17. SITE 59

Shipboard Scientific Party[1]

SITE DATA

Occupied: July 31-August 2, 1969.

Position: Abyssal Floor of Pacific, just East of Mariana Trench: Latitude: 11° 46.8'N. Longitude: 147° 34.9'E.

Water Depth: 5554 meters (59.0, 59.1). 5547 meters (59.2).

Hole 59.0: One core (no recovery).

Hole 59.1: Three cores (only one recovered).

Hole 59.2: Six cores.

Total Depth: 1135 meters in Cretaceous cherty and ashy clay.

MAIN RESULTS

Neogene brown clays overlie a condensed section of Paleocene and Eocene clay with traces of chalk.

The hole bottomed in Cretaceous cherty brown clays with beds of lithified ash, which here form the upper opaque acoustic layer. More sediments lie below. Thus, this site has a "western Pacific" type sequence, much like that found far to the north, and contrasts markedly with the section found on the Caroline Ridge and in the Philippine Sea.

BACKGROUND

Having found the Caroline Ridge type of geology to extend as far as Site 58, the ship steamed further northeast, across an area of rugged topography to meet the flat and deeper Pacific sea floor in the vicinity of the *Argo* seismic reflection profile for which Karig's profile sketch had been transmitted by facsimile (see Chapter 20). This profile seemed much like the Pacific profiles to the north, showing up to 0.1 second of an upper transparent layer, and, at about 0.29 second, Horizon B'. Topographically, this site also appeared to belong to the Pacific *sensu stricto.* The object was to find old Pacific crust, (1) in the hopes of being able to penetrate it and to date the basement, (2) in order to compare it with the sites drilled far to the north (45, 46, 51, 52); and, (3) in order to define the boundary between the younger (Oligocene) curst of the Caroline Ridge area and the true Pacific Ocean crust of Jurassic or older age.

Unfortunately, the profiler broke down on leaving Site 58, but the *Argo* profile provided a target. The rugged area crossed before reaching the site (Figure 1), with mountains having steeper faces to the northeast, is a major fracture zone. Bottom soundings in the vicinity of Site 59 are given as Figure 2.

OPERATIONS

The beacon of Site 59 was dropped at 1130 hours, July 31, and Hole 59.0 was spudded at 2200 hours. Drilling took place to the first indication of hard material—at 122 meters; and, a core was cut which achieved no penetration and yielded no recovery.

The tools were brought back to mudline, and Hole 59.1 was spudded. This hole seemed to offer no resistance to drilling. Two cores attempted at 34 and 43 meters achieved no recovery, but from 52 to 61 meters recovery was of 4 meters of Quaternary brown clay with streaks of diatom-radiolarian ooze, a core patently not cut in that depth. It was concluded that the drill was following the old hole (59.0), and tools were brought back to mudline.

Hole 59.2 yielded 6 cores and bottomed in Cretaceous chert and clay at a total depth of 135 meters. It was hoped to penetrate at least some distance into the Cretaceous, but the drilling became alarmingly rough, and a damaged bit was suspected. The drill string was retrieved, but the light-set diamond bit was recovered in fairly good condition. Drilling again might have achieved more penetration, but it was decided against another round trip here because experience showed that light-set diamond bits do not achieve much penetration in cherty sediments; there were no more massive diamond bits, nor a sub for the one remaining button roller bit. This site was therefore abandoned at 1000 hours, August 2, in the hopes that Leg 7 would drill another hole in this vicinity, with a more suitable bit. This subsequently happened at Site 61, described in the Leg 7 report.

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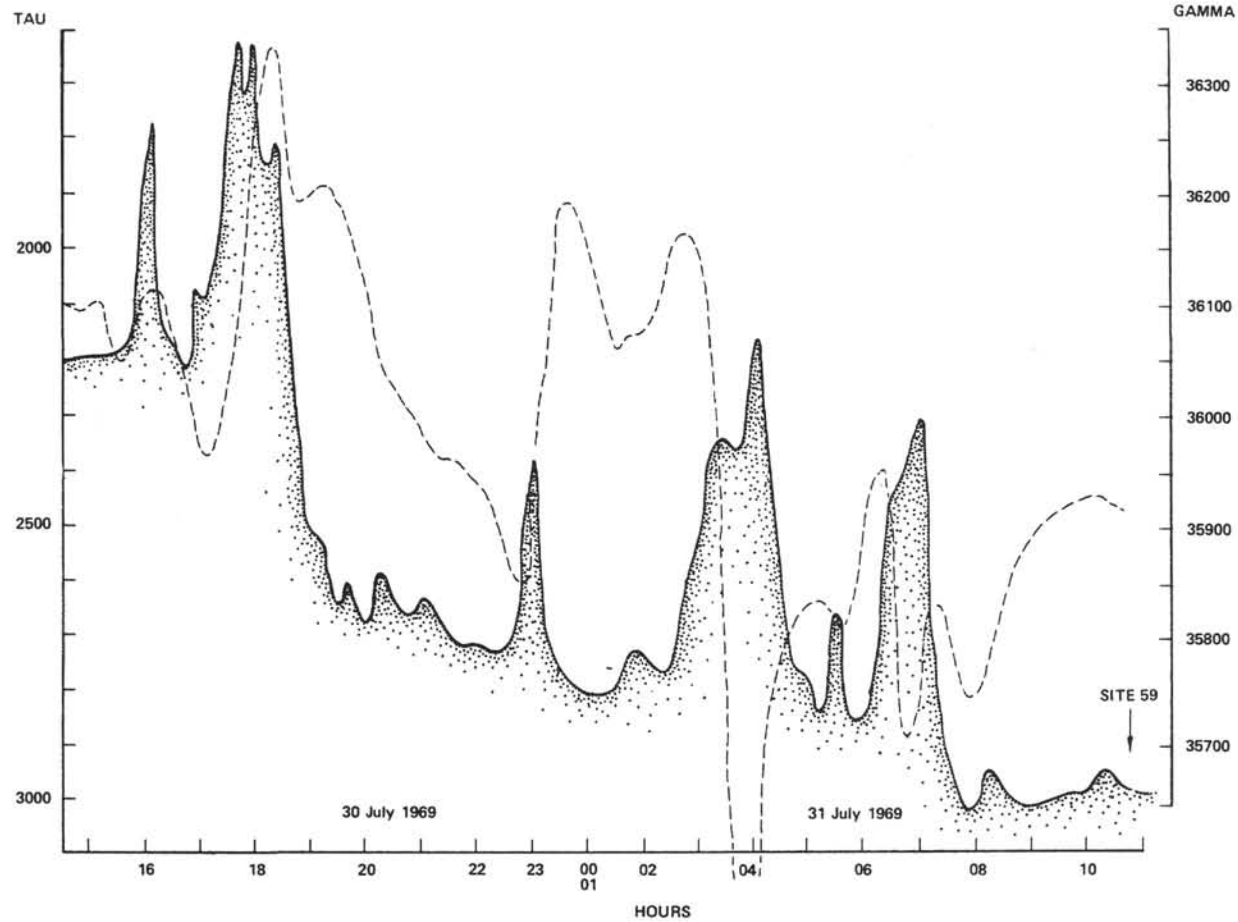

Figure 1. Challenger *bathymetric and magnetic profile at Site 59.*

NATURE OF THE SEDIMENTS

Of the ten cores attempted in three holes at this site, three had no recovery and seven recovered sediment at various intervals between 51.8 and 135.6 meters subbottom depth.

Hole 59.0

A single core was attempted at 122 meters subbottom depth, where a hard layer was encountered, but no recovery was obtained.

Hole 59.1

Cores 1 and 2, attempted at 41 and 50 meters subbottom, had no recovery. Core 3 was drilled between 51.8 and 61.0 meters below mudline and yielded about 3.6 meters of sediment of Quaternary age; it also contained Radiolaria of Miocene, Eocene and Cretaceous age. The sediment recovered is interlayered very pale brown to yellowish-brown diatom ooze and dark yellowish-brown to dark brown zeolitic clay. The diatom ooze is very soft and composed dominantly of frustules of *Ethmodiscus rex* along with small amounts of Radiolaria, sponge spicules, volcanic glass, clay minerals and zeolites. Two components, ragged, lath-shaped zeolites and clay minerals, compose most of the zeolitic clays which also contain common amounts of limonitic granules, silt-size feldspar and quartz grains, mica, and fresh and altered volcanic glass, including yellowish palagonite. Sponge spicules and nannofossils are the only organic elements present and occur in very small amounts.

Hole 59.2

Six cores were cut in a continuous sequence between 89.3 and 135.6 meters subbottom depth, but only Core 2 recovered a barrel full of sediment.

The top few decimeters of Core 1 is brown zeolitic clay, much like that in Core 3 of Hole 59.1 except that fresh and altered volcanic glass and plagioclase are more abundant. The bottom of Core 1, all of Core 2, and the top part of Core 3 is poorly sorted, dark brown to dark yellowish-brown, clay-rich radiolarian ooze or radiolarian-sponge ooze (Chapter 38). This siliceous sediment has common to abundant clay minerals and well preserved radiolarian tests, sponge spicules, and small amounts of diatom remains. Fresh and altered volcanic glass fragments, including palagonite and altered, weakly

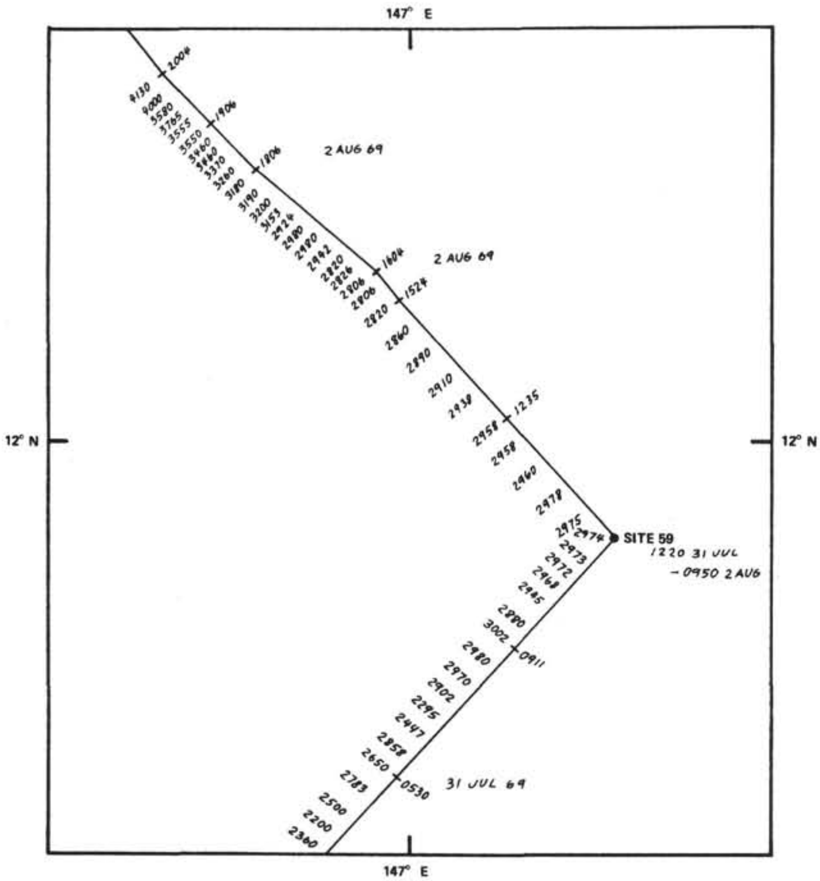

Figure 2. *Bottom soundings in area of Site 59.*

birefringent palagonite, are common; and, variable amounts of limonitic grains, plagioclase, pyroxenes and hematitic grains are also present.

Beginning in Section 2 of Core 3 and extending to the bottom of the hole, the dominant sediment is dark yellowish-brown to dark brown zeolitic clay, much like that at the top of Core 1. Within this brown clay (which contains some potash feldspar, small amounts of plagioclase and clinoptolite according to X-ray studies by Rex) are three variations:

(a) The lower 60 centimeters of Core 4 are zeolitic radiolarian ooze dominated by clay minerals and well-preserved Radiolaria, but also containing common lath-shaped zeolites (Chapter 38).

(b) With the upper 20 centimeters of the sediment recovered in Core 5 are small amounts of dark reddish-brown volcanic sand composed dominantly of angular grains of fresh and altered volcanic glass, in addition to, subordinate amounts of chert fragments, Radiolaria, feldspars, amphiboles, and nannofossils.

(c) The lower 75 centimeters of Core 5 are dark brown zeolitic clay dominated by very abundant, fine-grained, anhedral zeolites and containing siderite identified by X-ray diffraction.

Core 6 recovered about 2.25 meters of very soupy and highly disturbed brown zeolitic clay in which are embedded pebble-size fragments of rounded, grayish-brown clay, and angular chips of brown to reddish-brown, thinly laminated chert or silicified tuff. The washed fraction of this sediment contains Radiolaria, reddish volcanic glass, yellowish palagonite, sponge spicules and cosmic (?) spherules. This material appears to have been thoroughly mixed during coring, and penetration was apparently stopped by chert.

PHYSICAL PROPERTIES

These physical properties are not representative of *in situ* conditions because of sediment disturbance during coring operations.

Natural Gamma Radiation

Holes 59.0, 59.1 and 59.2

Quaternary *Ethmodiscus* ooze and zeolitic clay, and Lower Miocene zeolitic clay and radiolarian ooze, with

TABLE 1
Summary of Coring at Site 59

Core No.	Interval Cored (below mudline) (ft)	(m)	Recovery (ft)	(m)
59.0-1[a]	400-402	121.9-122.5	0	0.0
59.1-1	110-140	33.5-42.7	0	0.0
59.1-2	140-170	42.7-51.8	0	0.0
59.1-3	170-200	51.8-61.0	10	3.0
59.2-1[b]	293-323	89.3-98.5	14	4.3
59.2-2	323-353	98.5-107.6	26	7.9
59.2-3	353-383	107.6-116.7	4	1.2
59.2-4	383-413	116.7-125.9	3	0.9
59.2-5	413-433	125.9-132.0	3	0.9
59.2-6	433-444	132.0-135.3	11	3.4

Water Depth: [a]5554.4* meters (18,223* feet)
[b]5546.8* meters (18,198* feet)

intervals of spicules and ash, were cored at 52 to 108 meters below sediment surface from Site 59. Natural gamma emissions ranged from 0 to 7100 counts/7.6-cm core segment/1.25 minutes, with a mode of 400 counts between 52 to 108 meters. The Quaternary dark brown zeolitic clay and the *Ethmodiscus* diatom ooze contained in Section 1 of Core 59.1/3 (at 51.8 meters) had the highest gamma count of 7100. Below this, Quaternary zeolitic clays had counts of about 1000 with another high count of 1500 emitted from another *Ethmodiscus* diatom ooze in Section 3 of the same core. Below this core, at 89 to 108 meters, the Lower Miocene zeolite clay and clayey radiolarian oozes had core averages of 400 counts.

Gamma radiation decreased with depth (52 to 108 meters) from Quaternary to Lower Miocene sediments. Gamma averages of the cores versus depth varied directly with wet-bulk density and heat conductivity, and inversely with porosity and sound velocity. Strict correlation to sediment type in the Miocene sediments did not seem to occur.

Porosity, Wet-Bulk Density, and Water Content

Holes 59.0, 59.1 and 59.2

Porosity, wet-bulk density, and water content within the Quaternary to Lower Miocene sediments recovered at Site 59 ranged from 66 to 97 per cent (?), 1.44 to 1.15 (?) g/cc, and 68 to 72 per cent. In general, typical porosities of the cores increased from 78 per cent (1.31 g/cc)–in Quaternary zeolitic clay and *Ethmodiscus* diatom ooze at 52 to 56 meters–to between 83 per cent (1.31 g/cc) and 92 per cent (?) (1.15?) g/cc) in Miocene zeolitic clays and radiolarian oozes between 89 and 108 meters.

Sound Velocity

Holes 59.0, 59.1 and 59.2

Sound velocity through sediments from Site 59 within 52 to 108 meters ranged from 1.46 to 1.64 km/sec, with an average of 1.54 km/sec. The reworked Quaternary zeolitic clay and *Ethmodiscus* diatom ooze, from 52 to 61 meters, had a low average velocity of 1.48 km/sec. Lower Miocene radiolarian zeolitic clay and ooze, from 89 to 108 meters, had typical velocities of 1.48 and 1.57 km/sec, respectively, and ranged from 1.48 to 1.64 km/sec.

Thermal Conductivity

Holes 59.0, 59.1 and 59.2

Heat conductivity ranges from 1.85 to 2.17×10^{-3} cal-$^\circ C^{-1} cm^{-1} sec^{-1}$, with an average of 1.97×10^{-3}. The highest value occurred in the reworked Quaternary zeolitic clay and the lower values (1.87 to 1.96×10^{-3}) occurred in the upper Oligocene and lower Miocene radiolarian oozes and zeolitic clay. In general, conductivity slightly decreased with depth.

Penetrometer

Holes 59.0, 59.1 and 59.2

Penetrometer values at Site 59 range from 50×10^{-1} millimeters to complete penetration. The values which did not completely penetrate the sediment averaged 159×10^{-1} millimeter. Penetration appeared to irregularly decrease with depth. Quaternary zeolitic clay and *Ethmodiscus* diatom ooze (52 to 61 meters) average 167×10^{-1} millimeters with the greatest penetration in the diatom oozes. The lower Miocene and upper Oligocene radiolarian oozes and zeolitic clays had modes of 60 and 170×10^{-1} millimeters (89 to 126 meters). Lower Oligocene zeolitic clays with ash (126 to 132 meters) averaged 70 to 170×10^{-1} millimeters. The ash content here apparently contributed to the decrease in penetration.

CONCLUSIONS

Site 59 is located on old Pacific crust; the upper transparent layer is mainly Neogene; the Eocene and Paleocene are present in a very condensed section within the third core of Hole 59.2 (of which only 1.2 meters were recovered), and the top of the Cretaceous also lies within this core. The Paleocene contains some carbonate, while the Cretaceous is devoid of calcareous nannofossils. Chert occurs in the Cretaceous, but it cannot be certain whether it is present or absent in the Eocene-Paleocene section. The identification of chert rests on the presence of Cretaceous-type Radiolaria, which are not as yet pinned down more precisely to stages.

Drilling at this site thus penetrated a succession somewhat similar to that encountered at Sites 45, 46, 51 and 52, and which was formed on a crust that probably dates back to Jurassic time.

The fracture zone which was crossed southwest of Site 59 is most likely the boundary between the young and old crust in this area.

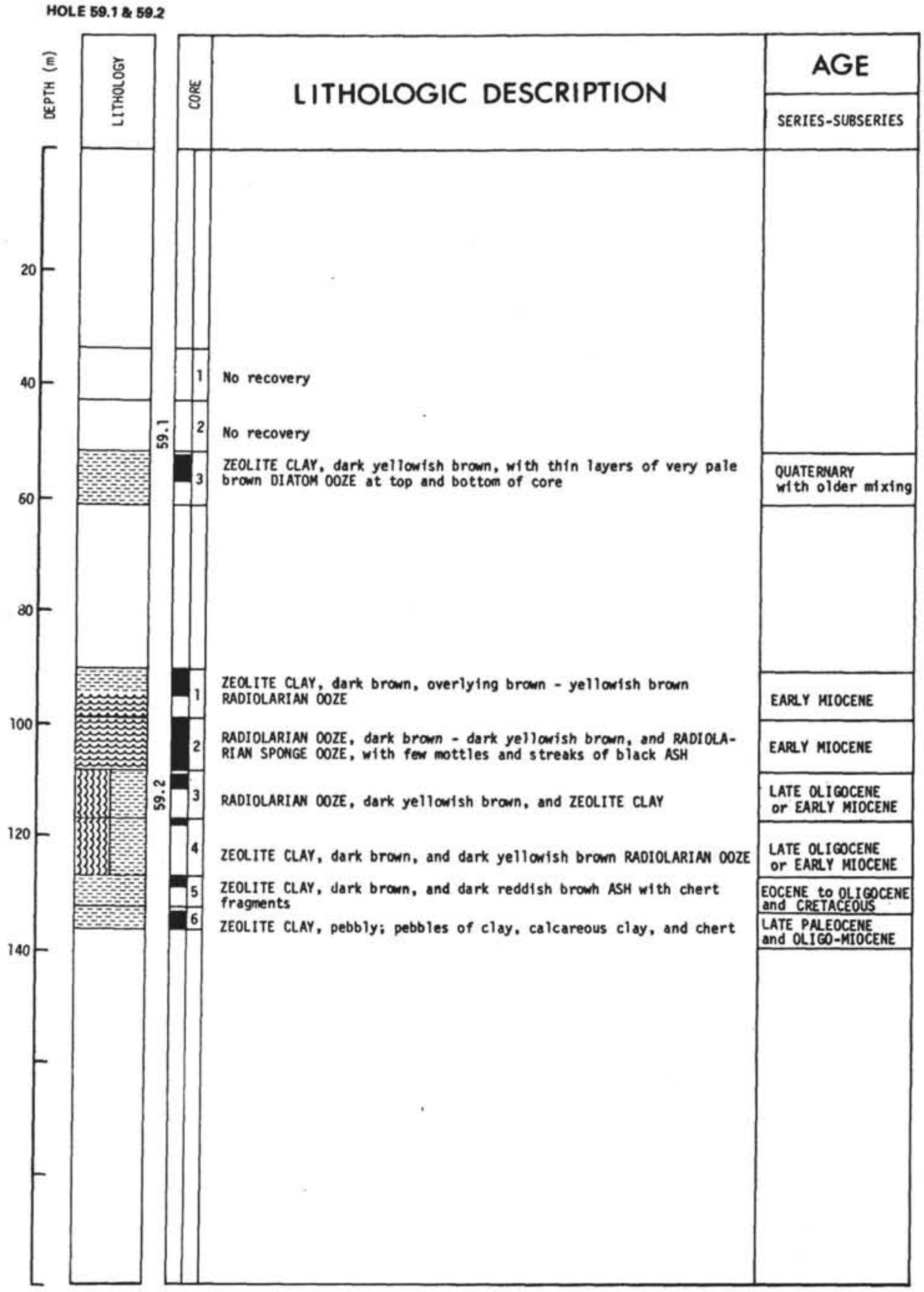

Figure 3. *Summary of lithology in Hole 59.1 and 59.2.*

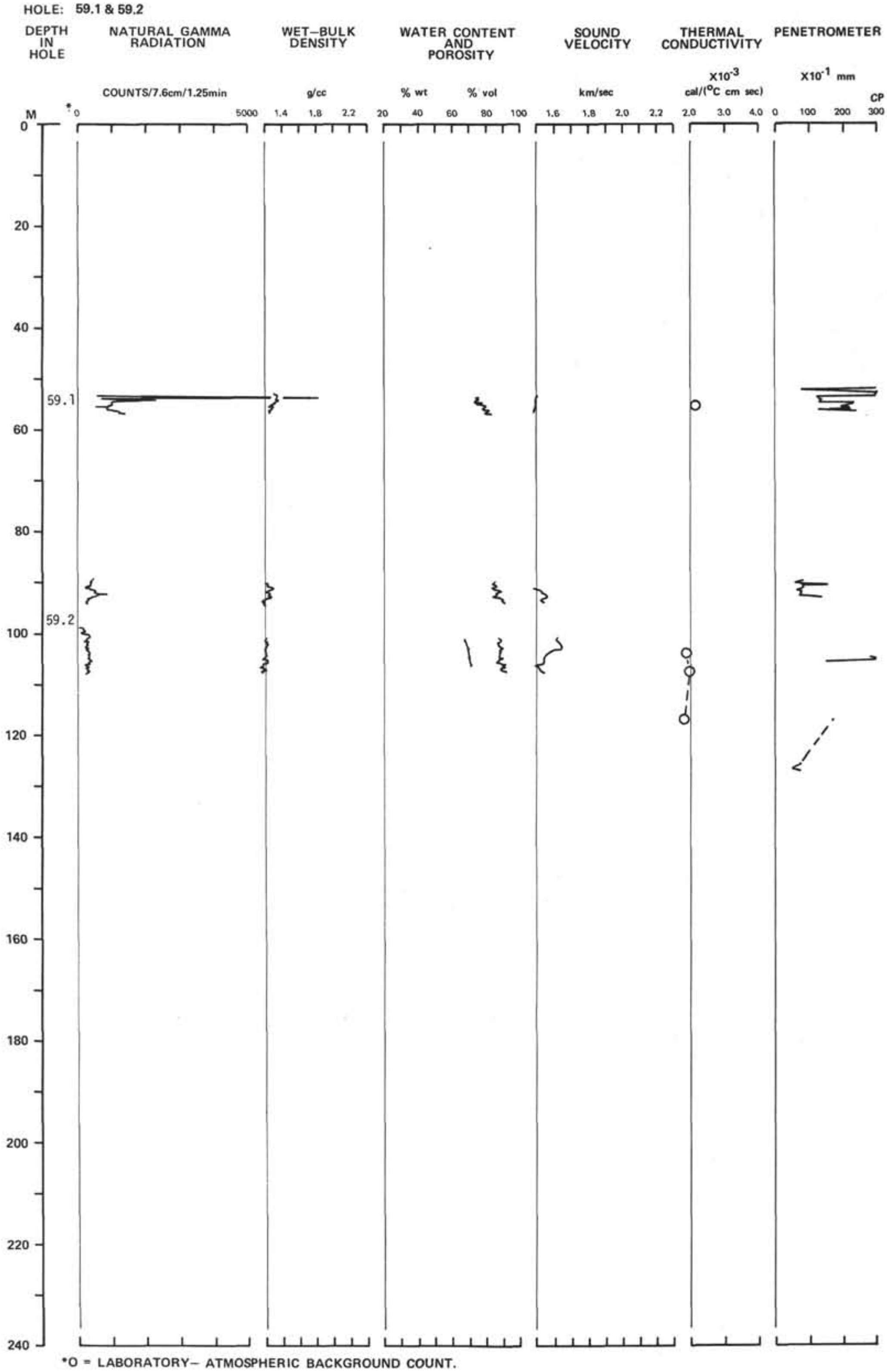

Figure 4. *Summary of physical properties in Hole 59.1 and 59.2.*

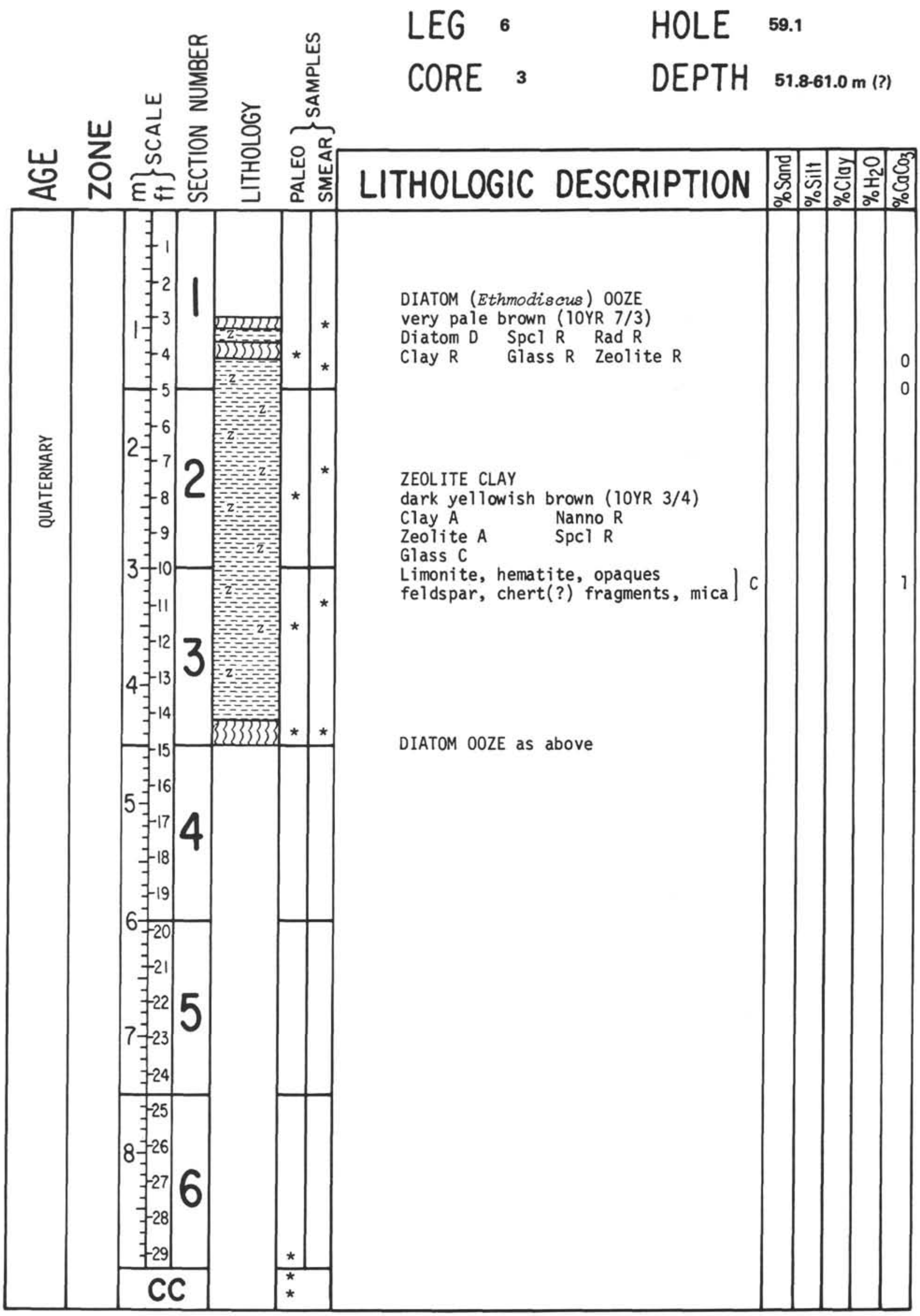

Figure 5. *Summary of lithology in Hole 59.1 Core 3.*

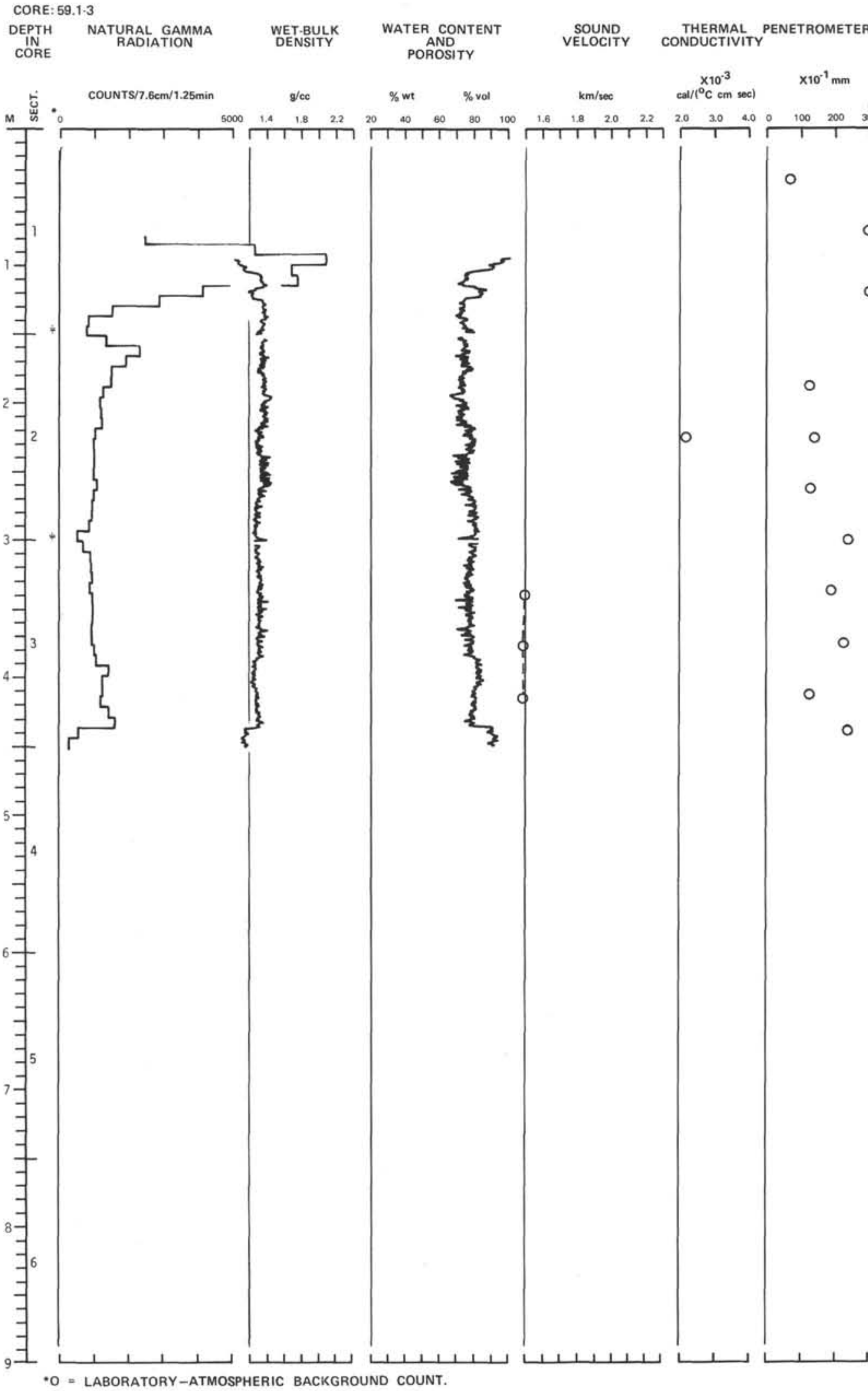

Figure 6. *Summary of physical properties in Hole 59.1 Core 3.*

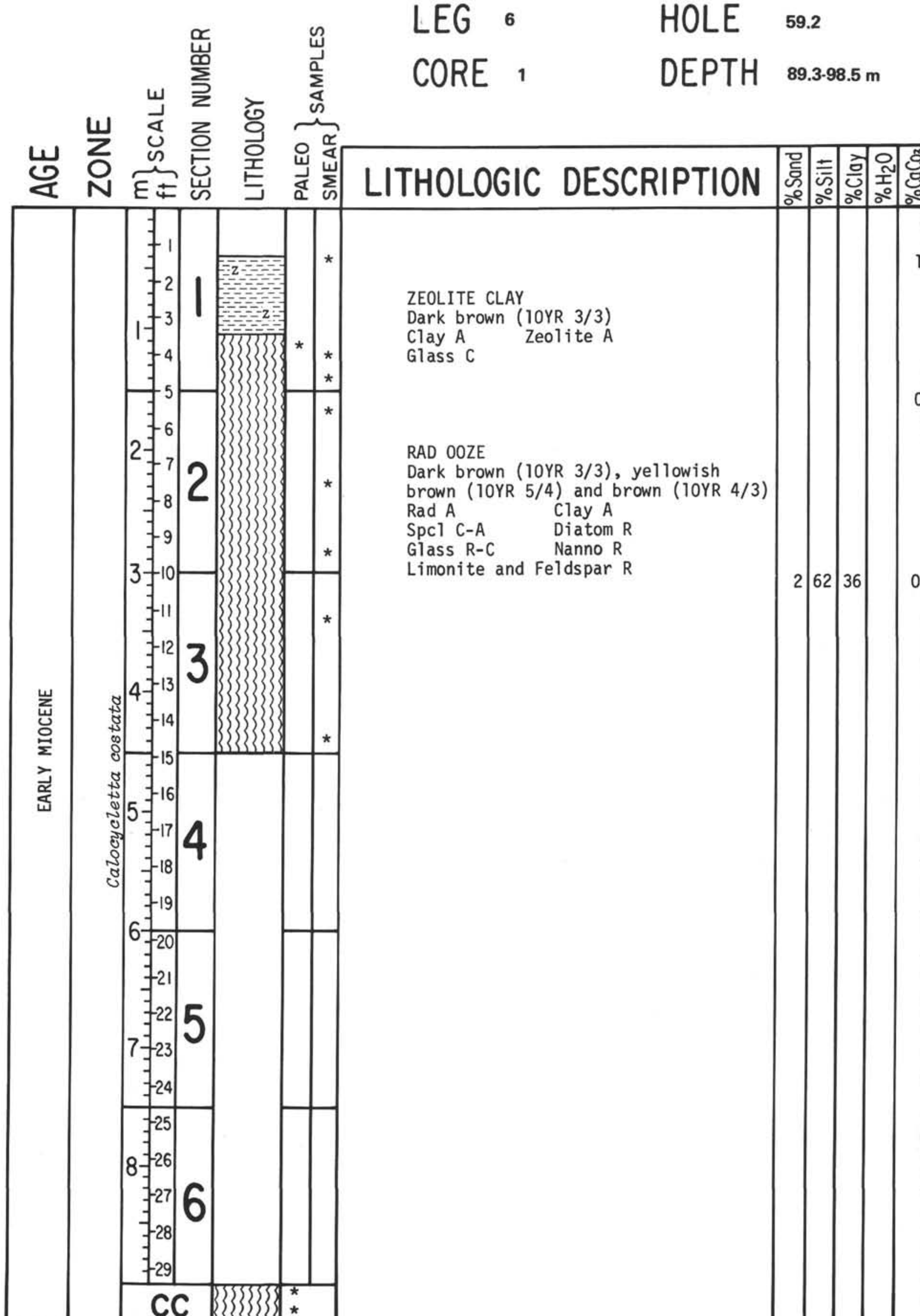

Figure 7. *Summary of lithology in Hole 59.2 Core 1.*

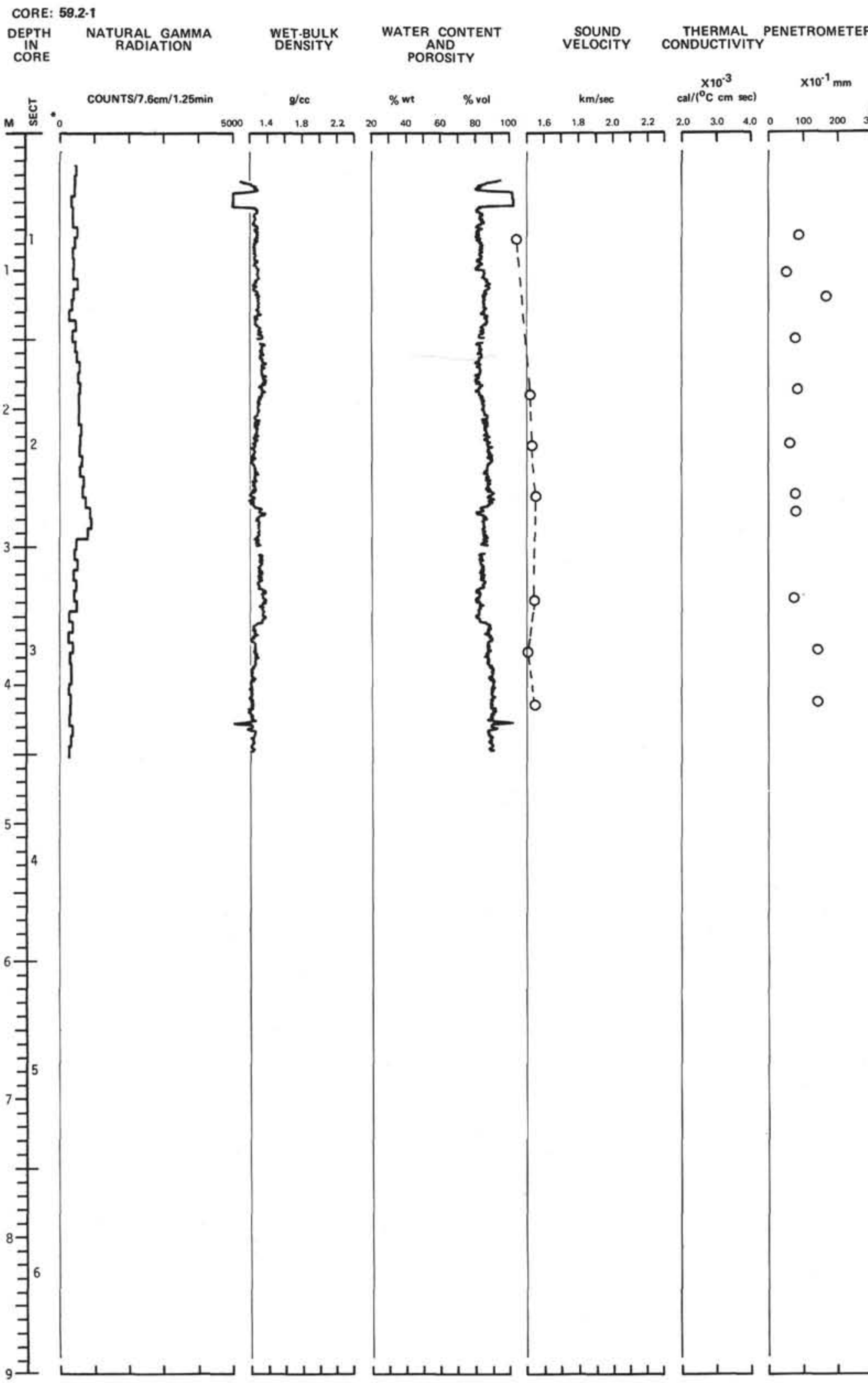

Figure 8. *Summary of physical properties in Hole 59.2 Core 1.*

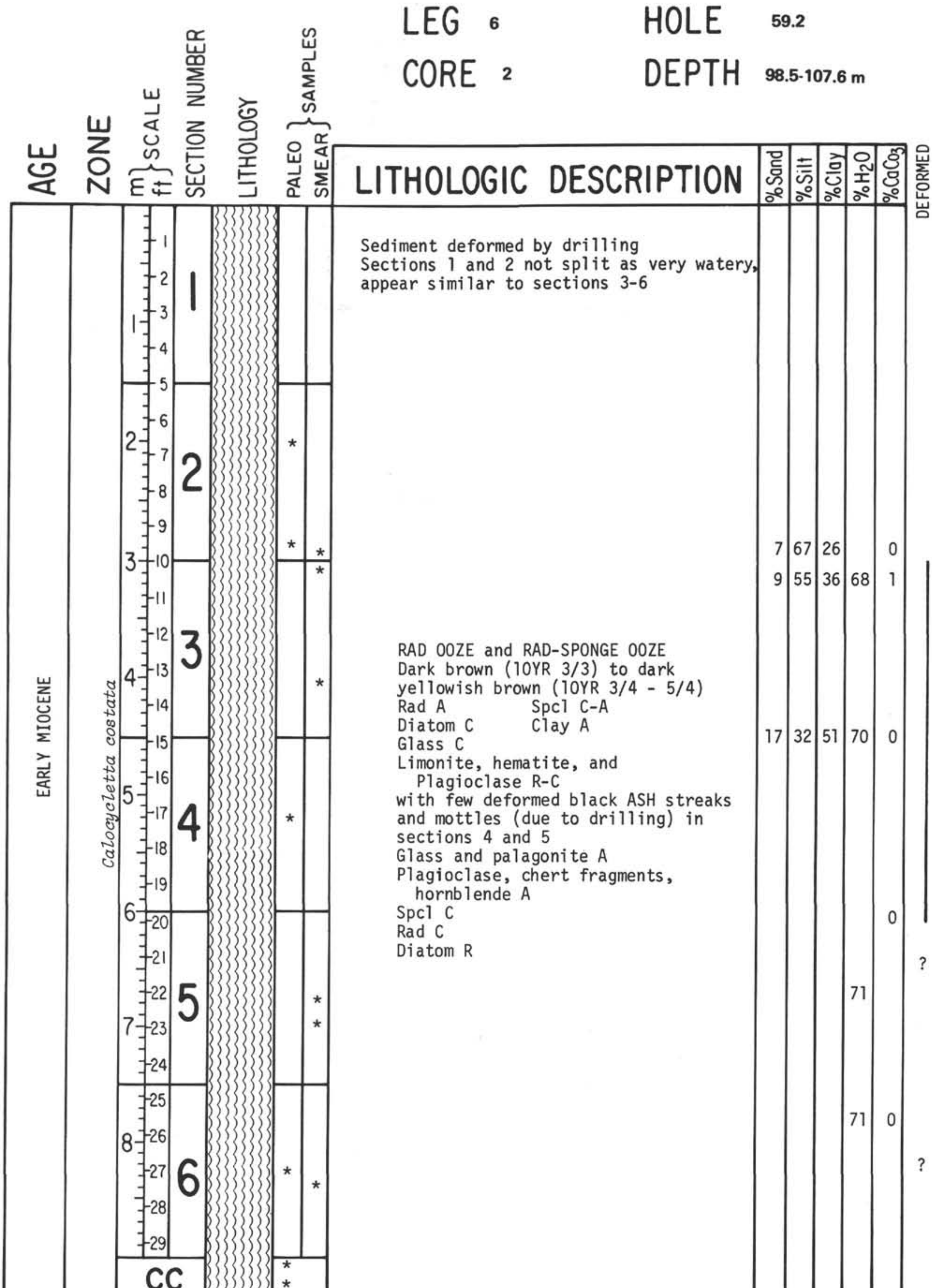

Figure 9. *Summary of lithology in Hole 59.2 Core 2.*

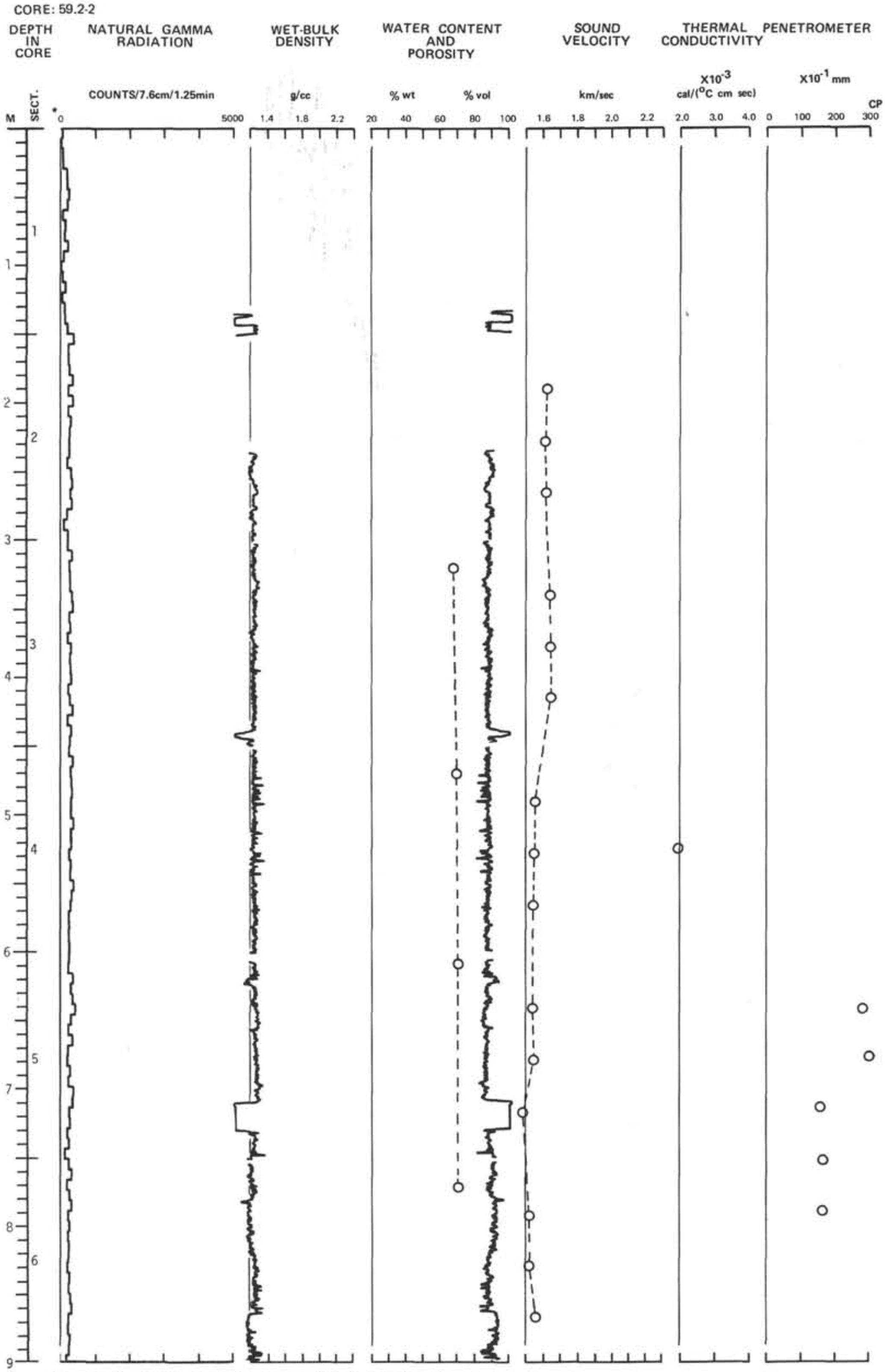

Figure 10. *Summary of physical properties in Hole 59.2 Core 2.*

LEG 6 HOLE 59.2

CORE 3 DEPTH 107.6-116.7 m

AGE	ZONE	SECTION NUMBER	PALEO SAMPLES	SMEAR SAMPLES	LITHOLOGIC DESCRIPTION	%Sand	%Silt	%Clay	%H_2O	%$CaCO_3$
LATE OLIGOCENE or EARLY MIOCENE	? *Triquetrorhabdulus carinatus* *Calocycletta costata*	1	*	*	Core liner collapsed, sections not split, sampled at bottom RAD OOZE Dark yellowish brown (10YR 3/4) Rad A Spcl C Clay A Glass and palagonite C Plagioclase, limonite, hematite C Zeolite R	7	70	23		0
		2	*	*	ZEOLITE CLAY Dark yellowish brown (10YR 3/4) Clay A Zeolite A Glass and palagonite C Plagioclase, limonite, hematite C	1	45	54		0
		3								
		4								
		5								
		6								
		CC	*							

Figure 11. *Summary of lithology in Hole 59.2 Core 3.*

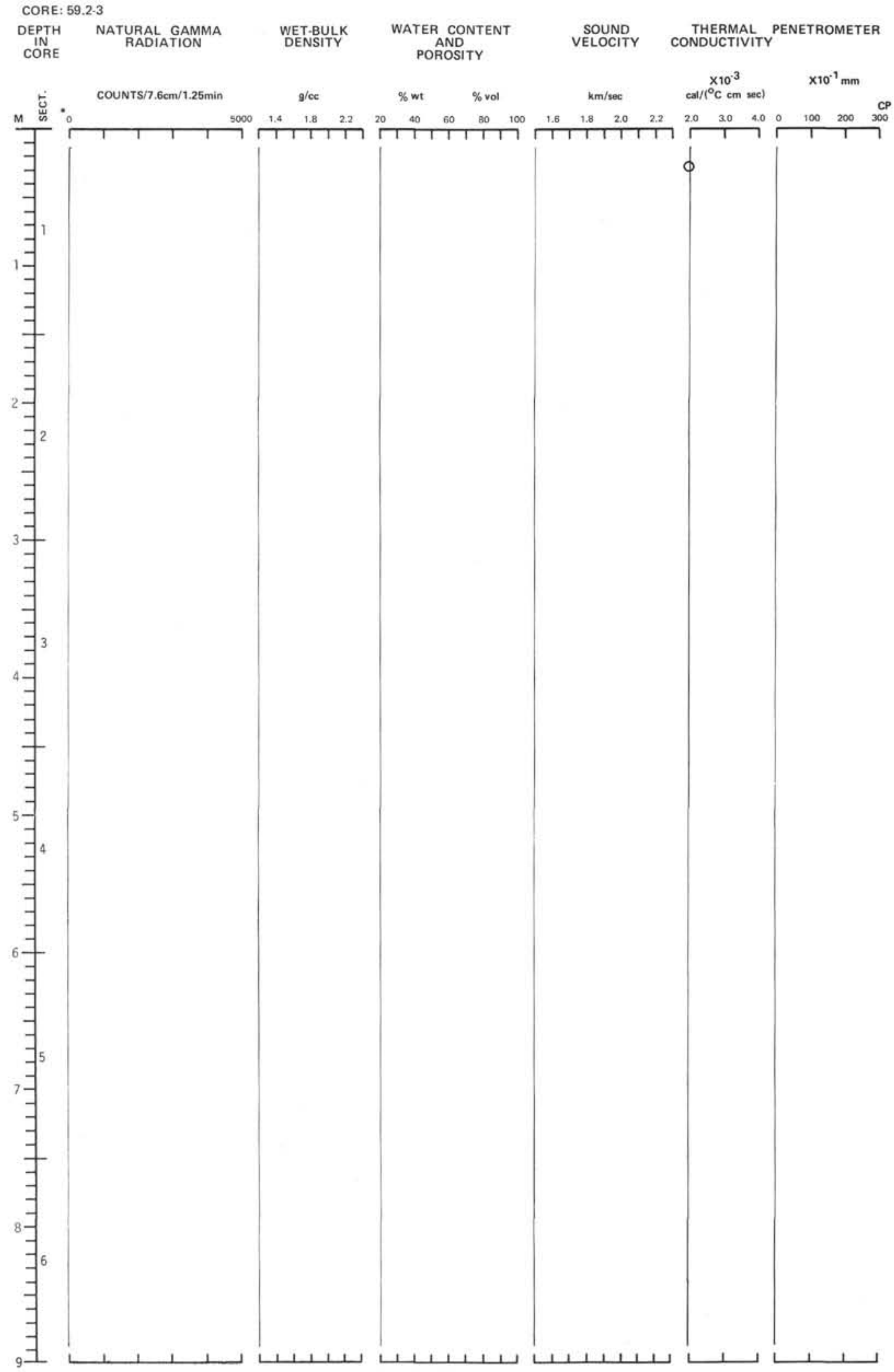

Figure 12. *Summary of physical properties in Hole 59.2 Core 3.*

LEG 6 HOLE 59.2

CORE 4 DEPTH 116.7-125.9 m

AGE	ZONE	SCALE (m / ft)	SECTION NUMBER	LITHOLOGY	SAMPLES: PALEO	SAMPLES: SMEAR	LITHOLOGIC DESCRIPTION	%Sand	%Silt	%Clay	%H2O	%CaCO3
LATE OLIGOCENE or EARLY MIOCENE	*Triquetrorhabdulus carinatus* / *Calocycletta costata*	0–1.5 m / 0–5 ft	1		*	* *	ZEOLITE CLAY Dark brown (10YR 4/3) Clay A Zeolite A Glass and palagonite C Fish R RAD OOZE Dark yellowish brown (10YR 4/4) Rad A Clay A Spcl C Zeolite C Glass C Plagioclase and limonite C Foram R	6	56	38	66	0
		1.5–3 m / 5–10 ft	2									
		3–4.5 m / 10–15 ft	3									
		4.5–6 m / 15–20 ft	4									
		6–7.5 m / 20–25 ft	5									
		7.5–9 m / 25–30 ft	6									
			CC		* *							

Figure 13. *Summary of lithology in Hole 59.2 Core 4.*

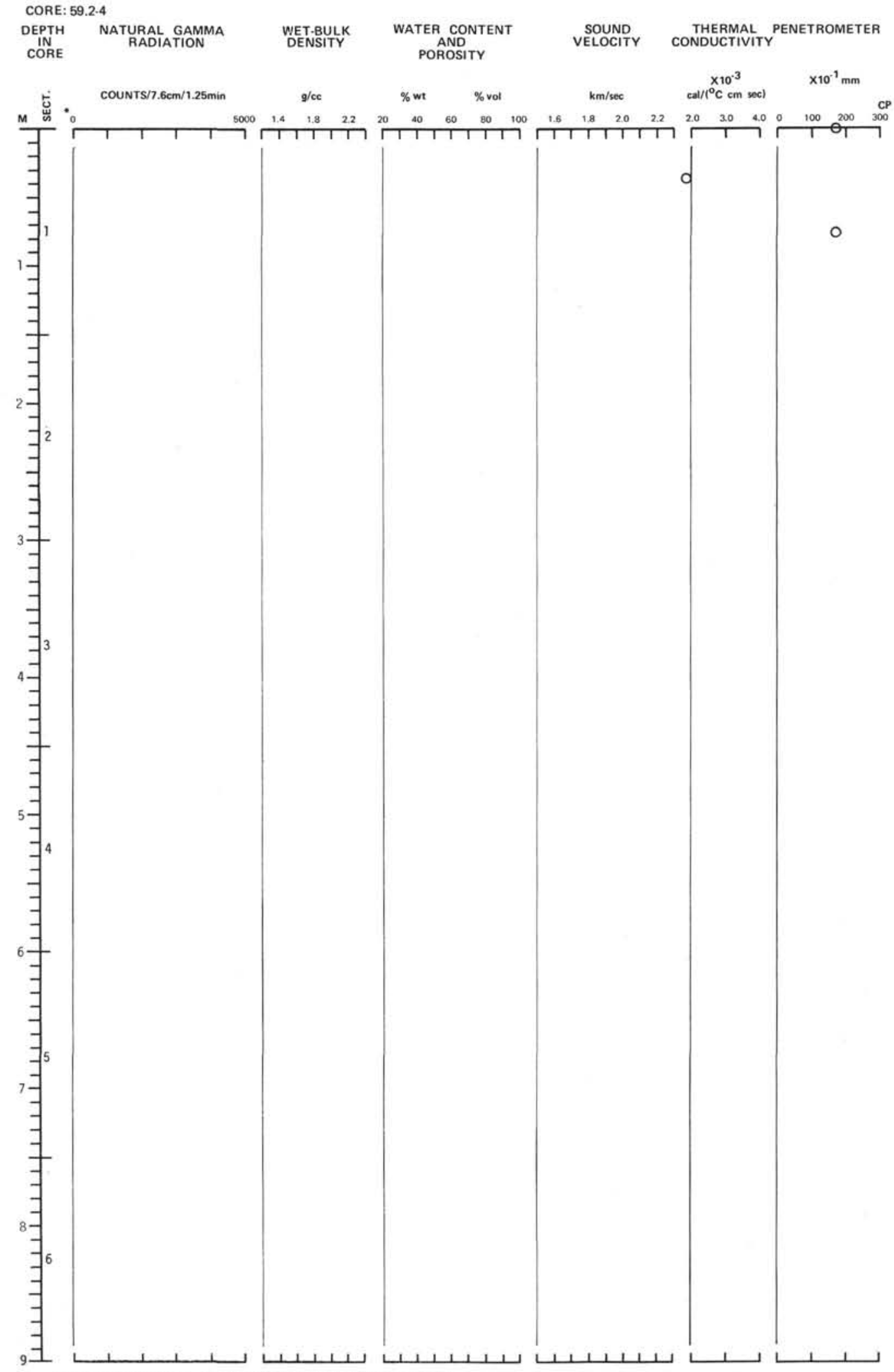

Figure 14. *Summary of physical properties in Hole 59.2 Core 4.*

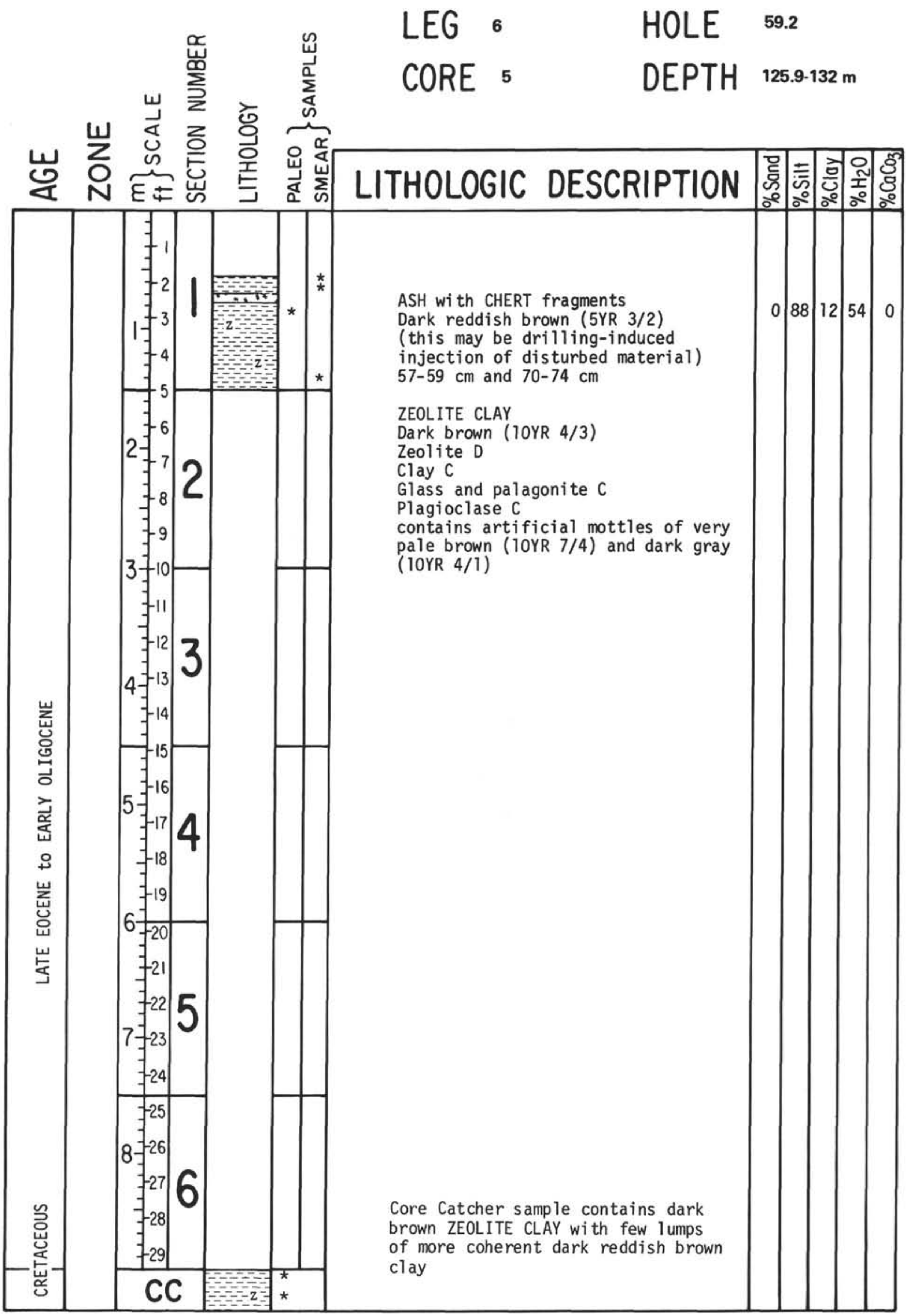

Figure 15. *Summary of lithology in Hole 59.2 Core 5.*

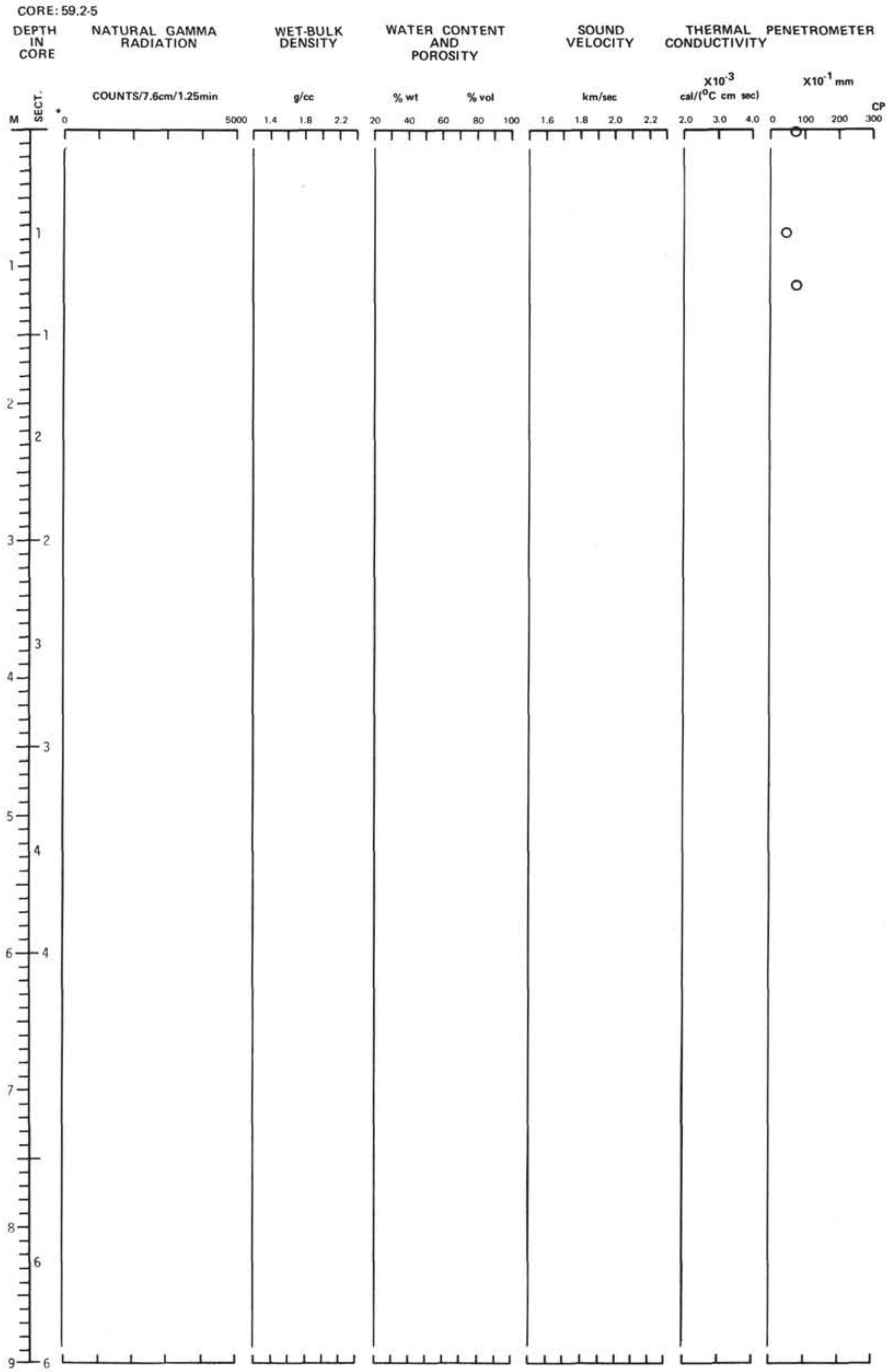

Figure 16. *Summary of physical properties in Hole 59.2 Core 5.*

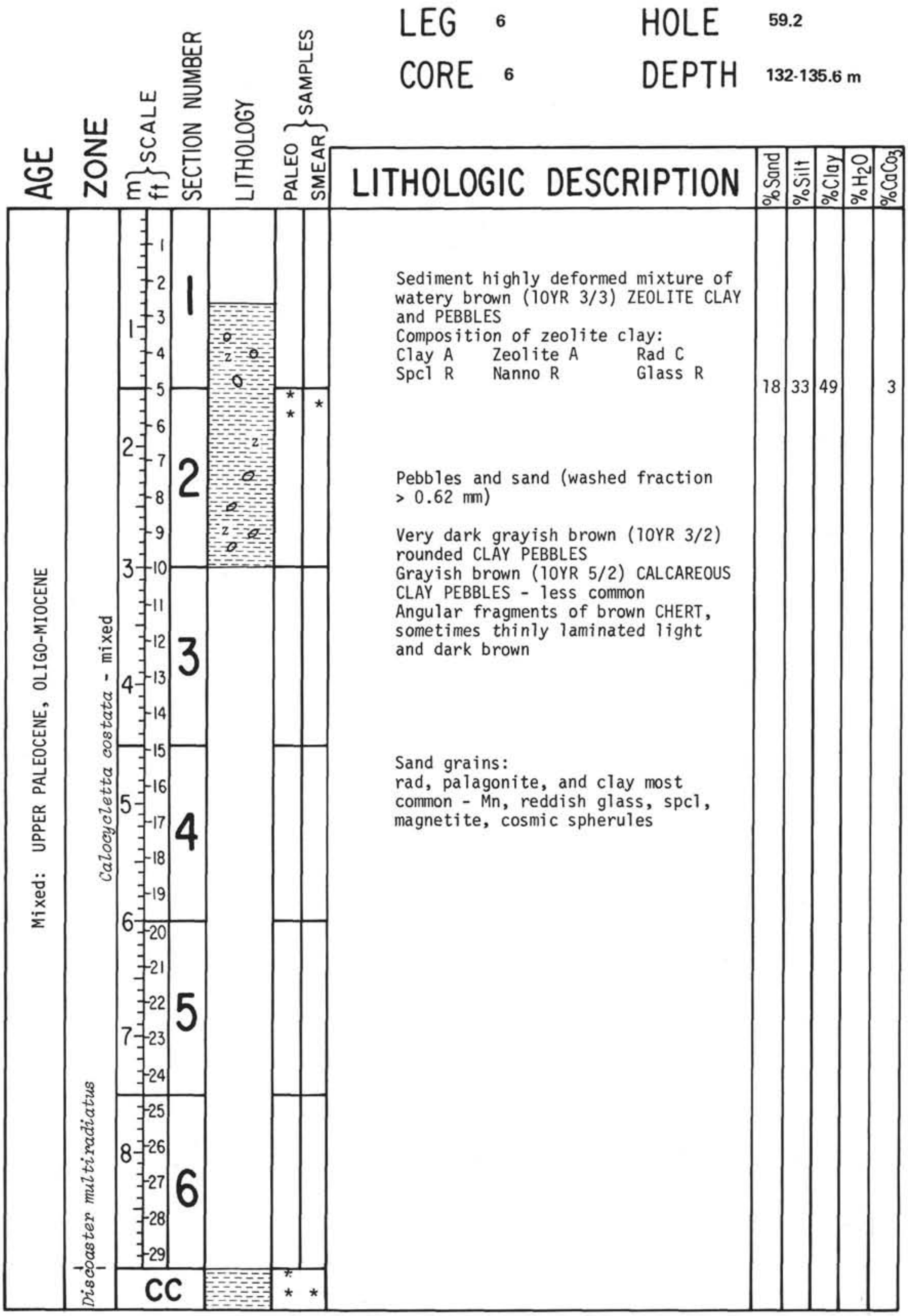

Figure 17. *Summary of lithology in Hole 59.2 Core 6.*

LEG 6 HOLE 59.1

CORE 3 DEPTH 51.8-61.0 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None.	None.	Radiolaria are present in this core in variable abundance. The top part contains a Quaternary assemblage with minor reworked Miocene and possibly Cretaceous specimens. The bottom part contains a Quaternary assemblage with reworked Miocene, Eocene, and Crataceous specimens. TOP: *Panartus tetrathalamus, Euchitonia elegans, Eucyrticium tumidulum,* and *Pterocanium praetextum* (Quat.). *Calocycletta costata* (Mioc.). BOTTOM: *Panartus tetrathalamus, Spongaster tetras, Euchitonia elegans,* and *Lithopera bacca* (Quat.). *Dorcadospyris sp., Cannartus mammiferus, Stichocorys wolffii* (Mioc.). *Thyrsocyrtis* sp. cf. *T. rhizodon* (Eoc.). *Amphipyndax sp.* and "*Dictyomitra multicostata*" (Cret.).

Figure 18. *Summary of biostratigraphy in Hole 59.1 Core 3.*

LEG 6 HOLE 59.2

CORE 1 DEPTH 89.3-98.5 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None.	No nannoplankton are present in samples from the core catcher material.	This core contains Radiolaria of the upper lower Miocene *Calocycletta costata* Zone. TOP: *Calocycletta costata, Stichocorys wolffii, S. delmontense, Calocycletta virginis, Dorcadospyris simplex, Cyrtocapsella cornuta,* and *Cannartus violina.* BOTTOM: *Calocycletta costata, Stichocorys wolffii, Dorcadospyris dentata, D. simplex, Cyrtocapsella cornuta,* and *Cannartus violina.*

Figure 19. *Summary of biostratigraphy in Hole 59.2 Core 1.*

LEG 6 HOLE 59.2

CORE 2 DEPTH 98.5-107.6 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None.	None.	Radiolaria in this core belong to the upper lower Miocene *Calocycletta costata* Zone. TOP: *Stichocorys wolffii, S. delmontense, Calocycletta costata, C. virginis, Cyrtocapsella cornuta, Dorcadospyris simplex, D. dentata,* and *Cannartus tubarius.* BOTTOM: *Calocycletta costata, Stichocorys wolffii, S. delmontense, Cyrtocapsella cornuta, Dorcadospyris simplex, D. dentata, Cannartus violina,* and *C. tubarius.*

Figure 20. *Summary of biostratigraphy in Hole 59.2 Core 2.*

LEG 6 HOLE 59.2

CORE 3 DEPTH 107.6-116.7 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
The core-catcher sample includes rare and very small specimens of *Globigerina bradyi*, *G. angustiumbilicata*, *G. praebulloides*, *Dassigerinella chipolensis*. They determine the age of sediments in limits of the *Globigerinita dissimilis* Zone, Lower Miocene - the *Globorotalia kugleri* Zone, lower Lower Miocene (or upper Upper Oligocene in Bolli's zonal scale, 1957).	Although most samples are barren, the core-catcher sample contains an upper upper Oligocene assemblage probably referrable to the lower *Triquetrorhabdulus carinatus* Zone. Species present include *Coccolithus* sp. aff. *C. bisectus*, *C. eopelagicus*, *Cyclococcolithina neogammation*, *Discoaster deflandrei*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *Triquetrorhabdulus carinatus*.	Radiolaria are rare in this core. The species present represent the upper lower Miocene *Calocycletta costata* Zone. TOP: see shore lab report. BOTTOM: *Calocycletta costata*, *Stichocorys wolffii*, *Dorcadospyris simplex*, *Cannartus prismaticus*, and *C. tubarius*.

Figure 21. *Summary of biostratigraphy in Hole 59.2 Core 3.*

LEG 6 **HOLE** 59.2

CORE 4 **DEPTH** 116.7-125.9 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Very rare and small specimens of *Globorotalia kugleri, Globigerina bradyi, G. angustiumbilicata, Cassigerinella chipolensis* indicate that sediments belong to the *Globorotalia kugleri* Zone, lower Lower Miocene (or upper Upper Oligocene in Bolli's zonal scale, 1957).	Upper upper Oligocene assemblages of the *Triquetrorhabdulus carinatus* Zone are present. Some reworked upper Eocene specimens are also present. Species present include *Coccolithus* sp. aff. *C. bisectus, Cyclococcolithina neogammation, Discoaster deflandrei, Sphenolithus* sp. aff. *S. belemnos, S. moriformis,* and *Triquetrorhabdulus carinatus*. Reworked species include *Discoaster barbadiensis, D. tani tani,* and *Reticulofenestra umbilica.*	Radiolaria are abundant in this core. The species present are of the upper lower Miocene *Calocycletta costata* Zone. TOP: see shore lab report. BOTTOM: *Calocycletta costata, Stichocorys wolffii, S. delmontense, Dorcadospyris simplex, Cyrtocapsella cornuta, Cannartus violina, C. mammiferus,* and *Dorcadospyris forcipata.*

Figure 22. *Summary of biostratigraphy in Hole 59.2 Core 4.*

LEG 6 HOLE 59.2

CORE 5 DEPTH 125.9-132 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None.	Scarce nannoplankton at the top of the core suggest a lower Oligocene correlation, whereas the assemblage from the core-catcher sample is upper Eocene or lowest Oligocene. TOP: *Coccolithus bisectus*, *C.* sp. cf. *C. scissurus*, *Discoaster deflandrei*, *D.* sp. cf. *D. tani tani*, *Reticulofenestra umbilica*. BOTTOM: *Bramletteius serraculoides*, *Coccolithus bisectus*, *Cyclococcolithina lusitanicus*, *Discoaster barbadiensis*, *D. deflandrei*, *D. tani ornata*, and *Reticulofenestra umbilica*.	This core contains fairly well preserved Radiolaria of Campanian (Upper Cretaceous) age. These were probably derived from harder material in the core catcher. As the core below contains no Cretaceous it appears that these Radiolaria represent admixture due to drilling or were contributed from a nearby outcrop. TOP: see shore lab report. BOTTOM: *Amphipyndax* sp. cf. *A. stocki*, "*Dictyomitra multicostata*", *Dictyomitra*" spp., and *Pseudoaulophacus* sp.

Figure 23. *Summary of biostratigraphy in Hole 59.2 Core 5.*

LEG 6 **HOLE** 59.2

CORE 6 **DEPTH** 132-135.6 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None.	Assemblages at the top indicate an upper Eocene or lower Oligocene correlation and include some reworked Paleocene specimens such as *Cruciplacolithus tenuis* and *Fasciculithus tympaniformis*. There are mixed lithologies in the core-catcher sample. A gray clay contains an upper Oligocene to lower Miocene assemblage, whereas a white clay contains abundant nannoplankton of the upper Paleocene *Discoaster multiradiatus* Zone. Species from the white clay include *Chiasmolithus bidens*, *Discoaster multiradiatus*, *Toweius eminens*, and reworked *Watznaueria barnesae*.	This core contains a radiolarian assemblage of the upper lower Miocene *Calocycletta costata* Zone. TOP: *Calocycletta costata*, *Stichocorys wolffii*, *S. delmontense*, *Cyrtocapsella cornuta*, *Dorcadospyris simplex*, *D. dentata*, *Cannartus mammiferus*, and *C. tubarius*. BOTTOM: *Colocycletta costata*, *Stichocorys wolffii*, *Cyrtocapsella cornuta*, *Dorcadospyris dentata*, *Cannartus mammiferus*, and *C. tubarius*

Figure 24. *Summary of biostratigraphy in Hole 59.2 Core 6.*

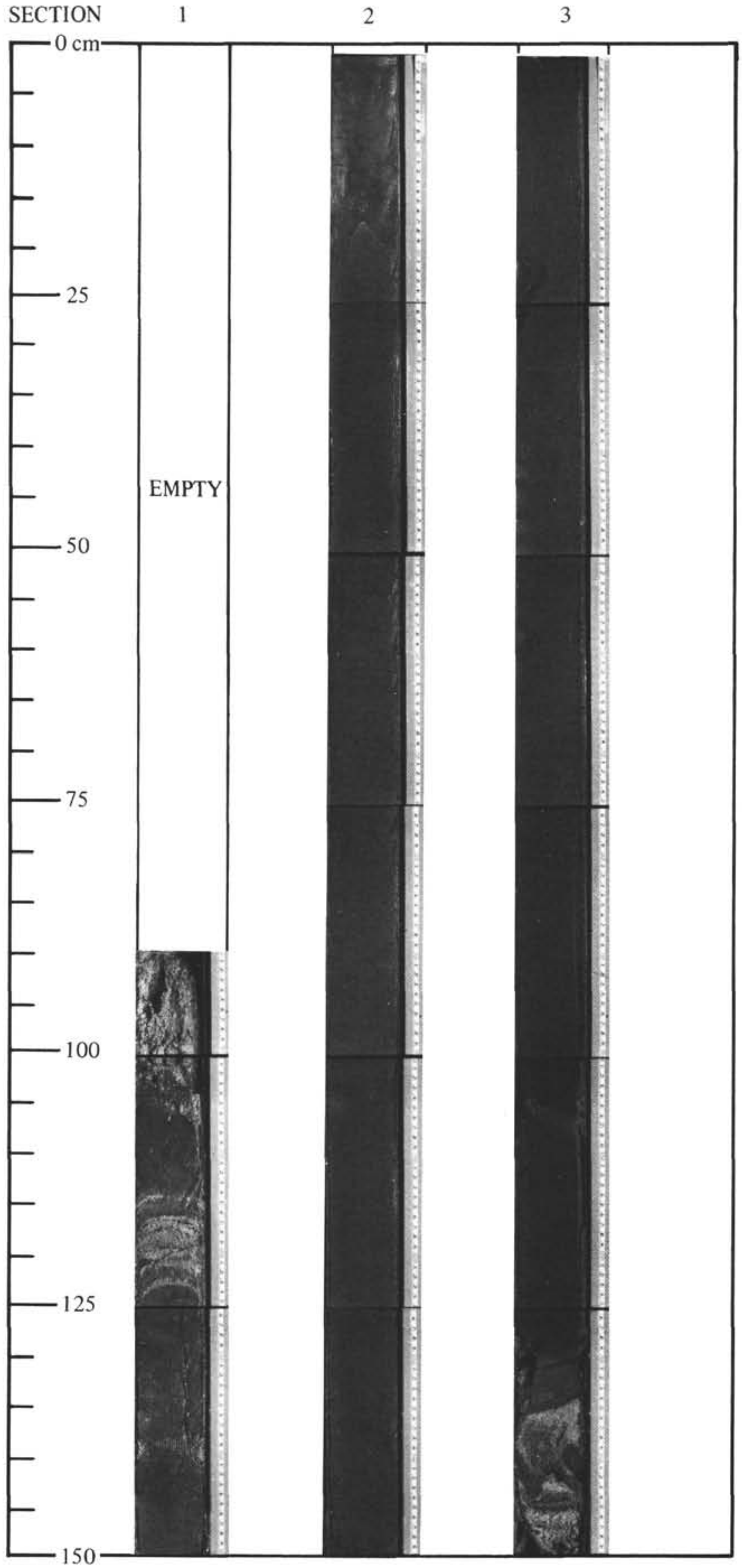

Plate 1. *Photographs of Hole 59.1 Core 3.*

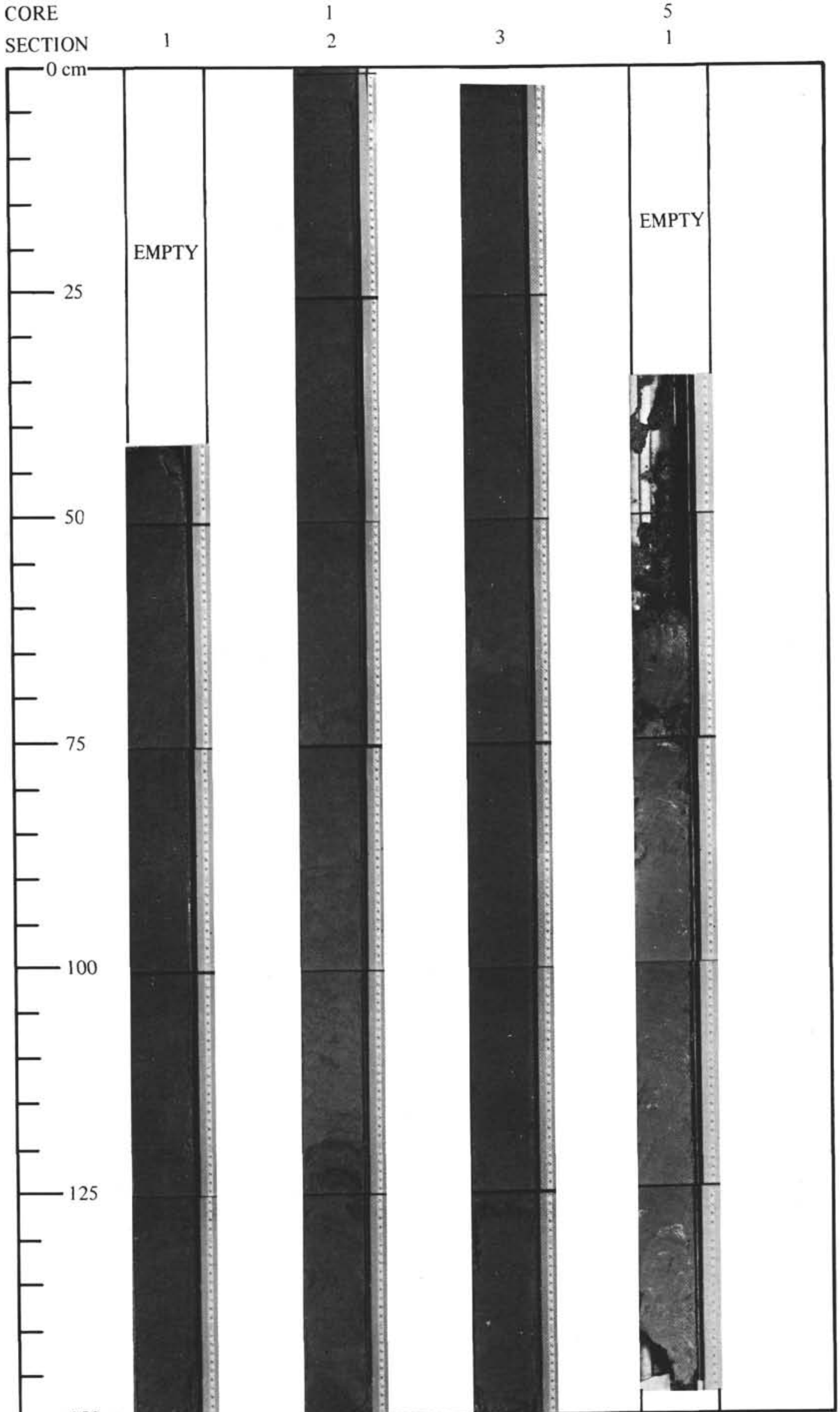

Plate 2. *Photographs of Hole 59.2 Cores 1 and 5.*