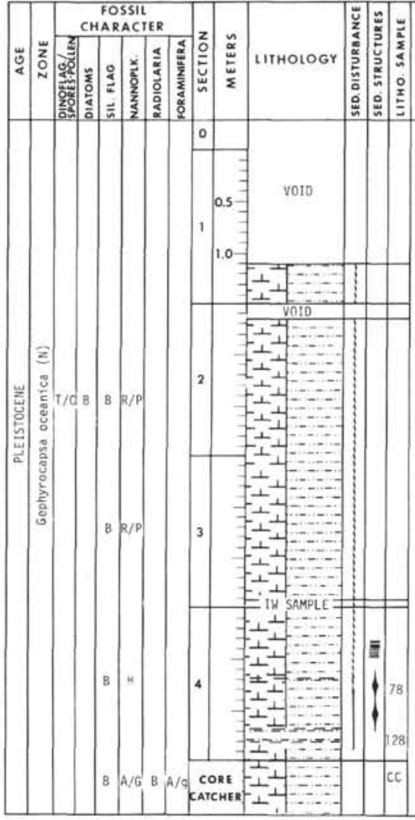
2- 5% Sand	7-15% Quartz
10-60% Silt	3- 5% Feldspar
35-88% Clay	TR- 1% Mica
	TR- 1% Heavy minerals
	35-55% Clay minerals
	TR- 2% Opaques
	0- 2% Opaques
	0- 2% Lithics
	0- 1% Glauconite
	20% Authigenic carbonate
	25% Nannofossils
	TR% Diatoms
	TR% Sponge spicules

Carbon-Carbonate (DSDP)
2-49 (2.2, 0.5, 14)
4-89 (1.3, 0.3, 9)

Grain Size (DSDP)
2-79 (4.4, 24.2, 71.4)
4-99 (5.1, 24.4, 70.5)

Explanatory notes in Chapter 1

SITE 339 HOLE CORE 3 CORED INTERVAL: 17.5-27.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), medium gray (N5), greenish-gray (5GY 6/1). Intense deformation, massive, soft. Color streaking in Sec. 4 (70 cm). Thinly stratified, moderately deformed, sand stratum, Chondrites burrows.

MAJOR LITHOLOGY

5Y 4/1

CALCAREOUS MUD (Smears 4-78, CC)
7% Sand
25-30% Silt
60-65% Clay

10-15% Quartz
2- 5% Feldspar
0-TR% Mica
TR- 1% Heavy minerals
TR- 1% Opaques
60-65% Clay minerals
TR- 1% Glauconite
7-15% Authigenic carbonate
7-10% Nannofossils
0-TR% Foraminifera

MINOR LITHOLOGY

5Y 4/1

SANDY MUD (Smear 4-128)
40% Sand
25% Silt
35% Clay

30% Quartz
5% Feldspar
2% Heavy minerals
7% Opaques
1% Volcanic glass
35% Clay minerals
1% Glauconite
5% Authigenic carbonate
2% Foraminifera
2% Nannofossils

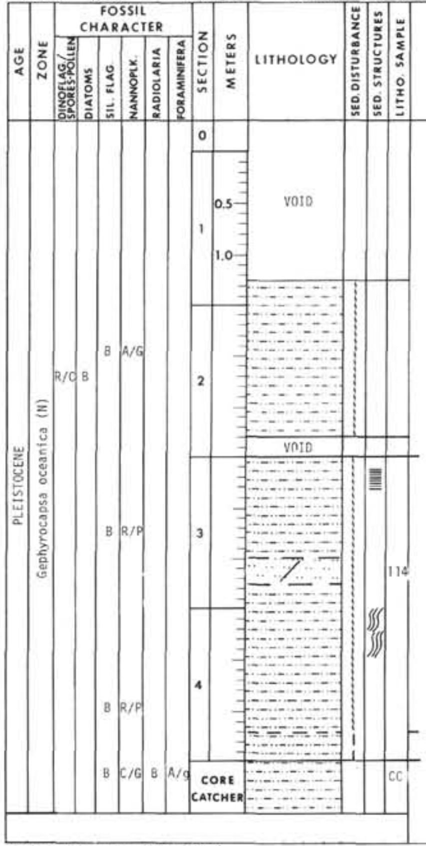
Carbon-Carbonate (DSDP)
2-100 (1.2, 0.4, 7)

5Y 4/1
with
N5,
5GY 6/1

Grain Size (DSDP)
3-73 (11.2, 28.5, 60.3)

5Y 2/1

SITE 339 HOLE CORE 4 CORED INTERVAL: 27.0-36.5 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1), olive gray (5Y 4/1), (5Y 3/2). Intense deformation, massive, soft. Sec. 3 - thinly stratified (100-150 cm) with dark gray laminae in 0-50 cm; Sec. 4-(0-120) thinly stratified, clay blebs, fragments. Brownish gray (5YR 4/1) at 120 cm with synsedimentary folds, syndepositional contorted strata. Carbonaceous inclusion (3-114).

MAJOR LITHOLOGY

5GY 4/1

MUD (Smear CC)
5% Sand
23% Silt
72% Clay

10% Quartz
2% Feldspar
1% Mica
TR% Heavy minerals
2% Opaques
1% Palagonite
72% Clay
1% Glauconite
5% Authigenic carbonate
5% Nannofossils
TR% Diatoms

5Y 4/1

MINOR LITHOLOGY

SANDY SILT (Smear 3-114)
45% Sand
45% Silt
10% Clay

20% Quartz
5% Feldspar
47% Opaques and Heavy minerals (chiefly magnetite)
10% Palagonite
10% Clay minerals
2% Glauconite
7% Authigenic carbonates

Carbon-Carbonate (DSDP)
3-69 (2.1, 0.6, 12)

5YR 4/1

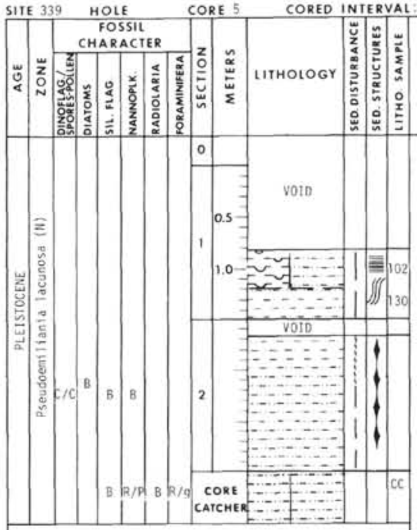
Carbon-Carbonate (PP)
4-2 (top) (0.57, 1.26)
4-2 (bottom) (0.01, 0.30)

5Y 3/2

Grain Size (DSDP)
3-129 (5.4, 18.5, 76.1)

Explanatory notes in Chapter 1

SITE 339 HOLE CORE 5 CORED INTERVAL: 36.5-46.0 m



5YR 4/1

5YR 6/1
5YR 4/1

5Y 3/2

LITHOLOGIC DESCRIPTION

Colors: light brownish-gray (5YR 6/1), brownish gray (5YR 4/1). Intense-moderate deformation. Sec. 4 - thinly stratified, soft, synsedimentary deformation (slumping), bioturbated (110-150 cm). Chondrites burrows, locally hardened tubes, mottling; Sec. 2 - massive, soft bioturbated, scattered clay fragments, burrows filled with lighter material.

MAJOR LITHOLOGY

MUD (Smears 1-130, CC)
7% Sand 10-15% Quartz
10-30% Silt 2- 5% Feldspar
60-75% Clay TR- 1% Mica
TR- 1% Heavy minerals
1- 2% Opaques
TR- 1% Palagonite
60-75% Clay minerals
TR- 1% Glauconite
2- 7% Authigenic carbonate
0-TR% Foraminifera
2- 5% Nannofossils
0-TR% Diatoms
0-TR% Sponge spicules
0-TR% Radiolarians

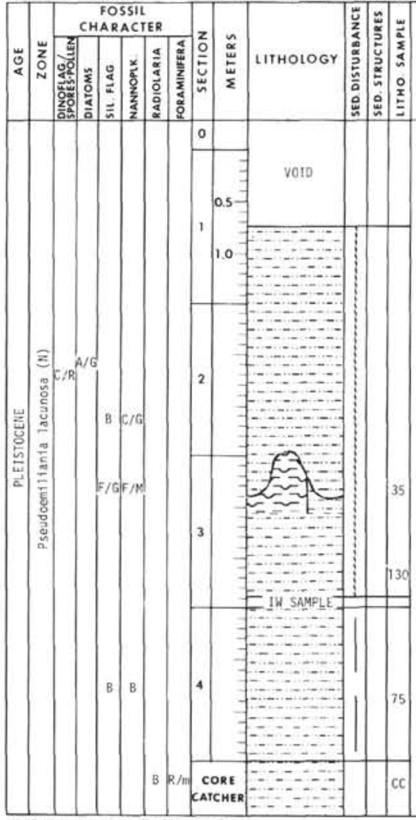
MINOR LITHOLOGY

DIATOMACEOUS MUD (Smear 1-102)
5% Quartz
1% Heavy minerals
5% Opaques
TR% Volcanic glass
62% Clay minerals
TR% Glauconite
2% Foraminifera
15% Diatoms
5% Radiolarians
5% Sponge spicules

Carbon-Carbonate (DSDP)
2-76 (1.4, 0.6, 6)

Grain Size (DSDP)
2-74 (17.0, 29.1, 54.0)

SITE 339 HOLE CORE 6 CORED INTERVAL: 46.0-55.5 m



Explanatory notes in Chapter 1

5YR 4/1

5YR 2/1
with
5Y 4/1

5Y 2/1
with
10YR 6/6

N4

LITHOLOGIC DESCRIPTION

Colors: brownish gray (5YR 4/1), brown black (5YR 2/1) olive gray (5Y 4/1), medium dark gray (N4). Intense deformation to moderate (Sec. 4). Scattered clay (<0.5 mm) clasts in Sec. 1. Color mottling common, some pebbles noted throughout; scattered ash particles.

MAJOR LITHOLOGY

MUD (Smears 3-130, 4-75, CC)
5- 8% Sand 10-25% Quartz
10-20% Silt 2- 5% Feldspar
72-82% Clay TR- 1% Heavy minerals
TR% Mica
2- 3% Opaques
65-70% Clay minerals
0- 1% Glauconite
1- 2% Zeolites
0- 2% Authigenic carbonate
TR% Diatoms
TR% Nannofossils

MINOR LITHOLOGY

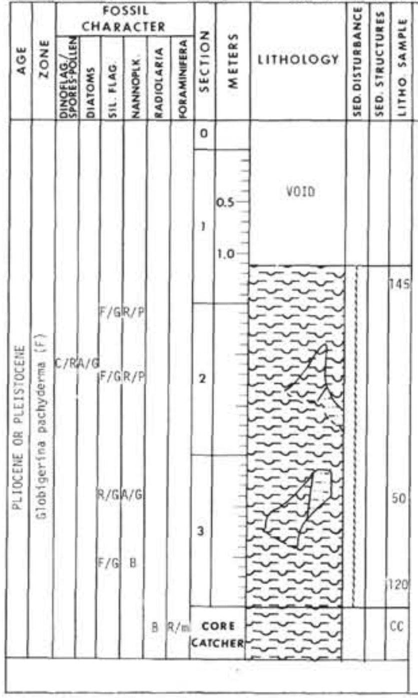
MUDDY DIATOM OOZE (Smear 3-35)
5% Quartz
TR% Mica
TR% Heavy minerals
TR% Opaques
TR% Glauconite
30% Clay minerals
45% Diatoms
7% Radiolarians
7% Sponge spicules

Carbon-Carbonate (DSDP)
2-90 (2.0, 0.7, 10)

Carbon-Carbonate (PP)
6-2 (top) (0.71, 0.50)
6-2 (bottom) (0.64, 0.86)

Grain Size (DSDP)
4-60 (16.3, 36.7, 47.0)

SITE 339 HOLE CORE 7 CORED INTERVAL: 55.5-65.0 m



LITHOLOGIC DESCRIPTION

Colors: light olive gray (5Y 5/2), dark greenish-gray (5GY 4/1), greenish gray (5G 6/1), olive black (5Y 2/1) yellow orange (10YR 6/6). Intense deformation, color streaking, patches.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 1-145, 3-120, CC)

0- 5%	Quartz
0-TR%	Feldspar
0-TR%	Mica
TR%	Heavy minerals
10-20%	Clay minerals
70-80%	Diatoms
0- 5%	Radiolarians
0- 5%	Sponge spicules
0-TR%	Silicoflagellates

5GY 4/1

MINOR LITHOLOGY

MUDDY DIATOM OOZE (Smear 3-50)

7% Sand	10%	Quartz
	TR%	Mica
	TR%	Heavy minerals
	TR%	Opaques
	20%	Clay minerals
	3%	Authigenic carbonate
	10%	Nannofossils
	45%	Diatoms
	5%	Radiolarians
	3%	Sponge spicules

5Y 2/1

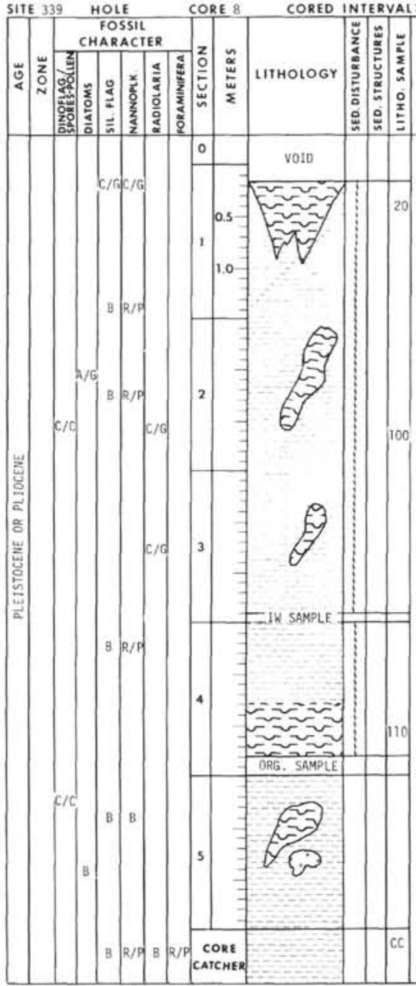
5G 4/1

5Y 5/2

Carbon-Carbonate (DSDP)
2-100 (0.6, 0.4, 2)

Grain Size (DSDP)
3-90 (10.3, 26.4, 63.4)

SITE 339 HOLE CORE 8 CORED INTERVAL: 65.0-74.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2). dark greenish-gray (5GY 4/1), dark yellow brown (10YR 4/2), bluish gray (5B 5/1). Intense deformation, soft, massive, color streaks. Granite pebble (20 mm) - Sec. 5.

MAJOR LITHOLOGIES

a) DIATOM OOZE (Smears 1-20, 4-110)

0-TR%	Opaques
10-25%	Clay minerals
50-80%	Diatoms
7-10%	Radiolarians
3-10%	Sponge spicules
TR- 5%	Silicoflagellates

b) CLAY (Smears 2-100, CC)

1% Sand	2- 5%	Quartz
5% Silt	TR- 2%	Mica
96% Clay	TR%	Heavy minerals
	2%	Opaques
	70-80%	Clay minerals
	5-10%	Authigenic carbonate
	5-10%	Nannofossils
	TR- 5%	Diatoms
	TR%	Radiolarians
	1%	Sponge spicules

5GY 4/1
with
10YR 4/2

Carbon-Carbonate (DSDP)
2-60 (1.5, 0.6, 8)
5-70 (0.4, 0.4, 1)

Carbon-Carbonate (PP)
8-4 (top) (0.01, 0.37)
8-4 (bottom) (0.41, 0.58)

5GY 4/1

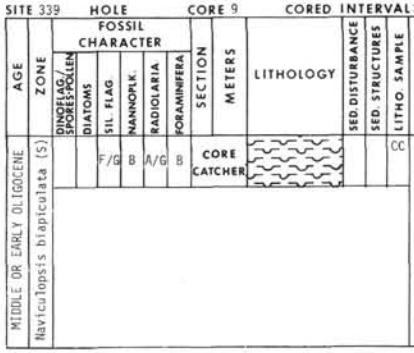
Grain Size (DSDP)
4-30 (13.8, 32.0, 54.2)

10YR 4/2

5Y 3/2

Explanatory notes in Chapter 1

SITE 339 **HOLE** **CORE** 9 **CORED INTERVAL**: 74.5-84.0 m



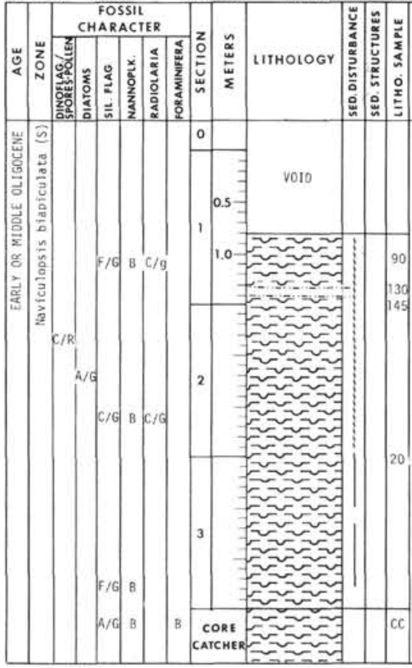
LITHOLOGIC DESCRIPTION

5Y 5/2

Core catcher only: light olive gray (5Y 5/2).

DIATOM OOZE (Smear CC)
TR% Mica
TR% Opaques
20% Clay minerals
55% Diatoms
5% Radiolarians
15% Sponge spicules
TR% Silicoflagellates

SITE 339 **HOLE** **CORE** 10 **CORED INTERVAL**: 84.0-93.5 m



LITHOLOGIC DESCRIPTION

5GY 6/1
with
5G 6/1

5Y 5/2

Colors: light olive gray (5Y 5/2), greenish gray (5GY 6/1) (5G 6/1). Color splotches, intense deformation, soft to firm, H_2S odor.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 1-90, 1-145, 3-20, CC)
0-TR% Quartz
0-TR% Mica
0-TR% Heavy minerals
0- 3% Opaques
10-24% Clay minerals
60-80% Diatoms
5-10% Radiolarians
3-10% Sponge spicules
TR- 1% Silicoflagellates

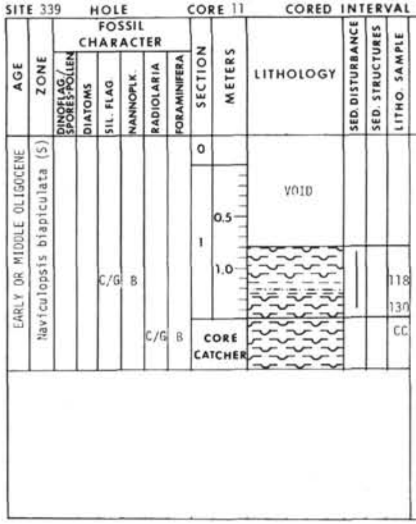
MINOR LITHOLOGY

DIATOMACEOUS MUD (Smear 1-130)
TR% Mica
5% Opaques
75% Clay minerals
10% Diatoms
5% Radiolarians
5% Sponge spicules

Carbon-Carbonate (DSDP)
3-95 (0.3, 0.0, 3)

Grain Size (DSDP)
2-110 (1.5, 27.0, 71.5)
3-130 (3.3, 32.3, 64.3)

SITE 339 **HOLE** **CORE** 11 **CORED INTERVAL** 93.5-103.0 m



LITHOLOGIC DESCRIPTION

5GY 5/2

10G 6/2
5GY 5/2

5Y 5/2

Colors: light olive gray (5Y 5/2), dusky yellow green (5GY 5/2), pale green (10G 6/2) - mottles.

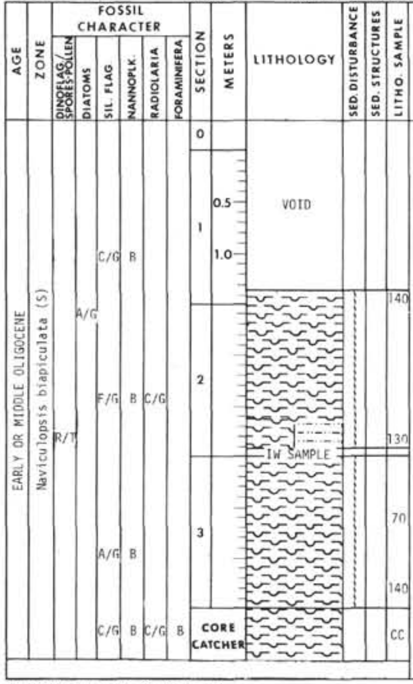
MAJOR LITHOLOGY

DIATOM OOZE (Smears 1-30, CC)
TR% Quartz
0- 2% Opaques
15-20% Clay minerals
70-76% Diatoms
2- 5% Radiolarians
2- 5% Sponge spicules
TR% Silicoflagellates

MINOR LITHOLOGY

DIATOMACEOUS MUD (Smear 1-118)
5% Quartz
TR% Mica
TR% Heavy minerals
70% Clay minerals
20% Diatoms
2% Radiolarians
2% Sponge spicules

SITE 339 **HOLE** **CORE** 12 **CORED INTERVAL**: 103.0-108.0 m



LITHOLOGIC DESCRIPTION

5Y 6/1

5GY 5/2

5Y 5/2

Colors: light olive gray (5Y 5/2) (5Y 6/1), dusky yellow green (5GY 5/2), pale green (10G 6/2). Intense deformation, soft.

MAJOR LITHOLOGY

DIATOM OOZE/DIATOMITE (Smears 1-140, 3-70, 3-140, CC)
0- 2% Opaques
0- 5% Volcanic glass
10-15% Clay minerals
68-80% Diatoms
5-10% Radiolarians
0-10% Sponge spicules
0- 2% Silicoflagellates

MINOR LITHOLOGY

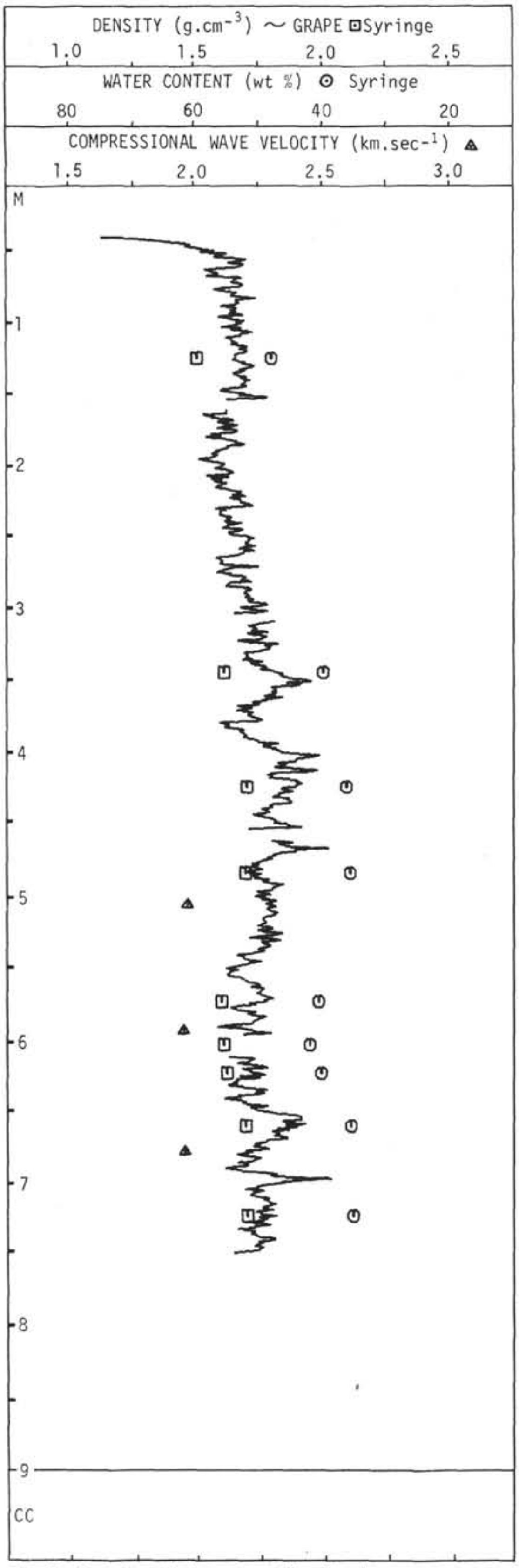
MUDDY DIATOM OOZE (Smear 2-130)
3% Sand
5% Quartz
1% Opaques
32% Clay minerals
40% Diatoms
10% Radiolarians
10% Sponge spicules
2% Silicoflagellates

Carbon-Carbonate (DSDP)
3-60 (0.5, 0.6, 0)

Carbon-Carbonate (PP)
12-1 (top) (0.42, 0.05)
12-1 (bottom) (0.44, 0.02)

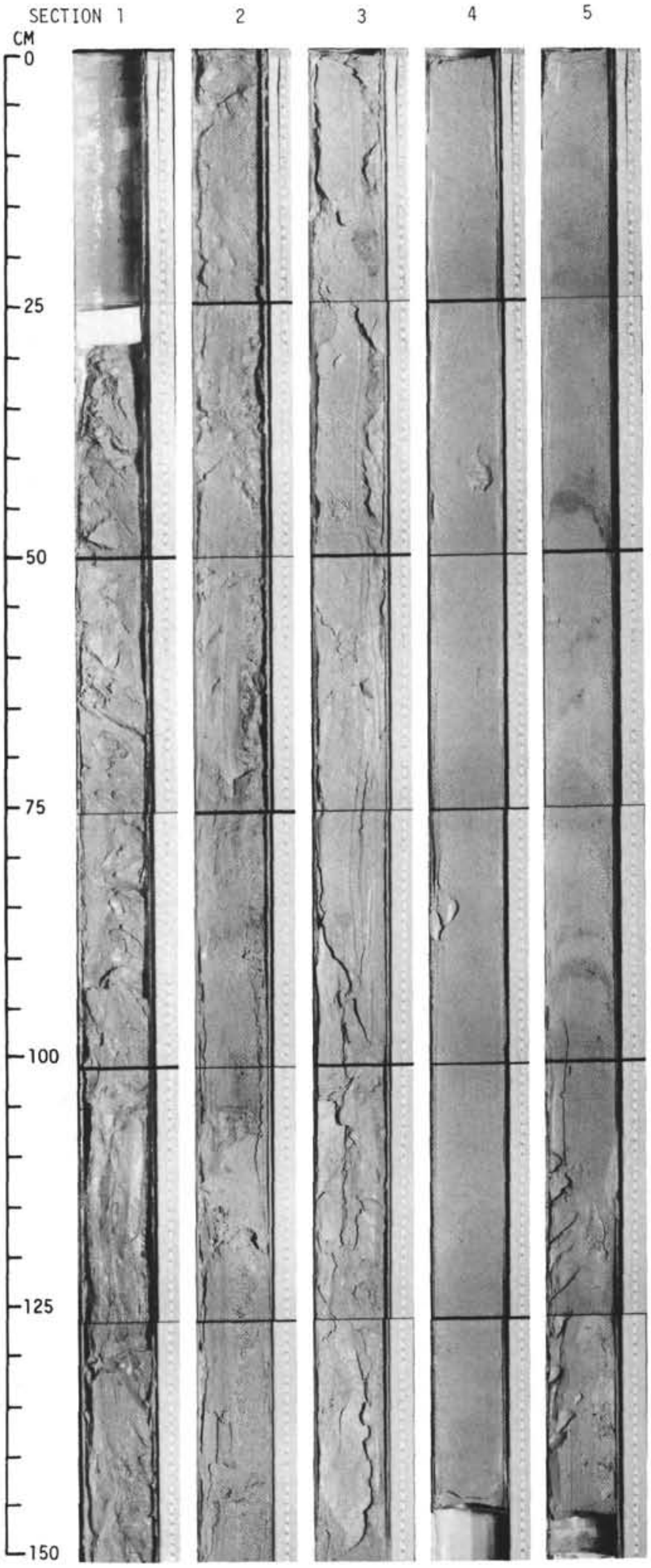
Grain Size (DSDP)
3-10 (0.2, 21.4, 78.4)

Explanatory notes in Chapter 1

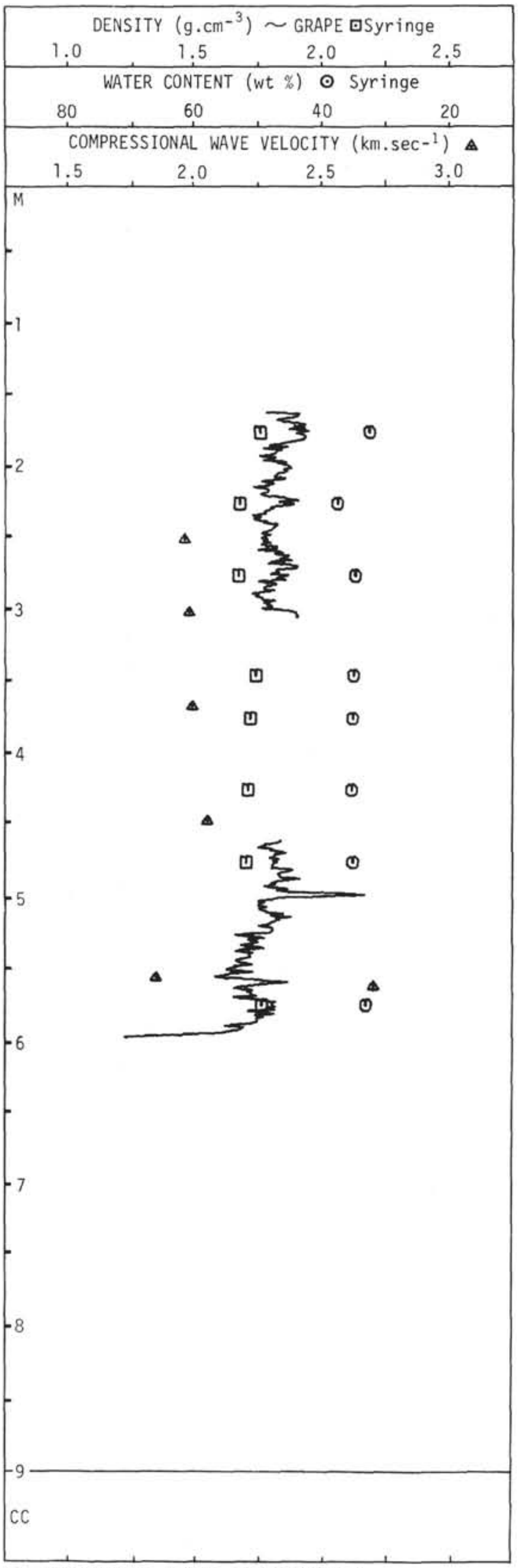


For Explanatory Notes, see Chapter 1

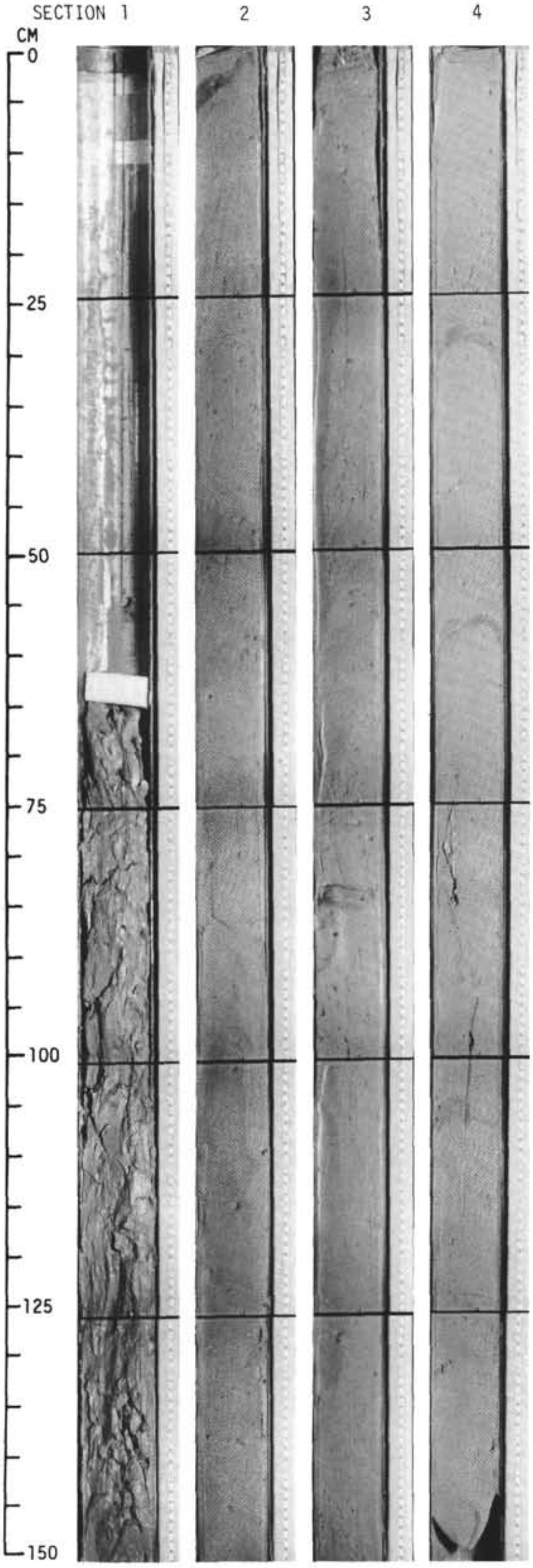
339-1

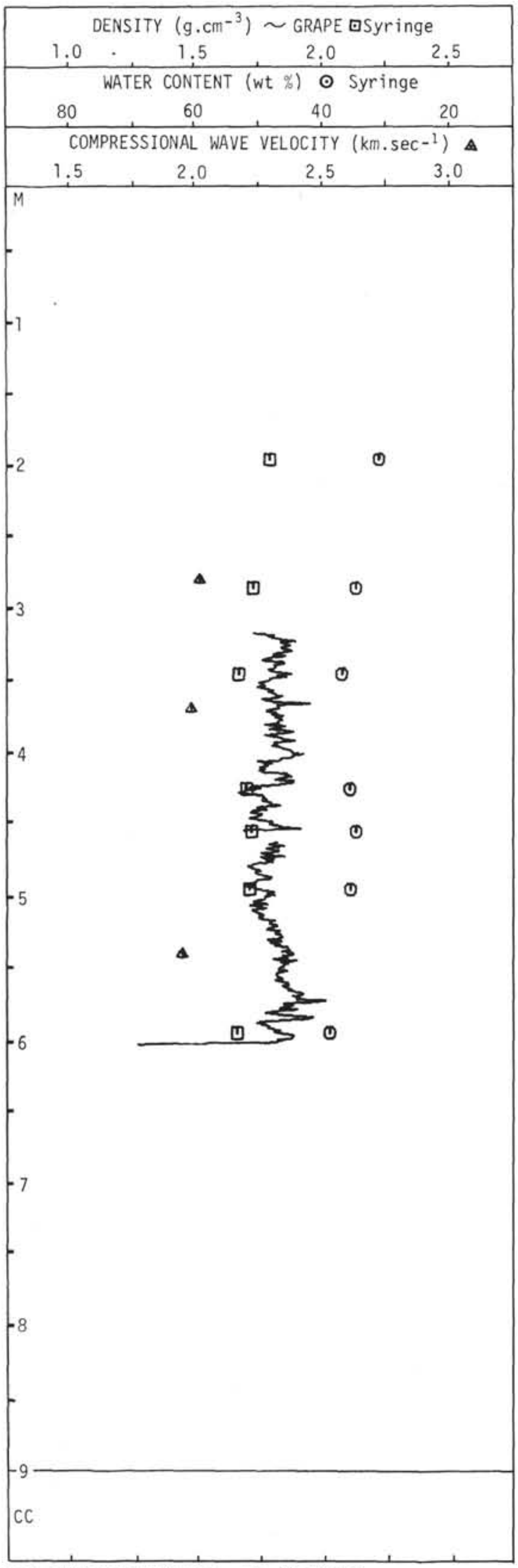


339-2



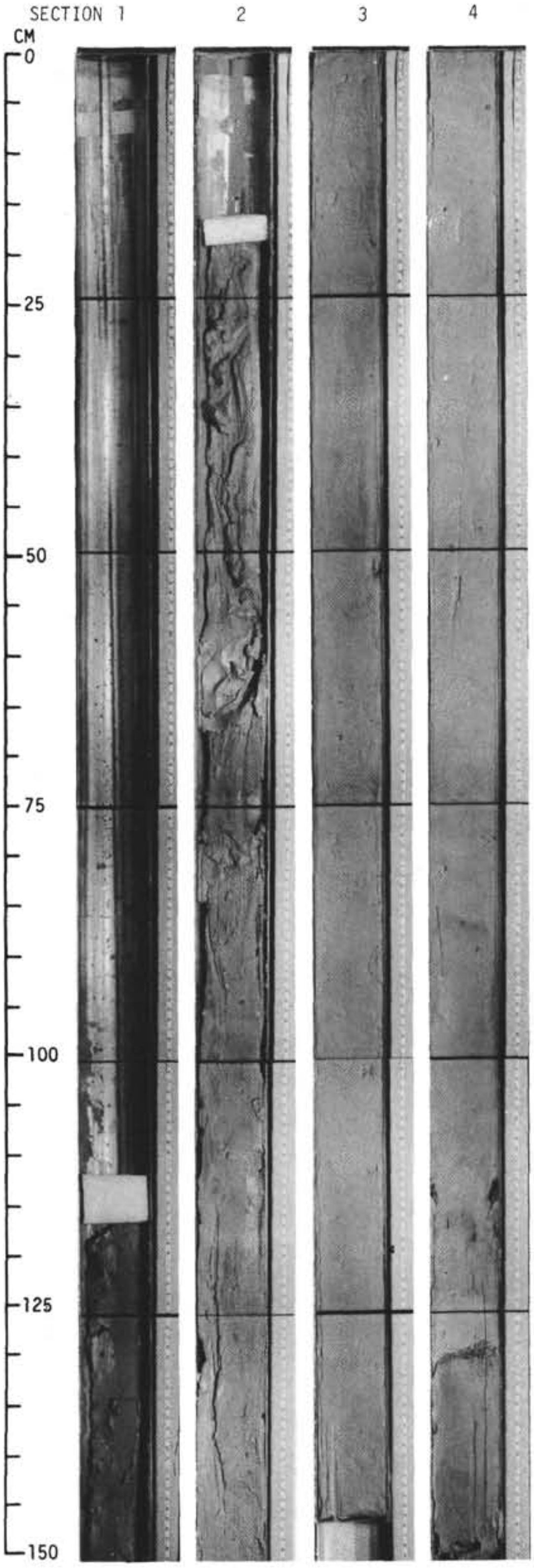
For Explanatory Notes, see Chapter 1

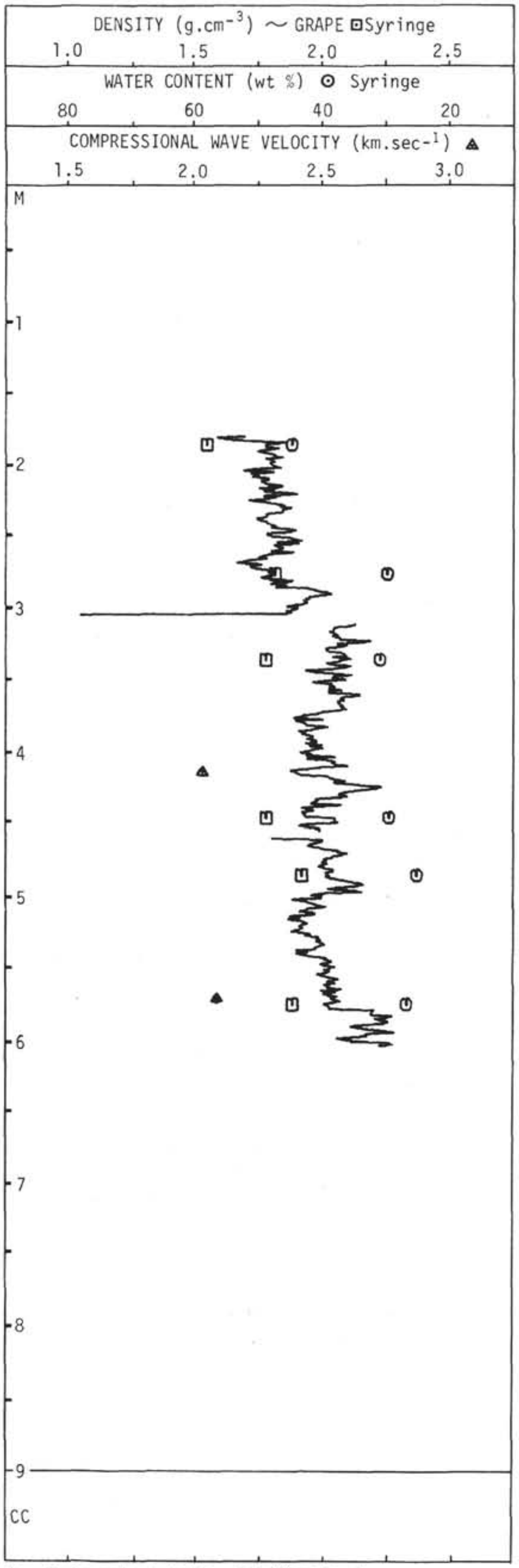




For Explanatory Notes, see Chapter 1

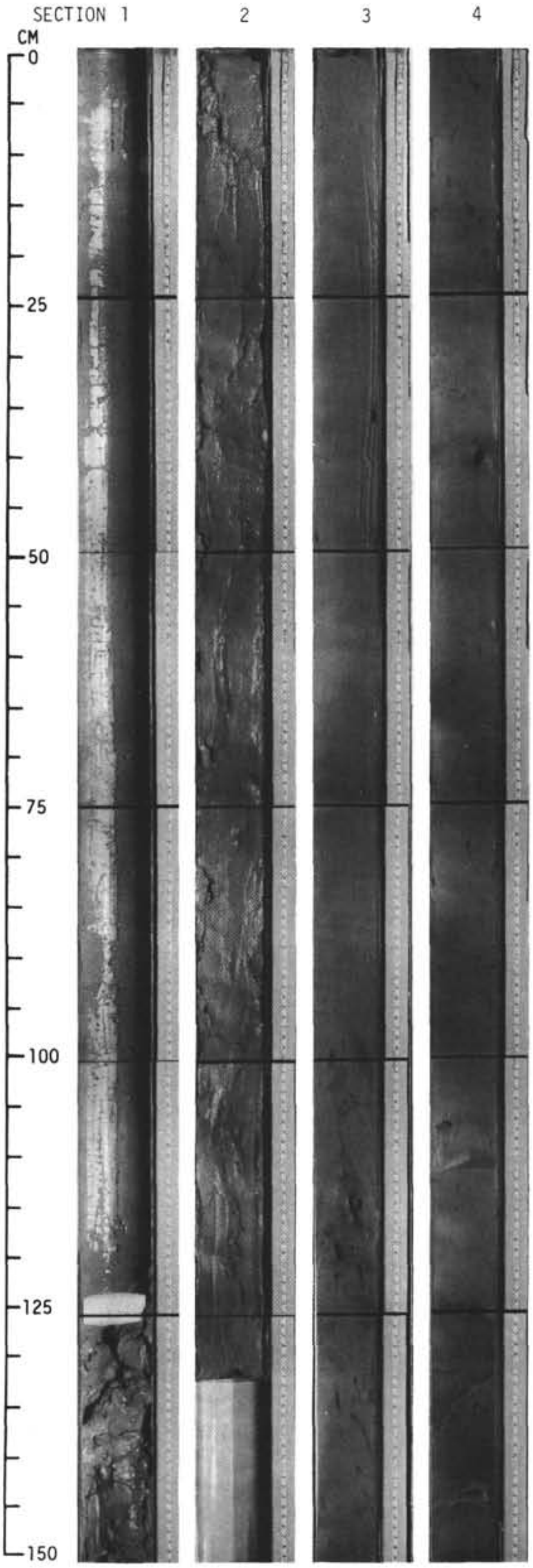
339-3





For Explanatory Notes, see Chapter 1

339-4



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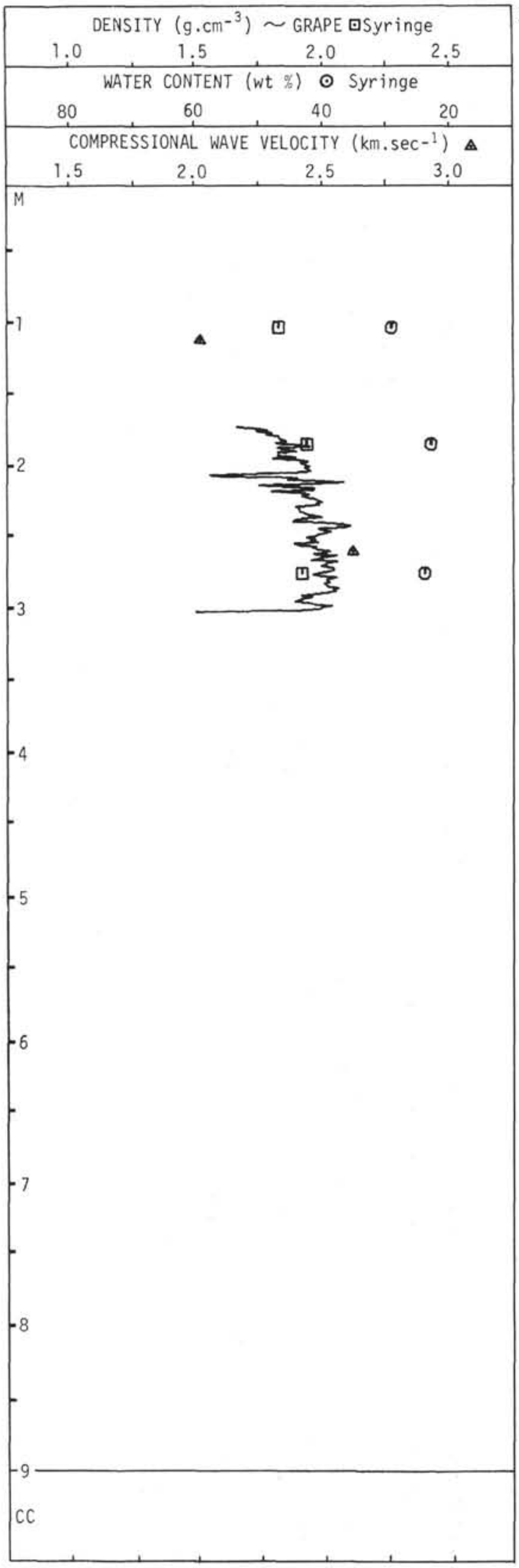
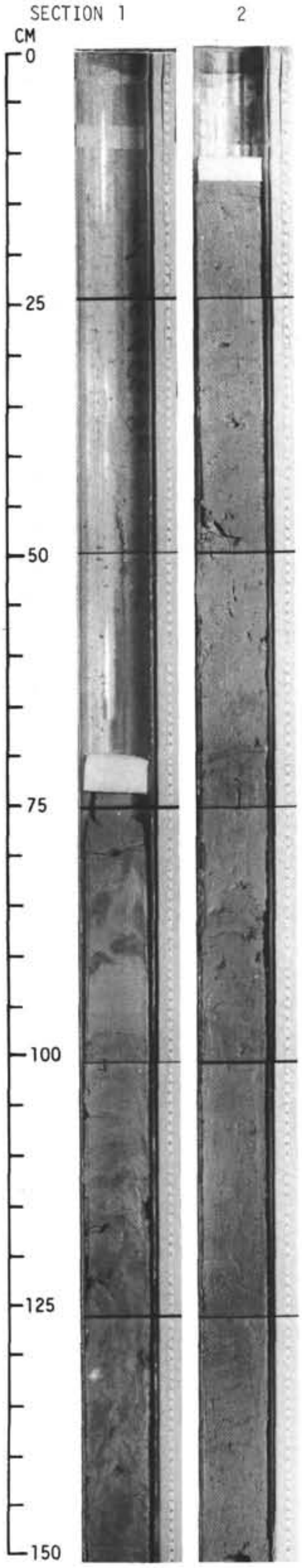


For Explanatory Notes, see Chapter 1



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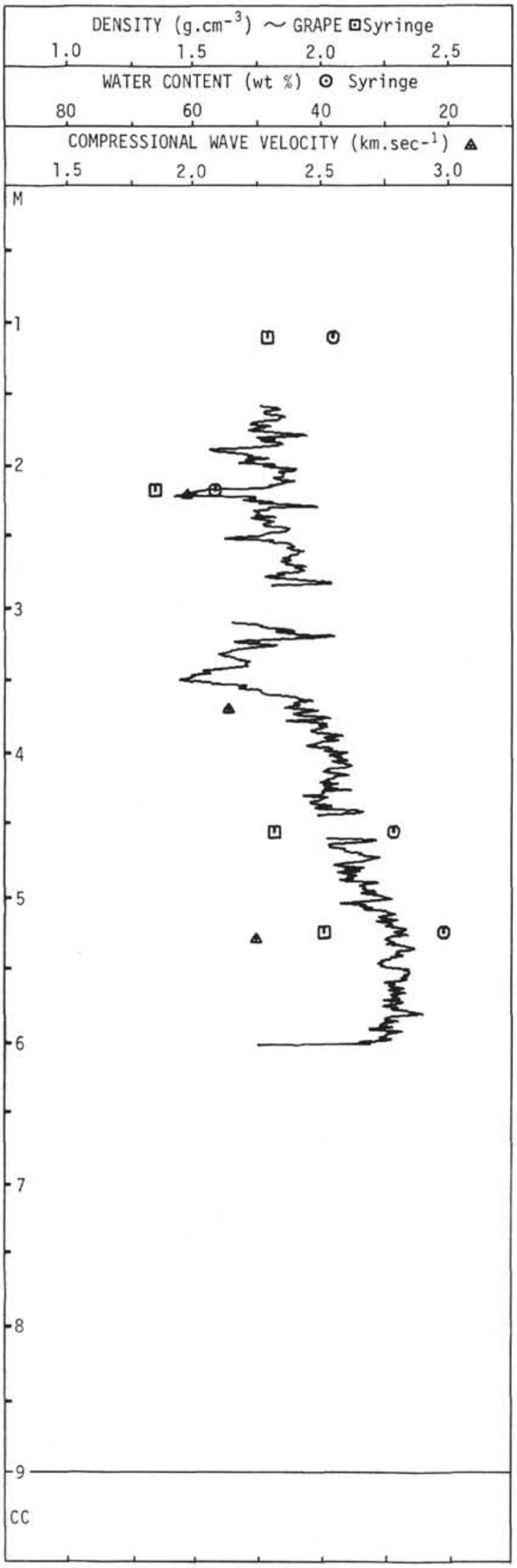
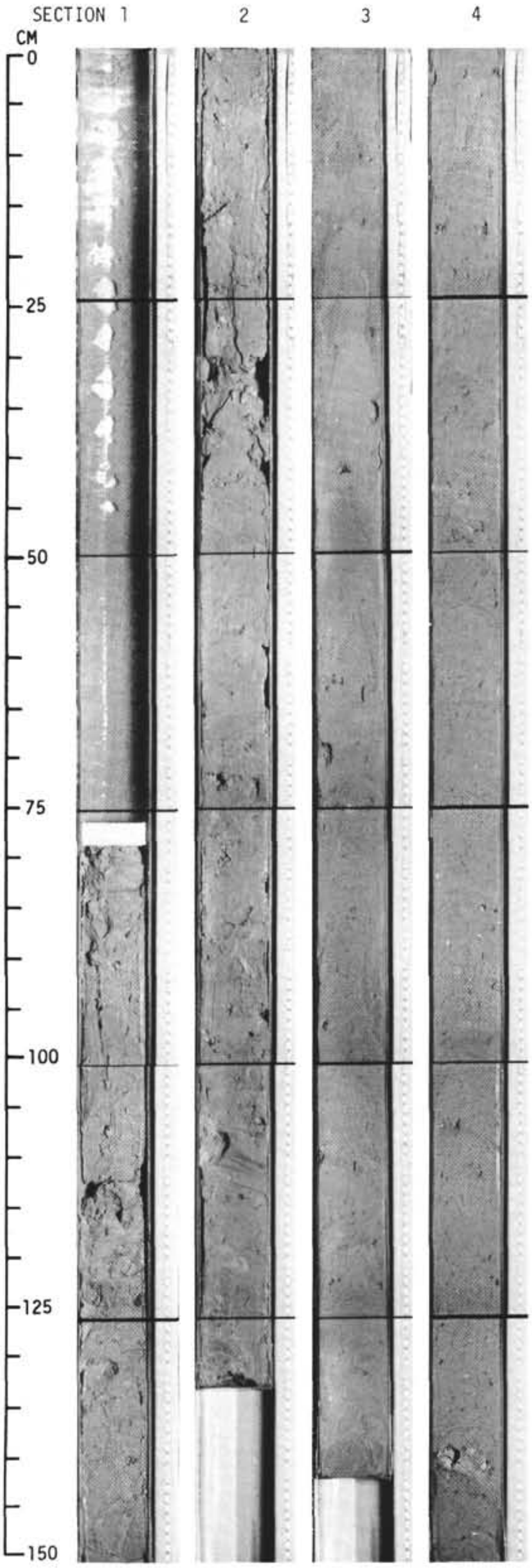
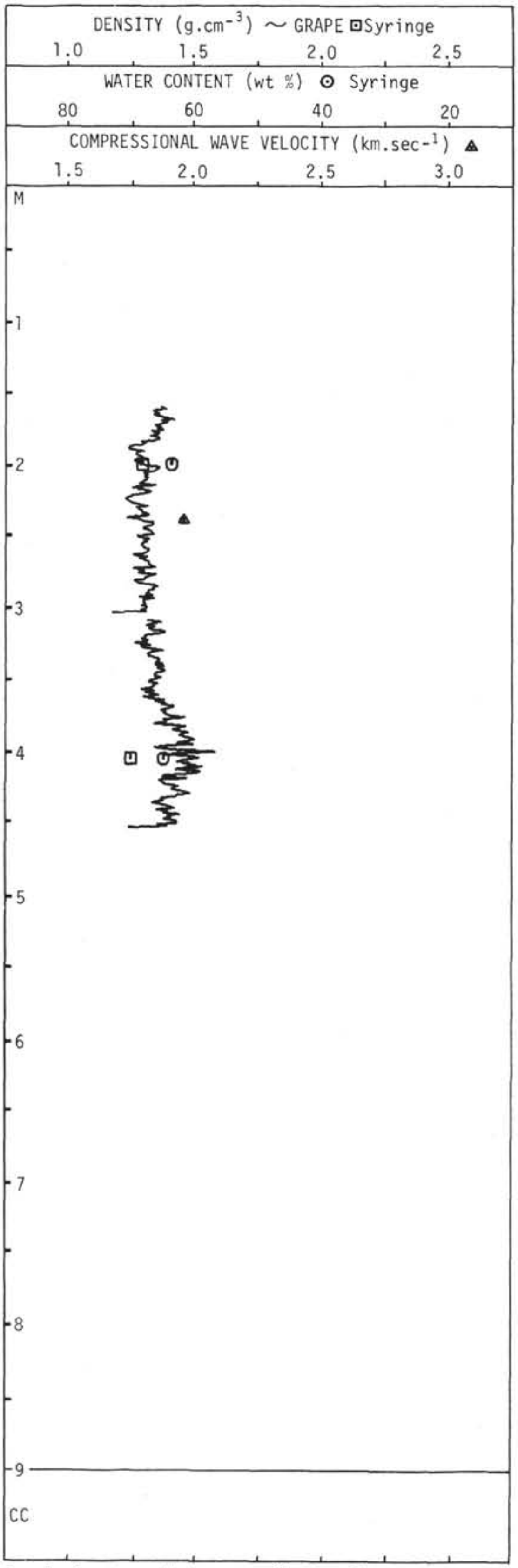


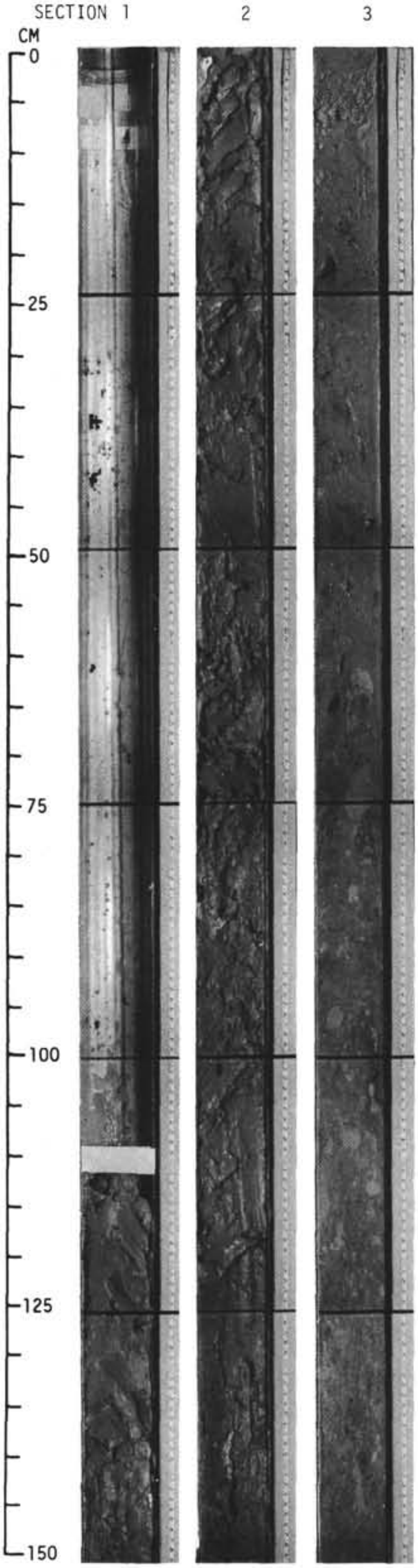


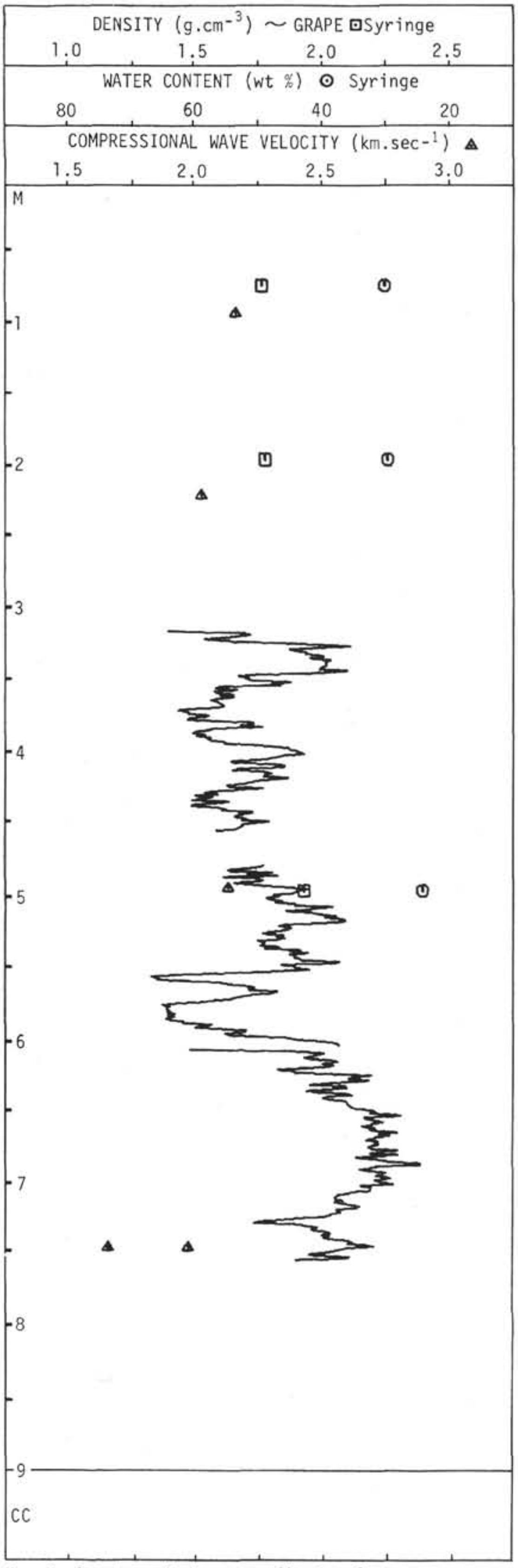
For Explanatory Notes, see Chapter 1

339-7



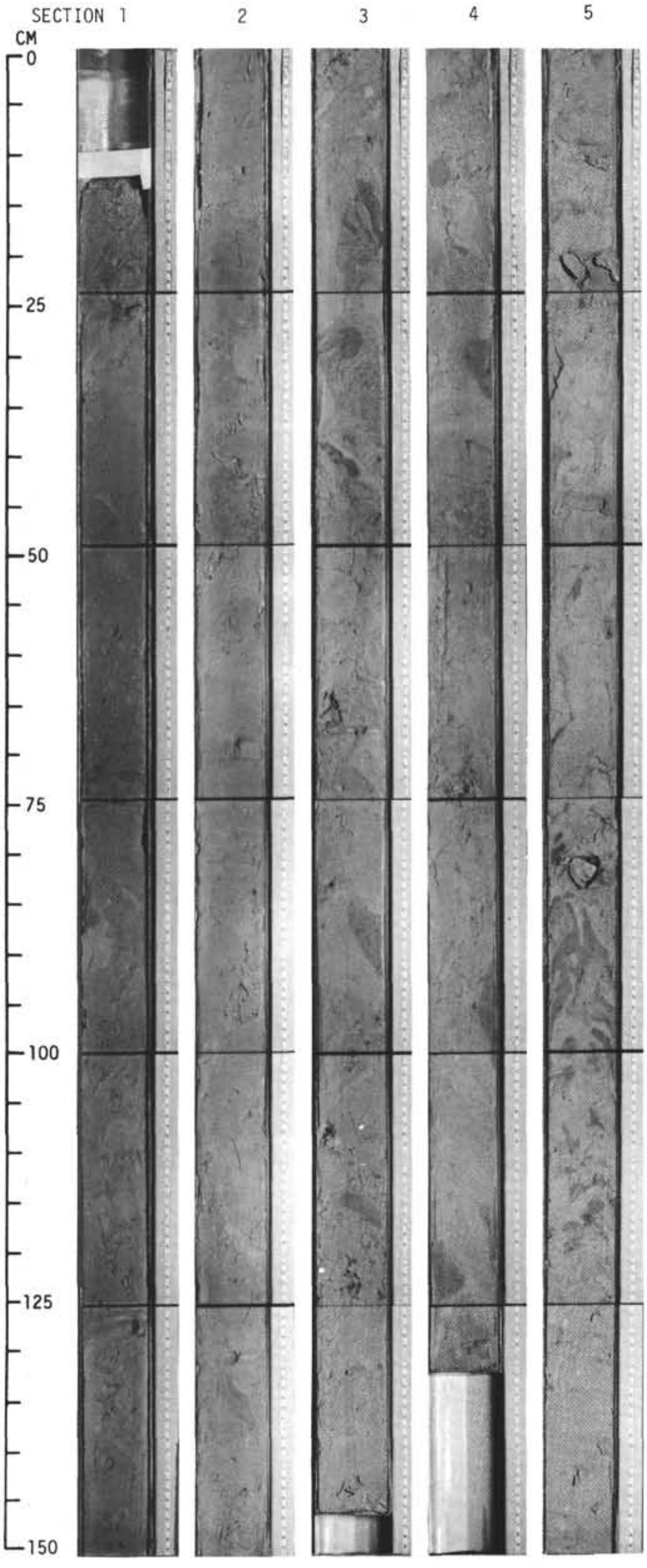
For Explanatory Notes, see Chapter 1

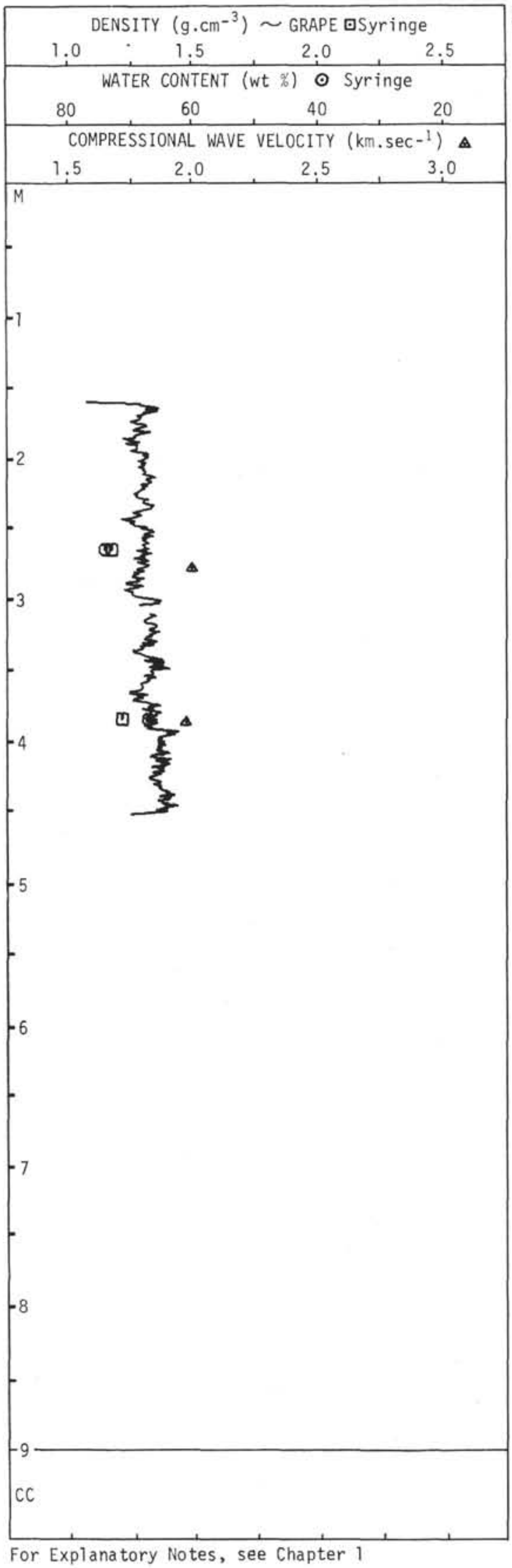




For Explanatory Notes, see Chapter 1

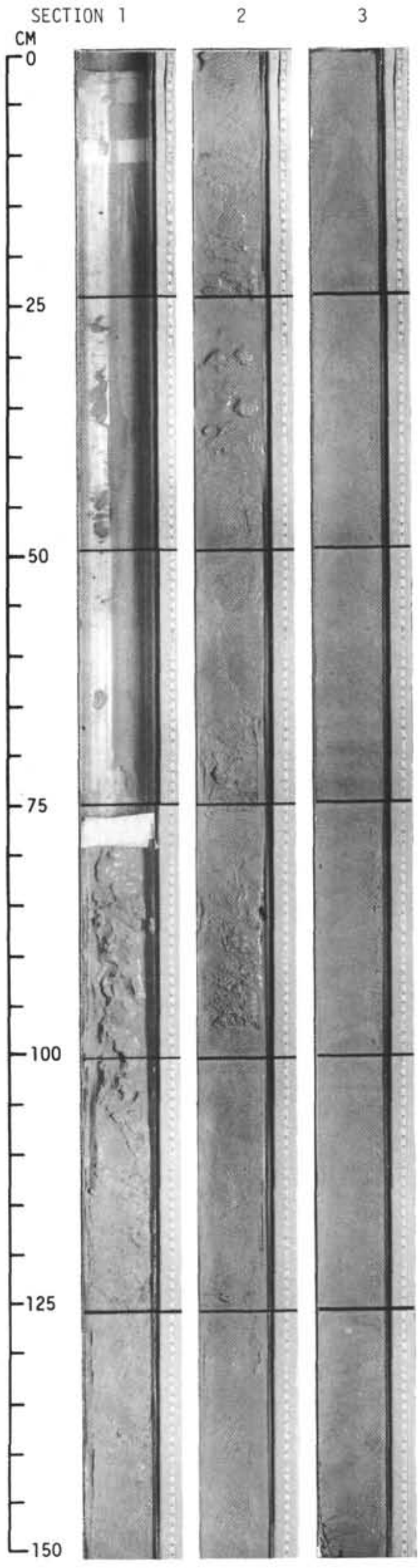
339-8

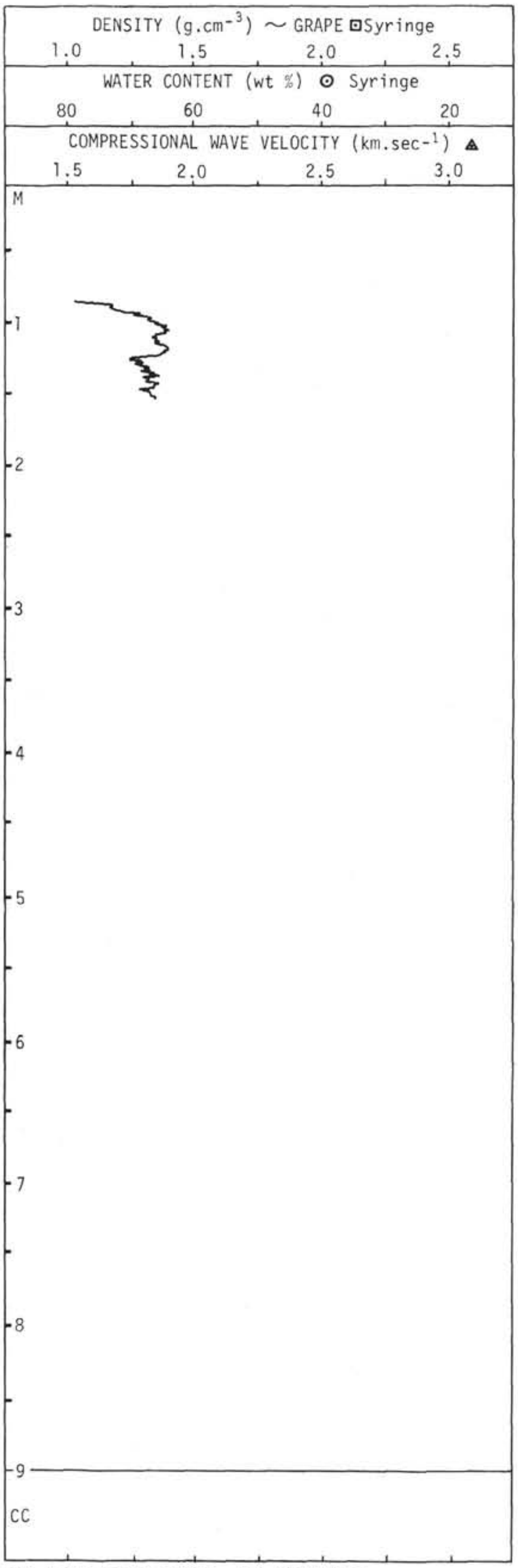




For Explanatory Notes, see Chapter 1

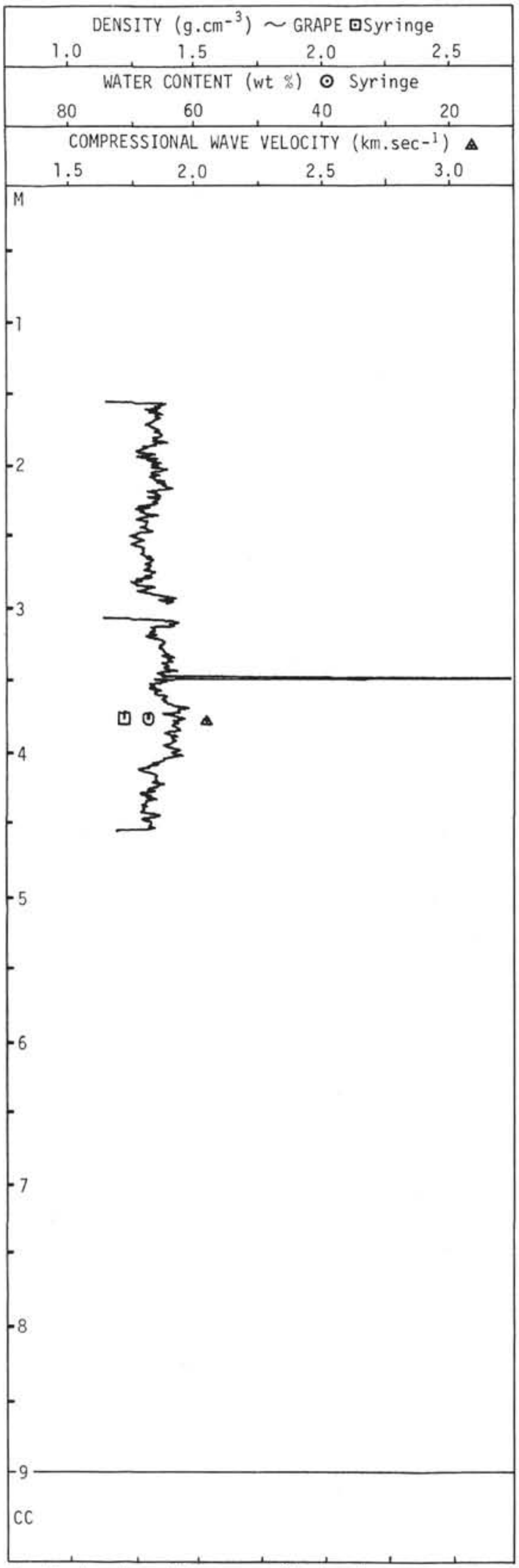
339-10





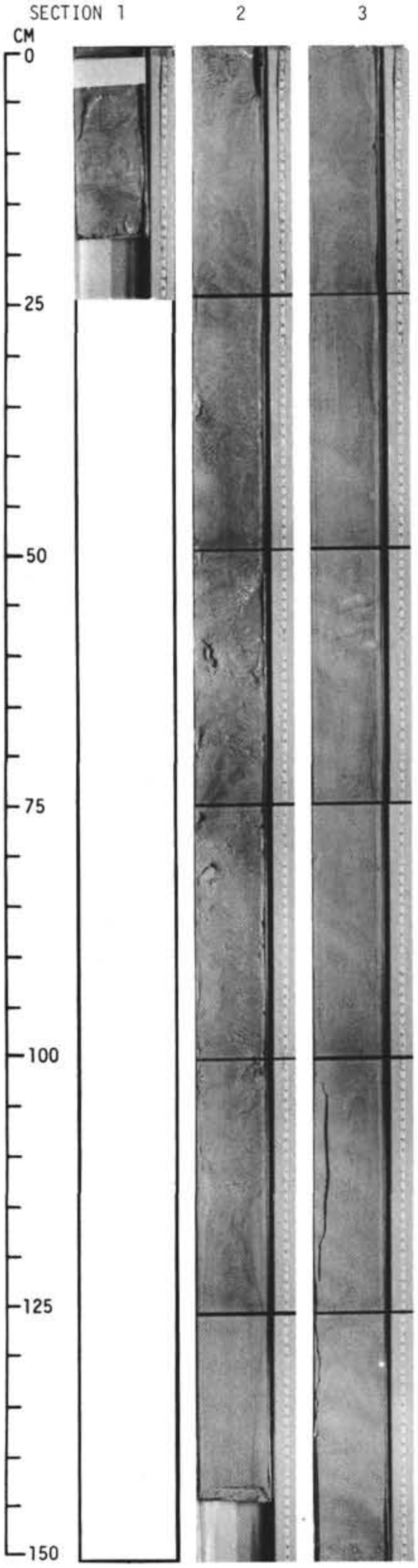
For Explanatory Notes, see Chapter 1

339-11

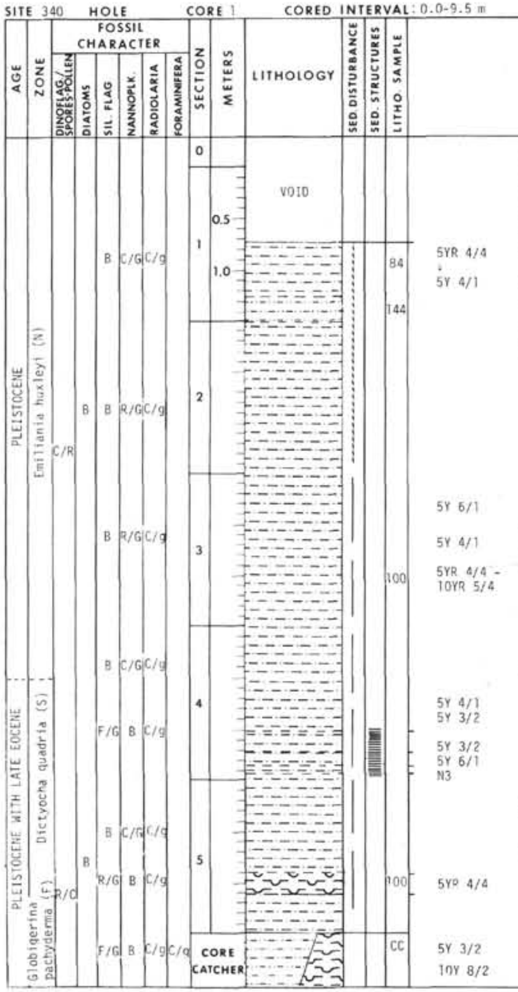


For Explanatory Notes, see Chapter 1

339-12



SITE 340 HOLE CORE 1 CORED INTERVAL: 0.0-9.5 m



LITHOLOGIC DESCRIPTION

Colors: moderate brown (5YR 4/4), olive gray (5Y 4/1) (5Y 3/2), light olive gray (5Y 6/1), pale green yellow (10Y 8/2), moderate brown (5YR 4/4), moderate yellow brown (10YR 5/4). Color variations, streaking common. Scattered pebbles (1.5 cm). Intense-moderate deformation.

MAJOR LITHOLOGIES

a) SANDY MUD (Smears 1-84, 3-100)

15% Sand	20-25% Quartz
35-40% Silt	0- 2% Feldspar
45-50% Clay	1- 5% Heavy minerals
	2- 5% Opaques
	0- 1% Volcanic glass
	45-52% Clay minerals
	TR- 1% Glauconite
	5-10% Authigenic carbonate
	0-TR% Foraminifera
	5-10% Nannofossils
	2- 5% Diatoms
	TR- 2% Sponge spicules
	0-TR% Silicoflagellates

b) MUD (Smear CC)

5% Sand	7% Quartz
15% Silt	1% Heavy minerals
80% Clay	2% Opaques
	78% Clay minerals
	7% Authigenic carbonate
	5% Nannofossils
	TR% Diatoms
	TR% Sponge spicules

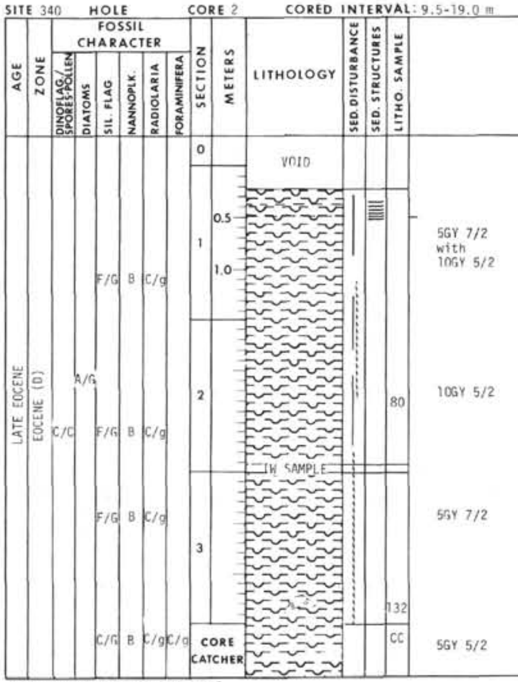
c) DIATOM OOZE (Smears 5-100, CC)

0-TR% Quartz
0-TR% Volcanic glass
0-TR% Clay minerals
85-90% Diatoms
7% Radiolarians
3- 7% Sponge spicules
TR- 1% Silicoflagellates

Carbon-Carbonate (DSDP)
3-93 (2.9, 0.4, 21)

Grain Size (DSDP)
3-107 (29.0, 33.0, 38.0)

SITE 340 HOLE CORE 2 CORED INTERVAL: 9.5-19.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), grayish yellow green (5GY 7/2), grayish green (10GY 5/2). Intense-moderate deformation. Color gradations in Sec. 1. Clay clasts throughout.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 2-80, CC)

0-TR% Glauconite
70-85% Diatoms
15-20% Radiolarians
0- 5% Sponge spicules
TR- 1% Volcanic glass
TR- 1% Silicoflagellates

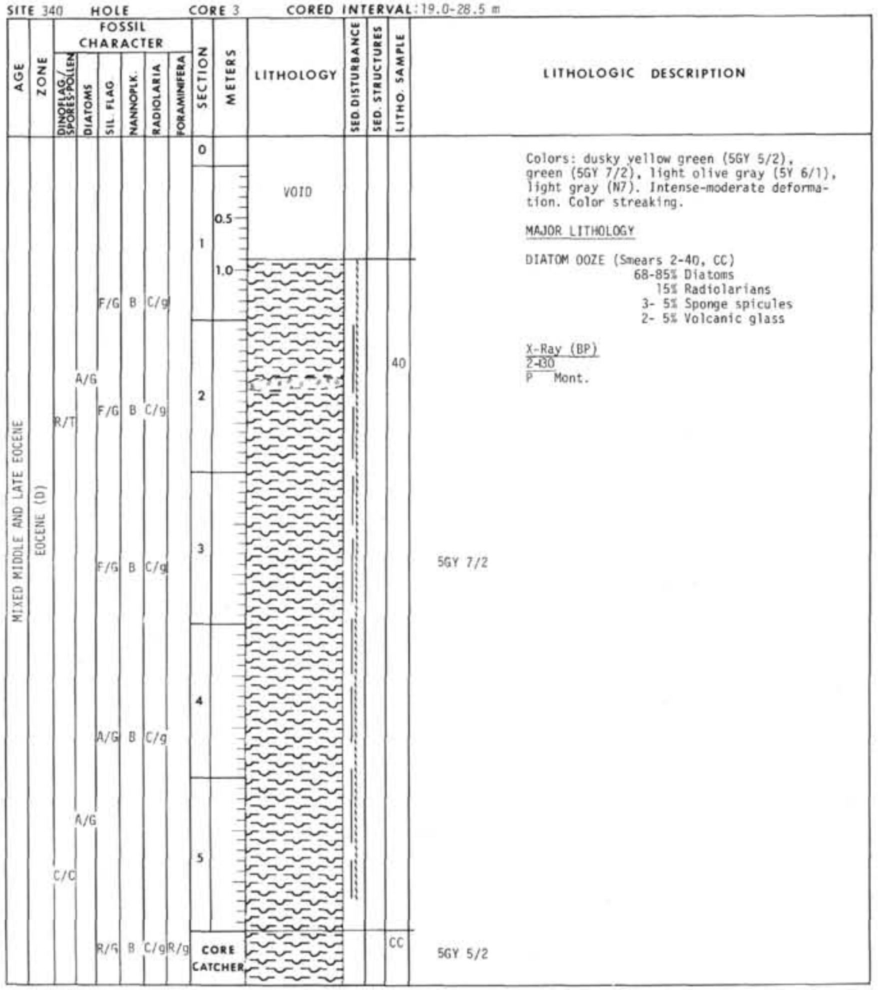
MINOR LITHOLOGY

VOLCANIC ASH (Smear 3-132)

7% Quartz
10% Opaques
78% Volcanic glass
5% Clay minerals
TR% Diatoms

X-Ray (BP)
2-80
P Mont.

Explanatory notes in Chapter 1



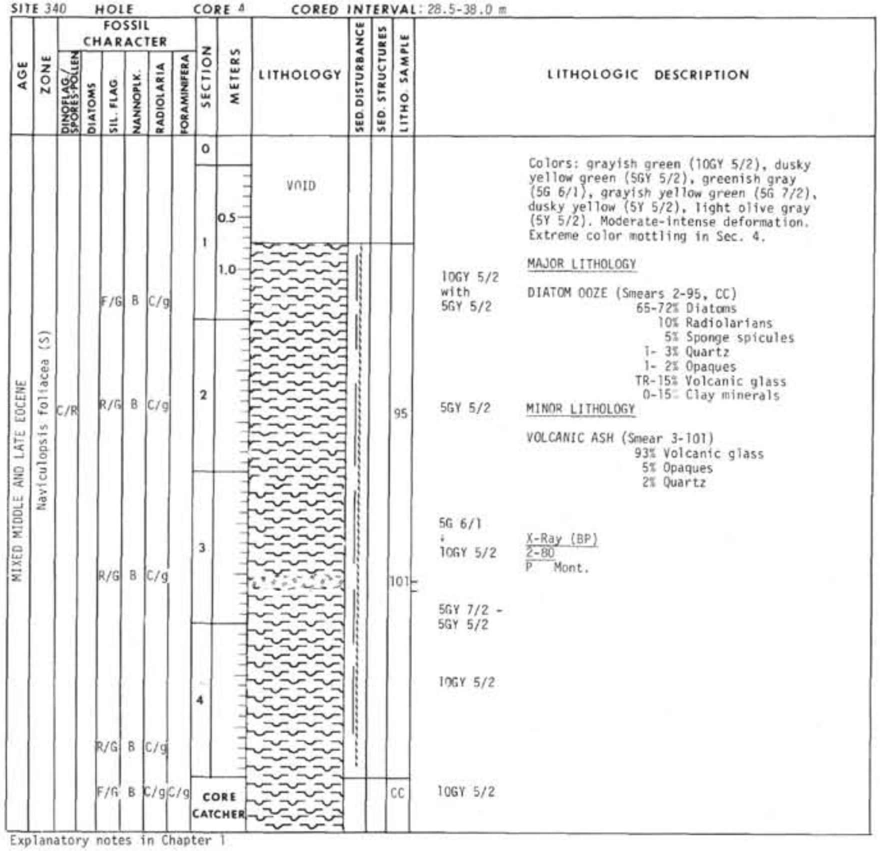
Colors: dusky yellow green (5GY 5/2), green (5GY 7/2), light olive gray (5Y 6/1), light gray (N7). Intense-moderate deformation. Color streaking.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 2-40, CC)

68-85%	Diatoms
15%	Radiolarians
3- 5%	Sponge spicules
2- 5%	Volcanic glass

X-Ray (BP)
2-130
P Mont.



Colors: grayish green (10GY 5/2), dusky yellow green (5GY 5/2), greenish gray (5G 6/1), grayish yellow green (5G 7/2), dusky yellow (5Y 5/2), light olive gray (5Y 5/2). Moderate-intense deformation. Extreme color mottling in Sec. 4.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 2-95, CC)

65-72%	Diatoms
10%	Radiolarians
5%	Sponge spicules
1- 3%	Quartz
1- 2%	Opaques
TR-15%	Volcanic glass
0-15%	Clay minerals

MINOR LITHOLOGY

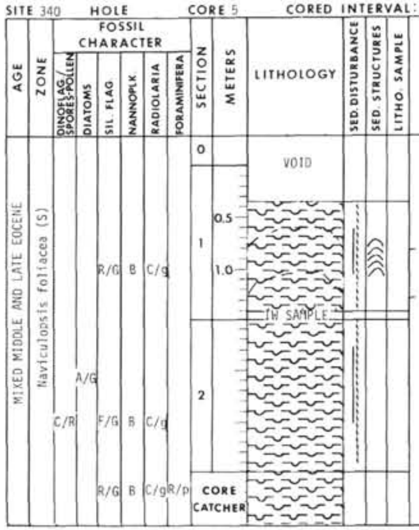
VOLCANIC ASH (Smear 3-101)

93%	Volcanic glass
5%	Opaques
2%	Quartz

X-Ray (BP)
2-80
P Mont.

Explanatory notes in Chapter 1

SITE 340 HOLE CORE 5 CORED INTERVAL: 38.0-47.5 m



LITHOLOGIC DESCRIPTION

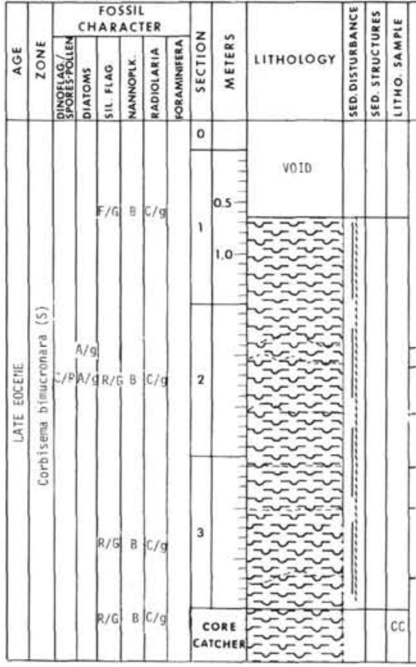
Colors: grayish green (10GY 5/2), dusky yellow green (5GY 5/2), olive gray (5Y 5/2). Intense-moderate deformation.

MAJOR LITHOLOGY

DIATOM OOZE

X-Ray (BP)
2-80
P Mont.

SITE 340 HOLE CORE 6 CORED INTERVAL: 47.5-57.0 m



LITHOLOGIC DESCRIPTION

Color: grayish green (10GY 5/2), (5GY 5/2), light olive gray (5Y 5/2), grayish olive (10Y 4/2), olive gray (5Y 3/2), pale olive (10Y 6/2), grayish brown (5YR 3/2). Intense deformation, color mottling.

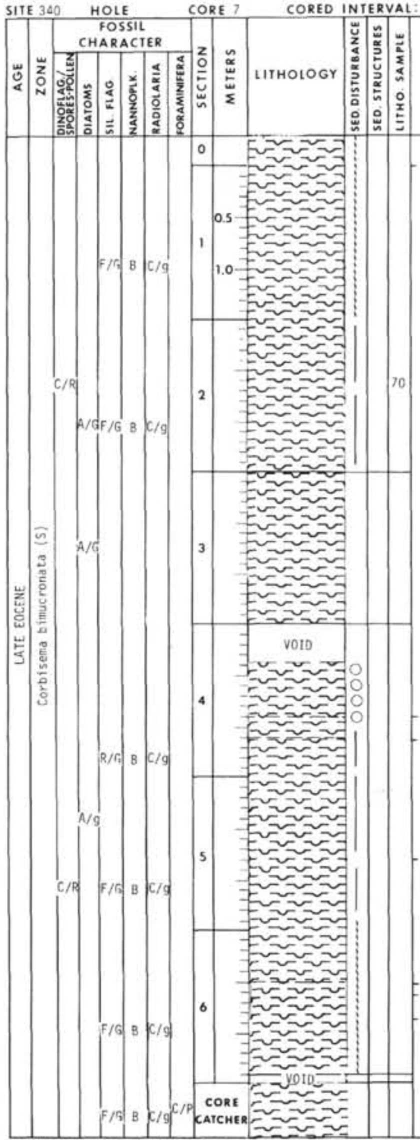
MAJOR LITHOLOGY

DIATOM OOZE (Smear CC)
75% Diatoms
5% Sponge spicules
5% Silicoflagellates
10% Clay minerals
2% Quartz

Carbon-Carbonate (DSDP)
2-27 (0.3, 0.3, 0)

X-Ray (BP)
2-80
P Mont.

SITE 340 HOLE CORE 7 CORED INTERVAL: 57.0-66.5 m



LITHOLOGIC DESCRIPTION

Colors: grayish green (5GY 6/1), grayish green (10GY 5/2), dusky yellow green (5GY 5/2), grayish blue green (5BG 5/2). Moderate-intense deformation, color mottling, variegated.

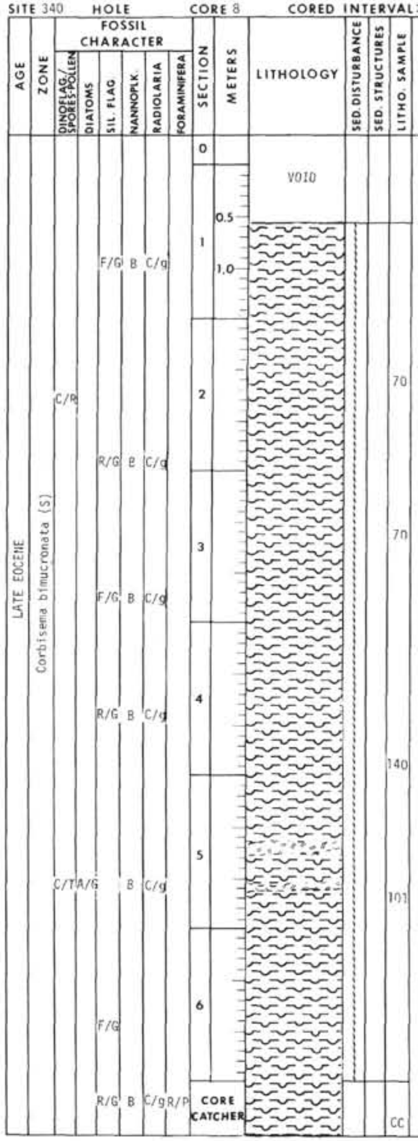
MAJOR LITHOLOGY

DIATOM OOZE (Smear 2-70)
2% Quartz
TR% Opaques
1% Volcanic glass
15% Clay minerals
65% Diatoms
10% Radiolarians
7% Sponge spicules

X-Ray (BP)
1-71
P Mont.
TR Ill.
TR Kaol., Chlo.

Explanatory notes in Chapter 1

SITE 340 HOLE CORE 8 CORED INTERVAL: 66.5-76.0 m



LITHOLOGIC DESCRIPTION

Colors: grayish green (5GY 6/1), dusky yellow green (5GY 5/2), grayish green (5GY 4/1) (10GY 5/2), pale green (10G 6/2). Intense deformation - color streaking.

5GY 5/2 + 10GY 4/4

MAJOR LITHOLOGY

DIATOM OOZE (Smears 2-70, 3-70, 4-140, CC)
0-TR% Quartz
TR% Opaques
TR- 3% Volcanic glass
80-87% Diatoms
5-10% Radiolarians
5-10% Sponge spicules

5G 5/2

MINOR LITHOLOGY

VOLCANIC ASH (Smear 5-101)
95% Volcanic glass
5% Opaques
TR% Diatoms

Carbon-Carbonate (DSDP)
4-50 (0.2, 0.2, 0)

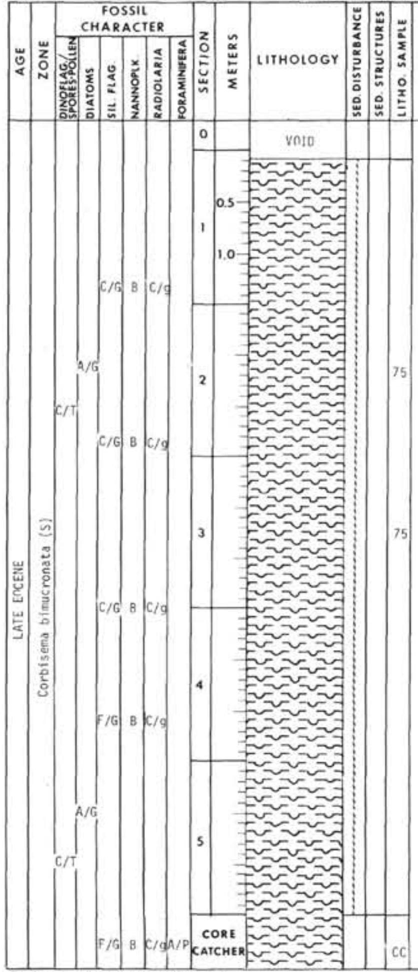
10GY 5/2

X-Ray (BP)
3-80
P Mont.
TR Ill.
TR Kaol., Chlo.

10G 6/2, 5GY 5/2, 10GY 5/2

5GY 6/1

SITE 340 HOLE CORE 9 CORED INTERVAL: 76.0-85.5 m



LITHOLOGIC DESCRIPTION

Colors: grayish green (5GY 6/1), gray olive green (5GY 3/2), dusky yellow (5GY 5/2), pale green (10G 6/2). Intense deformation, soft, massive, streaked.

5GY 3/2 with 5GY 5/2, 10G 6/2

MAJOR LITHOLOGY

DIATOM OOZE (Smears 2-75, 3-75, CC)
0- 1% Opaques
TR- 3% Volcanic glass
0-TR% Glauconite
79-90% Diatoms
5-10% Radiolarians
3- 7% Sponge spicules
0-TR% Silicoflagellates

5GY 5/2

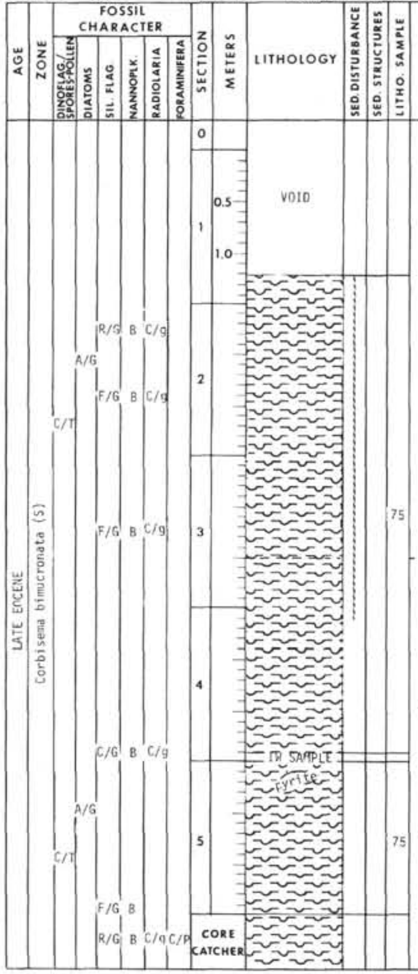
Carbon-Carbonate (DSDP)
3-15 (0.3, 0.4, 0)

X-Ray (BP)
1-80
P Mont.
TR Ill.
TR Kaol., Chlo.

5GY 6/1

Explanatory notes in Chapter 1

SITE 340 HOLE CORE 10 CORED INTERVAL: 85.5-95.0 m



LITHOLOGIC DESCRIPTION

Colors: greenish gray (5GY 6/1), dusky yellow green (5GY 5/2). Massive, soft, pyrite zone (1 cm), Sec. 5. Variegated colors Secs. 4-5. Intense deformation.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 3-75, 5-75)

10% Silt	2% Opaques
90% Clay	20% Clay minerals
	63% Diatoms
	10% Radiolarians
	5- 7% Sponge spicules

5GY 5/2

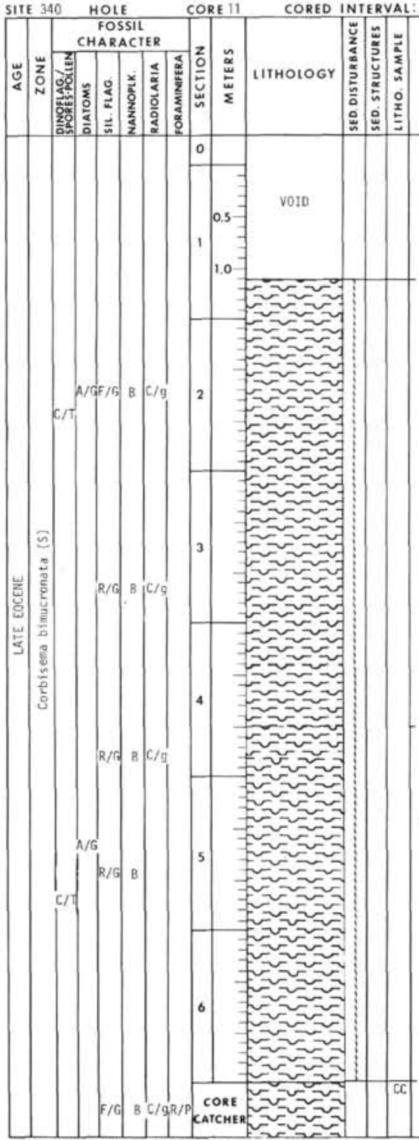
X-Ray (BP)
5-80
P Mont.
TR Ill.
TR Kaol., Chlo.

Variegated

Variegated

5GY 6/1

SITE 340 HOLE CORE 11 CORED INTERVAL: 95.0-104.5 m



LITHOLOGIC DESCRIPTION

Grayish green (5GY 6/1), dusky yellow green (5GY 5/2). Intense deformation. Variegated Secs. 5 and 6.

MAJOR LITHOLOGY

DIATOM OOZE (Smear CC)
2% Quartz
1% Heavy minerals
84% Diatoms
5% Radiolarians
7% Sponge spicules
1% Silicoflagellates

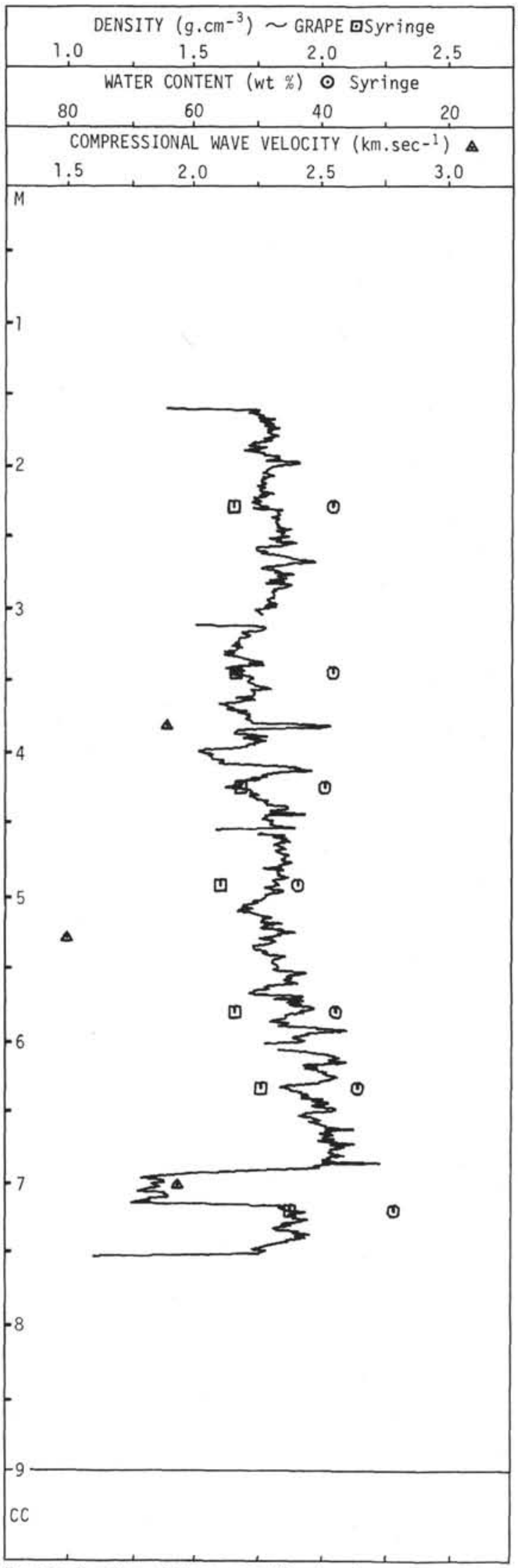
5GY 5/2

X-Ray (BP)
4-50
P Mont.
TR Ill.
TR Kaol., Chlo.

Variegated

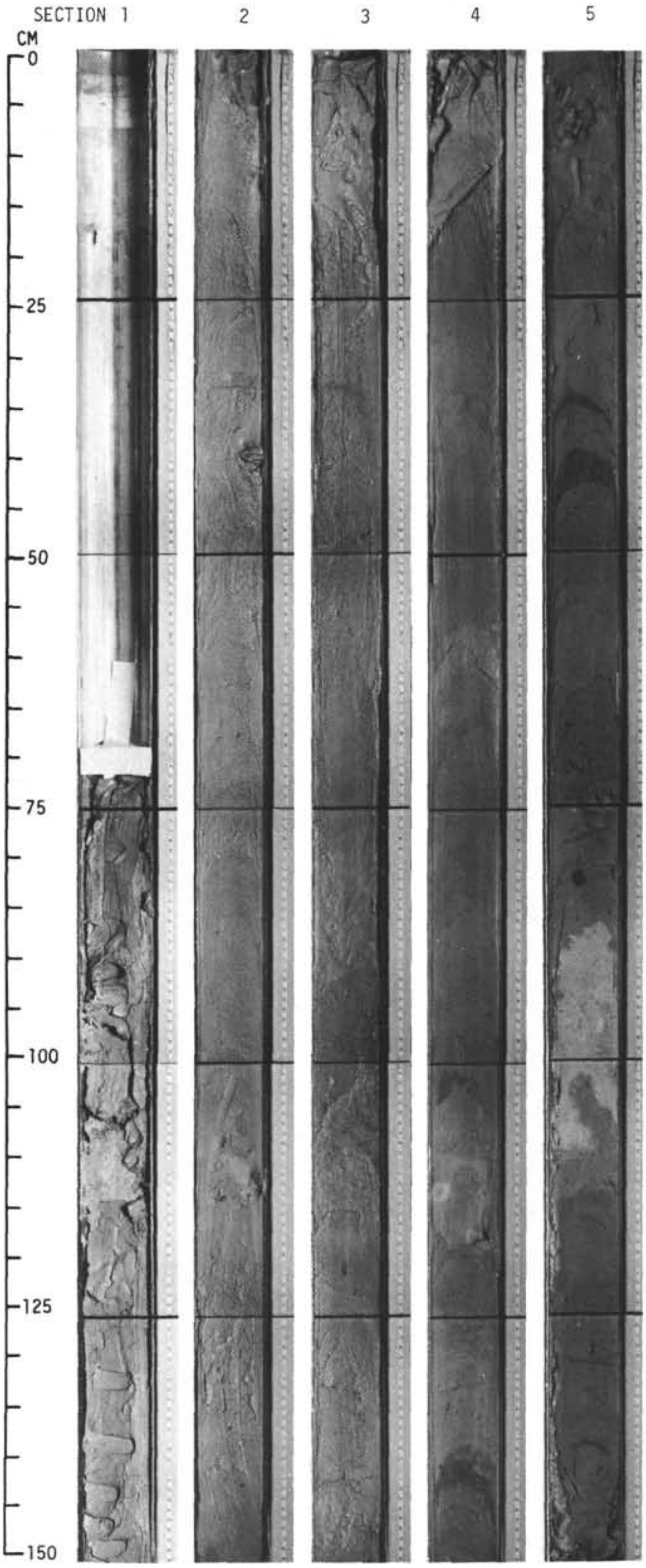
5GY 6/1

Explanatory notes in Chapter 1

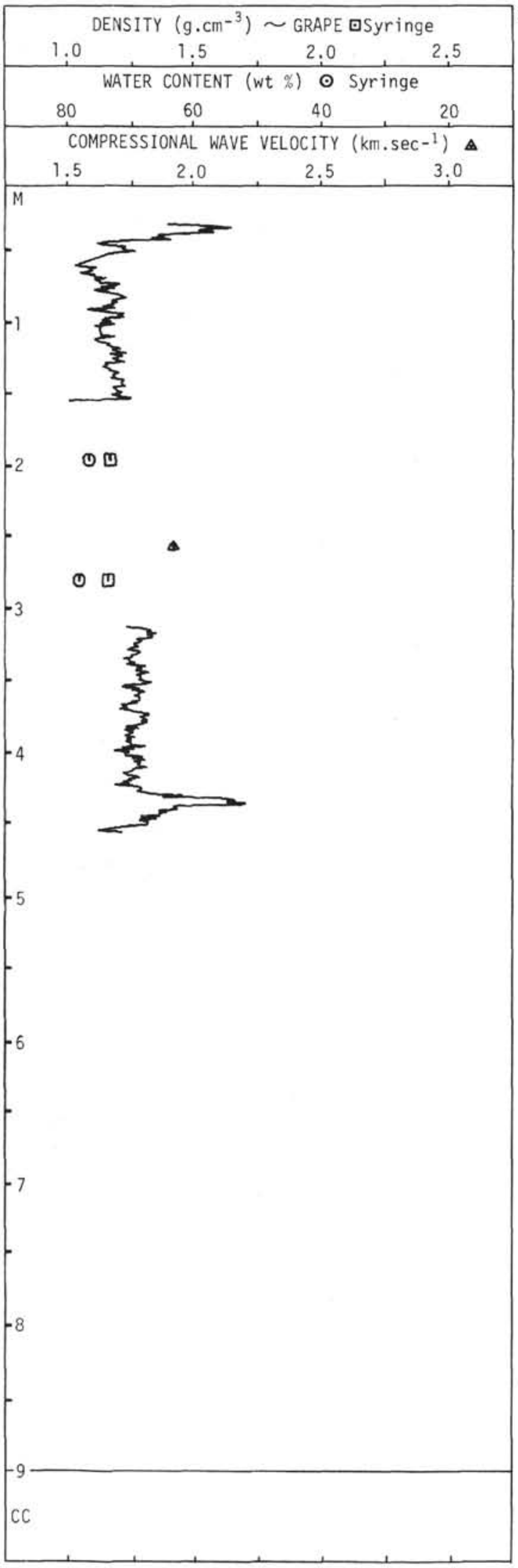


For Explanatory Notes, see Chapter 1

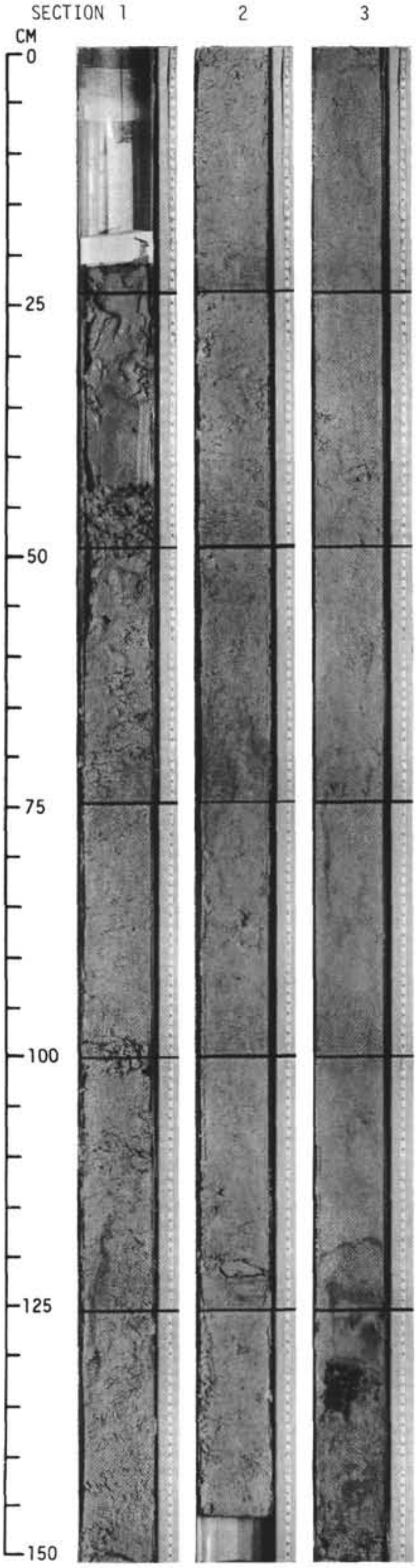
340-1

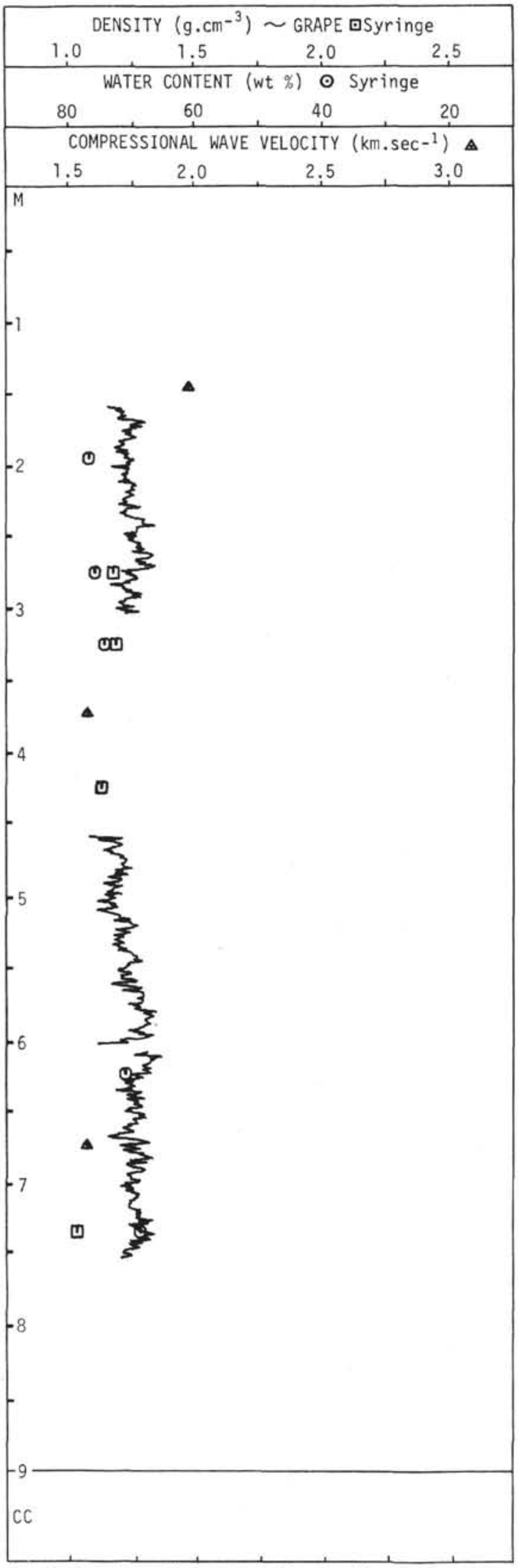


340-2



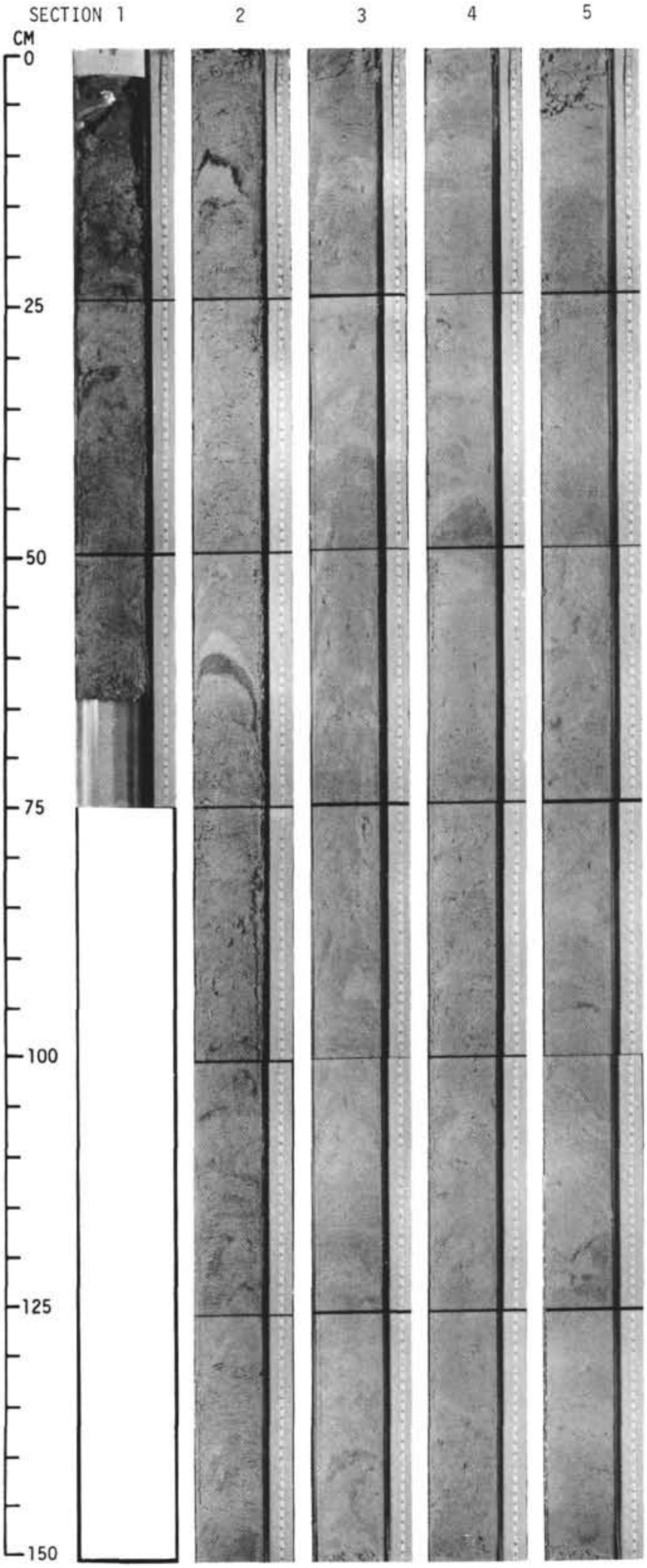
For Explanatory Notes, see Chapter 1

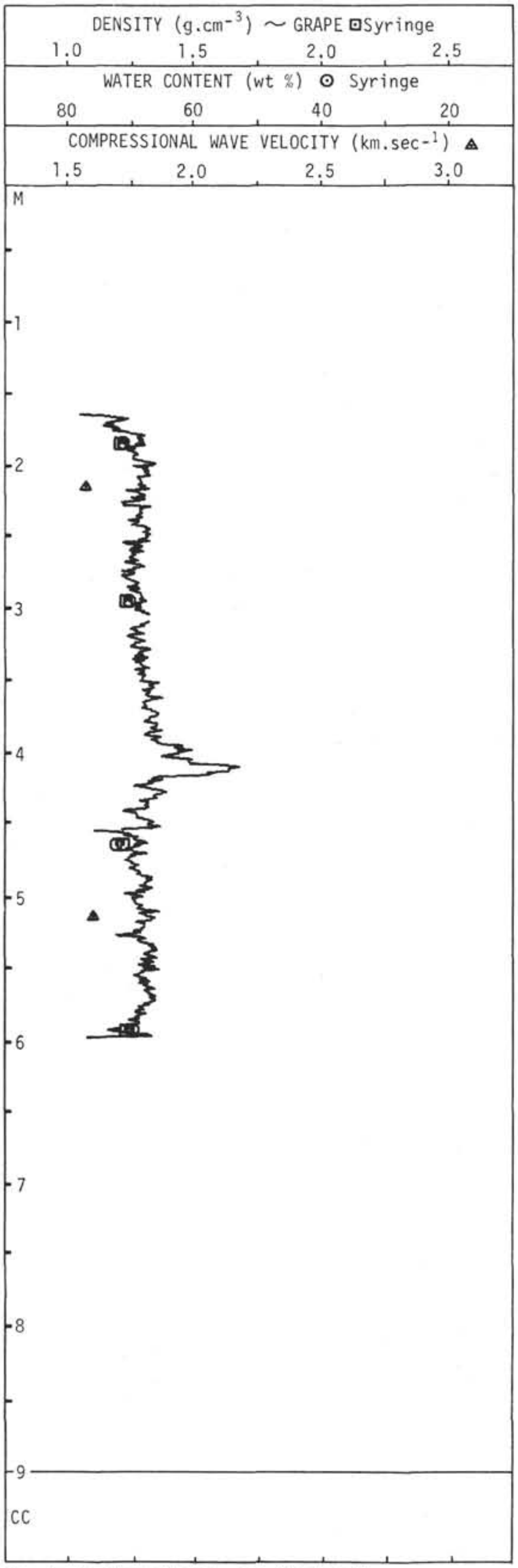




For Explanatory Notes, see Chapter 1

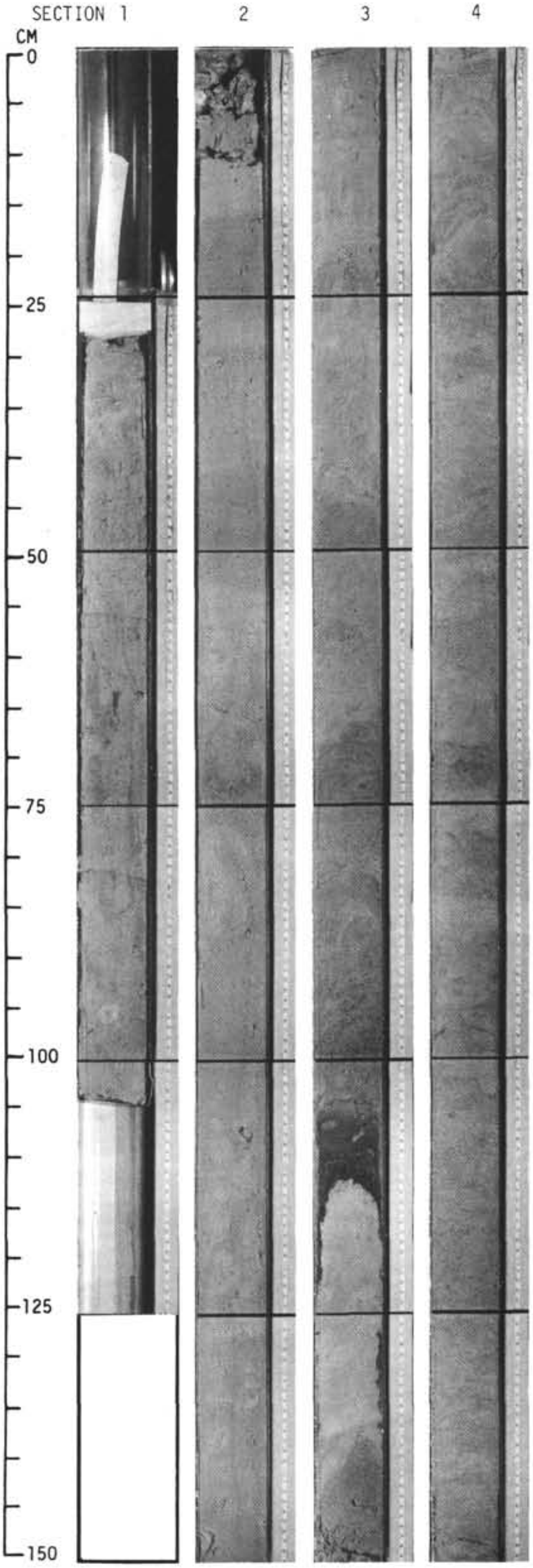
340-3



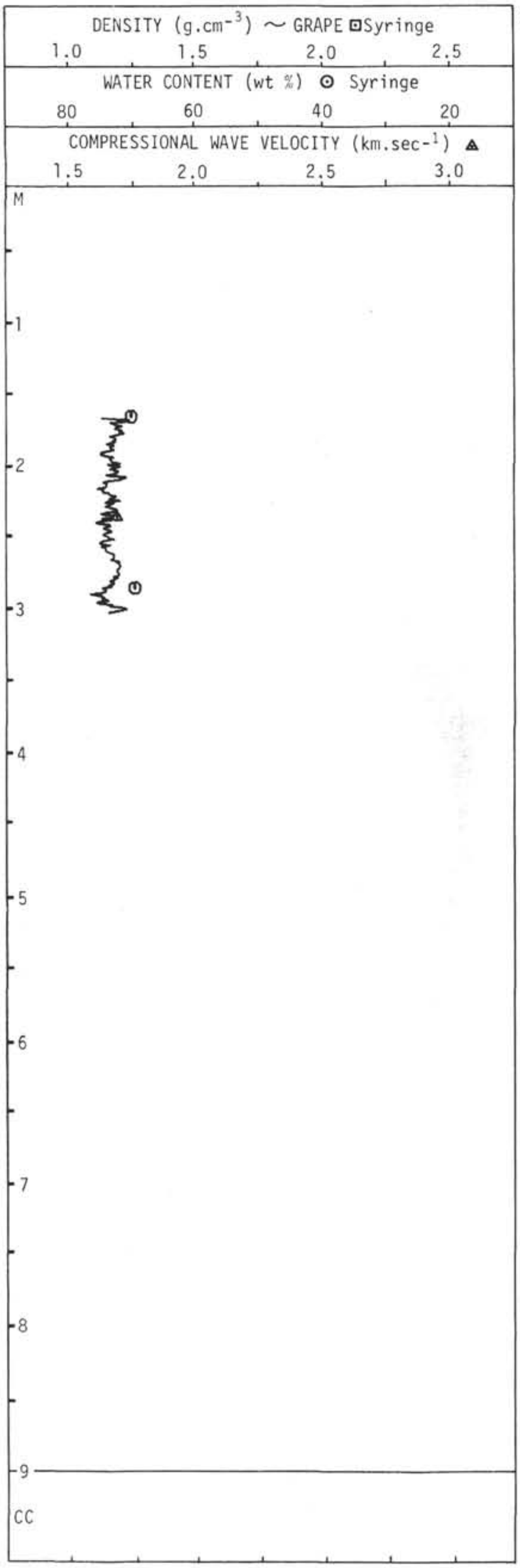


For Explanatory Notes, see Chapter 1

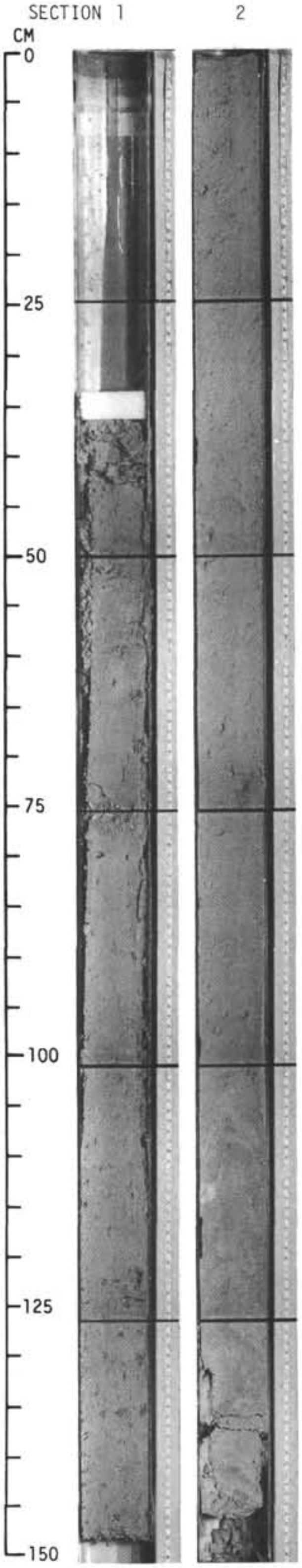
340-4

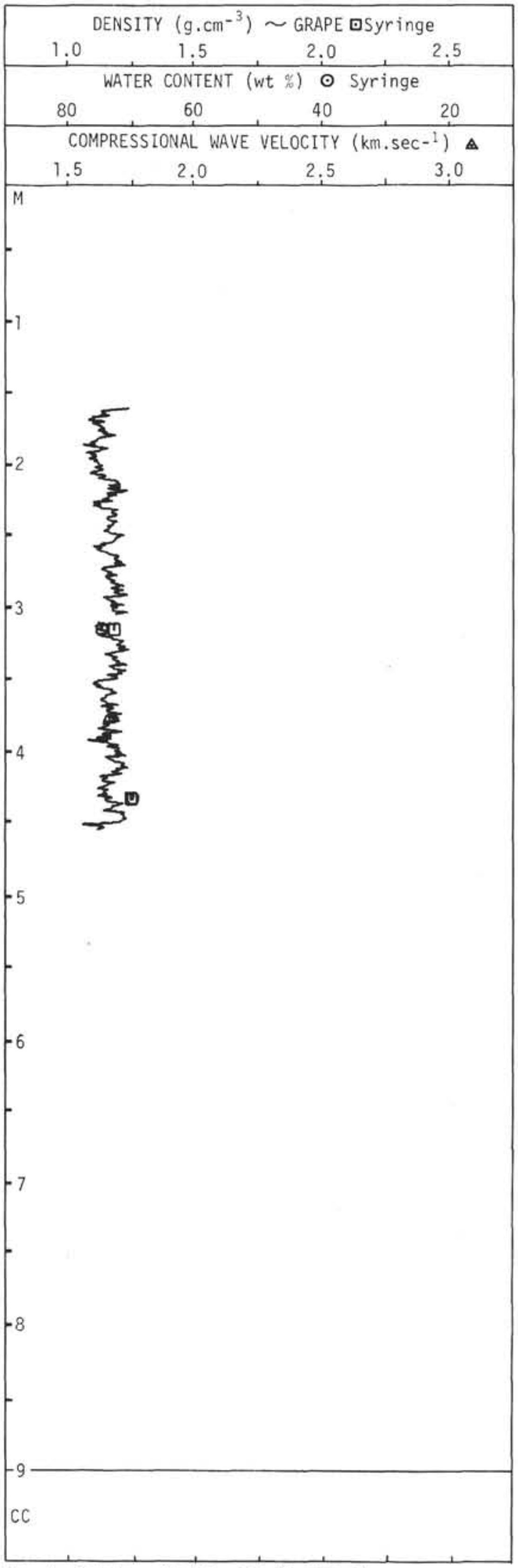


340-5



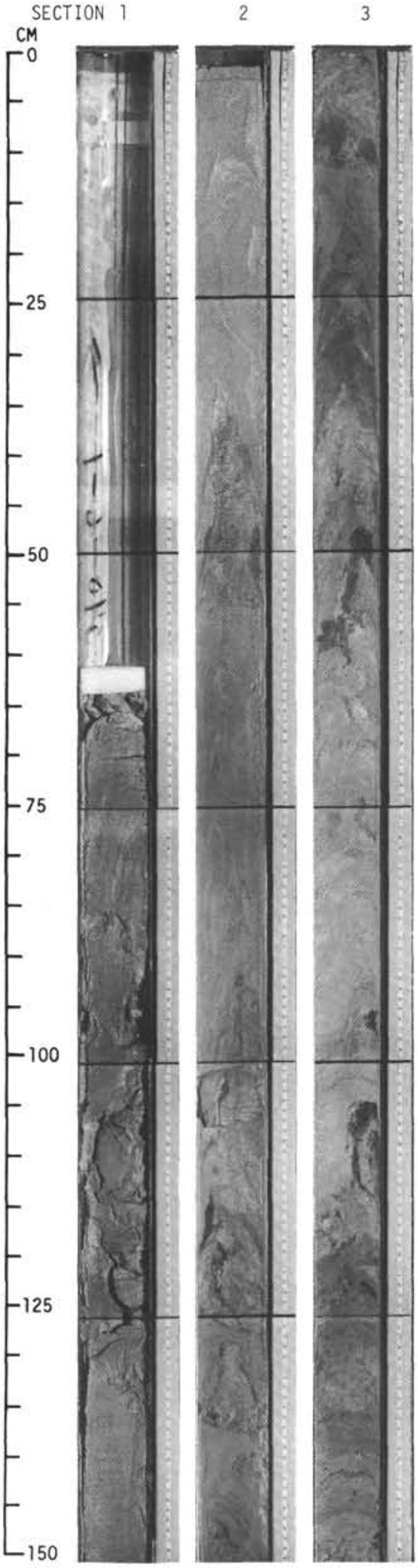
For Explanatory Notes, see Chapter 1

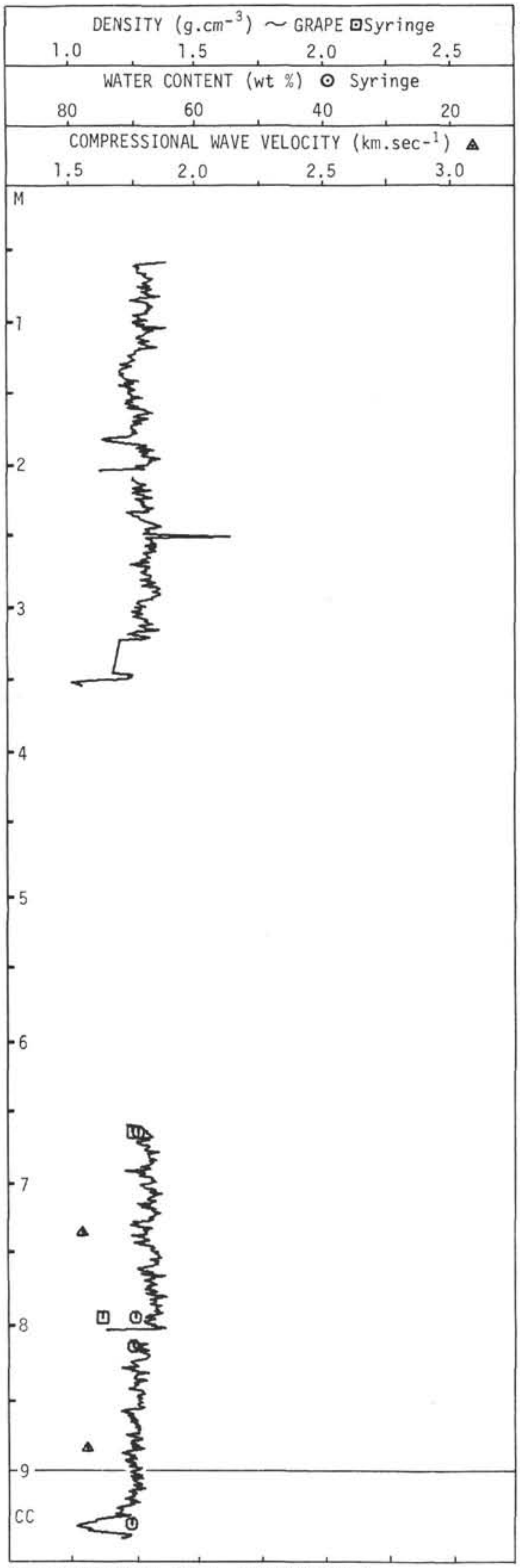




For Explanatory Notes, see Chapter 1

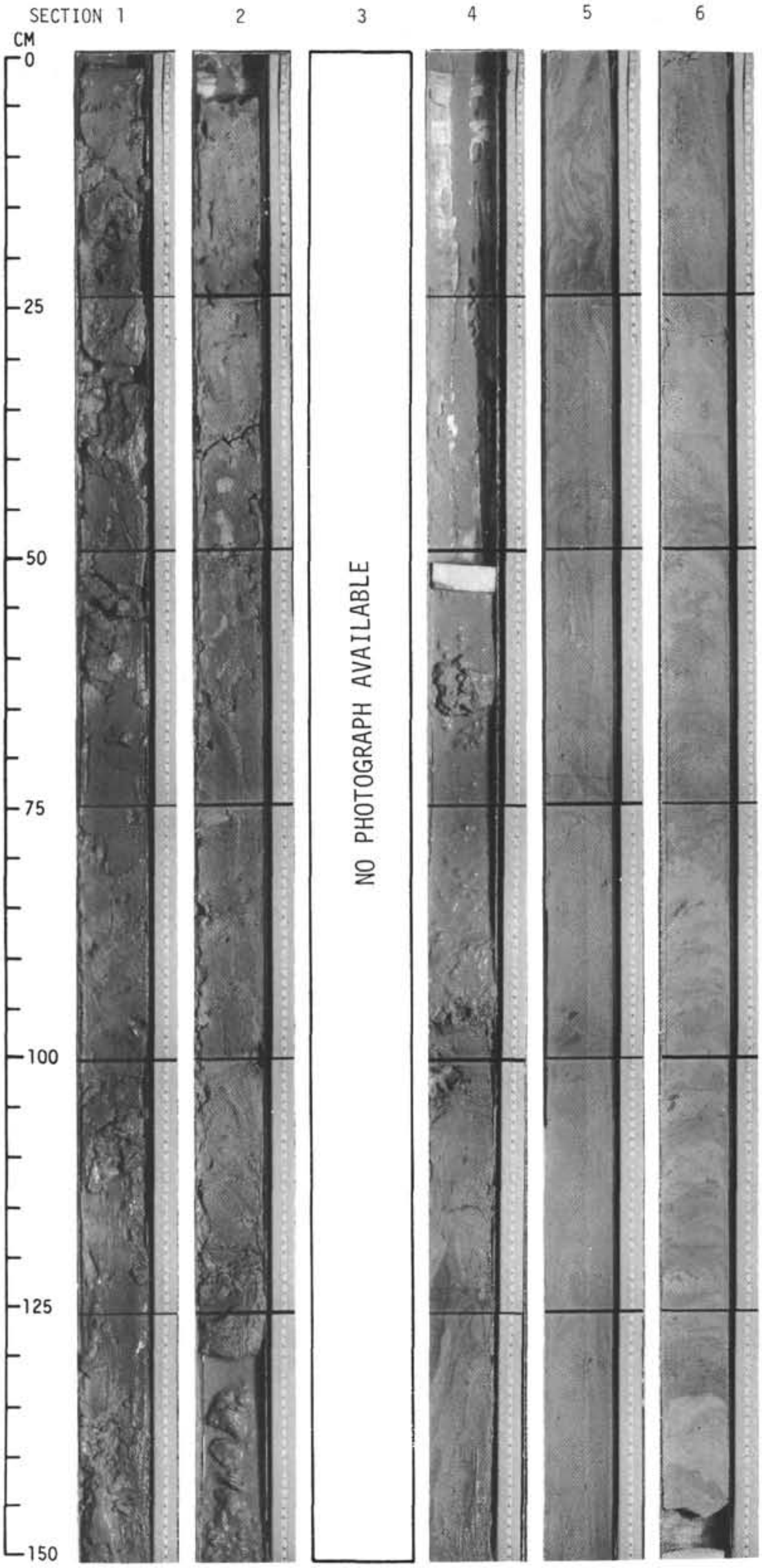
340-6



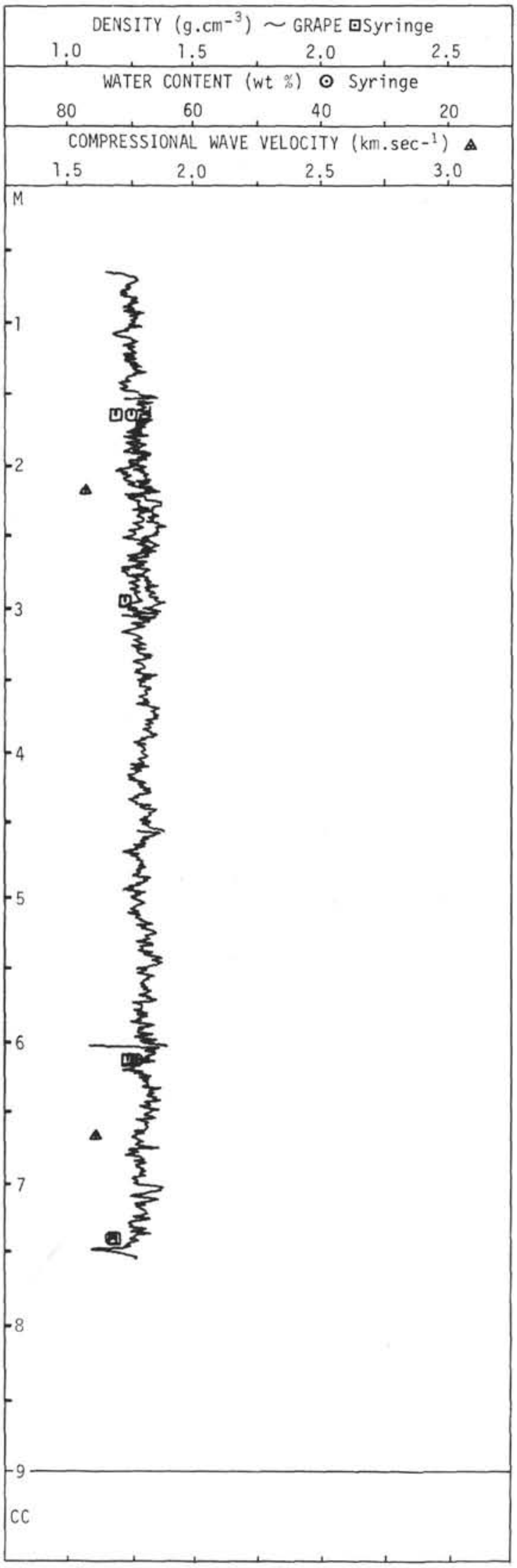


For Explanatory Notes, see Chapter 1

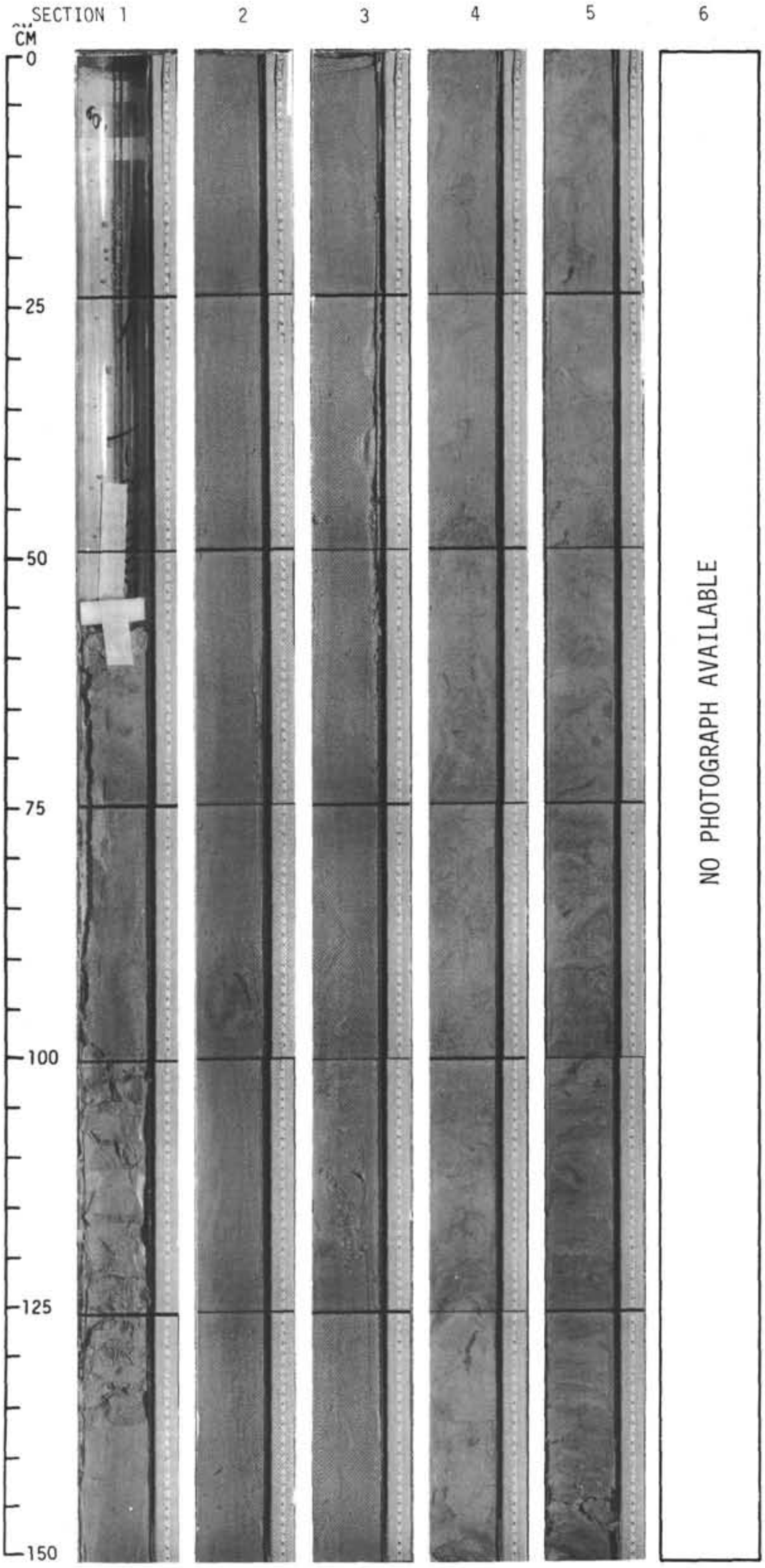
340-7

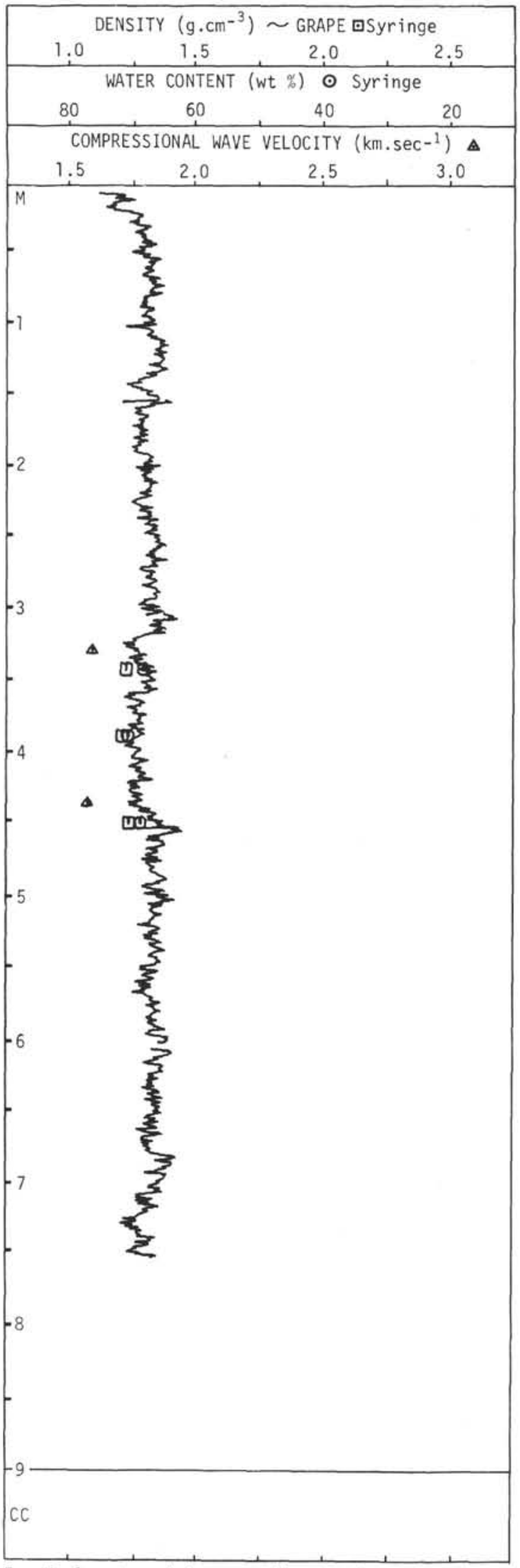


340-8



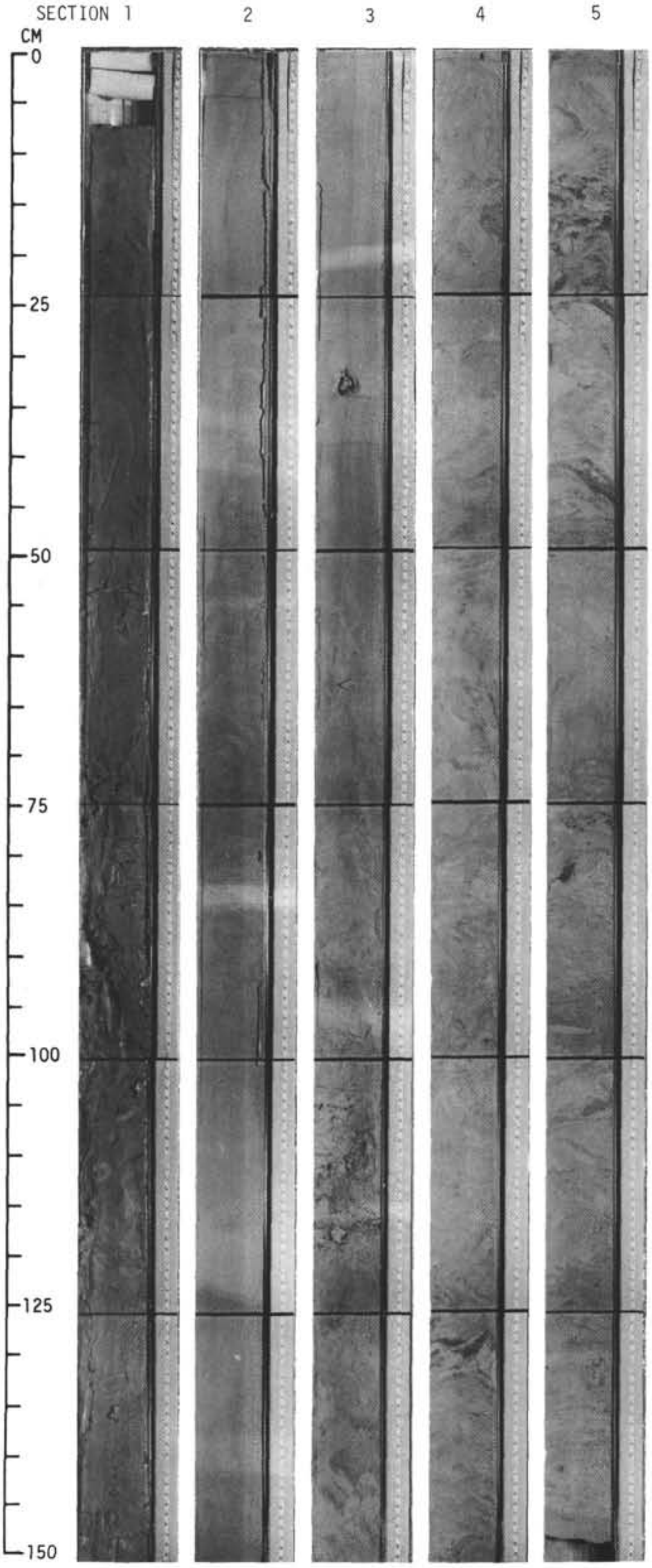
For Explanatory Notes, see Chapter 1

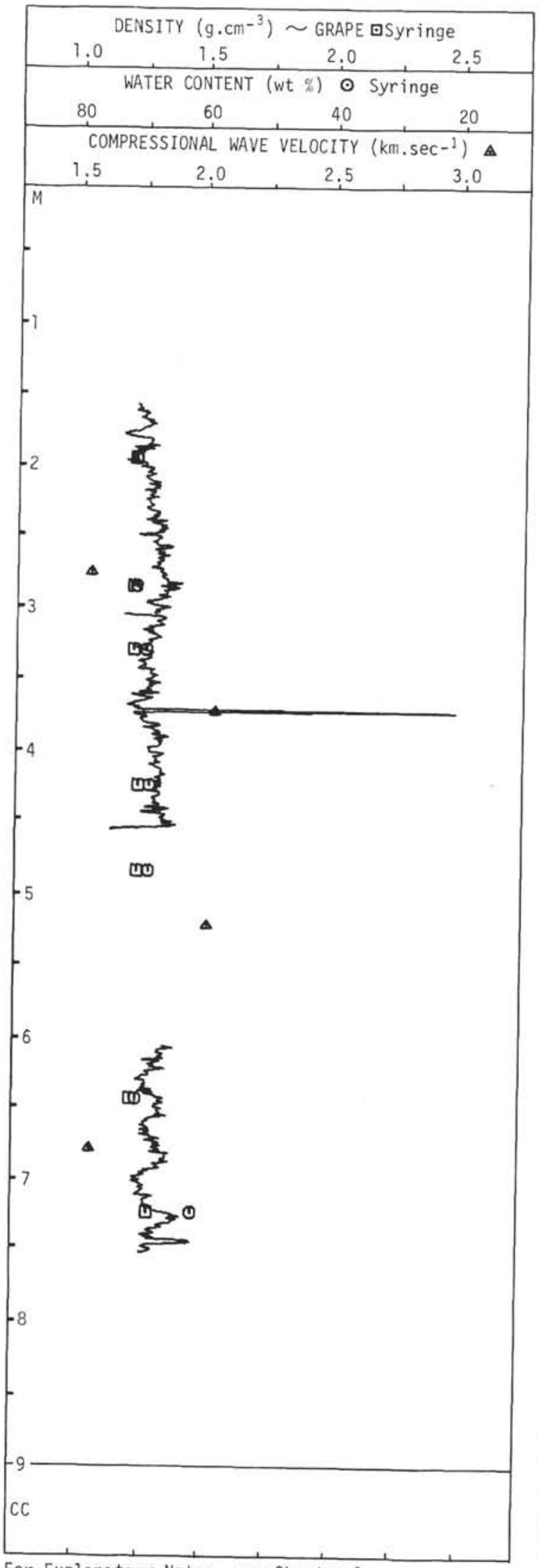




For Explanatory Notes, see Chapter 1

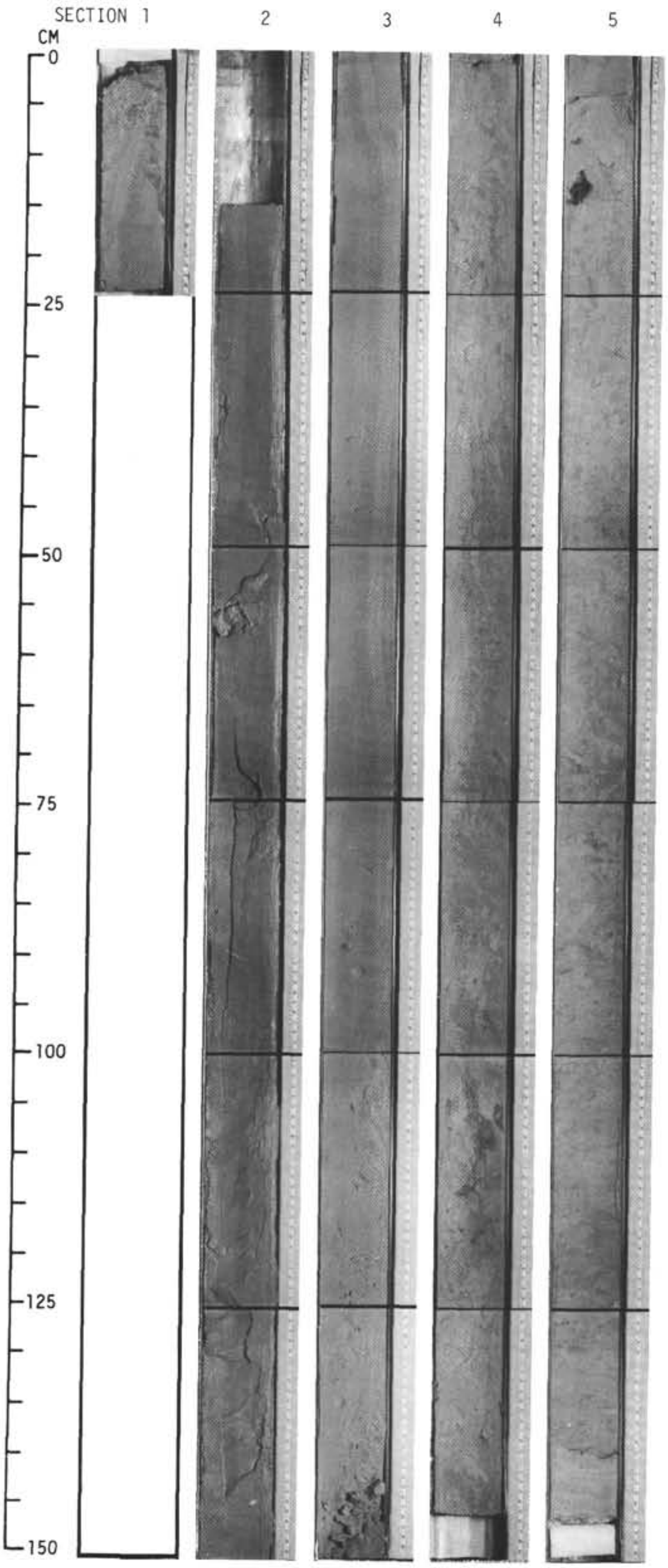
340-9



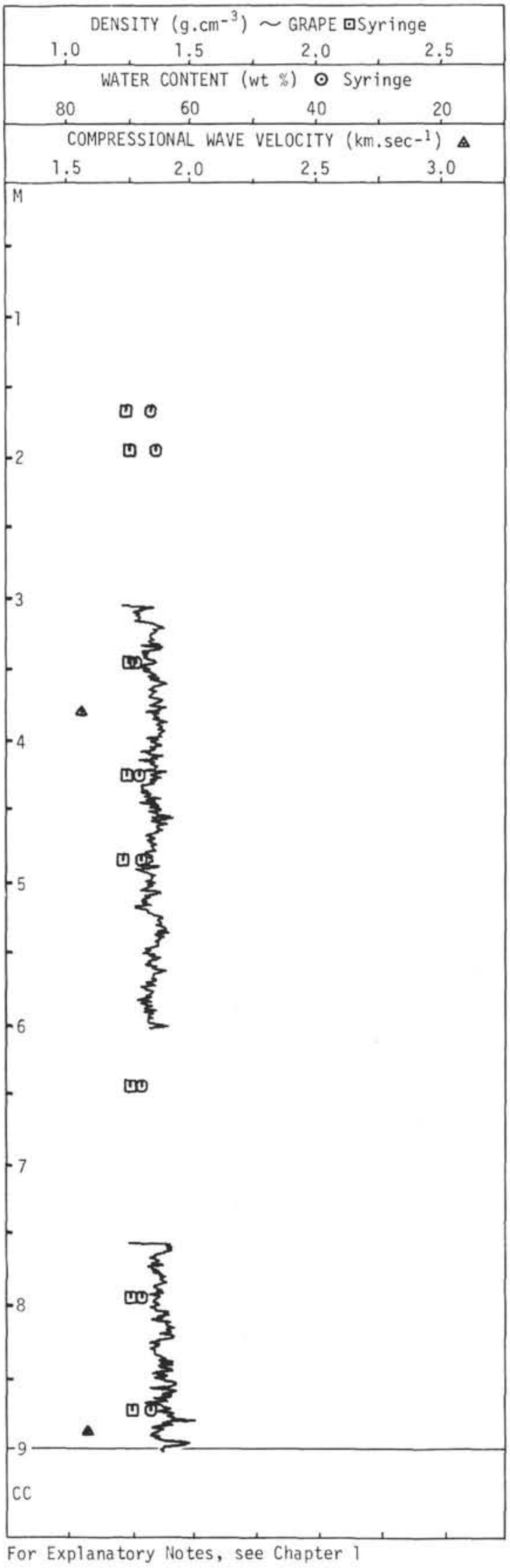


For Explanatory Notes, see Chapter 1

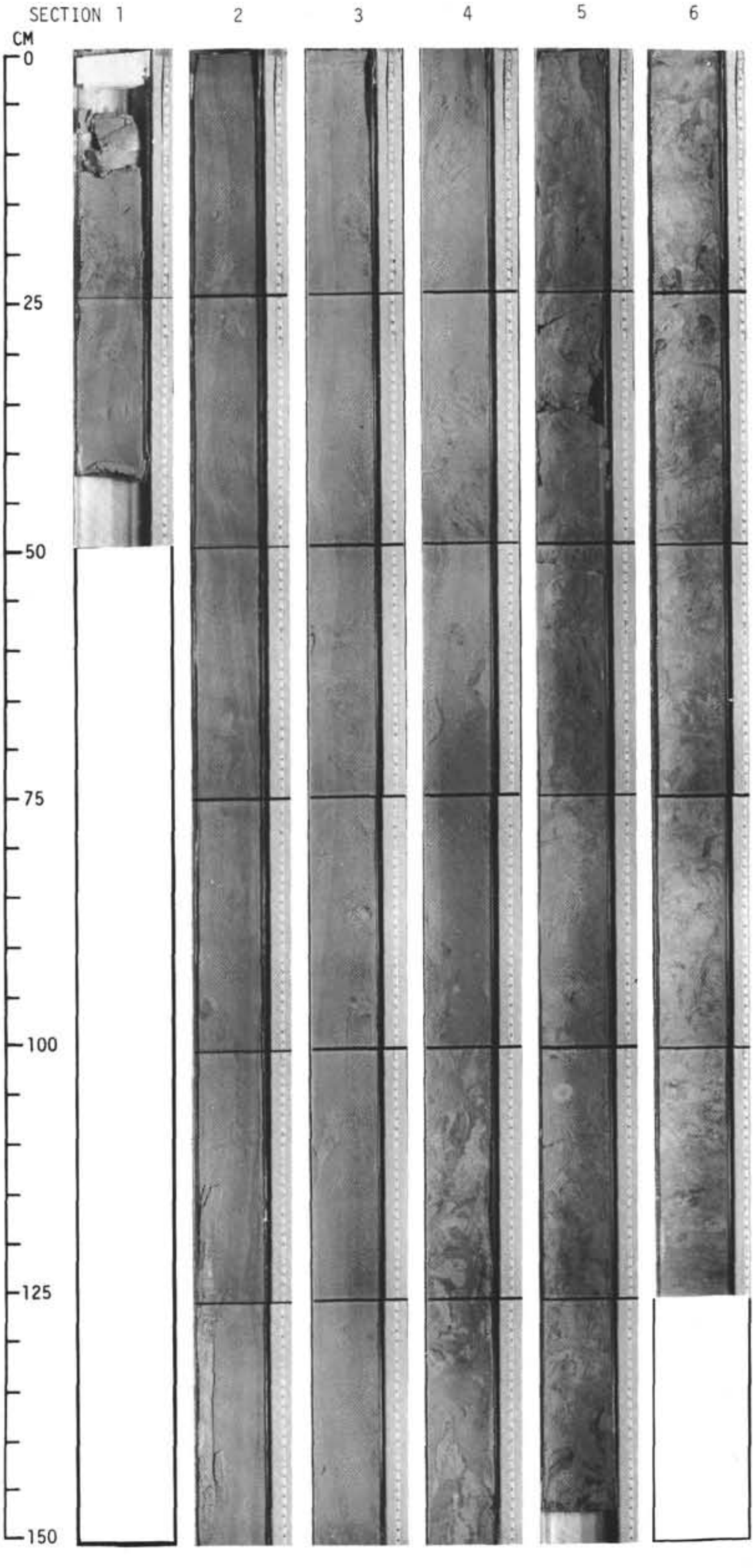
340-10



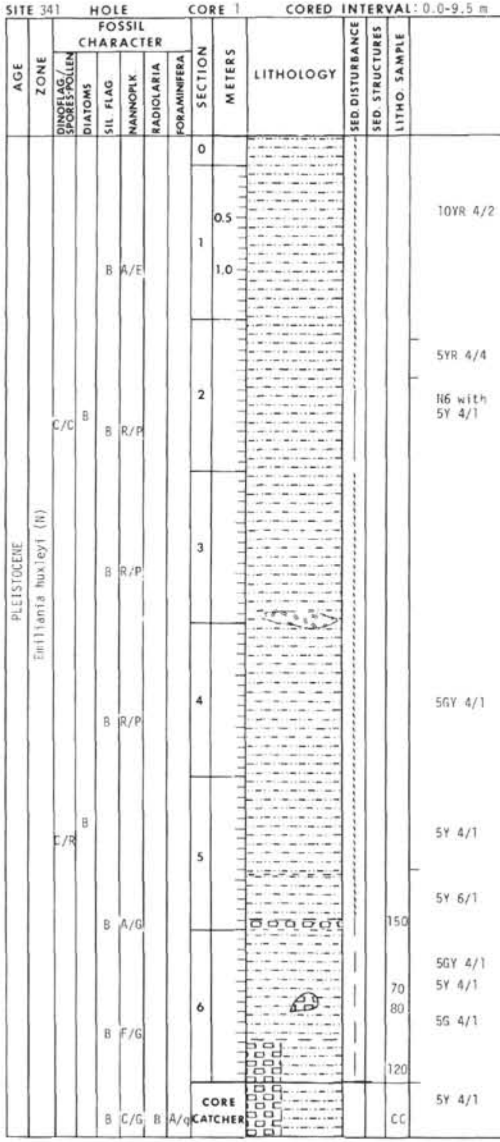
340-11



For Explanatory Notes, see Chapter 1



SITE 341 HOLE CORE 1 CORED INTERVAL: 0.0-9.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 4/1), dark yellow brown (10YR 4/2), moderate brown (5YR 4/4), medium gray (N6), dark greenish-gray (5GY 4/1). Generally intensely deformed, color mottling. Cretaceous pebble at 6-70.

MAJOR LITHOLOGIES

a) CALCAREOUS MUD (Smears 6-120, CC)
5% Sand
10-18% Silt
77-85% Clay
5% Quartz
3% Feldspar
0- 2% Mica
1% Heavy minerals
TR- 1% Opaques
50-55% Clay minerals
TR% Pyrite
20-25% Authigenic carbonate
1% Foraminifera
10-15% Nannofossils

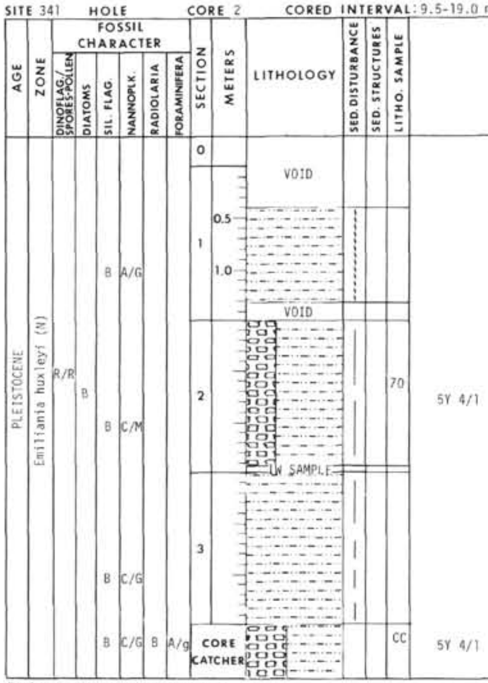
b) MUD (Smear 6-80)
15% Sand
46% Silt
39% Clay
50% Quartz
7% Feldspar
2% Heavy minerals
1% Opaques
39% Clay minerals
1% Glauconite

c) CALCAREOUS OOZE (Smears 5-150, 6-70)
0- 5% Quartz
15-100% Authigenic carbonate
0- 5% Foraminifera
0- 75% Nannofossils
TR% Heavy minerals, volcanic glass, glauconite

Carbon-Carbonate (DSDP)
2-8 (0.9, 0.3, 5)

Grain Size (DSDP)
2-0 (8.4, 42.0, 49.5)
6-138 (4.1, 18.5, 77.5)

SITE 341 HOLE CORE 2 CORED INTERVAL: 9.5-19.0 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

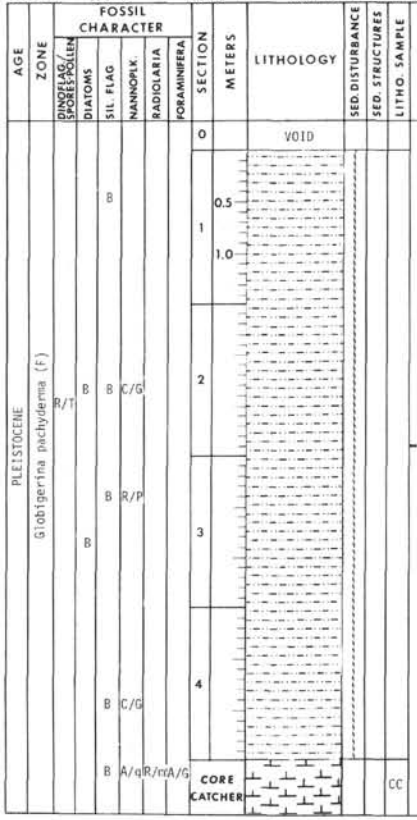
Colors: olive gray (5Y 4/1). Scattered pebbles throughout.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smears 2-70, CC)
5% Sand
20% Silt
75% Clay
5% Quartz
3% Feldspar
TR% Mica
TR% Heavy minerals
2% Opaques
65% Clay minerals
15% Authigenic carbonate
10% Nannofossils

Carbon-Carbonate (PP)
2-1 (top) (0.28, 0.95)
2-1 (bottom) (0.91, 0.87)

SITE 341 **HOLE** **CORE** 3 **CORED INTERVAL**: 19.0-28.5 m



LITHOLOGIC DESCRIPTION

Colors: light olive gray (5Y 5/2), olive gray (5Y 4/1). Intensely disturbed.

MAJOR LITHOLOGIES

SANDY MUD OR MUD?

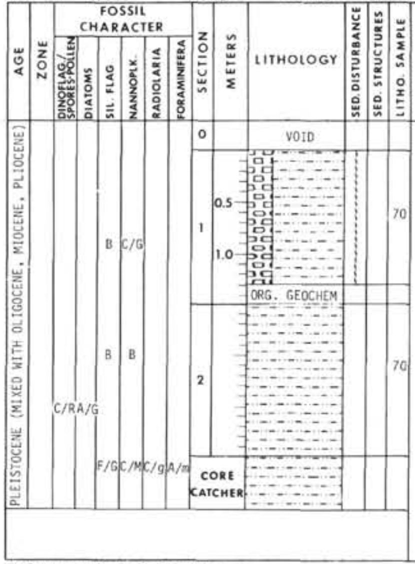
NANNOFOSSIL OOZE (Smear CC)

5Y 4/1

5Y 5/2

5Y 4/1

SITE 341 **HOLE** **CORE** 4 **CORED INTERVAL**: 28.5-38.0 m



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: dark greenish gray (5GY 4/1), light olive gray (5Y 6/1), medium bluish gray (5B 5/1), grayish blue green (5BG 5/2), dusky yellow (5GY 5/2). Intense deformation, color mottling, streaking.

5Y 6/1

MAJOR LITHOLOGY

a) MUD (Smear 2-70)

7% Sand	3% Opaques
30% Silt	63% Clay minerals
63% Clay	2% Radiolarians
	2% Sponge spicules
20 Quartz	3% Heavy minerals
TR% Mica, Volcanic glass, Zeolites	2% Feldspar

5B 5/1

5BG 5/2

5GY 5/2

b) CALCAREOUS MUD (Smear 1-70)

7% Sand	5% Quartz
15% Silt	2% Feldspar
78% Clay	TR% Heavy minerals
	1% Opaques
68% Clay minerals	15% Authigenic carbonate
10% Nannofossils	
TR% Diatoms	

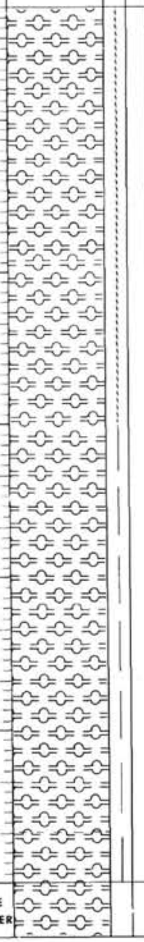
5GY 4/1

Carbon-Carbonate (PP)
4-1 (top) (0.91., 0.66)
4-1 (bottom) (0.40, 1.53)

SITE 341 HOLE CORE 5 CORED INTERVAL: 38.0-47.5 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA	SECTION	METERS	LITHO. SAMPLE	
PLEISTOCENE (MIXED WITH PLIOCENE)								0			
				B	C/G			1	0.5 1.0		
		C/R	A/G	F/G	F/P			2			
				B	R/P			3			5GY 5/2 with N4
				C/G F/G	B R/P			4			5Y 4/1
		A/R	A/G	C/G	R/P			5			5Y 4/1 5Y 5/2
				F/G	B			6		90	5Y 4/1
				F/G	C/G	C/g	C/g	CORE CATCHER		CC	5GY 3/2

VOID



LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), dusky yellow green (5GY 5/2), medium dark gray (N4), olive gray (5Y 4/1), light olive gray (5Y 5/2). Intense-moderate deformation, mottled.

MAJOR LITHOLOGY

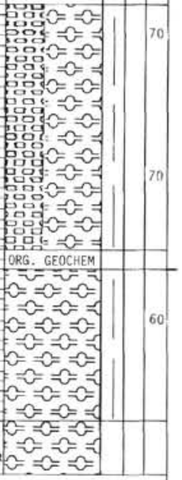
SILICEOUS OOZE (Smears 6-90, CC)

100% Clay	5%	Quartz
	45-50%	Diatoms
	12-20%	Radiolarians
	20-30%	Sponge spicules
	1%	Silicoflagellates
	1- 3%	Opaques
	0- 1%	Volcanic glass
	0- 5%	Authigenic carbonate
	0- 3%	Nannofossils
	0- 1%	Mica
	TR%	Glauconite

SITE 341 HOLE CORE 6 CORED INTERVAL: 47.5-57.0 m

AGE	ZONE	DINOFLAG./SPORES-POLLEN	DIATOMS	SIL. FLAG	NANNOPLK.	RADIOLARIA	FORAMINIFERA	SECTION	METERS	LITHO. SAMPLE	
PLEISTOCENE (MIXED WITH MIOCENE, PLIOCENE)								0			
				F/G	C/M			1	0.5 1.0	70	
		A/R	A/G	F/G	C/M			2		70	5BG 5/2
				C/G	B			3		60	10GY 5/2 5BG 5/2 5Y 6/1
				C/G	R/P	F/m	C/g	CORE CATCHER			5GY 3/2

VOID



Explanatory notes in Chapter 1

LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), grayish blue green (5BG 5/2), grayish green (10GY 5/2), light olive (5Y 6/1). Moderate deformation, mottling.

MAJOR LITHOLOGIES

a) CALCAREOUS SILICEOUS OOZE (Smears 1-70, 2-70)

7-12%	Quartz and Feldspar
TR- 1%	Heavy minerals
2%	Opaques
15-20%	Clay minerals
TR%	Glauconite
10-15%	Authigenic carbonate
15%	Nannofossils
20-25%	Diatoms
5- 7%	Radiolarians
10-15%	Sponge spicules
1%	Silicoflagellates

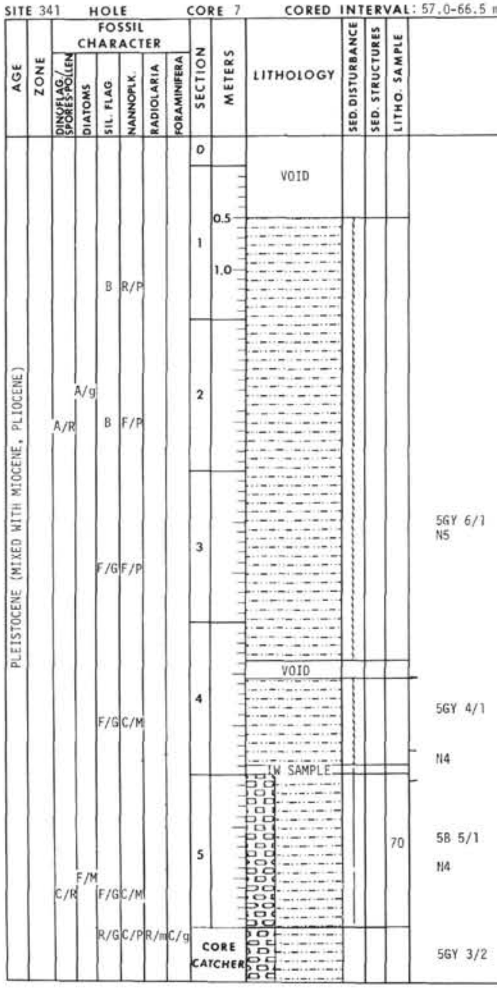
b) SILICEOUS OOZE (Smear 3-60)

1%	Quartz
TR%	Mica
2%	Opaques
1%	Volcanic glass
20%	Clay minerals
30%	Diatoms
20%	Radiolarians
20%	Sponge spicules
1%	Silicoflagellates

Carbon-Carbonate (DSDP)
2-70 (1.3, 0.6, 6)

Carbon-Carbonate (PP)
6-2 (top) (0.92, 0.79)
6-2 (bottom) (0.96, 0.73)

SITE 341 HOLE CORE 7 CORED INTERVAL: 57.0-66.5 m



LITHOLOGIC DESCRIPTION

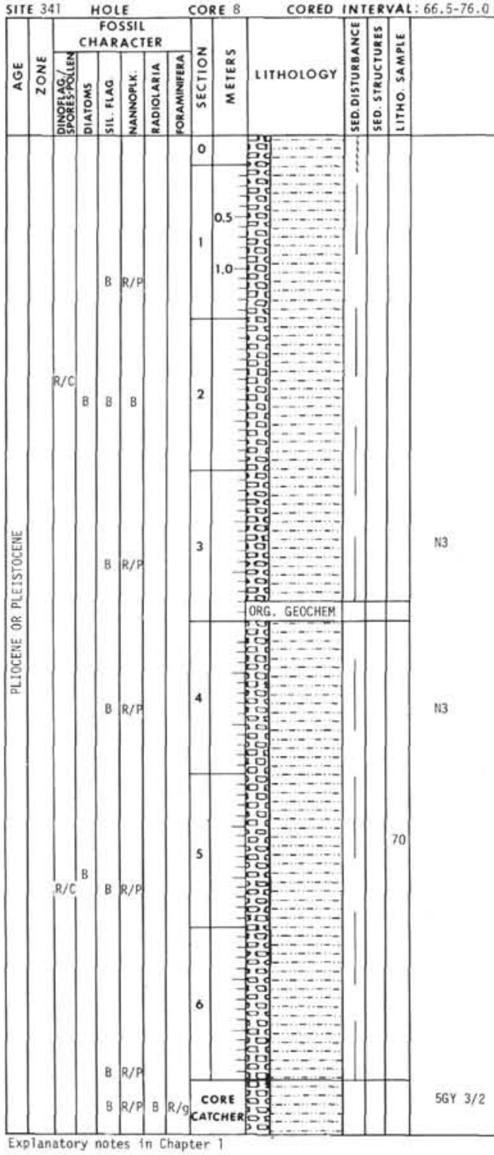
Color: grayish olive green (5GY 3/2), greenish-gray (5GY 6/1), medium gray (N5), dark greenish gray (5GY 4/1), medium bluish-gray (5B 5/1). Intense-moderate deformation.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear 5-70)	
10% Sand	15% Quartz and Feldspar
11% Silt	1% Mica
79% Clay	5% Opaques
	TR% Volcanic glass
	54% Clay minerals
	15% Carbonate
	10% Nannofossils
	TR% Diatoms

Carbon-Carbonate (DSDP)
2-30 (0.6, 0.5, 1)

SITE 341 HOLE CORE 8 CORED INTERVAL: 66.5-76.0 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive green (5GY 3/2), dark greenish-gray (5GY 4/1), dark gray (N3).

MAJOR LITHOLOGY

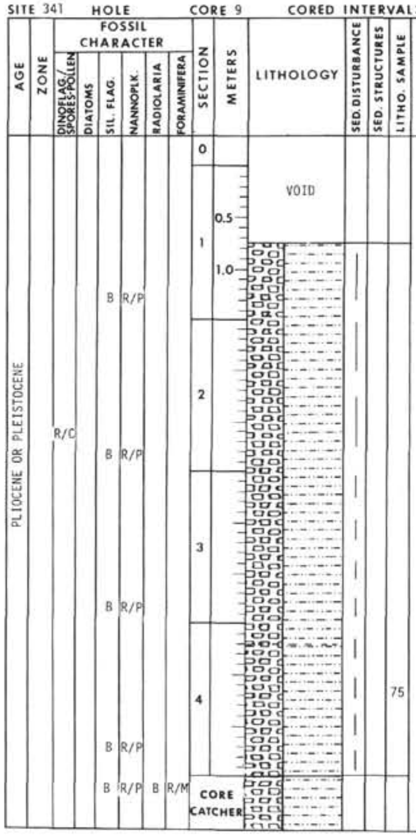
CALCAREOUS SANDY? MUD (Smear 5-70)	
20% Sand	15% Quartz
20% Silt	15% Feldspar
60% Clay	2% Heavy minerals
	2% Opaques
	45% Clay minerals
	TR% Glauconite
	2% Mica
	TR% Volcanic glass
	10% Authigenic carbonate
	10% Nannofossils

Carbon-Carbonate (DSDP)
4-40 (1.4, 0.6, 7)

Carbon-Carbonate (PP)
8-3 (top) (0.68, 0.66)
8-3 (bottom) (0.66, 0.58)

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 9 CORED INTERVAL: 76.0-85.5 m



LITHOLOGIC DESCRIPTION

Colors: greenish black (5GY 2/1), dark gray (N3). Moderate deformation, pebbles throughout, Schist in Secs. 3-4 (2-6 cm). Massive, firm.

MAJOR LITHOLOGY

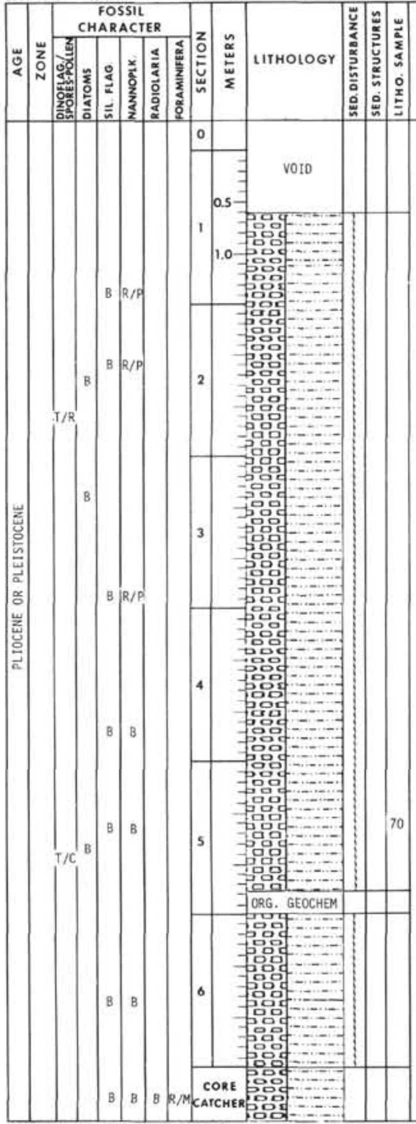
CALCAREOUS MUD (Smear 4-75)

7% Sand	15% Quartz
33% Silt	5% Feldspar
60% Clay	5% Mica
	2% Heavy minerals
	38% Clay minerals
	10% Opaques
	15% Authigenic carbonate
	10% Nannofossils

N3

5GY 2/1

SITE 341 HOLE CORE 10 CORED INTERVAL: 85.5-95.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1), dark gray (N3). Intense deformation, pebbles scattered throughout (4 cm Schist, Secs. 5 and 6).

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear 5-70)

5% Sand	20% Quartz
33% Silt	5% Feldspar
60% Clay	1% Mica
	2% Heavy minerals
	40% Clay minerals
	TR% Palagonite, glauconite
	0- 2% Opaques
	20% Authigenic carbonate
	10% Nannofossils

Carbon-Carbonate (DSDP)
4-69 (1.5, 0.4, 9)

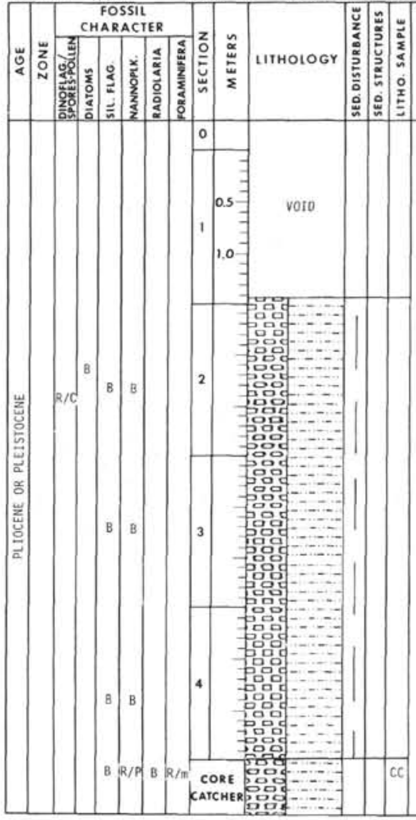
Carbon-Carbonate (PP)
10-5 (top) (0.43, 1.08)
10-5 (bottom) (0.45, 1.05)

N3

5GY 4/1

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 11 CORED INTERVAL: 95.0-104.5 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1), dark gray (N3). Moderate deformation, pebbles throughout, with granite pebble (4 cm) in Sec. 4.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear CC)

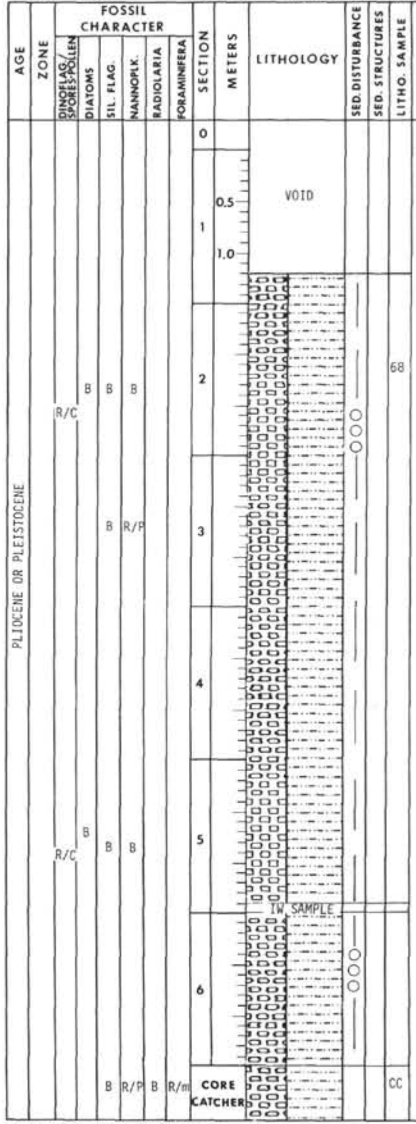
15% Sand	25% Quartz and Feldspar
25% Silt	2% Heavy minerals
60% Clay	47% Clay minerals
	2% Opaques
	2% Mica
	15% Authigenic carbonate
	7% Nannofossils

Carbon-Carbonate (DSDP)
2-75 (1.4, 0.4, 8)

N3

5GY 4/1

SITE 341 HOLE CORE 12 CORED INTERVAL: 104.5-105.5 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5G 4/1), dark gray (N3). Moderate deformation; scattered pebbles.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smears 2-68, CC)

3-10% Sand	10% Quartz
27-45% Silt	2% Feldspar
45-70% Clay	0-TR% Mica
	1- 2% Heavy minerals
	2% Opaques
	63% Clay minerals
	1% Zeolites
	10-20% Carbonate
	TR- 5% Nannofossils
	0- 3% Diatoms
	0- 1% Radiolarians
	0- 5% Sponge spicules

Carbon-Carbonate (DSDP)
4-10 (1.5, 0.4, 9)

Grain Size (DSDP)
4-67 (12.3, 27.0, 60.7)

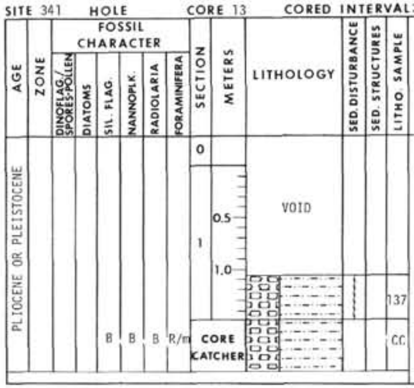
N3

N3

5G 4/1

Explanatory notes in Chapter 1

SITE 341 **HOLE** **CORE** 13 **CORED INTERVAL:** 105.5-114.0 m



LITHOLOGIC DESCRIPTION

N4

5G 4/1

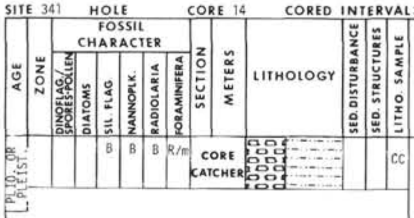
Colors: dark greenish-gray (5G 4/1); medium dark gray (N4). Intense deformation, soft structureless.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear 1-137, CC)
7-15% Sand
23-25% Silt
60-70% Clay

12-20% Quartz and Feldspar
2% Mica
2% Heavy minerals
2% Opaques
42-52% Clay minerals
TR% Volcanic glass, Diatoms, Glauconite, Zeolites
20% Carbonate
7-10% Nannofossils

SITE 341 **HOLE** **CORE** 14 **CORED INTERVAL:** 123.5-133.0 m



LITHOLOGIC DESCRIPTION

5G 4/1

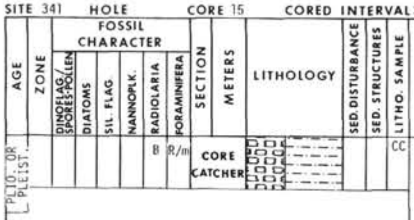
Core catcher only: dark greenish-gray (5G 4/1) with pebbles.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear CC)
10% Sand
20% Silt
70% Clay

20% Quartz and Feldspar
2% Heavy minerals
55% Clay minerals
7% Nannofossils
15% Authigenic carbonate
1% Opaques
(Carbonate fragments present.)

SITE 341 **HOLE** **CORE** 15 **CORED INTERVAL:** 142.5-152.0 m



LITHOLOGIC DESCRIPTION

5G 4/1

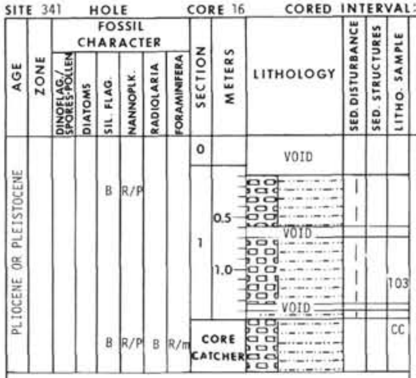
Core catcher only: dark greenish-gray (5G 4/1). Mud with pebbles.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear CC)
12% Sand
20% Silt
68% Clay

20% Quartz and Feldspar
TR% Mica, Opaques
2% Heavy minerals
55% Clay minerals
15% Authigenic carbonate
7% Nannofossils

SITE 341 **HOLE** **CORE** 16 **CORED INTERVAL:** 161.5-171.0 m



LITHOLOGIC DESCRIPTION

5G 4/1

Colors: dark greenish-gray (5G 4/1), medium dark gray (N4) massive, structureless, pebbles.

MAJOR LITHOLOGY

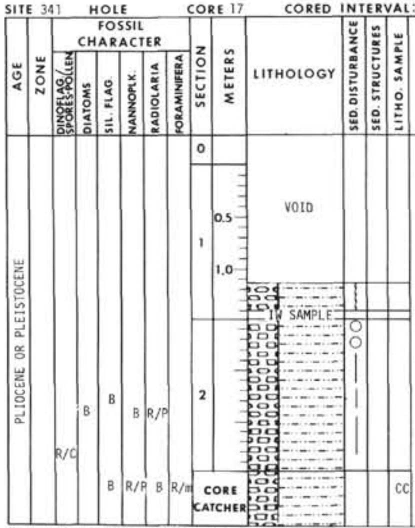
CALCAREOUS MUD (Smears 1-103, CC)
10-20% Sand
30% Silt
50-60% Clay

25% Quartz
10% Feldspar
2% Mica
3% Heavy minerals
1% Opaques
30% Clay minerals
1% Glauconite
20% Carbonate
7% Nannofossils

Carbon-Carbonate (DSDP)
1-99 (1.2, 0.3, 8)

Grain Size (DSDP)
1-49 (26.8, 30.9, 42.3)

SITE 341 **HOLE** **CORE** 17 **CORED INTERVAL:** 180.5-190.0 m



LITHOLOGIC DESCRIPTION

N4

N4

5G 4/1

Colors: dark greenish-gray (5G 4/1), medium dark gray (N4). Massive, pebbles.

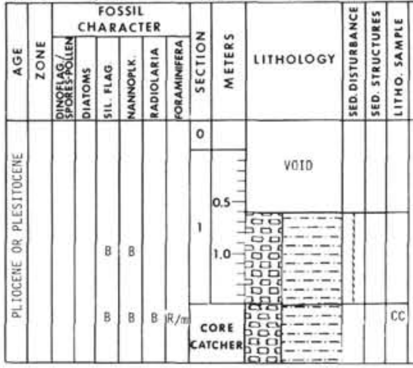
MAJOR LITHOLOGY

CALCAREOUS MUD (Smear CC)
7% Sand
28% Silt
65% Clay

15% Quartz and Feldspar
2% Mica
1% Heavy minerals
50% Clay minerals
25% Carbonate
7% Nannofossils

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 18 CORED INTERVAL: 199.5-209.0 m



LITHOLOGIC DESCRIPTION

5G 4/1

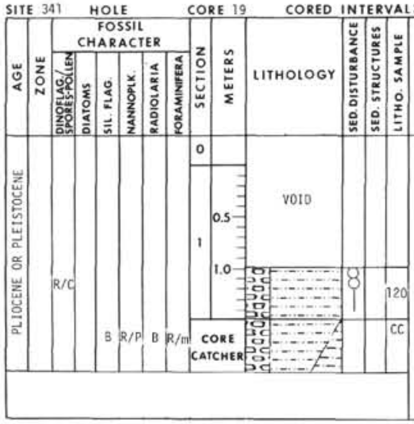
Color: dark greenish-gray (5G 4/1), medium dark gray (N4). Structureless, massive, intense deformation.

MAJOR LITHOLOGY

CALCAREOUS MUD (Smear CC)

30% Sand	25% Quartz
40% Silt	10% Feldspar
30% Clay	2% Mica
	5% Heavy minerals
	3% Opaques
	23% Clay minerals
	1% Glauconite, Zeolites
	25% Carbonate
	5% Nannofossils

SITE 341 HOLE CORE 19 CORED INTERVAL: 218.5-228.0 m



LITHOLOGIC DESCRIPTION

5G 4/1

5G 4/1

Colors: dark greenish-gray (5G 4/1), medium dark gray (N4). Firm, stiff.

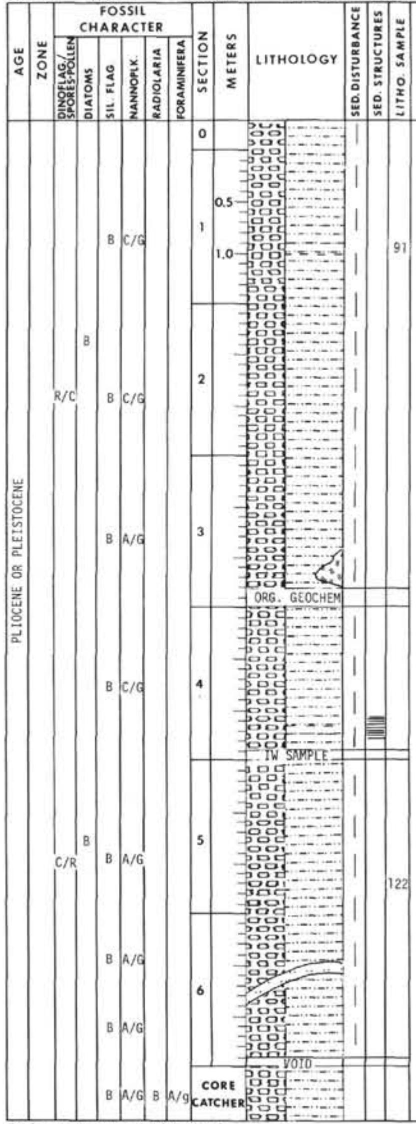
MAJOR LITHOLOGY

CALCAREOUS MUD (Smear 1-120, CC)

5-15% Sand	15% Quartz and Feldspar
25-30% Silt	1% Heavy minerals
55-70% Clay	2- 3% Opaques
	TR- 1% Volcanic glass
	48% Clay minerals
	0- 5% Zeolites
	25% Carbonate
	5% Nannofossils
	TR% Radiolarians
	0- 2% Sponge spicules

(Also SANDY MUD in CC.)

SITE 341 HOLE CORE 20 CORED INTERVAL: 237.5-247.0 m



LITHOLOGIC DESCRIPTION

5GY 4/1

5G 4/1

5G 4/1

5Y 4/1

5GY 6/1

5G 4/1

5Y 4/1

5B 5/1

5G 4/1

Colors: dark greenish-gray (5G 4/1), dark greenish-gray (5GY 4/1), olive gray (5Y 4/1), medium blue gray (5B 5/1). Possible turbidite unit: Sec. 1 - stiff, slight defomation, color interbeds; Secs. 2-3, massive, very stiff, brittle, 3-4 cm interbeds; Sec. 4 - semilithified, 1-3 cm bedding, color grading.

MAJOR LITHOLOGY

MARLY CALCAREOUS OOZE (Smear 5-122)

5% Sand	10% Quartz
20% Silt	5% Feldspar
75% Clay	2% Heavy minerals
	1% Opaques
	35% Clay minerals
	TR% Glauconite
	1% Zeolites
	40% Carbonate
	5% Nannofossils

MINOR LITHOLOGY

SILT (Smear 1-91)

20% Sand	60% Quartz
75% Silt	10% Feldspar
5% Clay	2% Mica
	10% Heavy minerals
	7% Opaques
	10% Carbonate

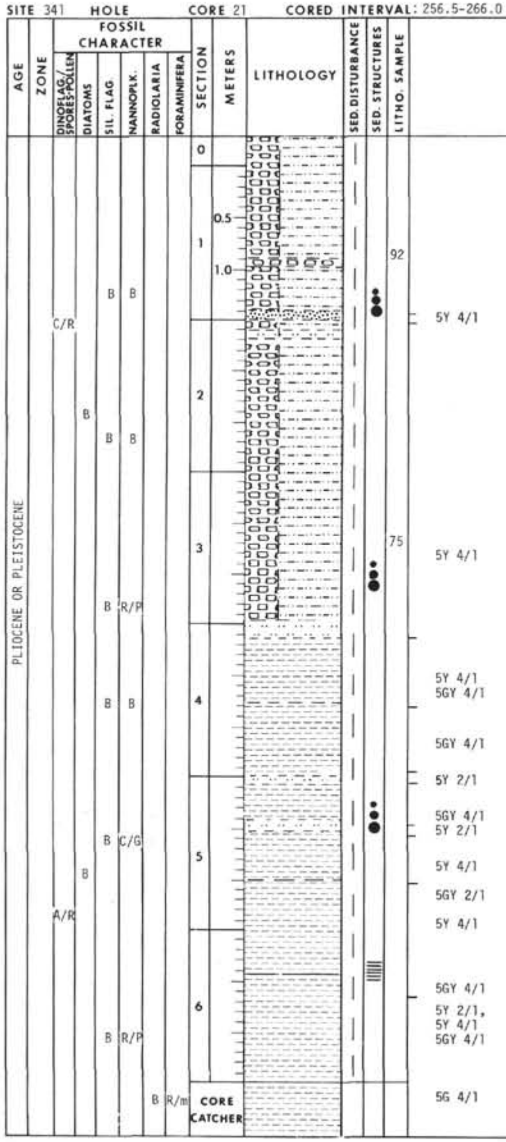
Carbon-Carbonate (DSDP)
1-120 (1.3, 0.3, 8)

Carbon-Carbonate (PP)
20-3 (top) (0.32, 0.87)
20-3 (bottom) (0.36, 1.01)

Grain Size (DSDP)
1-70 (0.1, 20.8, 79.1)
6-90 (2.8, 42.4, 54.8)

Explanatory notes in Chapter 1

SITE 341 **HOLE** **CORE** 21 **CORED INTERVAL**: 256.5-266.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5G 4/1), olive gray (5Y 4/1), dark greenish-gray (5GY 4/1), olive black (5Y 2/1). Possible turbidite sequence: Sec. 1 - firm, stiff, slight deformation; 3-5 mm pebbles in 1-70 cm, graded beds - color interbeds, silty, sandy zone; Sec. 2 - stiff, firm, with 1-5 mm scattered pebbles, massive, with 2 cm color interbeds; quartzite pebbles; Sec. 3 - sharp - gradational contacts, graded beds, color layers; Sec. 4 - scattered pebbles (130-150 cm), faint color bedding; Sec. 5 - 1 mm scattered pebbles, rip-up zones, grading; Sec. 6 - massive, faint bedding, scattered pebbles.

MAJOR LITHOLOGIES

a) CALCAREOUS OOZE (Smear 1-92)
3% Quartz
TR% Mica, Heavy minerals
1% Opaques
80% Authigenic carbonate
15% Nannofossils

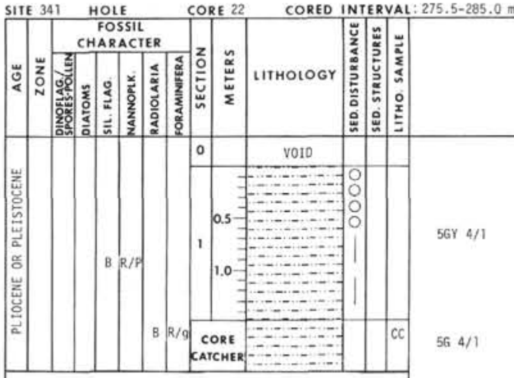
b) MARLY CALCAREOUS OOZE (Smear 3-75)

7% Sand	12% Quartz and Feldspar
13% Silt	2% Mica
80% Clay	1% Heavy minerals
	TR% Opaques
	35% Clay minerals
	40% Authigenic carbonate
	10% Nannofossils

Carbon-Carbonate (DSDP)
2-30 (2.1, 0.4, 15)

Grain Size (DSDP)
3-110 (0.5, 22.3, 77.2)

SITE 341 **HOLE** **CORE** 22 **CORED INTERVAL**: 275.5-285.0 m



LITHOLOGIC DESCRIPTION

Color: dark greenish-gray (5G 4/1) (5GY 4/1). Moderate deformation, faint color layering.

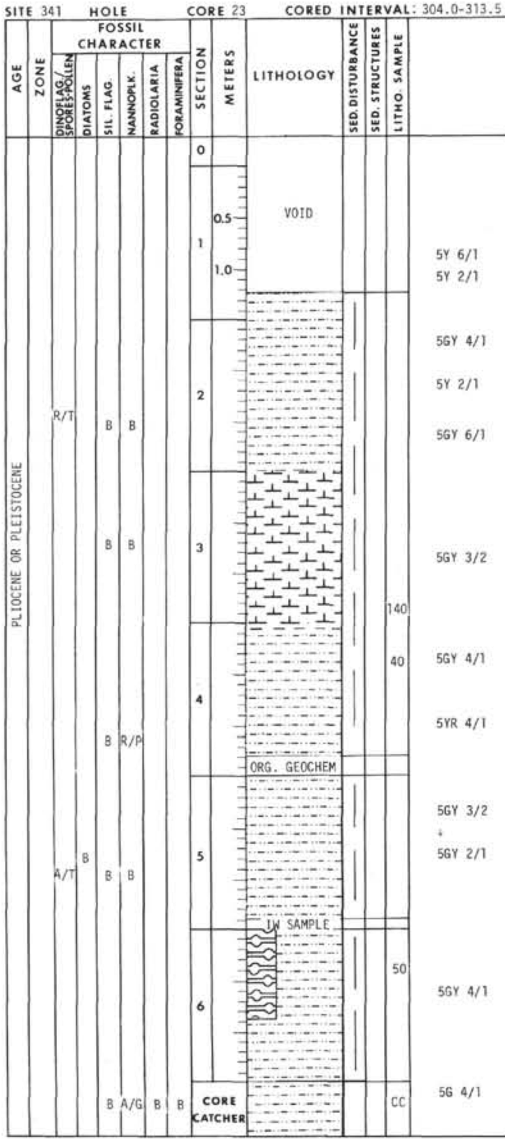
MAJOR LITHOLOGY

MUD (Smear CC)

8% Sand	20% Quartz and Feldspar
26% Silt	TR% Mica
66% Clay	1% Heavy minerals
	2% Opaques
	TR% Volcanic glass
	66% Clay minerals
	TR% Glauconite
	5% Authigenic carbonate
	2% Sponge spicules
	TR% Foraminifera, Nannofossils, Diatoms

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 23 CORED INTERVAL: 304.0-313.5 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5G 4/1), light olive gray (5Y 6/1), dark greenish-gray (5GY 4/1), olive black (5Y 2/1), grayish olive green (5GY 3/2), brownish gray (5YR 4/1). Semiconsolidated, massive, competent in Sec. 1; fissile in Sec. 2; color variations, quartzite pebbles in Secs. 4 and 5; plus pyrite concretions (Secs. 5-6).

MAJOR LITHOLOGIES

a) NANNOFOSSIL OOZE (Smear 3-140)
10% Quartz and Feldspar
TR% Volcanic glass, Foraminifera
80% Nannofossils
TR% Sponge spicules
10% Authigenic carbonate

b) MUD (Smears 4-40, CC)

3- 5% Sand	10-15% Quartz and Feldspar
20-25% Silt	TR% Heavy minerals
72-75% Clay	72-75% Clay minerals
	3% Authigenic carbonate
	TR- 3% Mica
	0- 3% Lithics

MINOR LITHOLOGY

SILICEOUS MUD (Smear 6-50)

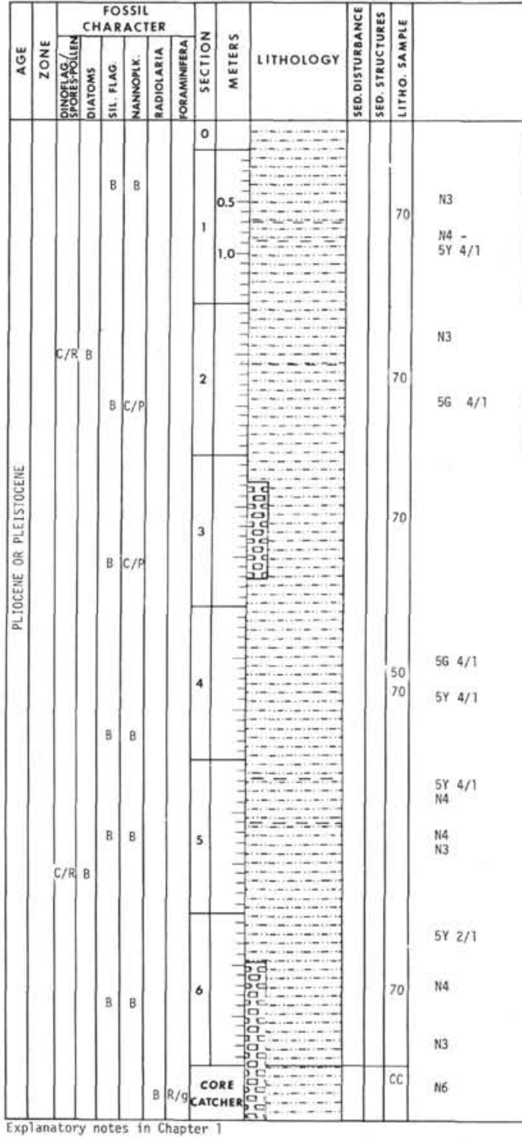
10% Sand	10% Quartz and Feldspar
30% Silt	5% Mica
60% Clay	1% Heavy minerals
	2% Opaques
	5% Volcanic glass
	60% Clay minerals
	2% Diatoms
	15% Sponge spicules

Carbon-Carbonate (DSDP)
6-55 (0.4, 0.4, 1)

Carbon-Carbonate (PP)
23-4 (top) (0.59, 1.26)
23-4 (bottom) (0.63, 0.17)

Grain Size (DSDP)
6-60 (4.9, 28.9, 66.2)

SITE 341 HOLE CORE 24 CORED INTERVAL: 313.5-323.0 m



LITHOLOGIC DESCRIPTION

Colors: medium gray (N6), olive gray (5Y 4/1), dark gray (N3), dark greenish-gray (5G 4/1), medium dark gray (N4), brownish black (5YR 2/1), olive black (5Y 2/1). Little/slight deformation.

MAJOR LITHOLOGIES

a) MUDSTONE (Smears 1-70, 2-70, 4-50, 4-70)

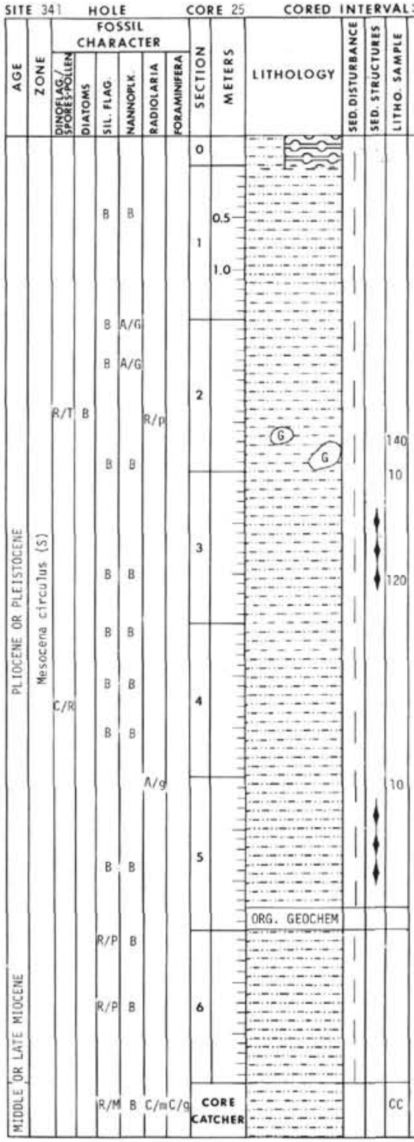
7-15% Sand	15-20% Quartz and Feldspar
10-26% Silt	0- 5% Mica
66-75% Clay	2- 3% Heavy minerals
	66-75% Clay minerals
	1- 2% Opaques
	0- 1% Volcanic glass
	2- 5% Lithics
	0- 3% Authigenic carbonate

b) CALCAREOUS MUD (Smears 3-70, 6-70, CC)

4- 8% Sand	5-15% Quartz and Feldspar
16-30% Silt	1- 2% Mica
62-80% Clay	0- 1% Heavy minerals
	TR- 1% Opaques
	62-80% Clay minerals
	7-20% Authigenic carbonate
	TR- 5% Nannofossils

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 25 CORED INTERVAL: 332.5-342.0 m



LITHOLOGIC DESCRIPTION

5GY 4/1

Colors: dark greenish-gray (5GY 4/1), dark gray (N3), grayish green (5G 5/2), dusky yellow green (5GY 5/2), pale green (10G 6/2), grayish blue green (5BG 5/2), dusky blue (5PB 3/2). Slight deformation, laminated, very thinly stratified, faintly mottled. Bioturbation noted: Sec. 3, Sec. 5 (Zoophycus).

5G 5/2
↓
5GY 5/2
↓
10G 6/2

5BG 2/2

5PB 3/2

5G 5/2

5Y 4/1

5GY 4/1

MAJOR LITHOLOGIES

a) MUDSTONE (Smears 3-120, 5-10, CC)

15-25% Sand	15-20% Quartz and Feldspar
20-35% Silt	TR- 2% Mica
50-65% Clay	TR% Heavy minerals
	3- 7% Opaques
	2- 8% Volcanic glass
	50-65% Clay minerals
	TR- 1% Glauconite
	TR- 7% Diatoms
	TR% Radiolarians
	5-10% Sponge spicules

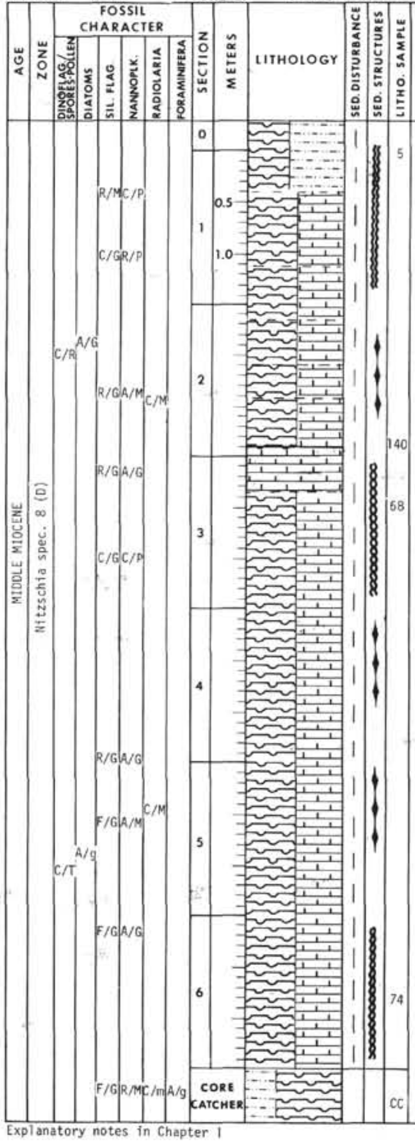
b) GLAUCONITIC MUDSTONE (Smears 2-140, 3-10)

15% Sand	15% Quartz and Feldspar
40% Silt	2% Mica
45% Clay	1% Heavy minerals
	2% Opaques
	15% Volcanic glass
	46% Clay minerals
	15% Glauconite
	TR% Dolomite rhombs, Nannofossils, Diatoms
	3% Sponge spicules

Carbon-Carbonate (PP)
25-5 (top) (0.30, 1.57)
25-5 (bottom) (0.02, 1.39)

Grain Size (DSDP)
3-122 (26.0, 30.0, 44.1)

SITE 341 HOLE CORE 26 CORED INTERVAL: 351.5-361.0 m



Explanatory notes in Chapter I

Reworked

LITHOLOGIC DESCRIPTION

5Y 6/1

5YR 4/1

5Y 6/1

5YR 4/1

5Y 4/1

5YR 4/1

5GY 5/2

Colors: dusky yellow green (5GY 5/2), brownish gray (5YR 4/1), light olive gray (5Y 6/1). Slight to moderate deformation. Sec. 1 - massive, Zoophycus burrows (Helminthoida), gradational color contacts; Sec. 2 - burrows, extensive in section; Sec. 3 - as per Sec. 2; Secs. 4 and 5 - Zoophycus with others. Sec. 6 - as per Sec. 5.

MAJOR LITHOLOGIES

a) ?CALCAREOUS DIATOMITE (Smear 3-68)/MARLY SILICEOUS CHALK (Smear 6-74)

TR- 3% Quartz and Feldspar
0- 2% Mica
TR- 1% Heavy minerals
2% Opaques
3% Volcanic glass
30% Clay minerals
30-35% Nannofossils
12-20% Diatoms
3- 5% Radiolarians
7% Sponge spicules

b) DIATOMACEOUS MUD (Smear 1-5)/MUDDY DIATOMITE (Smear CC)

5% Quartz and Feldspar
1- 4% Mica
TR- 1% Heavy minerals
1- 3% Opaques
3- 5% Volcanic glass
20-40% Clay minerals
TR% Glauconite
0-15% Nannofossils
30-35% Diatoms
5% Radiolarians
7-10% Sponge spicules

MINOR LITHOLOGY

CHALK (Smear 2-140)

TR% Quartz, Opaques, Glauconite
13% Clay minerals
70% Nannofossils
7% Diatoms
3% Radiolarians
5% Sponge spicules

Carbon-Carbonate (DSDP)
3-8 (4.7, 0.0, 39)

Grain Size (DSDP)
3-64 (1.4, 27.7, 70.9)

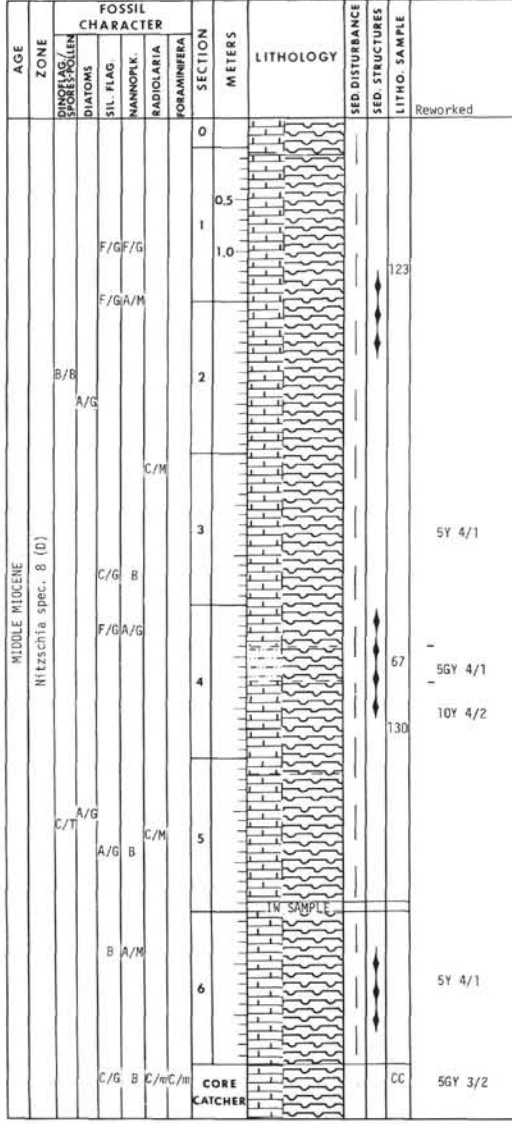
X-Ray (BP)

4-100
26% Mont.
39% Ill.
22% Kaol.
13% Chlo.

5-100
30% Mont.
35% Ill.
21% Kaol.
14% Chlo.

6-100
20% Mont.
46% Ill.
20% Kaol.
14% Chlo.

SITE 341 HOLE CORE 27 CORED INTERVAL: 370.5-380.0 m



LITHOLOGIC DESCRIPTION

Colors: dusky yellow green (5GY 5/2), olive gray (5Y 4/1), brownish gray (5YR 4/1), dark greenish gray (5GY 4/1), grayish olive (10Y 4/2). Slight deformation, massive, abundant burrows (Helminthoida), Zoophycus, color variations but no structures.

MAJOR LITHOLOGIES

a) CALCAREOUS DIATOMACEOUS MUDSTONE (Smear 1-123) CALCAREOUS DIATOMITE (Smears 4-130, CC)

2- 5%	Quartz
TR- 2%	Mica
2- 3%	Opaques
18-30%	Clay minerals
0-TR%	Glauconite
3- 8%	Authigenic carbonate
10-20%	Nannofossils
20-45%	Diatoms
0- 5%	Radiolarians
7-15%	Sponge spicules
1%	Silicoflagellates

b) MUDDY DIATOMITE (Smear 4-67)

2%	Opaques
5%	Volcanic glass
25%	Clay minerals
5%	Authigenic carbonate
5%	Nannofossils
40%	Diatoms
5%	Radiolarians
12%	Sponge spicules
1%	Silicoflagellates

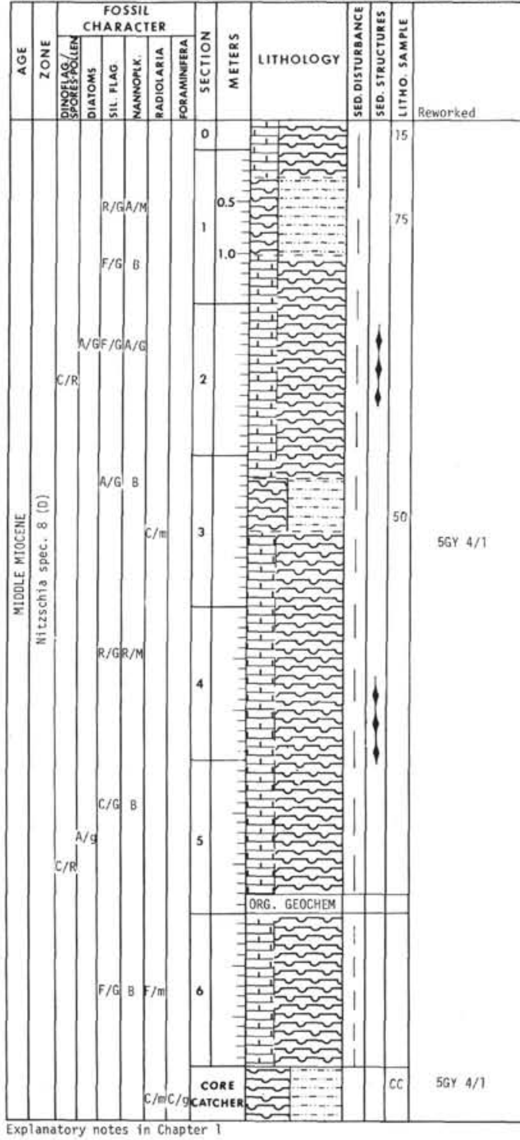
Carbon-Carbonate (DSDP)
4-82 (2.0, 0.0, 17)

Grain Size (DSDP)
3-81 (1.3, 22.2, 76.5)

X-Ray (BP)
6-50

31%	Mont.
33%	Ill.
20%	Kaol.
16%	Chlo.

SITE 341 HOLE CORE 28 CORED INTERVAL: 389.5-399.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1); massive, hard-firm, with slight deformation, some bioturbation.

MAJOR LITHOLOGIES

a) DIATOMACEOUS MUDSTONE (Smear CC)/ASHY DIATOMACEOUS MUDSTONE (Smear 3-50)

0- 2%	Quartz
2%	Mica
TR%	Heavy minerals
2-15%	Opaques
0-10%	Volcanic glass
21-50%	Clay minerals
1- 3%	Authigenic carbonate
0- 1%	Nannofossils
20-30%	Diatoms
3- 5%	Radiolarians
10-20%	Sponge spicules
TR%	Silicoflagellates

b) CALCAREOUS DIATOMITE (Smear 0-15)/ CALCAREOUS DIATOMACEOUS MUDSTONE (Smear 1-75)

0- 2%	Quartz
1%	Mica
TR%	Opaques
0- 2%	Volcanic glass
20-50%	Clay minerals
0- 5%	Authigenic carbonate
20-30%	Nannofossils
15-30%	Diatoms
3- 5%	Radiolarians
7%	Sponge spicules
TR%	Silicoflagellates

Carbon-Carbonate (DSDP)
3-79 (1.5, 0.0, 13)

Carbon-Carbonate (PP)
28-5 (top) (0.86, 0.91)
28-5 (bottom) (0.97, 1.40)

Grain Size (DSDP)
3-73 (0.6, 21.0, 78.5)

X-Ray (BP)
3-50

33%	Mont.
37%	Ill.
17%	Kaol.
13%	Chlo.

6-50

44%	Mont.
29%	Ill.
13%	Kaol.
14%	Chlo.

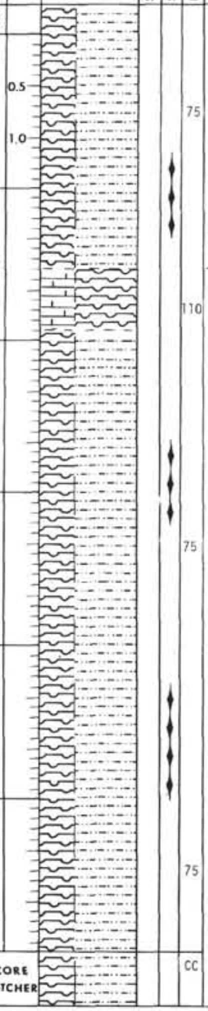
Explanatory notes in Chapter 1

SITE 341 **HOLE** **CORE** 29 **CORED INTERVAL:** 399.0-408.5 m

AGE: MIDDLE MIOCENE

ZONE: *Nitzschia* spec. 8 (D)

SECTION	DINOFLAG./ SPORES-POLLEN	DIATOMS	SIL. FLAG.	NANNOPLK.	RADIOLARIA	FORAMINIFERA	LITHO. SAMPLE	Reworked
0								
1			A/G	B			75	5Y 4/1 5GY 4/1
2	C/R	A/G	F/G	C/M	F/m		110	5GY 4/1 - - -
3			F/G	B				
4			F/G	A/P			75	10Y 4/2
5	C/C	A/g	A/G	B	A/m			
6			F/G	R/P			75	5GY 4/1
CORE CATCHER					A/g	C/g	CC	10YR 2/2



LITHOLOGIC DESCRIPTION

Colors: dusky yellowish-brown (10YR 2/2), olive gray (5Y 4/1), dark greenish-gray (5GY 4/1), grayish olive (10Y 4/2). Hard, massive, no deformation, minimal bioturbation extensive, "oil" odors.

MAJOR LITHOLOGIES

a) CALCAREOUS DIATOMITE (Smears 1-75, 2-110, 4-75)

2%	Quartz
1%	Mica
2%	Opaques
0- 3%	Volcanic glass
15%	Clay minerals
TR%	Glauconite
TR- 5%	Authigenic carbonate
TR%	Foraminifera
25-30%	Nannofossils
15-25%	Diatoms
0- 7%	Radiolarians
15-25%	Sponge spicules
TR%	Silicoflagellates

b) DIATOMACEOUS MUDSTONE (Smears 6-75, CC)

2- 4%	Quartz
1- 3%	Mica
2- 3%	Opaques
1- 3%	Volcanic glass
44-50%	Clay minerals
1- 2%	Glauconite
1- 3%	Authigenic carbonate
TR%	Foraminifera
1%	Nannofossils
10-30%	Diatoms
5- 7%	Radiolarians
12-15%	Sponge spicules
TR%	Silicoflagellates

Carbon-Carbonate (DSDP)
1-120 (1.7, 0.0, 14)
5-52 (3.3, 0.0, 28)

Grain Size (DSDP)
5-105 (0.4, 25.3, 74.3)

X-Ray (BP)
6-80

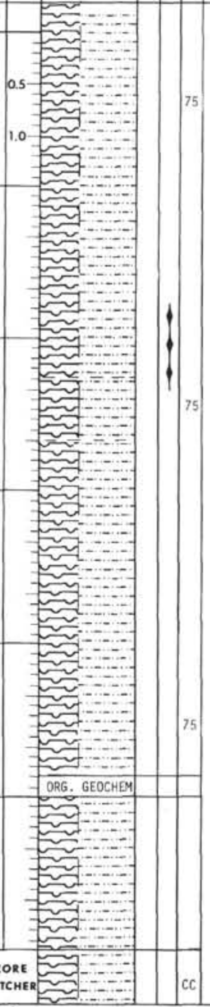
22%	Mont.
36%	Ill.
42%	Kaol., Chlo.

SITE 341 **HOLE** **CORE** 30 **CORED INTERVAL:** 408.5-418.0 m

AGE: MIDDLE MIOCENE

ZONE: *Coscinodiscus plicatus* (D)

SECTION	DINOFLAG./ SPORES-POLLEN	DIATOMS	SIL. FLAG.	NANNOPLK.	RADIOLARIA	FORAMINIFERA	LITHO. SAMPLE	
0								
1			C/G	B			75	5GY 4/1
2	C/R	A/g	F/G	C/P	F/P			
3			C/G				75	
4			C/G	R/P				10Y 4/2
5	C/R	C/g	R/G	B	F/P		75 ORG. GEOCHEM	5G 4/1 5GY 4/1
6			R/G	R/P				
CORE CATCHER					C/m	C/g	CC	10YR 2/2



LITHOLOGIC DESCRIPTION

Colors: dusky yellow brown (10YR 2/2), dark greenish-gray (5GY 4/1), grayish olive (10Y 4/2). Hard, no deformation, mildly bioturbated.

MAJOR LITHOLOGY

DIATOMACEOUS MUDSTONE (Smears 1-75, 3-75, 5-75, CC)

1- 2%	Quartz and Feldspar
0- 2%	Mica
0-TR%	Heavy minerals
2- 6%	Opaques
0-TR%	Volcanic glass
54-56%	Clay minerals
TR- 1%	Glauconite
2- 3%	Authigenic carbonate
0-TR%	Foraminifera
0-10%	Nannofossils
15-30%	Diatoms
2- 3%	Radiolarians
7-12%	Sponge spicules

Carbon-Carbonate (PP)
30-5 (top) (1.77, 0.06)
30-5 (bottom) (1.27, 0.20)

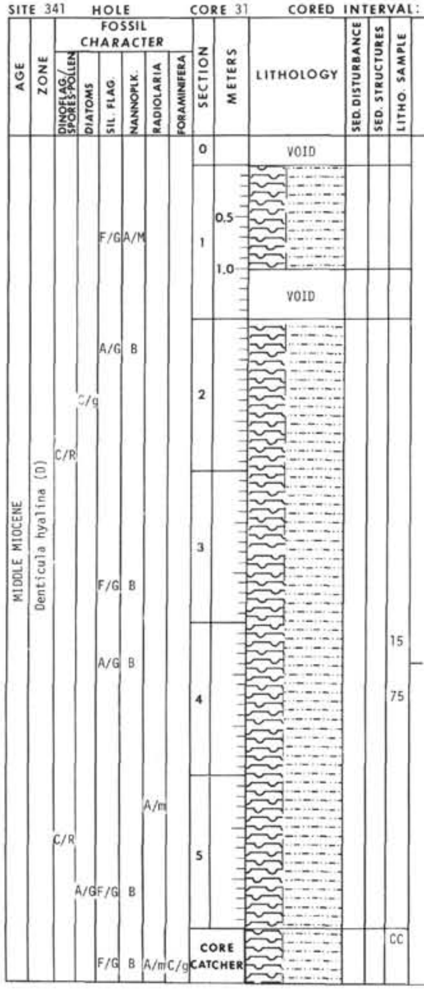
Grain Size (DSDP)
1-112 (0.1, 33.3, 66.6)

X-Ray (BP)
5-98

42%	Mont.
25%	Ill.
18%	Kaol.
14%	Chlo.

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 31 CORED INTERVAL: 418.0-427.5 m



LITHOLOGIC DESCRIPTION

5GY 4/1

5Y 2/1

10YR 2/2

Colors: dusky yellowish-brown (10YR 2/2), dark greenish-gray (5GY 4/1), brownish black (5Y 2/1). Hard, massive, no deformation, minimal bioturbation, hydrocarbon odor.

MAJOR LITHOLOGY

DIATOMACEOUS MUDSTONE (Smears 4-15, 4-75, CC)

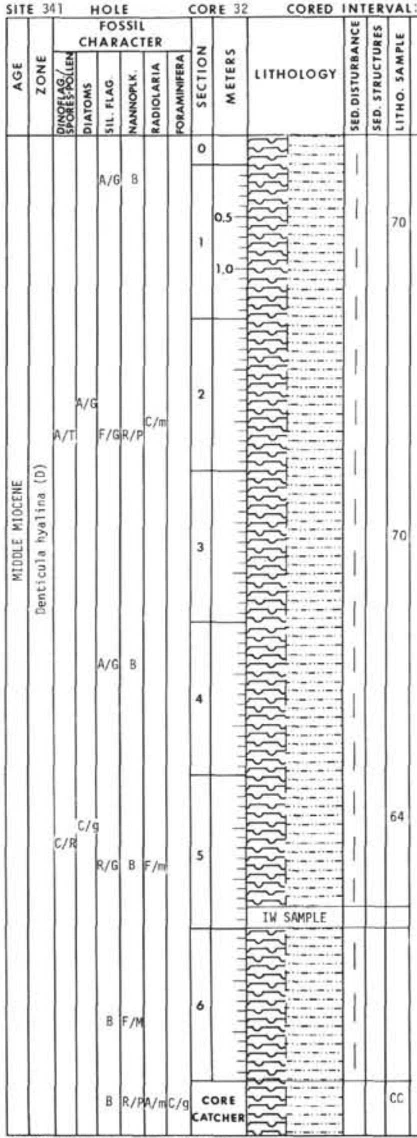
4-10%	Quartz and Feldspar
1- 2%	Mica
2- 4%	Opaques
0-TR%	Volcanic glass
48-66%	Clay minerals
TR- 1%	Glauconite
1- 2%	Authigenic carbonate
12-20%	Diatoms
TR- 7%	Radiolarians
7-10%	Sponge spicules

Grain Size (DSDP)
3-47 (0.1, 38.7, 61.2)

X-Ray (BP)
5-65

36%	Mont.
34%	Ill.
15%	Kaol.
15%	Ill.

SITE 341 HOLE CORE 32 CORED INTERVAL: 427.5-437.0 m



LITHOLOGIC DESCRIPTION

5YR 2/1

5YR 2/1

5YR 3/2

Colors: Grayish brown (5YR 3/2), brownish black (5YR 2/1). Hard, massive, slight deformation, hydrocarbon odor.

MAJOR LITHOLOGY

DIATOMACEOUS MUDSTONE (Smears 1-70, 3-70, 5-64, CC)

3-10%	Quartz and Feldspar
0- 2%	Mica
2- 4%	Opaques
0- 1%	Volcanic glass
45-65%	Clay minerals
TR- 1%	Glauconite
0- 2%	Authigenic carbonate
0- 5%	Nannofossils
15%	Diatoms
3%	Radiolarians
10-12%	Sponge spicules
TR%	Silicoflagellates

Carbon-Carbonate (DSDP)
2-113 (1.6, 0.0, 13)

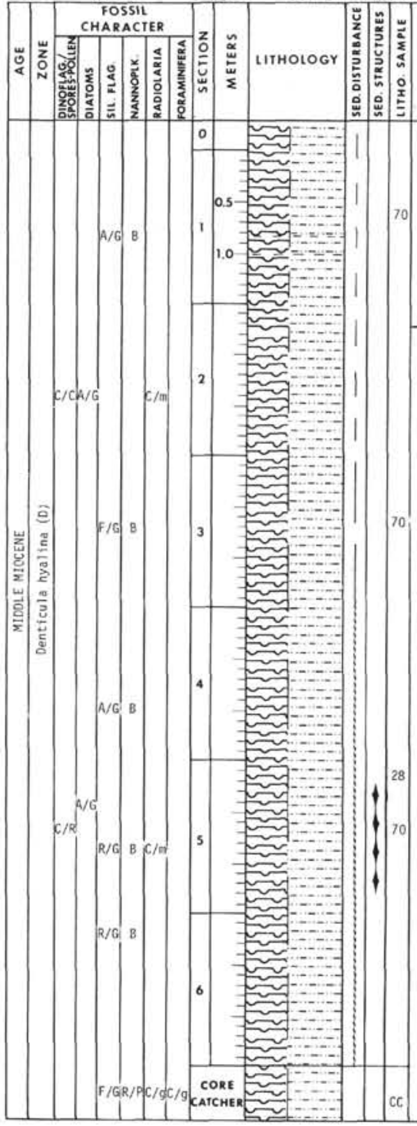
Grain Size (DSDP)
2-64 (0.2, 22.0, 77.8)

X-Ray (BP)
5-80

32%	Mont.
38%	Ill.
17%	Kaol.
13%	Chlo.

Explanatory notes in Chapter 1

SITE 341 HOLE CORE 33 CORED INTERVAL: 437.0-446.5 m



N4
↓
5YR 4/1

5YR 4/1

5YR 2/1

5YR 3/2

LITHOLOGIC DESCRIPTION

Colors: grayish brown (5YR 3/2), olive gray (5Y 4/1), medium dark gray (N4), brownish gray (5YR 4/1), brownish black (5YR 2/1). Generally hard, firm, massive, >deformation in Secs. 4-6. Burrows (Chondrites) in Sec. 5. Hydrocarbon odor.

MAJOR LITHOLOGY

DIATOMACEOUS MUDSTONE (Smears 1-70, 3-70, 5-28, 5-70, CC)

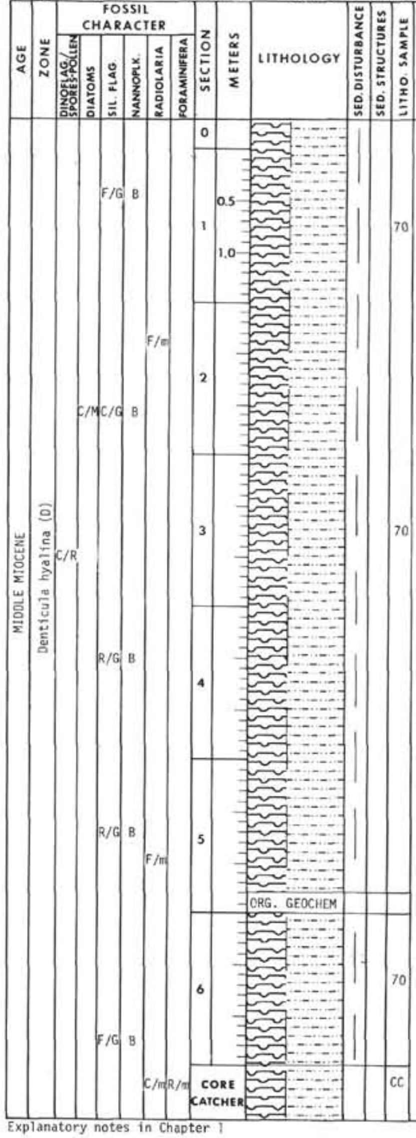
2-10%	Quartz and Feldspar
2- 3%	Mica
4-10%	Opaques
0- 5%	Volcanic glass
45-58%	Clay minerals
0- 1%	Glauconite
1- 2%	Authigenic carbonate
0- 5%	Nannofossils
15-20%	Diatoms
3- 5%	Radiolarians
10-12%	Sponge spicules
0-TR%	Silicoflagellates

Carbon-Carbonate (DSDP)
3-99 (1.7, 1.5, 2)

Grain Size (DSDP)
3-42 (0.4, 32.0, 67.7)

X-Ray (BP)
6-68
25% Mont.
39% Ill.
18% Kaol.
18% Chlo.

SITE 341 HOLE CORE 34 CORED INTERVAL: 446.5-456.0 m



5YR 4/1

5YR 2/1

5YR 3/2

LITHOLOGIC DESCRIPTION

Colors: grayish brown (5YR 3/2), brownish gray (5YR 4/1), brownish black (5YR 2/1). Hard, moderate deformation, faint laminations, bioturbated.

MAJOR LITHOLOGY

DIATOMACEOUS MUDSTONE (Smears 1-70, 3-70, 6-70, CC)

1- 5%	Quartz and Feldspar
2- 3%	Mica
5%	Opaques
1- 4%	Volcanic glass
51-57%	Clay minerals
0- 1%	Glauconite
0- 2%	Authigenic carbonate
15-20%	Diatoms
3- 5%	Radiolarians
7-15%	Sponge spicules
0- 1%	Silicoflagellates

Carbon-Carbonate (DSDP)
3-80 (1.8, 1.8, 0)

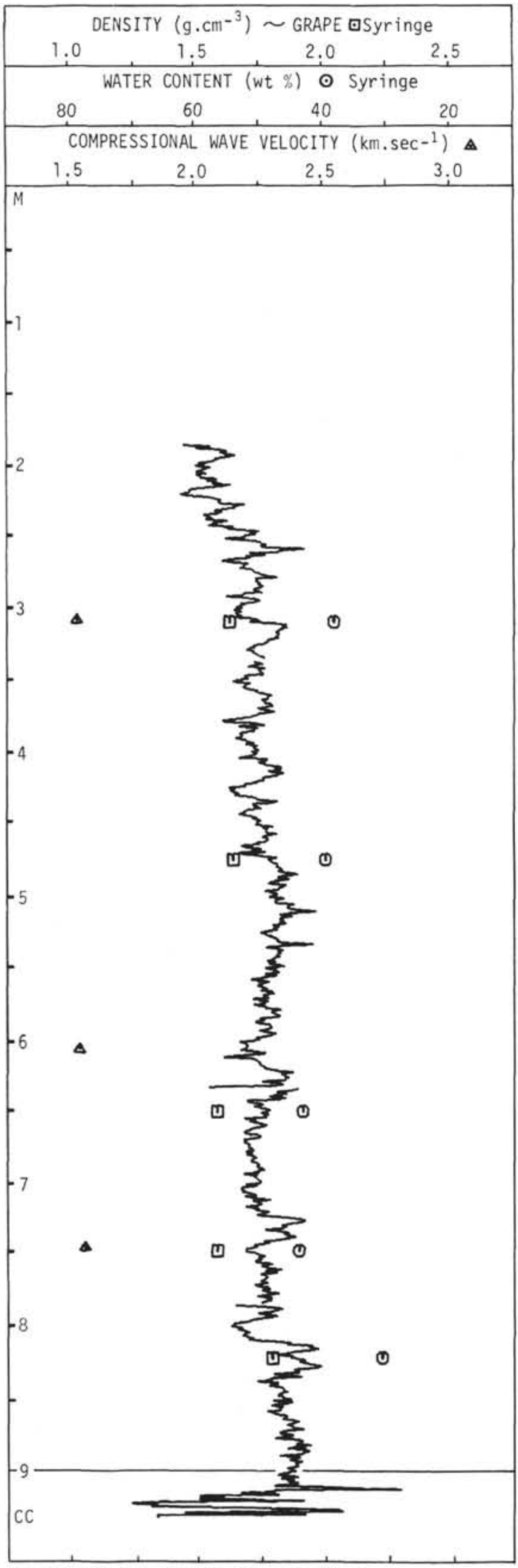
Carbon-Carbonate (PP)
34-5 (top) (1.74, 0.02)
34-5 (bottom) (0.05, 1.11)

Grain Size (DSDP)
3-36 (0.1, 28.1, 71.8)

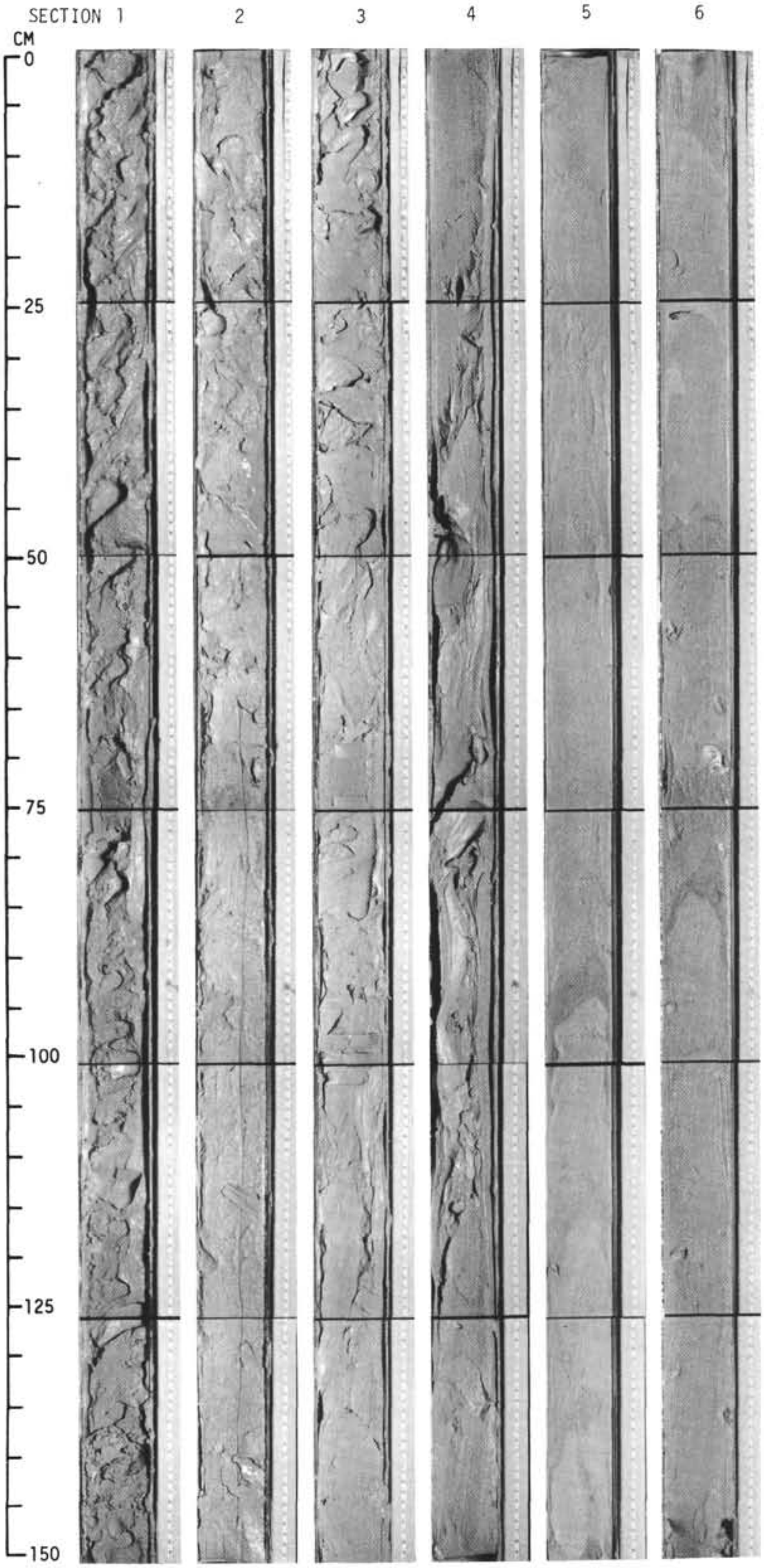
X-Ray (BP)
3-64
32% Mont.
30% Ill.
20% Kaol.
18% Chlo.

Explanatory notes in Chapter 1

341-1



For Explanatory Notes, see Chapter 1



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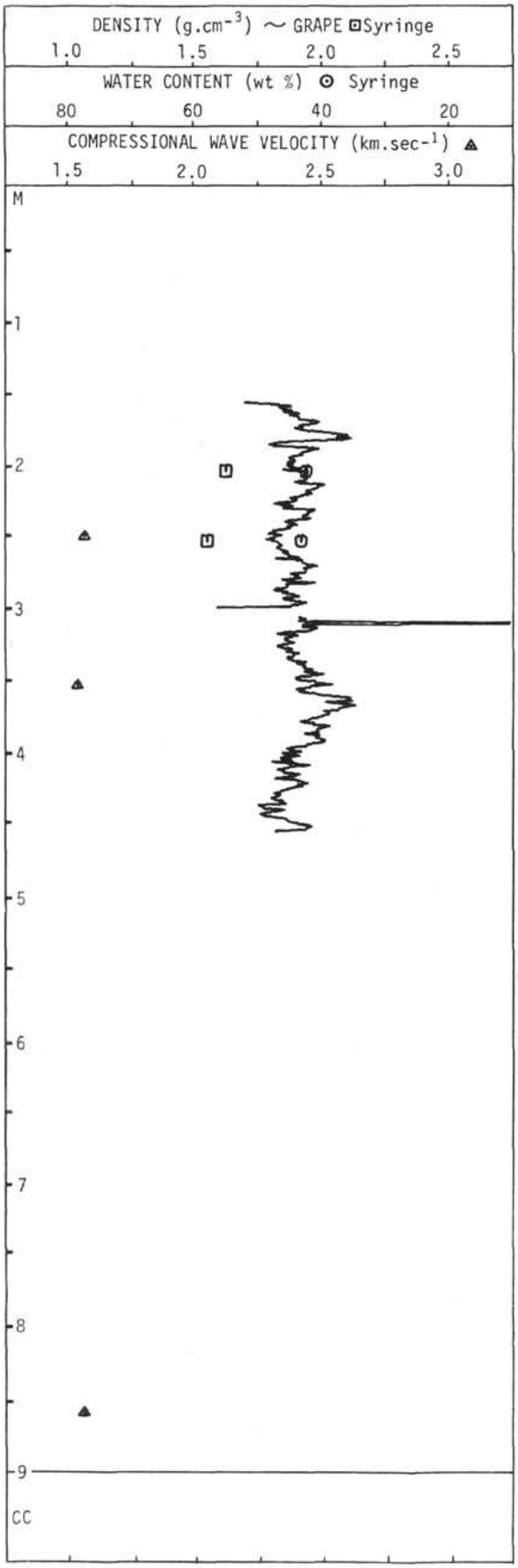
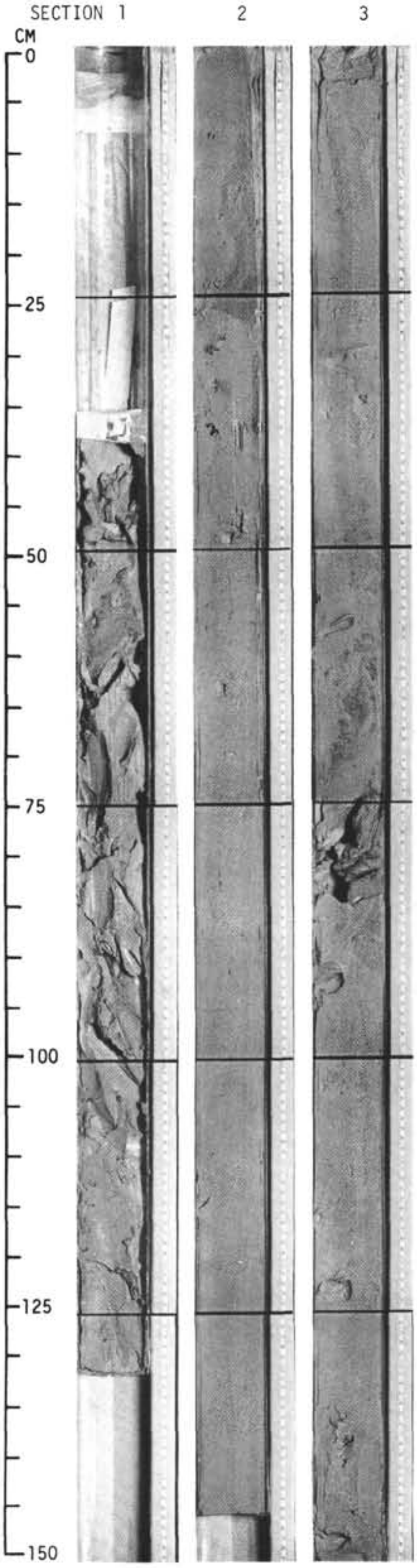
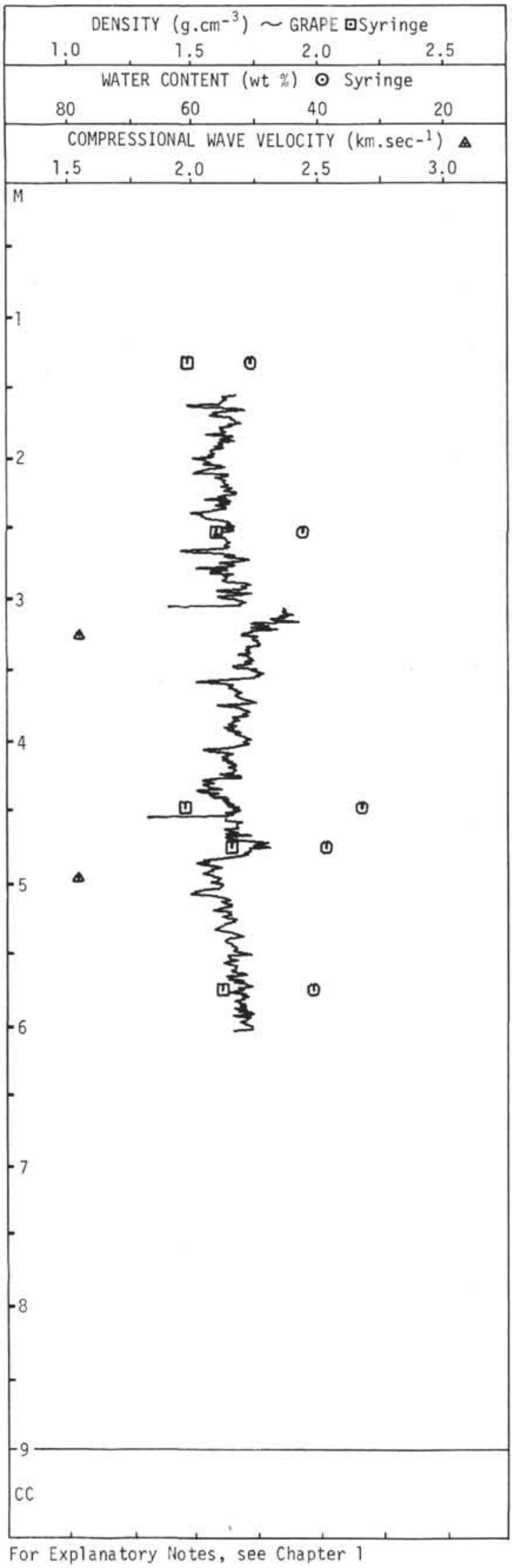


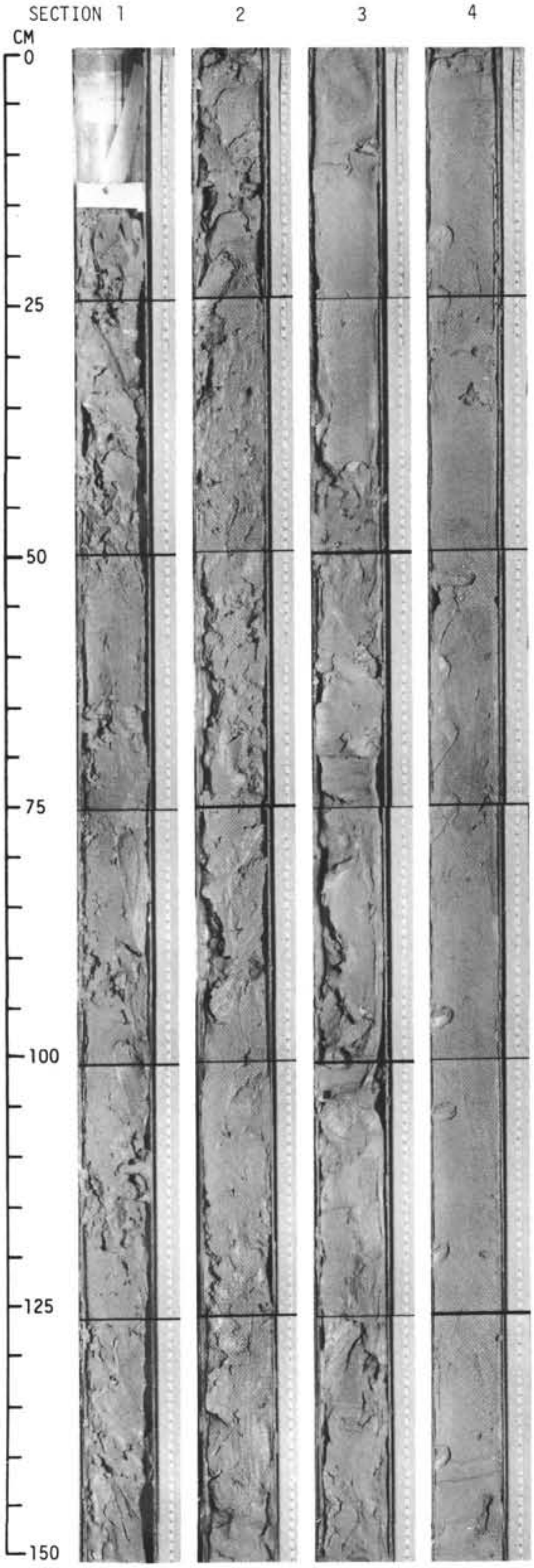


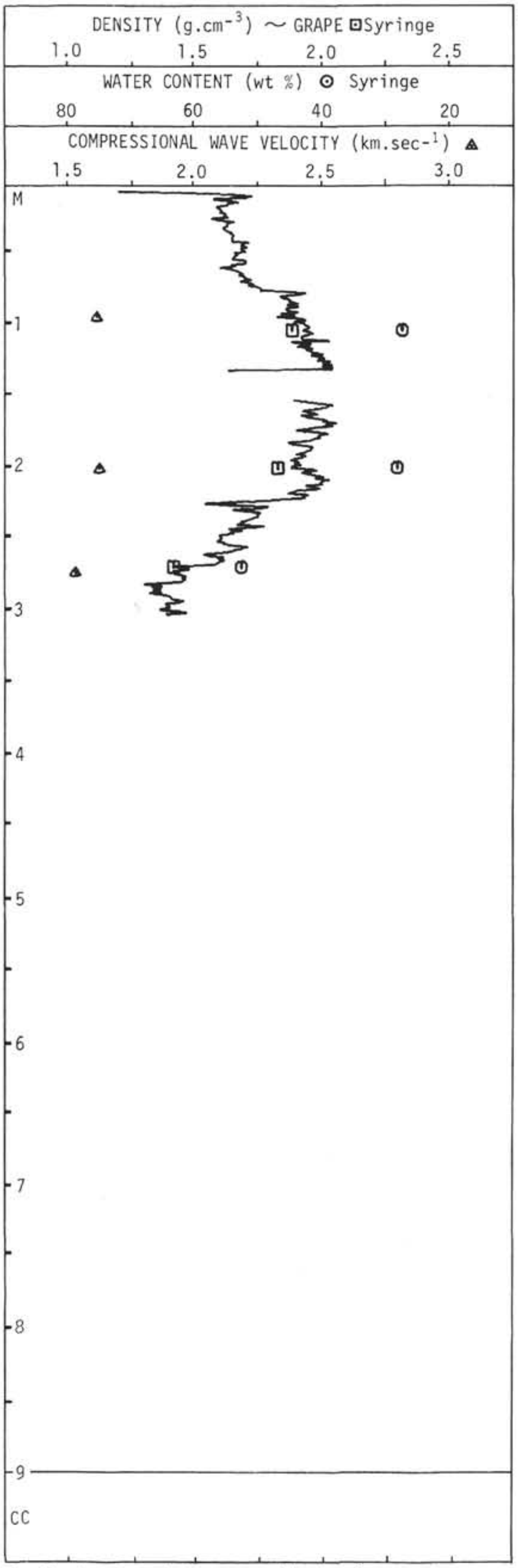
For Explanatory Notes, see Chapter 1



For Explanatory Notes, see Chapter 1

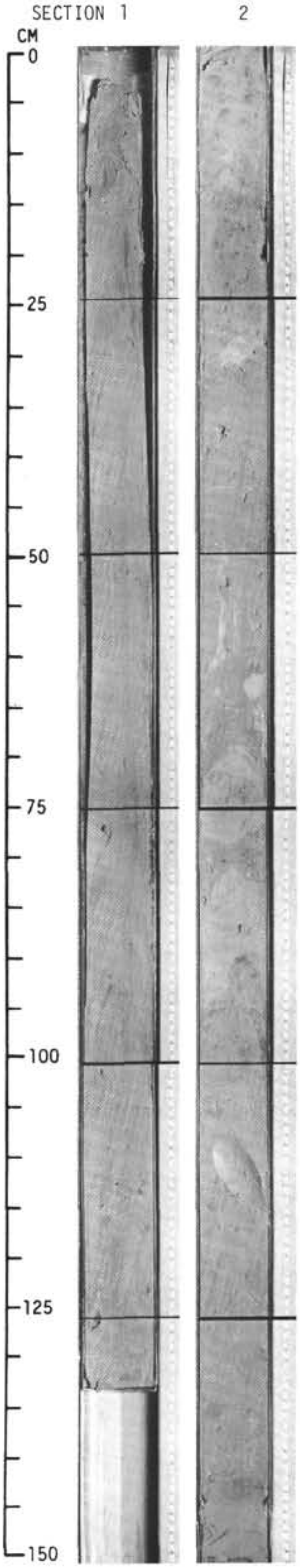
341-3

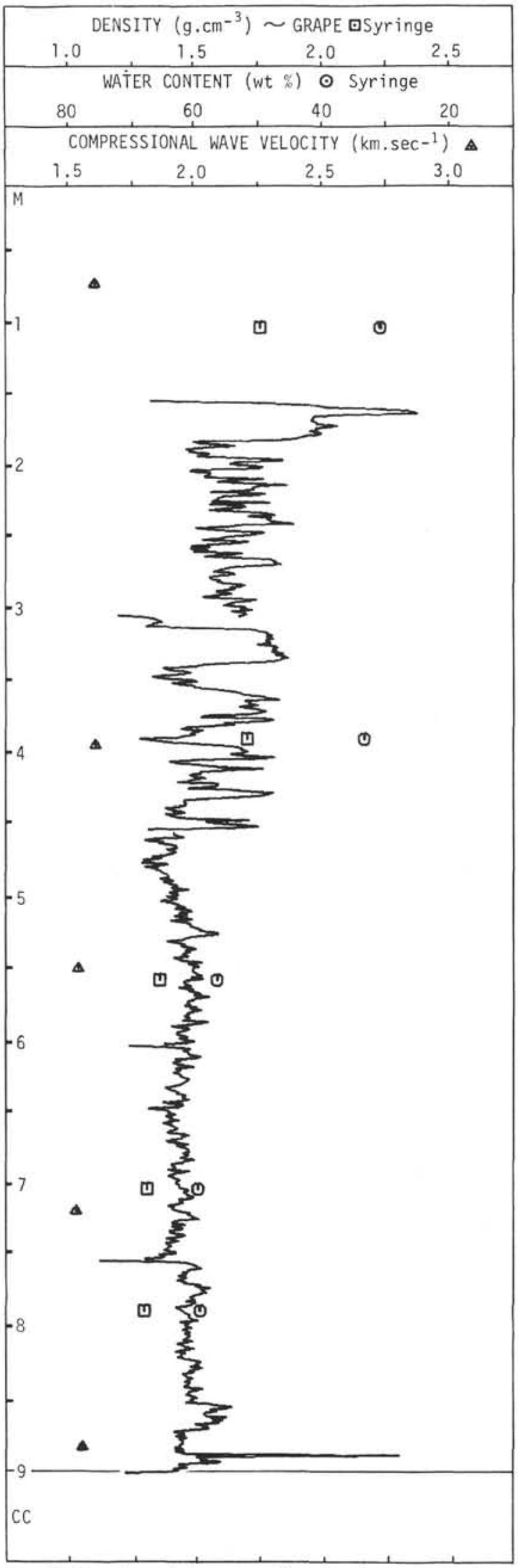




For Explanatory Notes, see Chapter 1

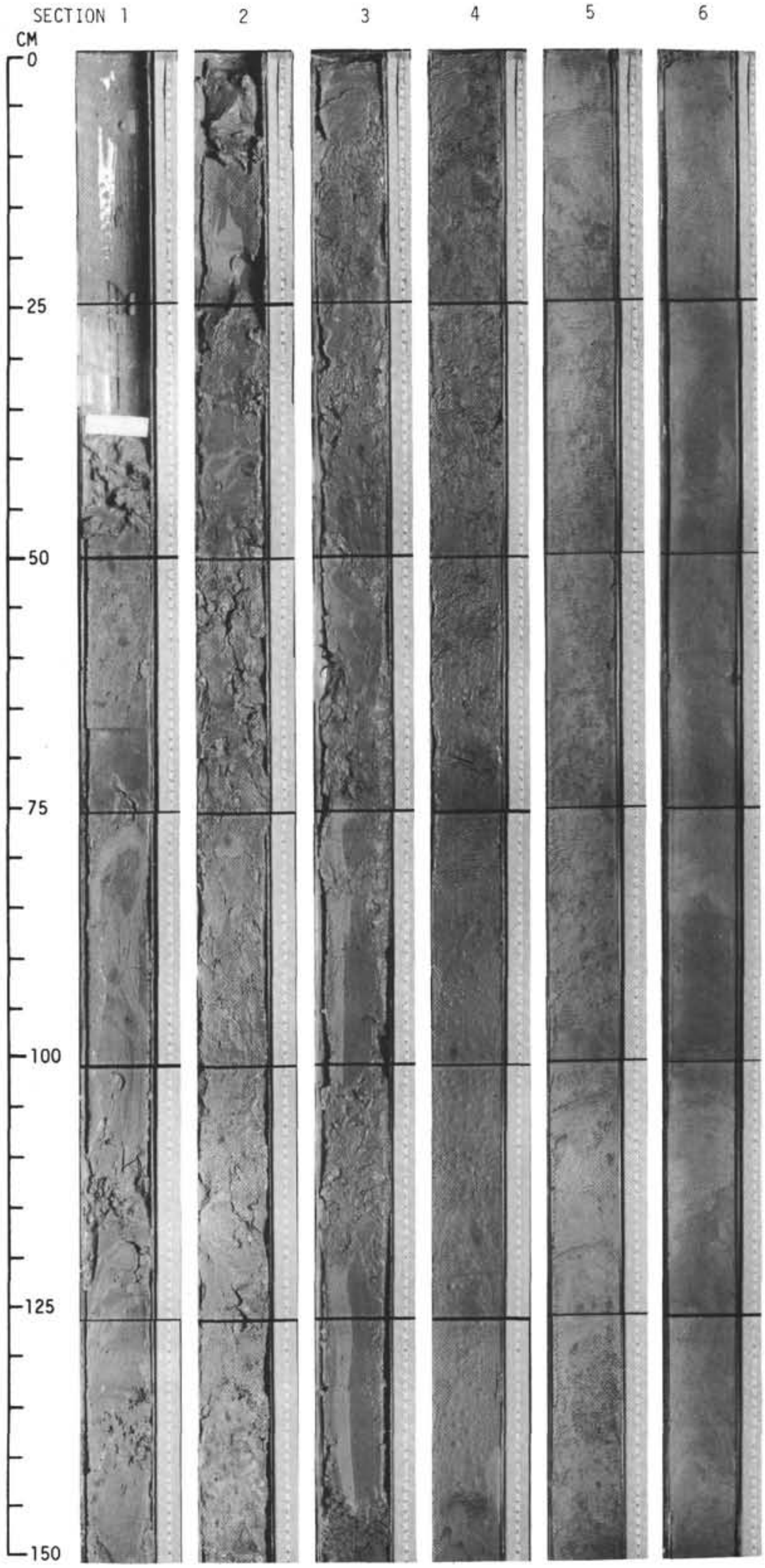
341-4

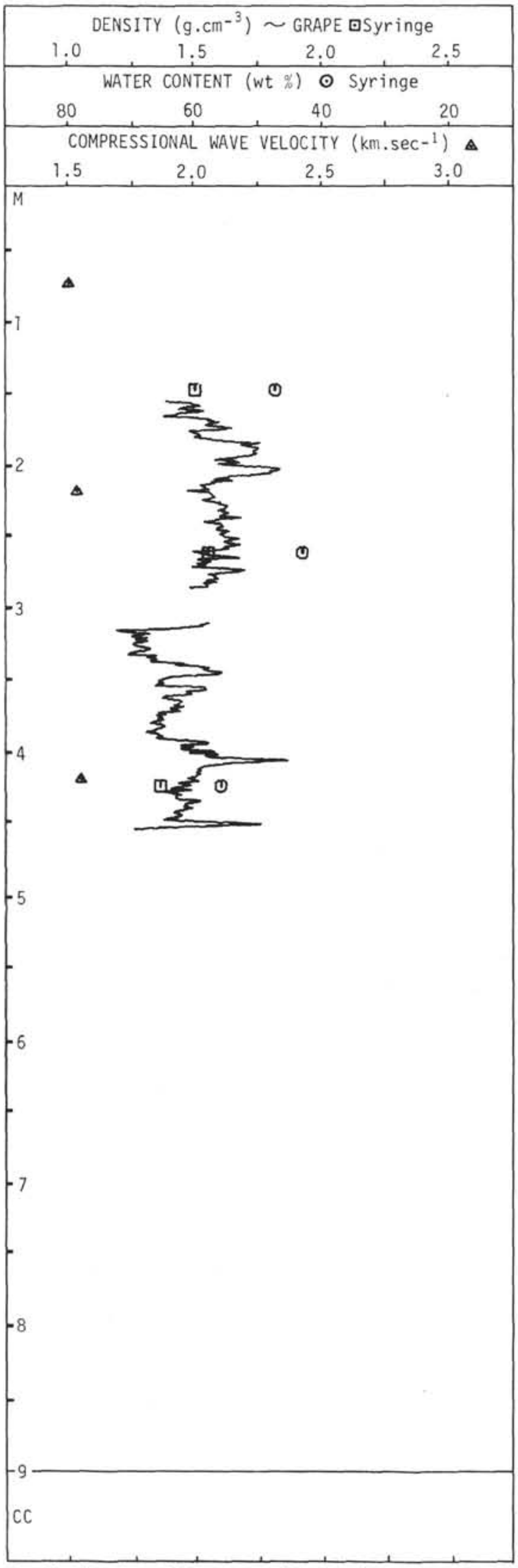




For Explanatory Notes, see Chapter 1

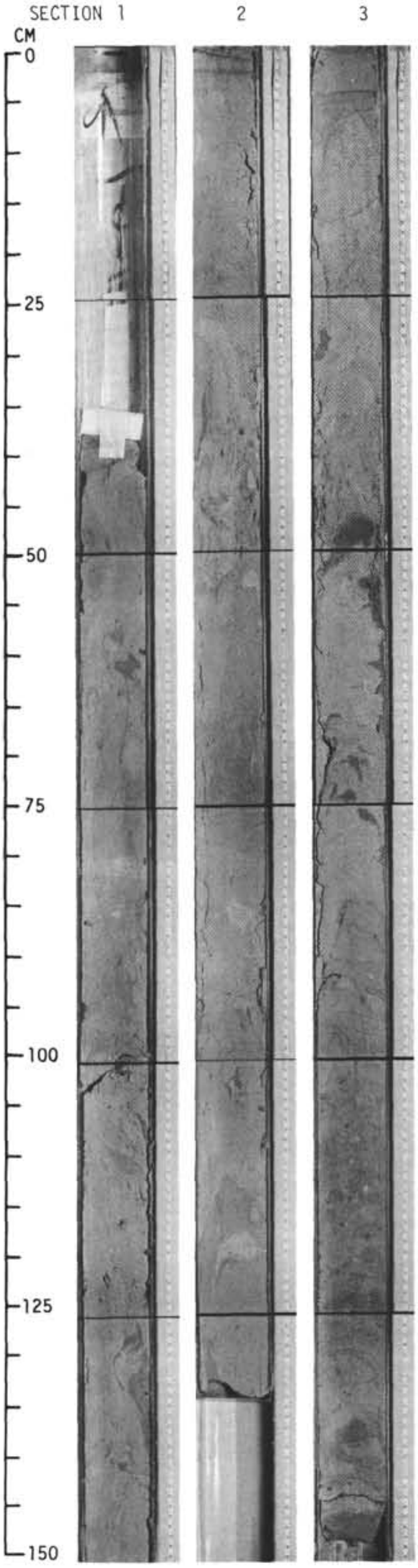
341-5

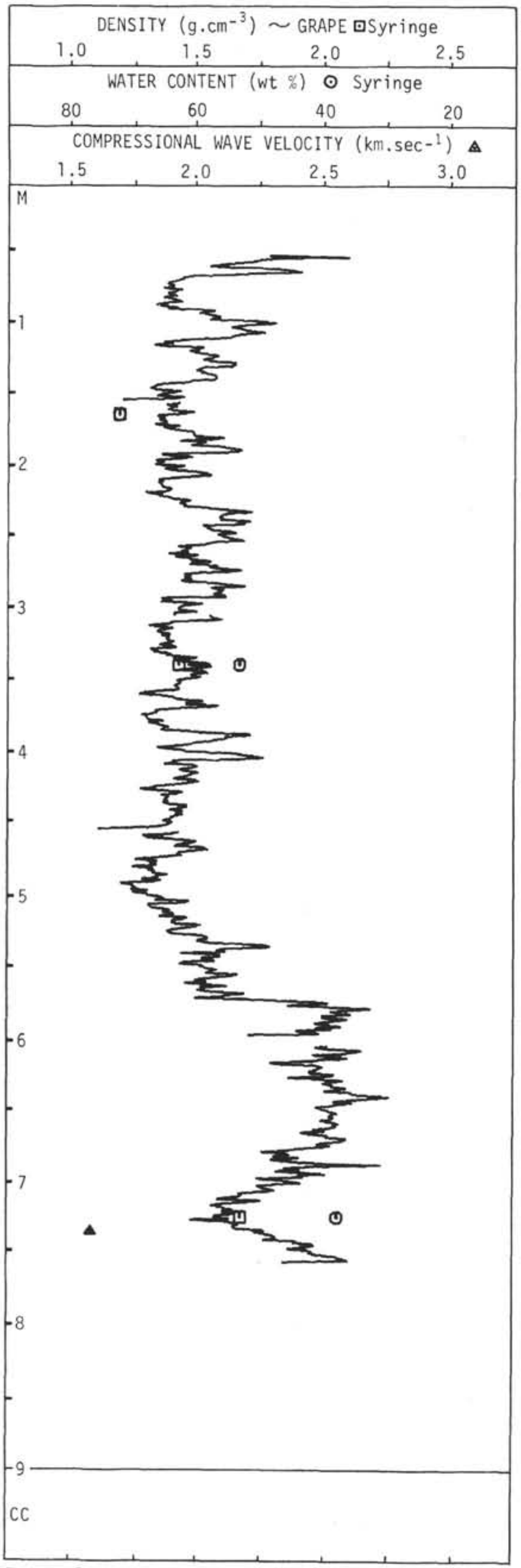




For Explanatory Notes, see Chapter 1

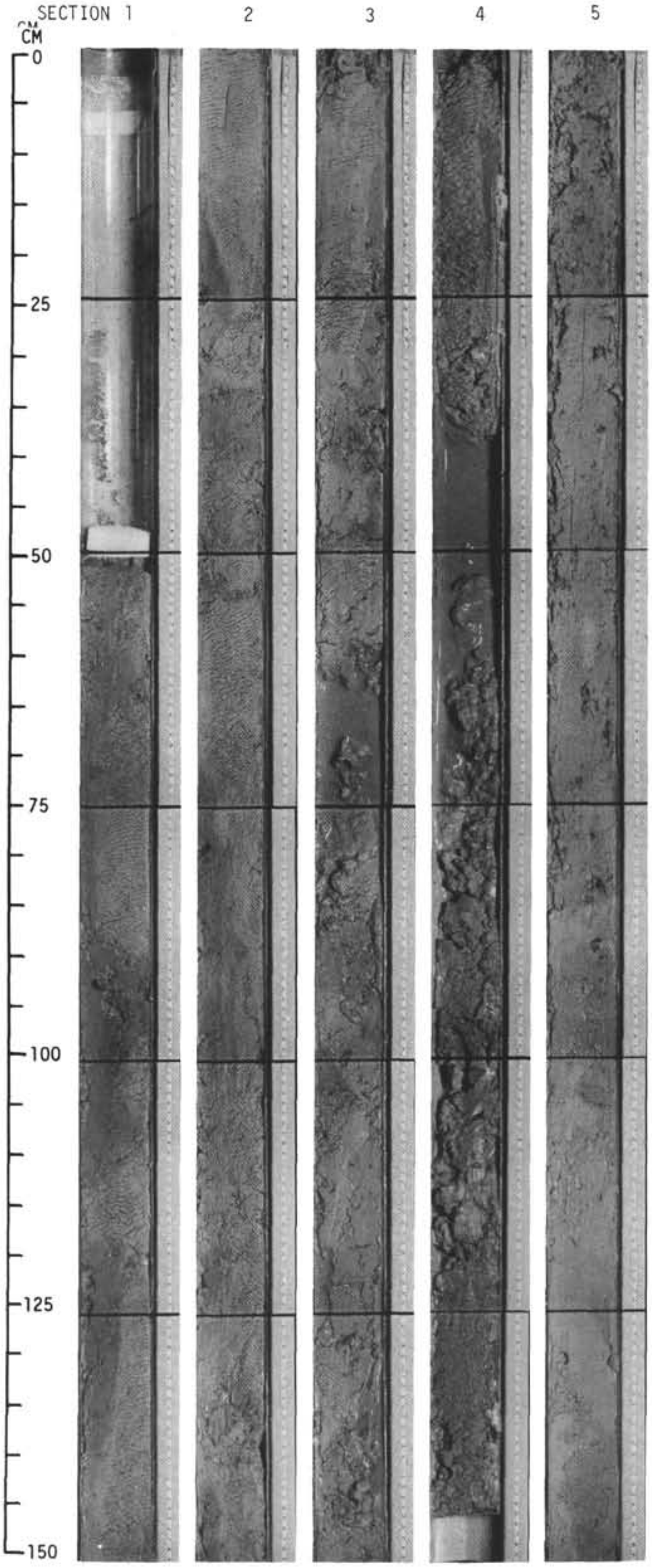
341-6

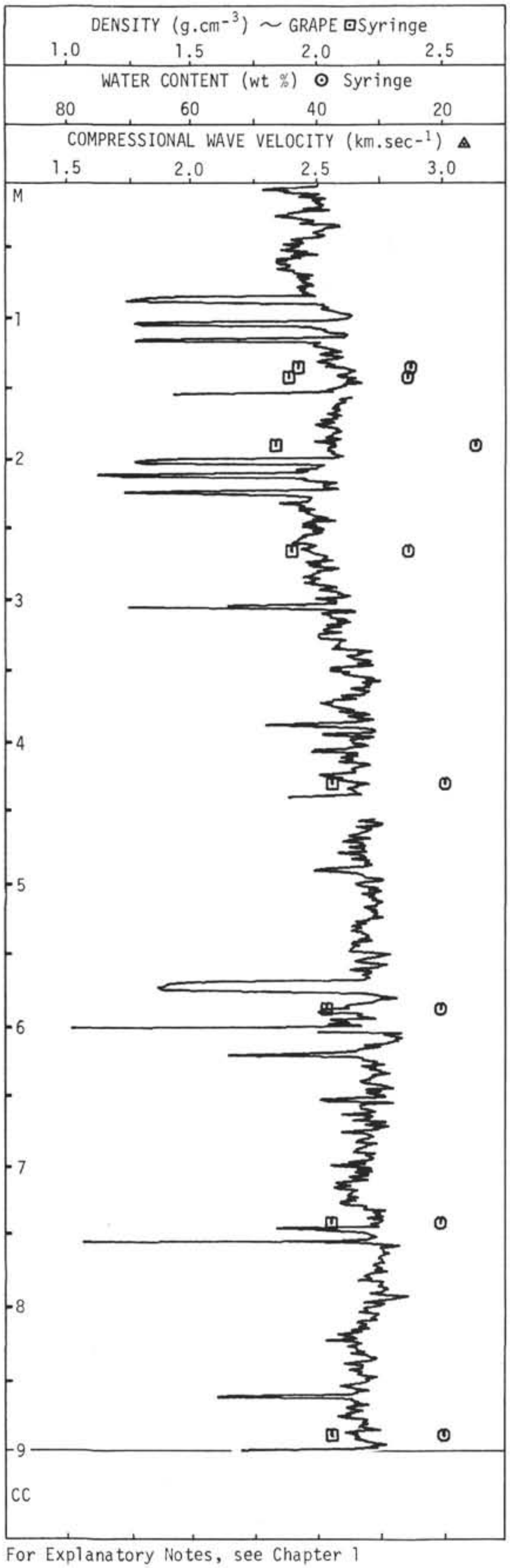




For Explanatory Notes, see Chapter 1

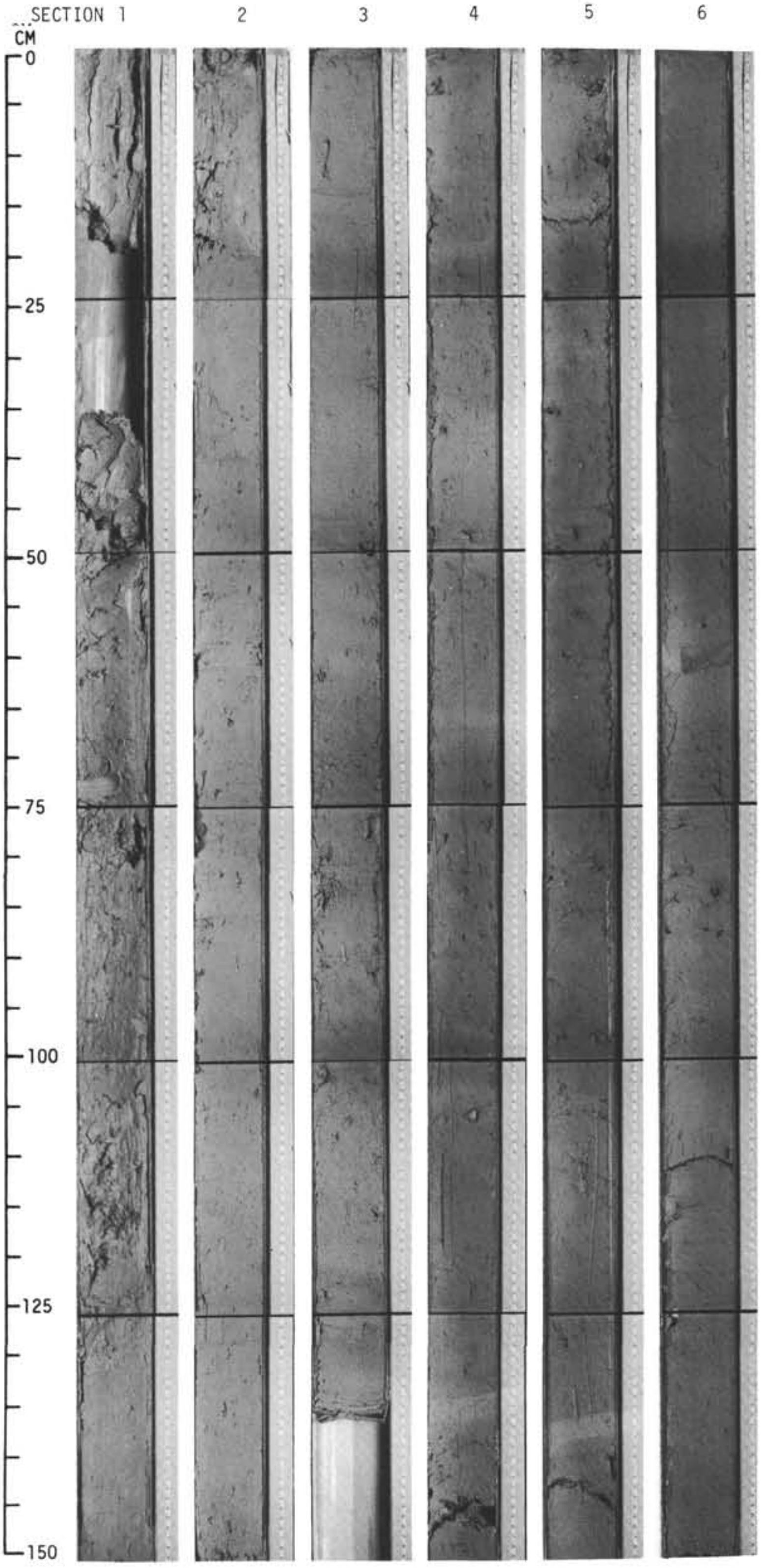
341-7

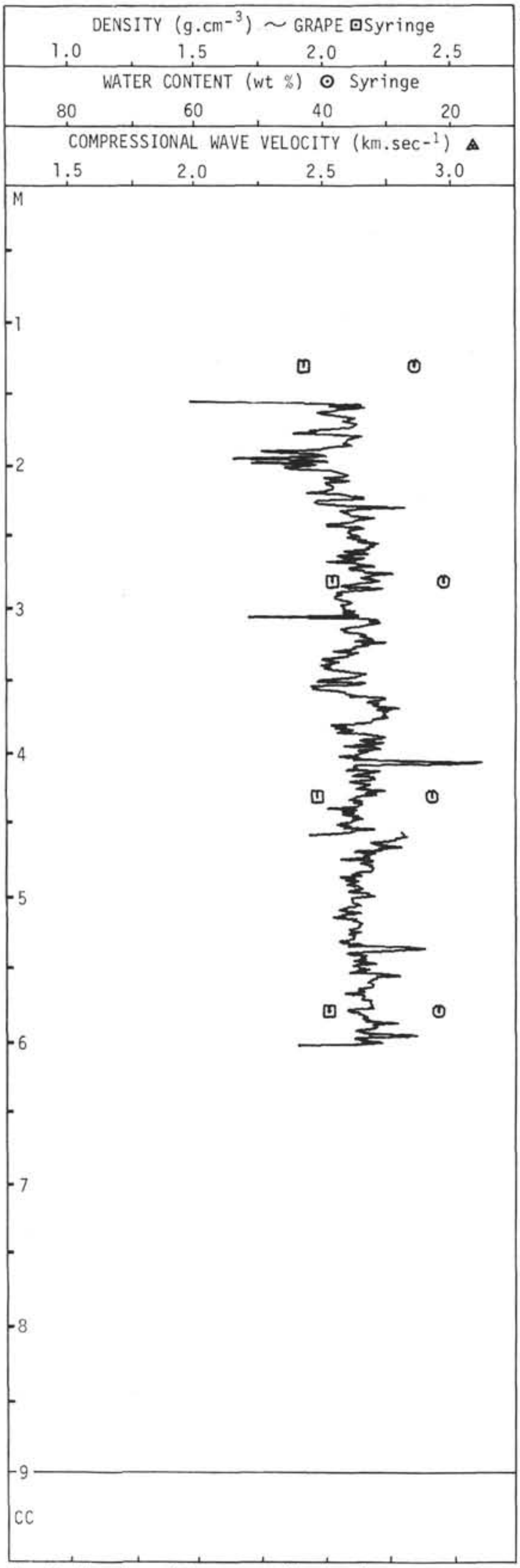




For Explanatory Notes, see Chapter 1

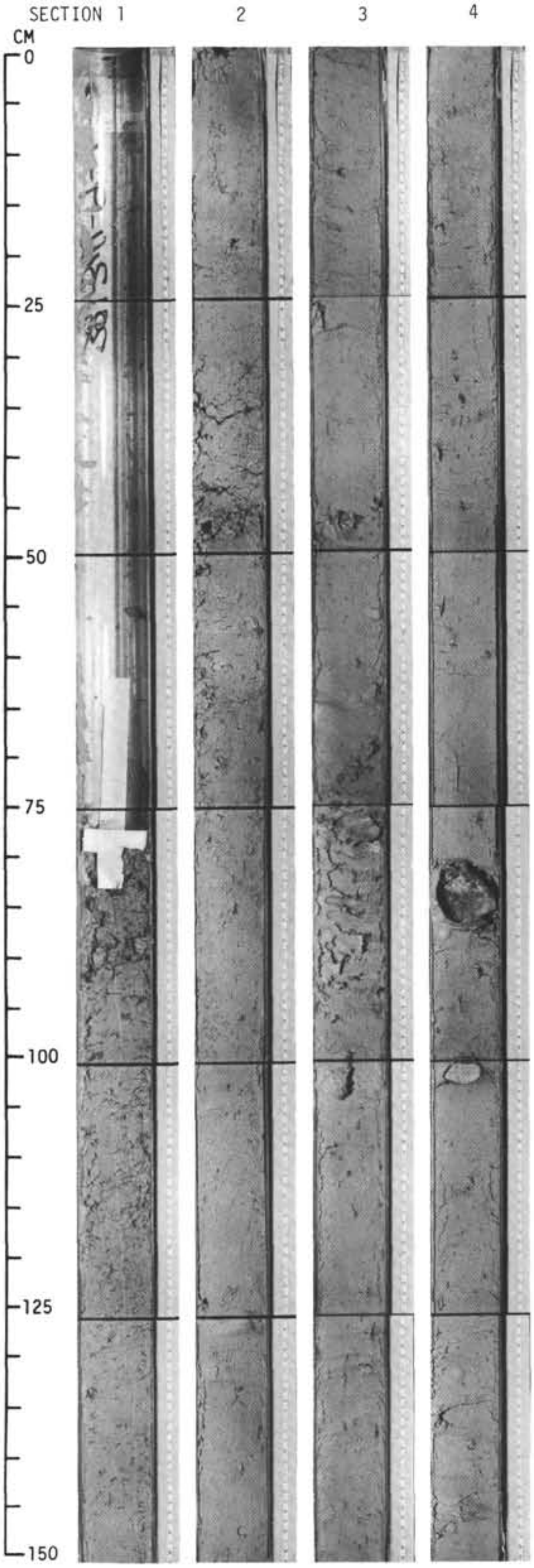
341-8

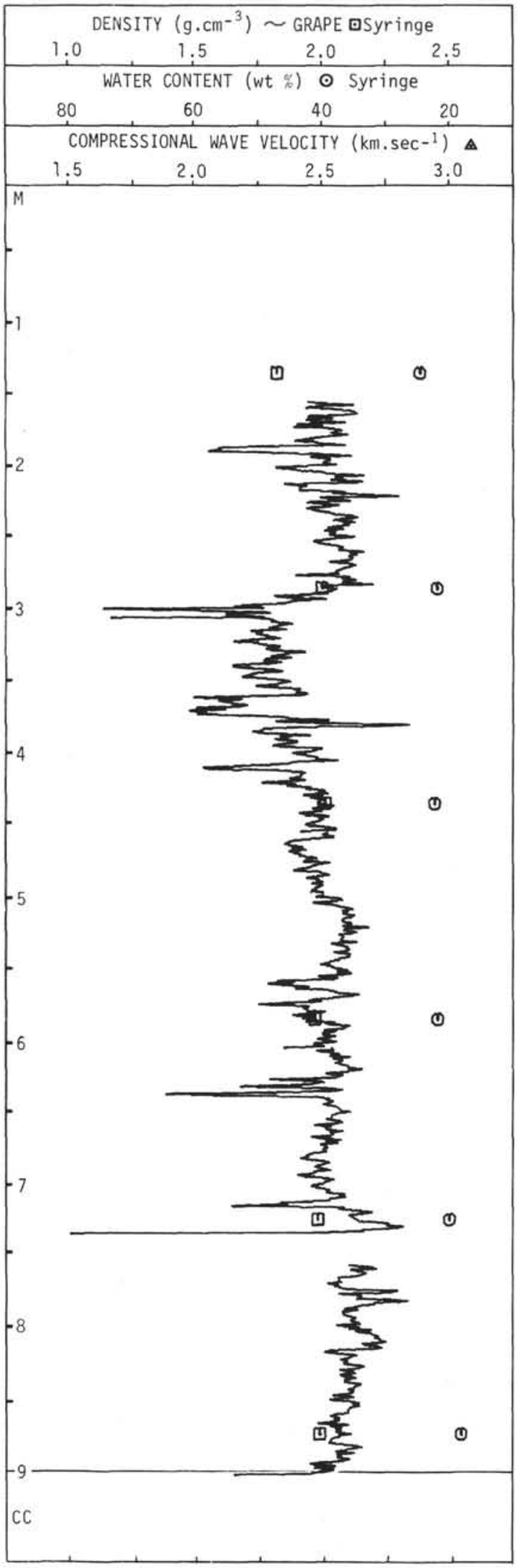




For Explanatory Notes, see Chapter 1

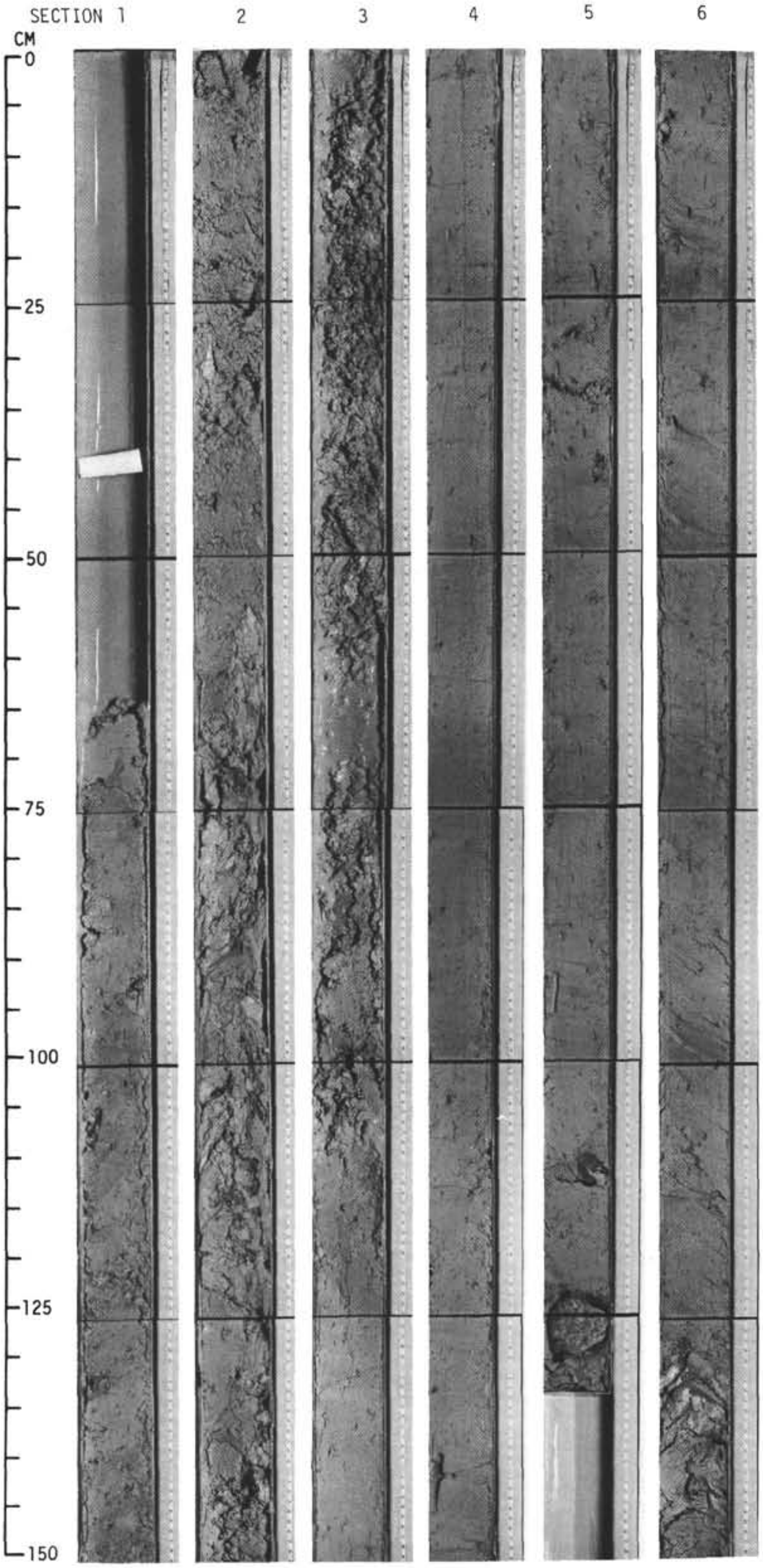
341-9

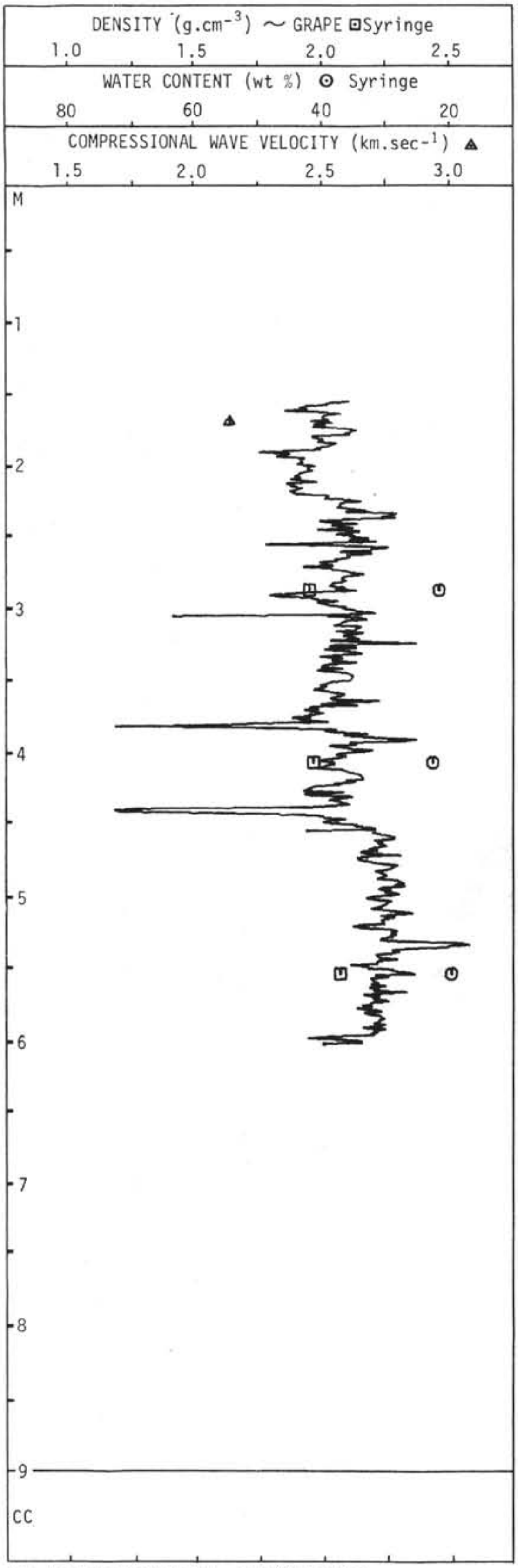




For Explanatory Notes, see Chapter 1

341-10





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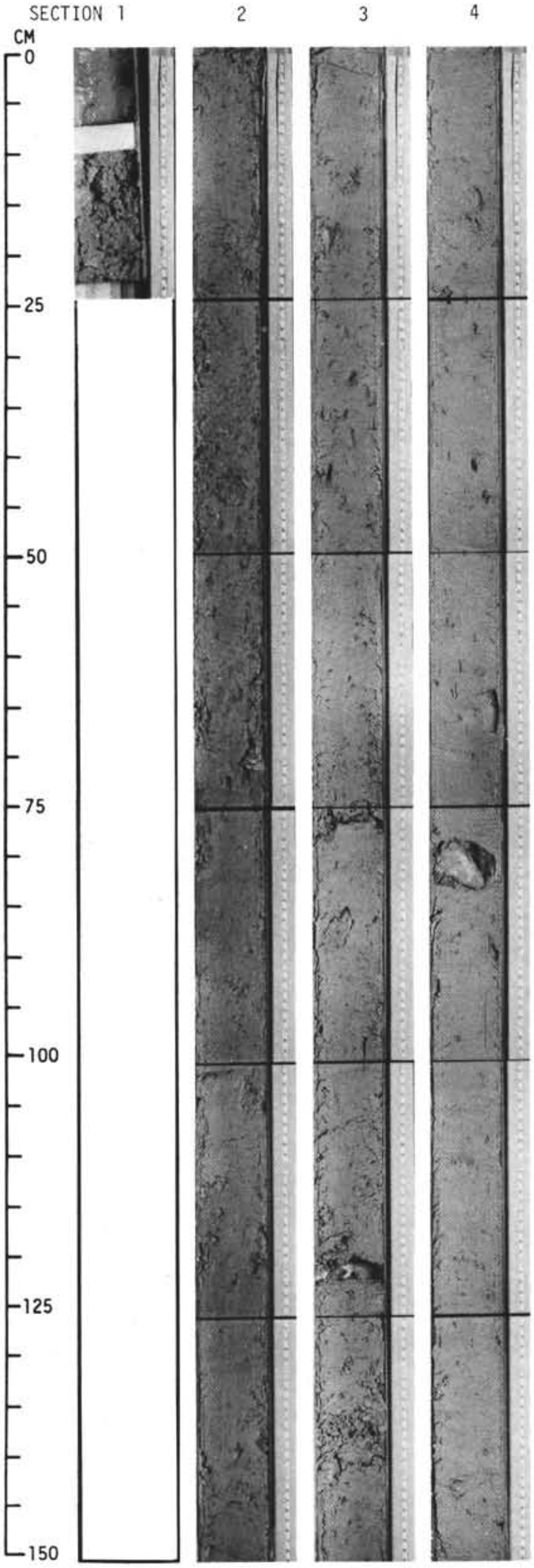
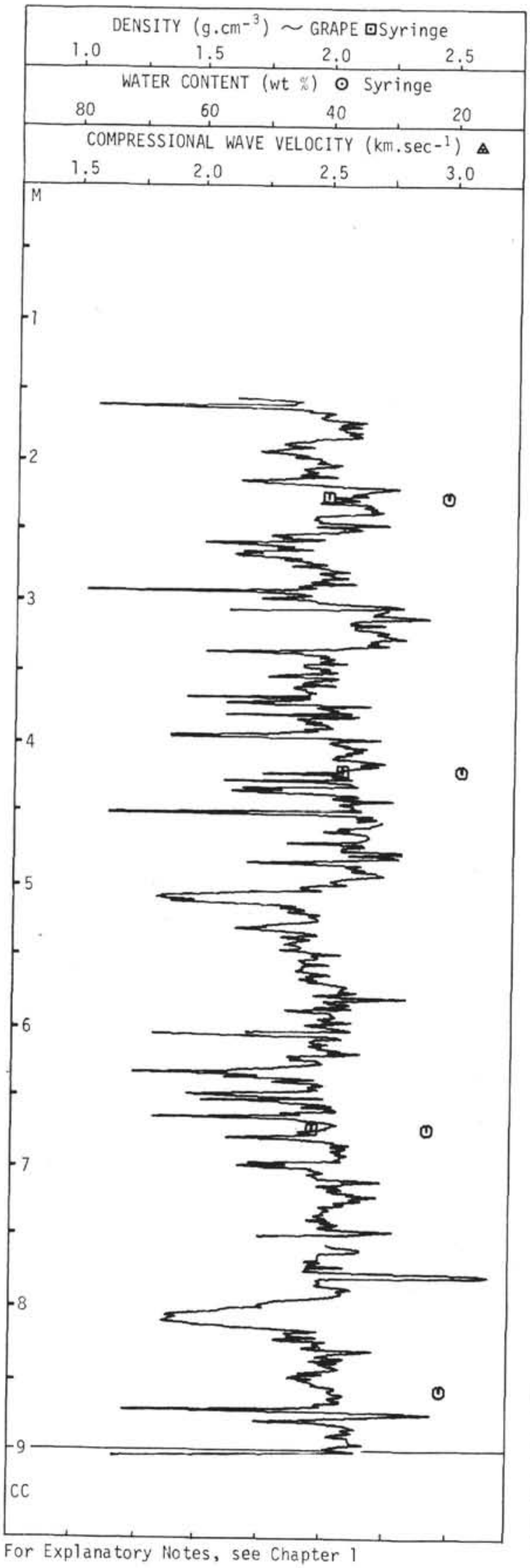
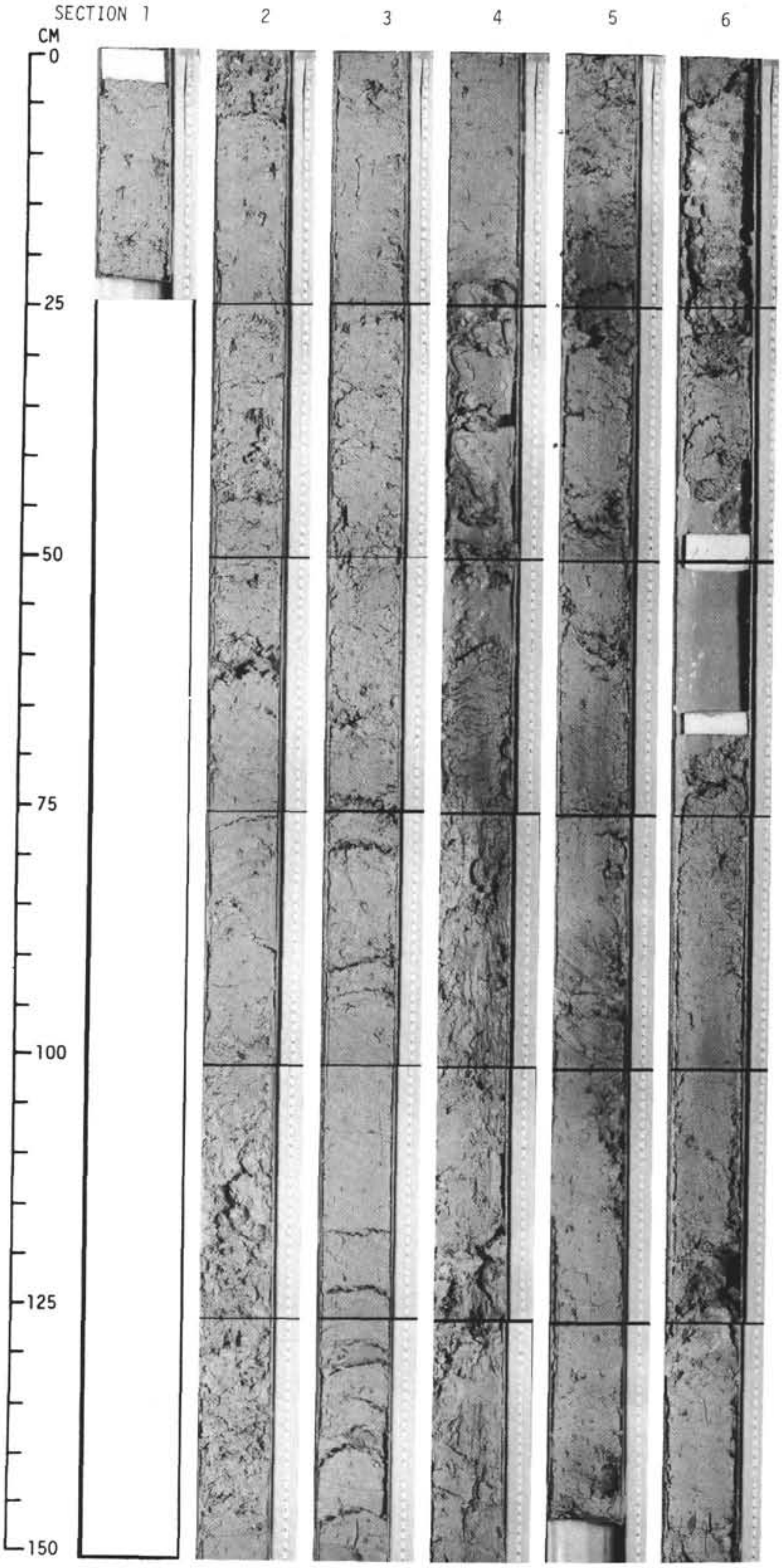
341-11

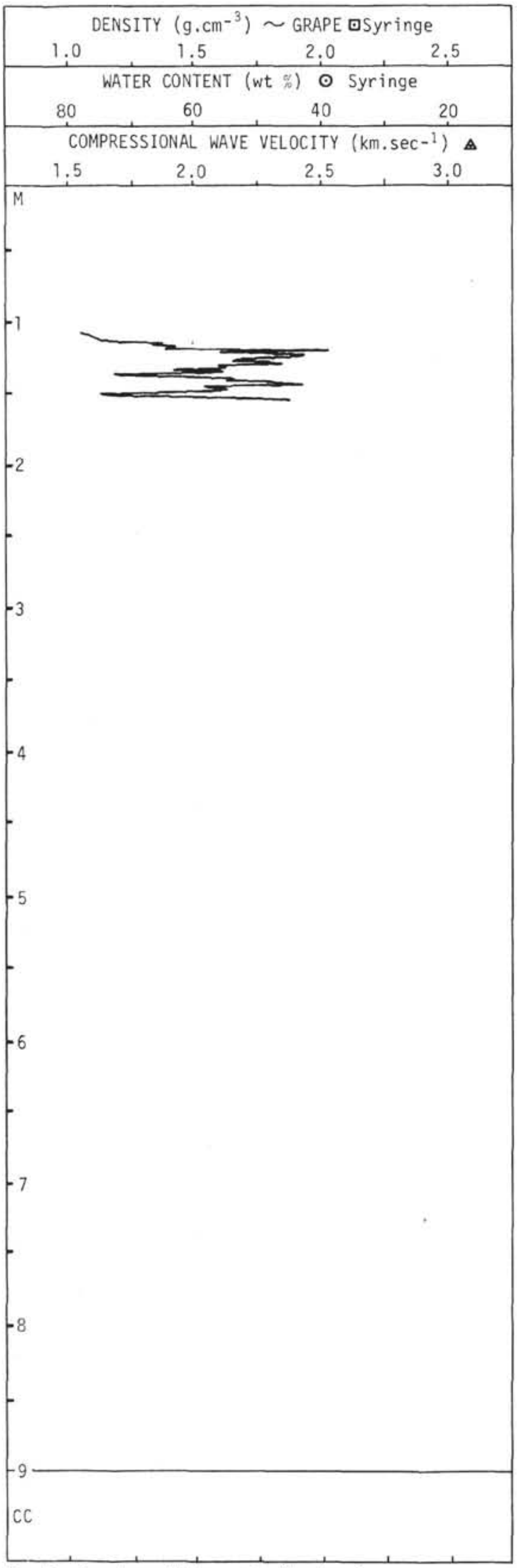




For Explanatory Notes, see Chapter 1

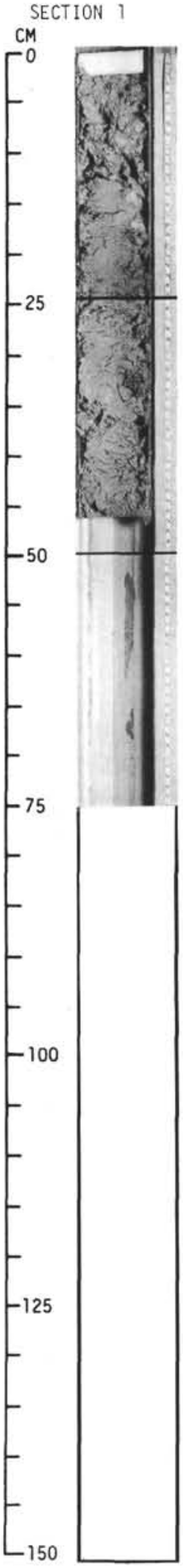
341-12



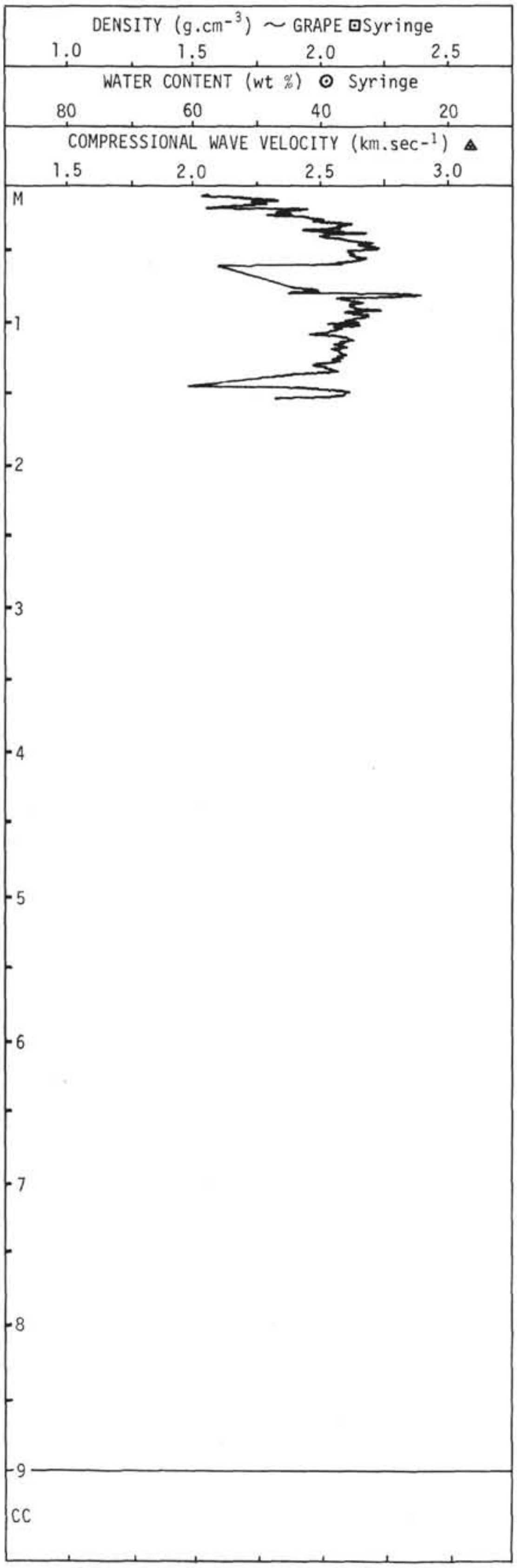


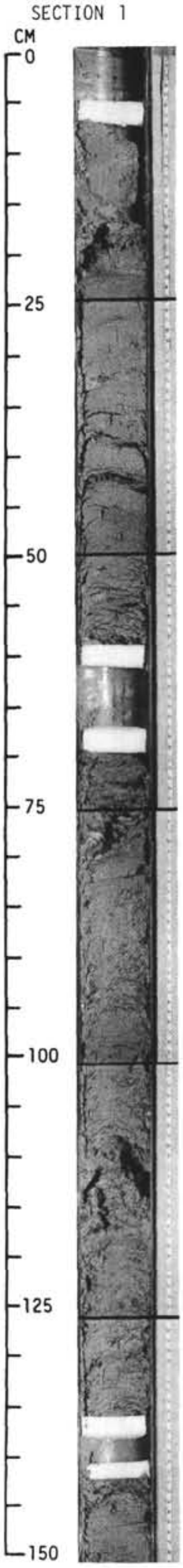
For Explanatory Notes, see Chapter 1

341-13



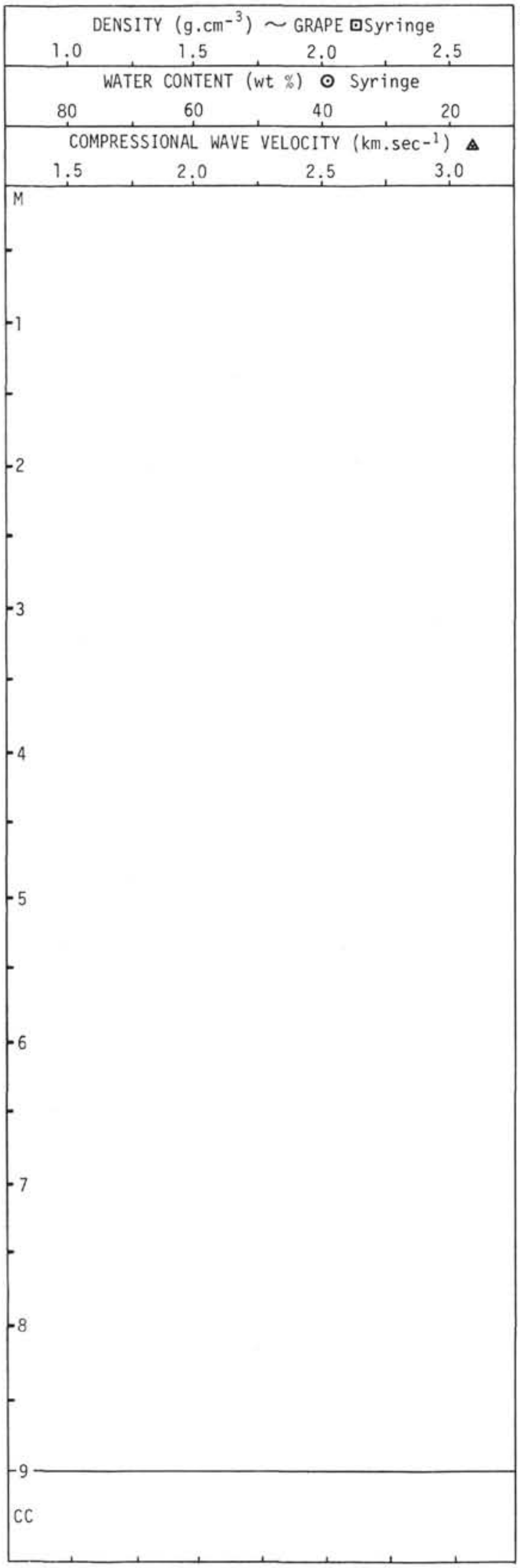
341-16



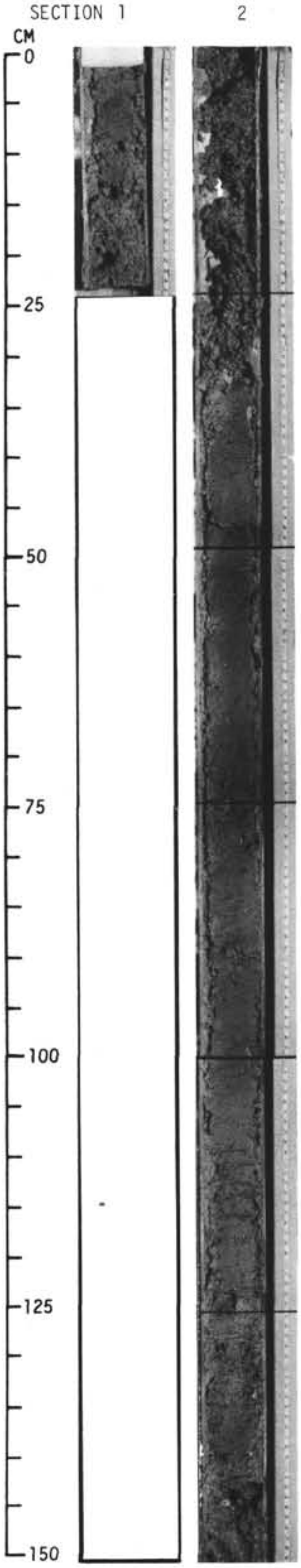


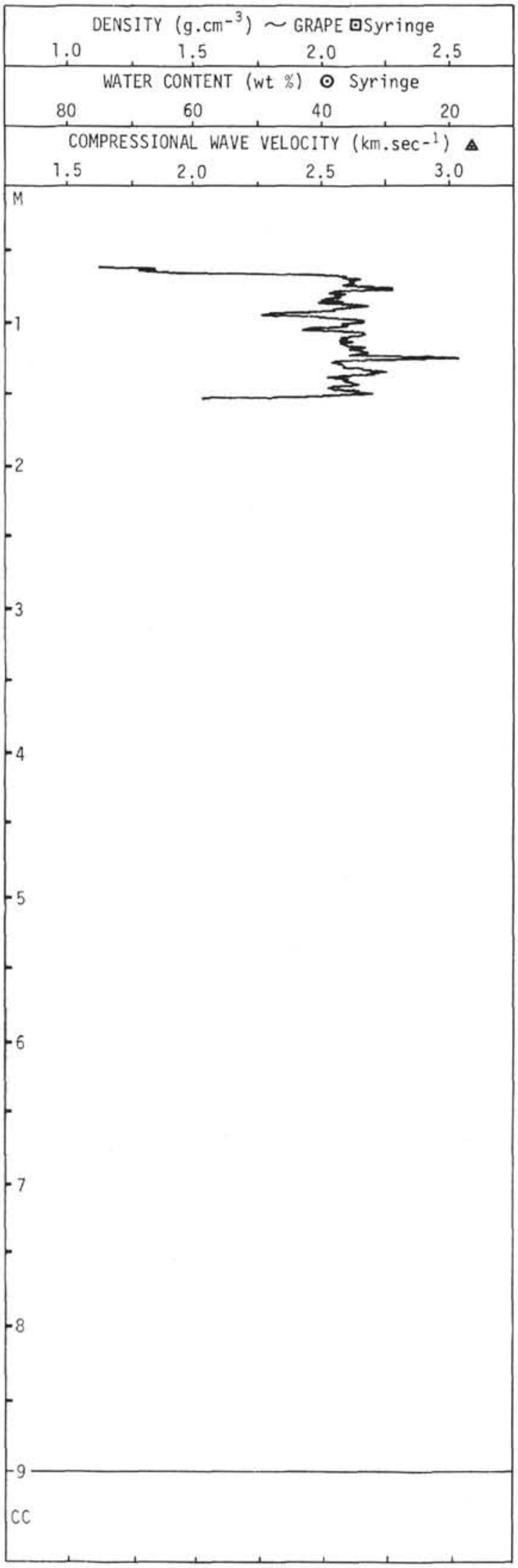
For Explanatory Notes, see Chapter 1

341-17



For Explanatory Notes, see Chapter 1





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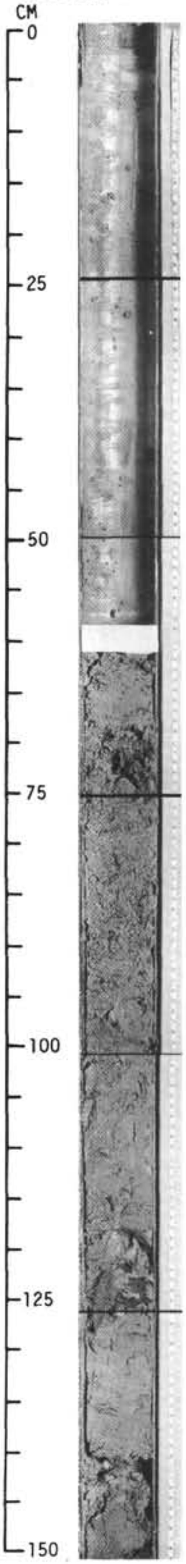
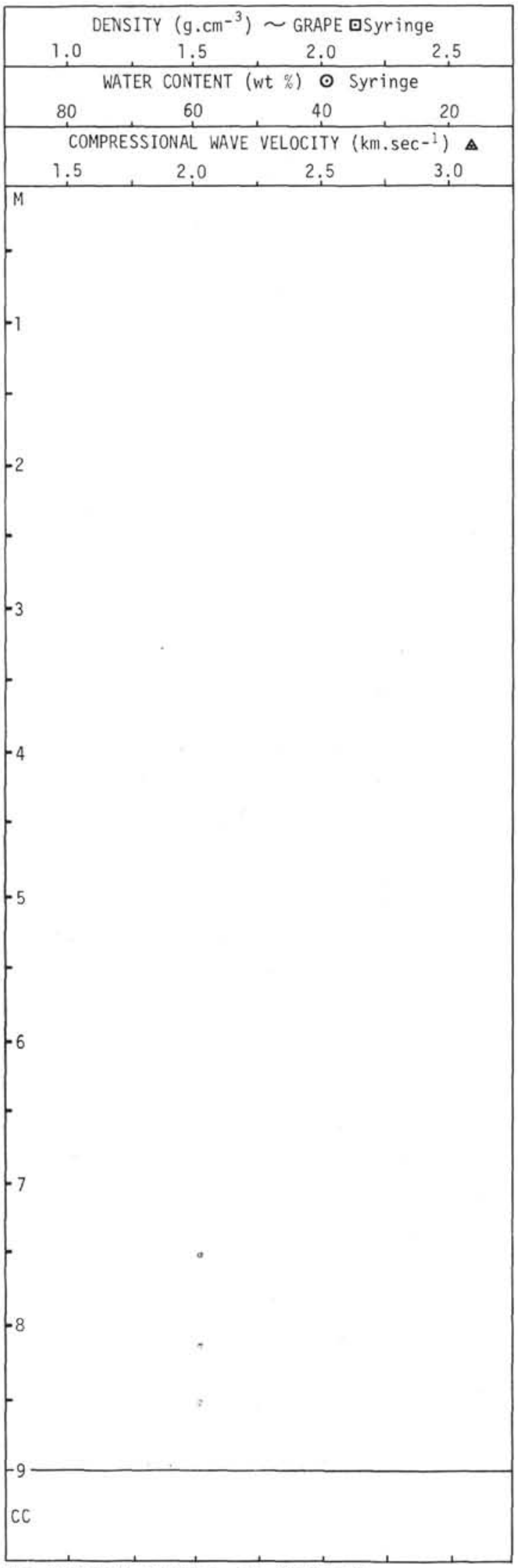
341-18

SECTION 1





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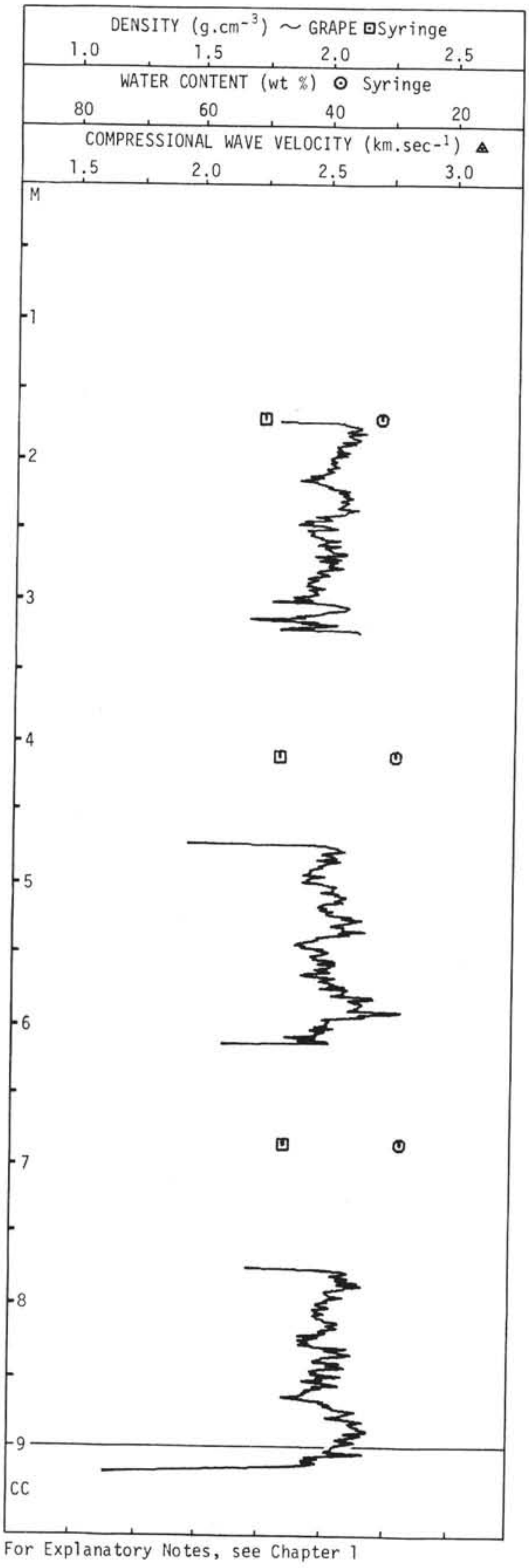
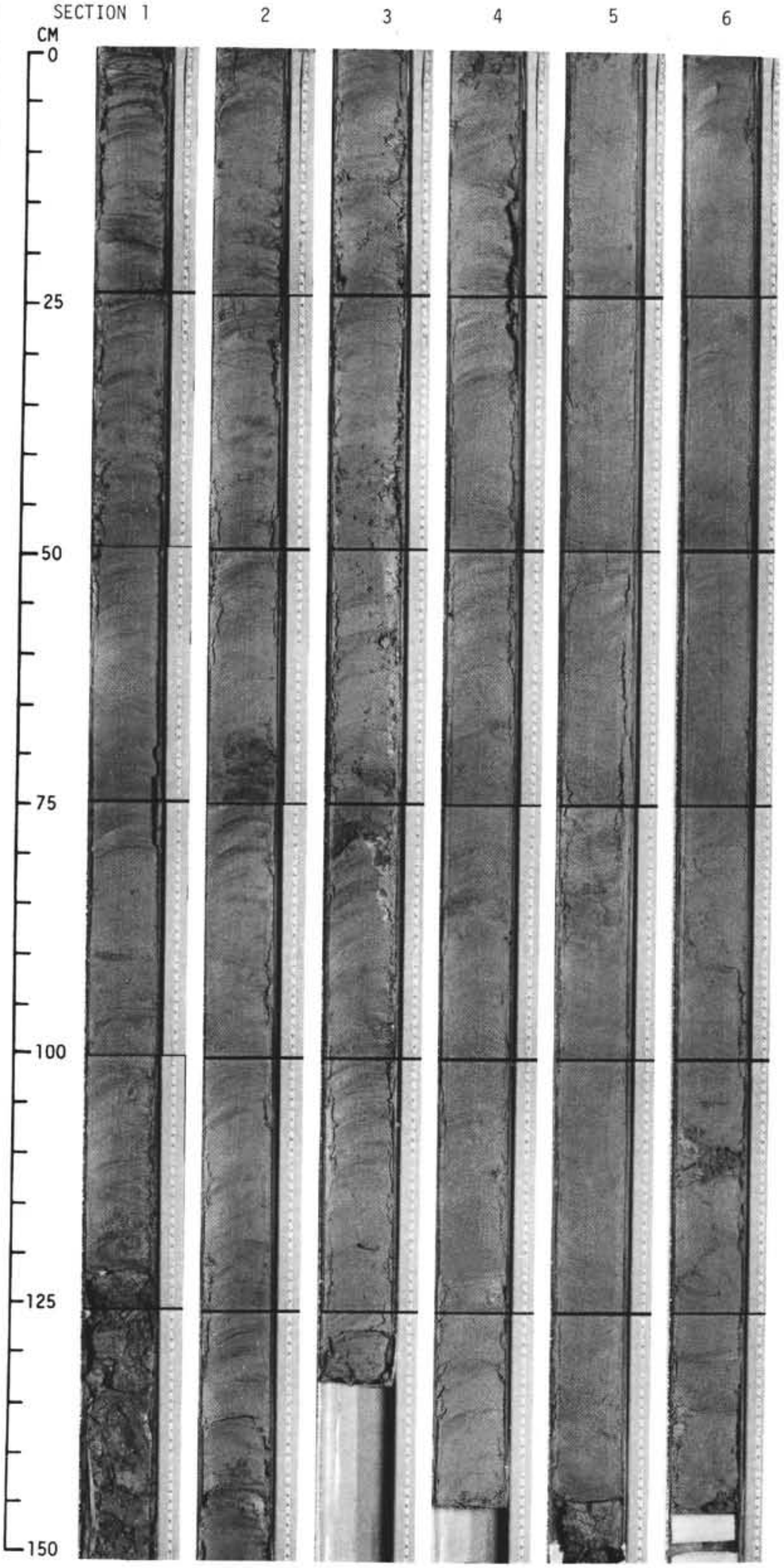
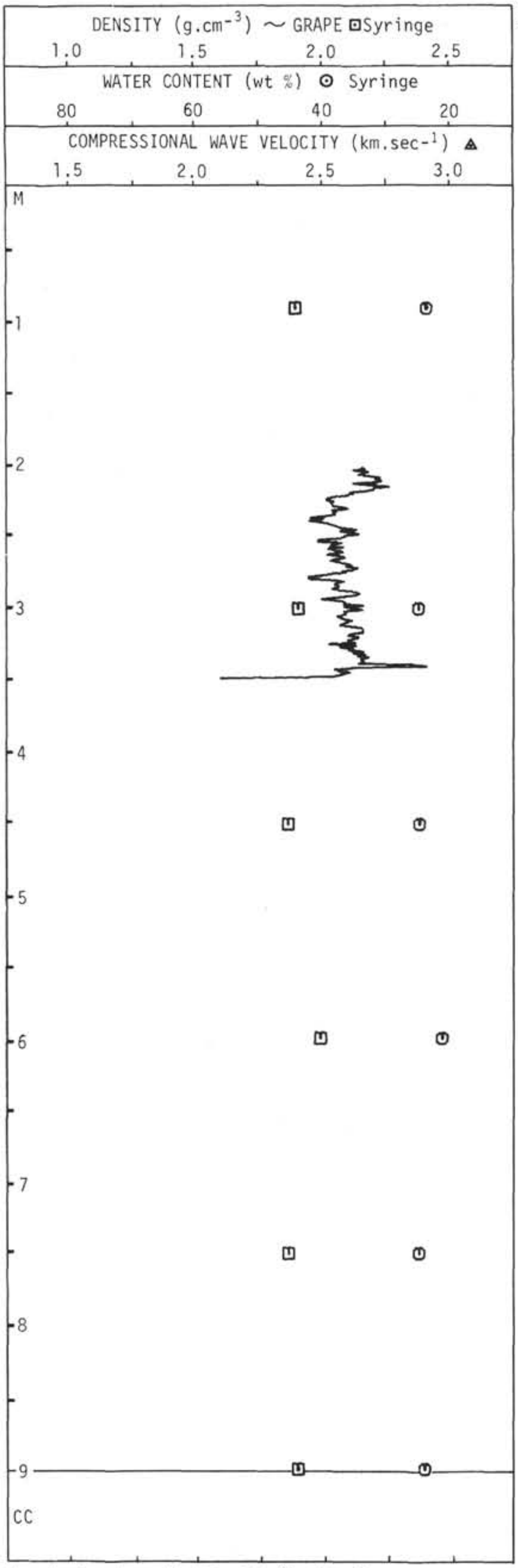
341-19



For Explanatory Notes, see Chapter 1

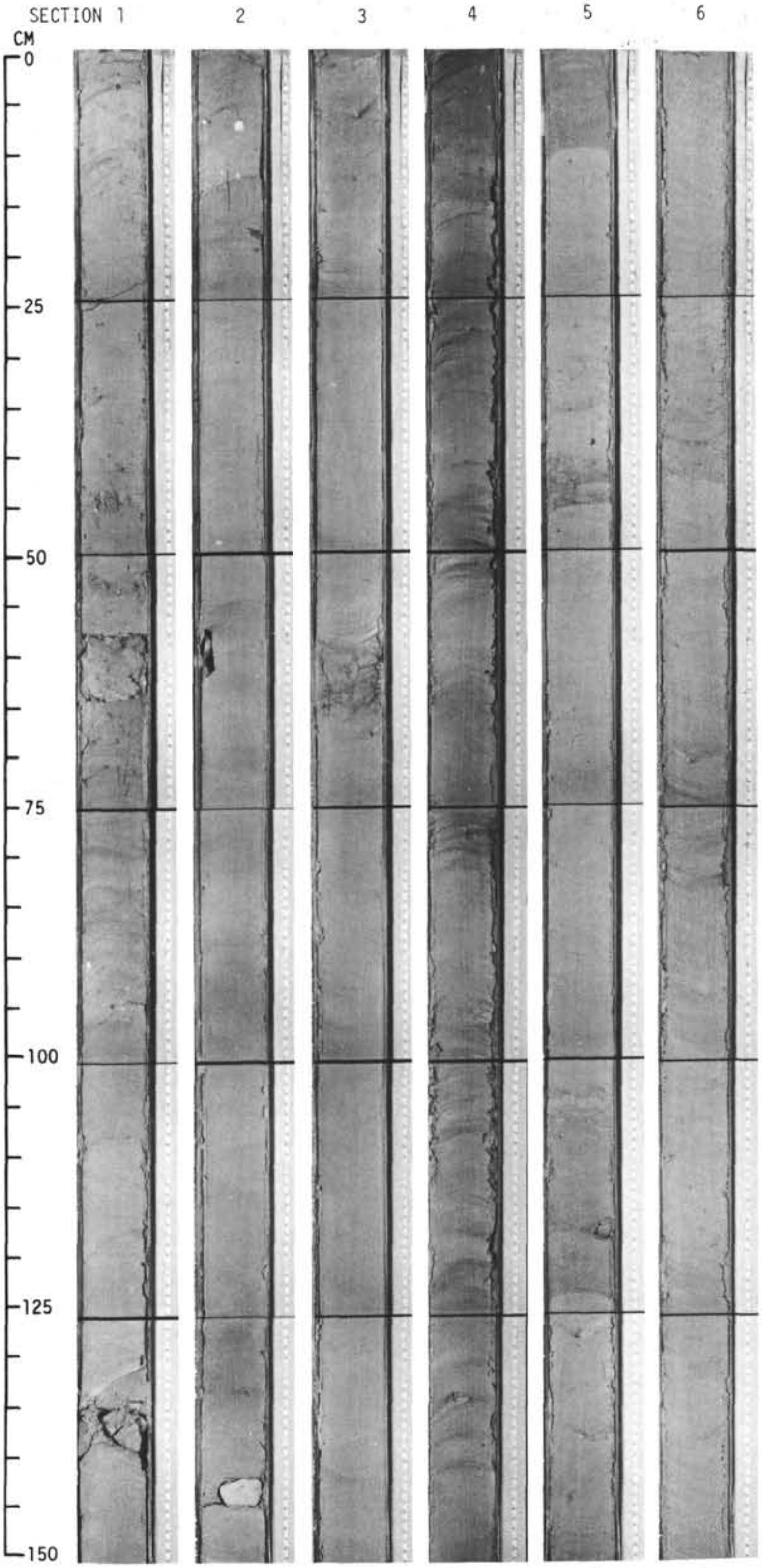
341-20

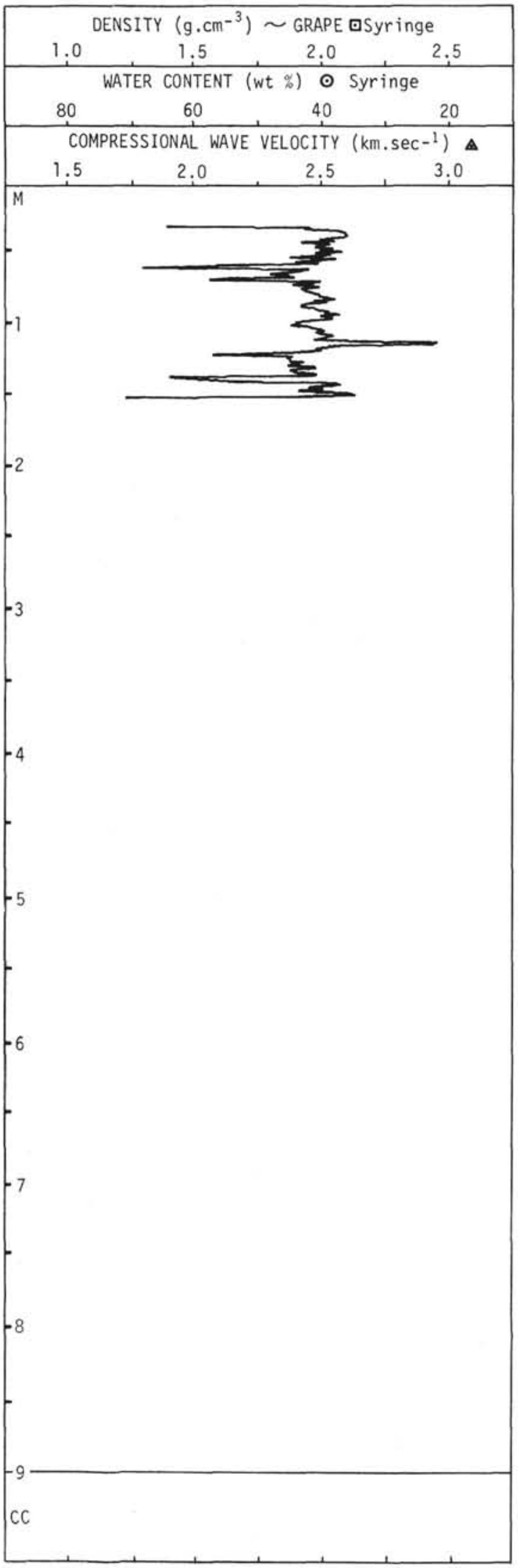




For Explanatory Notes, see Chapter 1

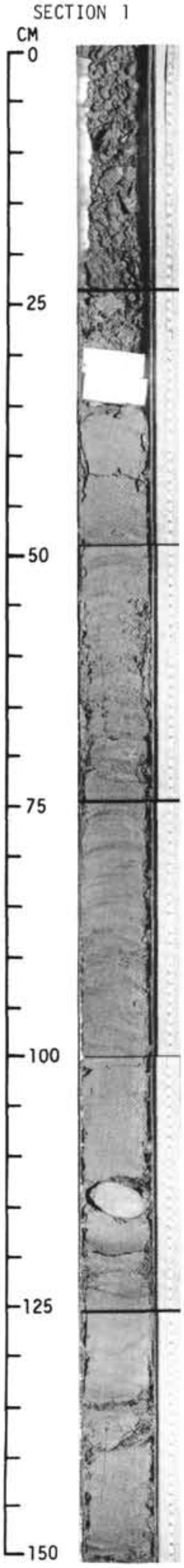
341-21



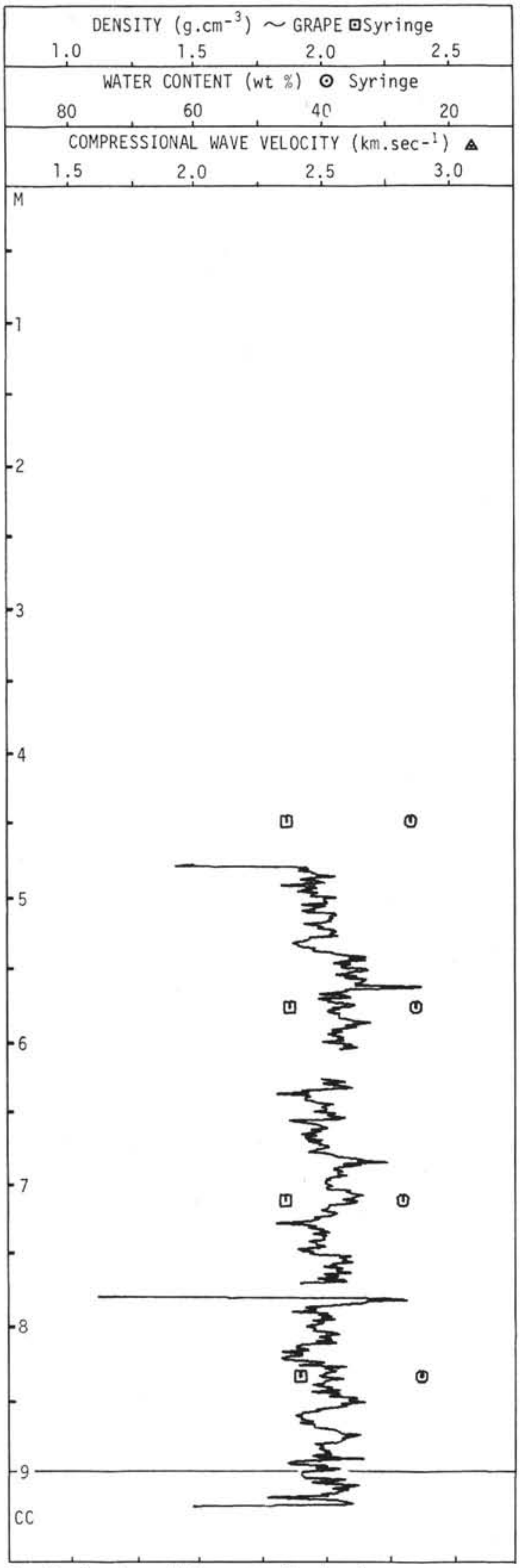


For Explanatory Notes, see Chapter 1

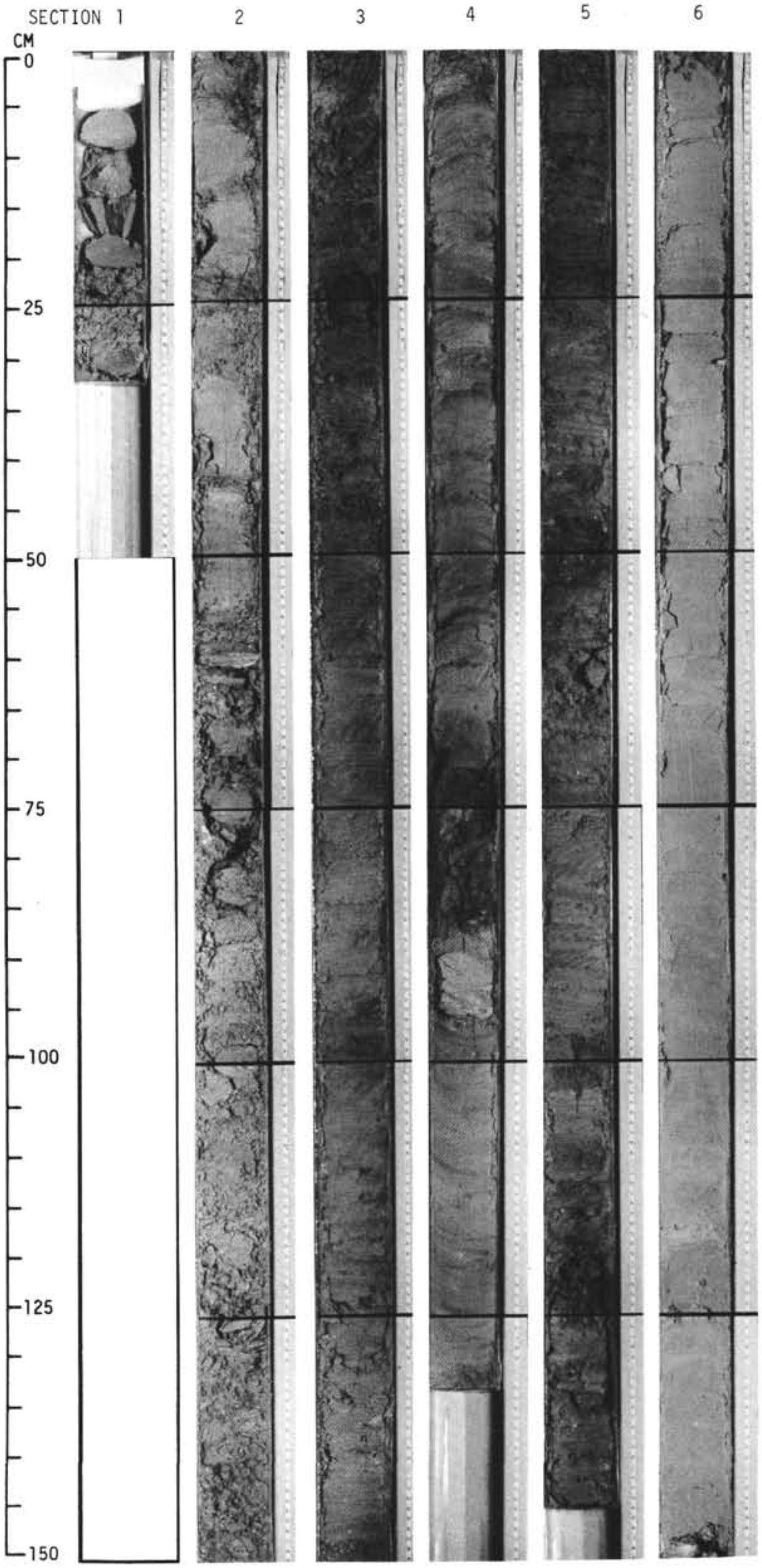
341-22

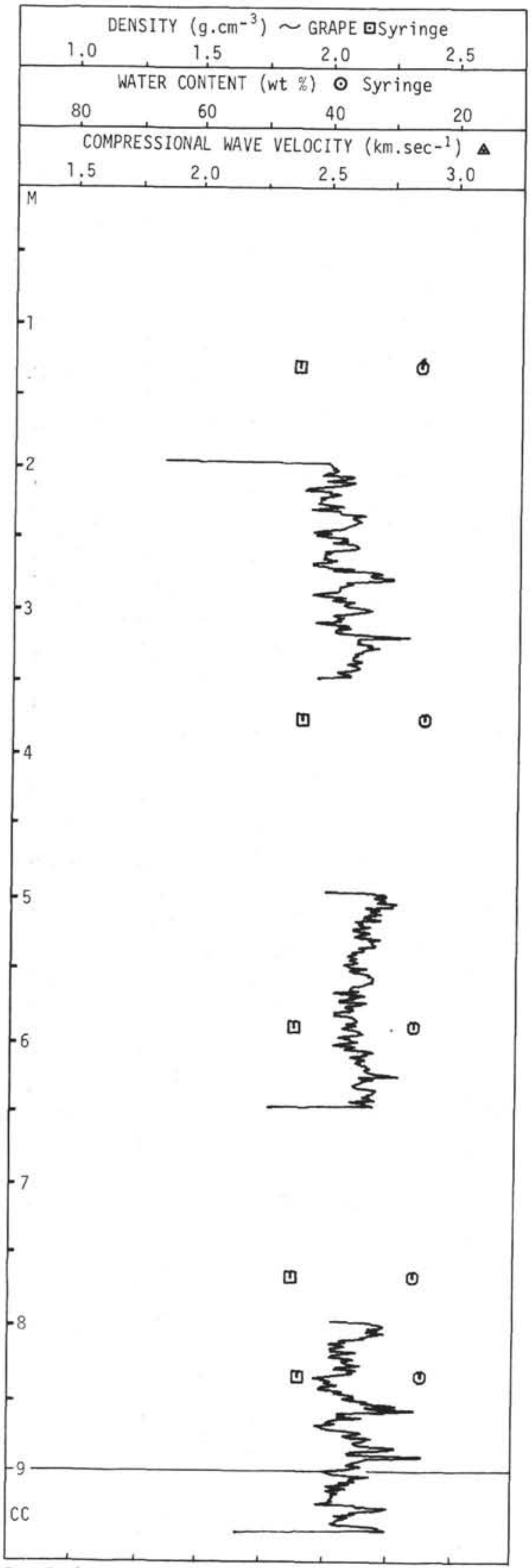


341-23



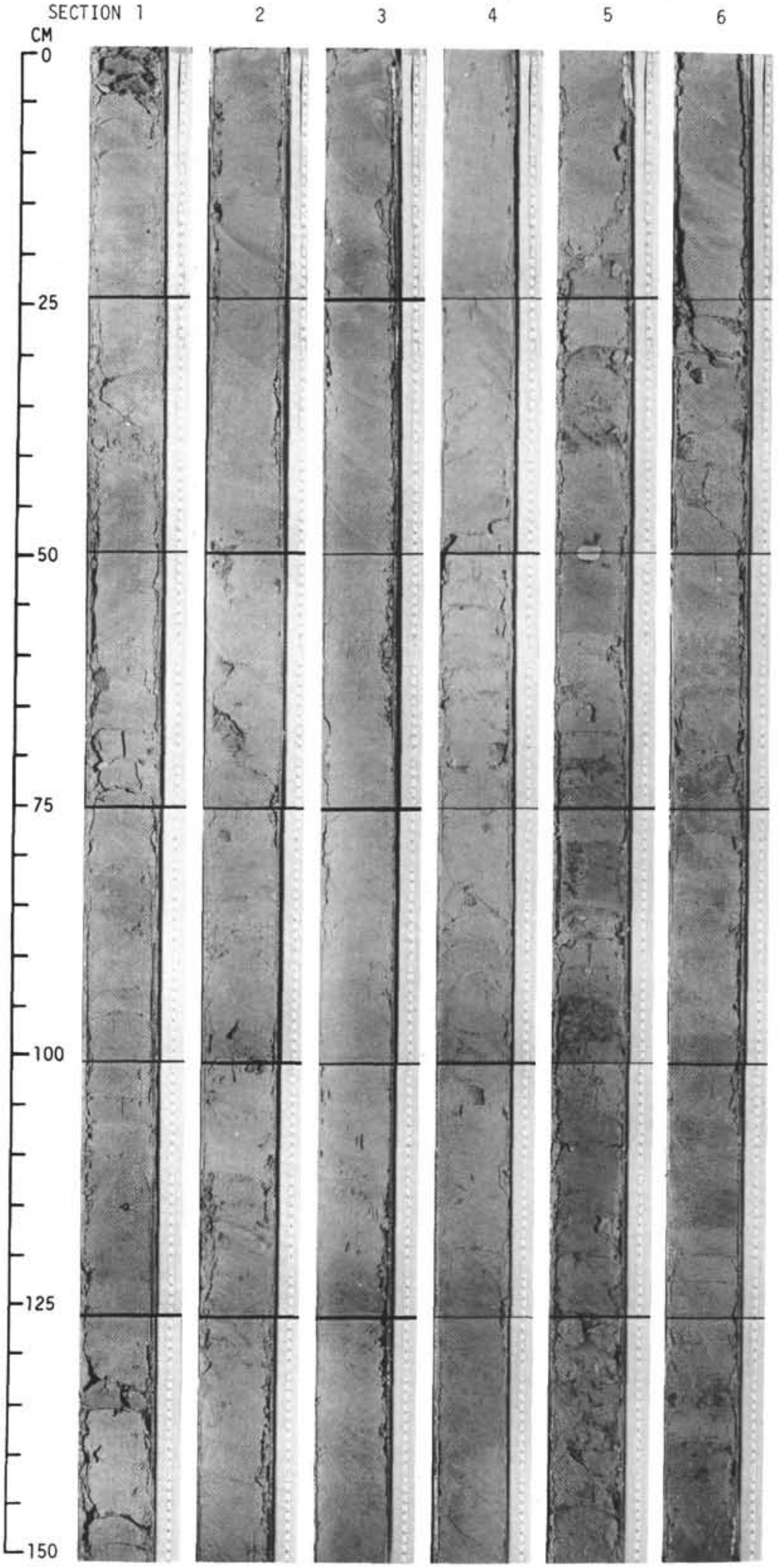
For Explanatory Notes, see Chapter 1

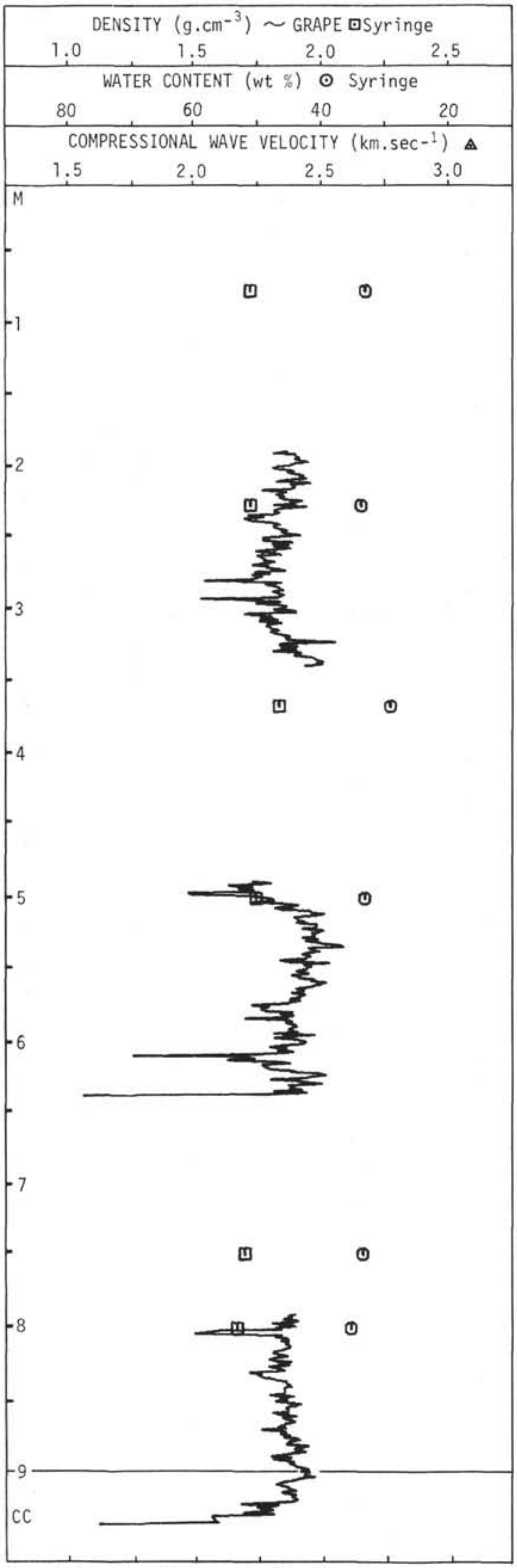




For Explanatory Notes, see Chapter 1

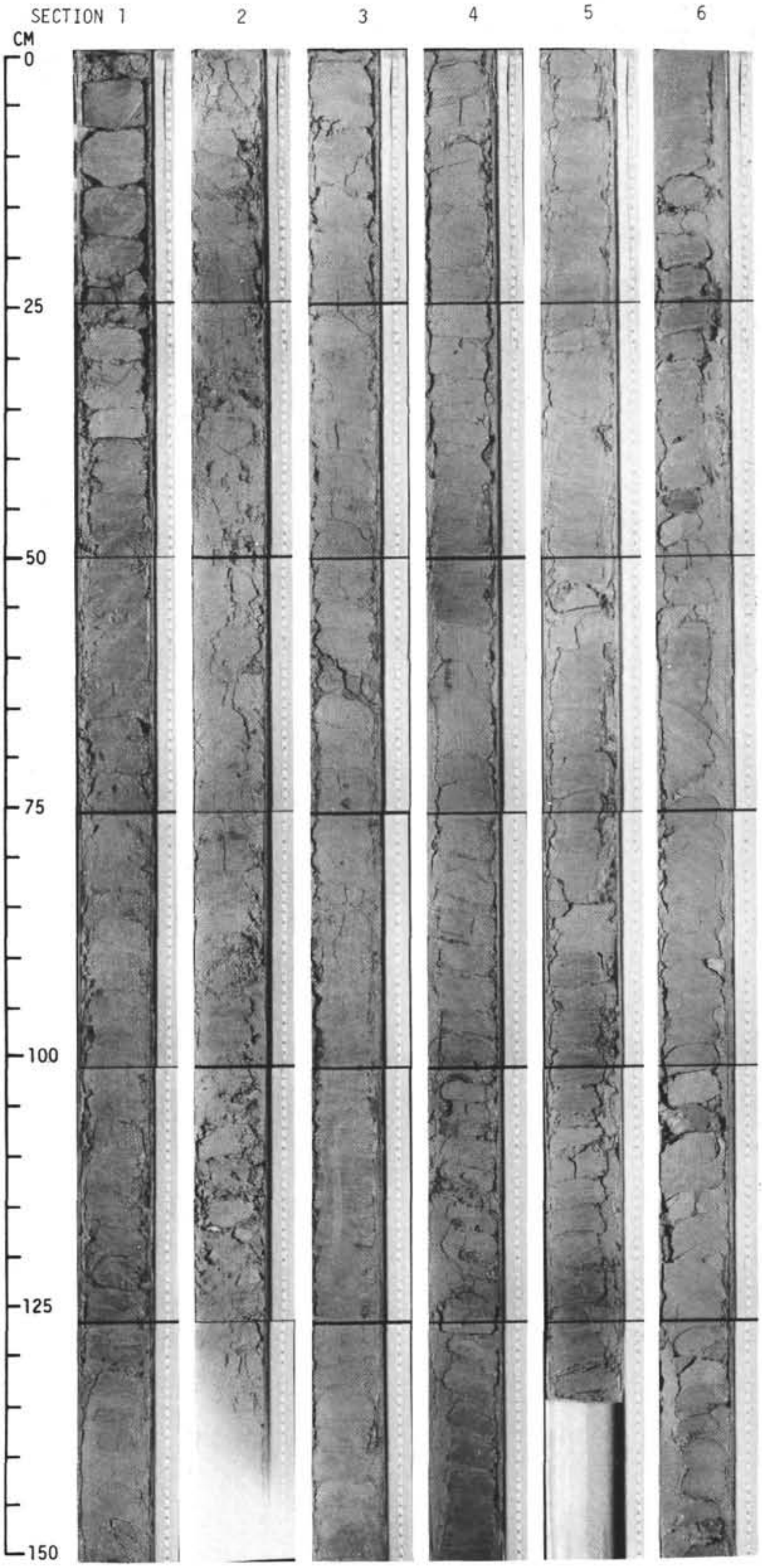
341-24

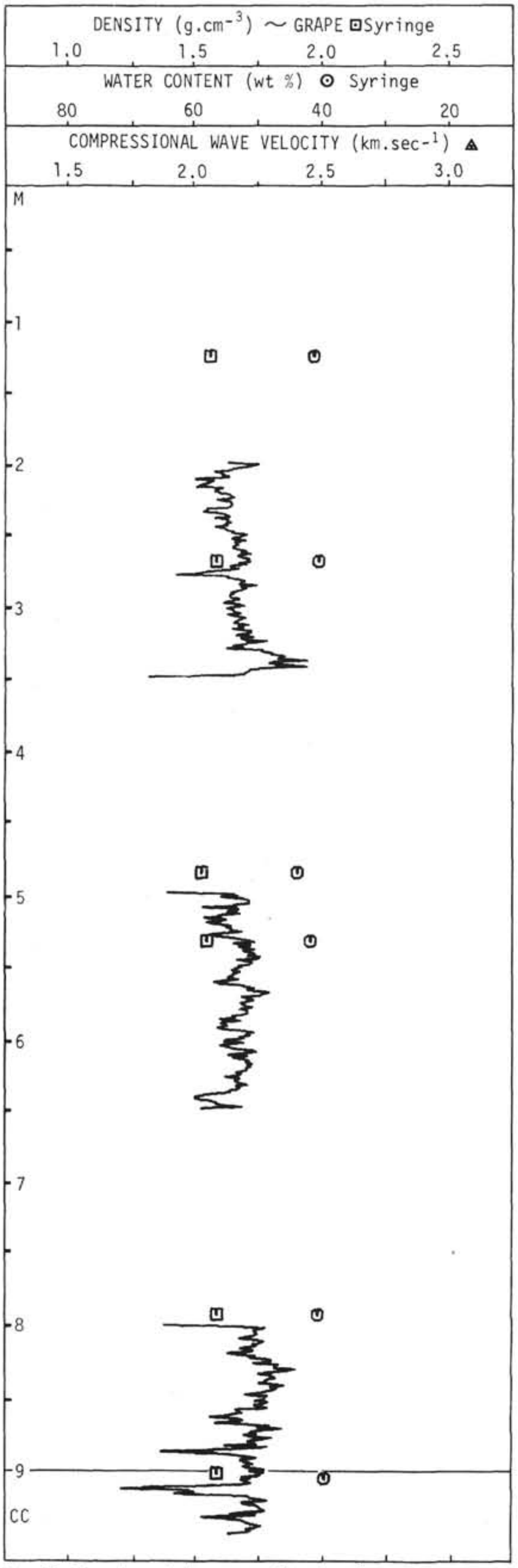




For Explanatory Notes, see Chapter 1

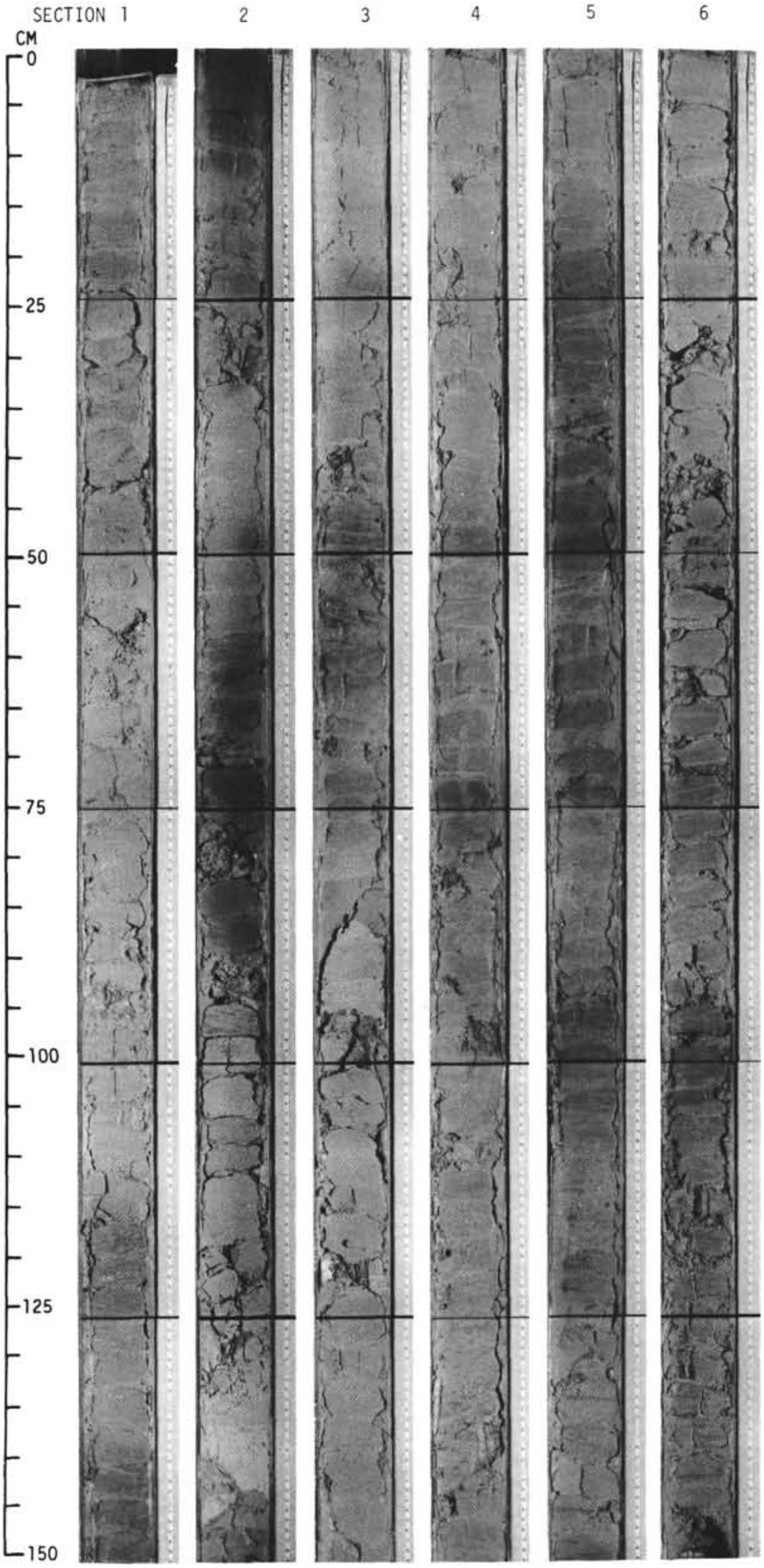
341-25





For Explanatory Notes, see Chapter 1

341-26



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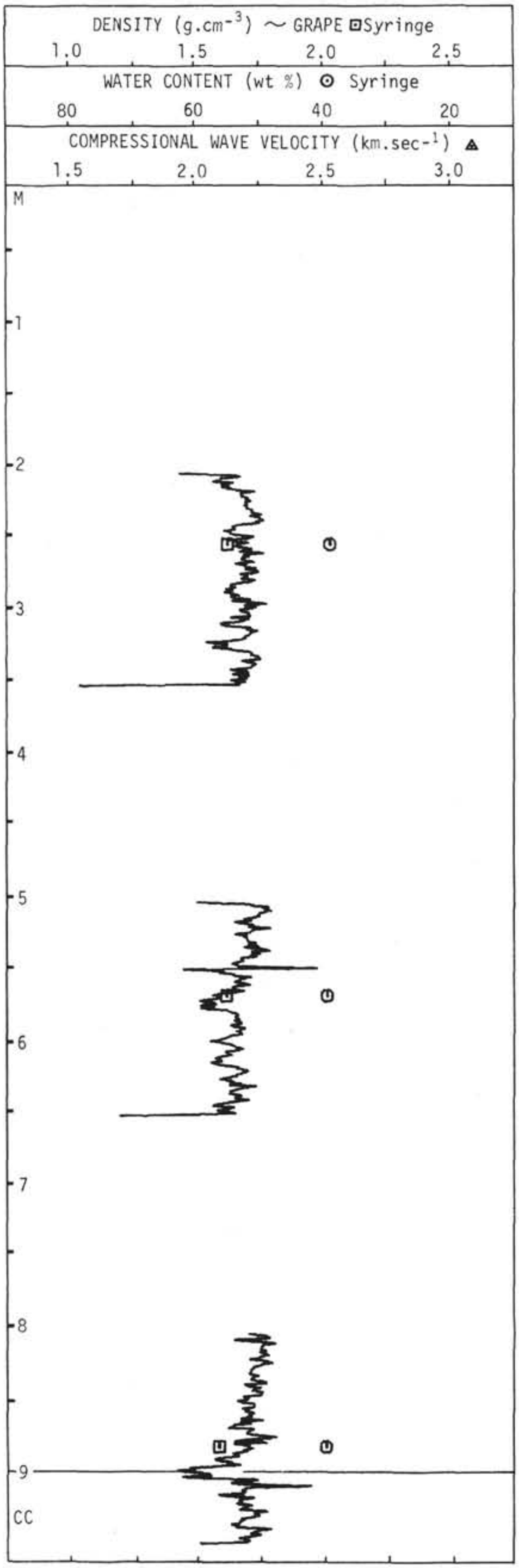
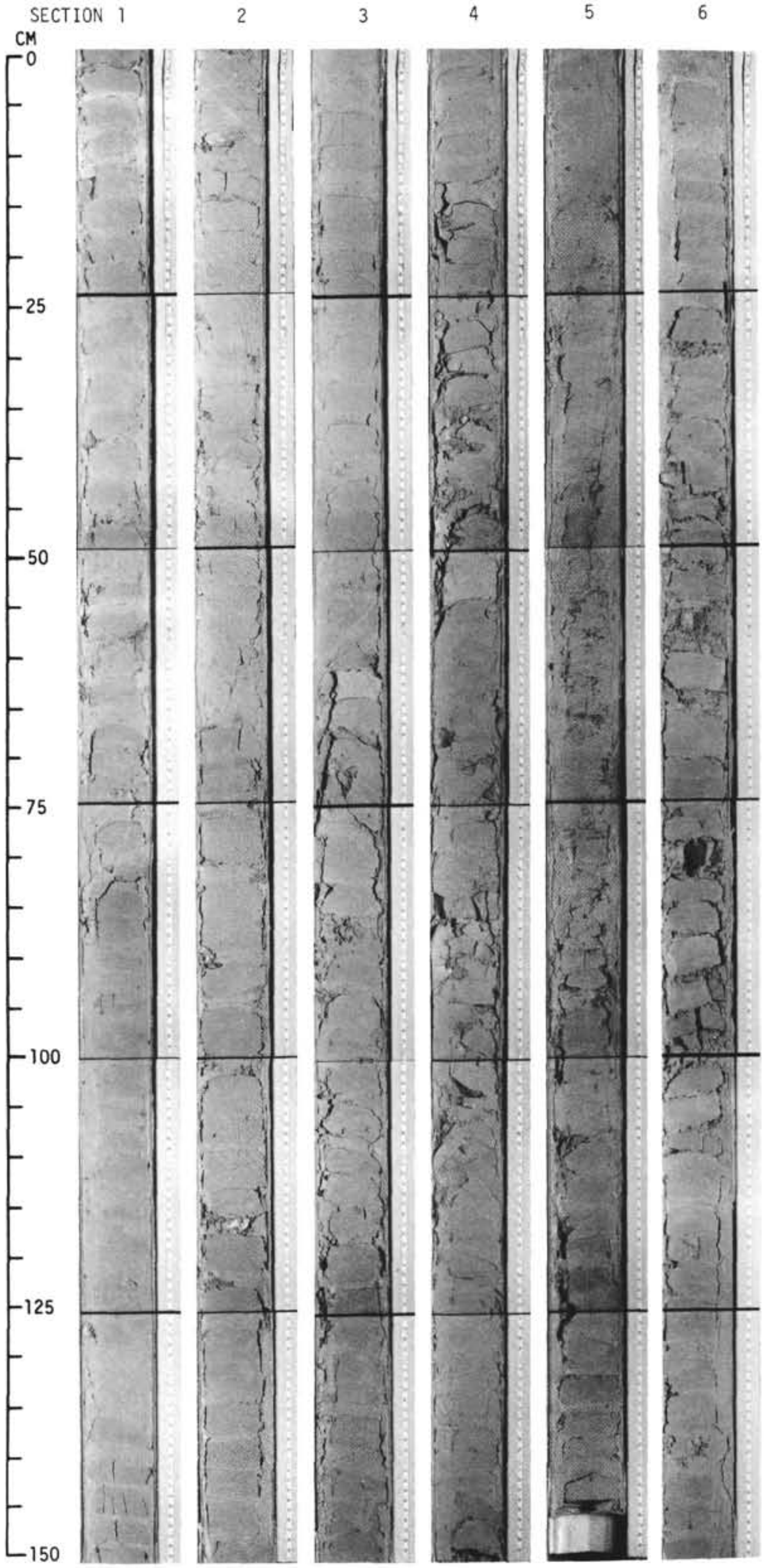
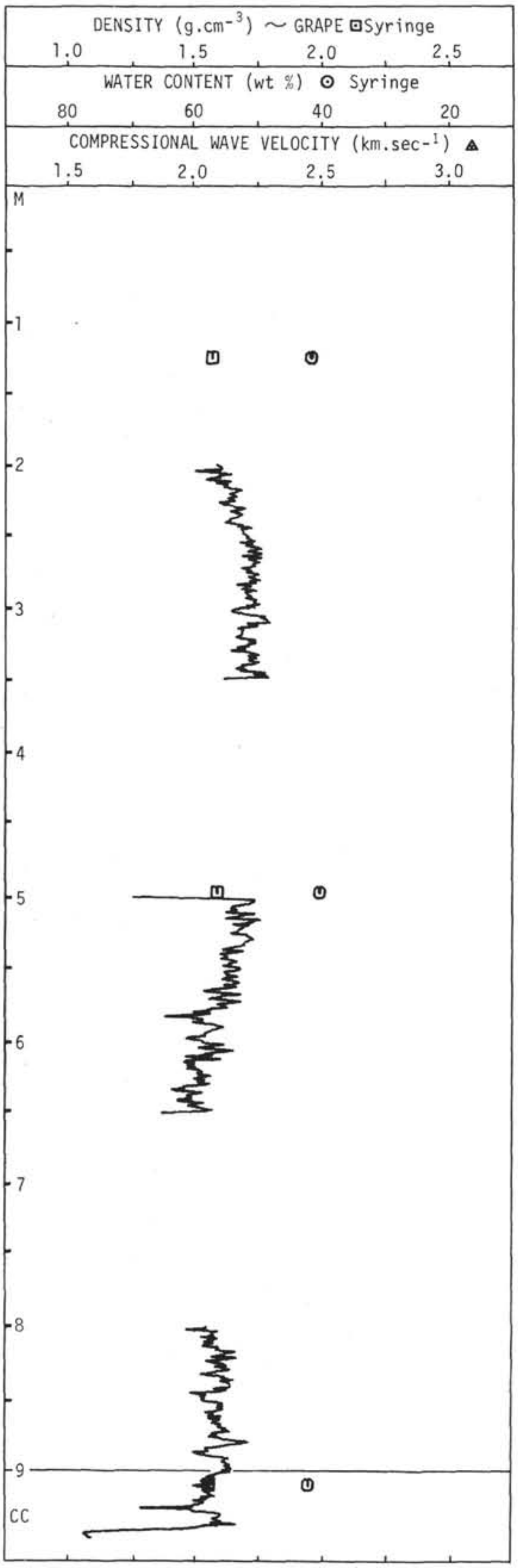


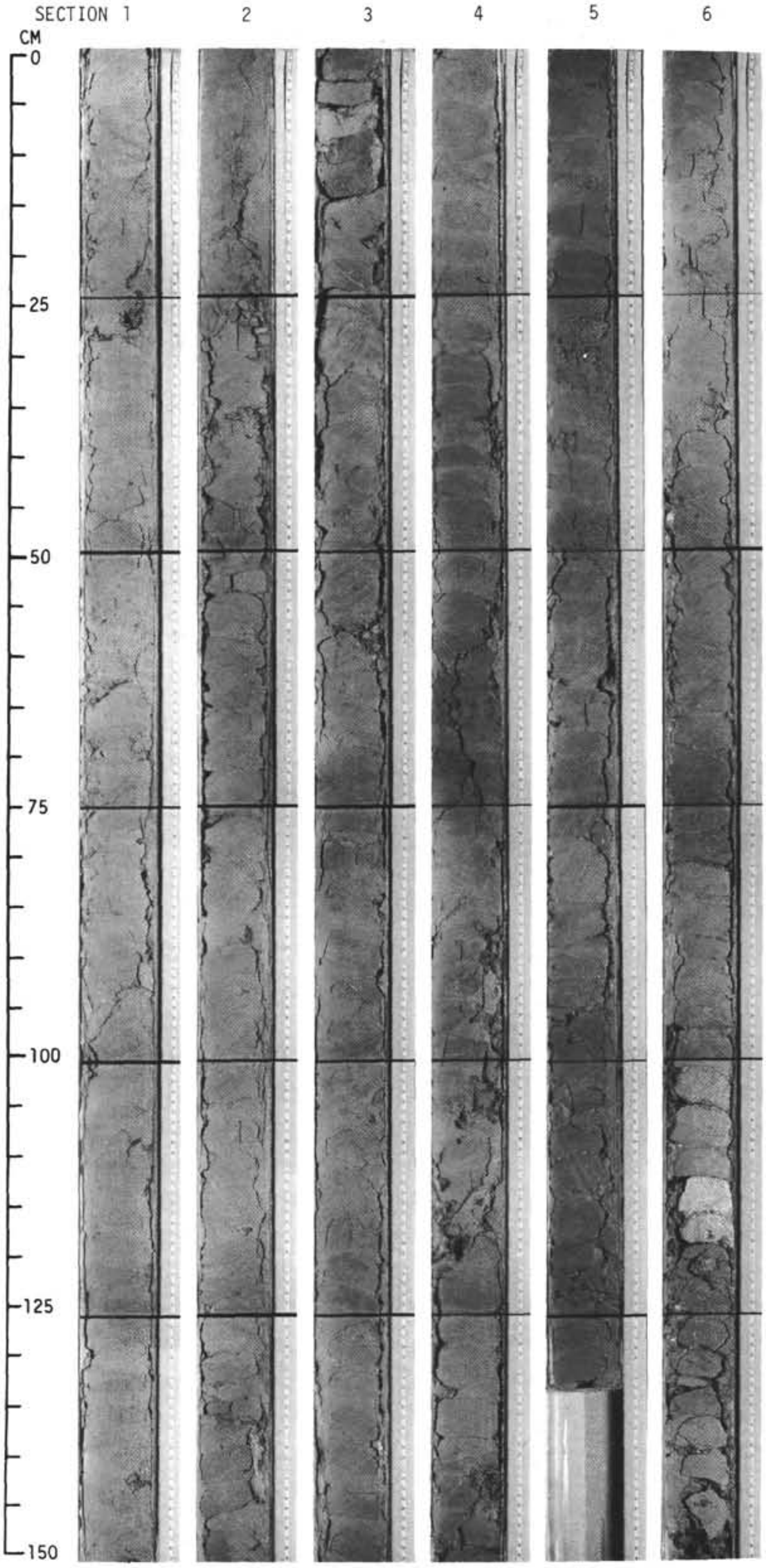
For Explanatory Notes, see Chapter 1

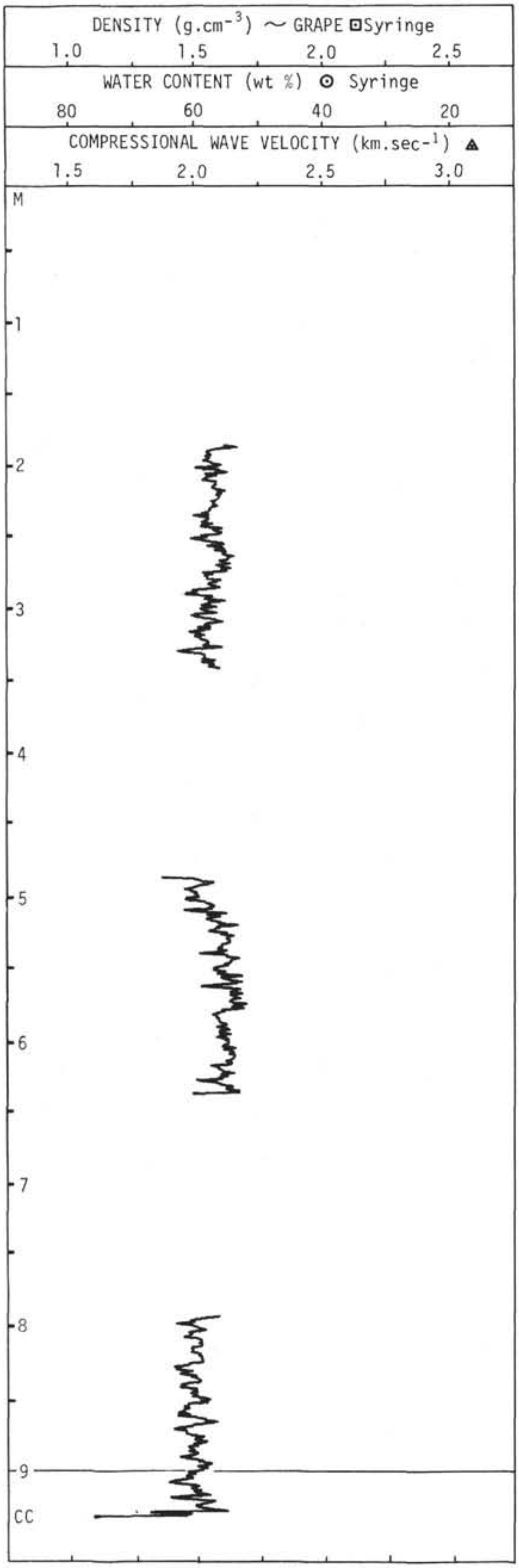




For Explanatory Notes, see Chapter 1

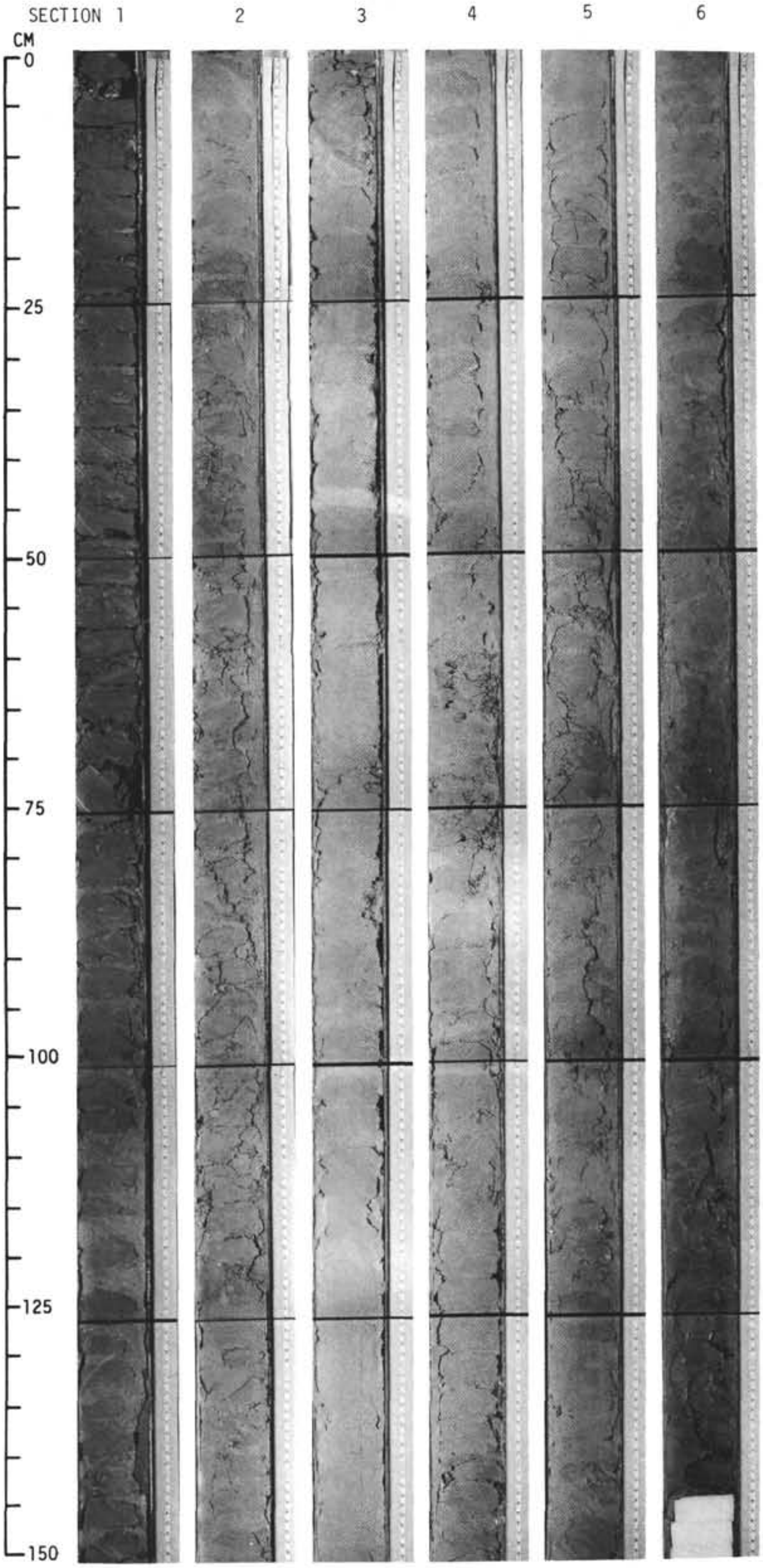
341-28

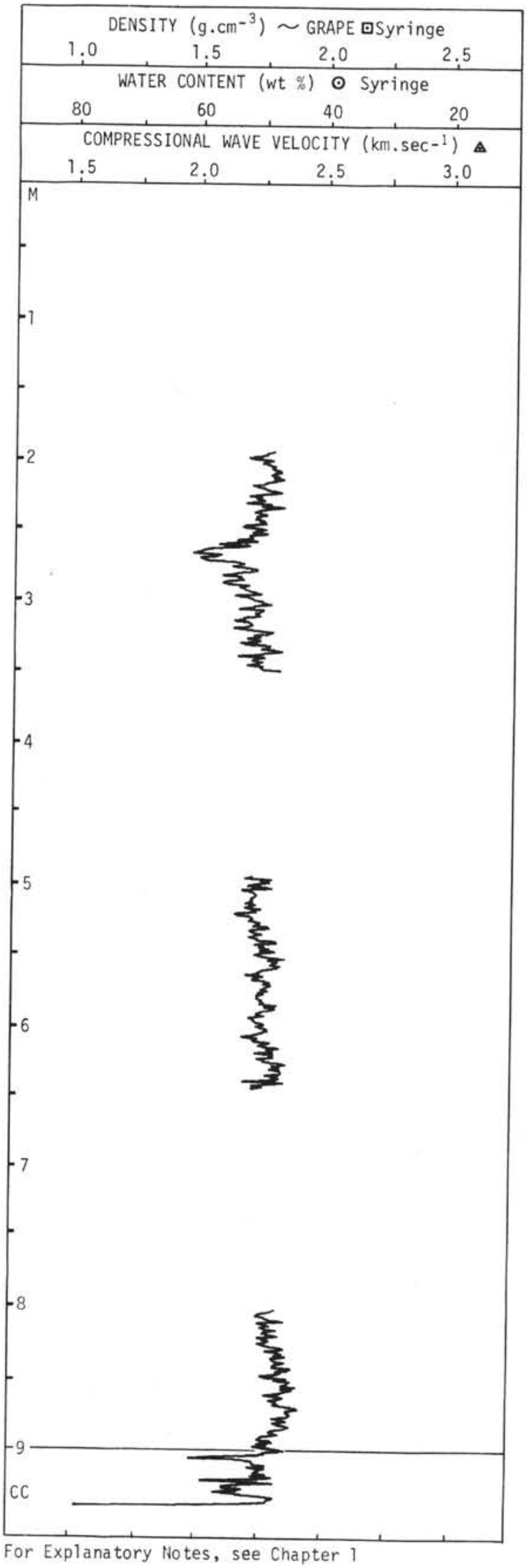




For Explanatory Notes, see Chapter 1

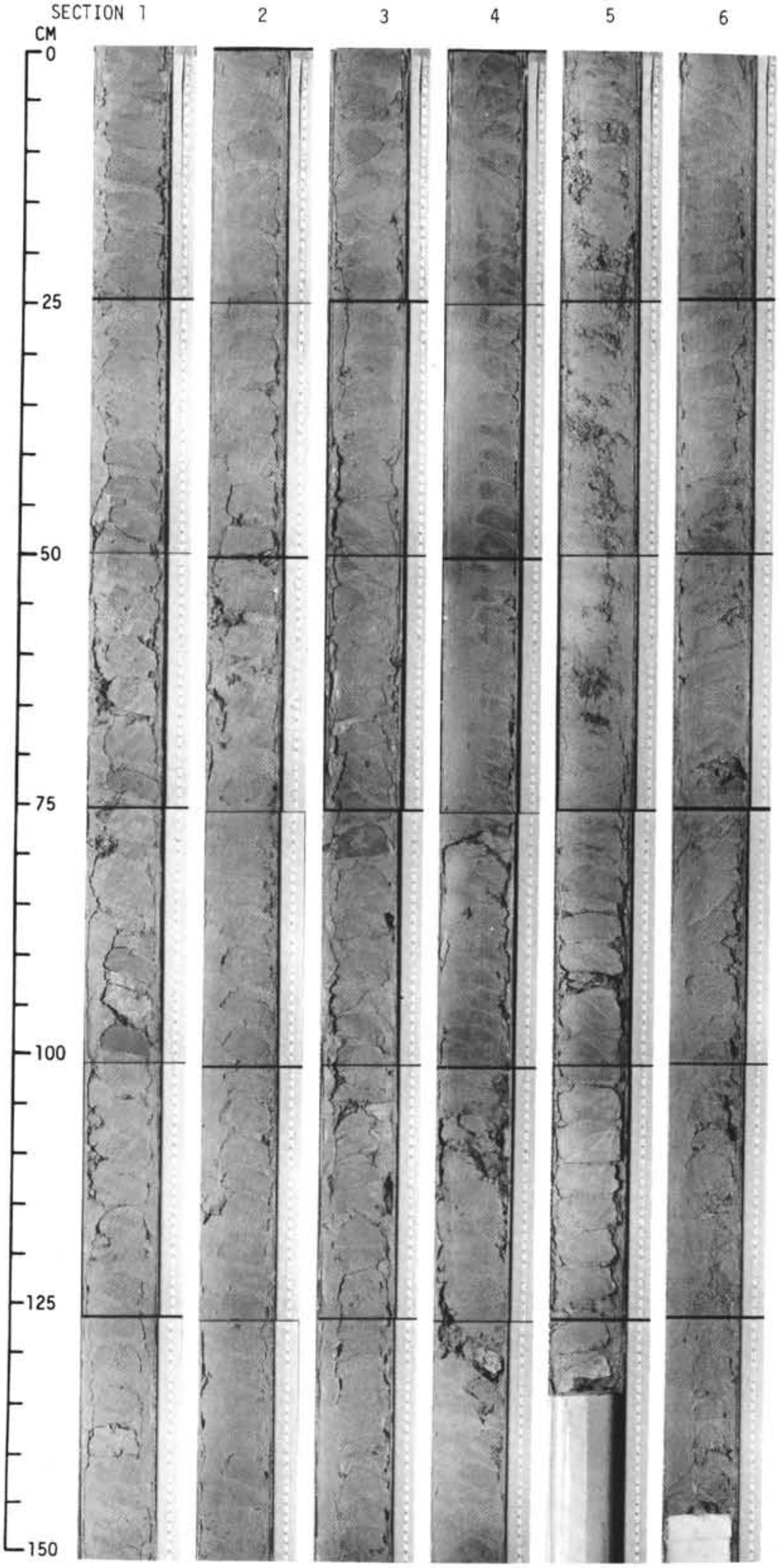
341-29

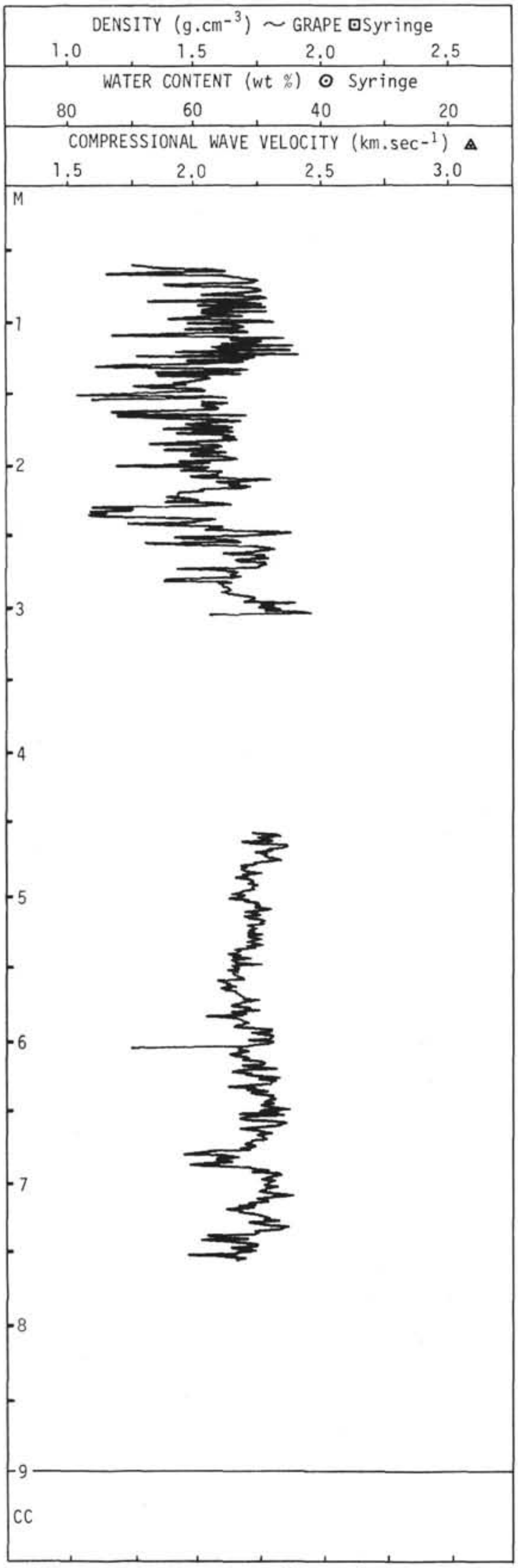




For Explanatory Notes, see Chapter 1

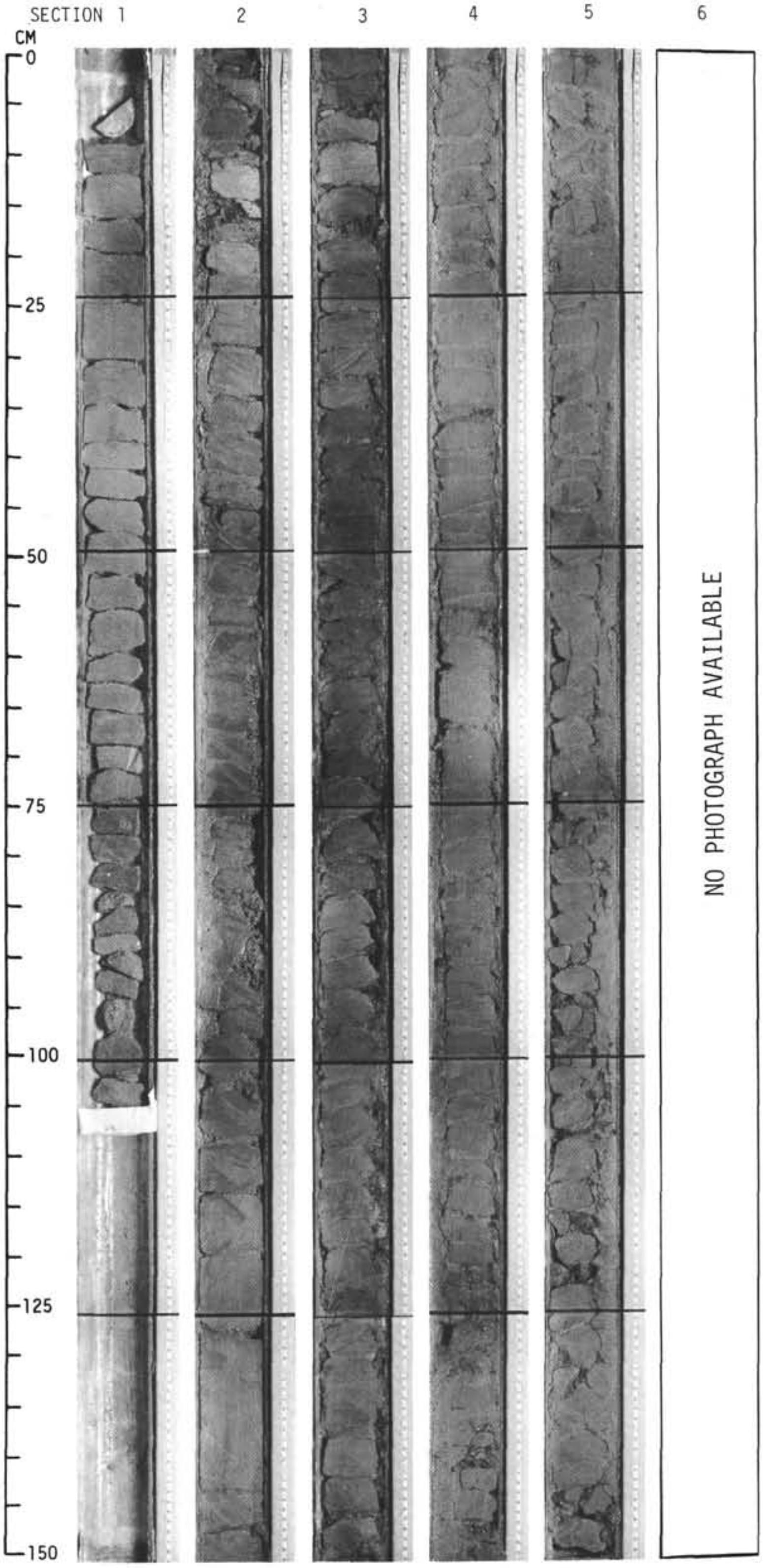
341-30

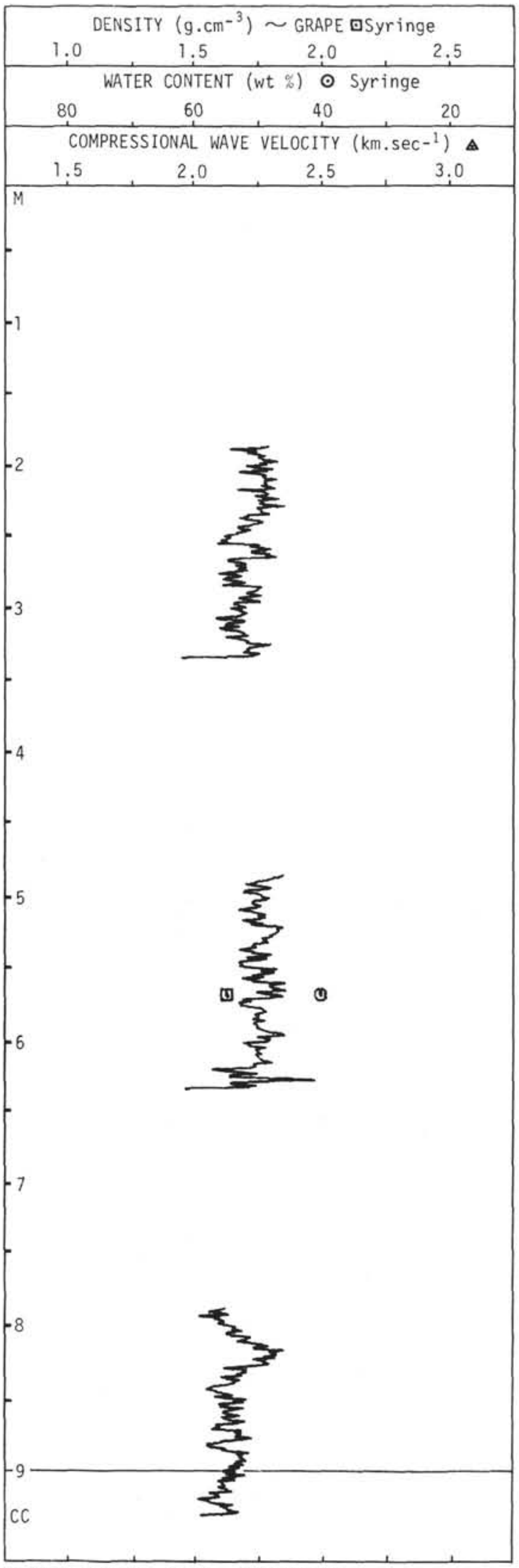




For Explanatory Notes, see Chapter 1

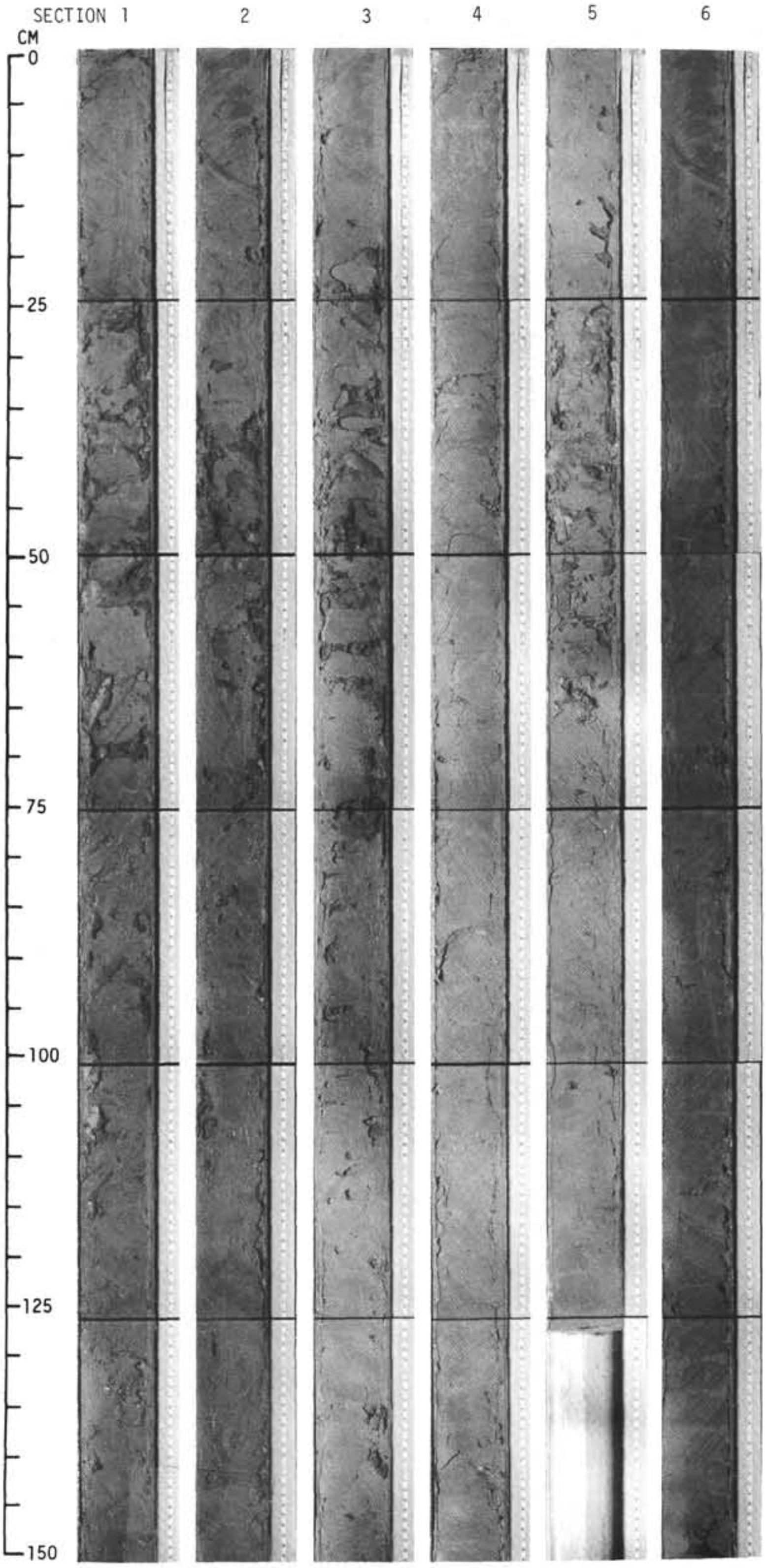
341-31

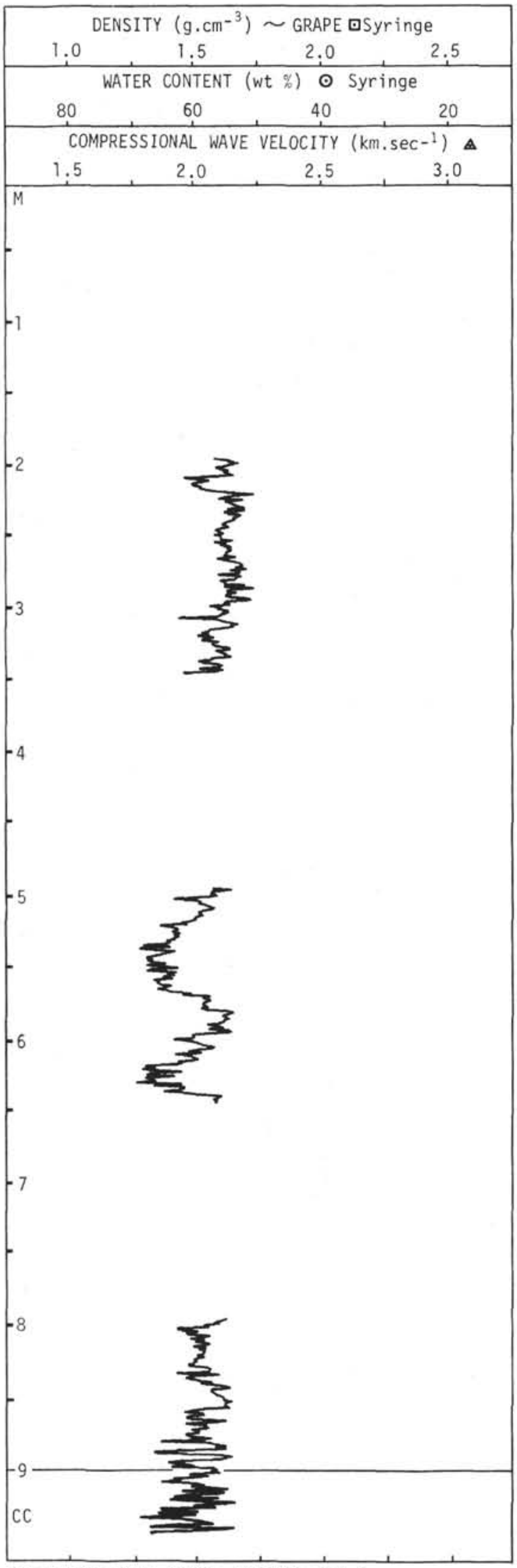




For Explanatory Notes, see Chapter 1

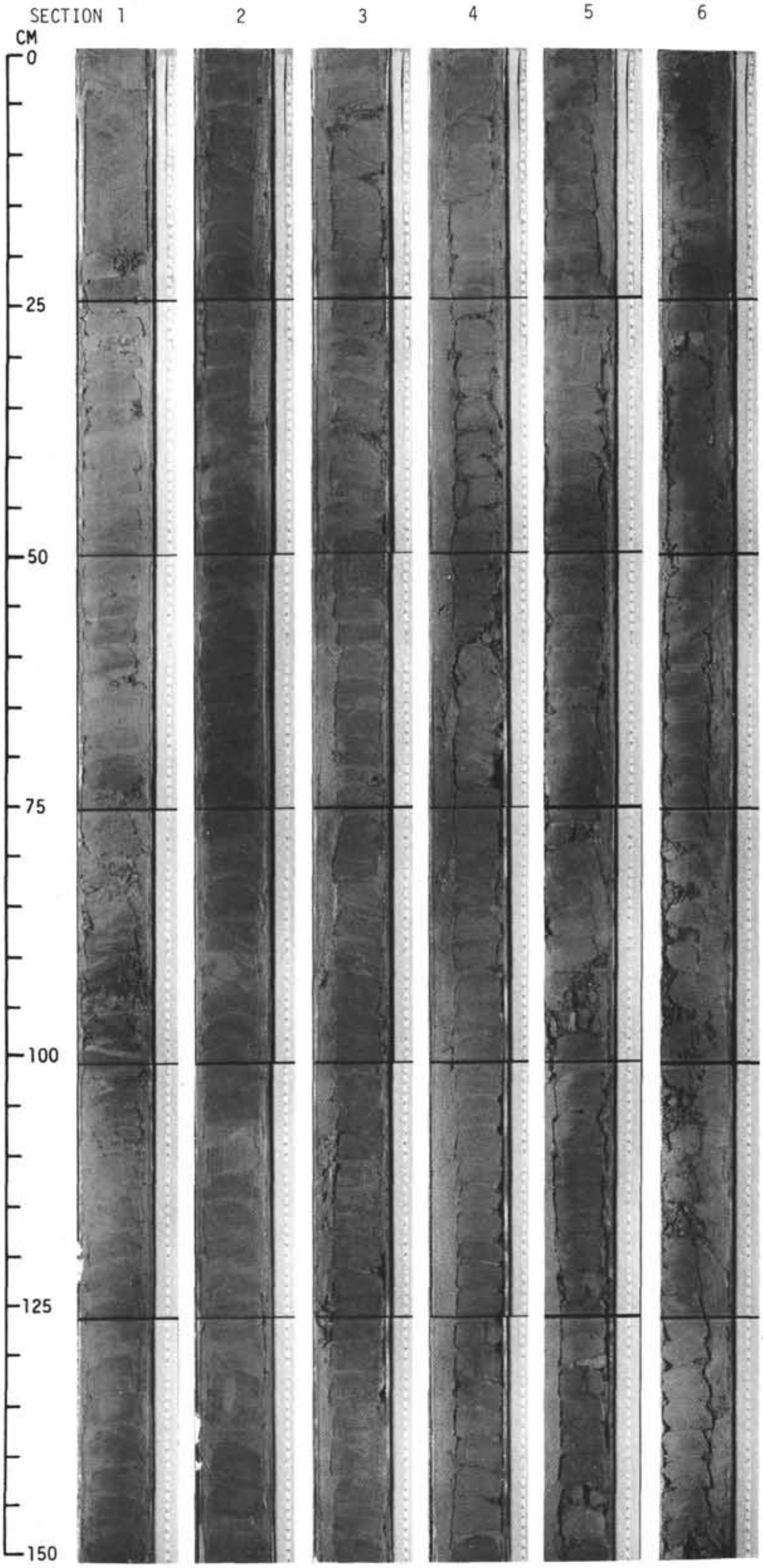
341-32

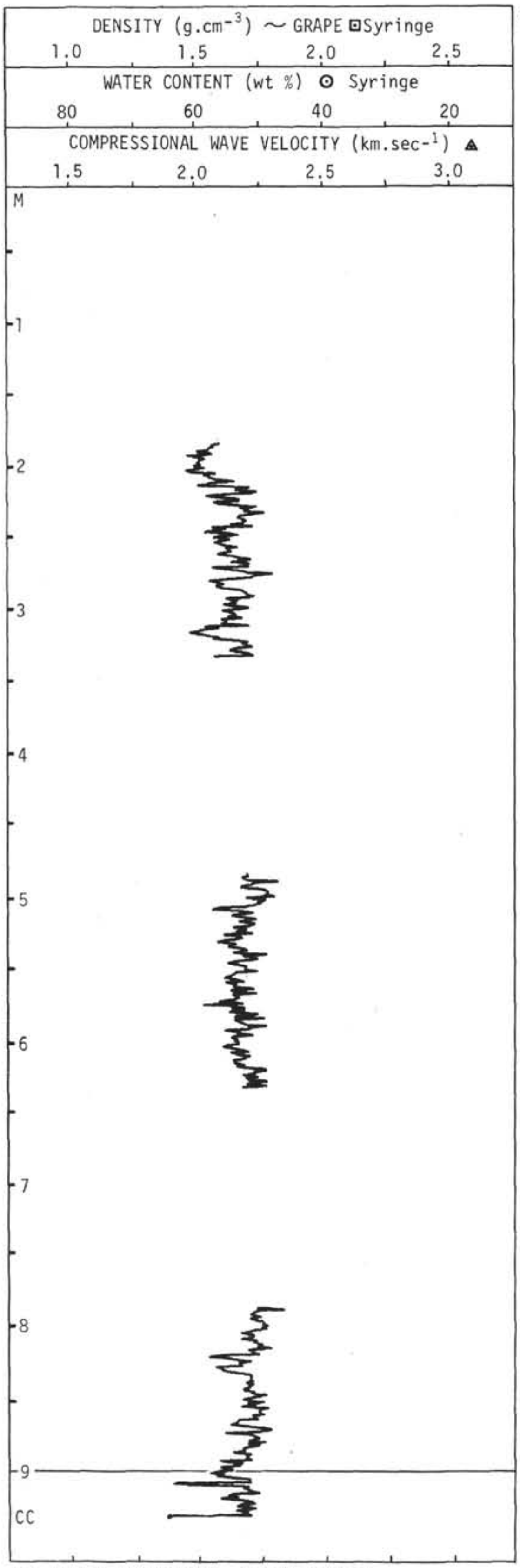




For Explanatory Notes, see Chapter 1

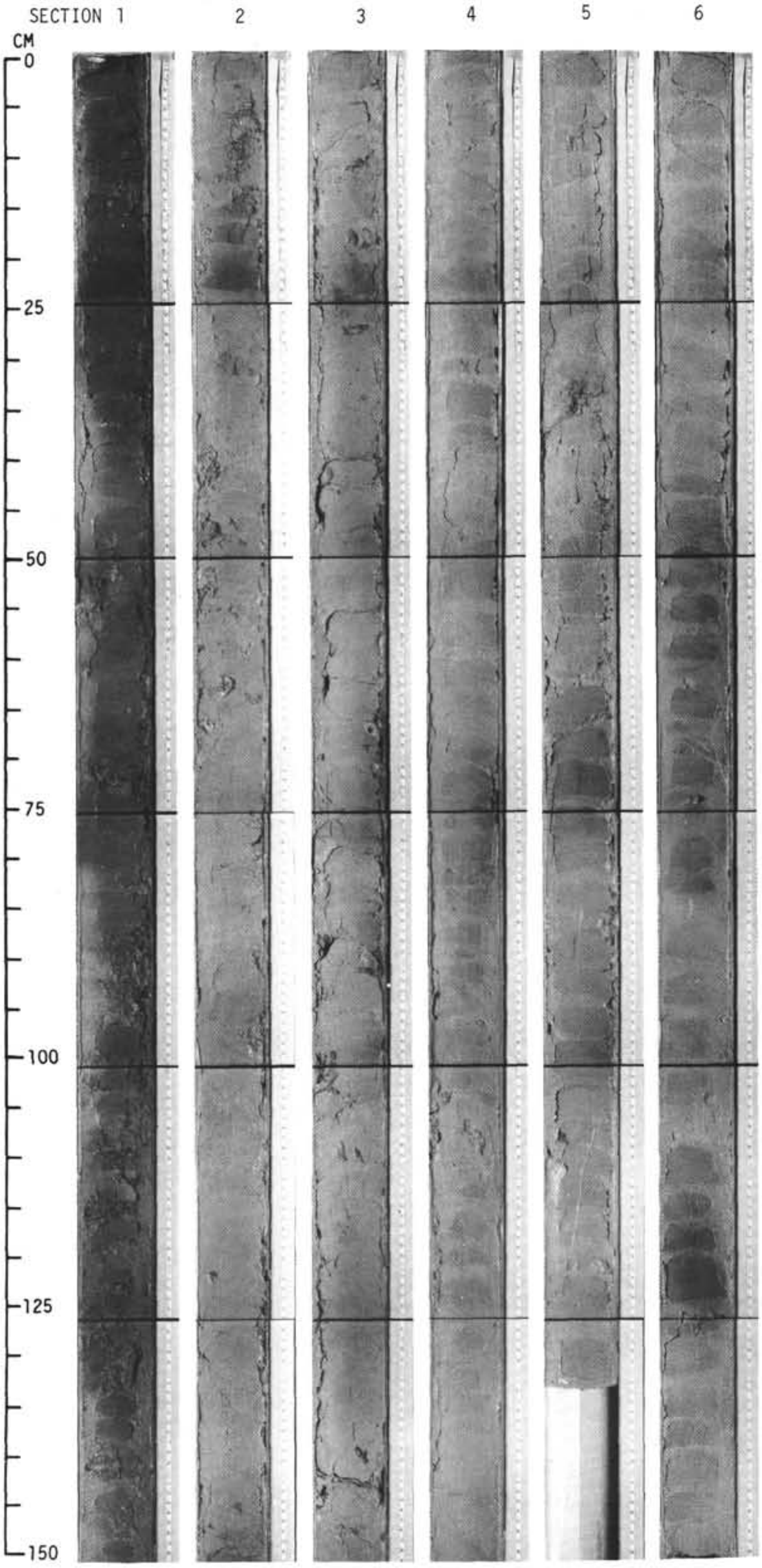
341-33



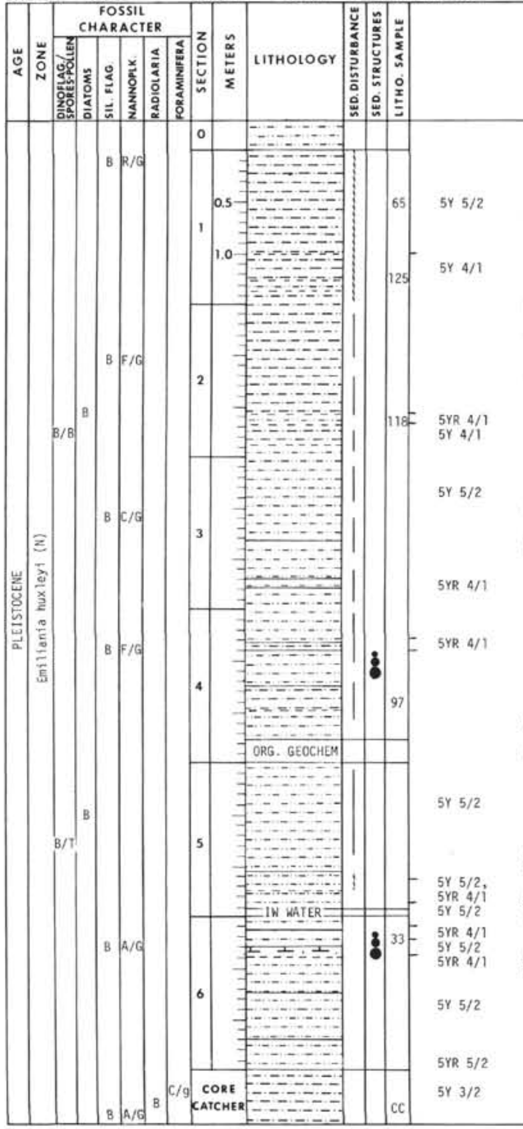


For Explanatory Notes, see Chapter 1

341-34



SITE 342 HOLE CORE 1 CORED INTERVAL: 0.0-9.0 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2) (5Y 4/1), light olive gray (5Y 5/2), brownish gray (5YR 4/1), pale olive (10Y 6/2). Sec. 1 - soft, massive, structureless; Sec. 2 - scattered pebbles, interbeds of sandy mud; Sec. 3 as per Sec. 2, interbeds; Sec. 4 - possible graded beds (70 cm), organic blebs; Sec. 5 - as above; Sec. 6 - color interbeds, graded bed 30-80 cm, color mottles.

MAJOR LITHOLOGIES

a) SANDY MUD (Smears 1-65, 2-118, CC)
10-15% Sand 15-20% Quartz
15-30% Silt TR- 3% Feldspar
60-70% Clay 0- 1% Mica
TR- 1% Heavy minerals
1- 4% Opaques
62-70% Clay minerals
0-TR% Glauconite
0- 2% Foraminifera
2-10% Nannofossils
0-TR% Diatoms

b) MUD (Smears 1-125, 4-97)
5- 8% Sand 8-15% Quartz
32-44% Silt 1% Heavy minerals
50-60% Clay 1- 2% Opaques
1- 5% Volcanic glass
51-62% Clay minerals
0- 2% Glauconite
5-20% Authigenic carbonate
0-TR% Foraminifera
0- 7% Nannofossils
0- 3% Diatoms
0- 1% Radiolarians
0-15% Sponge spicules
0-TR% Silicoflagellates

MINOR LITHOLOGY

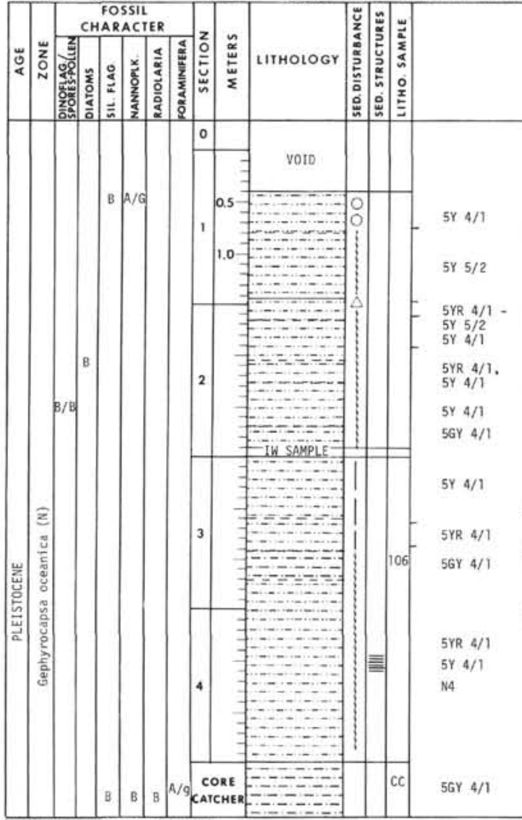
NANNOFOSSIL OOZE (Smear 6-33)
7% Quartz
TR% Heavy minerals
8% Authigenic carbonate
5% Foraminifera
80% Nannofossils

Carbon-Carbonate (DSDP)
4-80 (1.5, 0.0, 10)

Carbon-Carbonate (PP)
1-4 (top) (0.22, 0.79)
1-4 (bottom) (0.19, 1.13)

Grain Size (DSDP)
5-139 (8.4, 27.4, 64.2)

SITE 342 HOLE CORE 2 CORED INTERVAL: 37.5-47.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1), olive gray (5Y 4/1), light olive gray (5Y 5/2), brownish gray (5YR 4/1), dark greenish gray (5GY 4/1), medium dark gray (N4). Sec. 1 - massive, scattered very fine pebbles, deformed; Sec. 2 - massive, color interbeds, soft, scattered pebbles; Sec. 3 - pebbles (mica schist - 3 cm), deformed sediments; Sec. 4 - laminated - very thin stratified, firm scattered pebbles.

MAJOR LITHOLOGY

SANDY MUD (Smears 3-106, CC)
10% Sand 15% Quartz
10-15% Silt 2% Feldspar
75-80% Clay 0-TR% Mica
1- 2% Heavy minerals
1- 2% Opaques
75-80% Clay minerals
TR% Glauconite
TR- 2% Authigenic carbonate
0-TR% Diatoms

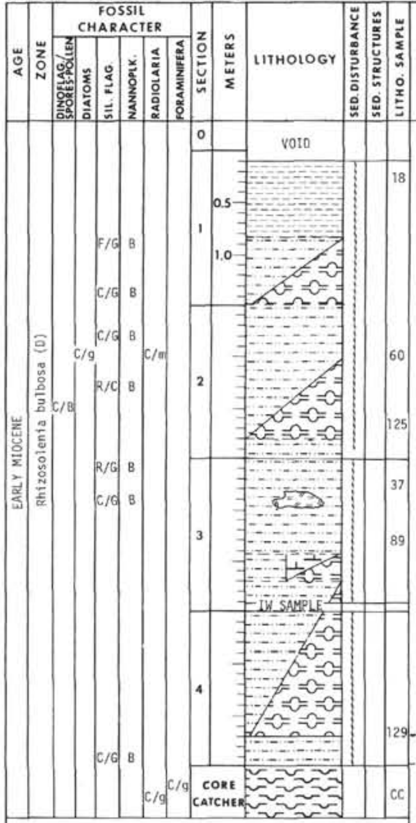
Carbon-Carbonate (DSDP)
2-90 (0.3, 0.2, 0)

Carbon-Carbonate (PP)
2-2 (top) (0.07, 0.23)
2-2 (bottom) (0.51, 0.11)

Grain Size (DSDP)
3-40 (6.7, 33.6, 59.7)

Explanatory notes in Chapter 1

SITE 342 **HOLE** **CORE** 3 **CORED INTERVAL:** 85.0-94.5 m



LITHOLOGIC DESCRIPTION

5Y 4/1
5Y 4/1
5Y 4/1 and 5GY 6/1
5YR 3/2
5YR 4/1
5Y 4/1

Colors: olive gray (5Y 4/1), brownish gray (5YR 4/1), light olive gray (5Y 6/1), greenish gray (5GY 6/1), grayish brown (5YR 3/2). Intense deformation. Sec. 1 - firm, soft, relict thin stratification, pebbles, including siliceous material 80-150 cm; Sec. 2 - originally thinly stratified; Sec. 4 - originally thinly stratified.

MAJOR LITHOLOGY

SPONGE SPICULE MUD (Smears 2-60, 2-125)

5-20% Sand	7-15% Quartz
27-32% Silt	0- 2% Feldspar
48-67% Clay	1- 2% Heavy minerals
	1- 2% Opaques
	7% Volcanic glass
	48-67% Clay minerals
	0- 1% Glauconite
	0-TR% Authigenic carbonate
	2- 5% Diatoms
	1- 2% Radiolarians
	10% Sponge spicules

MINOR LITHOLOGIES

a) CLAY (Smear 1-18)
7% Quartz
1% Feldspar
1% Heavy minerals
1% Opaques
90% Clay minerals
TR% Glauconite

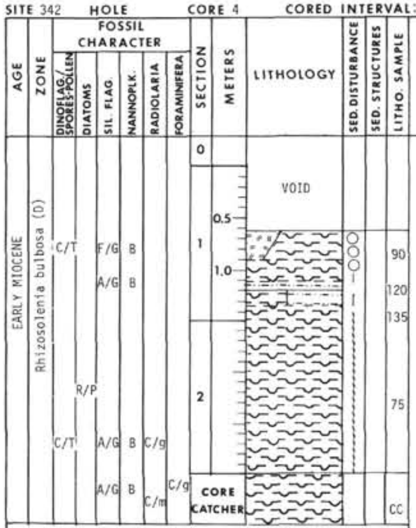
b) VOLCANIC ASH (Smear 3-37)
30% Opaques
70% Volcanic glass

c) NANNOFOSSIL OOZE (Smear 3-89)
7% Quartz
TR% Heavy minerals
TR% Opaques
2% Volcanic glass
1% Glauconite
5% Authigenic carbonate
TR% Foraminifera
75% Nannofossils
1% Diatoms
7% Sponge spicules

d) DIATOM OOZE (Smear CC)
5% Quartz
3% Opaques
3% Volcanic glass
10% Clay minerals
TR% Glauconite
57% Diatoms
7% Radiolarians
15% Sponge spicules
TR% Silicoflagellates

Carbon-Carbonate (DSDP)
2-110 (0.3, 0.3, 0)
Carbon-Carbonate (PP)
3-2 (top) (0.39, 0.36)
3-2 (bottom) (0.63, 0.01)
Grain Size (DSDP)
3-60 (13.2, 46.0, 40.8)

SITE 342 **HOLE** **CORE** 4 **CORED INTERVAL:** 123.0-132.5 m



LITHOLOGIC DESCRIPTION

10Y 4/2
10Y 4/2 - 10YR 2/2
10YR 2/2
10Y 4/2
10Y 4/2
10YR 2/2
10YR 6/2
10Y 4/2

Colors: grayish olive (10Y 4/2), dusky yellow brown (10YR 2/2), pale yellow brown (10YR 6/2). Generally intensely deformed. Sec. 1 - gradation zone gray→brown colors. Unit firm, extensive mottling.

MAJOR LITHOLOGY

DIATOM OOZE (Smears 1-135, 2-75, CC)
0- 3% Quartz
0-TR% Mica
0-TR% Heavy minerals
1- 2% Opaques
TR- 2% Volcanic glass
0-TR% Glauconite
70-82% Diatoms
0- 7% Radiolarians
12-18% Sponge spicules
1- 4% Silicoflagellates

MINOR LITHOLOGIES

a) MUDDY DIATOM OOZE (Smear 1-120)
3% Quartz
TR% Heavy minerals
15% Opaques
1% Volcanic glass
1% Palagonite
20% Clay minerals
TR% Glauconite
43% Diatoms
5% Radiolarians
7% Sponge spicules
TR% Silicoflagellates

b) ASHY DIATOM OOZE (Smear 1-90)
3% Quartz
1% Heavy minerals
3% Opaques
20% Volcanic glass
TR% Glauconite
52% Diatoms
5% Radiolarians
15% Sponge spicules

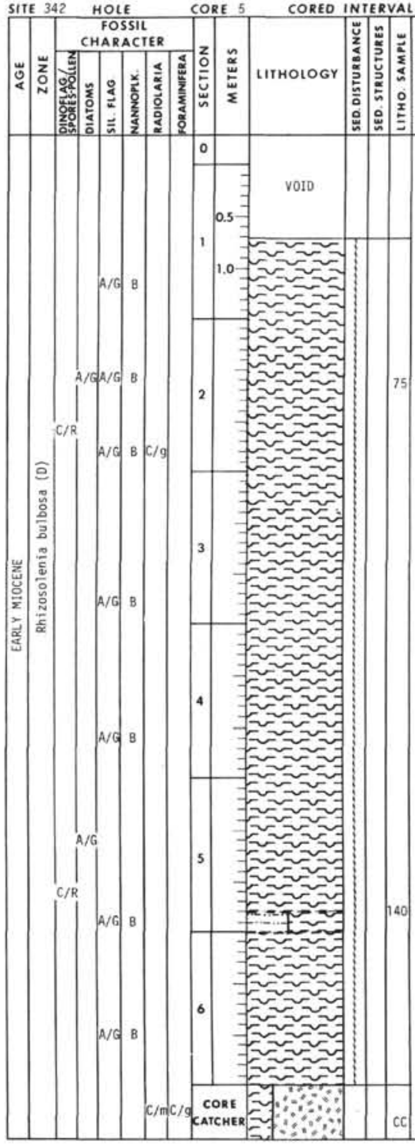
Carbon-Carbonate (DSDP)
2-84 (0.7, 0.0, 6)

Carbon-Carbonate (PP)
4-1 (top) (0.93, 0.04)
4-1 (bottom) (0.99, 0.02)

Grain Size (DSDP)
2-60 (2.1, 31.5, 66.4)

Explanatory notes in Chapter 1

SITE 342 HOLE CORE 5 CORED INTERVAL: 132.5-142.0 m



10Y 4/2

10Y 4/2
with
5Y 4/4

10Y 4/2

LITHOLOGIC DESCRIPTION

Colors: grayish olive (10Y 4/2), moderate olive brown (5Y 4/4). Intense deformation, color mottling, generally firm, but stiff in Sec. 6.

MAJOR LITHOLOGIES

a) DIATOM OOZE (Smears 2-75, 5-140)

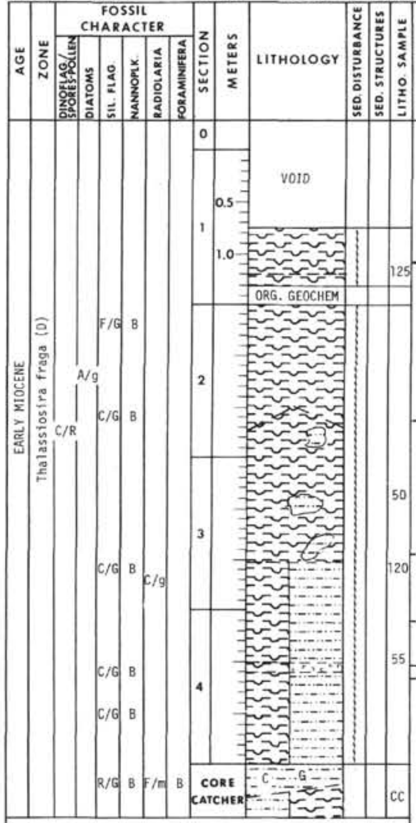
2%	Quartz
0-TR%	Mica
0-TR%	Heavy minerals
2%	Opaques
0-TR%	Volcanic glass
0-TR%	Glauconite
75-80%	Diatoms
5-10%	Radiolarians
7-10%	Sponge spicules
1- 5%	Silicoflagellates

b) ASHY DIATOM OOZE (Smear CC)

3%	Quartz
TR%	Mica
4%	Opaques
20%	Volcanic glass
15%	Clay minerals
41%	Diatoms
5%	Radiolarians
10%	Sponge spicules
2%	Silicoflagellates

Grain Size (DSDP)
3-31 (0.3, 27.7, 72.1)

SITE 342 HOLE CORE 6 CORED INTERVAL: 142.0-151.5 m



10Y 4/2
5Y 4/4

5Y 3/2

5Y 3/2

5Y 4/4,
5G 4/1,
5Y 3/2

5Y 3/2
with
5Y 4/4

5G 5/2

5Y 3/2
with
5Y 4/4
5Y 3/2 -
5Y 4/4

5Y 3/2

5G 4/1
with
10GY 4/4

LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5G 4/1), dark yellow green (10GY 4/4), grayish olive (10Y 4/2), moderate olive brown (5Y 4/4), olive gray (5Y 3/2), grayish green (5G 5/2). Intense deformation, color mottles.

MAJOR LITHOLOGY

DIATOM OOZE (Smear 1-125)

10% Sand	1%	Quartz
35% Silt	1%	Feldspar
55% Clay	3%	Mica
	TR%	Heavy minerals
	5%	Opaques
	25%	Clay minerals
	10%	Glauconite
	1%	Authigenic carbonate
	47%	Diatoms
	2%	Radiolarians
	5%	Sponge spicules
	3%	Silicoflagellates

MINOR LITHOLOGIES

a) DIATOMACEOUS MUD (Smear 3-120)

1%	Quartz
TR%	Heavy minerals
TR%	Volcanic glass
60%	Clay minerals
7%	Glauconite
25%	Diatoms
3%	Radiolarians
7%	Sponge spicules
2%	Silicoflagellates

b) DIATOMACEOUS ASHY MUD (Smear 4-55)

TR%	Quartz
TR%	Heavy minerals
5%	Opaques
25%	Volcanic glass
42%	Clay minerals
5%	Glauconite
15%	Diatoms
2%	Radiolarians
5%	Sponge spicules
1%	Silicoflagellates

c) SANDY GLAUCONITIC MUD (Smear CC)

20% Sand	TR%	Quartz
60% Silt	TR%	Mica
20% Clay	TR%	Heavy minerals
	20%	Opaques
	2%	Volcanic glass
	54%	Clay minerals
	10%	Glauconite
	10%	Diatoms
	2%	Radiolarians
	2%	Sponge spicules

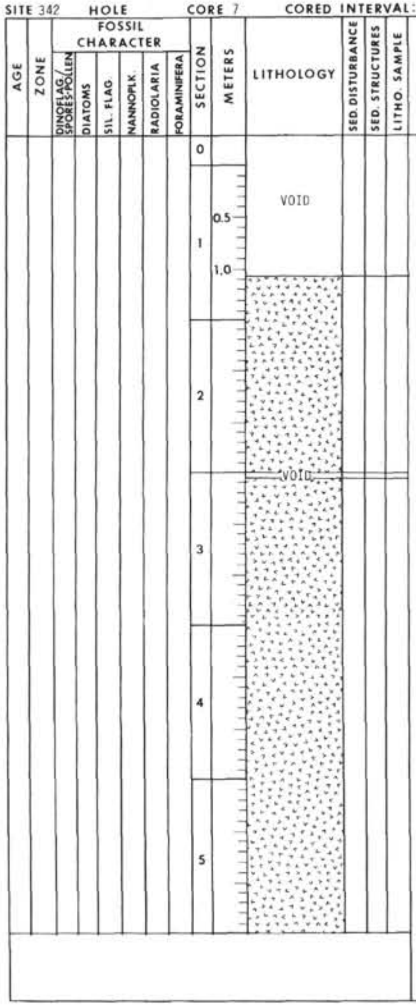
Carbon-Carbonate (DSDP)
2-129 (1.0, 0.3, 7)

Carbon-Carbonate (PP)
6-1 (top) (1.14, 0.01)
6-1 (bottom) (1.08, 0.11)

Grain Size (DSDP)
2-100 (11.2, 31.6, 57.1)

Explanatory notes in Chapter 1

SITE 342 HOLE CORE 7 CORED INTERVAL: 151.5-161.0 m



LITHOLOGIC DESCRIPTION

BASALT

Sec. 1 (107-117 cm) drill pebbles of fine-grained brecciated basalt; (117-150 cm) medium light gray to dark gray, massive phyric basalt.

Thin Section - dolerite basalt with diabase texture, xenolith(?) or palgioclase aggregates, phyric (10%) (altered olivine, augite, plagioclase).

Sec. 2 (0-150 cm) medium light gray (N6) to medium dark gray (N4) fine- to medium-grained basalt with plagioclase and pyroxene phenocrysts (1-2 mm). Irregular vesicles (0.2 to 10 mm), sometimes filled by white calcite, with dark green chlorite on walls. Noted at 65 to 80 cm. Also, calcite veins with small pyrite crystals from 100-130 cm.

Thin Section - dolerite basalt with diabasic texture, phyric (7-10%), olivine (altered), augite, plagioclase, plagioclase glomeroporphyritic clusters, poikilitic inclusion of plagioclase to augite.

Sec. 3 (0-50 cm) phyric doleritic basalt with fissure containing blue-gray chlorite and small needle-like crystals (zeolite?); (50-125 cm) phyric basalt with calcite veins; (125-150 cm) massive phyric basalt.

Thin Section - as per Sec. 2 with xenocrysts of biotite with plagioclase. Phyric (8-10%), altered olivine (1-2%), augite (3-4%), plagioclase (4-5%).

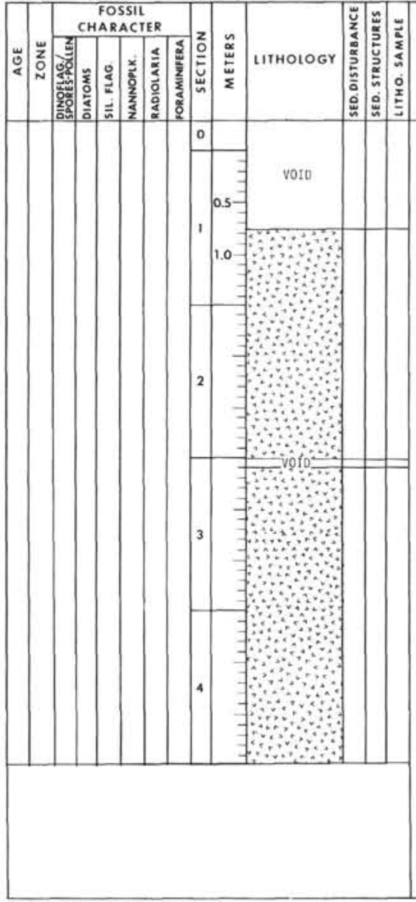
Sec. 4 - medium dark (N4) to grayish black (N2) massive phyric basalt with calcite veins to a massive phyric doleritic basalt with calcite veins and amygdules, as well as a porous texture.

Thin Section - as per Sec. 3 but olivine (2-3%), glomeroporphyritic cluster of plagioclase.

Sec. 5 - phyric basalt is very similar to basalt in Sec. 4. Also noted were slickensides with black chlorite on walls, calcite veins, and empty irregular vesicles (2-4 mm).

Thin Section - dolerite basalt with diabase texture, glomeroporphyritic aggregates of plagioclase and augite. Green (Cu montmorillonite?) amygdules, phyric (8-11%), altered olivine (1-2%), augite (2-4%), plagioclase (5-6%).

SITE 342 HOLE CORE 8 CORED INTERVAL: 161.0-170.5 m



LITHOLOGIC DESCRIPTION

BASALT

Sec. 1 (75-110 cm) drill pebbles of weathered basalt with yellow oxidation crust, and calcite veins; (110-150 cm) dark gray (N3) phyric basalt with plagioclase, pyroxene phenocrysts and rare amygdules of green and dark green chlorite and white calcite.

Thin Section - dolerite basalt, diabasic texture, glomeroporphyritic aggregates of plagioclase. Phyric (7-8%), altered olivine (1-2%), augite (2-3%), plagioclase (3-5%).

Sec. 2 phyric doleritic basalt with glomeroporphyric aggregates of plagioclase and clinopyroxene. Empty vesicles, vesicles with calcite, calcite veins; (125-150 cm) small empty vesicles (1-2 mm) rare small pieces of native copper (0.5-1 mm).

Thin Section - dolerite basalt, diabasic texture, glomeroporphyric aggregates of plagioclase, poikilitic inclusions plagioclase in augite, phyric (8-9%), altered olivine (1-2%), augite (2-3%), plagioclase (5-6%).

Sec. 3 phyric basalt is very similar to Sec. 2. Homogeneous, with rare thin calcite veins and rare empty small vesicles and chlorite-calcite amygdules. Rare pieces of native copper on all section. At 140 cm is a xenolith of coarse igneous rock (dolerite) (3 x 4 cm).

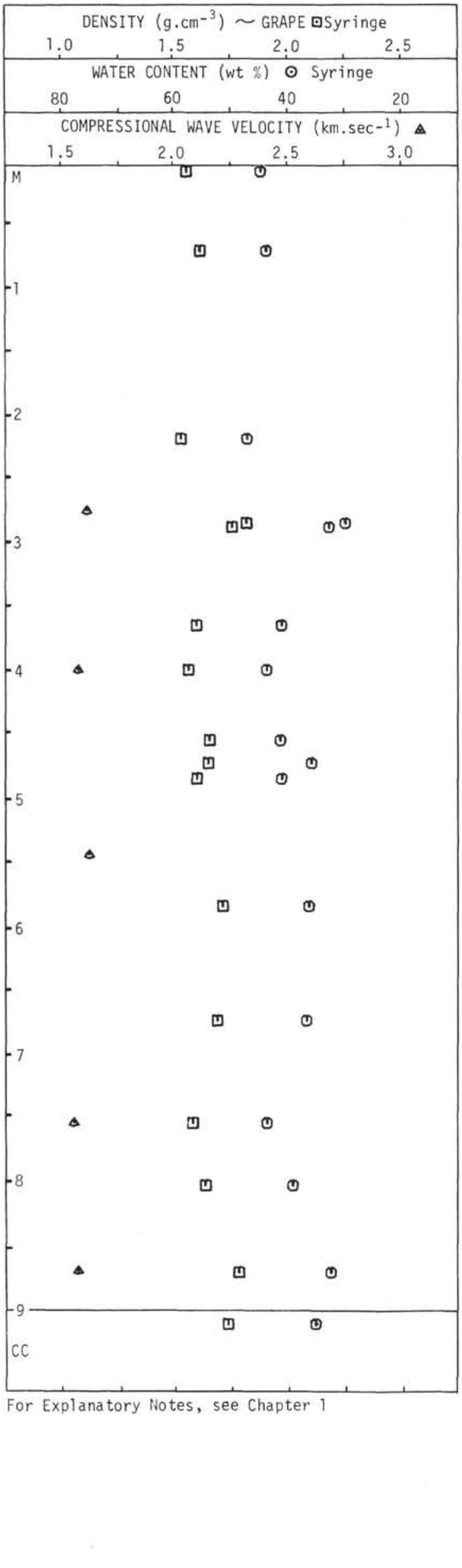
Thin Section - dolerite basalt, diabasic texture, glomeroporphyritic aggregates of plagioclase and augite. Phyric (8-10%), altered olivine (1-2%), augite (2-4%), plagioclase (4-6%).

Sec. 4 phyric basalt is similar to Sec. 3. Phyric basalt. Very rare thin calcite veins and thin fissures with black chlorite and needle-like long crystals on walls (zeolite?). Rare small irregular pieces of native copper on all section.

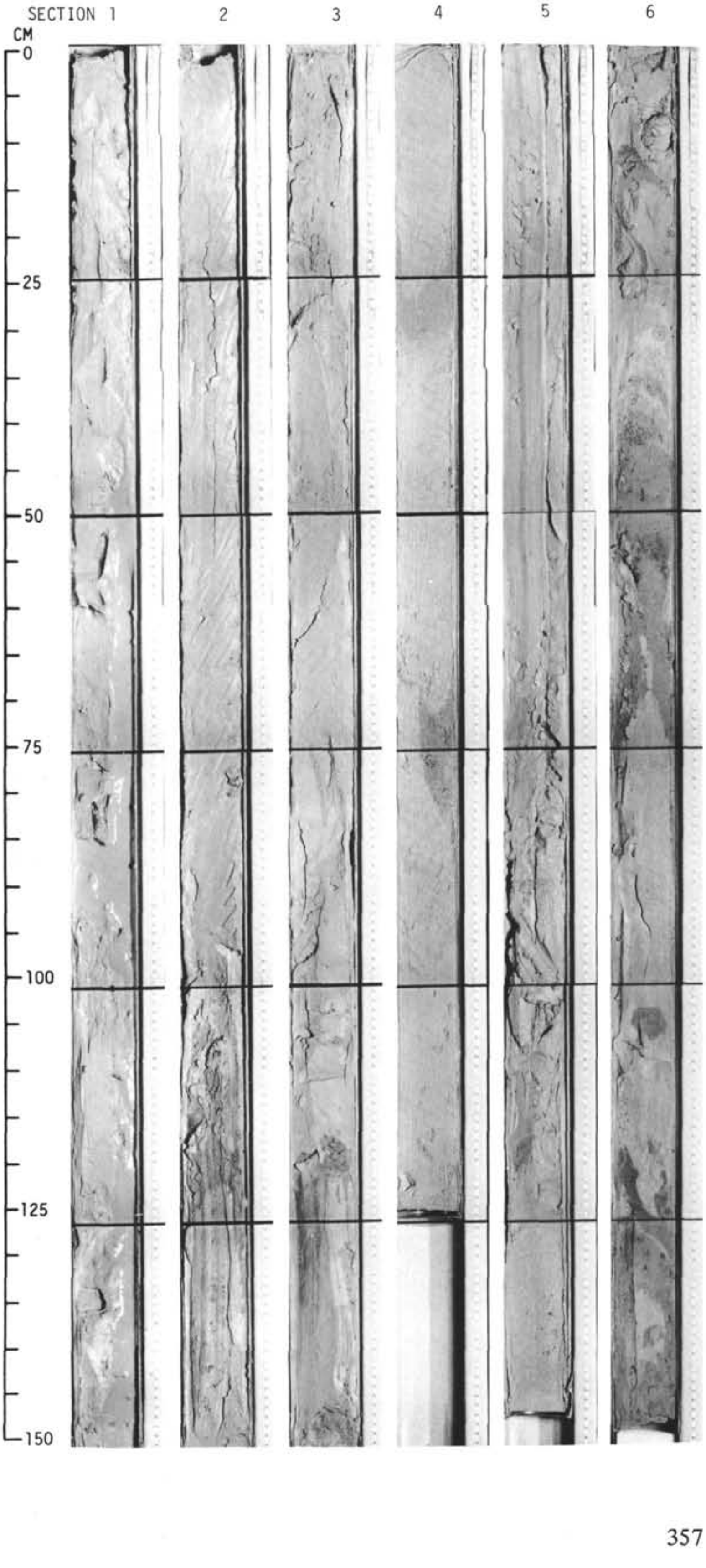
Thin Section - as per Sec. 3 - xenocrysts of biotite. Phyric (8-10%), altered olivine (1-2%), augite (2-3%), plagioclase (3-4%).

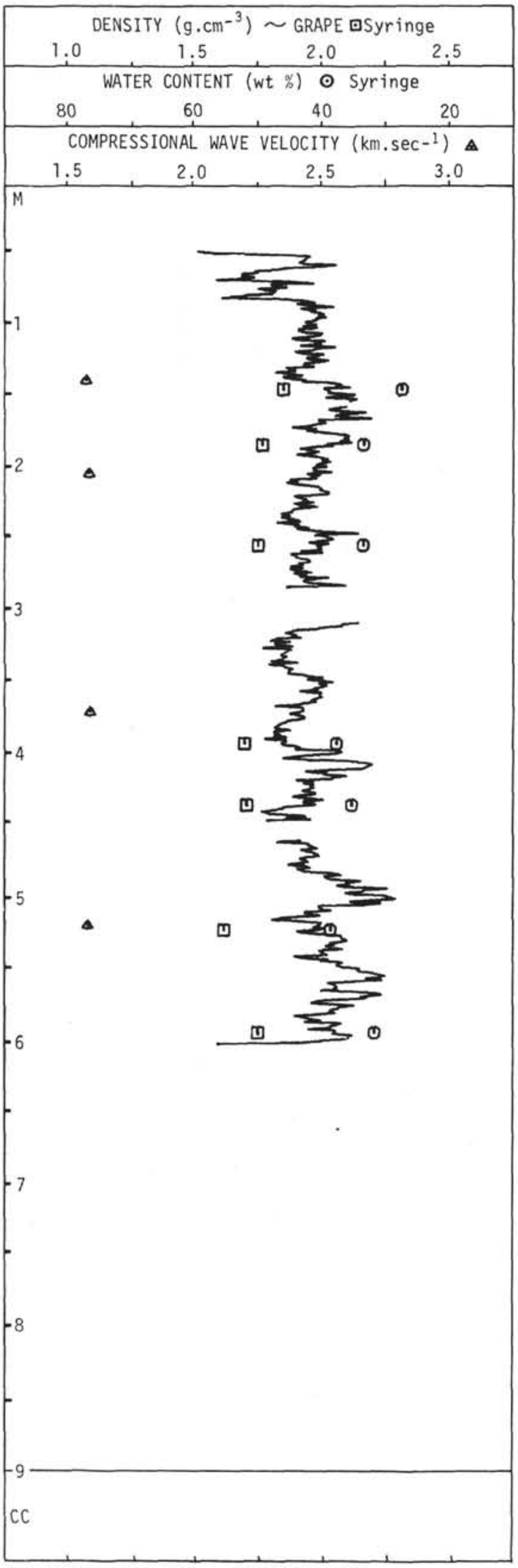
Explanatory notes in Chapter 1

342-1



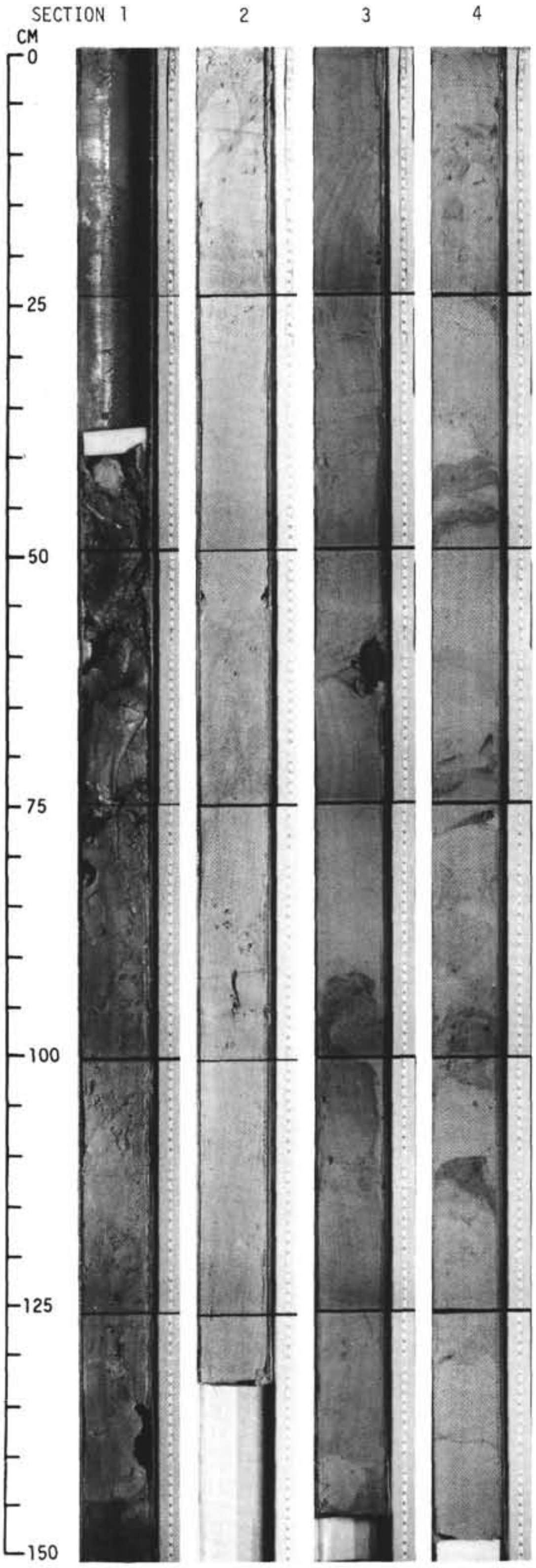
For Explanatory Notes, see Chapter 1

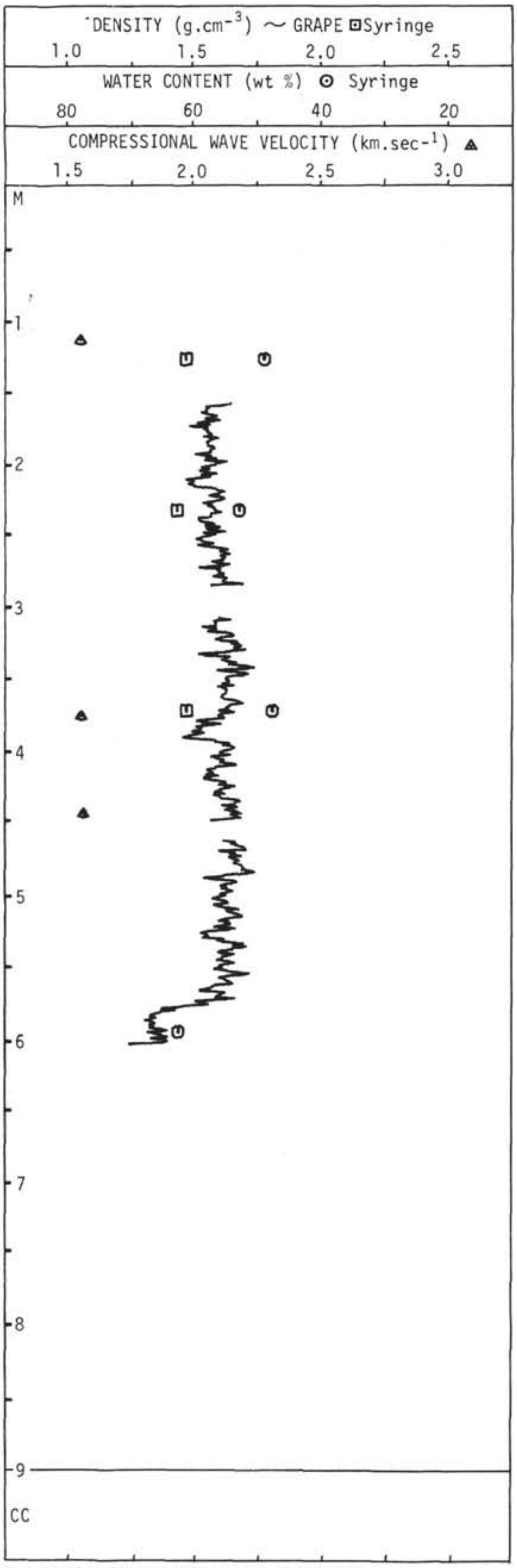




For Explanatory Notes, see Chapter 1

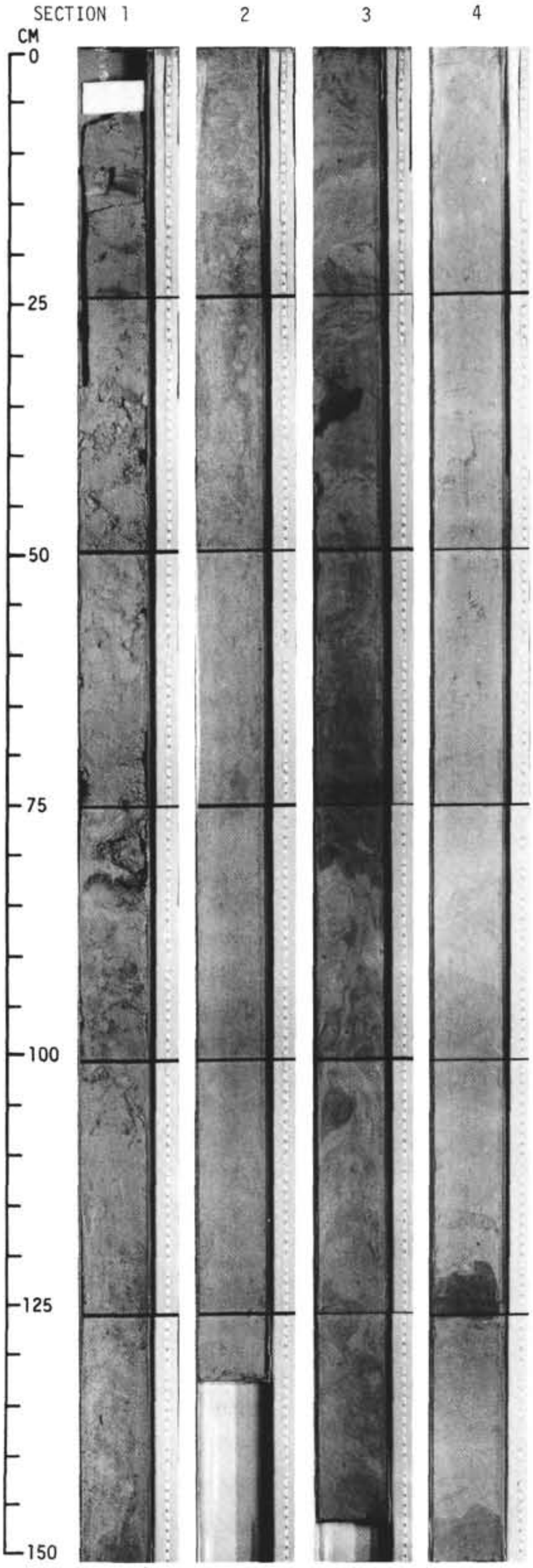
342-2

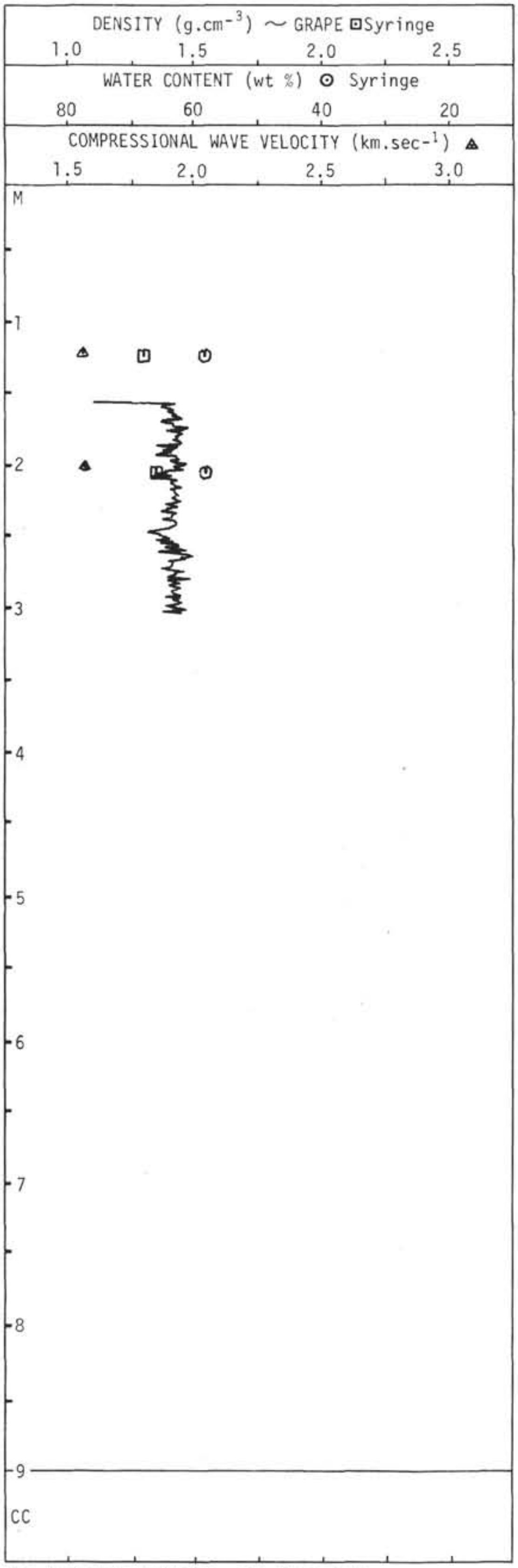




For Explanatory Notes, see Chapter 1

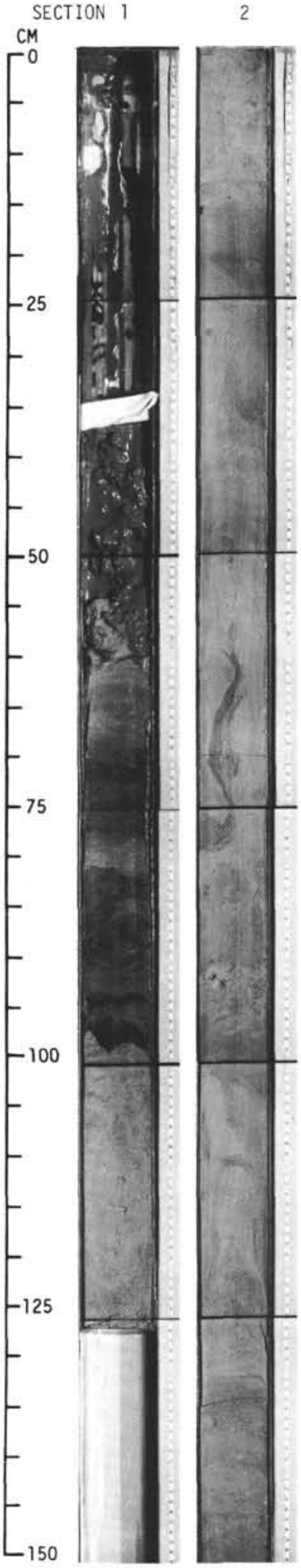
342-3

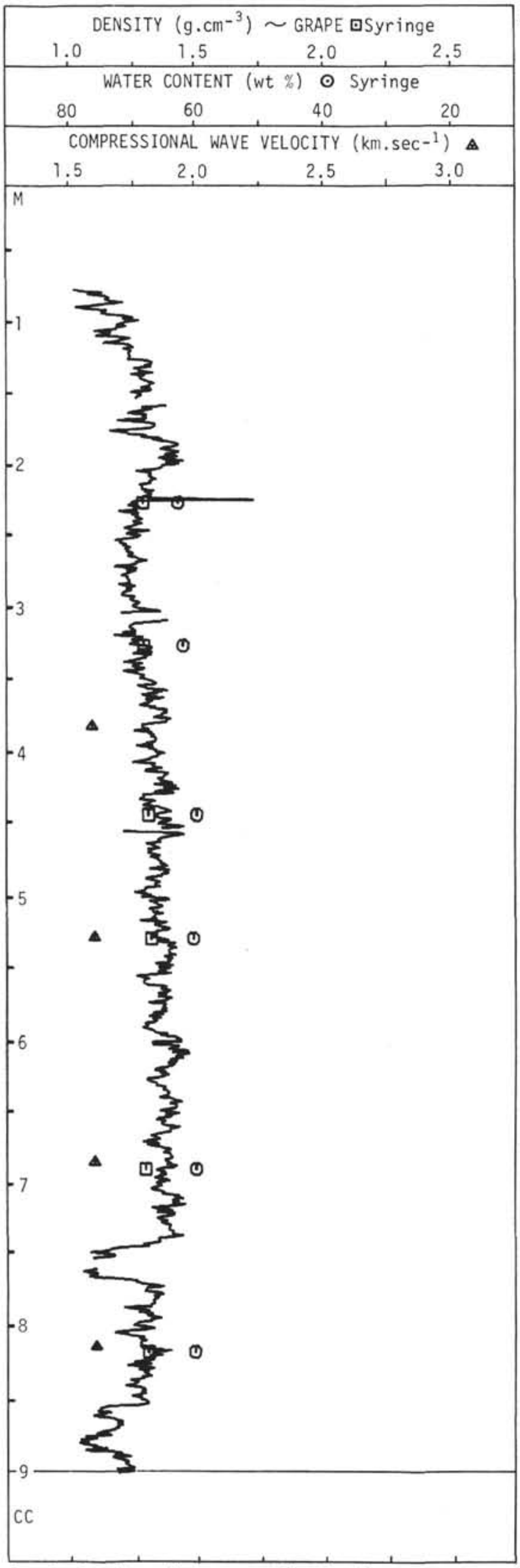




For Explanatory Notes, see Chapter 1

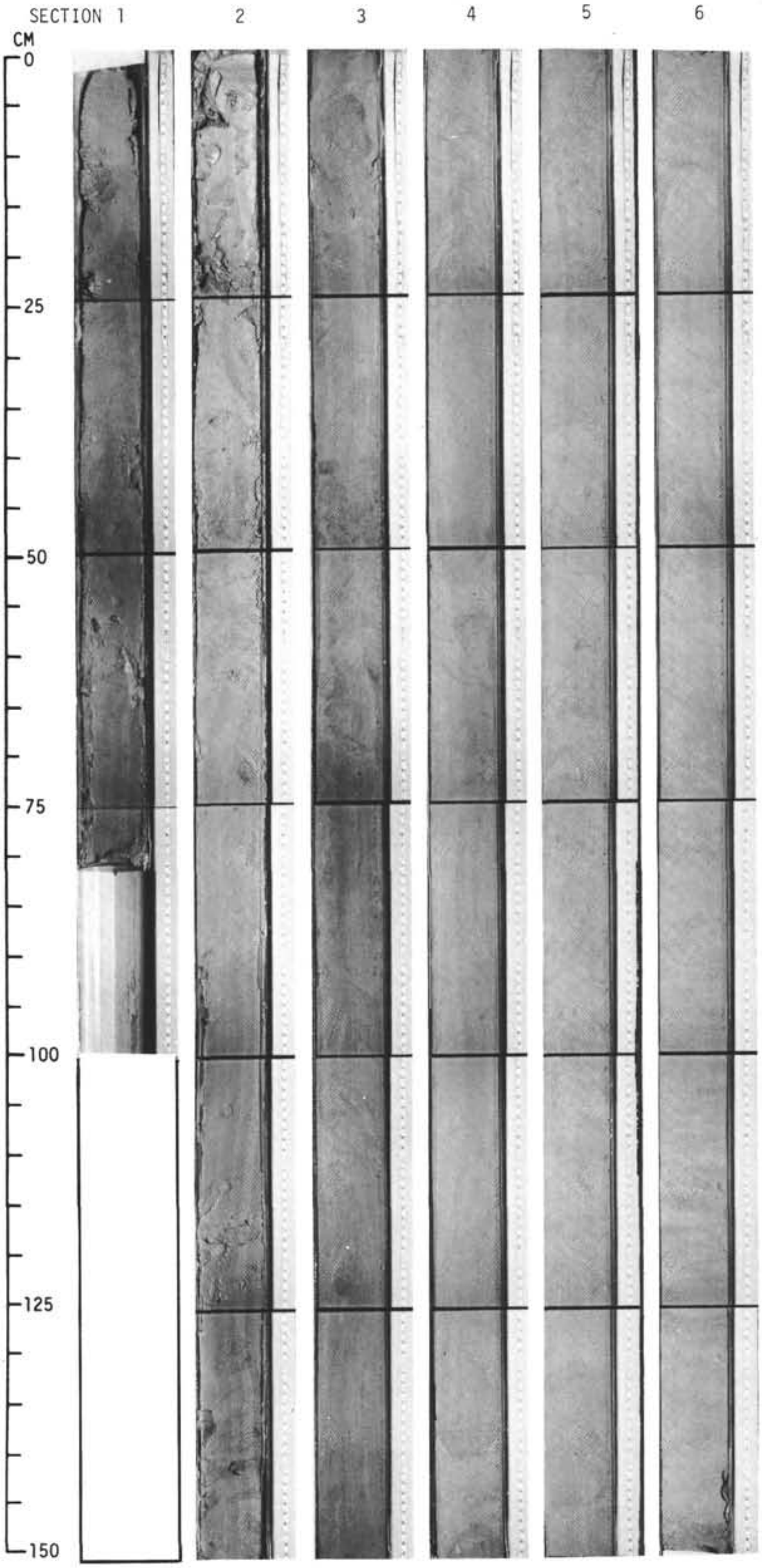
342-4

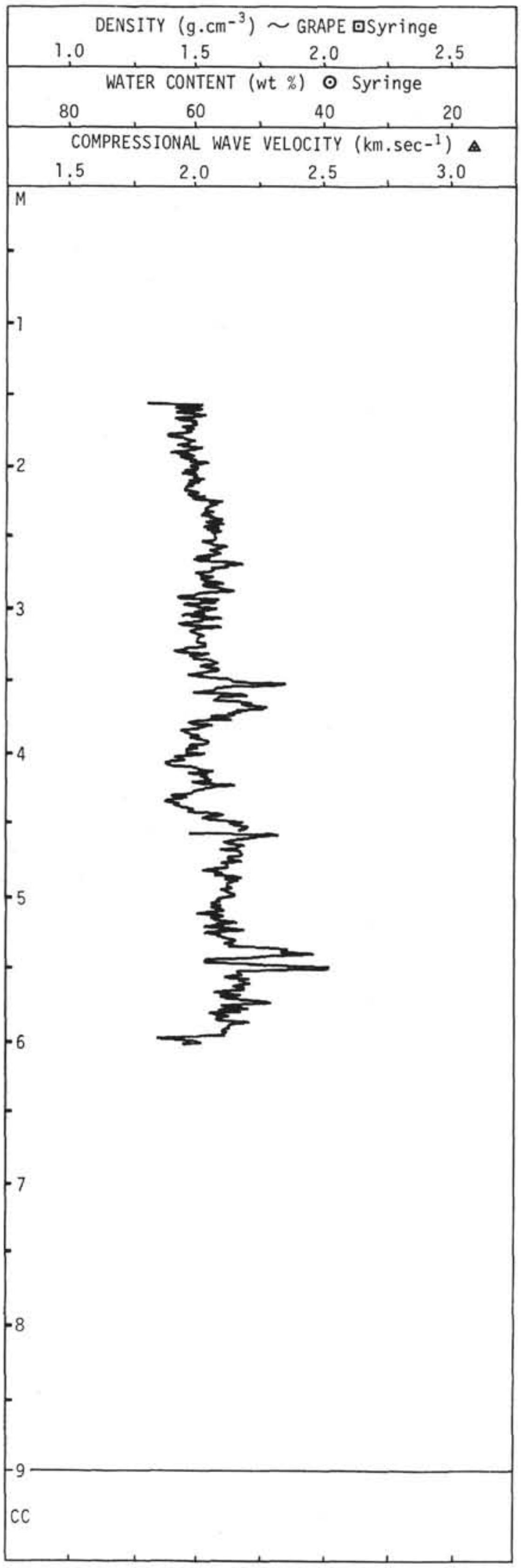




For Explanatory Notes, see Chapter 1

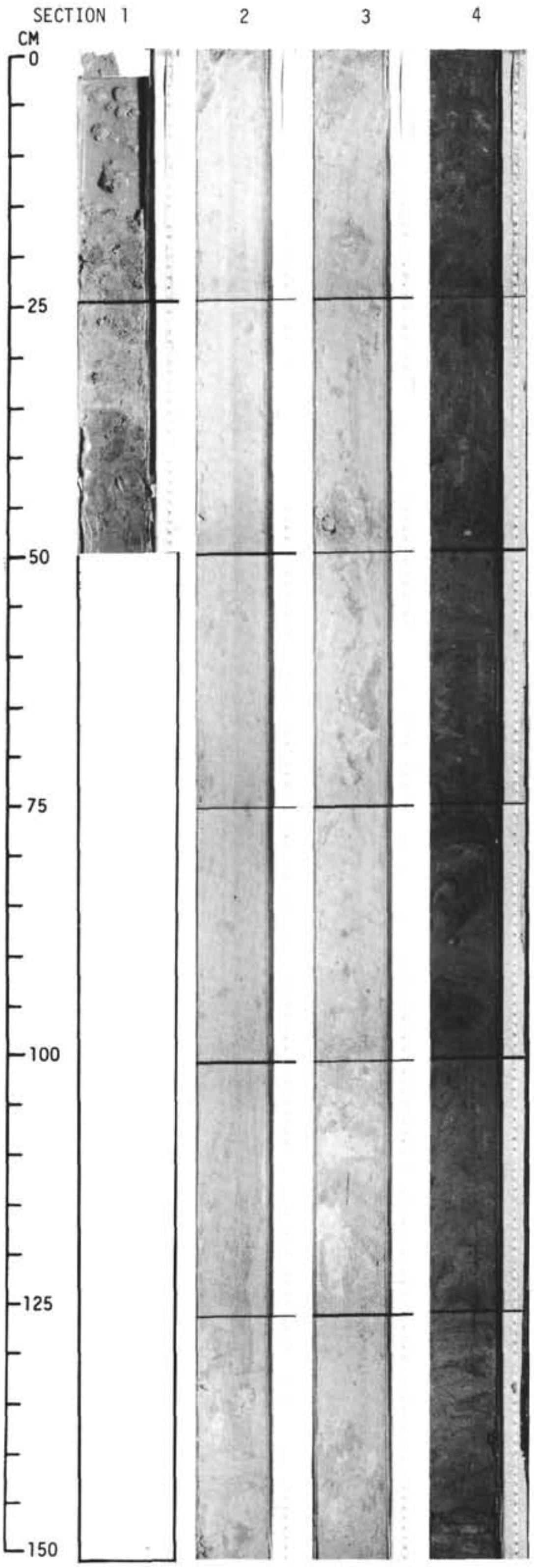
342-5



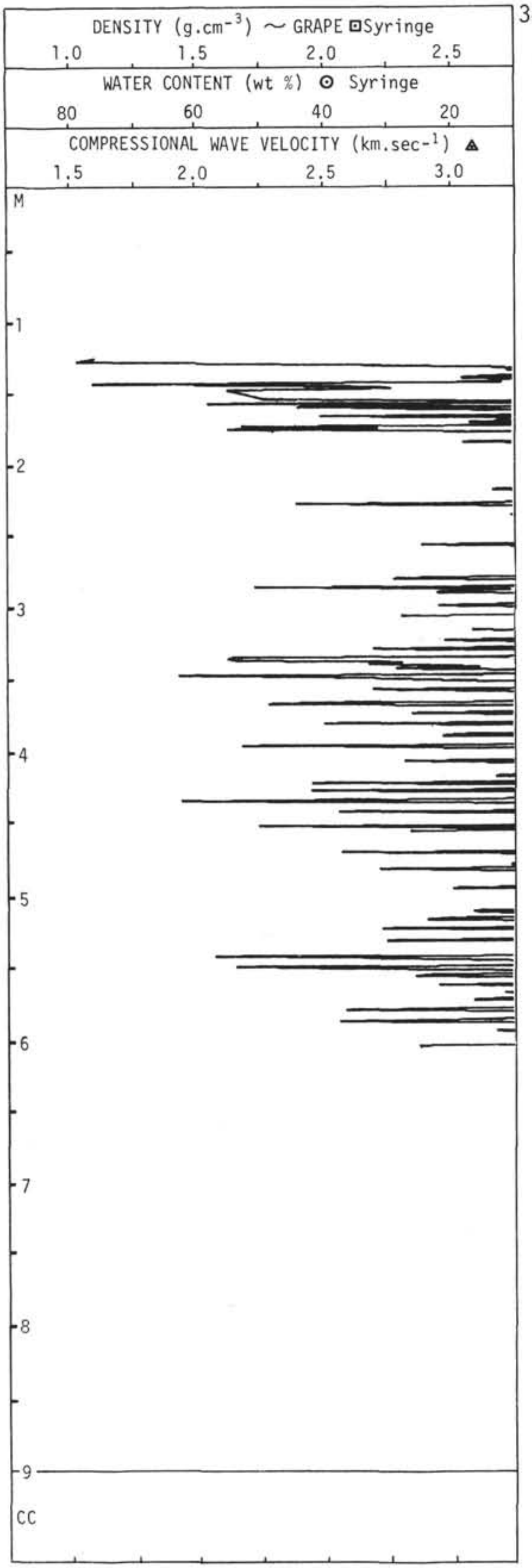


For Explanatory Notes, see Chapter 1

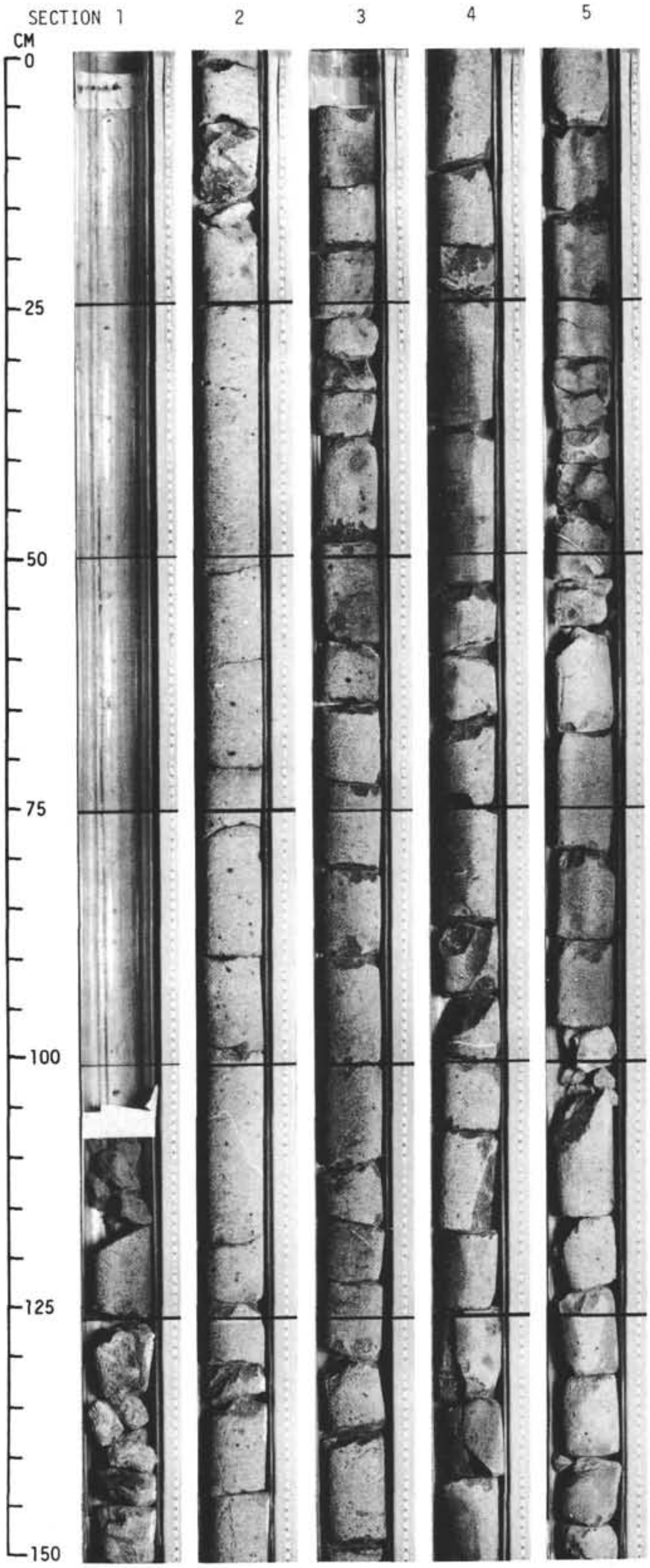
342-6



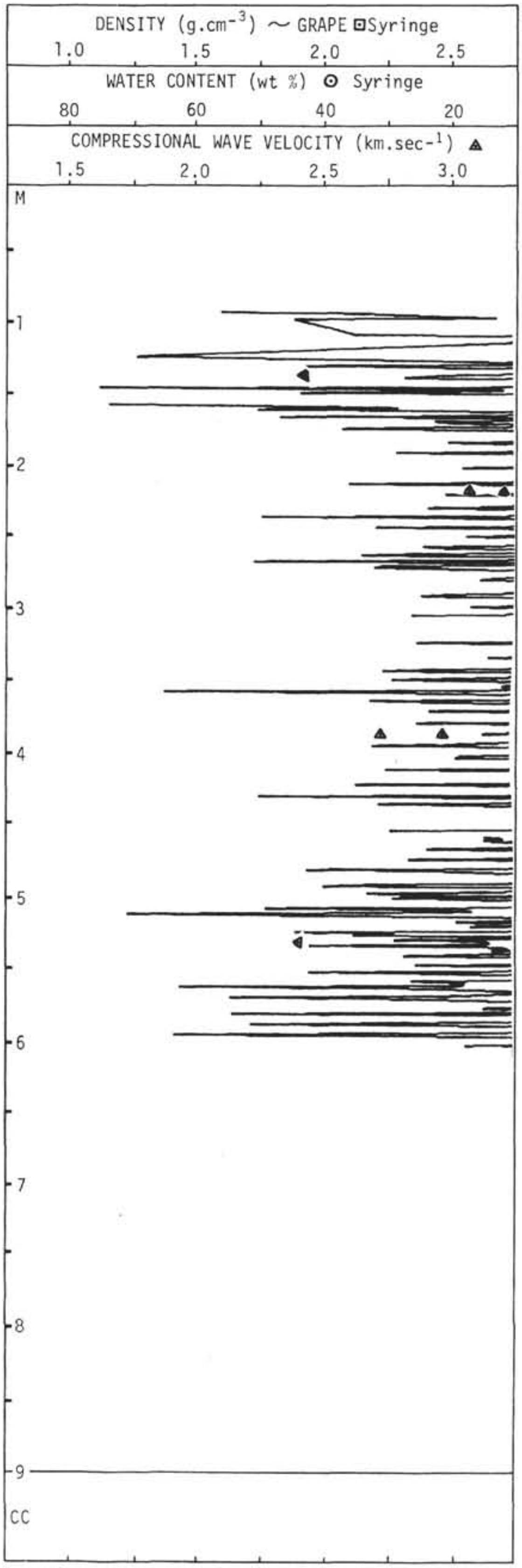
342-7



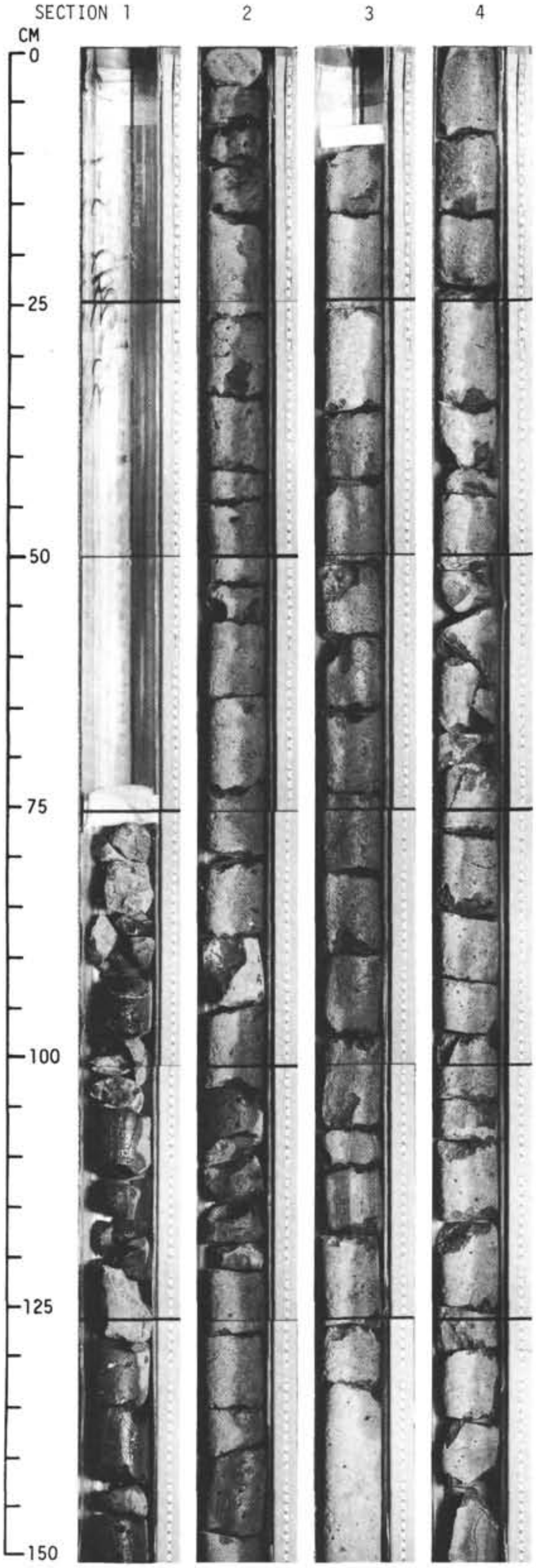
For Explanatory Notes, see Chapter 1



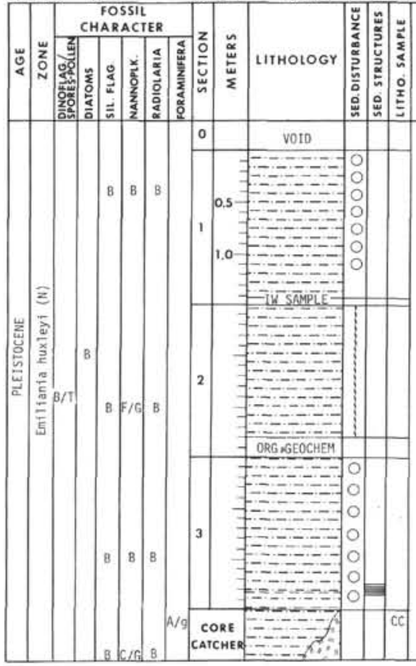
342-8



For Explanatory Notes, see Chapter 1



SITE 343 **HOLE** **CORE** 1 **CORED INTERVAL**: 0.0-3.0 m



LITHOLOGIC DESCRIPTION

5YR 4/1
10YR 4/2
5YR 3/2
10YR 4/1

Colors: dark yellowish brown (10YR 4/2), moderate brown (5YR 4/4), grayish brown (5YR 3/2). Soft, soupy, massive, structureless. Pebble zones (clay clasts), firmer in Sec. 3, stratification suggested.

MAJOR LITHOLOGY

SANDY MUD (Smear CC)

25% Sand	45% Quartz
25% Silt	5% Feldspar
50% Clay	5% Heavy minerals
	3% Opaques
	40% Clay minerals
	1% Glauconite
	1% Volcanic glass
	5% Authigenic carbonate

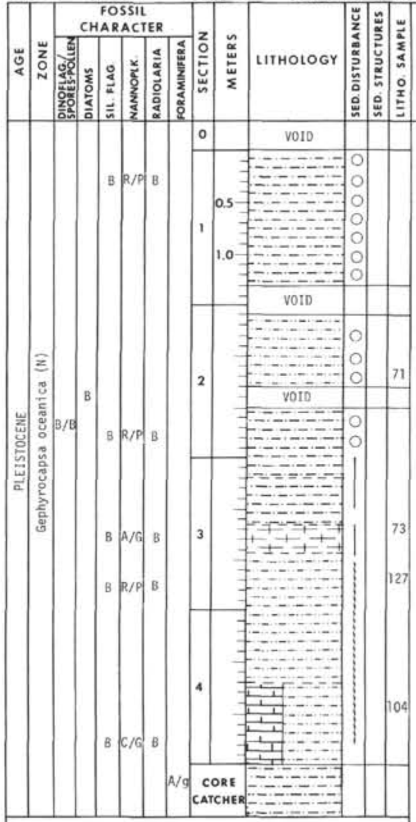
MINOR LITHOLOGY

VOLCANIC ASH (Smear CC)

80% Sand	2% Quartz
10% Silt	5% Opaques
10% Clay	80% Volcanic glass
	0- 3% Glauconite
	TR% Pyrite, Nannofossils
	0- 5% Foraminifera
	2% Heavy minerals
	15% Clay minerals

Carbon-Carbonate (PP)
1-2 (top) (0.34, 0.41)
1-2 (bottom) (0.46, 0.78)

SITE 343 **HOLE** **CORE** 2 **CORED INTERVAL**: 3.0-12.5 m



LITHOLOGIC DESCRIPTION

10YR 4/2
10YP 4/2
5YR 4/4
5YR 5/6
5Y 6/1
5Y 4/1
10YR 4/2
5YR 4/4
5YR 4/1
5Y 6/1
10YR 4/1

Colors: dark yellowish brown (10YR 4/2), moderate brown (5YR 4/4), light brown (5YR 5/6), light olive gray (5Y 6/1), olive gray (5Y 4/1). Secs. 1-2 has scattered ign.-meta. pebbles, massive, drilling breccia-soupy; Sec. 3 (0-20), soft, faint laminae, scattered very fine pebbles; (20-65), laminated-thin stratified, soft, firm, syndeposition contorted strata; (65-90) massive, soft-firm, terrigenous debris; (90-150 cm) soupy-relict laminae?; Sec. 4 - originally interstratified-laminated, no noticeable pebbles.

MAJOR LITHOLOGY

MUD (Smears 2-71, 3-127)

20% Sand	15-30% Quartz
30-35% Silt	2- 3% Feldspar
55-60% Clay	TR- 2% Heavy minerals
	1- 5% Opaques
	1% Volcanic glass
	55-62% Clay minerals
	TR% Glauconite
	0-TR% Dolomite rhombs
	3- 7% Authigenic carbonate
	0- 3% Foraminifera
	0- 5% Nannofossils
	0-TR% Radiolarians

MINOR LITHOLOGIES

a) FORAMINIFERAL NANNOFOSSIL OOZE (Smear 3-73)

7% Quartz
2% Feldspar
1% Heavy minerals
10% Authigenic carbonate
10% Foraminifera
70% Nannofossils
TR% Opaques, Volcanic glass, Sponge spicules, Glauconite

b) CALCAREOUS MUD (Smear 4-104)

10% Sand	15% Quartz
20% Silt	3% Feldspar
70% Clay	1% Mica
	1% Heavy minerals
	1% Foraminifera
	2% Opaques
	52% Clay minerals
	15% Authigenic carbonate
	10% Nannofossils
	TR% Volcanic glass, Glauconite

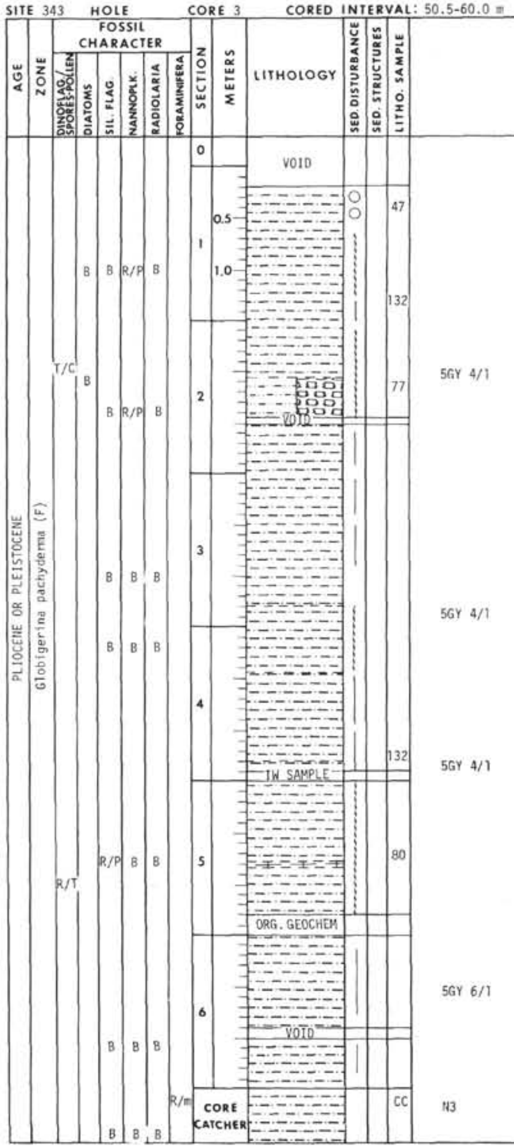
Grain Size (DSDP)
3-5 (20.1, 29.3, 50.6)
4-35 (20.9, 31.9, 47.2)

X-Ray (BP)

3-7		4-38	
22%	Mont.	20%	Mont.
40%	Ill.	50%	Ill.
16%	Kaol.	15%	Kaol.
21%	Chlo.	21%	Chlo.
A	Quartz, Plag.	A	Quartz
P	Micas	P	Micas, Plag.
P	Calcite	TR%	Calc.

Explanatory notes in Chapter 1

SITE 343 HOLE CORE 3 CORED INTERVAL: 50.5-60.0 m



LITHOLOGIC DESCRIPTION

Colors: dark gray (N3), dark greenish gray (5GY 4/1) (5GY 6/1). Generally intense deformation. Sec. 1 - soupy unconsol. sand with clay; may have had pre-existing bedding, few pebbles; Sec. 2 - incorporated sand; Sec. 3 - scattered pebbles (0-.5 cm), soft to firm. Clayey; Sec. 4 - sand with clay laminae; Sec. 5 - very thinly interstratified, soft+firm.

MAJOR LITHOLOGY
SANDY MUD (Smears 1-47, 1-132, CC)

50-65% Sand	45-50% Quartz
15-30% Silt	15% Feldspar
15-20% Clay	0- 1% Mica
	5-12% Heavy minerals
	TR- 2% Opaques
	0- 3% Volcanic glass
	11-20% Clay minerals
	0- 2% Glauconite
	5- 7% Authigenic carbonate
	1- 3% Nannofossils

MINOR LITHOLOGIES
a) MUD (Smear 4-132)

20% Sand	60% Quartz
55% Silt	10% Feldspar
17% Clay	TR% Mica
	2% Heavy minerals
	2% Opaques
	5% Volcanic glass
	12% Clay minerals
	TR% Glauconite
	5% Authigenic carbonate
	1% Foraminifera
	TR% Nannofossils

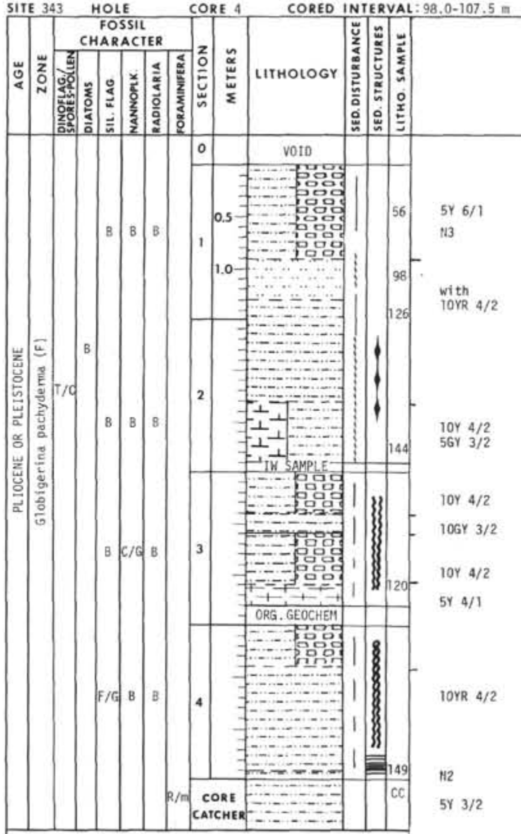
b) CALCAREOUS MUD (Smear 2-77)
15% Quartz
2% Feldspar
50% Clay minerals
15% Authigenic carbonate
15% Nannofossils
TR% Mica, Heavy minerals, Opaques, Glauconite

c) RADIOLARIAN DIATOM OOZE (Smear 5-80)
1% Quartz
1% Opaques
5% Volcanic glass
10% Clay minerals
40% Diatoms
40% Radiolarians
TR% Sponge spicules
1% Silicoflagellates

Carbon-Carbonate (DSDP)
2-75 (1.7, 0.5, 10)
Carbon-Carbonate (PP)
3-5 (top) (0.27, 0.59)
3-5 (bottom) (0.25, 0.44)
Grain Size (DSDP)
2-139 (69.1, 17.8, 13.1)
X-Ray (BP)
5-81

74%	Mont.
13%	Ill.
11%	K/C
A	Quar.
P	Micas, Plag.

SITE 343 HOLE CORE 4 CORED INTERVAL: 98.0-107.5 m



LITHOLOGIC DESCRIPTION

Colors: olive gray (5Y 3/2), light olive gray (5Y 6/1), dark gray (N3), dark yellow brown (10YR 4/2), grayish olive (10Y 4/2), grayish olive green (5GY 3/2), dusky yellow green (10GY 3/2), grayish black (N2). Sec. 1 - interstratified (2-7 cm), soft, firm, basalt pebble (3.5 cm); Sec. 2 (80-150 cm) scattered pebbles, locally bioturbated (*Chondrites*); Sec. 3 - scattered pebbles, *Helminthoida* burrows, massive, firm; Sec. 4 - as Sec. 3 - thin stratification to base, *Chondrites* burrows, mottling.

MAJOR LITHOLOGIES
MUD (Smears 1-126, 4-149, CC)

3- 8% Sand	20% Quartz
22-32% Silt	2- 5% Feldspar
65-70% Clay	TR% Mica
	2% Heavy minerals
	1- 7% Opaques
	1- 2% Volcanic glass
	65-70% Clay minerals
	TR- 2% Authigenic carbonate

MINOR LITHOLOGIES
a) SILT (Smear 1-98)

5% Sand	65% Quartz
85% Silt	14% Feldspar
10% Clay	4% Heavy minerals
	3% Opaques
	2% Volcanic glass
	10% Clay minerals
	TR% Glauconite
	2% Authigenic carbonate

b) CALCAREOUS MUD (Smear 2-144)

7% Sand	15% Quartz
38% Silt	2% Feldspar
55% Clay	TR% Mica
	1% Heavy minerals
	2% Opaques
	TR% Volcanic glass
	55% Clay minerals
	TR% Glauconite
	15% Authigenic carbonate
	10% Nannofossils

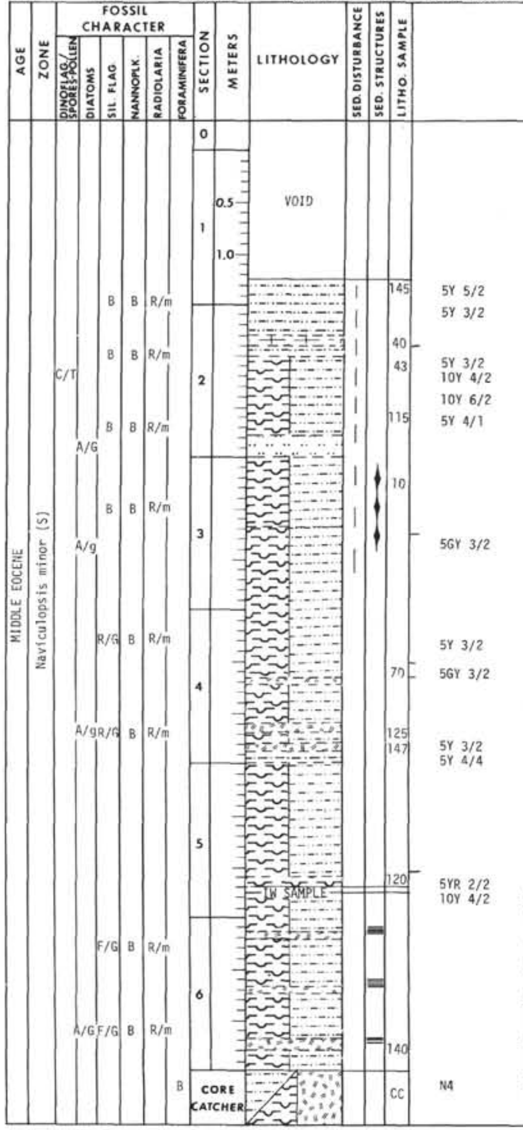
c) SANDY FORAMINIFERAL OOZE (Smear 3-120)
d) MARLY NANNOFOSSIL OOZE (Smear 1-56)

Carbon-Carbonate (DSDP)
2-75 (0.5, 0.3, 2)
4-70 (2.4, 0.1, 19)
Carbon-Carbonate (PP)
4-3 (top) (0.12, 3.88)
4-3 (bottom) (0.11, 3.41)
Grain Size (DSDP)
2-110 (39.7, 22.4, 37.9)
X-Ray (BP)
3-19

17%	Mont.
25%	Ill.
28%	Kaol.
28%	Chlo.
A	Quar.
P	Micas, Plag., Calc.

Explanatory notes in Chapter 1

SITE 343 **HOLE** **CORE** 5 **CORED INTERVAL:** 145.5-155.0 m



LITHOLOGIC DESCRIPTION

Colors: medium dark gray (N4), light olive gray (5Y 5/2), olive gray (5Y 3/2), dark gray (N3), greenish gray (5GY 6/1), grayish olive (10Y 4/2), pale olive (10Y 6/2), dusky yellow green (5GY 3/2), grayish brown (5Y 3/2) plus others. Sec. 1 - variegated, 3 cm sand laminations, large color variations; Sec. 2 - 5 cm color beds, mudstone clasts, color variations; Sec. 3 - as per Sec. 2, pyrite balls (2 mm), varying colors, bioturbation zones, hard zones; Sec. 4 - firm-stiff, massive with vague bedding. Color interbeds; Sec. 6 - 0.5-5 cm color interbeds, sharp boundaries.

MAJOR LITHOLOGIES

a) MUD (Smears 1-145, 2-40)

2- 5%	Sand	7-20%	Quartz
10-26%	Silt	2- 5%	Feldspar
69-88%	Clay	TR- 1%	Mica
		1- 2%	Heavy minerals
		1%	Opaques
		TR%	Volcanic glass
		67-88%	Clay minerals
		0-TR%	Glauconite
		0- 3%	Authigenic carbonate

b) MUDDY DIATOM OOZE (Smears 2-43, 3-10, 6-148)

5-15%	Quartz
TR- 3%	Mica
TR%	Heavy minerals
2- 7%	Opaques
0- 7%	Volcanic glass
14-20%	Clay minerals
TR%	Glauconite
0- 3%	Authigenic carbonate
40-50%	Diatoms
5-15%	Radiolarians
7-10%	Sponge spicules

c) DIATOMACEOUS MUDDY ASH (Smears 4-70, 4-75, CC)

2- 5%	Quartz
0- 2%	Feldspar
1- 3%	Mica
TR%	Heavy minerals
1- 3%	Opaques
30-50%	Volcanic glass
20-38%	Clay minerals
15-20%	Diatoms
5- 7%	Radiolarians
0- 7%	Sponge spicules
TR%	Silicoflagellates

MINOR LITHOLOGIES

a) SANDY MUD (Smear 4-147)
b) DIATOM OOZE (Smear 5-120)
c) SANDY MUD (Smear 2-115)
d) ALTERED? NANNOFOSSIL OOZE (Smear 4-148)

Carbon-Carbonate (DSDP)
2-78 (0.8, 0.0, 6)

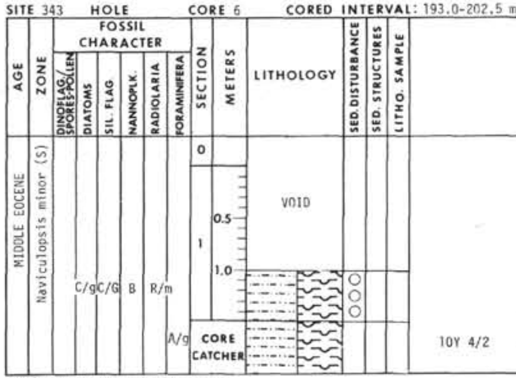
Carbon-Carbonate (PP)
5-5 (top) (0.07, 0.61)
5-5 (bottom) (0.39, 0.05)

Grain Size (DSDP)
3-84 (17.1, 48.3, 34.6)

X-Ray (BP)
2-74

63%	Mont.	32%	Ill.
18%	K/C	P	Quar., Micas, Plag.

SITE 343 **HOLE** **CORE** 6 **CORED INTERVAL:** 193.0-202.5 m



LITHOLOGIC DESCRIPTION

Colors: grayish olive (10Y 4/2), dark olive gray (5Y 3/2), brownish black (5Y 2/1).

MUDDY DIATOM OOZE

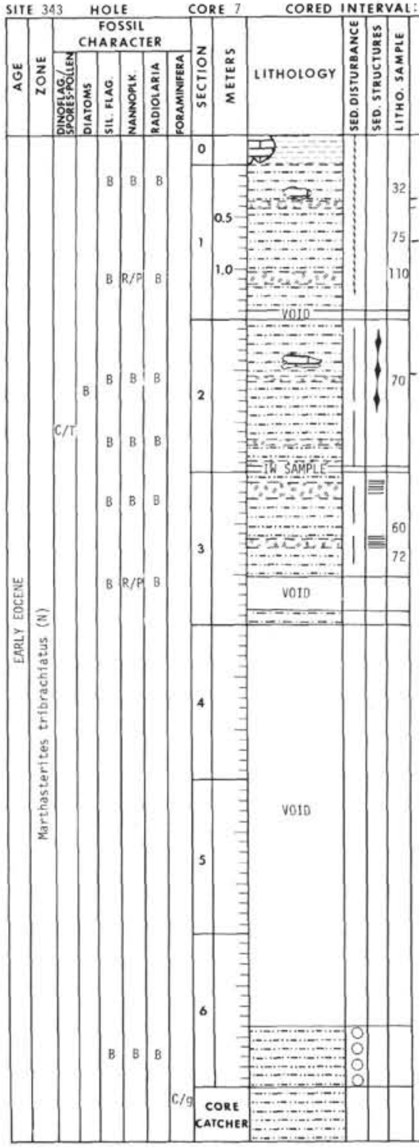
Carbon-Carbonate (DSDP)
1-110 (1.1, 0.0, 10)

X-Ray (BP)
1-129

P	Mont.
A	Ill.
A	K/C
TR%	Quar.

Explanatory notes in Chapter 1

SITE 343 HOLE CORE 7 CORED INTERVAL: 202.5-212.0 m



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

LITHOLOGIC DESCRIPTION

Colors: olive black (5Y 2/1), dark greenish gray (5G 4/1), olive gray (5Y 3/2), medium bluish-gray (5B 5/1). Sec. 1 - firm-stiff, 1-2 mm ash stringers, vague bedding, limestone pebbles; Sec. 2 - firm, moderate deformation minor bioturbation, color gradations; Sec. 3 - 2-5 cm bedding, stiffens below 65 cm; micronodules in Sec. 1 (110 cm).

MAJOR LITHOLOGY

MUD (Smears 2-70, 3-60)

0- 2% Sand	10-15% Quartz
20-33% Silt	1- 3% Feldspar
65-80% Clay	0- 2% Mica
	3- 8% Opaques
	TR- 5% VOlcanic glass
	65-80% Clay minerals
	2- 5% Authigenic carbonate

MINOR LITHOLOGIES

a) VOLCANIC ASH (Smears 1-110, 3-72)
0- 20% Mica
80-100% Palagonite

b) ALTERED NANNOFOSSIL OOZE (Smear 1-32)
100% Authigenic carbonate

Carbon-Carbonate (DSDP)
3-60 (0.4, 0.3, 1)

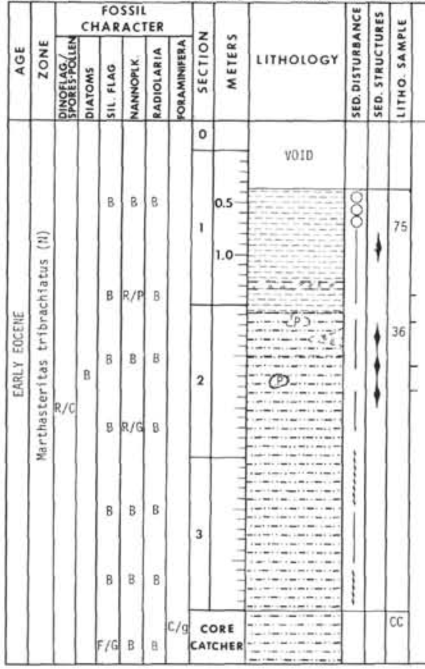
Carbon-Carbonate (PP)
7-3 (top) (0.97, 0.04)
7-3 (bottom) (1.32, 0.01)

Grain Size (DSDP)
1-50 (2.1, 37.9, 60.0)

X-Ray (BP)
1-120

73%	Mont.
2%	Ill.
11%	Kaol.
11%	Chlo.
P	Quar., Plag.
TR%	Micas, Dolo.

SITE 343 HOLE CORE 8 CORED INTERVAL: 212.0-221.5 m



5GY 4/1
5YR 2/2
5G 4/1
5GY 4/1
5Y 4/1
5B 5/1
5YR 2/1

LITHOLOGIC DESCRIPTION

Colors: brownish black (5YR 2/1), dark greenish-gray (5GY 4/1), dusky brown (5YR 2/2), olive gray (5Y 4/1), medium blue gray (5B 5/1). Sec. 1 - moderate deformation, color mottling, bioturbation 70-80 cm; Sec. 2 - pyrite nodules (bedded) (3 cm), lithified, bioturbated; Sec. 3 - intense but firm, color mottled, scattered claystone pebbles, 2 cm bedded zones.

MAJOR LITHOLOGIES

a) CLAY (Smear 1-75)

1% Sand	65% Clay minerals
3% Silt	20% Fecal pellets
96% Clay	15% Glauconite

b) MUD (Smear CC)

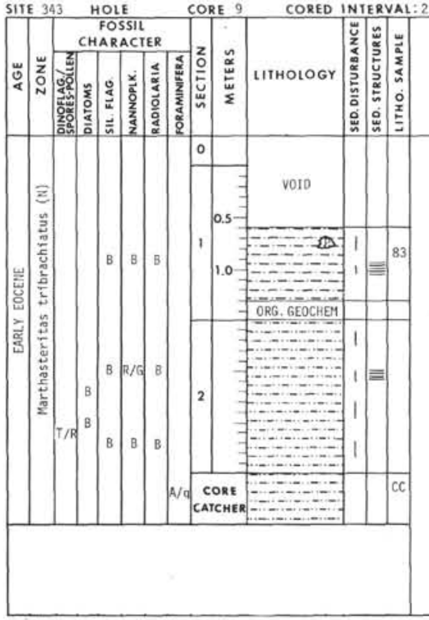
MINOR LITHOLOGY

ASH (Smear 2-36)

Carbon-Carbonate (DSDP)
3-30 (1.2, 0.4, 7)

Grain Size (DSDP)
3-46 (1.2, 37.5, 61.2)

SITE 343 HOLE CORE 9 CORED INTERVAL: 221.5-231.0 m



5YR 2/1
N5, N4
5YR 4/1
N3 with 5YR 4/1, N4
5B 5/1

LITHOLOGIC DESCRIPTION

Colors: medium bluish-gray (5B 5/1), brownish black (5YR 2/1), medium gray (N5), brownish gray (5YR 4/1), medium dark gray (N4). Laminated - thinly laminated, color layers.

MAJOR LITHOLOGIES

a) SANDY MUD (Smear 1-83)

20% Sand	2% Quartz
45% Silt	1% Heavy minerals
35% Clay	40% Opaques
	10% Volcanic glass
	35% Clay minerals
	7% Authigenic carbonate
	5% Nannofossils

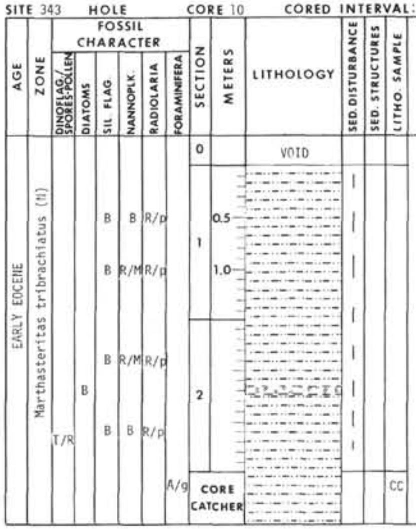
b) MUD (Smear CC)
7% Quartz
7% Mica
1% Heavy minerals
3% Opaques
TR% Volcanic glass
80% Clay minerals
TR% Pyrite

Carbon-Carbonate (PP)
9-1 (top) (0.08, 1.05)
9-1 (bottom) (1.34, 0.04)

Grain Size (DSDP)
2-130 (1.6, 52.3, 46.1)

Explanatory notes in Chapter 1

SITE 343 HOLE CORE 10 CORED INTERVAL: 231.0-240.5 m



LITHOLOGIC DESCRIPTION

Colors: greenish black (5G 2/1), medium dark gray (N4), brownish gray (5YR 4/1), dusky yellow green (10GY 3/2), olive gray (5Y 4/1). Slight deformation, thinly laminated, color mottled.

5YR 4/1

N4

MAJOR LITHOLOGY

MUDSTONE (Smear CC)

5% Sand	25% Quartz
52% Silt	7% Feldspar
43% Clay	3% Mica
	12% Opaques
	2% Volcanic glass
	43% Clay minerals
	5% Glauconite
	3% Authigenic carbonate

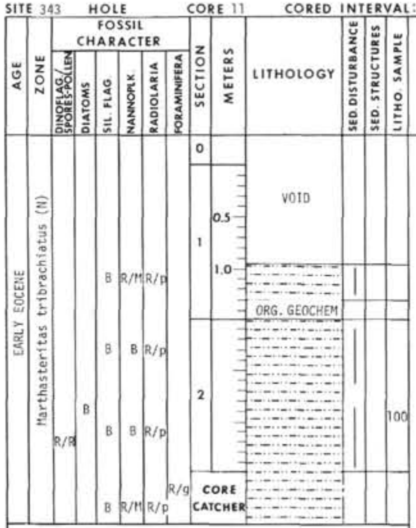
N4

Carbon-Carbonate (DSDP)
2-40 (0.9, 0.5, 3)

Grain Size (DSDP)
2-60 (0.3, 41.3, 58.4)

5G 2/1

SITE 343 HOLE CORE 11 CORED INTERVAL: 240.5-250.0 m



LITHOLOGIC DESCRIPTION

Colors: dark greenish-gray (5GY 4/1), brownish gray (5Y 4/1), medium dark gray (N4), grayish olive green (5GY 3/2). Mottled, originally stratified.

MAJOR LITHOLOGY

N4
5YR 4/1

MUD (Smear 2-100)

6% Sand	4% Mica
19% Silt	8% Heavy minerals
75% Clay	75% Clay minerals
	TR% Palagonite
	8% Opaques
	TR% Glauconite
	2% Authigenic carbonate

Carbon-Carbonate (DSDP)
2-70 (0.4, 0.3, 0)

Carbon-Carbonate (PP)
11-2 (top) (0.50, 0.04)
11-2 (bottom) (0.55, 0.06)

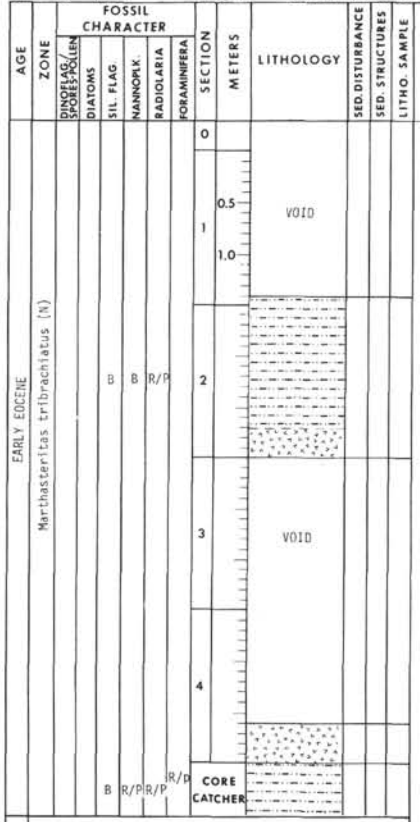
5GY 4/1

Grain Size (DSDP)
2-80 (5.7, 28.2, 66.1)

X-Ray (BP)
2-40

12%	Mont.
32%	Ill.
19%	Kaol.
36%	Chlo.
A	Quar.
P	Micas, Plag.
TR%	Dolo.

SITE 343 HOLE CORE 12 CORED INTERVAL: 250.0-252.0 m



LITHOLOGIC DESCRIPTION

Colors: greenish black (5G 2/1), olive gray (5Y 3/2).

Sec. 1 - MUD - intense deformation, claystone clasts (rip-up).

5Y 3/2

Sec. 2 - (0-3 cm) probable base of turbidite siltstone with mudstone rip-up clasts. Intense deformation (N3) penecontemporate folding; (3-12 cm) - 3 thin-graded beds (CDE). 4-5 cm ⁄⁄ stratified siltstone, mudstone (5Y 4/1) (5Y 2/1) minor unconformity; (12-25 cm) - complex Bouma sequence granule-size claystone conglomerate at base; ⁄⁄ stratified, siltstone above, x-stratified→very fine siltstone (with current ripple laminae, followed by ⁄⁄ laminae siltstone/claystone; (25-33 cm) - thin ⁄⁄ laminae gray black siltstone, not graded = Bouma D; unconformable above, with claystone clasts - from E ; (33-38 cm) - thin gray black massive (N2) silty→claystone, base unconformable; (38-62 cm) - thick massive silt→massive claystones at top. Dark gray (N3) - gray black (N2) - olive black (5Y 2/1). Silt layers pyritized with pyrite nodules, rip-up claystone clasts, calcite veins, local folding, possible x-stratified - ADE sequence; (62-70 cm) - graded, deformed with claystone, rip-up clasts, pull-apart layers with internal contortions - dark gray (N3) → massive mudstones; (70-76 cm) - dark gray (N3) - olive black (5Y 2/1) graded bed, very fine sand/silt → mudstones; (76-86 cm) - N3-N2 graded sequence, very fine sand/silt-channeled into mudstone, x-bed flute cast filling→⁄⁄ laminae-silt mud→mudstone = CDE; (86-107 cm) - N2-5Y 2/1 graded sequence - conglomerate→mudstone conglomerate clasts - mudstone (1.5 cm) subrounded, calcite veins, thin, flat laminae in siltstone→mudstone ABDE, possible x-stratified in C; (107-120 cm) - N2 to N5 conglomerate breccia subrounded - subangular clasts (2.5 cm) in $CaCO_3$ mudstone, calcite veins, mudstone clasts, upward graded to siltstone - pyrite nodule.

5G 2/1

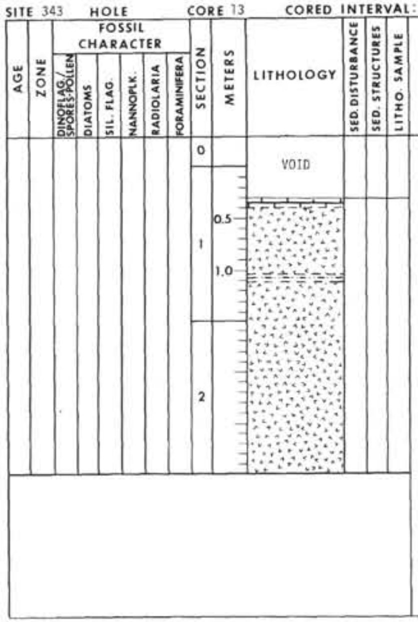
Smears (1-145, 2-82 = mudstone; 2-111 = claystone; 2-15, 2-61 = glauconitic mudstone)

*BASALT
Sec. 2 (118-130 cm) - drill pebbles of basalt; (130-150 cm) - grayish black (N2) basalt with pyrite impregnation.

Sec. 4 (110-150 cm) - drill pebbles of grayish black (N2) to medium dark gray (N4) basalt with plagioclase phenocrysts, and white calcite amygdules. Pyritization noted.

Explanatory notes in Chapter 1

SITE 343 HOLE CORE 13 CORED INTERVAL: 252.0-259.5 m



LITHOLOGIC DESCRIPTION

BASALT

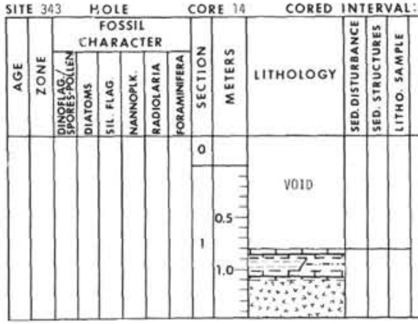
Sec. 1 (30-40 cm) - angular fragment of light olive gray clay limestone; (40-102 cm) - dark gray (N3) to grayish black (N3) basalt. Irregular white calcite amygdules in (0.2-2 mm) and cavities in (1-3 cm), filled by white calcite. Impregnation of pyrite rushes; (102-110 cm) - drill pebbles of mudstone; (110-150 cm) - medium dark gray (N4) basalt with pores and vesicles sometimes filled by white calcite, calcite veins.

Thin Section - altered chloritized basalt (dolerite-basalt), subdiabasic texture, skeletal plagioclase laths, devitrified glass relics, microphyric (8-9%), augite (2%), olivine (5%), plagioclase (2%).

Sec. 2 (0-37 cm) - dark gray (N3) to grayish black (N2) basalt; (37-55 cm) - drill fragments of basalt; (55-77 cm) - basalt with vesicles and cavites (3x5 cm) sometimes filled by calcite crystals. Slickensides. Pyritization noted; (77-150 - drill fragments of basalt, calcite crystals.

Thin Section - chloritized basalt (dolerite basalt), subdoleritic texture, microphyric (5-8%) (altered olivine, pyrite, plagioclase), chlorite, calcite amygdules.

SITE 343 HOLE CORE 14 CORED INTERVAL: 259.5-269.0 m

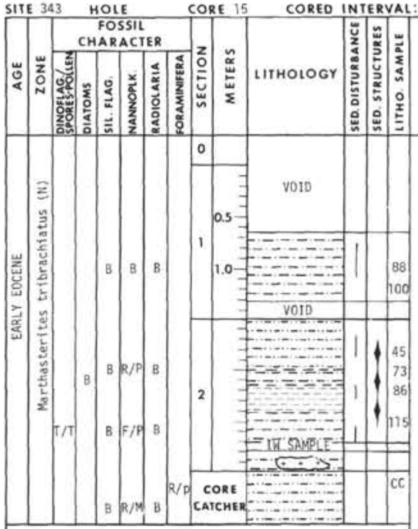


LITHOLOGIC DESCRIPTION

BASALT

Sec. 1 (80-85 cm) - angular fragments of phosphatic limestone; (85-110 cm) - small drill pebbles of claystone, mudstone and limestone. Round concretion of pyrite, angular fragment of limestone; (110-150 cm) - small drill fragments of medium dark gray (N4) basalt with dark green amygdules.

SITE 343 HOLE CORE 15 CORED INTERVAL: 269.0-278.5 m



LITHOLOGIC DESCRIPTION

Color: dark greenish-gray (5GY 4/1), olive gray (5Y 3/2), olive black (5Y 2/1), moderate-slight deformation, vague color bedding, firm-soft, massive with brittle zone 50-89 cm, Sec. 2. Some bioturbation - color streaking. Andesite pebble at Sec. 2.

5Y 3/2
5Y 2/1

MAJOR LITHOLOGIES

a) MUD (Smears 2-45, CC)

3- 5% Sand	4-15% Quartz
30% Silt	2-25% Feldspar
65-67% Clay	0- 3% Mica
	50-80% Clay minerals
	2- 7% Opaques
	0- 5% Glauconite
	1% Heavy minerals

5Y 3/2

b) CLAY (Smear 2-86)

5% Sand	5% Quartz
5% Silt	5% Mica/Chlorite
90% Clay	5% Opaques
	82% Clay minerals (ash)
	3% Glauconite

c) SANDY MUD (Smears 1-88, 1-100, 2-73, 2-115)

5GY 4/1

15-25% Sand	10-40% Quartz
30-50% Silt	5- 8% Feldspar
36-80% Clay	2- 5% Mica/Chlorite
	TR- 5% Heavy minerals
	7-10% Opaques
	36-82% Clay minerals
	0-15% Glauconite
	0- 2% Zeolites
	2-15% Carbonate

(High % of clay minerals may be chlorite.)

Carbon-Carbonate (DSDP)
2-110 (1.0, 0.8, 2)

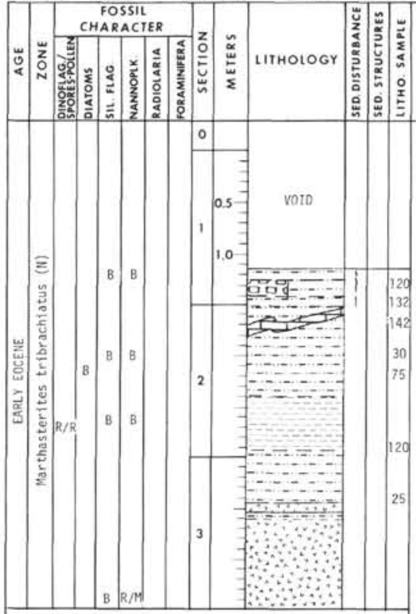
Carbon-Carbonate (PP)
15-1 (top) (0.55, 0.04)
15-1 (bottom) (0.62, 0.09)

X-Ray (BP)

2-39		2-86	
A	Mont.	13%	Mont.
77%	Ill.	8%	Ill.
22%	K/C	77%	K/C
A	Quar.	P	Quar.,
P	Micas,		Micas
	Plag.	TR%	Plag.

Explanatory notes in Chapter 1

SITE 343 HOLE CORE 16 CORED INTERVAL: 278.5-284.0 m



LITHOLOGIC DESCRIPTION

5Y 3/2
with
5YR 4/1

5GY 4/1

5G 4/1

Sec. 1 (115-125 cm) - olive gray (5Y 3/2), soft, mottled, calcite patches; (125-140 cm) - dark greenish-gray (5GY 4/1), lithified, with calcite veins, 1-2 mm bedding, veins (1-2 mm); (140-150 cm) - fine bedded-chlorite (altered zone?).
Sec. 2 olive gray (5Y 3/2) with brownish-gray (5YR 4/1), slight deformation, fine bedded, calcite patches, brecciated; (125-150 cm) - up to 1 cm clasts, calcite veining.

MAJOR LITHOLOGIES

a) MUD (Smears 1-148, 1-120, 3-25)

7-10% Sand	15% Quartz
20-30% Silt	0- 5% Feldspar
65-72% Clay	TR- 3% Mica
	1- 2% Heavy minerals
	2- 3% Opaques
	0- 2% Volcanic glass
	64-72% Clay minerals
	2- 4% Glauconite
	5% Authigenic carbonate

b) GLAUCONITIC SANDY MUD (Smear 1-142)

30% Sand	5% Quartz
40% Silt	2% Mica
40% Clay	20% Opaques
	15% Volcanic glass
	38% Clay minerals
	25% Glauconite

MINOR LITHOLOGIES

a) CALCAREOUS MUD (Smear 1-132)

5% Sand	10% Quartz
47% Silt	2% Mica
48% Clay	TR% Heavy minerals
	2% Opaques
	48% Clay minerals
	7% Glauconite
	30% Authigenic carbonate
	TR% Nannofossils

b) LIMESTONE (Smear 2-30)

7% Opaques
93% Authigenic carbonate

Carbon-Carbonate (DSDP)
1-123 (1.2, 0.0, 10)

X-Ray (BP)

1-146		3-24	
79%	Mont.	81%	Mont.
2%	Ill.	13%	Ill.
18%	K/C	8%	Kaol.
A	Quar.	10%	Chlo.
P	Micas	P	Quar.
TR%	Plag.	TR%	Calc, Micas

BASALT
Sec. 3 (45-55 cm) - fragmental, grayish black (N2), with coating of black clay; (55-63 cm) - mudstone; (63-150 cm) - basalt, fine-grained with slickensides,, pyritization. Chloritized variolitic basalt (dolerite basalt), subdoleritic texture, variolitic, highly chloritized.

Explanatory notes in Chapter 1

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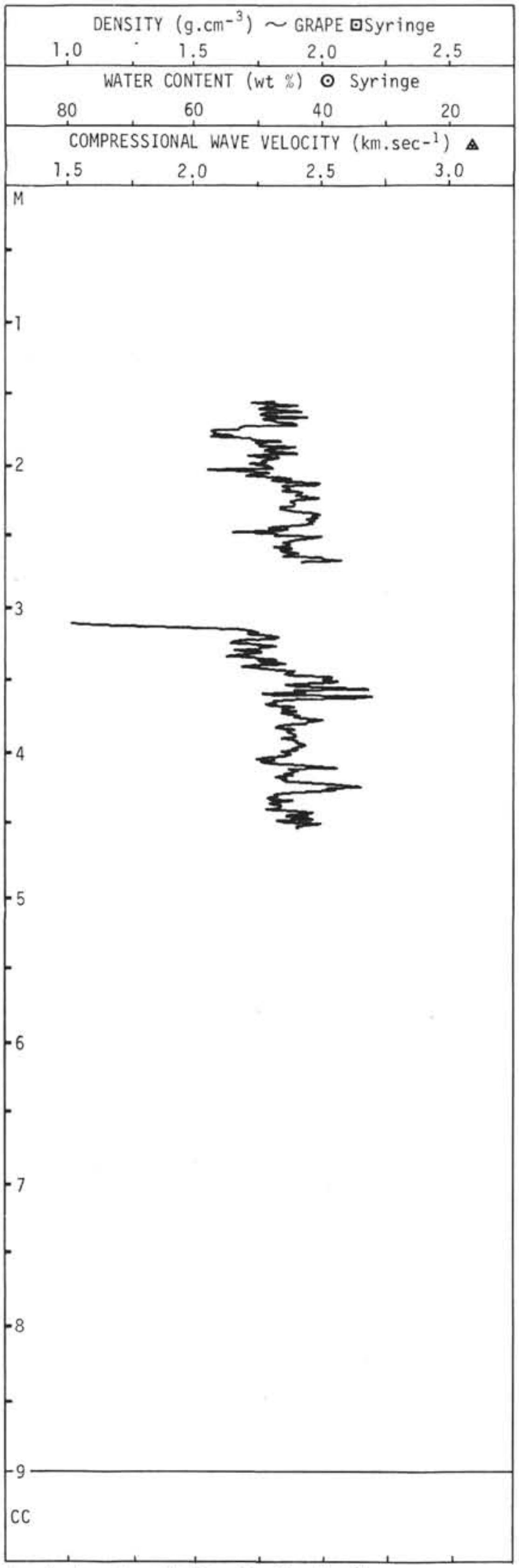

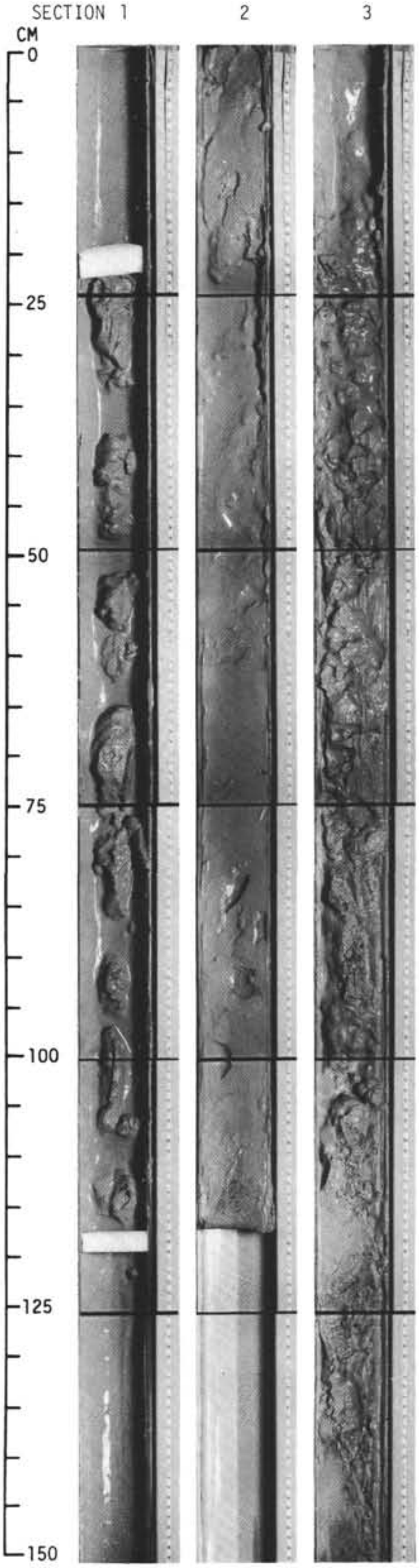

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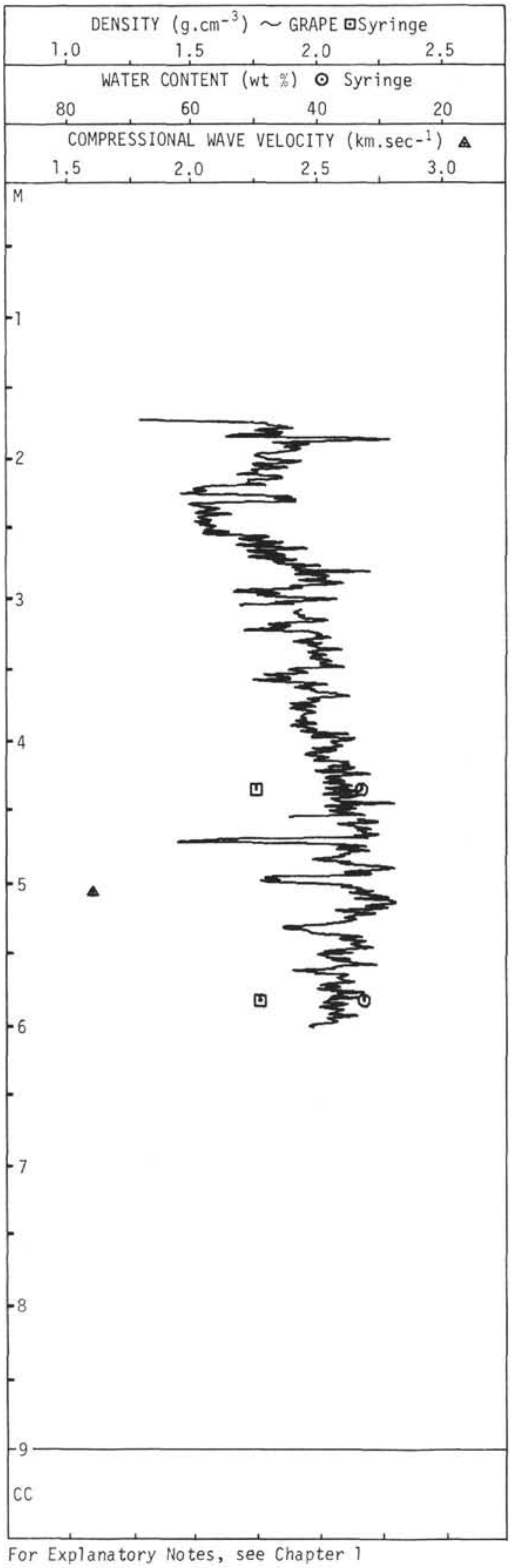

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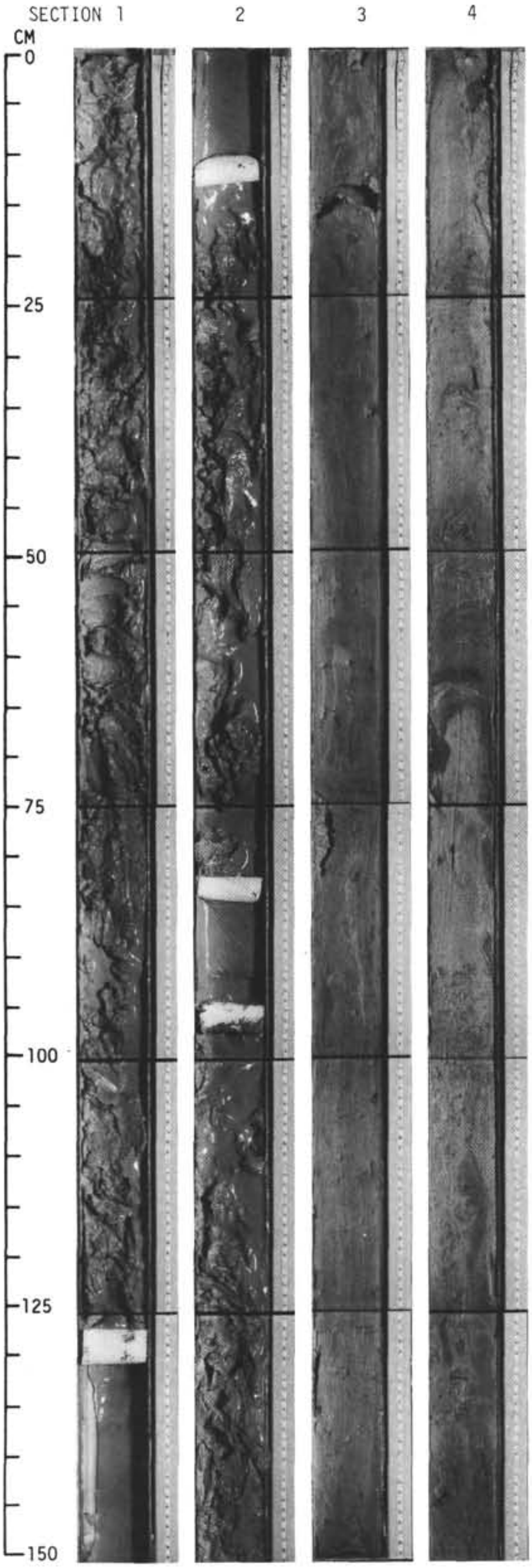

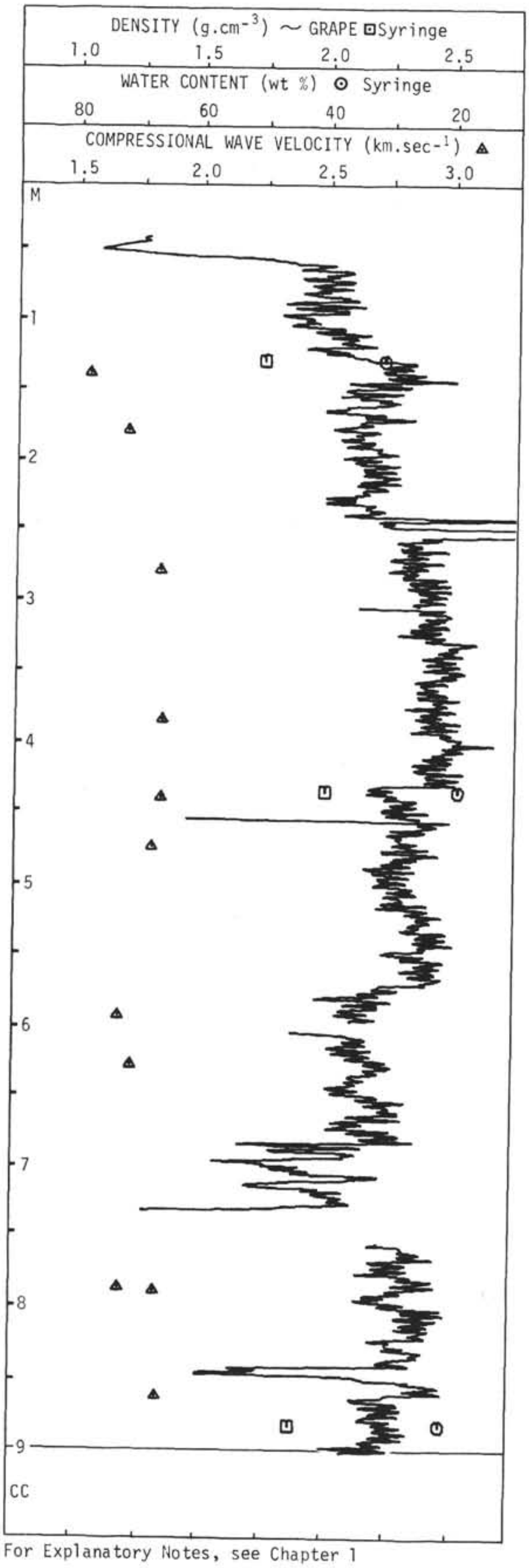

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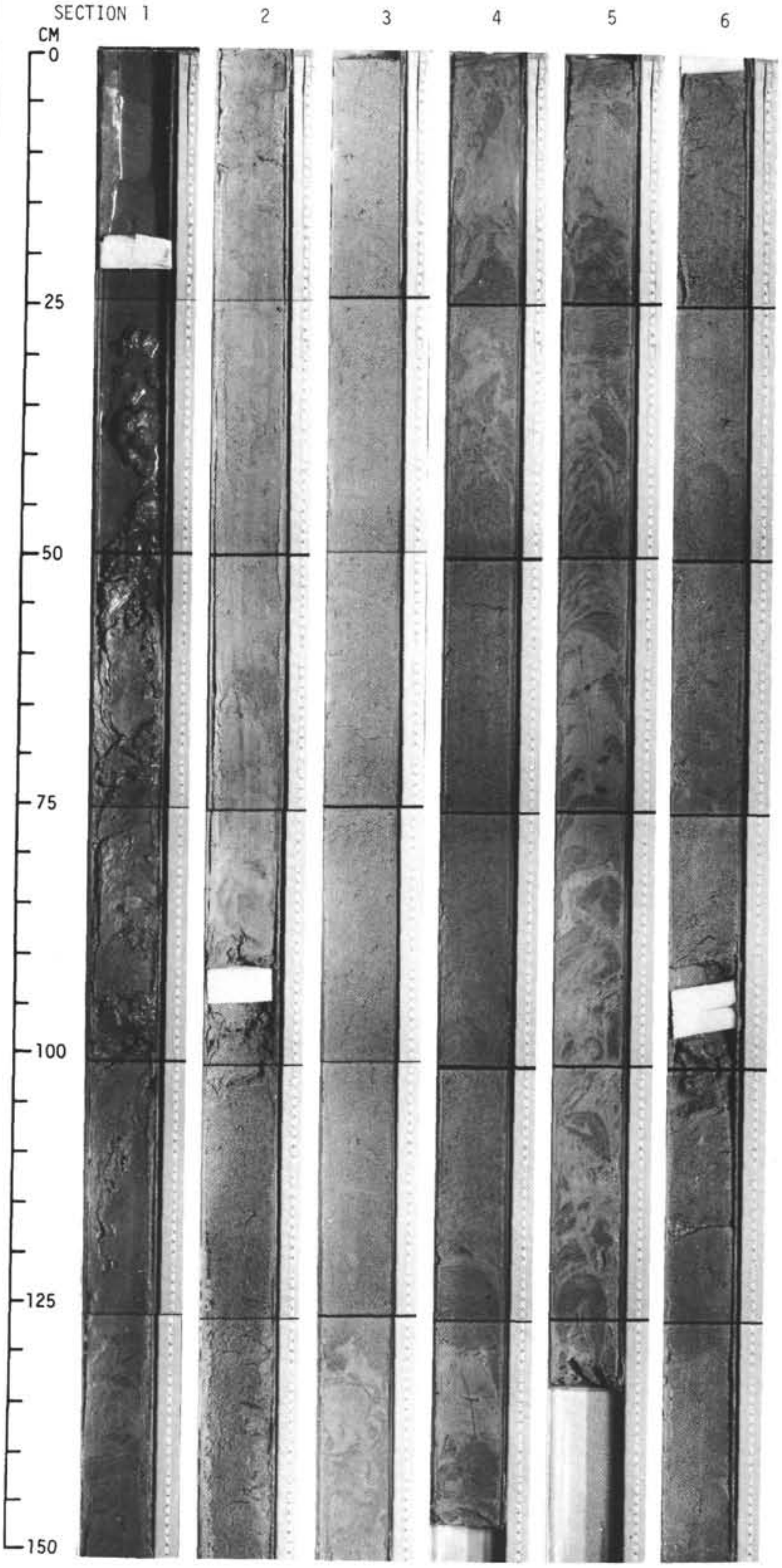

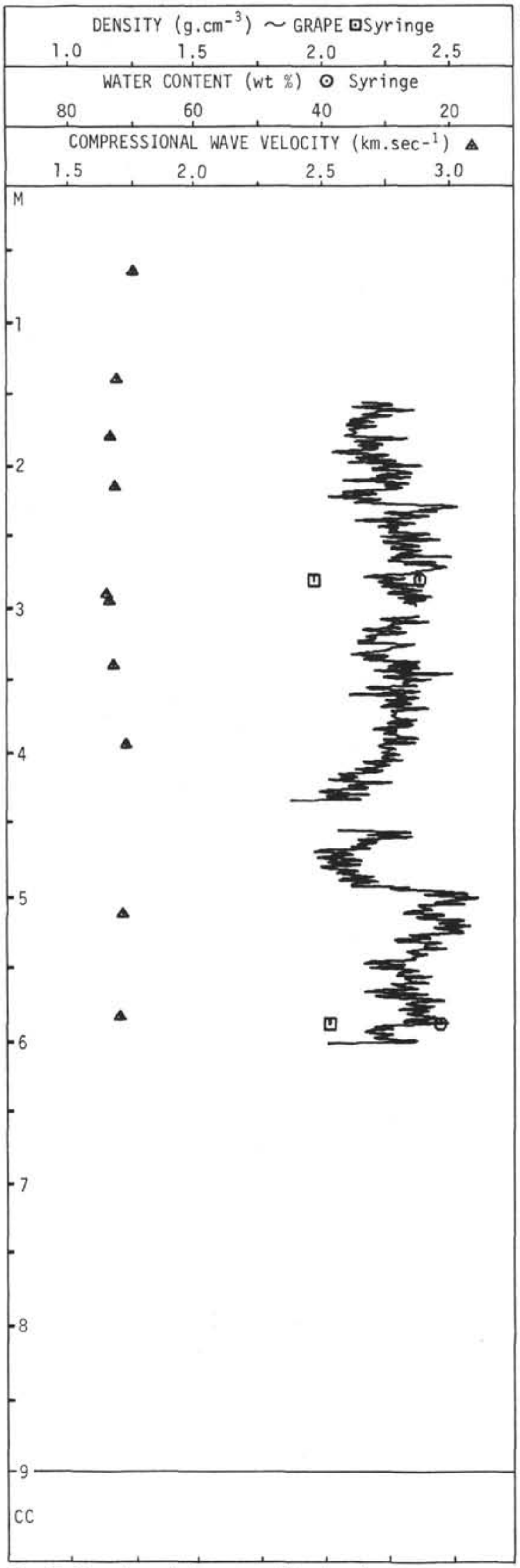

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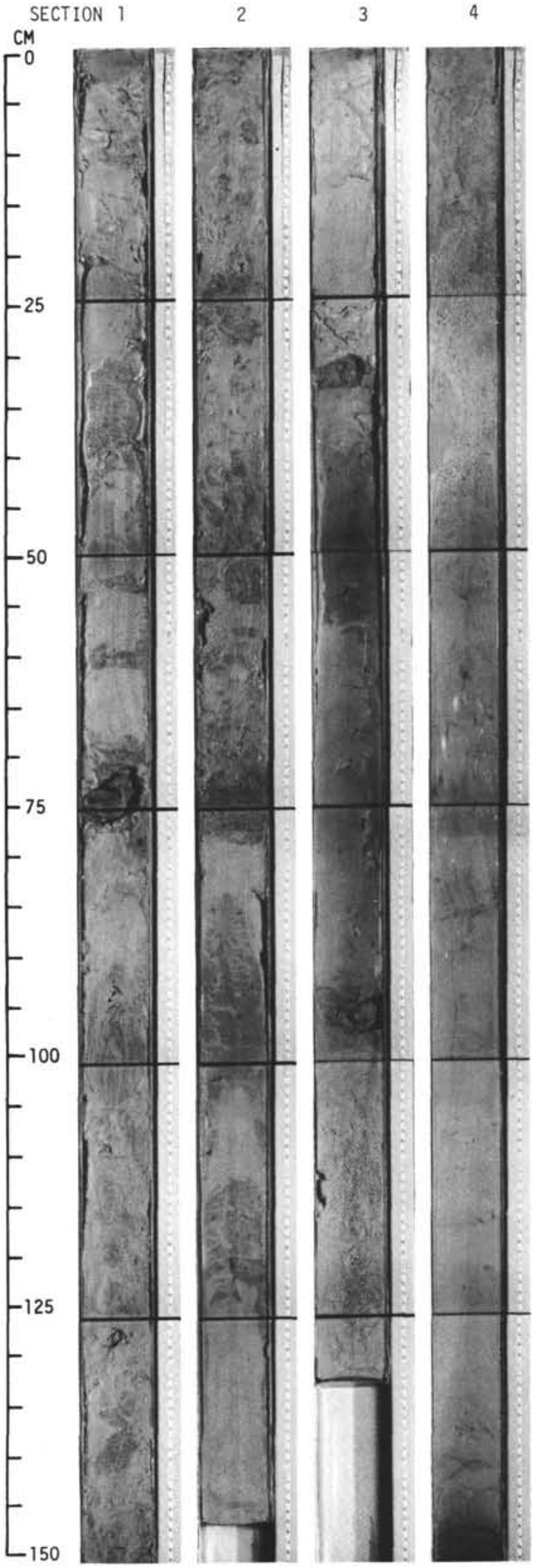

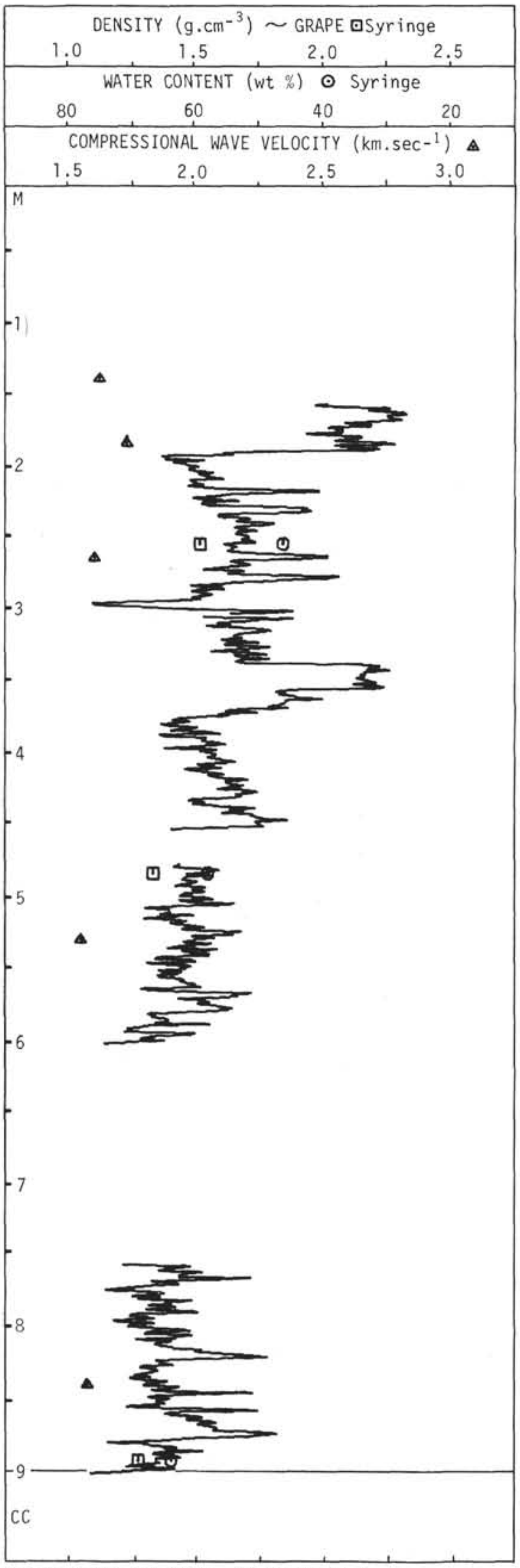

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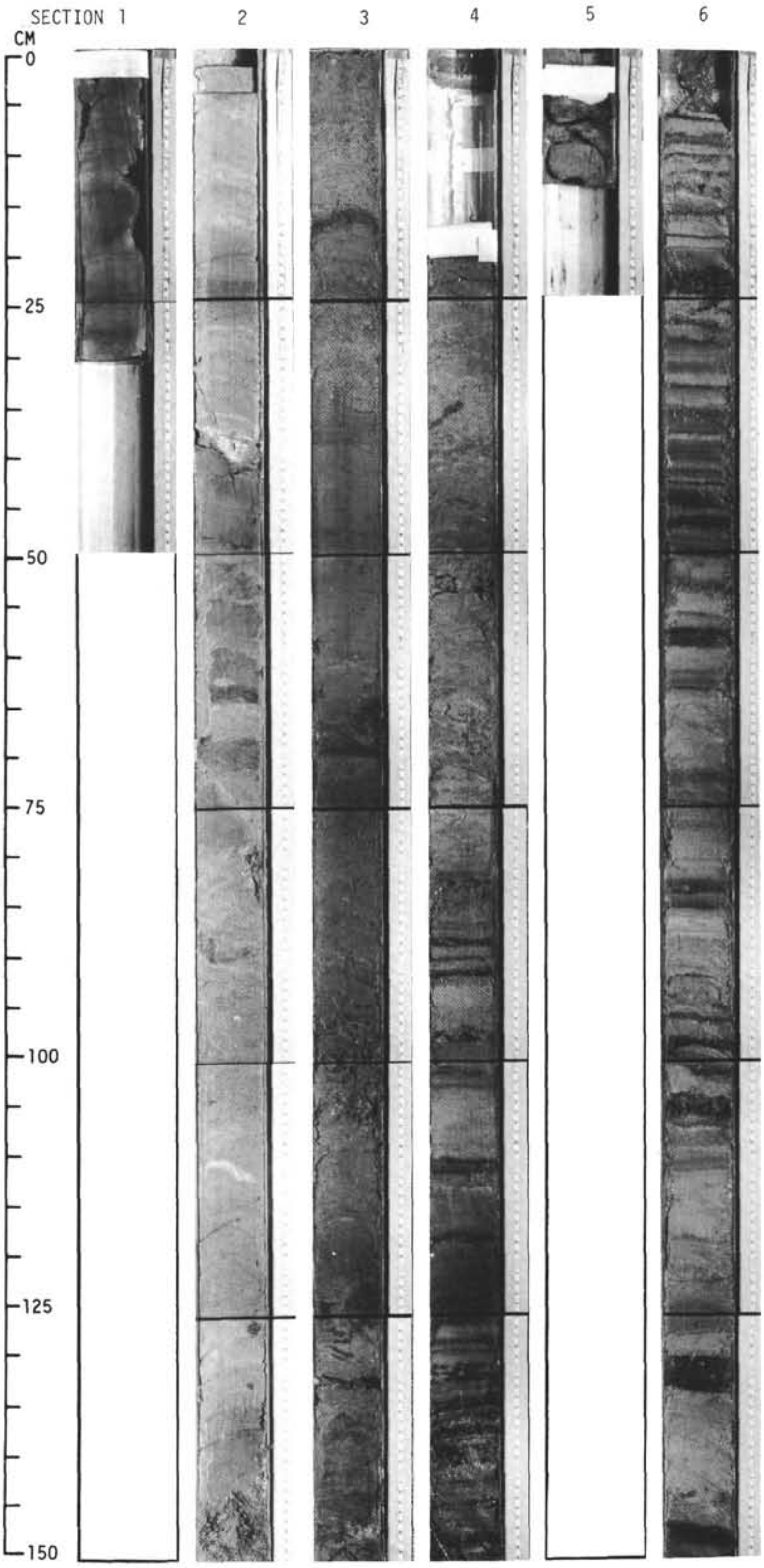

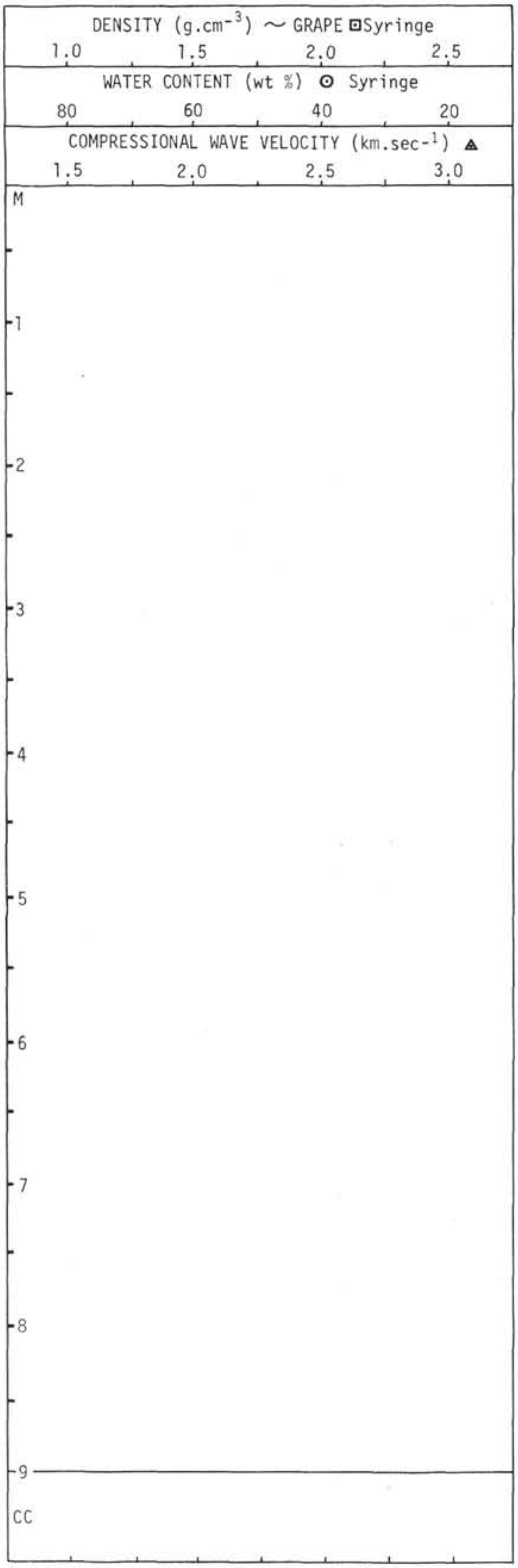

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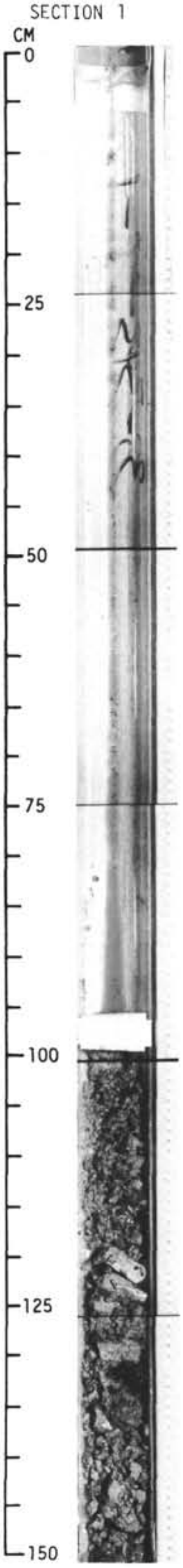

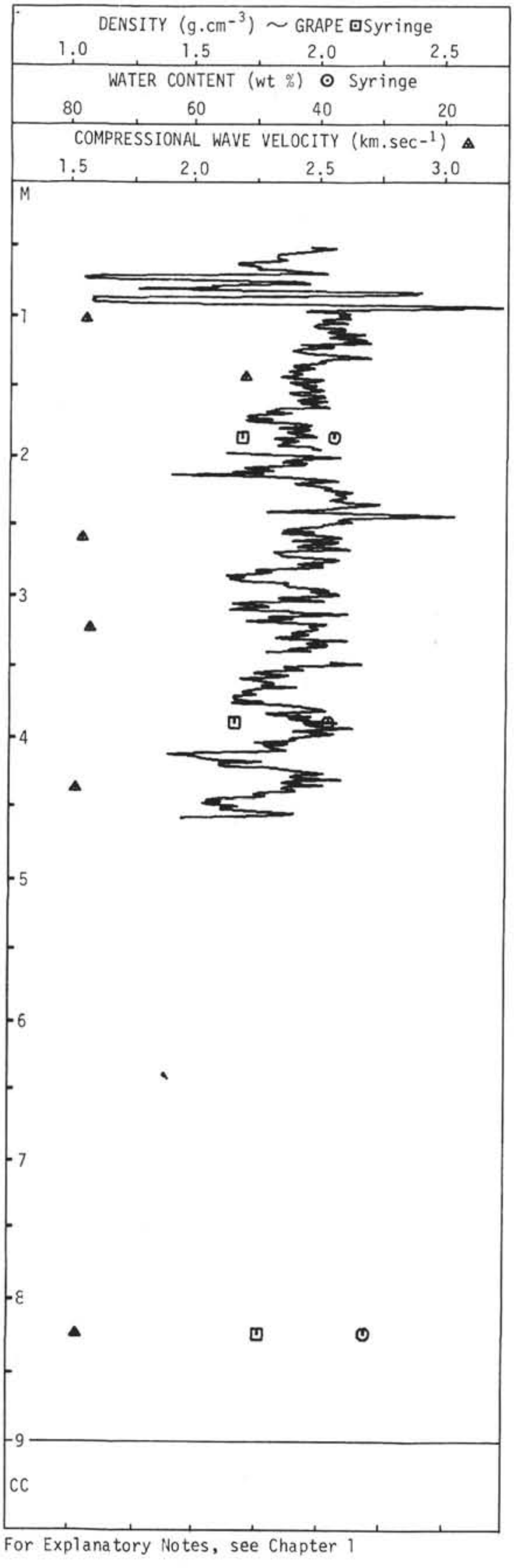

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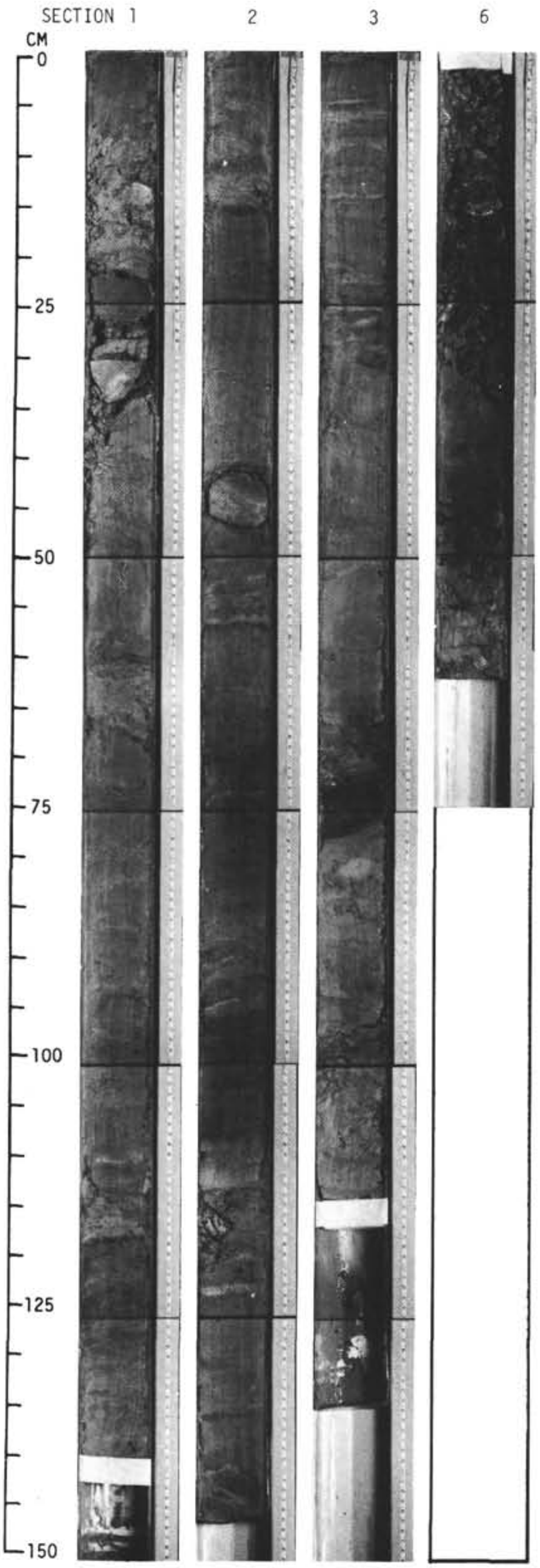

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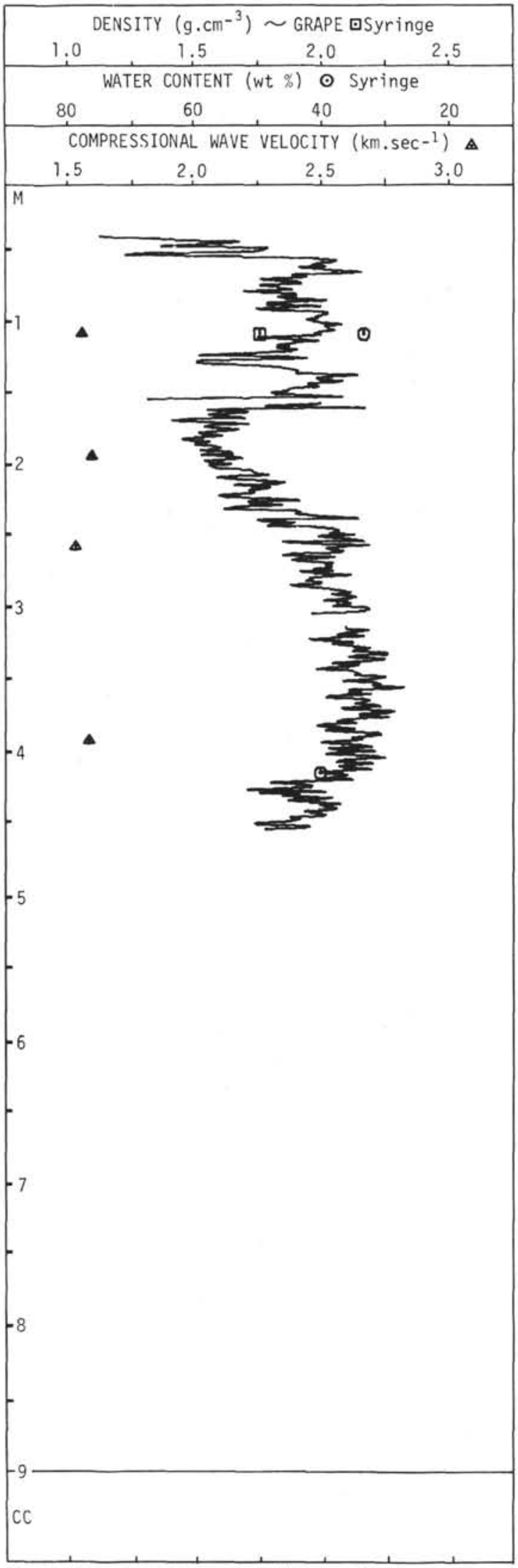

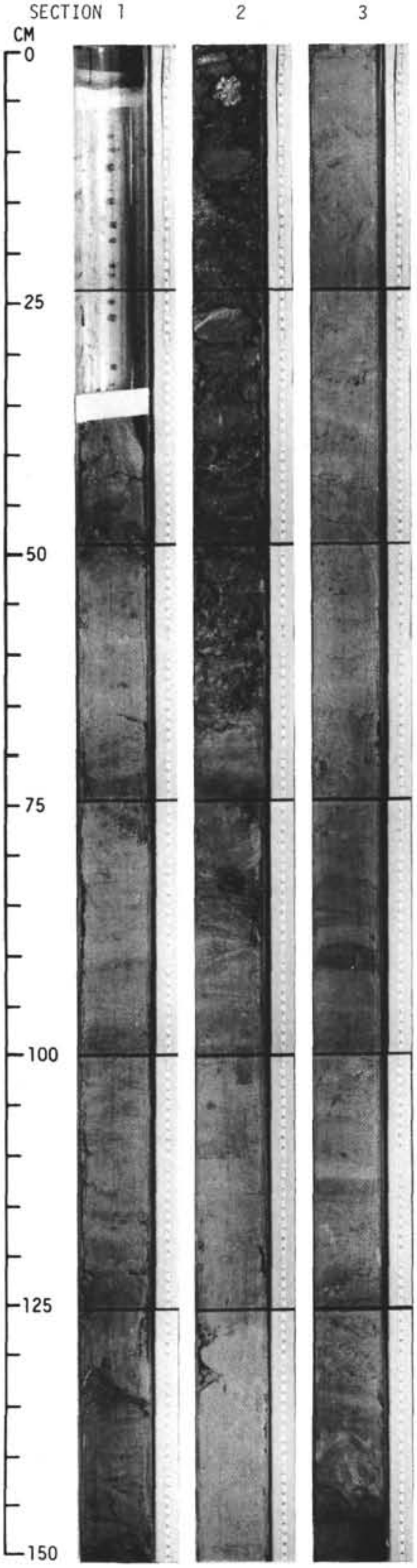

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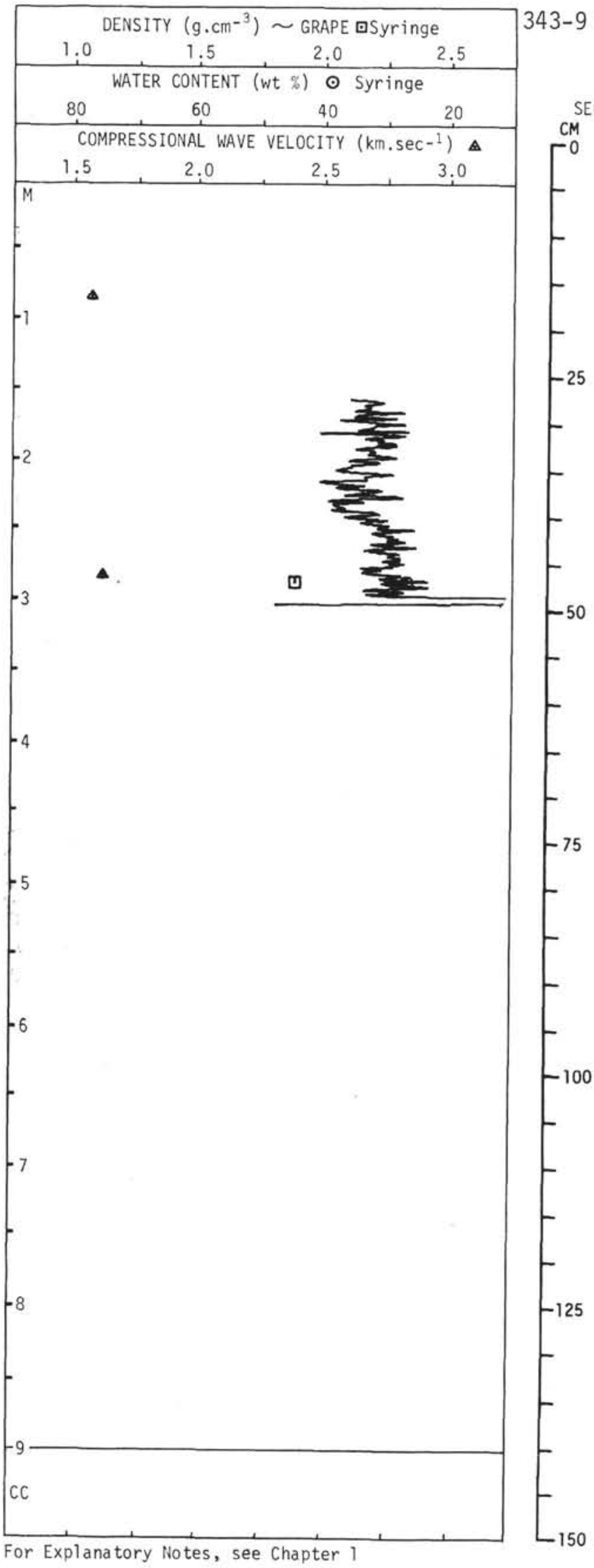

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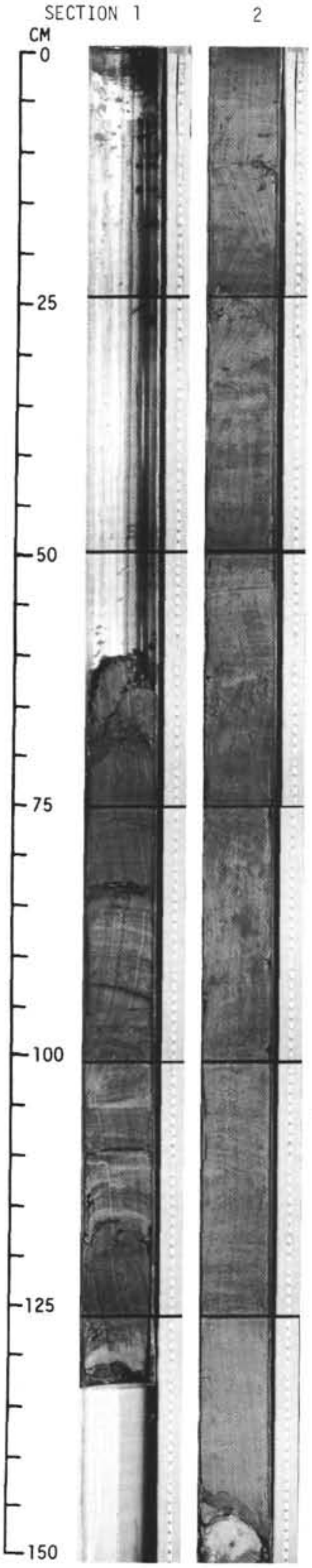

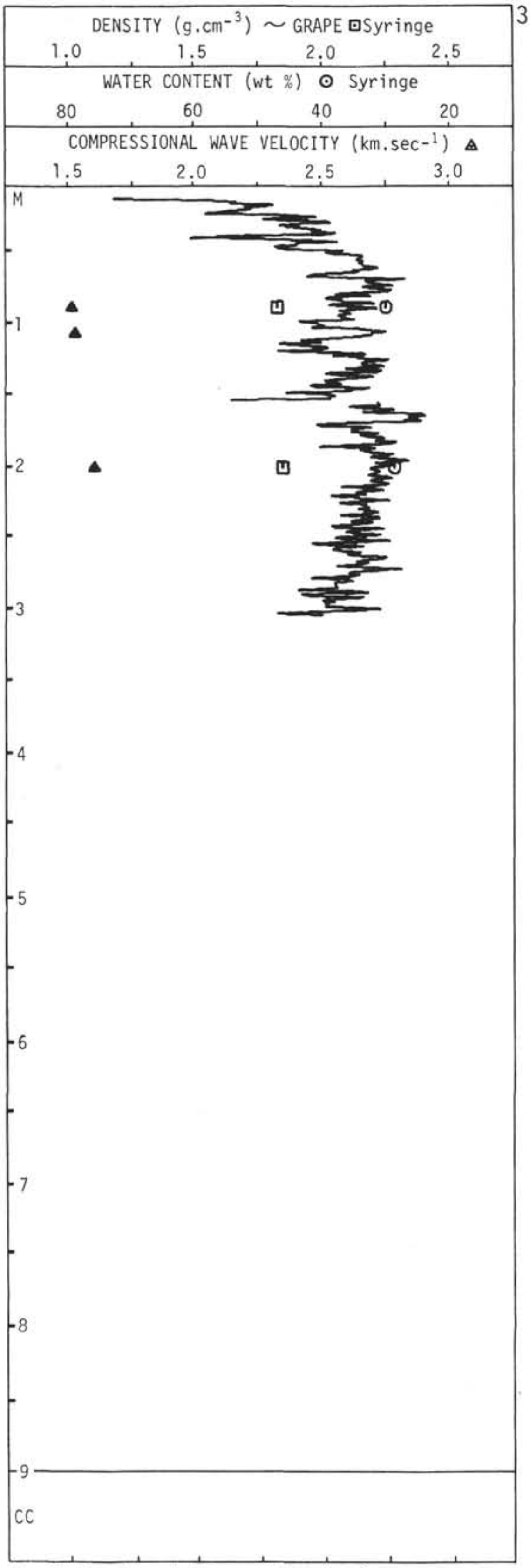

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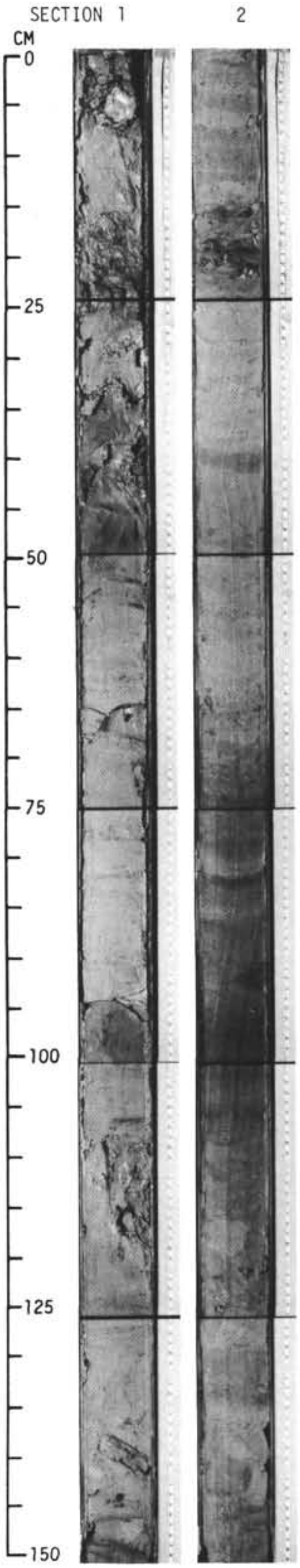

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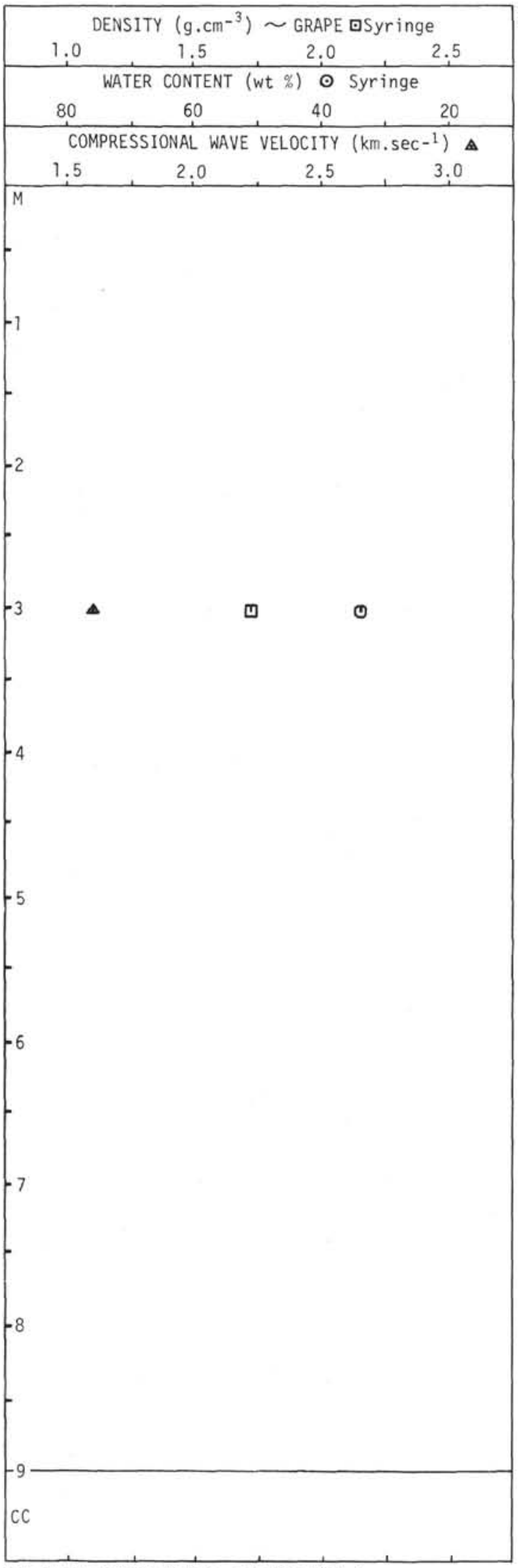

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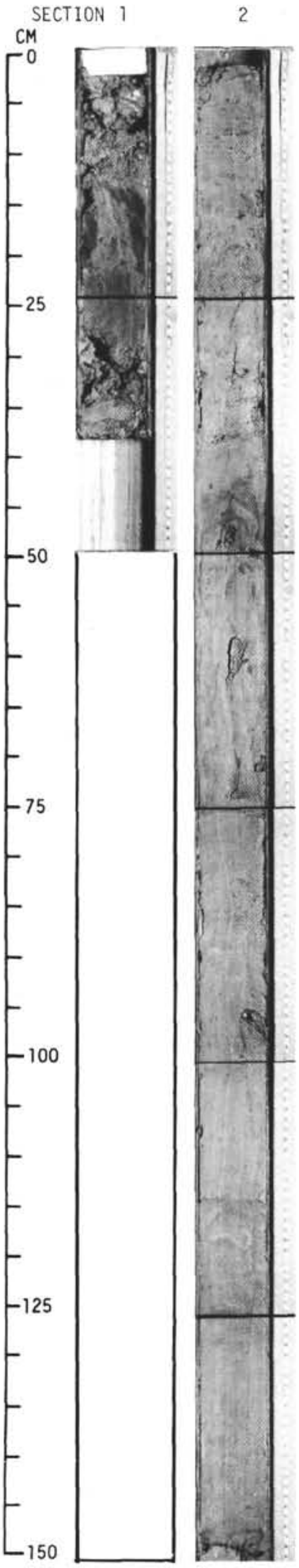

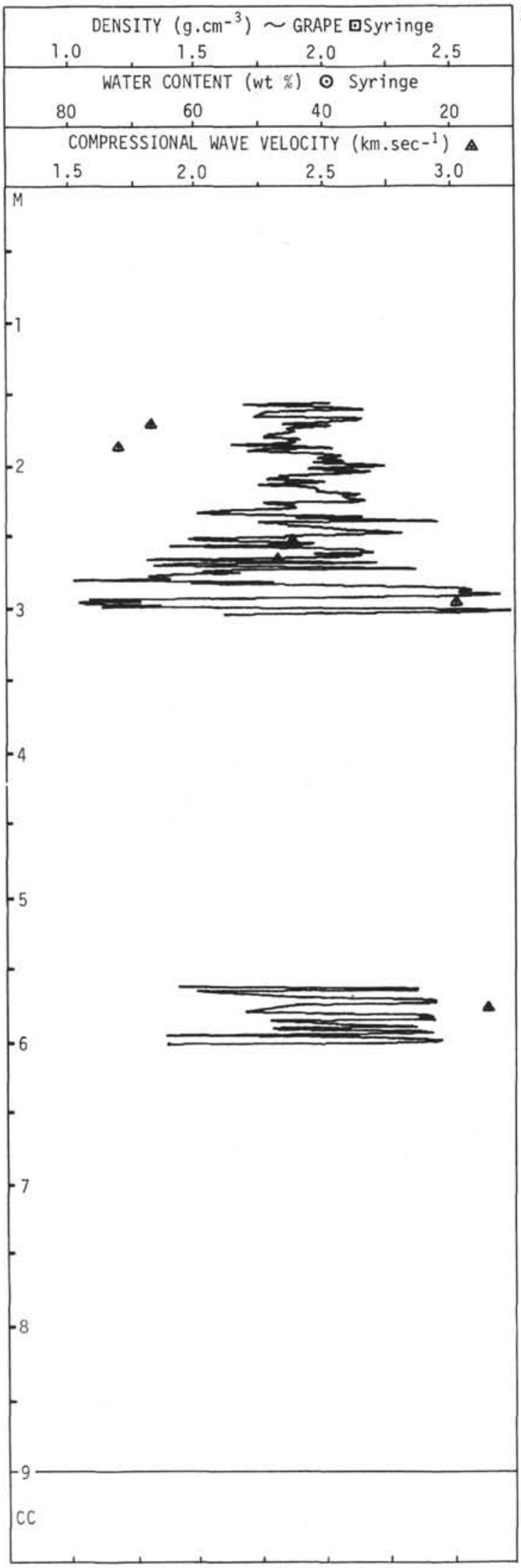

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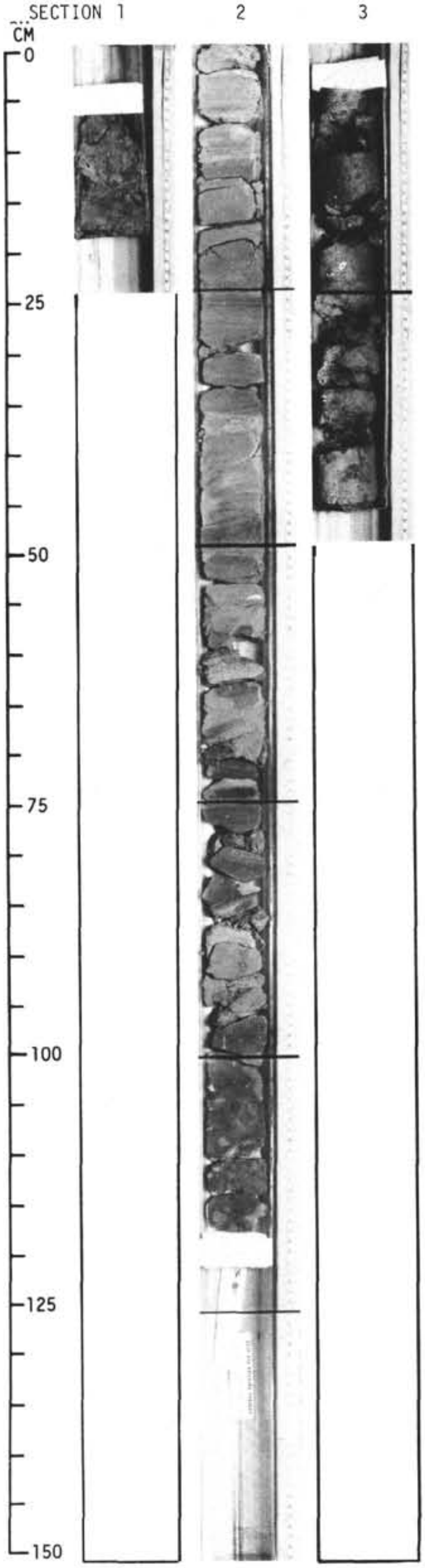

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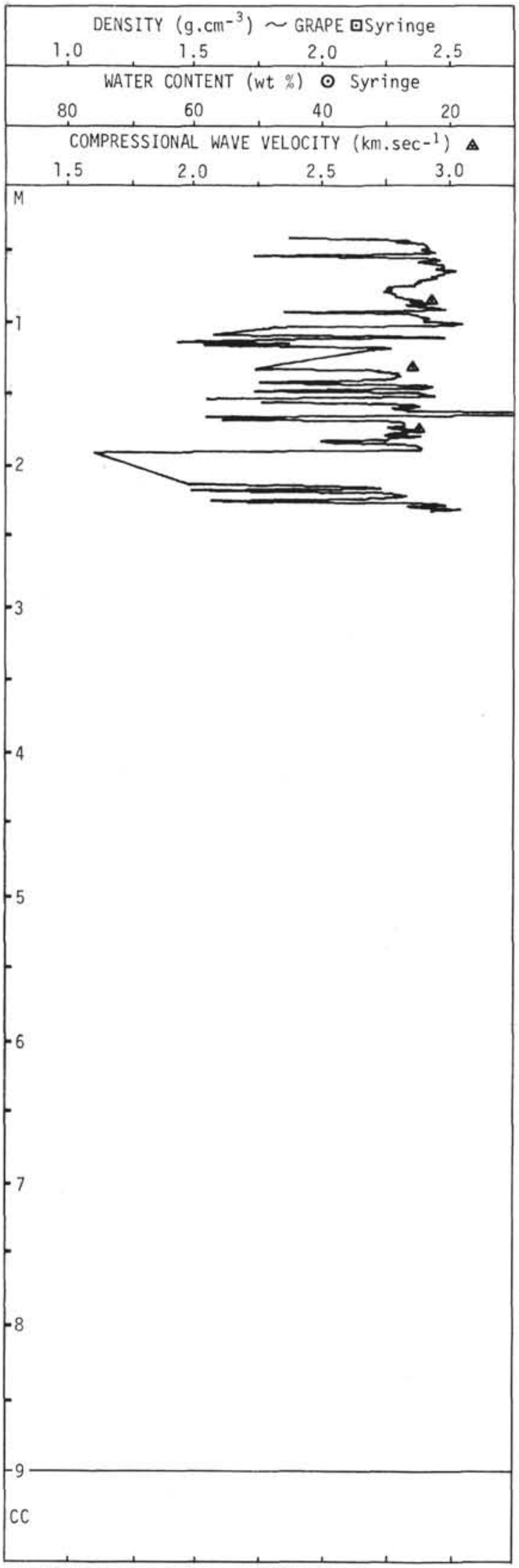

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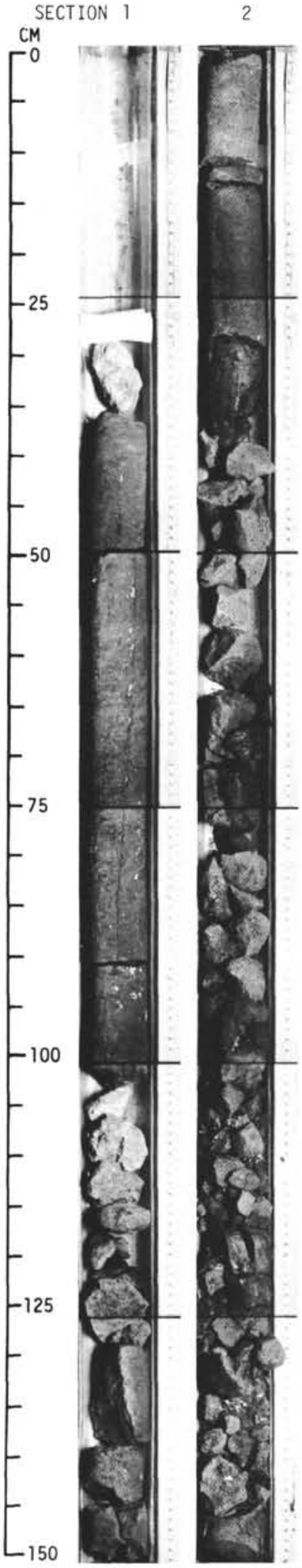

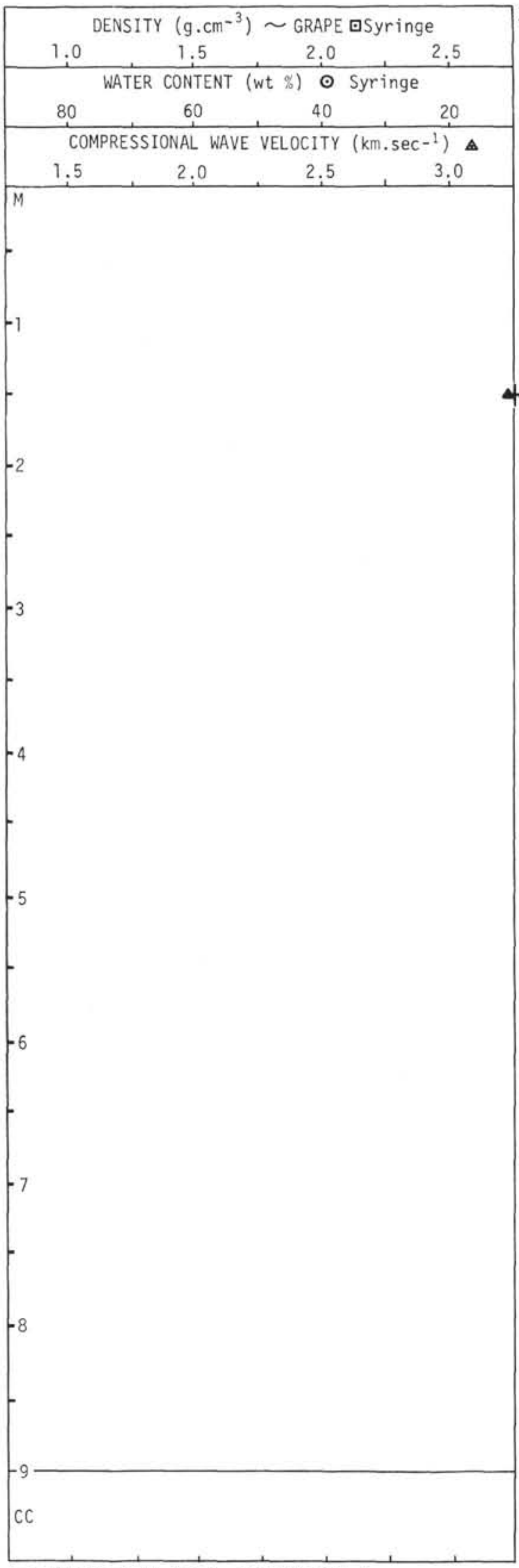

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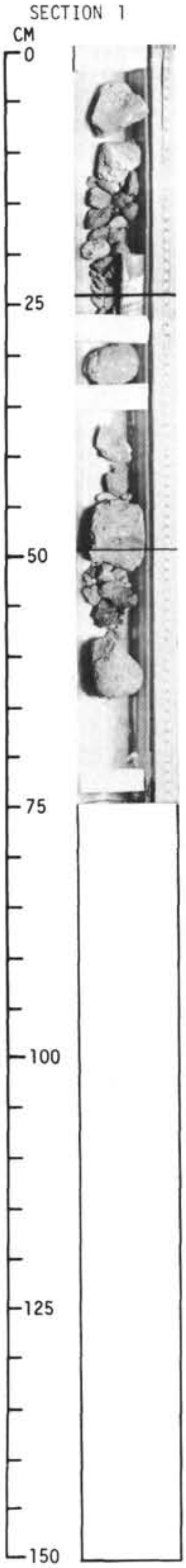

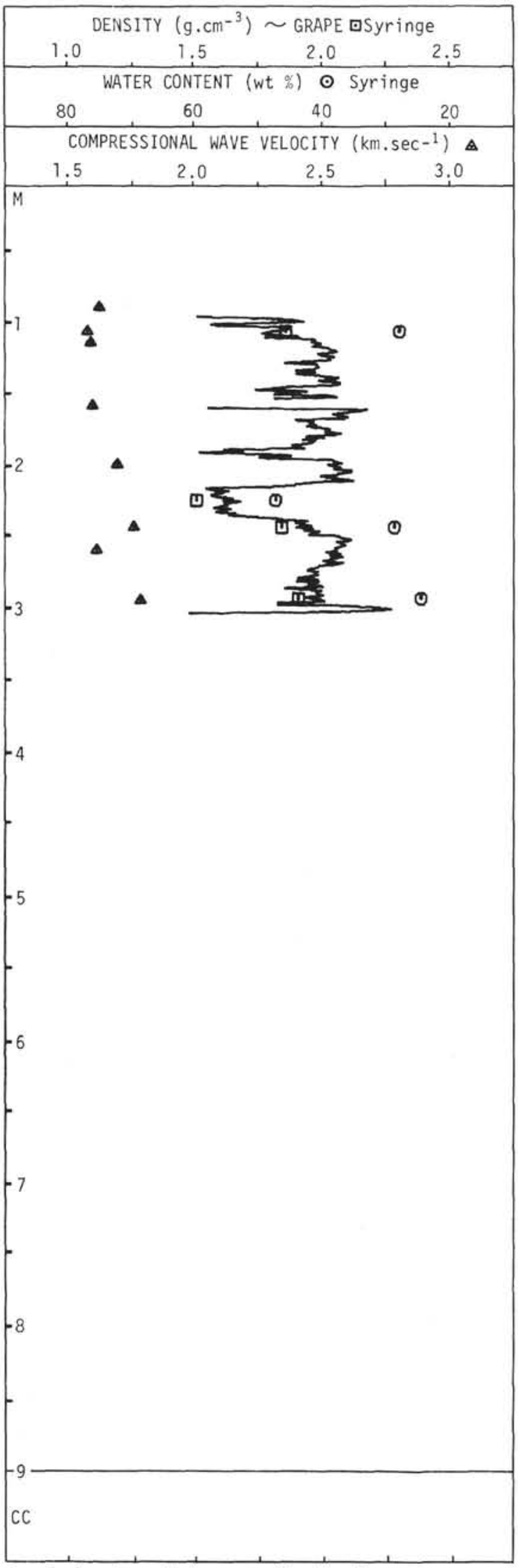

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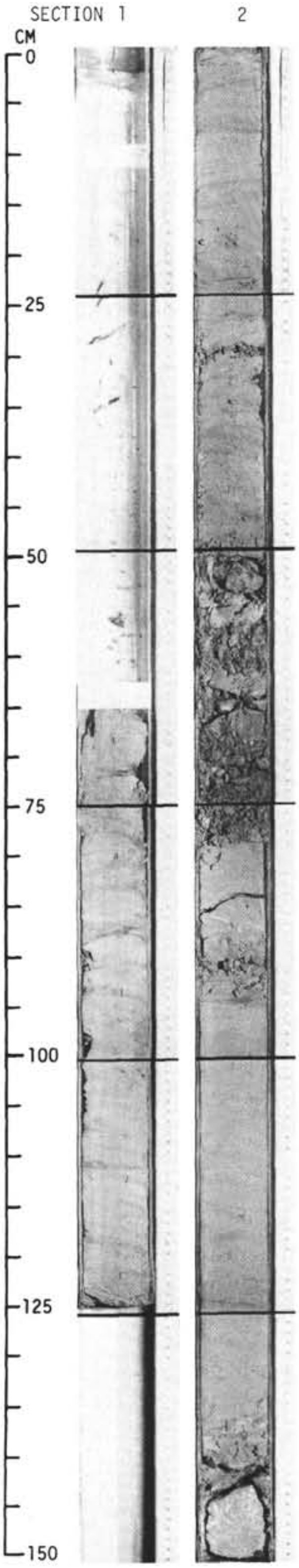

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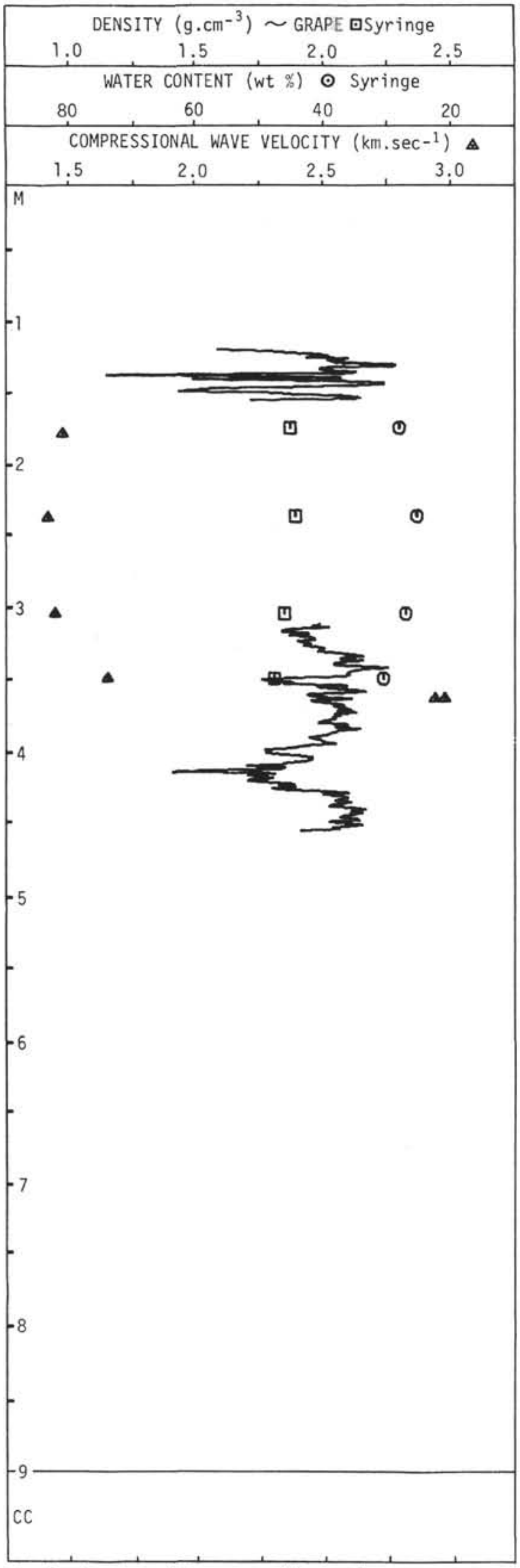

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