# 16. SITE 58

Shipboard Scientific Party[1]

## SITE DATA

**Occupied:** July 28-30, 1969.

**Position:** North flank of Caroline Ridge:
Latitude: 9° 14.1′N. Longitude: 144° 25.1′E.

**Water Depths:** 4503 meters (58.0, 58.1).
4486 meters (58.2).

**Holes:** 58.00 (on drillers record 58.0) cores none.
58.0 (on drillers record 58.1) 1 core.
58.1 (on drillers record 58.2) 3 cores.
58.2 (on drillers record 58.3) drill pipe stuck and shot off; 1 core.

**Total Depth:** 569 meters, probably in Oligocene or early Miocene basalt.

## MAIN RESULTS

At this site, drilled on the flat sea floor at the north flank of the Caroline Ridge, a flat, smooth basement underlies early Miocene sediment. While no cores were recovered from the basement, its drilling characteristics and the recovery of fresh diabasic basalt chips from the bumper sub make it highly probable that it is the same basaltic basement that was cored at Site 47.

The sediments at this site are pelagic oozes with some volcanic admixture, but are further characterized by sands and by pebbles of reef-derived carbonate and of volcanic glass and vesicular basalt. This site lies in a submarine valley leading from volcanic banks and islands and atolls, and is probably an avenue for currents.

## BACKGROUND

On crossing the Mariana Trench, out of the Philippine Sea into the Pacific Ocean proper, old ocean floor comparable to that which had been drilled at Sites 51 and 52 was expected to be found. Hopefully, it might have proved to be less cherty and more penetrable here. Yet what was found in the area of Sites 55, 56 and 57 showed an ocean floor apparently more closely allied to that of the Philippine Sea—a basaltic surface overlain by a late Oligocene-early Miocene section of pelagic sediments. The next endeavor was to find the old Pacific crust to the northeast, in order to finally penetrate it more deeply, and also in order to define the boundaries of these crustal provinces.

Accordingly, the ship steamed northeast on a course of 060, coming off the Caroline Ridge terraces onto flat sea floor at a depth of about 4200 meters. The sediments essentially disappeared, along our track, and then appeared again with a somewhat different character, showing a well defined middle opaque zone on the profiles. Site 58 (Figures 1 and 2) was staked where the sediments showed a thickness of some 0.18 seconds.

## OPERATIONS

The beacon was dropped at Site 58 at 1030 hours, July 28. Hole 58.0 (drillers Hole 58.1) was spudded at 1930 hours at a depth of 4503 meters and encountered a very hard and unexpected layer at 20 meters, whereupon tools were pulled back to mudline, and a new hole (58.0–drillers Hole 58.1) was spudded at 2130 hours and a core was cut but yielded almost no recovery. The hard spot was not encountered.

Pipe was again pulled back to mudline, and 58.1 (drillers Hole 58.2) was spudded at 2400. A surface core retrieved shallow-water-derived carbonate sand and pebbles. Mud was spotted to hold the sandy and pebbly upper sediments from collapsing into the hole. The base of the sediments was encountered, but an attempt to core the underlying material from 565 to 569 meters yielded no recovery.

Pipe was pulled back to mudline, the ship was offset 450 meters and Hole 58.2 (drillers Hole 58.3) was spudded at 1300 hours, July 29, at a water depth of 4486 meters in yet another attempt to recover basement. A core was cut in Miocene sediments, and during its retrieval the hole collapsed, filling the lower 70 meters of drill pipe with carbonate sand and pebbles. Pipe was worked for 4 hours without effect, and was shot off with a Schlumberger device at a bumper sub, whereupon the site was abandoned at 0900 hours, July 30.

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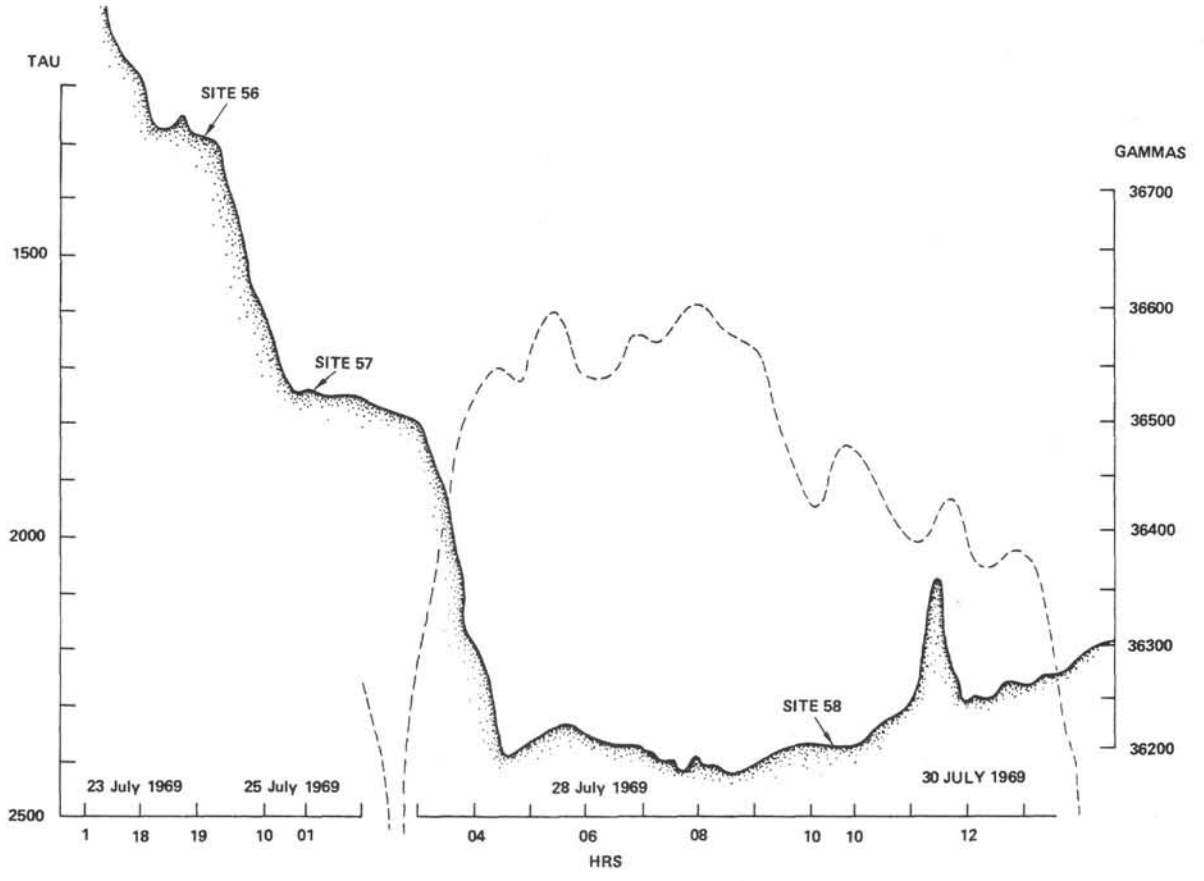


Figure 1. Challenger *bathymetric and magnetic profile at Site 58.*

## NATURE OF THE SEDIMENTS

Of five cores attempted in the three holes at Site 58, two were successful (Core 1, Hole 58.1, and Core 1, Hole 58.2), one recovered only a core catcher sample (Core 1, Hole 58.0), and two had no recovery (Cores 2 and 3, Hole 58.1).

### Hole 58.0

The single core from this hole was drilled from 15.2 to 20.1 meters below mudline, but only a catcher sample was recovered. This consists of gravel to coarse sand size sediment composed of: (a) fragments of black basalt, palagonite, and volcanic glasses with a wide variety of colors (black, dark green, olive-green, red and colorless); (b) subangular to subrounded grains of dense white limestone that appears somewhat recrystallized; staining tests indicate the presence of aragonite and magnesium calcite in addition to calcite; (c) abraded skeletal fragments of benthonic foraminifera, corals (including *Acropora*), echinoid spines, and sponge spicules; (d) small amounts of sand-size feldspars and opaque grains. Along with this coarse sediment is a small amount of silty calcareous clay containing nannofossils, foraminifera and finely abraded fragments of bryozoa and mollusks. The grain size and faunal composition of this sediment suggests redeposition.

### Hole 58.1

Core 1 in this hole was drilled from mudline to 9.1 meters but recovered only about 3.75 meters of highly variable calcareous and siliceous oozes. The upper few decimeters of the core are very pale brown, soft diatom ooze composed almost entirely of delicate tests of *Ethmodiscus* (Chapter 38). The remainder of Section 1 is white chalk ooze and pale brown nannoplankton marl ooze with abundant nannofossils and clay minerals, and common to rare amounts of diatoms, Radiolaria, and sponge spicules. At the top of Section 2 is a 20-centimeter layer of dark yellow-brown calcareous clay with well preserved siliceous microfossils. This unusual sediment contains abundant nannofossils and fine-grained anhedral calcite of skeletal or authigenic origin. Also present are significant amounts (10 to 15 per cent each) of lath-shaped zeolites, Radiolaria, clay minerals and limonitic grains, and smaller amounts of diatoms, sponge spicules and planktonic foraminifera.

The remainder of Section 2 and the top half of Section 3 are brown to pale brown and yellow-brown carbonate

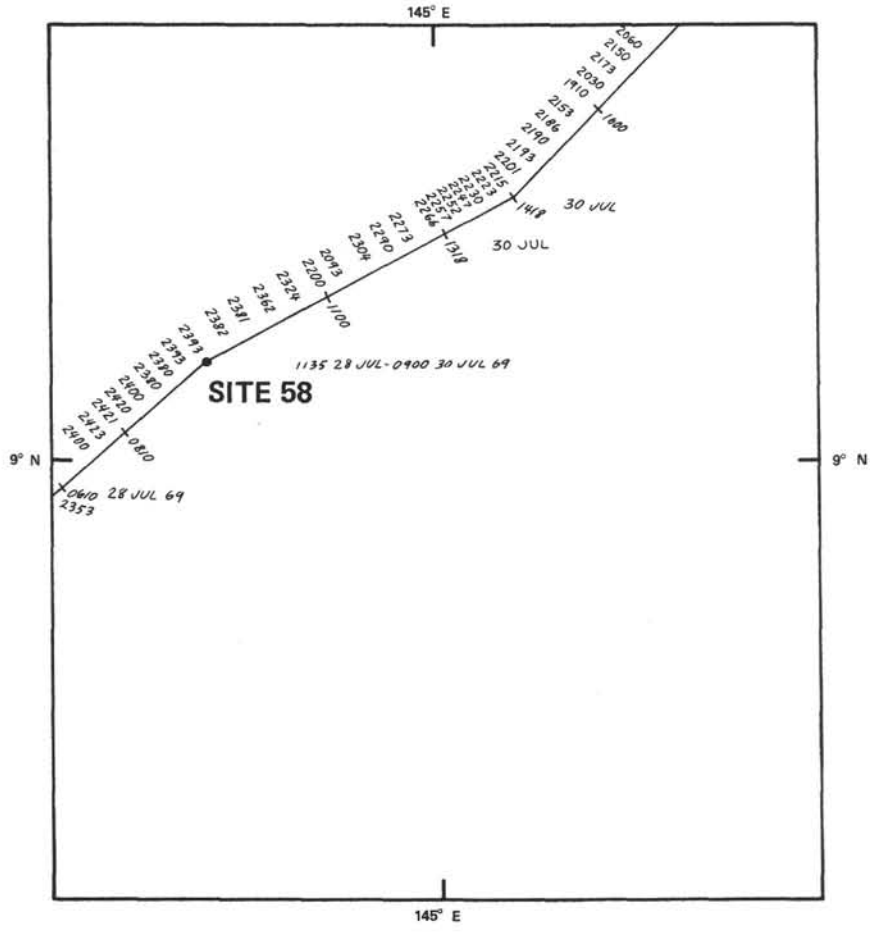


Figure 2. *Bottom soundings in area of Site 58.*

ooze composed of abundant anhedral calcite grains and nannofossils. The anhedral calcite is in the fine silt to clay size range; some of it appears to be finely abraded skeletal material, but the origin of most is indeterminate. Also present in this carbonate ooze are common planktonic foraminifera and small amounts of clay minerals, zeolites and limonitic grains. The lower 80 to 85 centimeters of Section 2 are very pale brown, calcareous sandy silt composed largely of abraded skeletal fragments of pelecypods, echinoderms and benthonic foraminifera, along with rare planktonic foraminifera and volcanic glass shards.

Cores 2 and 3 were attempted below 140 meters subbottom depth but had no recovery.

### Hole 58.2

The single core from this hole was drilled between 136.6 and 143.3 meters subbottom and recovered about 8.8 meters of sediment. The upper 4.3 meters (Sections 1 to 3) of this core are mainly pale brown nannoplankton chalk ooze and marl ooze, the lower 4.5 meters are pale brown nannoplankton chalk and marl ooze with thin interbeds of dark volcanic ash. Near the top of the core is a 45 to 50 centimeter thick layer of gravel with angular to rounded fragments of white and brown limestone, and dark gray to brown porphyritic and amygdaloidal volcanic rocks. The nannoplankton ooze and marl of this core is unusual compared to other sediments of this type encountered on Leg 6 in that significant amounts of well-preserved siliceous microfossils are present (Chapter 38) in the carbonate sediment; sponge spicules are unusually abundant, and radiolarian tests are common to abundant. The volcanic ash occurs in layers from a few centimeters to over 40 centimeters thick and contains 70 to 80 per cent of volcanic glass, much of which is vesicular and most of which is an olive green color and of basaltic composition (n = 1.55 to 1.585).

The sedimentation pattern evident at Site 58 suggests intervals of pelagic sedimentation alternating with episodes of resedimentation from adjacent areas; the latter type of deposition was probably responsible for introduction of the gravels and the shallow-water skeletal material. This pattern could explain, in addition, the apparently high sedimentation rate for Miocene sediments at this site, which in turn might in part be responsible for the abundance and excellent preservation of siliceous microfossils in the calcareous oozes, particularly those in Core 1 of Hole 58.2.

**TABLE 1**
**Summary of Coring at Site 58**

| Core No. | Interval Cored (below mudline) (ft) | Interval Cored (below mudline) (m) | Recovery (ft) | Recovery (m) |
|---|---|---|---|---|
| 58.0-1* | 50-66 | 15.2-20.1 | 1 | 0.3 |
| 58.1-1* | 0-30 | 0.0-9.1 | 15 | 4.6 |
| 58.1-2* | 565-569 | 172.2-173.4 | 0 | 0.0 |
| 58.1-3* | 569-569 | 173.4- | 0 | 0.0 |
| 58.2-1*[a] | 448-470 | 136.6-143.3 | 30 | 9.1 |

Water Depth: 4502.5 meters (14,772 feet)
[a]4486.4 meters (14,719 feet)

| *Scientific Log (this log) | | Drillers Log |
|---|---|---|
| Not listed | = | 58.0 |
| 58.0 | = | 58.1 |
| 58.1 | = | 58.2 |
| 58.2 | = | 58.3 |

## PHYSICAL PROPERTIES

These sediments were disturbed during coring operations, thus *in situ* physical properties are not necessarily represented.

### Natural Gamma Radiation

#### Hole 58.1

One core containing 4.6 meters of Pleistocene (reworked Pliocene-Miocene) diatom and nannoplankton ooze was recovered from 0 to 9 meters at Hole 58.1. The upper two sections (3 meters) had extremely high gamma radiation averaging 3000 counts/7.6-cm core segment/1.25 minutes. The total ranges were 2500 to 5000 counts in Section 1, and 500 to 5200 counts in Section 2. The sediment here was a Pleistocene *Ethmodiscus* diatom ooze grading down into predominantly chalk ooze. In Section 3 (3 to 4.5 meters) the natural gamma count ranged from 300 to 1100 counts, with an average of about 700 counts/7.6-cm segment/1.25 minutes. The sediment here was sandy skeletal calcareous silt.

The source of the high (nearly twice as high as any other sediment on Leg 6) gamma radiation close to the surface was not readily apparent, but it could be caused by the presence of one or more radioactive isotopes with relatively short half lives. Again, as at some other sites, the Pleistocene diatoms appeared to be associated with high gamma radiation.

#### Hole 58.2

Only one core of Oligocene nannoplankton radiolarian sponge spicule ooze was recovered from Hole 58.2 within 136 to 145 meters below the mudline. Sections 1 through 4 emitted 100 to 500 gamma ray counts with an average of about 250 counts/7.6-cm core segment/1.25 minutes. The count of 500 was caused by a wet-bulk density increase. Sections 5 and 6 had gamma ray counts ranging from 200 to 1100, with an average of about 500. The increase in natural gamma radiation in Sections 5 and 6 was associated with abundant volcanic ash in the ooze, and high wet-bulk density variations.

### Porosity, Wet-Bulk Density, and Water Content

#### Hole 58.1

Drilling in Hole 58.1 between 0 and 9.1 meters below the sediment surface recovered sediment of widely differing lithologies. These were Pleistocene diatom ooze, nannoplankton ooze, radiolarian-zeolitic clay, and calcareous skeletal silts. In the one core from this hole ranges of porosity, wet-bulk density, and water content were 42 to 94 per cent (?), 1.10 (?) to 1.92 g/cc, and 27 to 63 per cent, respectively. Section 1 (0 to 1.5 meters below the sediment surface) had maximum porosities about 90 per cent in the highly disturbed *Ethmodiscus* diatom ooze and a minimum of 62 per cent in nannoplankton chalk ooze; corresponding wet-bulk densities ranged from 1.18 to 1.64 g/cc. A water content sample of chalk ooze yielded 63 per cent water.

The sediment in Section 2 (1.5 to 3.0 meter depth) consisted of radiolarian zeolite clay, and non-skeletal silt-size carbonate with about 25 per cent nannoplankton. Porosities ranged from 62 to 85 per cent (?) and wet-bulk densities from 1.30 to 1.62 g/cc in the radiolarian zeolite ooze, while the carbonates were 43 to 62 per cent and 1.62 to 1.93 g/cc. A sediment sample at 128 centimeters in Section 2 had a porosity of 52 per cent, wet-bulk density of 1.96 g/cc, and water content of 27 per cent.

The lithology in Section 3 (3.0 to 4.5 meters) had an abrupt change at 65 centimeters. The upper part was non-skeletal carbonate ooze with porosities ranging from 56 to 72 per cent and wet-bulk densities from 1.46 to 1.72 g/cc. The lower part of Section 3 was a skeletal sandy silt of mainly echinoderm-pelecypod fragments which had a maximum density of 1.95 g/cc and a minimum porosity of 42 per cent.

#### Hole 58.2

Sediment recovered from Hole 58.2 at 135 to 144 meters below mudline was an Oligocene nannoplankton-radiolarian-sponge spicule ooze with porosities ranging from 50 to 84 per cent (?) (1.28 to 1.80 g/cc). The interval from 1370 to 1374 meters is an ooze containing abundant pebbles of limestone and volcanic rocks

with a maximum density of 2.05 g/cc and a minimum porosity of 32 per cent. The porosities of the rocks of course are much less as the GRAPE unit averages the rock porosity with the porosity of the sediments surrounding them. The typical sediment of this core was nannoplankton marl ooze with radiolarians and sponge spicules in some areas. Its porosity was typically about 70 per cent (1.45 g/cc). Volcanic ash layers in this sediment generally had lower porosities, as low as 49 per cent. The water content of sediment samples from the core recovered in Hole 58.2 ranged from 46 to 57 per cent.

### Sound Velocity

#### Hole 58.1

Sediment sound velocities (through Pleistocene *Ethmodiscus* diatom ooze, nannoplankton ooze, radiolarian zeolitic clay and calcareous skeletal sands in Hole 58.1, (0 to 9 meters) ranged from 1.51 to 1.78 km/sec with an average of 1.58 km/sec. The highest velocity (1.78 km/sec) was recorded in a dense skeletal silt (2.9 to 3.8 meters below the sediment surface) consisting almost entirely of pelecypod and echinoderm fragments. The yellow-brown chalk ooze (1.0 to 2.0 meters), characterized by non-skeletal carbonate with 25 per cent nannoplankton, had low to moderate velocities of 1.51, 1.60 and 1.64 km/sec. The remainder of the velocities were, in general, lower (1.51 to 1.55 km/sec) in the nannoplankton chalk ooze and radiolarian zeolite clays (0 to 0.5 meter).

#### Hole 58.2

In Hole 58.2, sound velocities measured through Oligocene nannoplankton-radiolarian-sponge spicule ooze (from 135 to 144 meters below the sediment surface) averaged 1.53 km/sec and had a complete range from 1.46 to 1.58 km/sec. There was a very slight increase in sound velocity in the lowermost two sections where volcanic ash was abundant, creating denser sediment.

### Thermal Conductivity

#### Holes 58.1 and 58.2

Two thermal conductivity measurements were made in Pleistocene echinoderm pelecypod silt and Oligocene nannoplankton-radiolarian-sponge spicule ooze from Holes 58.1 and 58.2. The Pleistocene skeletal silt at a depth of approximately 3.4 meters below mudline in Hole 58.1 had a thermal conductivity of $2.78 \times 10^{-3}$ cal-°C$^{-1}$ cm$^{-1}$ sec$^{-1}$. In Hole 58.2 Oligocene ooze at a depth of 139.0 meters below mudline had a higher thermal conductivity of $3.68 \times 10^{-3}$ cal-°C$^{-1}$ cm$^{-1}$ sec$^{-1}$.

### Penetrometer

#### Hole 58.1

Pleistocene *Ethmodiscus* diatom ooze, nannoplankton ooze, radiolarian zeolite clay and calcareous skeletal sands (0 to 4.5 meters) were penetrated completely with a minimum of $34 \times 10^{-1}$ millimeters. The Pleistocene *Ethmodiscus* ooze was penetrated $67 \times 10^{-1}$ millimeters with complete penetration in the underlying nannoplankton marl oozes of Section 1. The needle completely penetrated the brown radiolarian zeolite clay at the top of Section 2, but below it, brown silty chalk ooze had penetrations of 34 to $88 \times 10^{-1}$ millimeters.

#### Hole 58.2

Oligocene nannoplankton oozes with intervals of marl, radiolarians, ash, and sponge spicules were cored at Hole 58.2 at a depth of 136.6 to 143.3 meters. Penetration of the needle ranged from 24 to $81 \times 10^{-1}$ millimeters with an average of 49. It appears that the ash layers were penetrated more easily than the radiolarian nannoplankton beds, the greater resistance in the latter may be caused by an intermeshing of the radiolarian tests. Typically, pure nannoplankton oozes were penetrated more easily.

## CONCLUSIONS

The oceanic crust at Site 58 appears to be closely allied to that of the Caroline Ridge: A smooth, hard basement is overlain by Oligo-Miocene sediments. While no core was recovered from the basement, its drilling characteristics and the presence of fresh chips of diabasic basalt in the bumper sub make it extremely probable that the basement is very much like that at Site 57. The basalt (in the bumper sub) at Site 58 differs from that cored at Site 57 in the distinct greenish cast of its feldspars.

An unusual feature of the sediments at Site 58 is the admixture of shallow water clasts. The pelagic sediments are nannoplankton oozes with an admixture of diatoms and Radiolaria (including some *Ethmodiscus* diatomites). The admixed clasts consist of granules and pebbles of vesicular basalt, glass, skeletal material (large foraminifera, shell fragments, echinoderm debris, coral fragments), and lithified limestone. According to Sachs (personal communication) the larger foraminifera are mainly of late Oligocene to Miocene age, and none are older. The clasts occur partly in well-sorted sands, partly as pebbles dispersed in ooze matrix—reminiscent of the Cretaceous pebbly mudstone facies at Sites 4 and 5, Leg 1. Site 58 lies in a branched submarine valley extending to the flanks of Faraulep Atoll, Gaferut Island, and a number of banks which are of joint volcanic reef growth origin. Presumably this valley serves as an avenue for turbidity currents and other currents, and as an avenue for sediment transport.

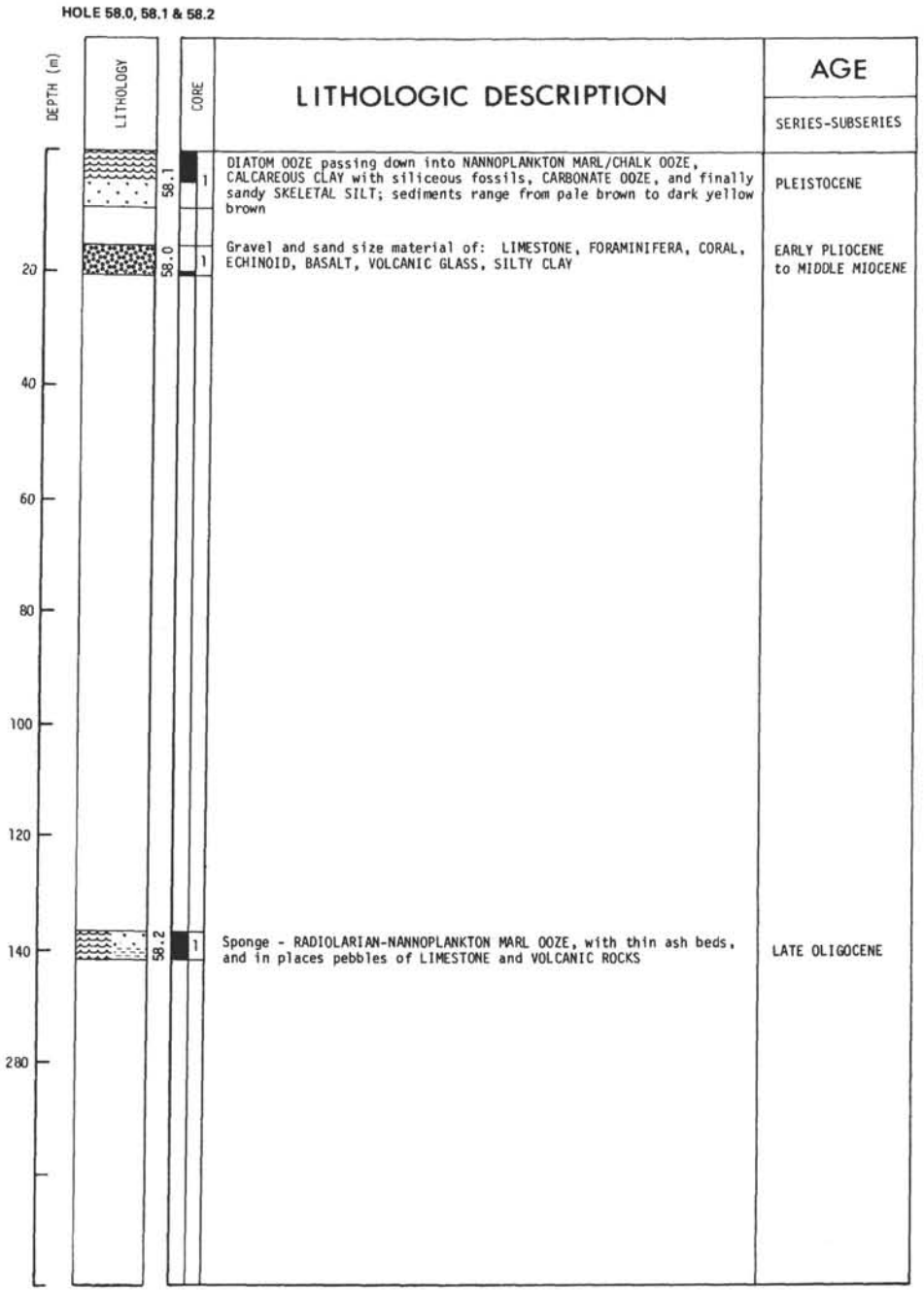


Figure 3. *Summary of lithology in Holes 58.0, 58.1, and 58.2.*

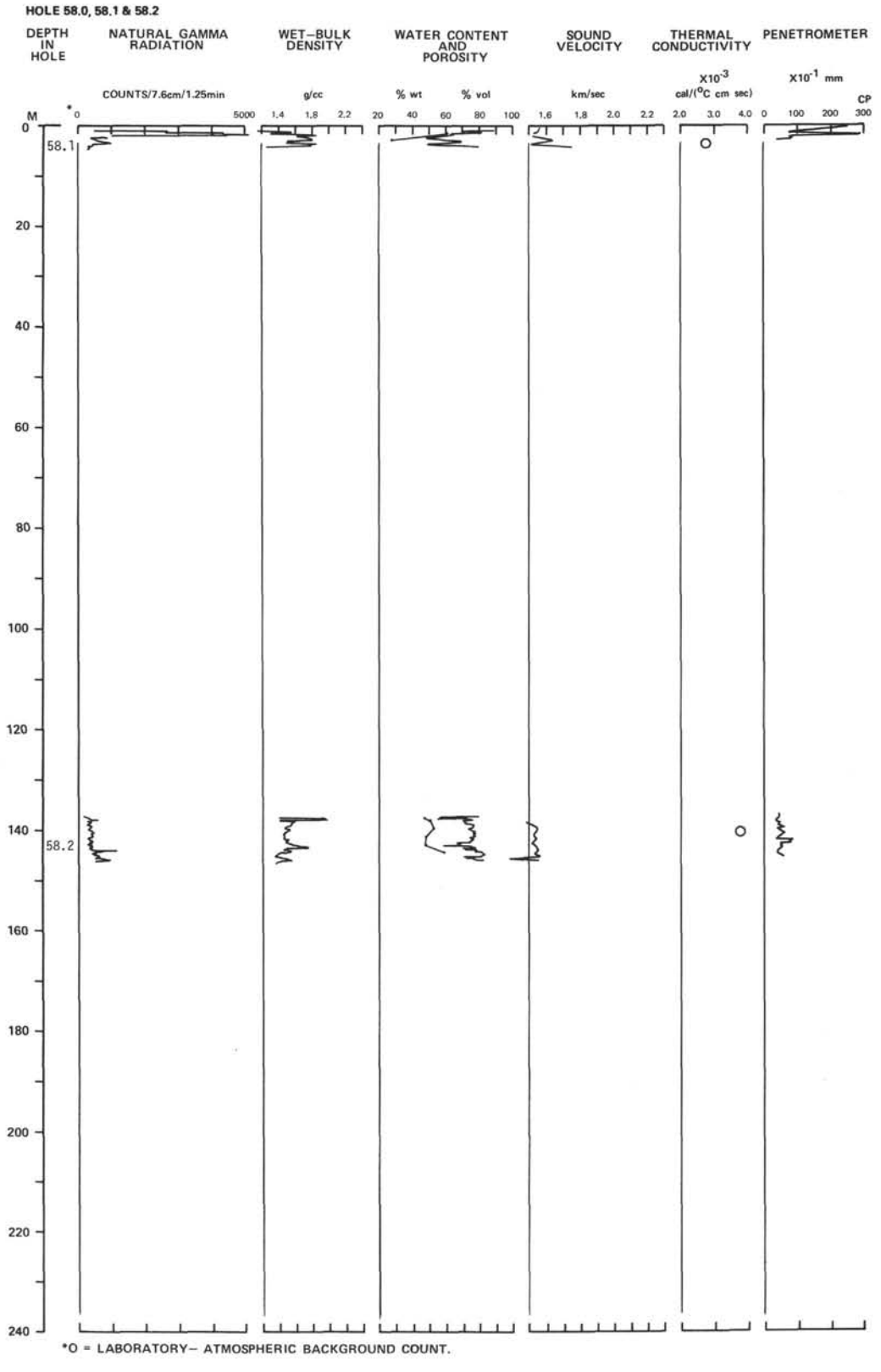


Figure 4. *Summary of physical properties in Holes 58.0, 58.1, 58.2.*

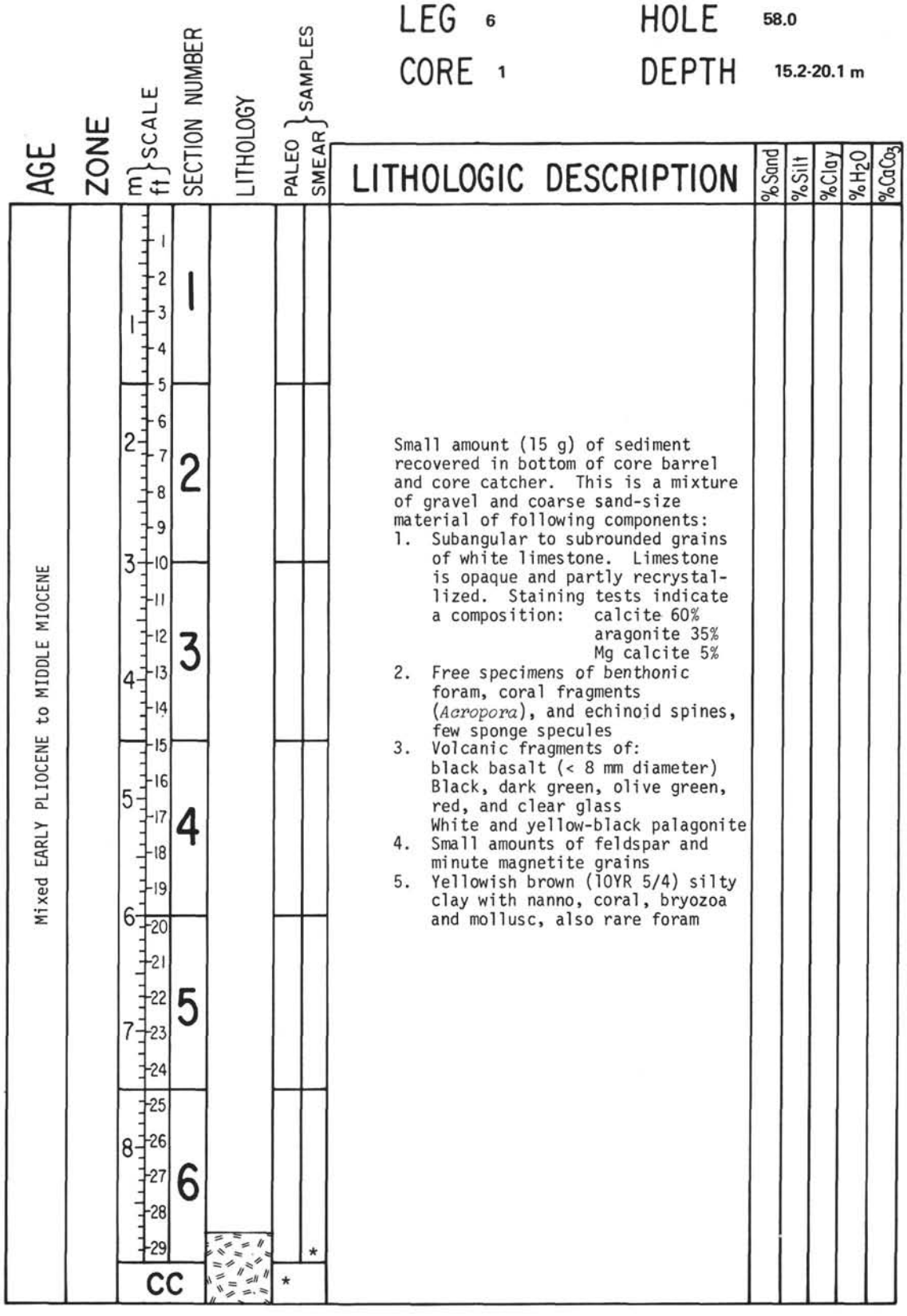


Figure 5. *Summary of lithology in Hole 58.0 Core 1.*

LEG 6 HOLE 58.0

CORE 1 DEPTH 15.2-20.1 m

| FORAMINIFERA | NANNOPLANKTON | RADIOLARIA |
|---|---|---|
| The mixed assemblage of Miocene and Pliocene planktonic Foraminifera was met in the core catcher sample. Miocene species: *Globorotalia menardii, G. scitula, G. mayeri, Sphaeroininellopsis grimsdalei, Globoquadrina altispira, Biorbulina bilobata, Candorbulina universa.* Pliocene species: *Globorotalia tumida, G. inflata, G. crassaformis, Sphaeroidinella dehiscens, Globigerinoides conglobatus, G. sacculifera, G. rubrum, Pulleniatina obliquiloculata.* | Samples of sand and clay from the core catcher contain a mixed assemblage of Miocene and Pliocene species. The species present that became extinct during the Miocene are *Cyclococcolithina neogammation, Discoaster deflandrei,* and *Sphenolithus heteromorphus.* Other species present, indicating an upper Miocene to lower Pliocene range, include *Ceratolithus rugosus, Cyclococcolithina macintyrei, Discoaster quintatus,* and *D. surculus.* | None. |

Figure 6. *Summary of biostratigraphy in Hole 58.0 Core 1.*

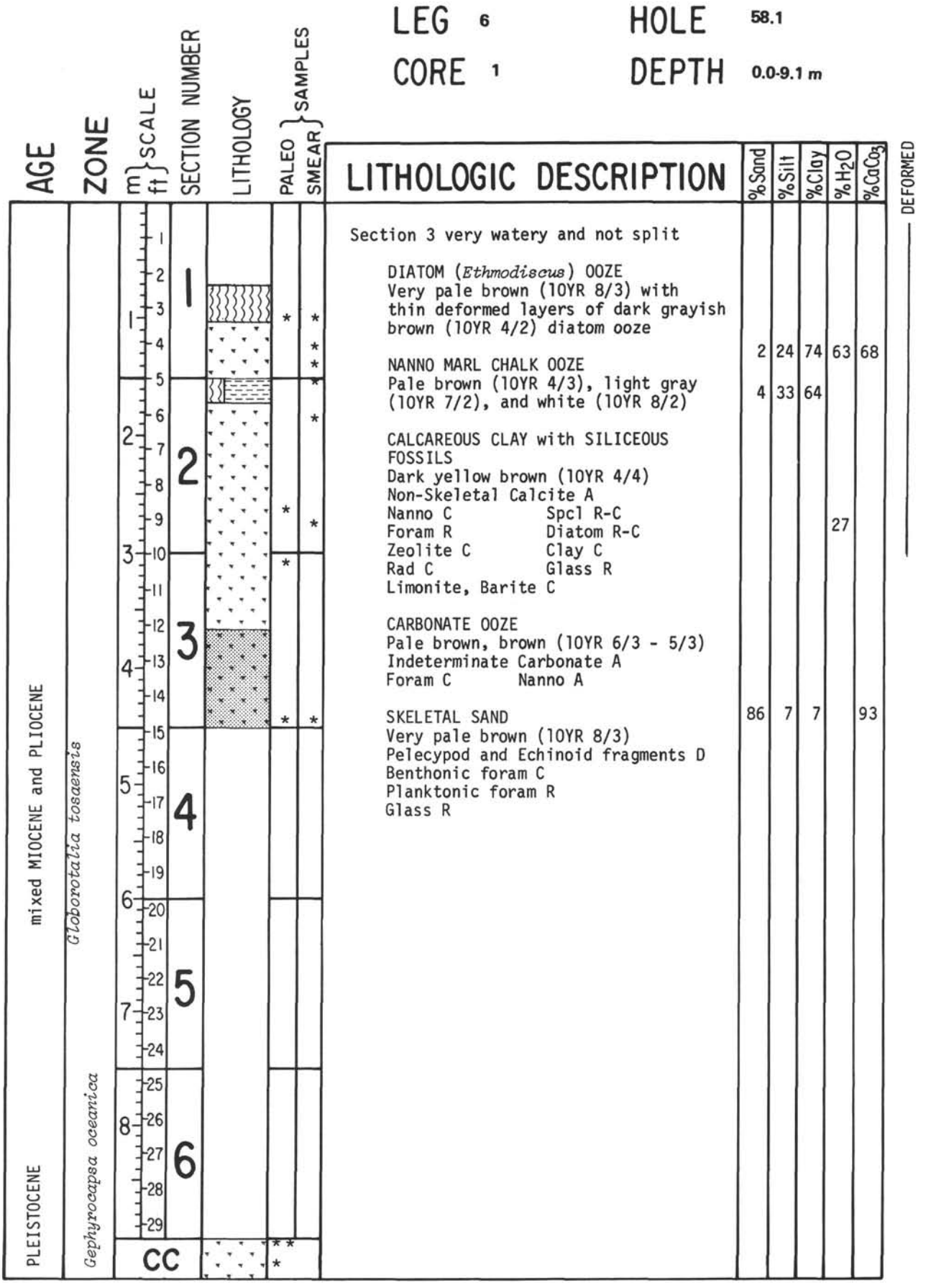


Figure 7. *Summary of lithology in Hole 58.1 Core 1.*

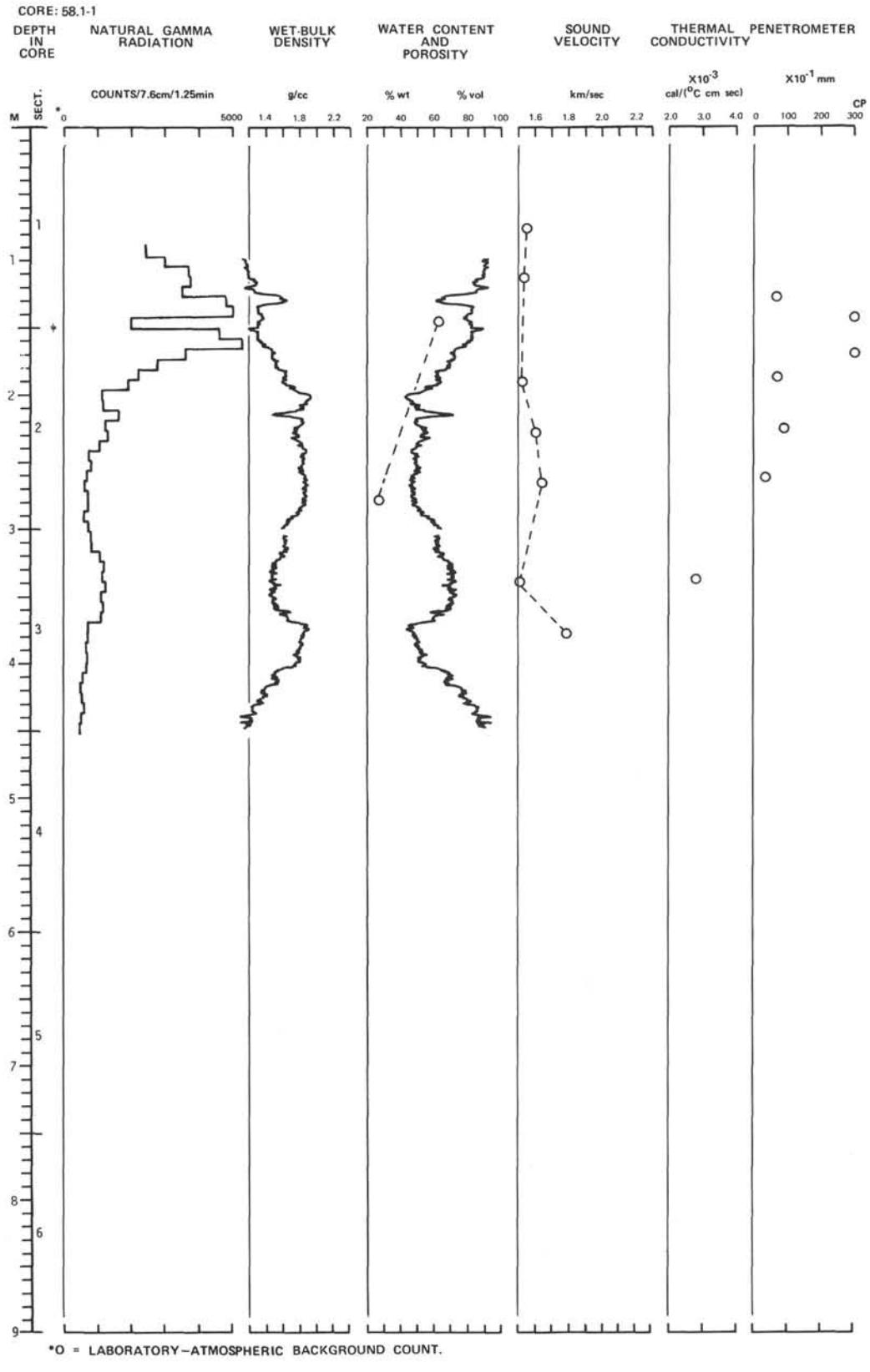


Figure 8. *Summary of physical properties in Hole 58.1 Core 1.*

LEG 6 HOLE 58.1

CORE 1 DEPTH 0.0-9.1 m

| FORAMINIFERA | NANNOPLANKTON | RADIOLARIA |
|---|---|---|
| Mixture of Pliocene and Miocene deep-water and shallow-water planktonic and benthonic Foraminifera is present - *Pulleniatina obliquiloculata, G. tosaensis, G. tumida, G. acostaensis humerosa, G. crassaformis, G. ungulata, G. hirsuta, G. inflata, G. cultrata, Candeina nitida, Globigerinoides ruber, G. trilobus, G. conglobatus, G. sacculifera, G. fistulosus, Sphaeroidinella dehiscens, Sphaeroidinellopsis grinsdalei, Globoquadrina altispira, G. dehiscens, Streblus beccarii, Amphistegina lessonii, Miogypsina* sp. sp. Pliocene species predominate. | A mixture of ages and lithologies is present. Most samples appear to be Pliocene with some Miocene mixing. Species present include *Ceratolithus rugosus, Coccolithus patecus, Cyclococcolithina leptoporus, C. macintyrei, C. neogammation, Discoaster brouweri, D. challengeri, D. deflandrei, Reticulofenestra pseudoumbilica, Sphenolithus heteromorphus, Triquetrorhabdulus rugosus.* A light brown clay from the core-catcher sample, however, contains a uniform assemblage of the upper Pleistocene *Gephyrocapsa oceanica* Zone with *Ceratolithus cristatus, Cyclococcolithina leptoporus, Cyclolithella annula,* and *Gephyrocapsa oceanica* being present. | Radiolaria are very rare in this core. The few identifiable species are from the middle and/or lower Miocene, suggesting reworking or contributions from exposed older sediments. TOP: not examined. BOTTOM: *Cyrtocapsella cornuta, Dorcadospyris sp.,* and *Cannartus prismaticus.* |

Figure 9. *Summary of biostratigraphy in Hole 58.1 Core 1.*

LEG 6 HOLE 58.1

CORE 2 DEPTH 172.2-173.4 m

| FORAMINIFERA | NANNOPLANKTON | RADIOLARIA |
|---|---|---|
| The core catcher sample belongs to the upper part of the *Globorotalia kugleri* Zone, lower Lower Miocene (or upper Upper Oligocene of Bolli's zonal scale, 1957). The assemblage of planktonic Foraminifera consists of numerous *Globorotalia kugleri, Globigerina juvenilis, G. bradyi, G. angustiumbilicata, Cassigerinella chipolensis* and infrequent *Globigerina ouachitaensis, Globoquadrina praedehiscens, Globigerinoides trilobus primordius.* | Only a trace of material was recovered from the core catcher. The assemblage of species present includes *Coccolithus eopelagicus, Cyclococcolithus neogammation, Discoaster deflandrei, D. druggi,* and *Triquetrorhabdulus carinatus* Zone, and in particular the upper part of the zone or the *Discoaster druggi* Subzone. | None. |

Figure 10. *Summary of biostratigraphy in Hole 58.1 Core 2.*

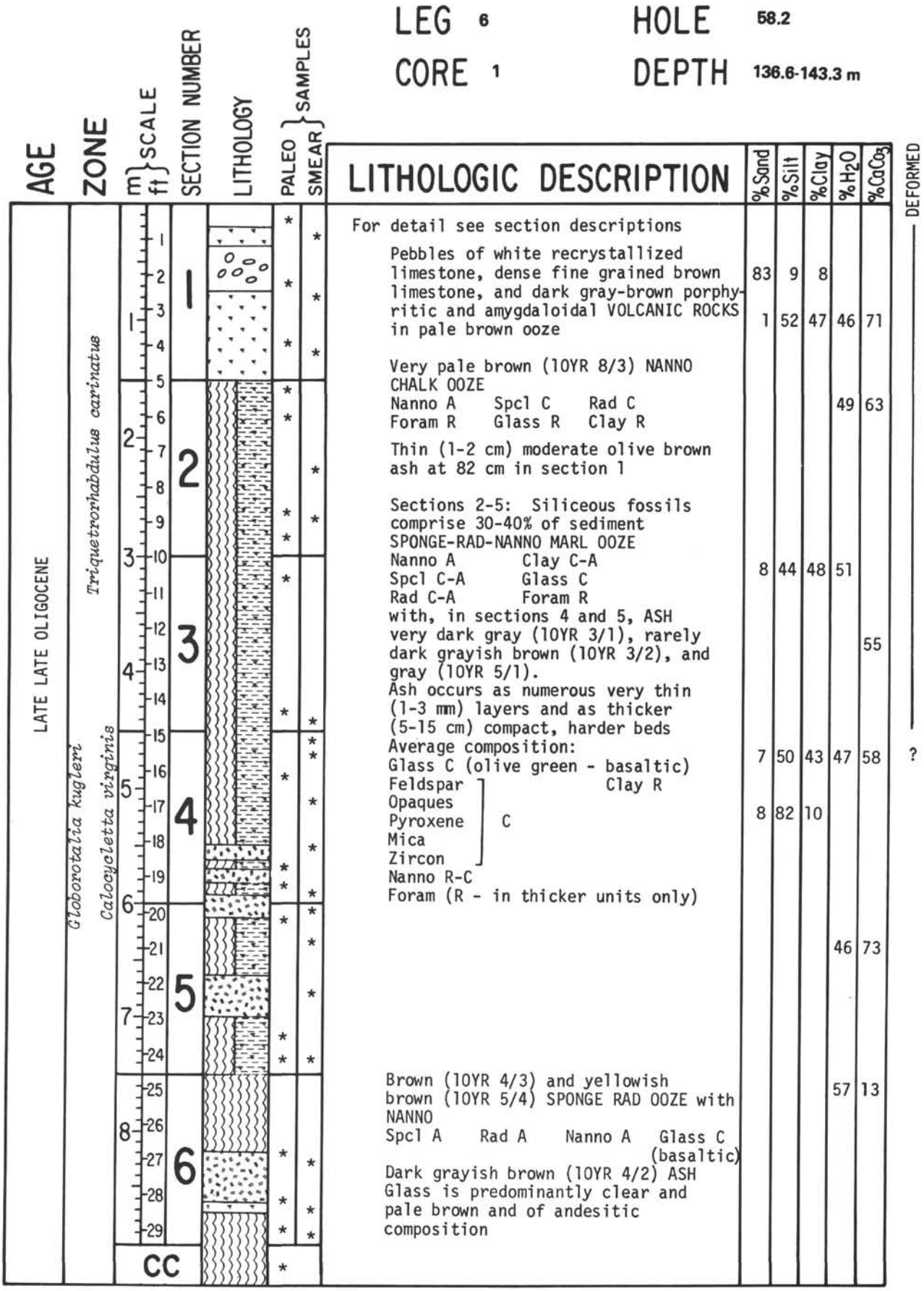


Figure 12. *Summary of physical properties in Hole 58.2 Core 1.*

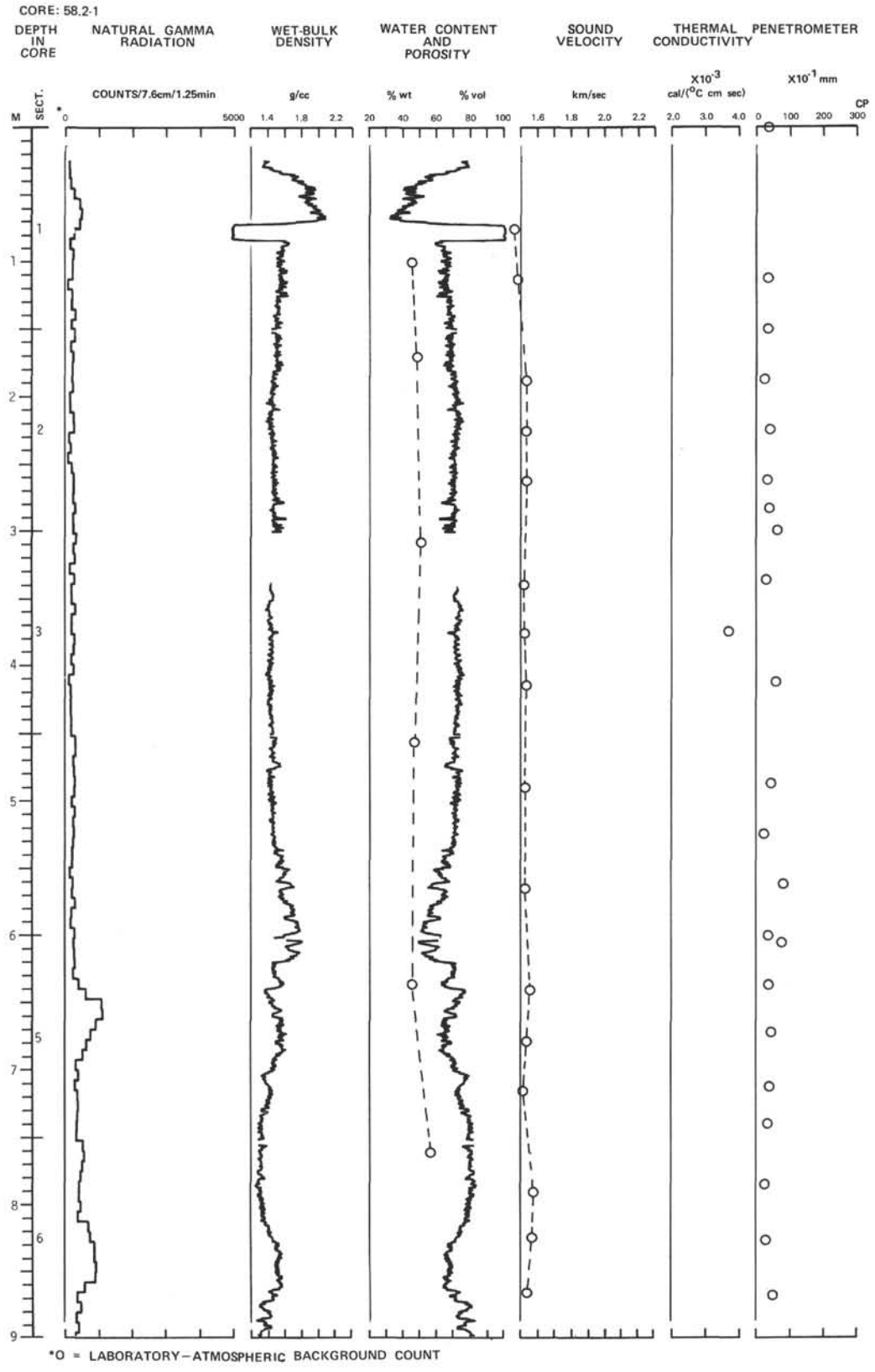


Figure 11. *Summary of lithology in Hole 58.2 Core 1.*

LEG 6 HOLE 58.2

CORE 1 DEPTH 136.6-143.3 m

| FORAMINIFERA | NANNOPLANKTON | RADIOLARIA |
|---|---|---|
| Throughout the core assemblages of the *Globorotalia kugleri* Zone present, lower Lower Miocene ( or upper Upper Oligocene of Bolli's zonal scale, 1957). Among planktonic foraminifers are numerous *Globorotalia kugleri, Globigerina bradyi, G. juvenilis, G. angustumbilicata, Cassigerinella chipolensis* accompanied by rare *Globigerinita unicava* and *Globorotalia siakensis.* | Upper upper Oligocene assemblages of the *Triquetrorhabdulus carinatus* Zone are present throughout the core. Species present include *Coccolithus* sp. aff. *C. bisectus, Cyclococcolithina neogammation, Discoaster deflandrei, Sphenolithus* sp. aff. *S. belemnos, S. moriformis,* and *Triquetrorhabdulus carinatus.* | This core contains Radiolaria of the lower lower Miocene *Calocycletta virginis* Zone. They are abundant and well preserved. TOP: *Calocycletta virginis, Cyrtocapsella cornuta, Dorcadospyris ateuchus, Cannartus prismaticus,* and *Lychnocanium bipes.* BOTTOM: *Calocycletta virginis, Cannartus prismaticus, Cyrtocapsella cornuta,* and *Dorcadospyris ateuchus.* |

Figure 13. *Summary of biostratigraphy in Hole 58.2 Core 1.*

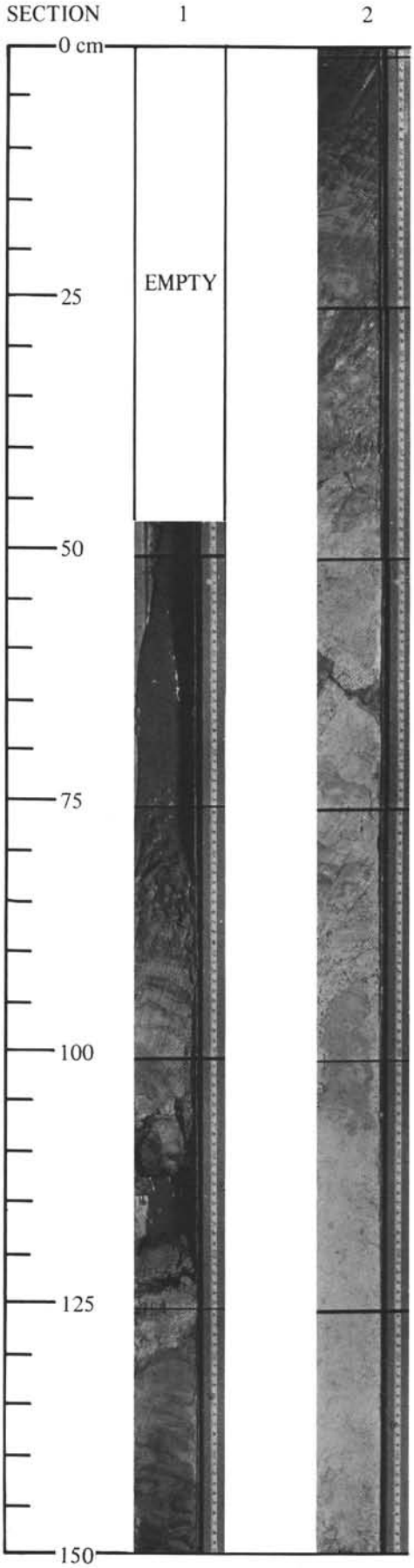


Plate 1. *Photographs of Hole 58.1 Core 1.*

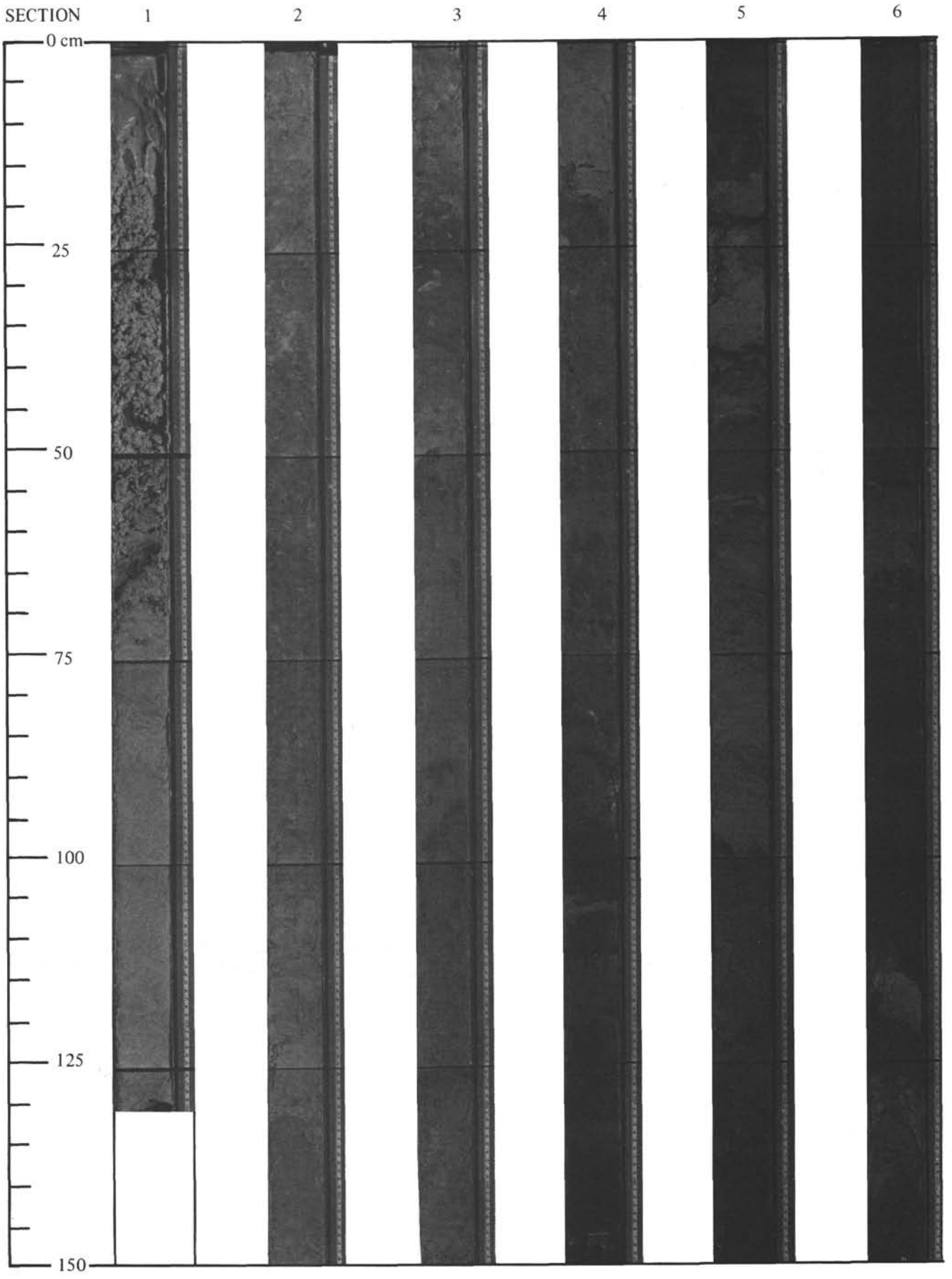


Plate 2. *Photographs of Hole 58.2 Core 1.*