13. SITE 55

Shipboard Scientific Party[1]

SITE DATA

Occupied: July 21-22, 1969.

Position: Caroline Ridge: Latitude: 9° 18.1'N
Longitude: 142° 32.1'E.

Water Depth: 2850 meters.

Cores: Fourteen cores.

Total Depth: 131 meters in uppermost Oligocene chalk ooze. Driven off location by typhoon Viola.

MAIN RESULTS

A continuously cored section through the highly fossiliferous Neogene chalk ooze section.

BACKGROUND

Having obtained a reasonably consistent date for a late phase of seafloor genesis in the eastern Philippine Sea, it was decided to spend the remaining time on the objective that had not been accomplished farther northeast: to date the age of the crust under the western Pacific Ocean floor. To accomplish this it was necessary (1) to locate enough sedimentary cover to permit spudding, and (2) on finding a section less cherty than are those to the north.

In the search for sufficient sedimentary cover, a look at Ewing *et al.* (1968) published isopach map (though far from their tracks), showed sediments thickening southward. Furthermore, it was expected that sediments would thicken over shallower areas such as the Caroline Ridge and Eauripik Ridge.

Accordingly, the *Glomar Challenger* steamed southward across the southern end of the Iwo Jima Ridge and the Mariana trench, to seek a site with its own profiler. Much of the flat area south of the trench has only a very thin and discontinuous cover of sediment, but toward the base of the Caroline Ridge the thickness increases to near 0.1 second. A comparatively transparent layer of such sediments overlies a massive opaque unit with a smooth, flat surface.

The upper opaque layer showed no bottom, nor consistent internal bedding, and the scientists were uncertain of whether its top corresponds to the Ewing *et al.* Horizon A', or Horizon B'.

The northern flank of the Caroline Ridge rises in a series of pronounced topographic steps or terraces; each topographic step corresponds to an even more sharply pronounced step in the surface of this opaque layer, bearing a mantle of sediment (Figure 1). On the lower steps the sediments are about 0.1 second thick, and drill Site 55 (Figures 1, 2, 3) was chosen on the fourth step in the profile, with a sediment thickness of 0.2 second. Figure 4 shows the bottom soundings in the area of Site 55.

Objectives

The primary objective at Site 55 was to test the character and age of the massive opaque unit; and, if this proved to be sedimentary, to penetrate it in the search for basement. A secondary objective was to obtain a good stratigraphic section of what was likely to be a carbonate sequence. In view of the limited thickness it was decided to core continuously.

OPERATIONS

Site 55 was occupied at 1700 hours July 21, 1969. Continuous cores were taken to a total depth of 131 meters when rising wind (35 knots) required all of the power not needed for drilling to hold the ship on location. The rising swell threatened to make drilling and especially pipe retrieval dangerous. An atmospheric low had formed to the southeast of the drilling location, and the barometer was dropping. It was, therefore, decided to pull the pipe, and to abandon this site, in order to steam eastward and to get out of the zone of influence of the storm as quickly as possible so as to resume drilling operations.

The site was abandoned at 1900 hours, July 22.

NATURE OF THE SEDIMENTS

Fourteen cores were recovered from the one hole at this site during continuous coring from the mudline to

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Figure 1. *Sketch of* Challenger *profile in area of Site 55.*

about 131 meters subbottom depth. The sediment encountered is chalk ooze dominated by nannoplankton and containing variable amounts of planktonic foraminifera, Radiolaria, and sponge spicules. This chalk ooze is predominantly white, less commonly very pale brown. The pale brown color is particularly characteristic of chalk ooze containing moderate (10 to 20 per cent) amounts of siliceous microfossils. Sediment in all of the cores was usually in a moderately to highly disturbed condition due to coring.

Variations in composition of the chalk oozes is summarized in Table 2; the weight percentage of each component was estimated from smear slides, and therefore should be taken only as a general compositional indicator. From mudline to a depth of 27.4 meters (Cores 1, 2 and 3), the sediment is a foraminiferal-nannoplankton chalk ooze (Chapter 38). From 27.4 to 54.9 meters (Cores 4, 5 and 6), the sediment is nannoplankton chalk ooze in which the nannofossils are dominantly or entirely discoasters (Chapter 38) and foraminifera are much less abundant than above. Siliceous microfossils, mainly well preserved Radiolaria and sponge spicules, first appear in notable amounts in Core 7 and, along with planktonic foraminifera, form a subordinate part of the nannoplankton chalk ooze to the bottom of the hole.

Carbonate material, other than nannofossils and obvious planktonic foraminifera, is present in generally small amounts in Cores 1 through 8. This material appears to be mainly finely abraded pelecypod and foraminiferal shells, but may include some authigenic calcite.

Based on visual observations of smear slides, the clay mineral content is estimated to be fairly constant at about 5 to 10 per cent throughout the succession of chalk oozes, but X-ray studies by Rex show a wide variation from nil to over 18 per cent. Small amounts of volcanic glass are present in Cores 2, 9, 10 and 12, and Core 13 had several beds, up to 10 centimeters thick, of gray nannoplankton chalk ooze with up to 20 per cent of pale brown to colorless, angular shards of volcanic glass. Traces of zeolites are found in some chalk oozes of Core 7, and chalk oozes in Core 8 have very small amounts of hematite.

PHYSICAL PROPERTIES

These samples were disturbed by drilling thus the data may not accurately represent *in situ* conditions.

Natural Gamma Radiation

At Site 55, 130 meters of Pleistocene to Oligocene foraminiferal-nannoplankton and nannoplankton chalk oozes had natural gamma radiation counts ranging from zero to 2100/7.6-cm core segment/1.25 minutes, with an average of about 100. A high gamma count of 2100 near the surface (0.6 to 2.5 meters) was emitted from very pale brown foraminiferal chalk ooze (Core 1, Sections 1 and 2) and had a rough exponential decrease with increasing depth of 80 centimeters. From 2.5 to 130 meters below the mudline, nannoplankton-foraminiferal chalk oozes emitted counts from zero to 300 with an average of 100.

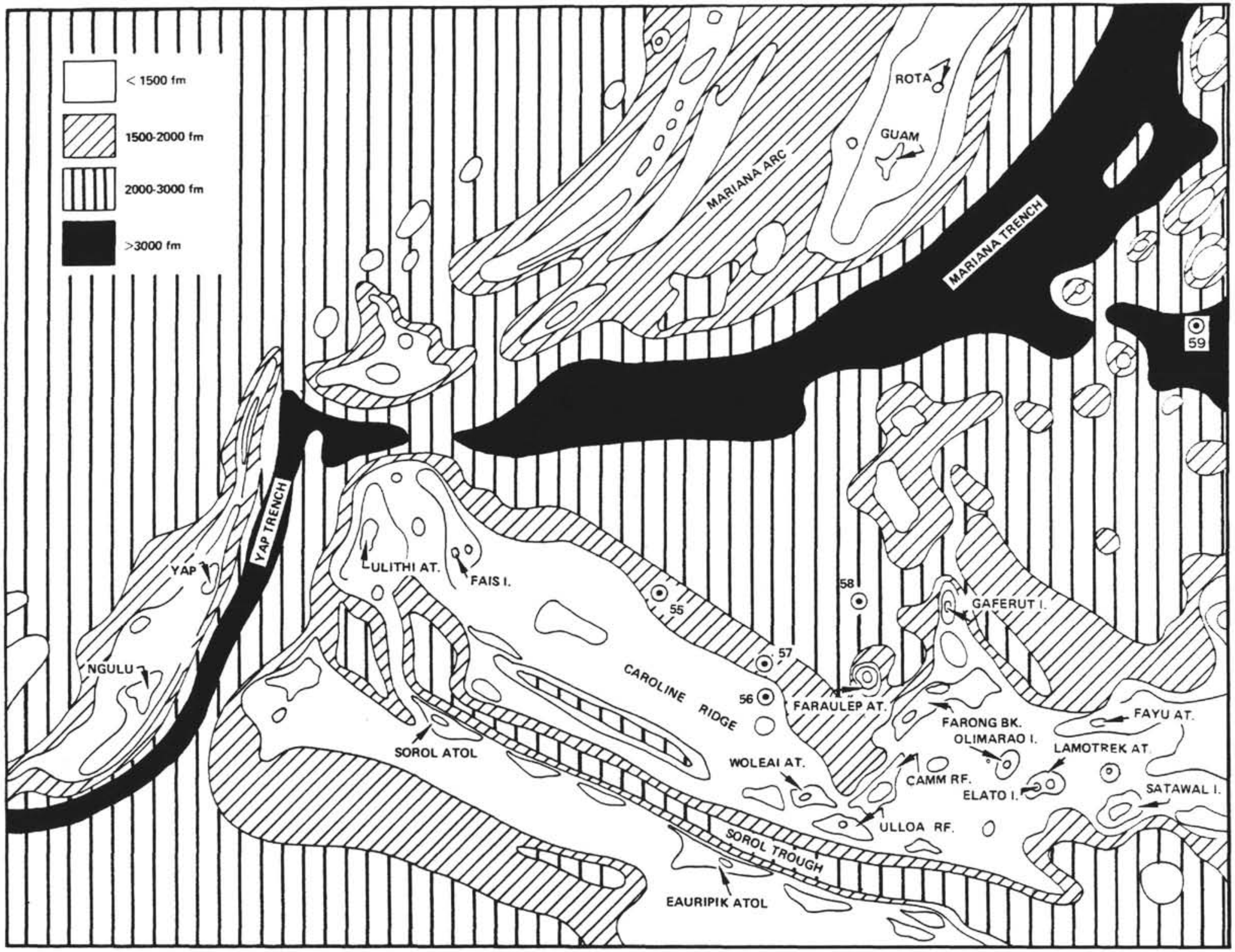


Figure 2. *Contour map of Sites 55, 56, 57, 58 and 59.*

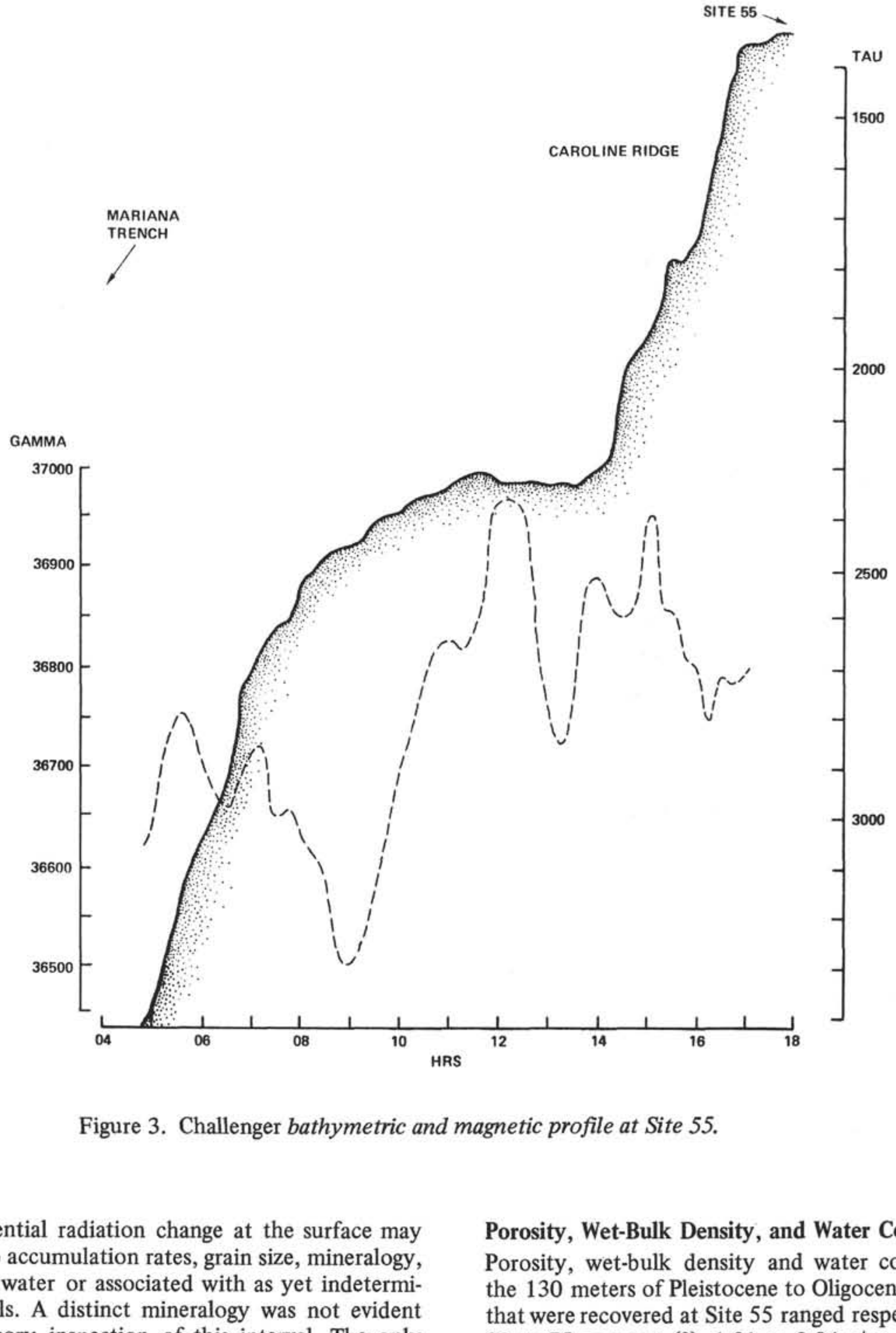


Figure 3. Challenger *bathymetric and magnetic profile at Site 55.*

This exponential radiation change at the surface may be related to accumulation rates, grain size, mineralogy, ions in the water or associated with as yet indeterminate minerals. A distinct mineralogy was not evident from a cursory inspection of this interval. The only unique feature in this sediment, compared to the remainder of this hole, was the high sand content, which appears to be predominantly foraminifera. However, the source of the gamma radiation is still unknown. The gamma count decreased by half in 38 centimeters or about 1.5×10^5 to 4.8×10^5 years. If this exponential decay represented the half life of a radioactive isotope, then it could have a half life of 1.5×10^5 to 4.8×10^5 years.

Porosity, Wet-Bulk Density, and Water Content

Porosity, wet-bulk density and water content within the 130 meters of Pleistocene to Oligocene chalk oozes that were recovered at Site 55 ranged respectively, from 30 to 75 per cent (?), 1.31 to 2.04 g/cc, and 29 to 50 per cent, with typical values of 60 to 65 per cent, 1.60 to 1.70 g/cc, and 41 per cent. Porosity irregularly decreased with increasing depth and appeared to have a rough inverse relationship to sound velocity and heat conductivity.

In general, the Miocene sediments had higher porosities than Oligocene sediments. Pleistocene to Miocene nannoplankton-foraminiferal oozes (0 to 94 meters) had

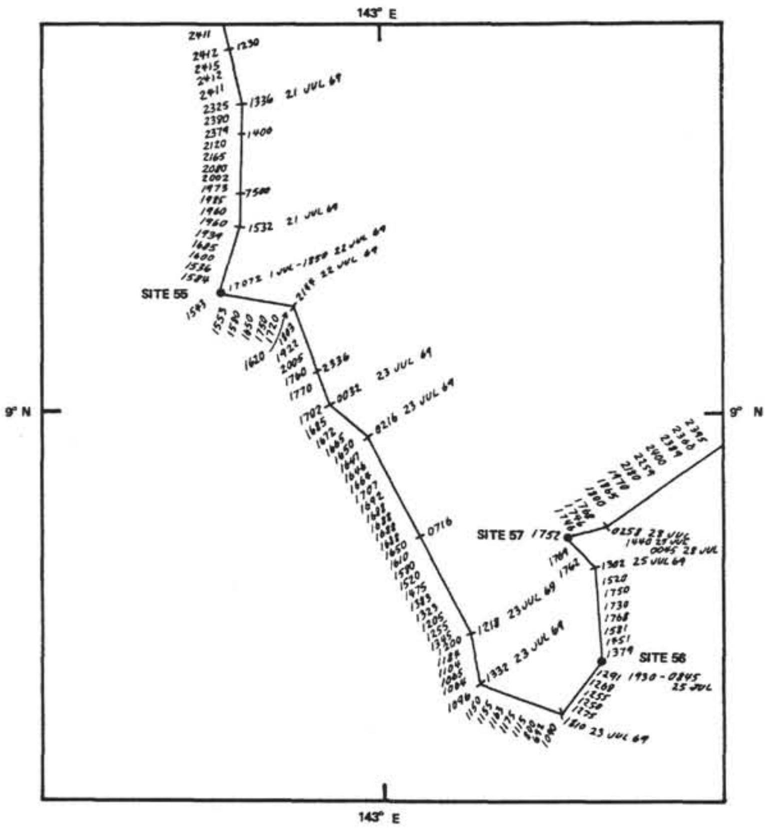


Figure 4. *Bottom soundings in area of Site 55.*

TABLE 1
Summary of Coring at Site 55

Core No.	Interval Cored (below mudline) (ft)	(m)	Recovery (ft)	(m)
55.0-1	0-30	0.0-9.1	30	9.1
55.0-2	30-60	9.1-18.3	30	9.1
55.0-3	60-90	18.2-27.4	30	9.1
55.0-4	90-120	27.4-36.6	30	9.1
55.0-5	120-150	36.6-45.7	30	9.1
55.0-6	150-180	45.7-54.9	30	9.1
55.0-7	180-210	54.9-64.0	30	9.1
55.0-8	210-240	64.0-73.2	30	9.1
55.0-9	240-270	73.2-82.3	10	3.0
55.0-10	270-300	82.3-91.4	30	9.1
55.0-11	300-330	91.4-100.6	30	9.1
55.0-12	[a]339-369	103.3-112.5	30	9.1
55,9-13	369-399	112.5-121.6	30	9.1
55.0-14	399-429	121.6-130.8	30	9.1

Water depth: 2849.9 meters (9350 feet)

[a]Nine feet added here is a correction due to an accumulative error in measuring the length of drill pipe.

porosities of about 65 per cent (1.60 g/cc) wet-bulk density. The upper Pliocene-Oligocene foraminiferal-nannoplankton oozes (94 to 130 meters) had porosities of about 58 per cent (1.70 g/cc) which decreased with increasing depth. No major systematic variations with lithology were observed, but some porosity variations were partly controlled by the grain size distribution of the sediment and the presence of foraminifera or radiolarians.

Sound Velocity

Sound velocity through the Pleistocene to Oligocene nannoplankton and nannoplankton-foraminiferal chalk oozes recovered at Hole 55.0 ranged from 1.46 to 1.77 km/sec and averaged 1.55 km/sec. In general, Pleistocene to Miocene sound velocity core averages are about 1.54 km/sec, yet below 100 meters in the Oligocene sound velocity tended to increase with increasing depth to 1.70 km/sec. This change relates to a wet-bulk density increase which may, in part, relate to compaction.

Thermal Conductivity

Heat conductivity at Hole 55.0 ranged from 2.1 to 4.4 (?) × 10^{-3} cal-°C^{-1} cm^{-1} sec^{-1} in chalk oozes of Pleistocene to upper Oligocene age from 0 to 130 meters below the sediment surface. Heat conductivity irregularly

TABLE 2
Estimated Composition of Sediment in Cores from Hole 55.0

			(% by weight)				
Core No.	Foram.	Nannopl.	Other CO_2	Clay	Rad.	Sponge	Others[a]
1	50	20	10-40	5	tr.	0	0
2	45	30	15	5	tr.	0	5
3	40	40	10	10	tr.	0	0
4	10	85	0	5	tr.	0	0
5	5	90	0	5	0	0	0
6	10	75	10	5	tr.	0	0
7	15	65	8	10	tr.	1	1
8	15	60	5	10	5	5	0
9	0	70	0	10	10	5	5
10	10	60	0	10	15	4	1
11	20	55	0	10	10	5	0
12	20	65	0	4	3	7	1
13	20	55-75	0	5	6	4	0-20
14	25	55	0	10	6	4	0

[a]mainly volcanic glass

increased with depth but did not appear to vary systematically with age or lithology.

Penetrometer

Penetrometer measurements in Pleistocene to Oligocene foraminiferal and nannoplankton ooze (0 to 130 meters) at Hole 55.0 ranged from 60 to complete penetration with an average of 149×10^{-1} millimeters for the partially penetrated values. Penetration irregularly decreased with increasing depth. Again, no distinct systematic variations were observed with regard to lithological changes in the chalk oozes except for a decrease in the maximum penetrations in the Oligocene foraminiferal-nannoplankton oozes at 100 to 130 meters.

CONCLUSIONS

Site 55 obtained an almost complete section through the Neogene, and passed barely into the Oligocene (*G. ciperoensis* zone in the last core catcher) perhaps halfway to the base of the sediments, when the birth of typhoon Viola halted the operation and forced the ship eastward.

HOLE 55.0

DEPTH (m)	CORE	LITHOLOGIC DESCRIPTION	AGE SERIES-SUBSERIES
	1	NANNOPLANKTON-FORAMINIFERAL CHALK OOZE, very pale brown with white mottles	PLEISTOCENE
	2	NANNOPLANKTON-FORAMINIFERAL CHALK OOZE, white and pale brown	LATE PLIOCENE
20	3	NANNOPLANKTON-FORAMINIFERAL CHALK OOZE	LATE PLIOCENE
	4	NANNOPLANKTON CHALK OOZE, white, Discoasters make up total nannoplankton content	EARLY LATE MIOCENE
40	5	NANNOPLANKTON CHALK OOZE, white, Discoasters make up total nannoplankton content	EARLY LATE MIOCENE
	6	NANNOPLANKTON CHALK OOZE, white	MIDDLE MIOCENE
60	7	FORAMINIFERAL-NANNOPLANKTON CHALK OOZE, white	EARLY MIDDLE MIOCENE
	8	NANNOPLANKTON CHALK OOZE, white	EARLY MIDDLE MIOCENE
80	9	NANNOPLANKTON CHALK OOZE, very pale brown	EARLY MIOCENE
	10	RADIOLARIAN NANNOPLANKTON CHALK OOZE, very pale brown	EARLY MIOCENE
100	11	FORAMINIFERAL-NANNOPLANKTON CHALK OOZE, pale brown	EARLY MIOCENE
	12	NANNOPLANKTON CHALK OOZE, white	MIOCENE or OLIGOCENE
120	13	NANNOPLANKTON CHALK OOZE, white, small amounts of gray ashey material present	LATE OLIGOCENE
	14	FORAMINIFERAL-NANNOPLANKTON CHALK OOZE, white	LATE OLIGOCENE
140			

Figure 5. *Summary of lithology in Hole 55.0.*

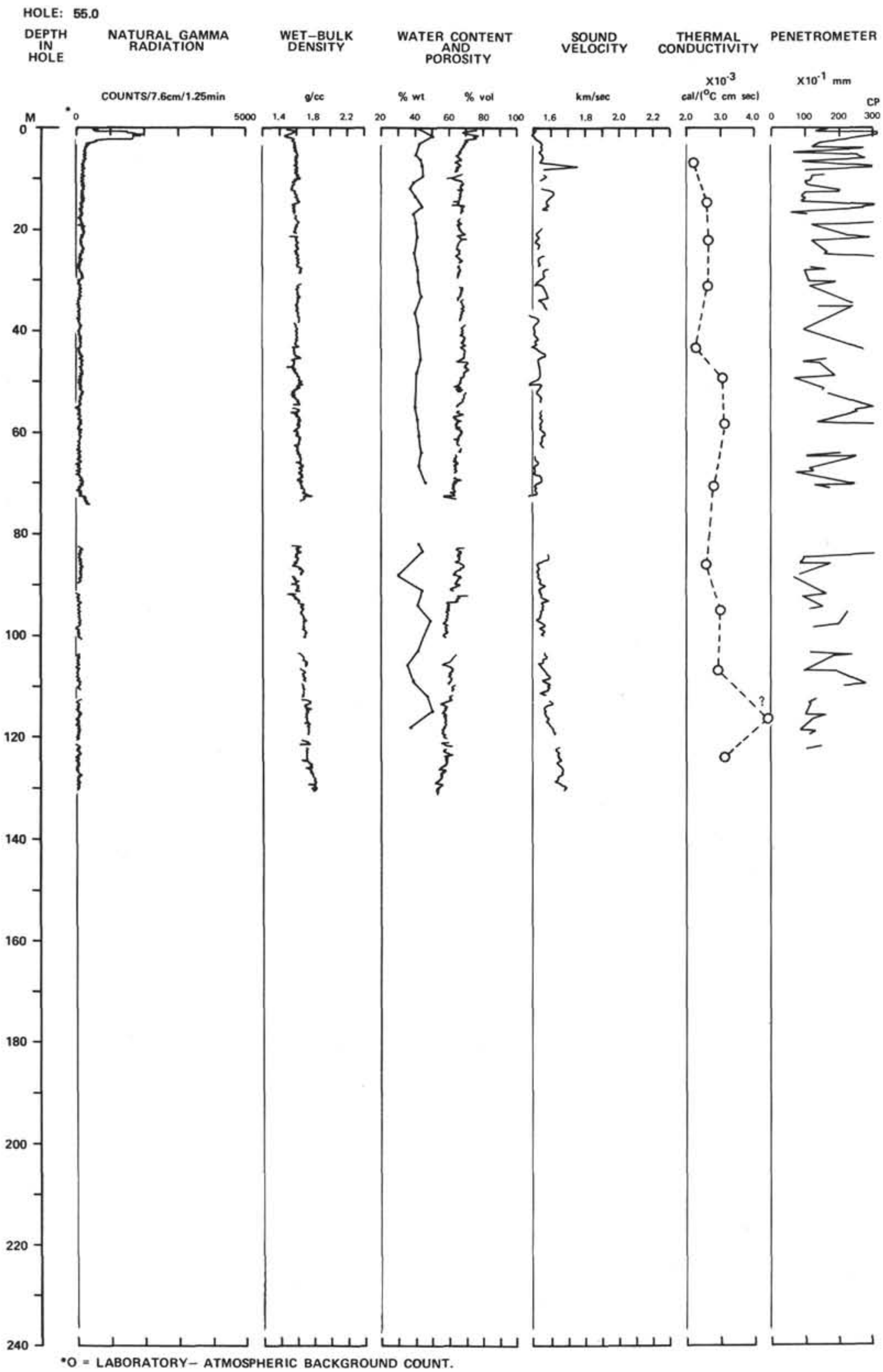


Figure 6. *Summary of physical properties in Hole 55.0*

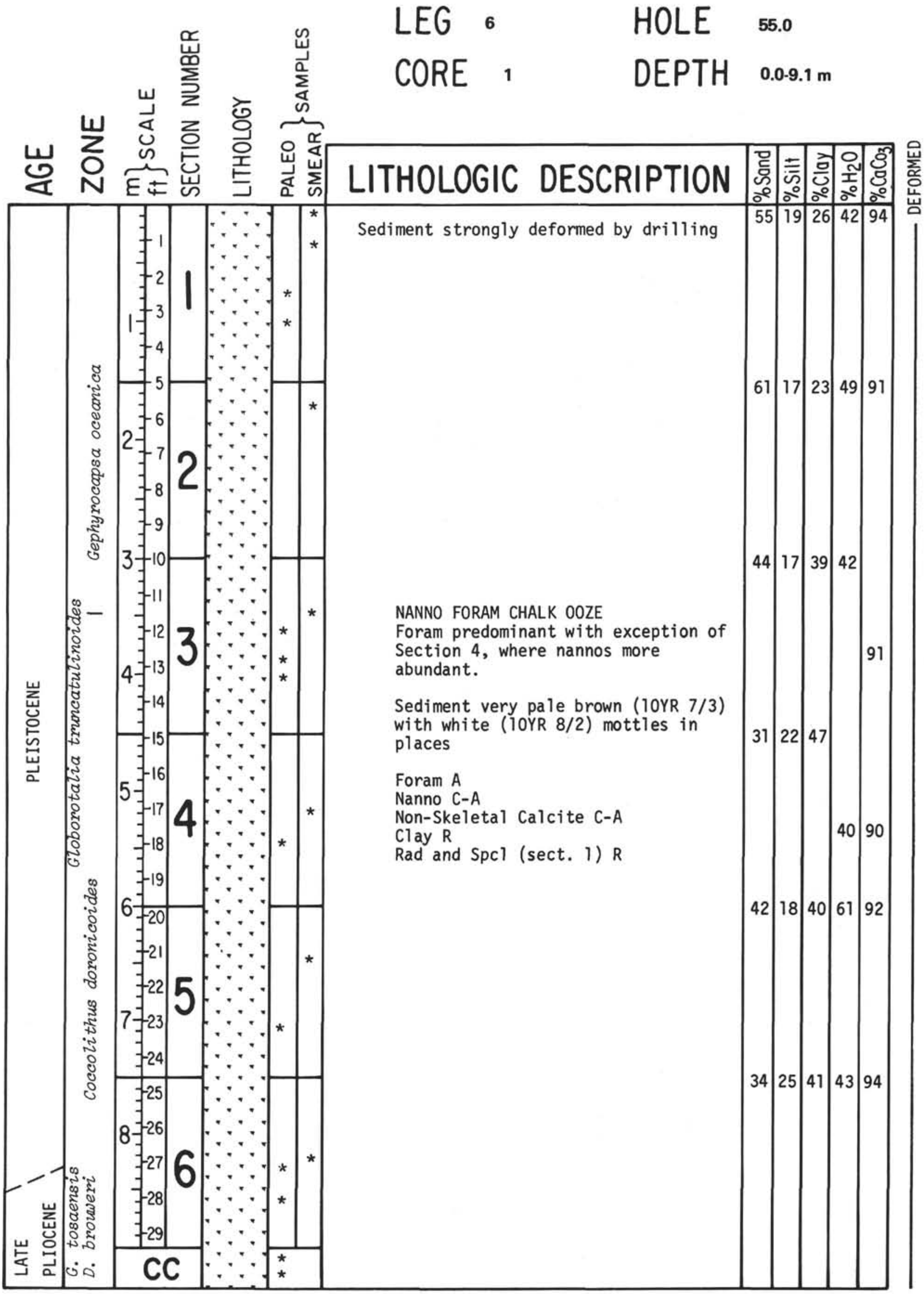


Figure 7. *Summary of lithology in Hole 55.0 Core 1.*

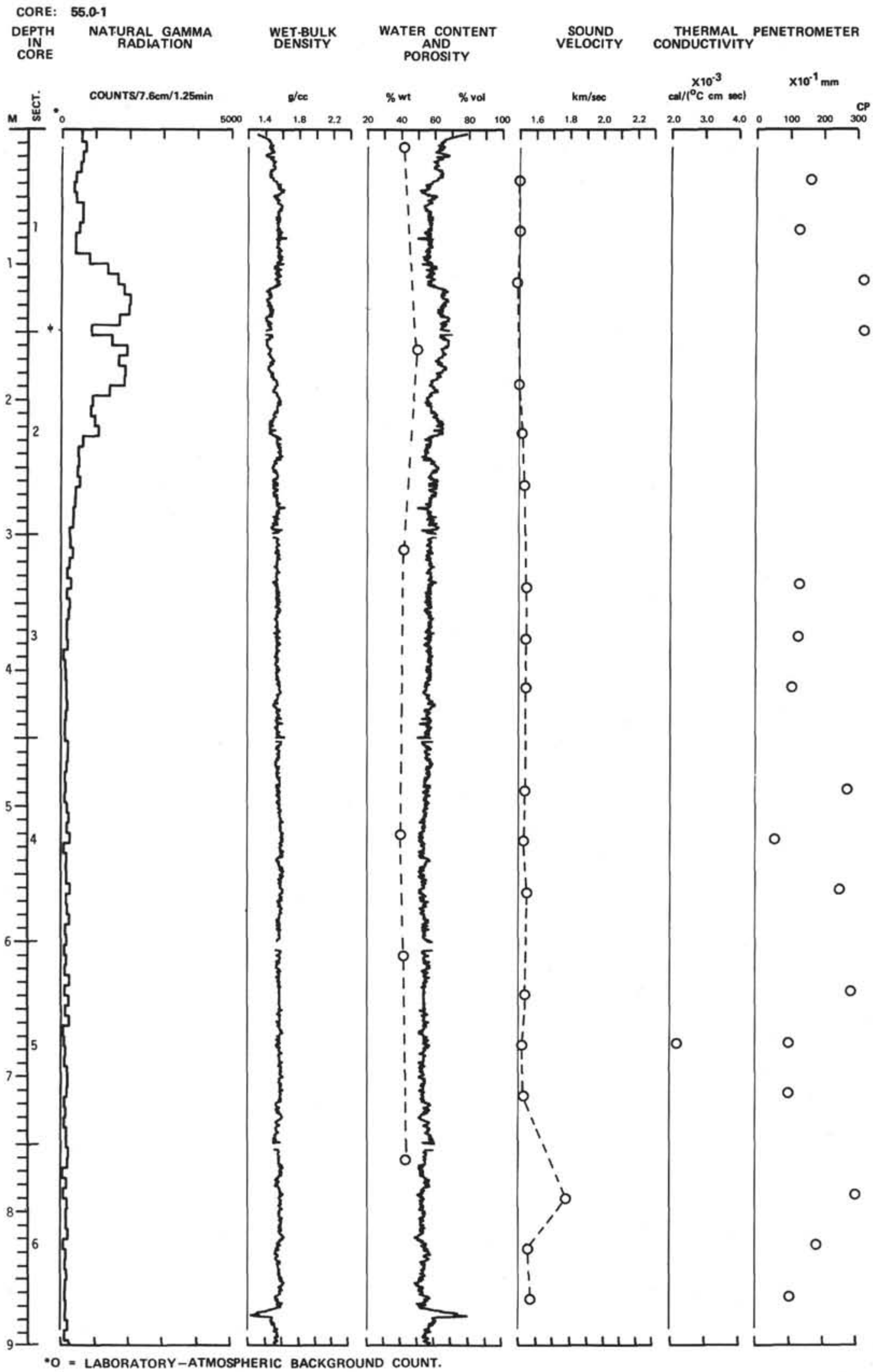


Figure 8. *Summary of physical properties in Hole 55.0 Core 1.*

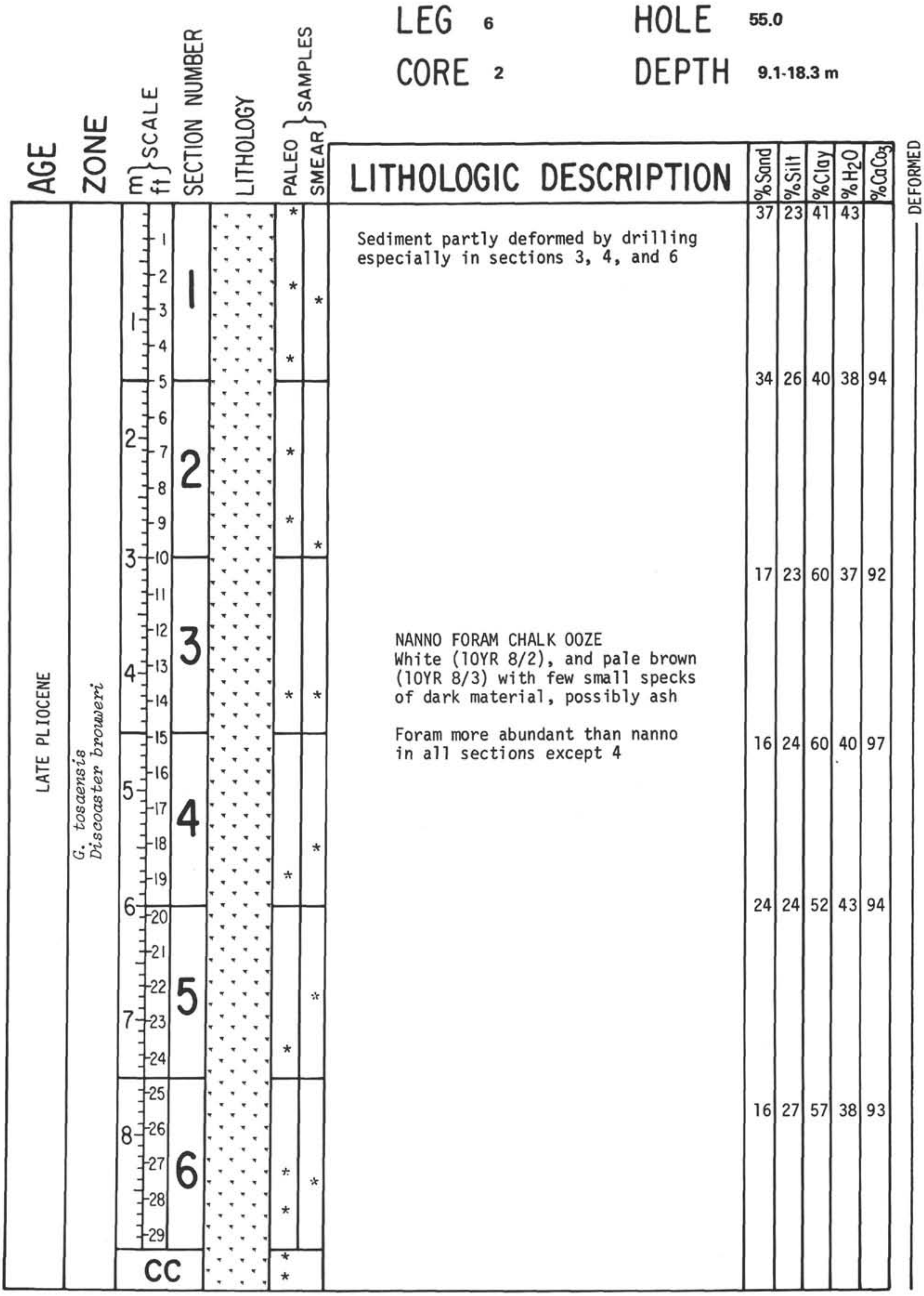


Figure 9. *Summary of lithology in Hole 55.0 Core 2.*

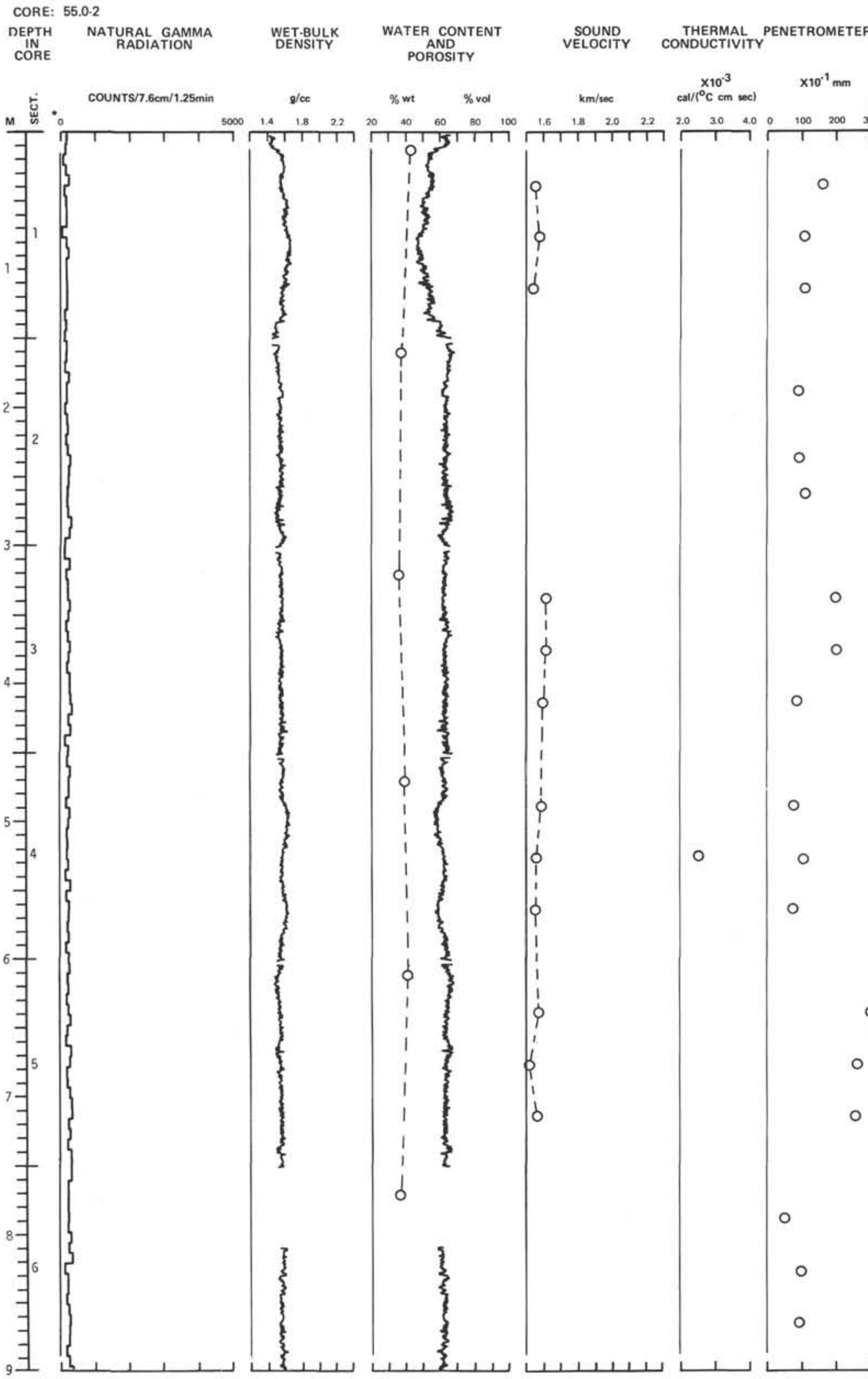


Figure 10. *Summary of physical properties in Hole 55.0 Core 2.*

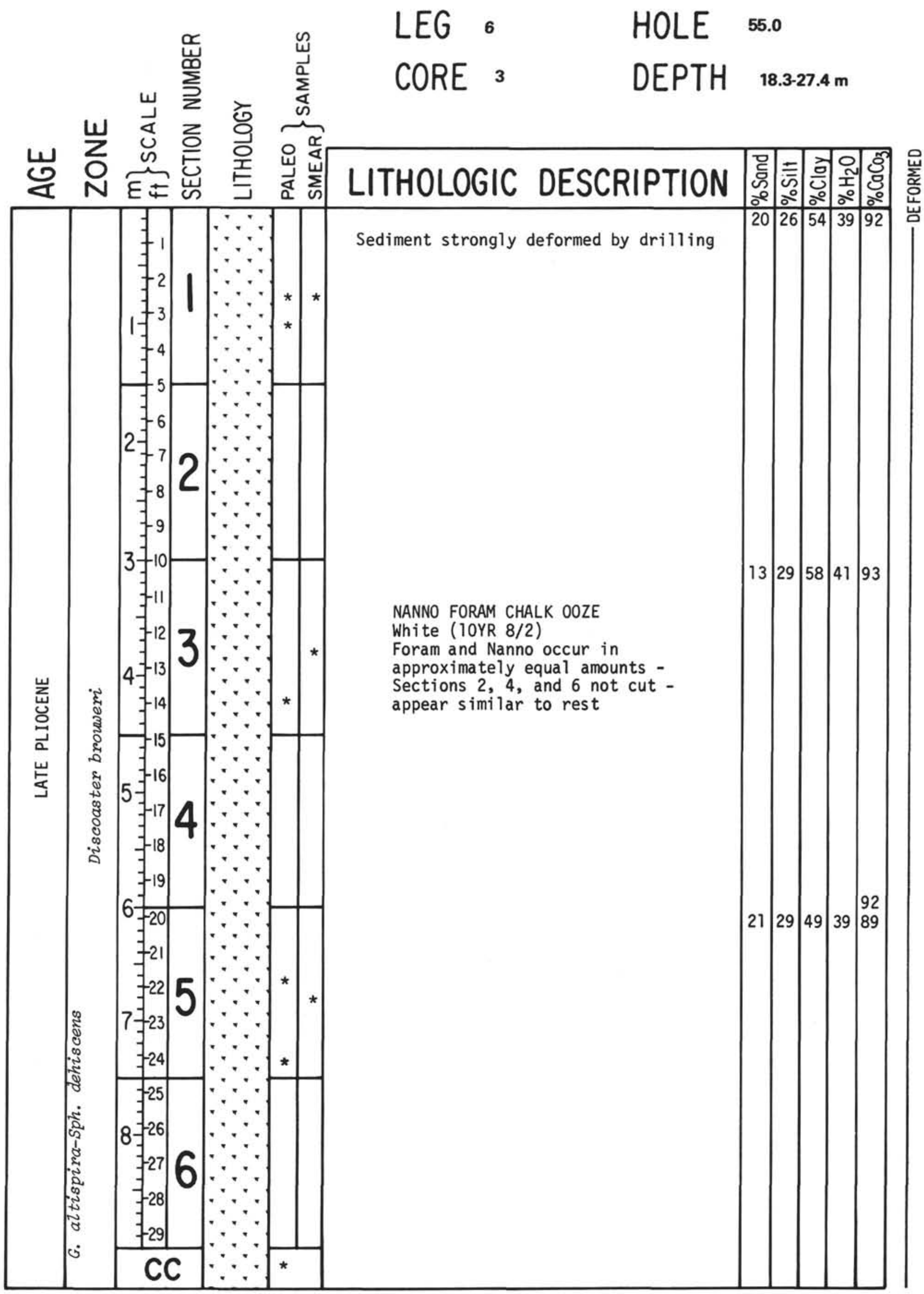


Figure 11. *Summary of lithology in Hole 55.0 Core 3.*

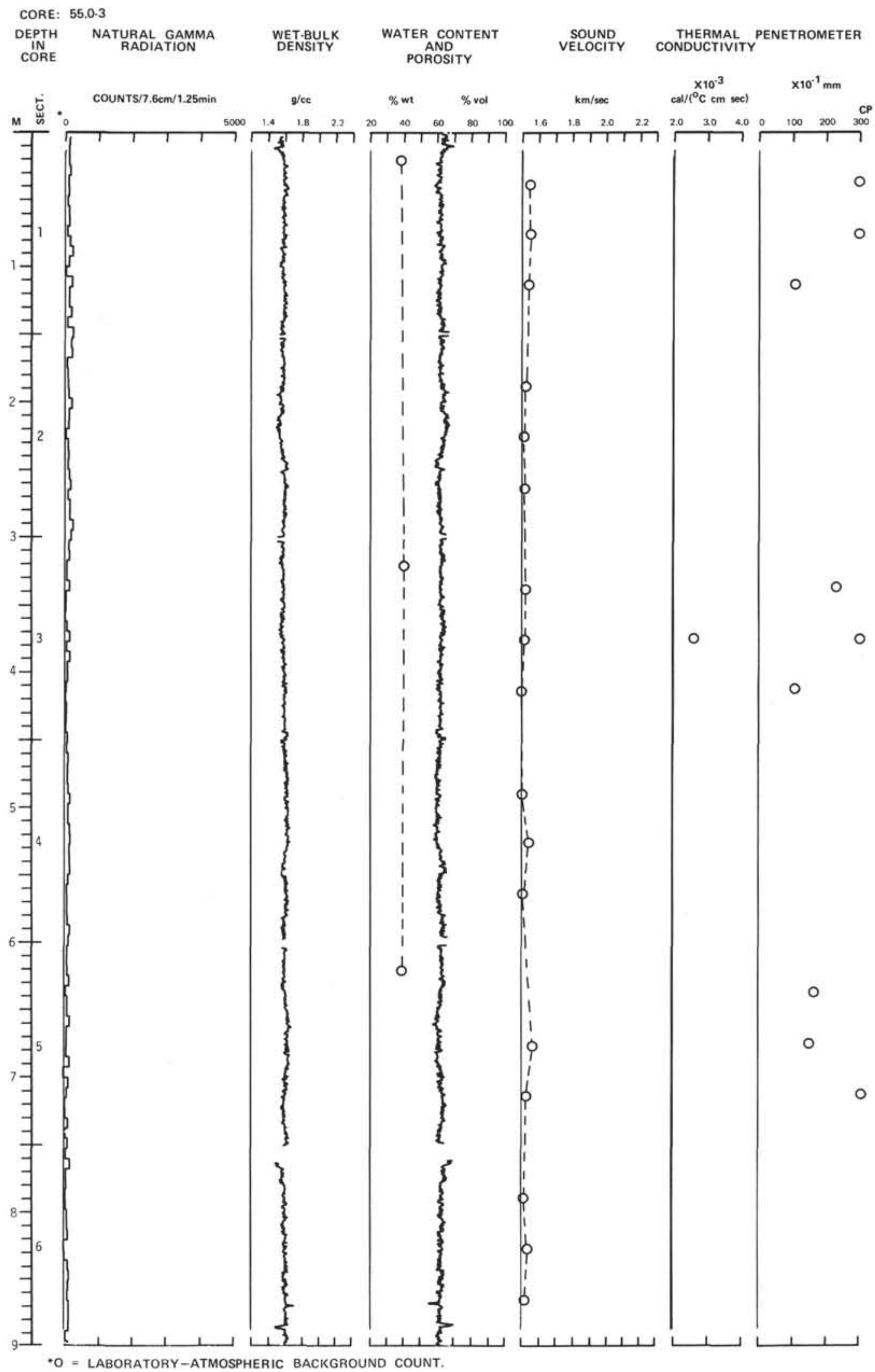


Figure 12. *Summary of physical properties in Hole 55.0 Core 3.*

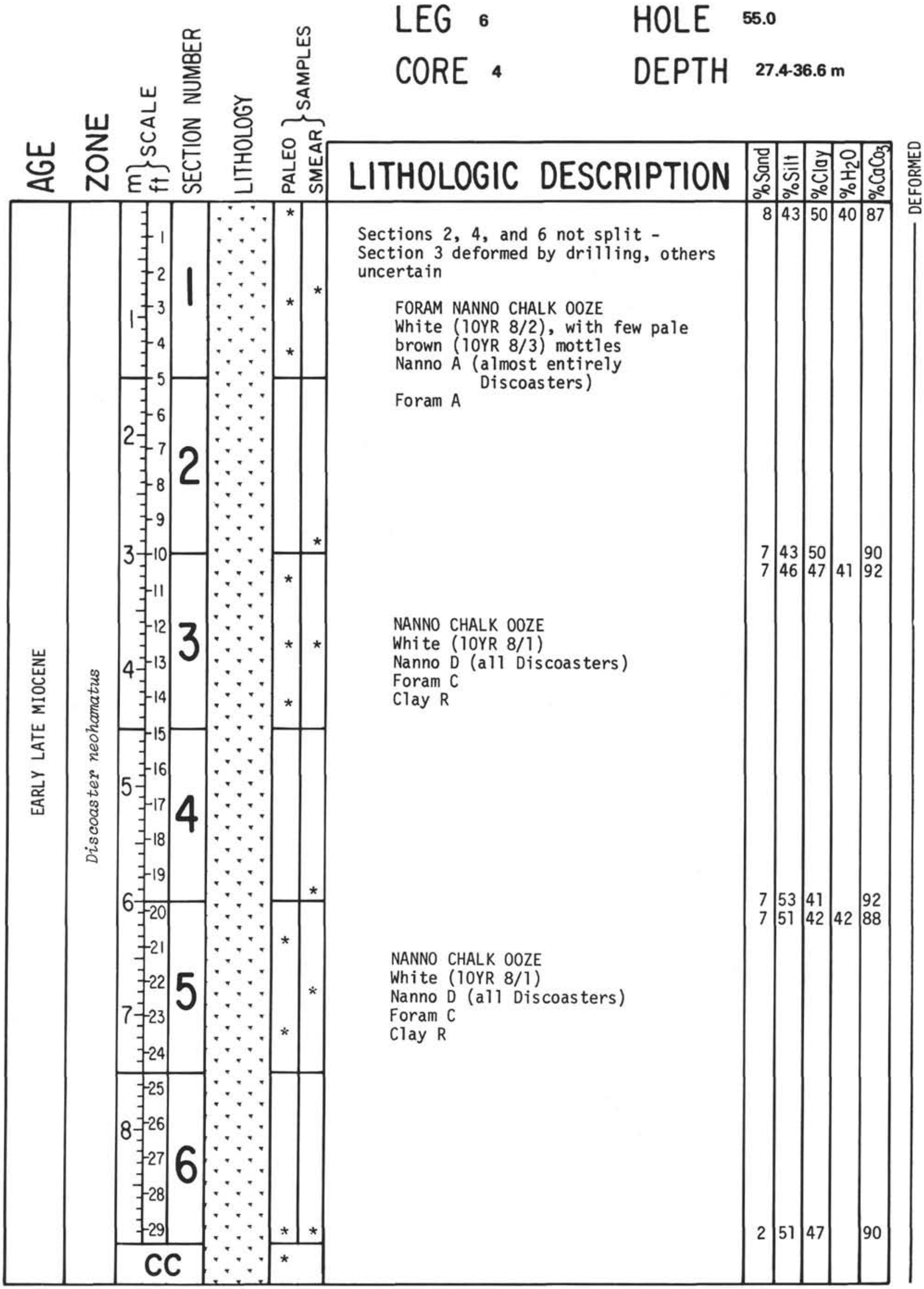


Figure 13. *Summary of lithology in Hole 55.0 Core 4.*

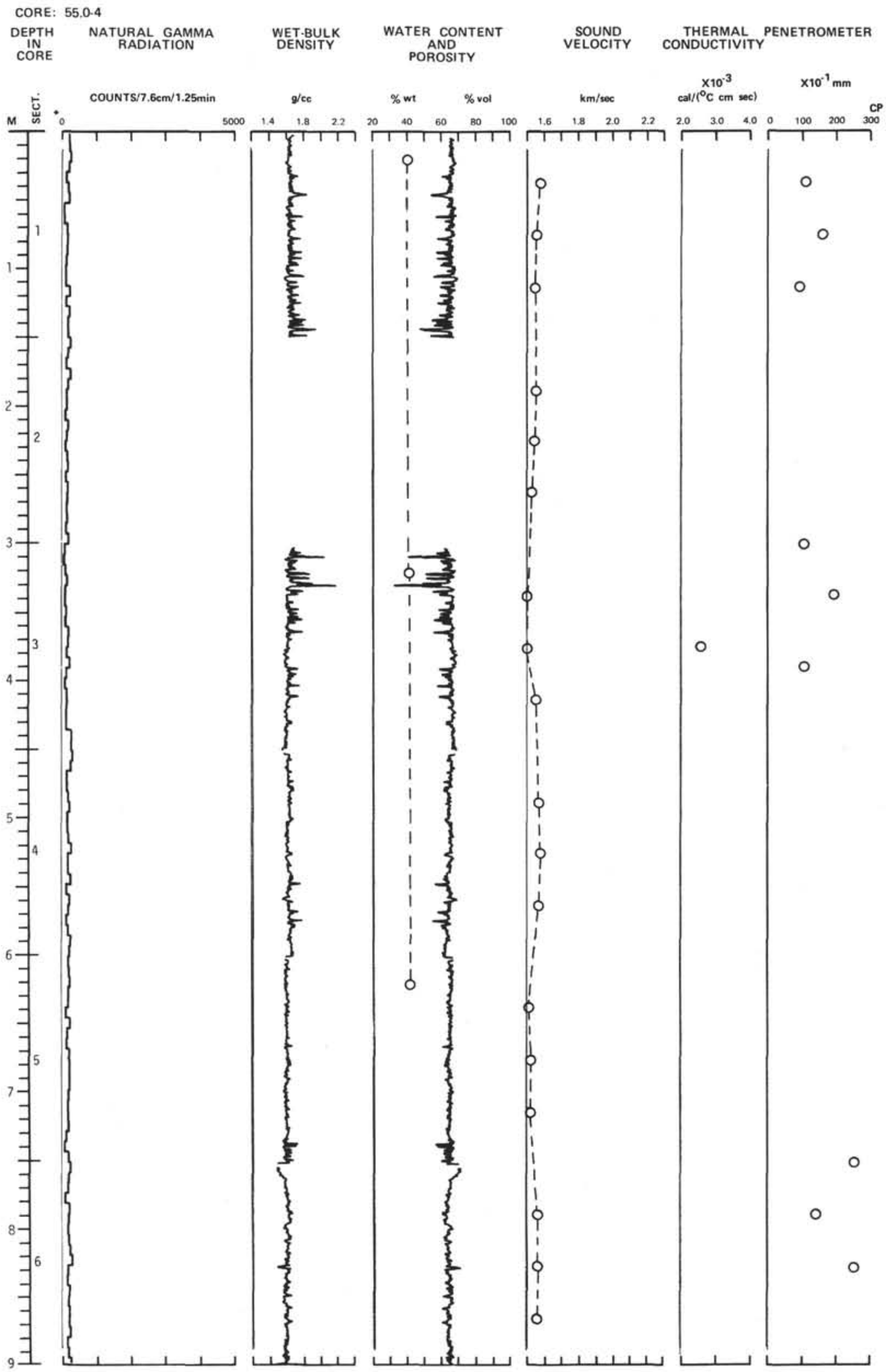


Figure 14. *Summary of physical properties in Hole 55.0 Core 4.*

LEG 6 HOLE 55.0

CORE 5 DEPTH 36.6-45.7 m

AGE	ZONE	SECTION NUMBER	LITHOLOGIC DESCRIPTION	%Sand	%Silt	%Clay	%H_2O	%$CaCO_3$
EARLY LATE MIOCENE	*G. menardii* / *Discoaster neohamatus*	1	Sections 2, 4, and 6 not split Sediment probably deformed by drilling as very watery	3	56	41	40	84
		2						
		3	NANNO CHALK OOZE White (10YR 8/1) Nanno D (all Discoasters) Foram C-R Clay R	1	53	46	41	87
		4						
		5		1	56	42		
LATE MID MIOCENE	*Discoaster hamatus*	6						
		CC						

DEFORMED

Figure 15. *Summary of lithology in Hole 55.0 Core 5.*

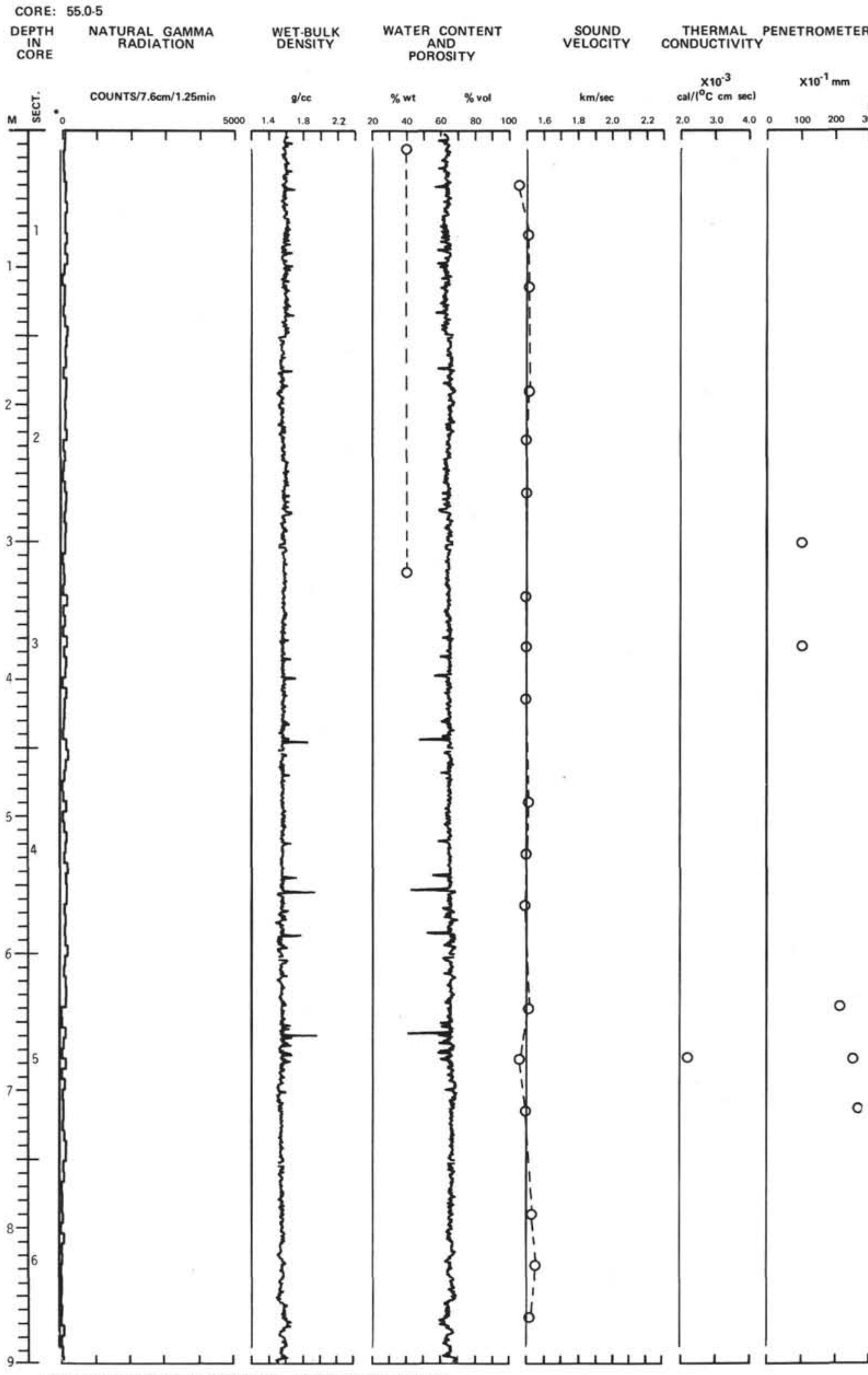


Figure 16. *Summary of physical properties in Hole 55.0 Core 5.*

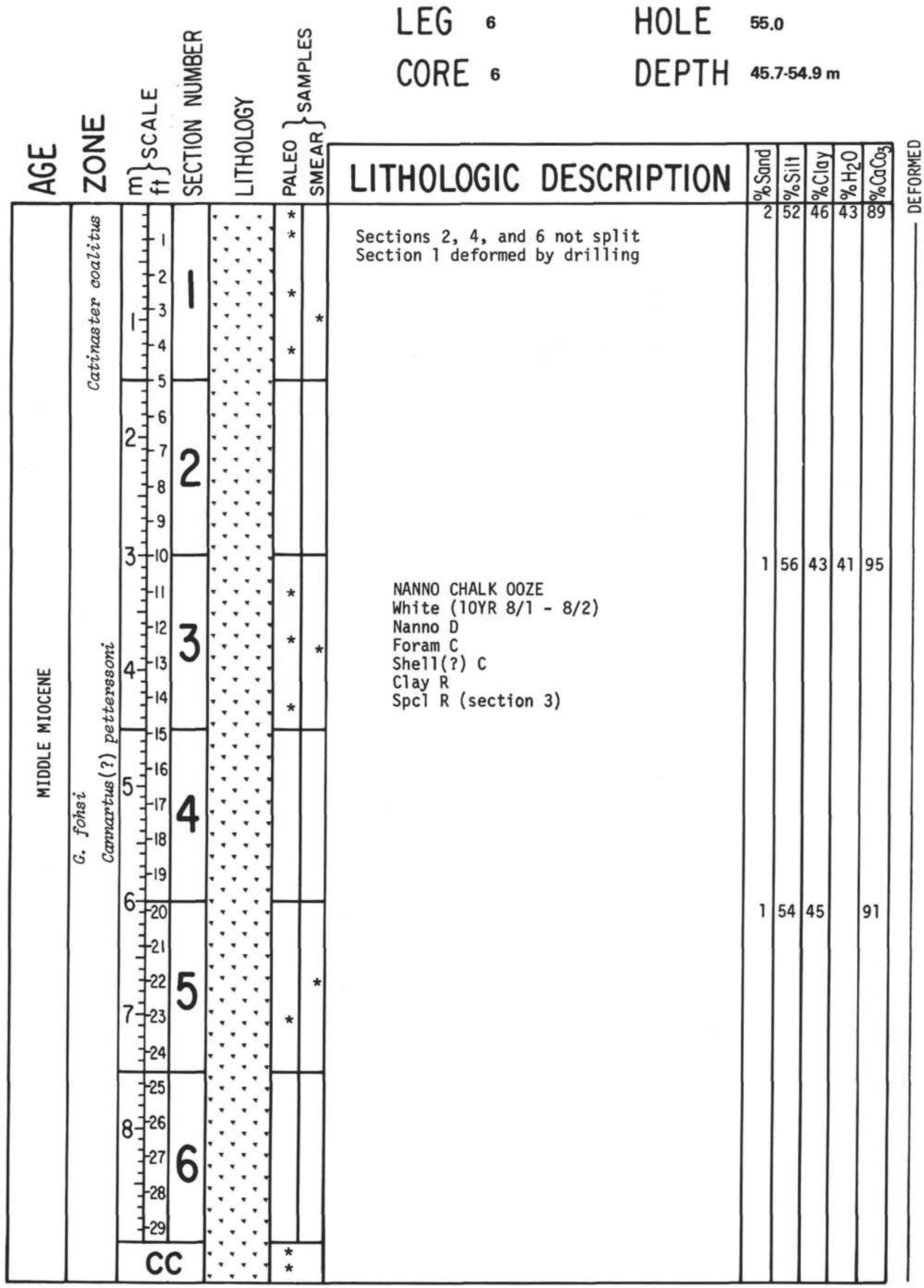


Figure 17. *Summary of lithology in Hole 55.0 Core 6.*

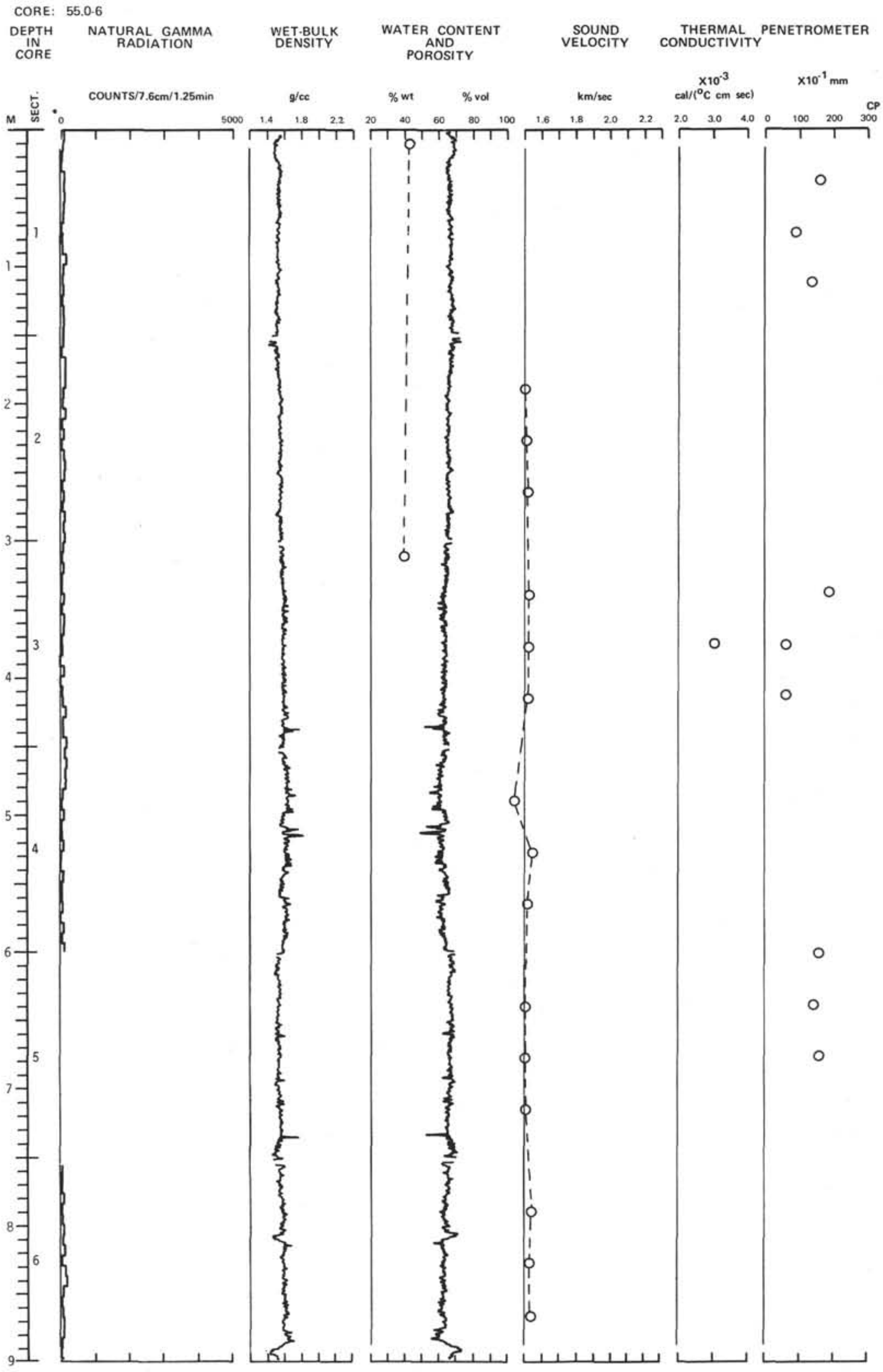


Figure 18. *Summary of physical properties in Hole 55.0 Core 6.*

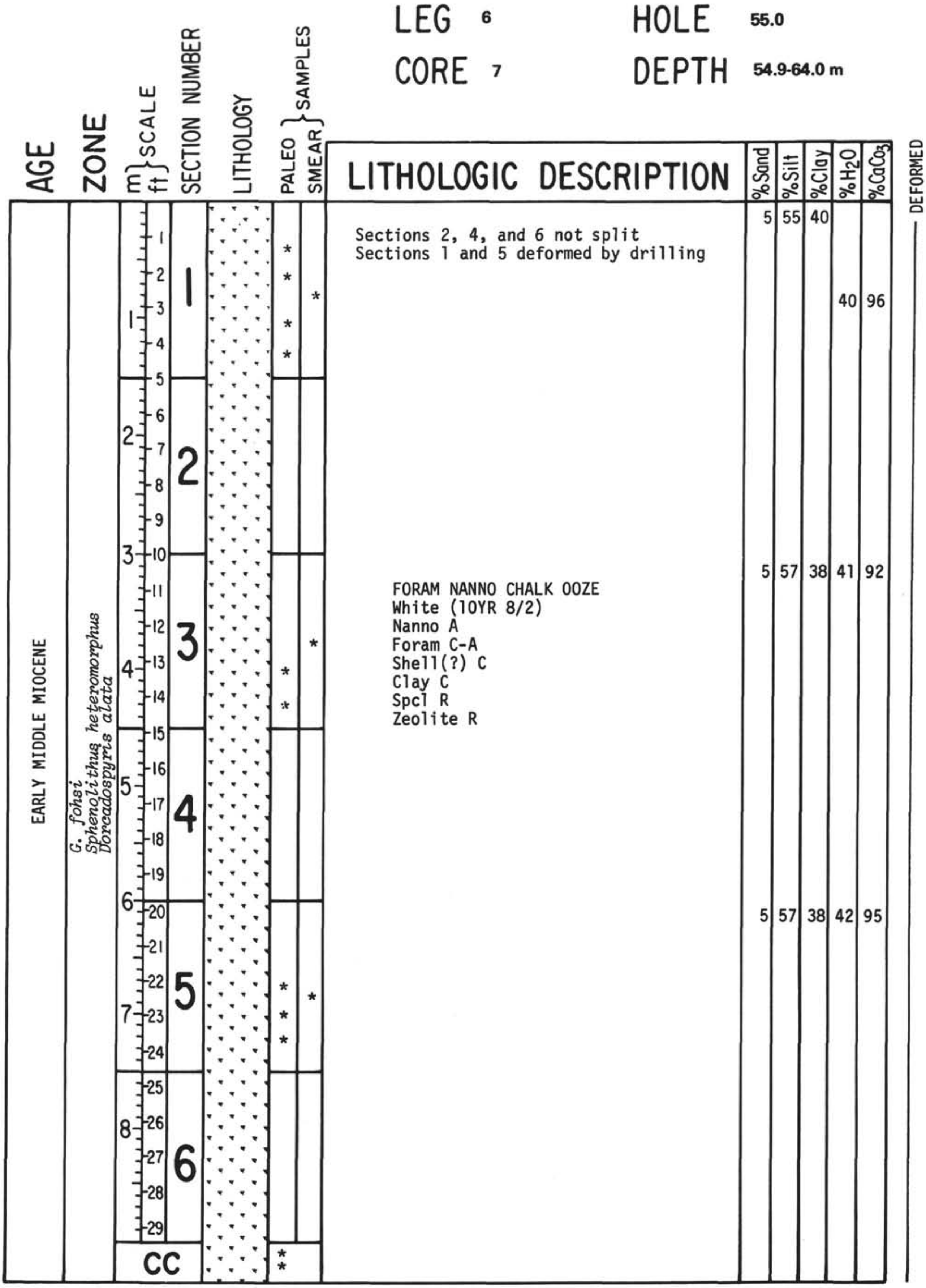


Figure 19. *Summary of lithology in Hole 55.0 Core 7.*

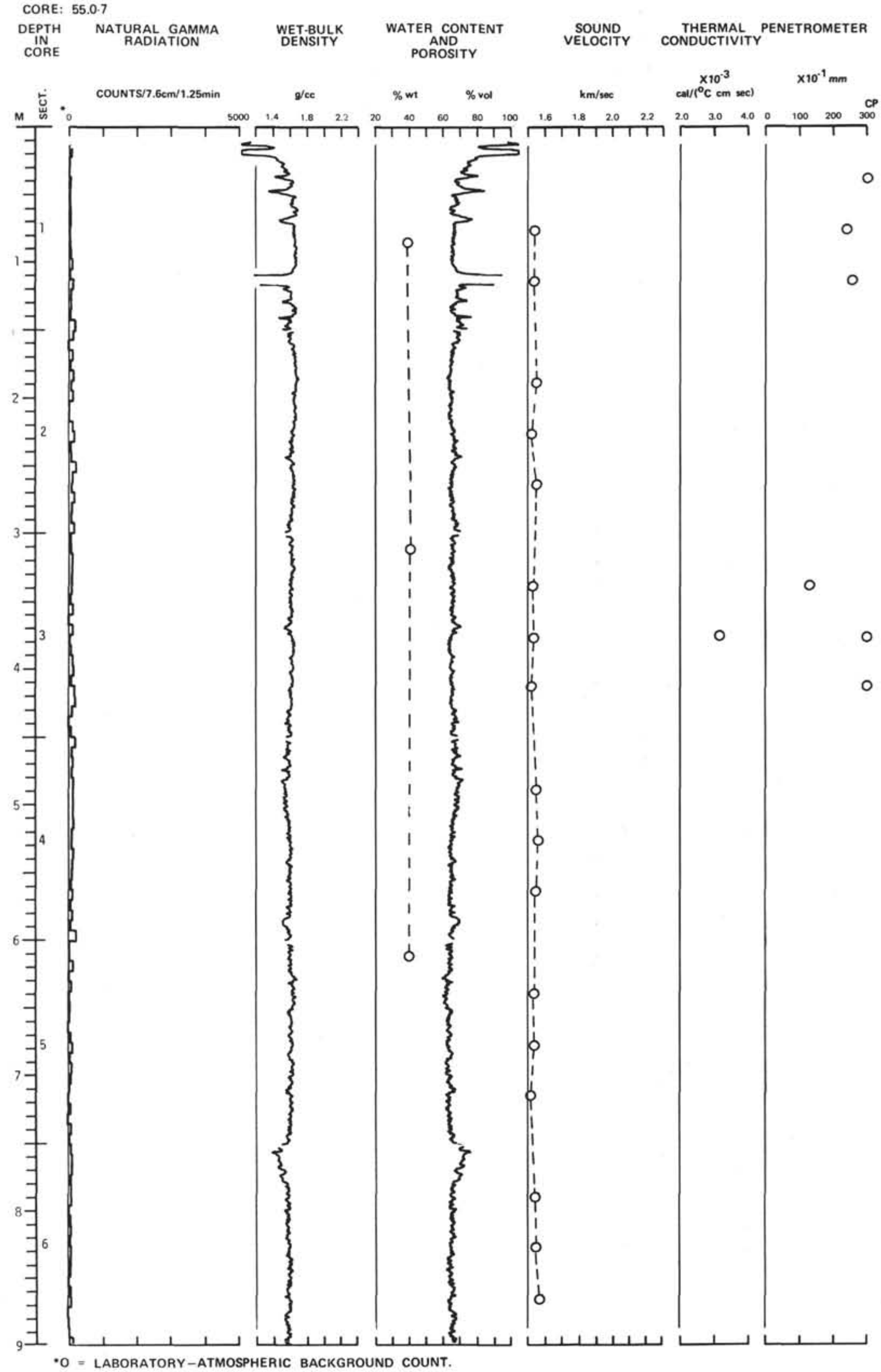


Figure 20. *Summary of physical properties in Hole 55.0 Core 7.*

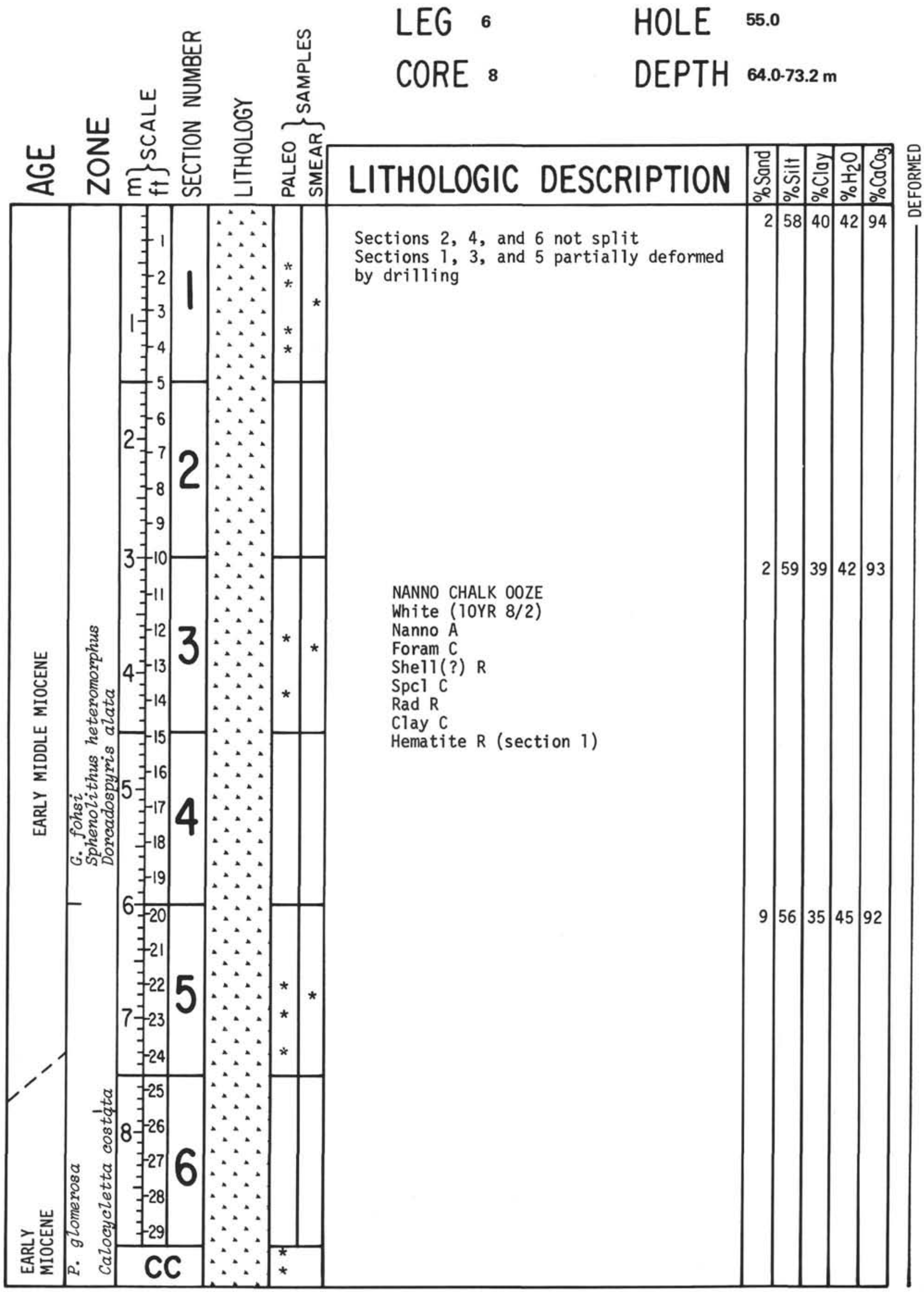


Figure 21. *Summary of lithology in Hole 55.0 Core 8.*

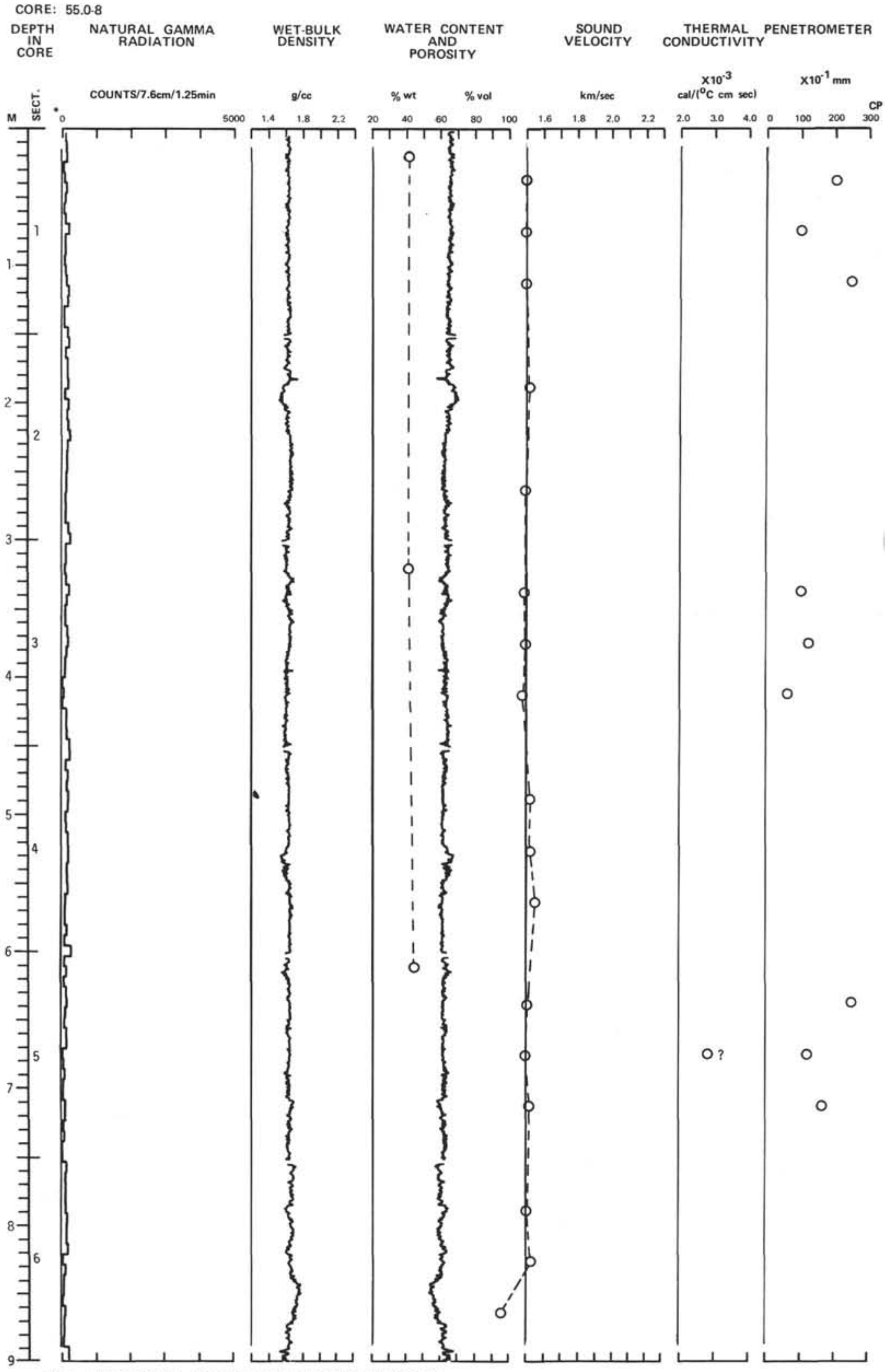


Figure 22. *Summary of physical properties in Hole 55.0 Core 8.*

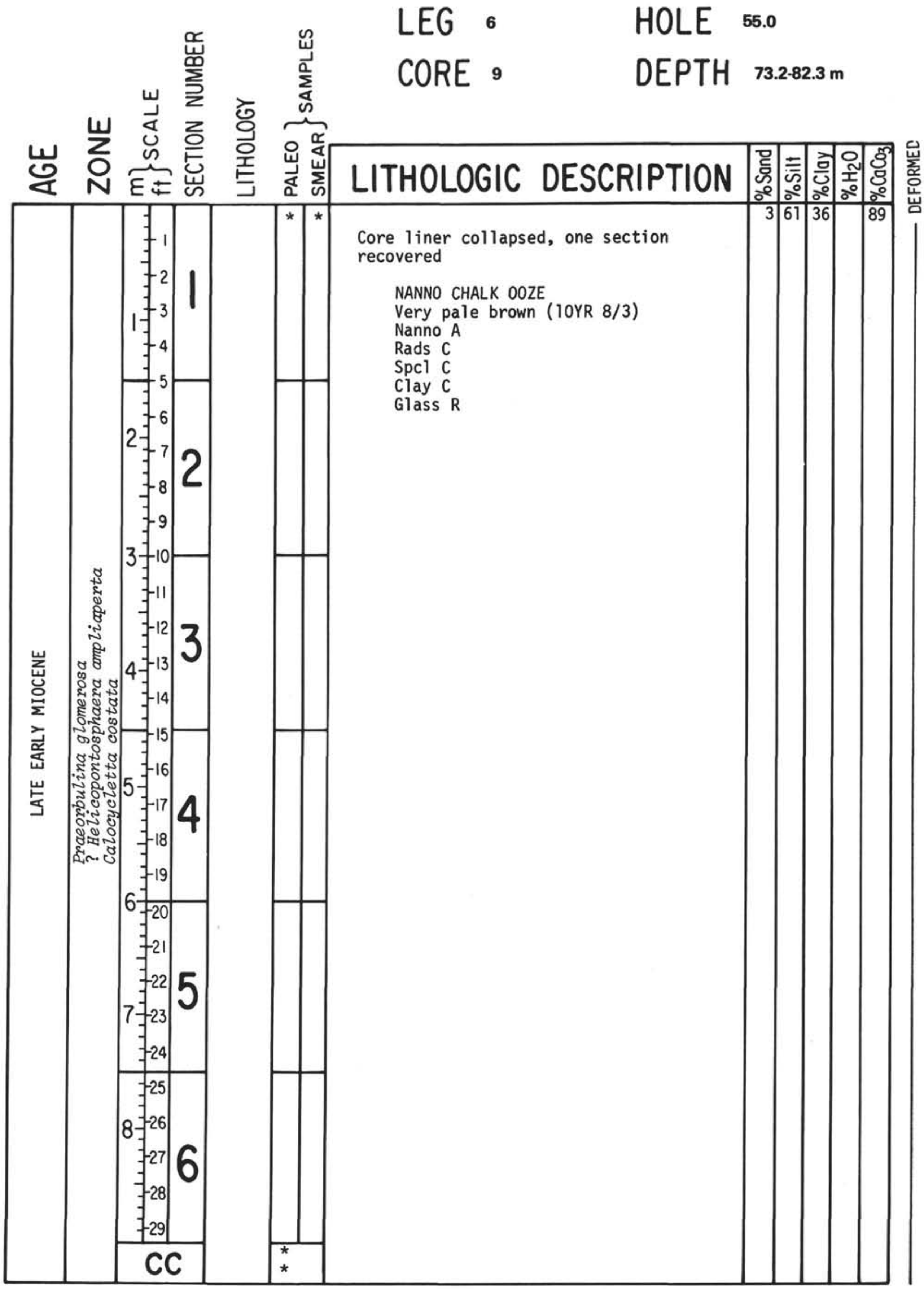


Figure 23. *Summary of lithology in Hole 55.0 Core 9.*

NO PHYSICAL PROPERTIES FOR HOLE 55.0 CORE 9

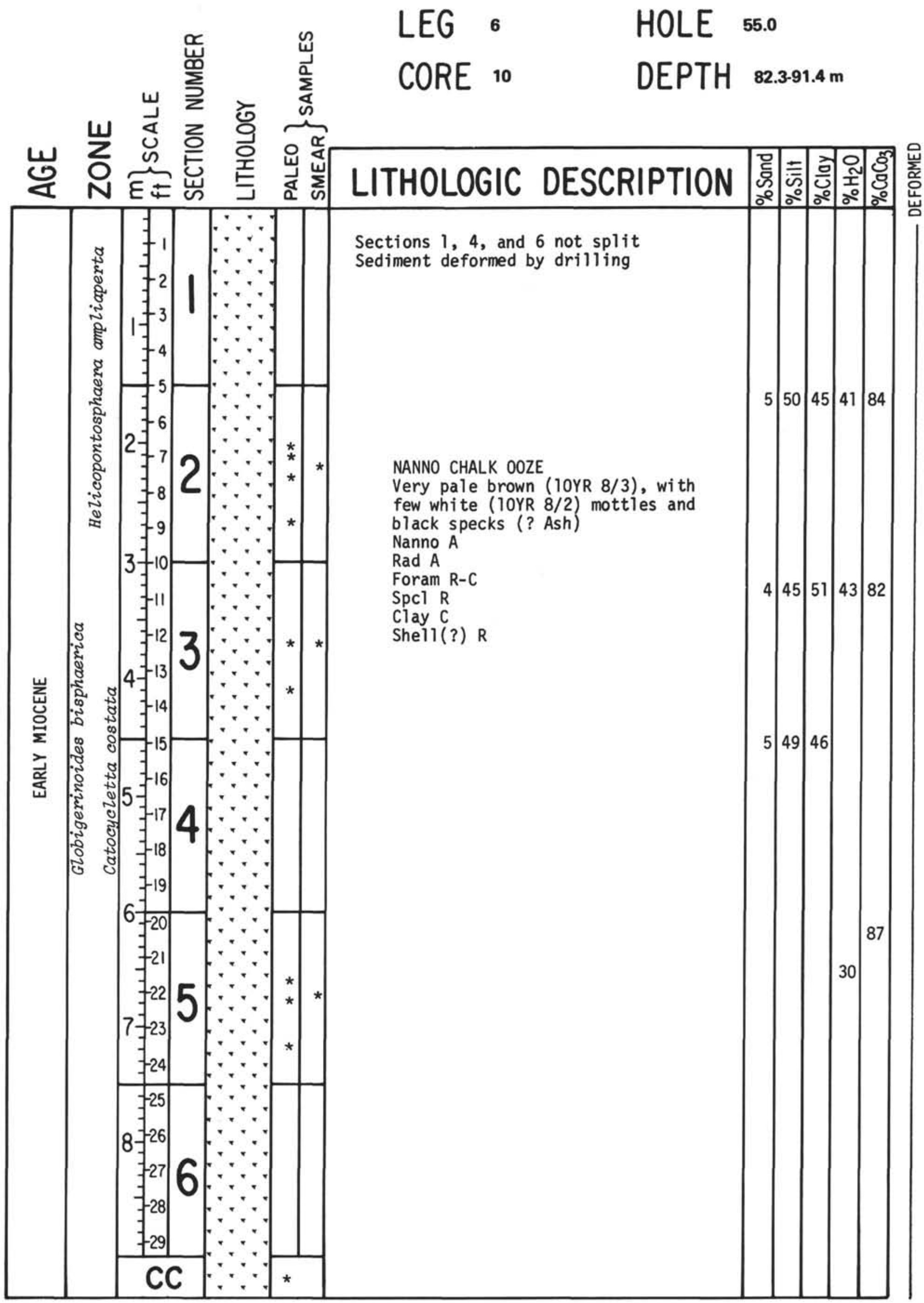


Figure 24. *Summary of lithology in Hole 55.0 Core 10.*

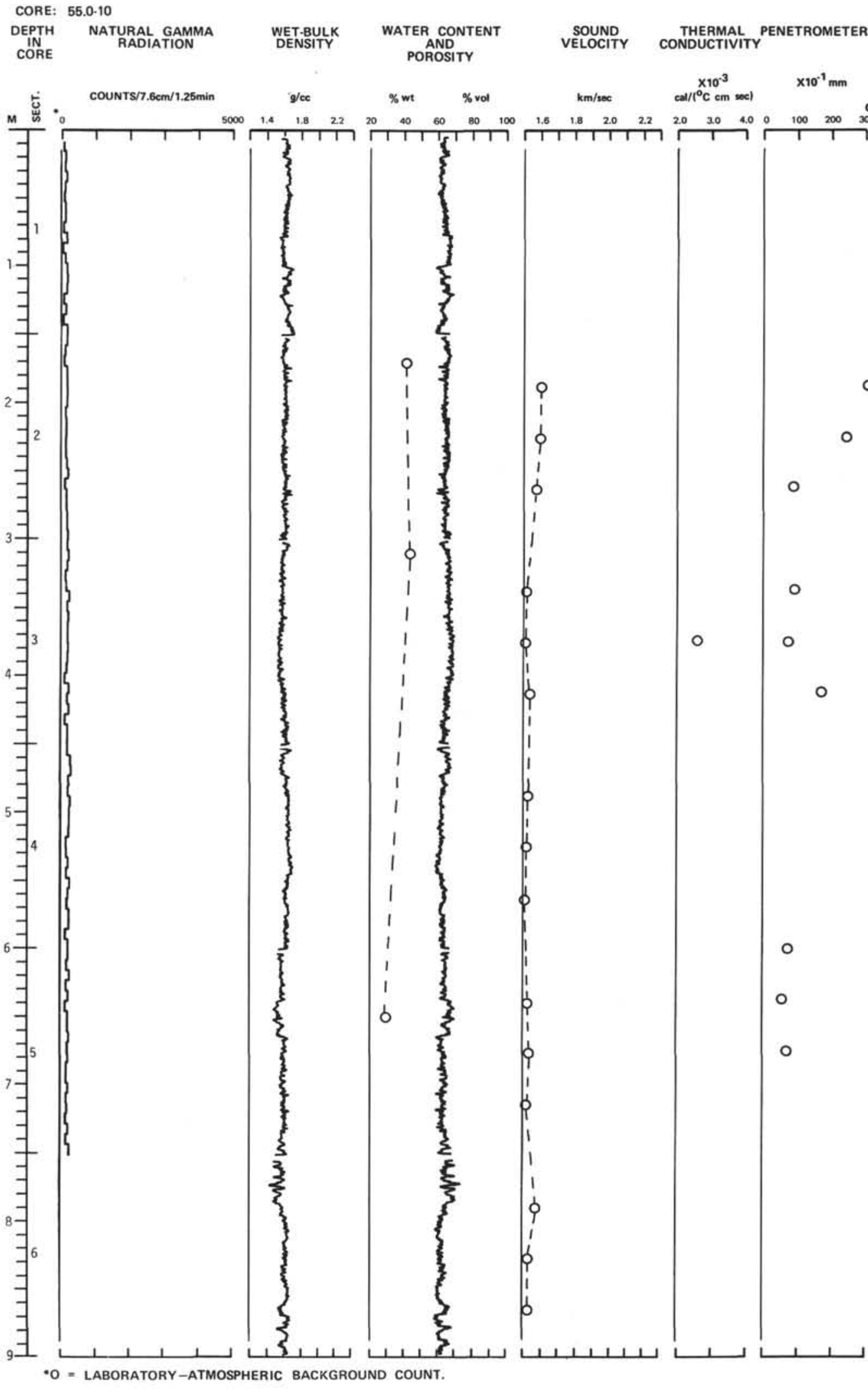


Figure 25. *Summary of physical properties in Hole 55.0 Core 10.*

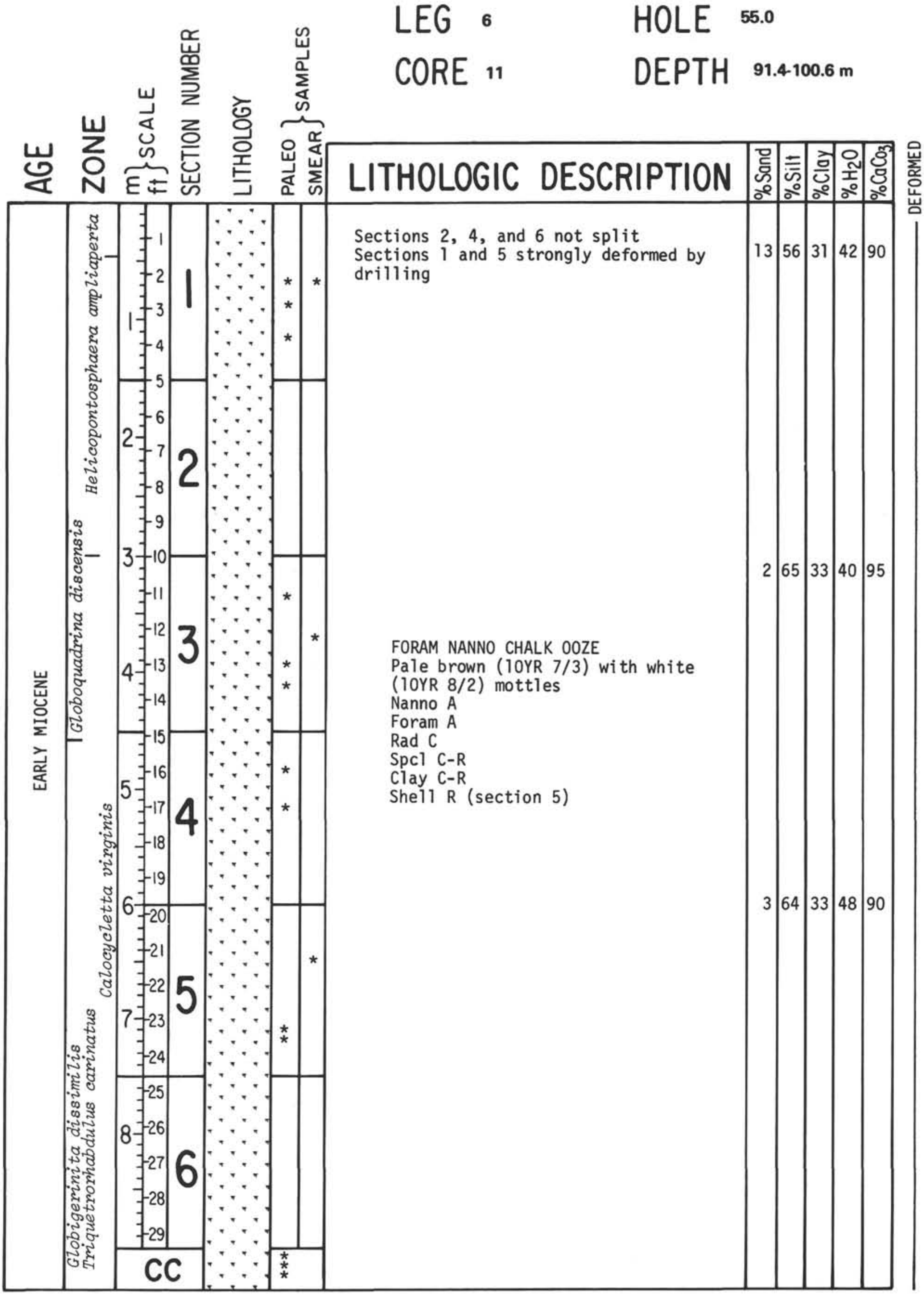


Figure 26. *Summary of lithology in Hole 55.0 Core 11.*

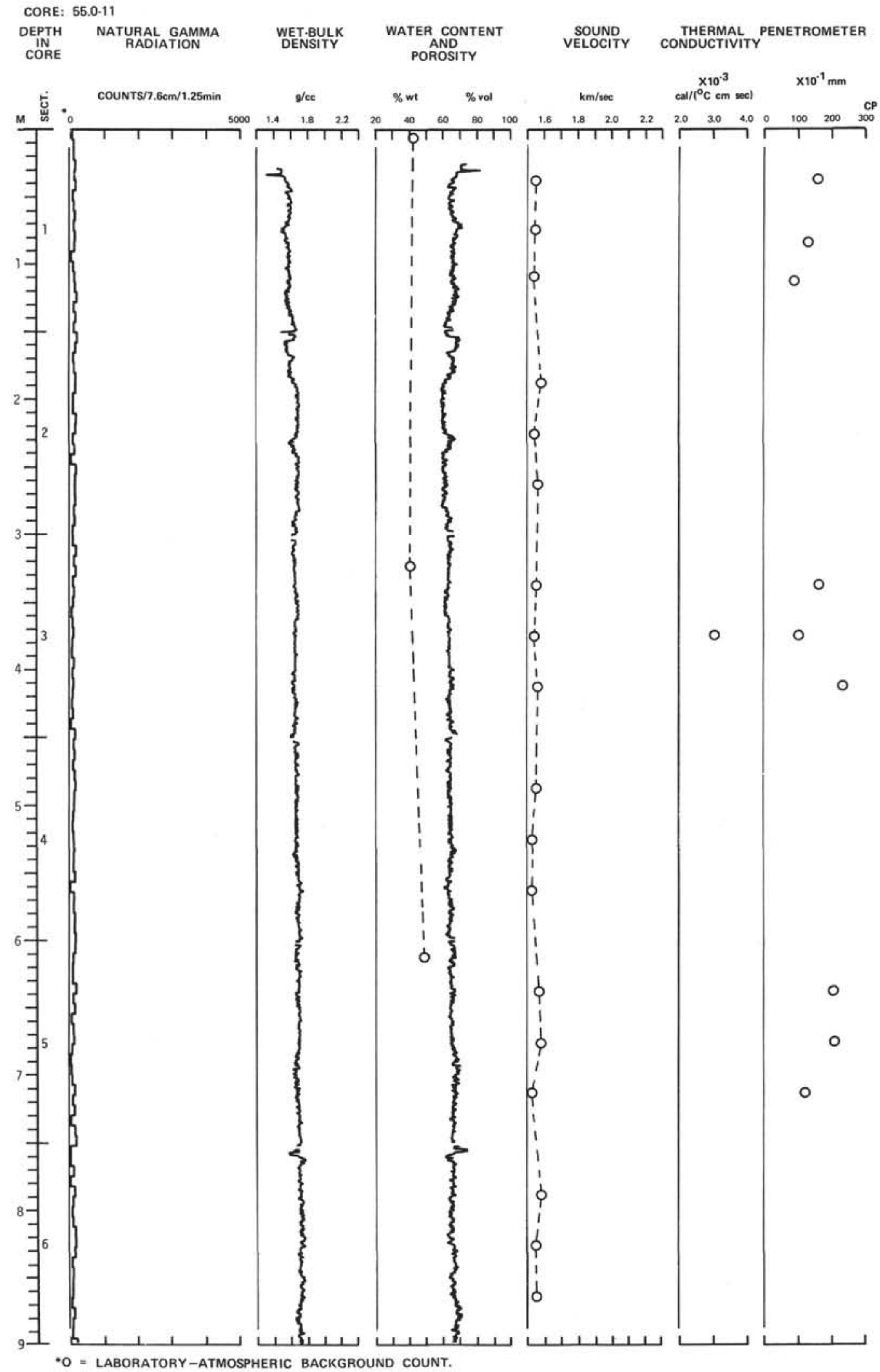


Figure 27. *Summary of physical properties in Hole 55.0 Core 11.*

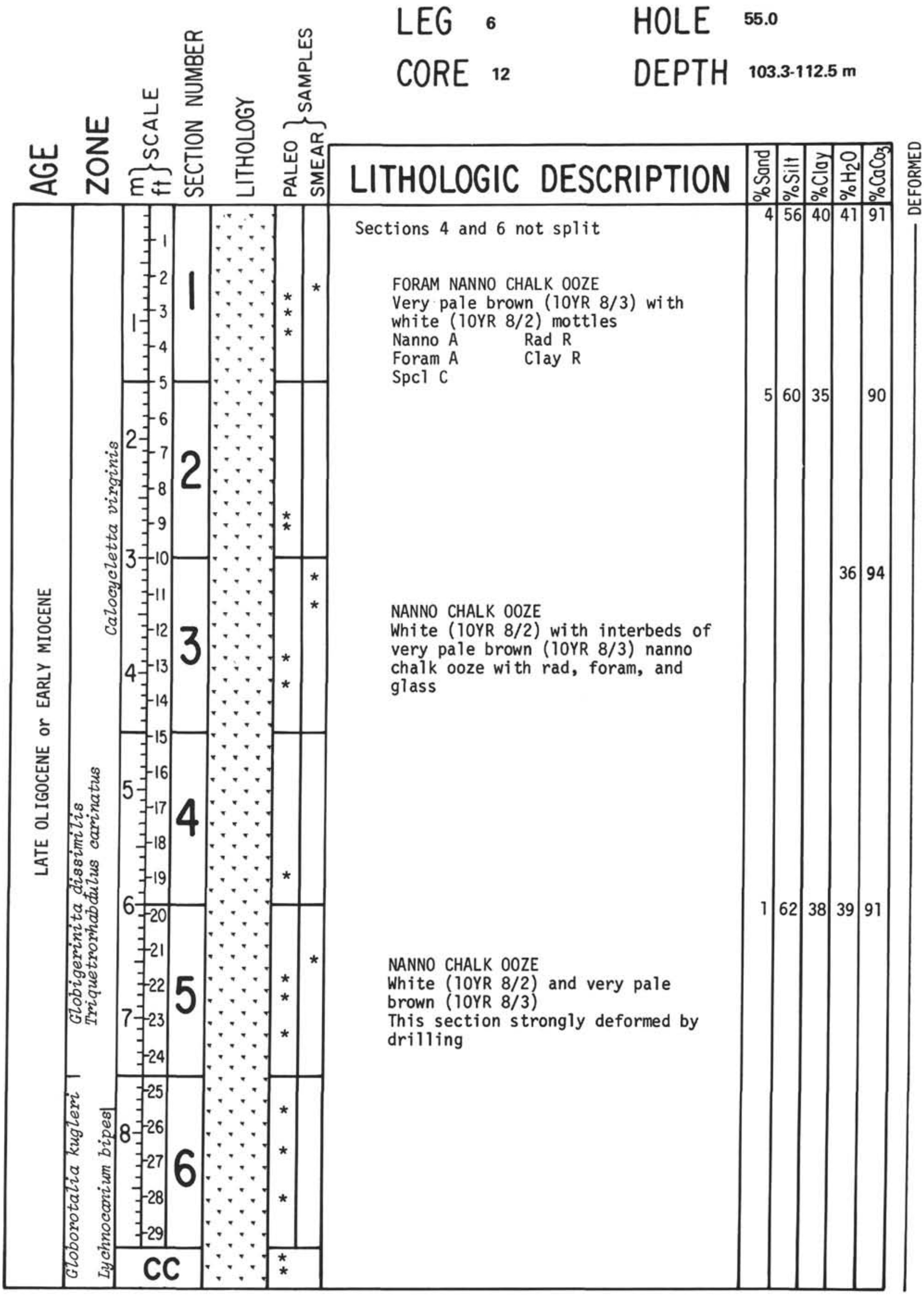


Figure 28. *Summary of lithology in Hole 55.0 Core 12.*

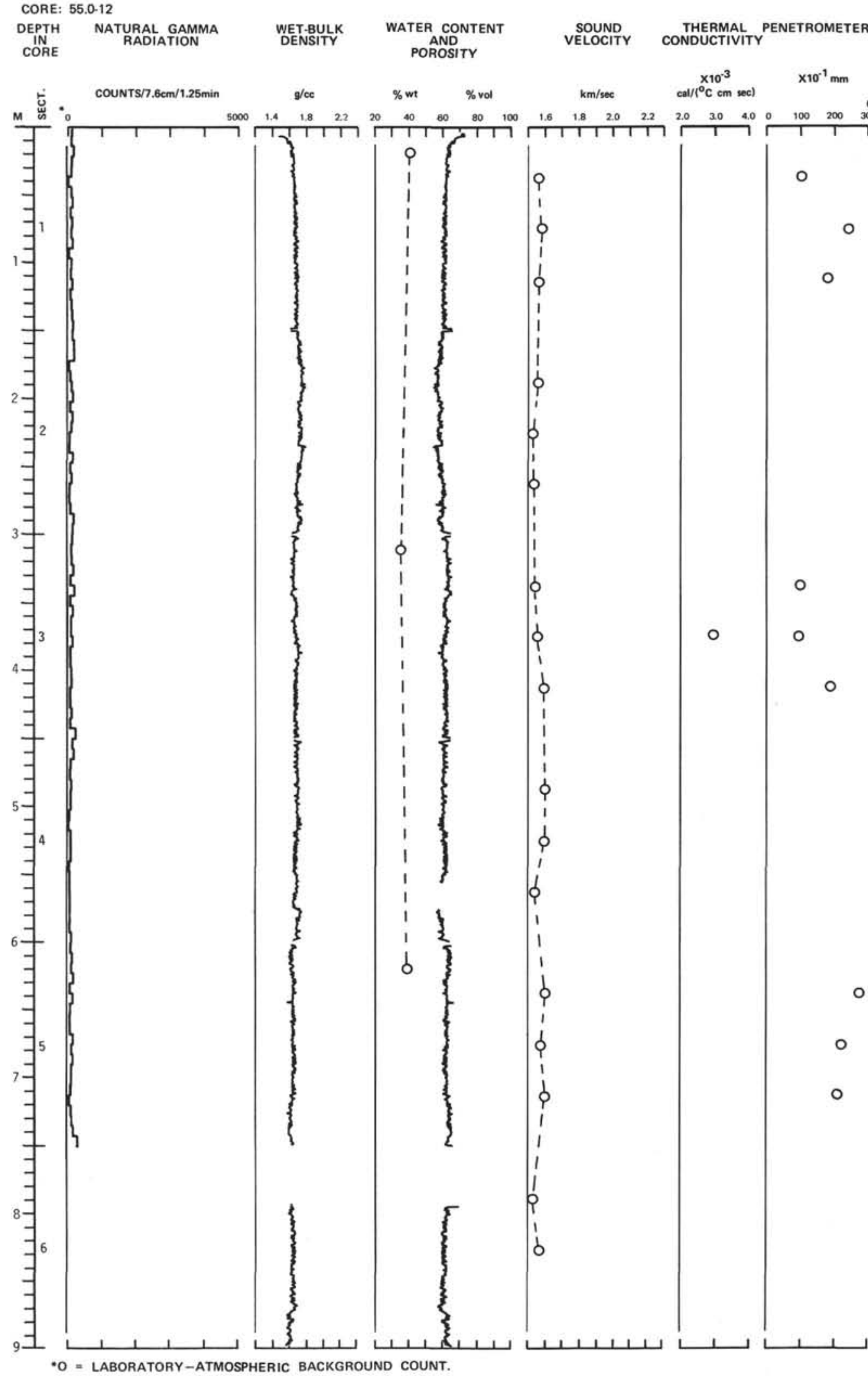


Figure 29. *Summary of physical properties in Hole 55.0 Core 12.*

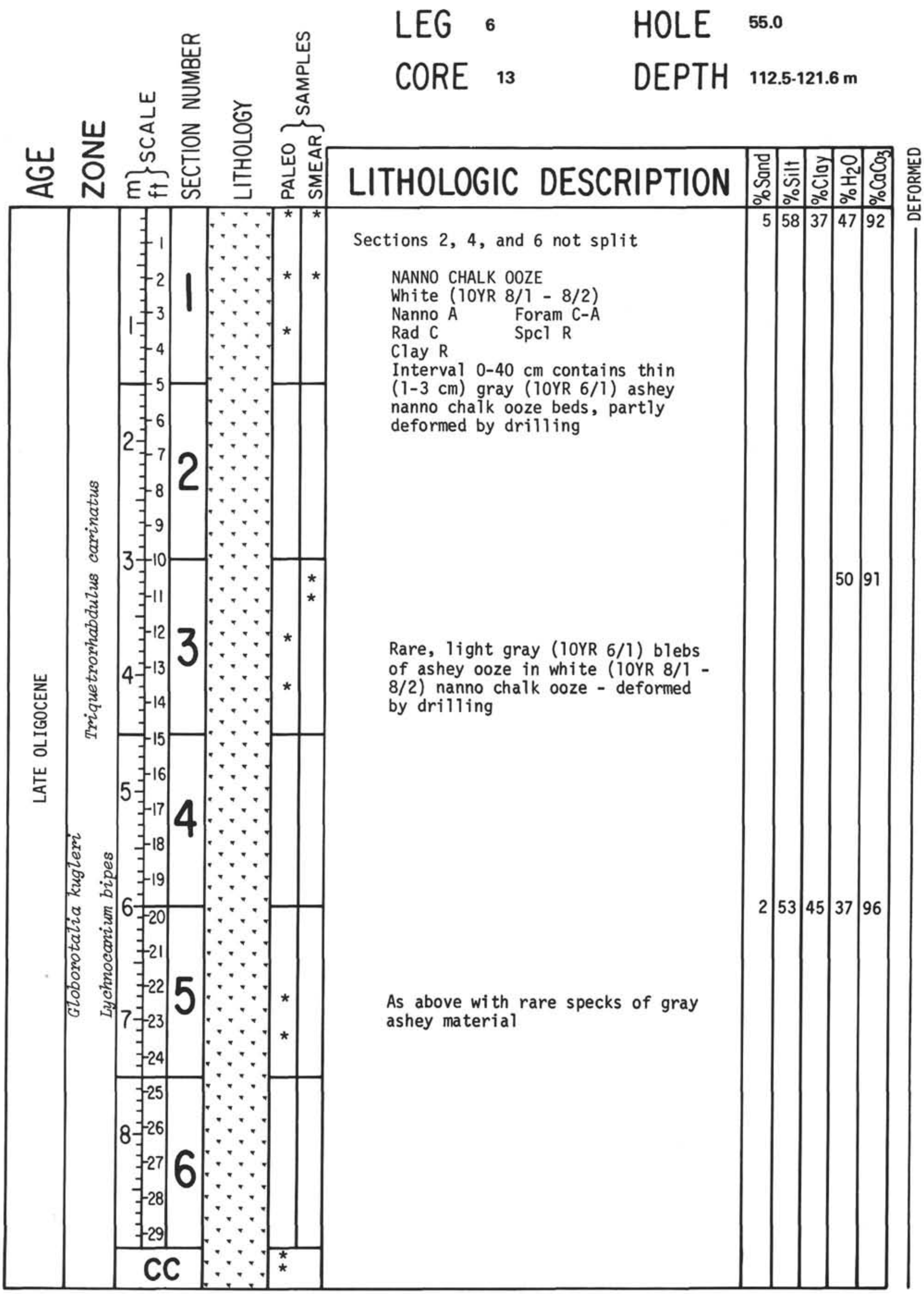
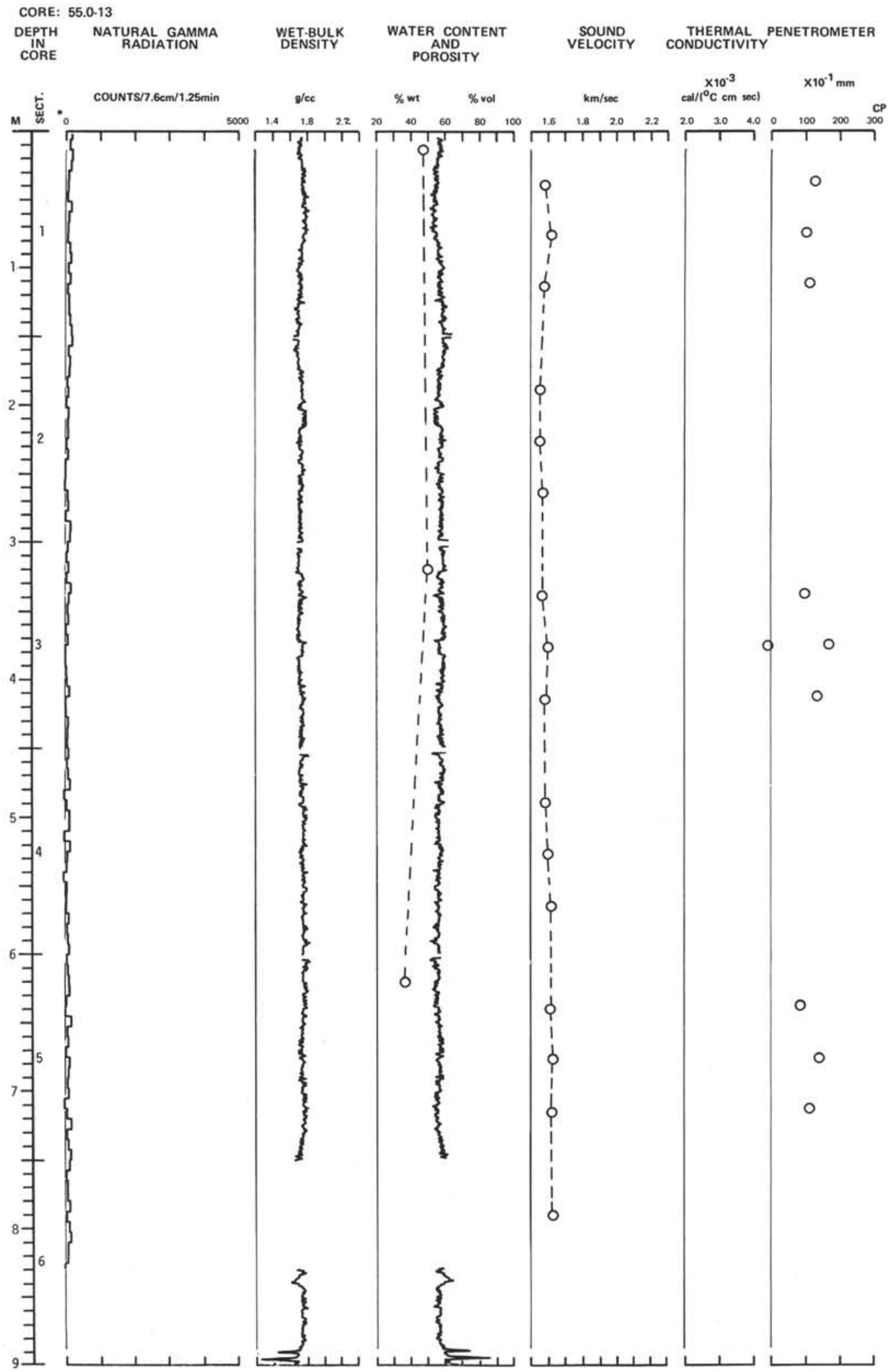


Figure 30. *Summary of lithology in Hole 55.0 Core 13.*



*O = LABORATORY–ATMOSPHERIC BACKGROUND COUNT.

Figure 31. *Summary of physical properties in Hole 55.0 Core 13.*

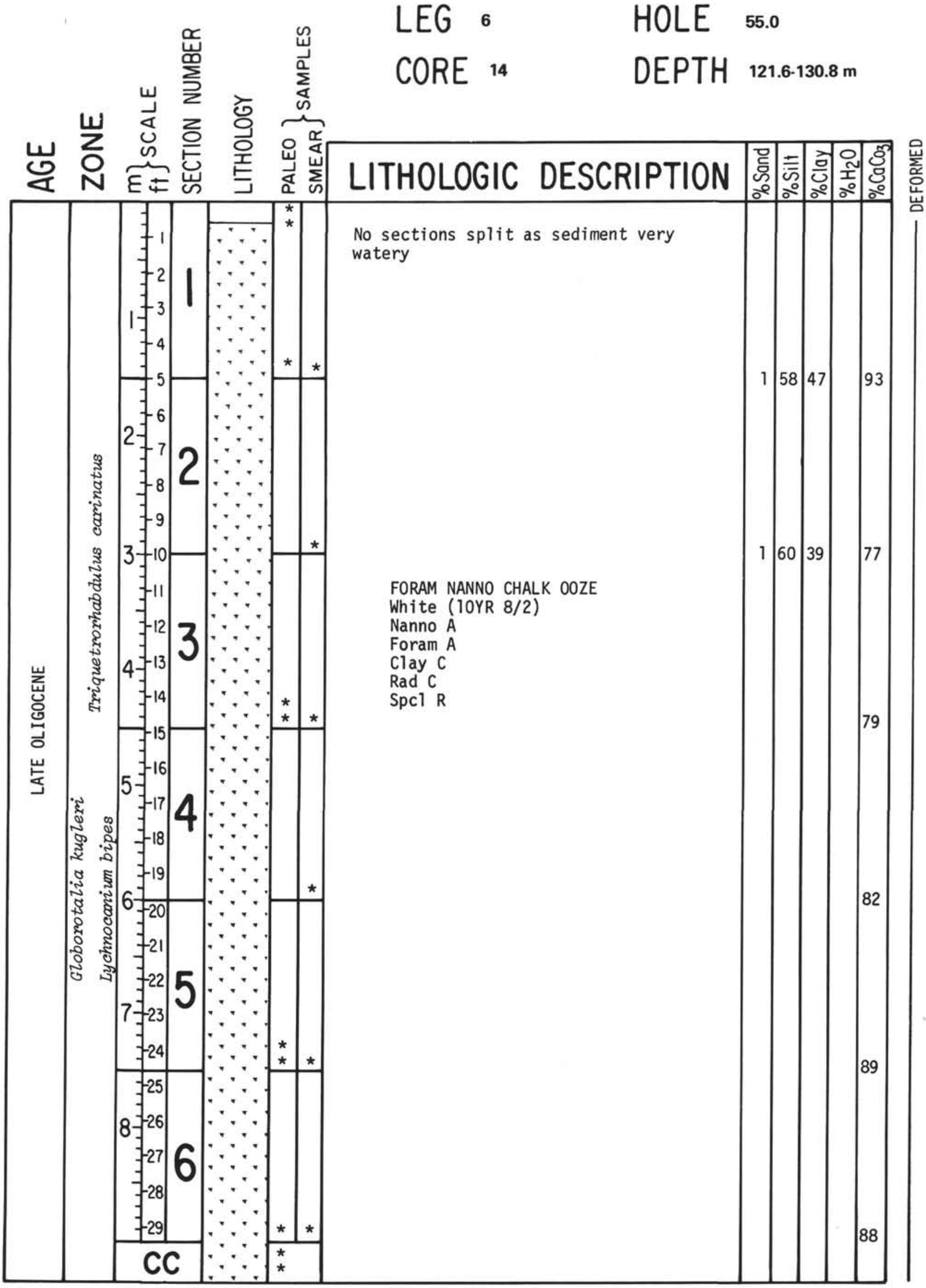


Figure 32. *Summary of lithology in Hole 55.0 Core 14.*

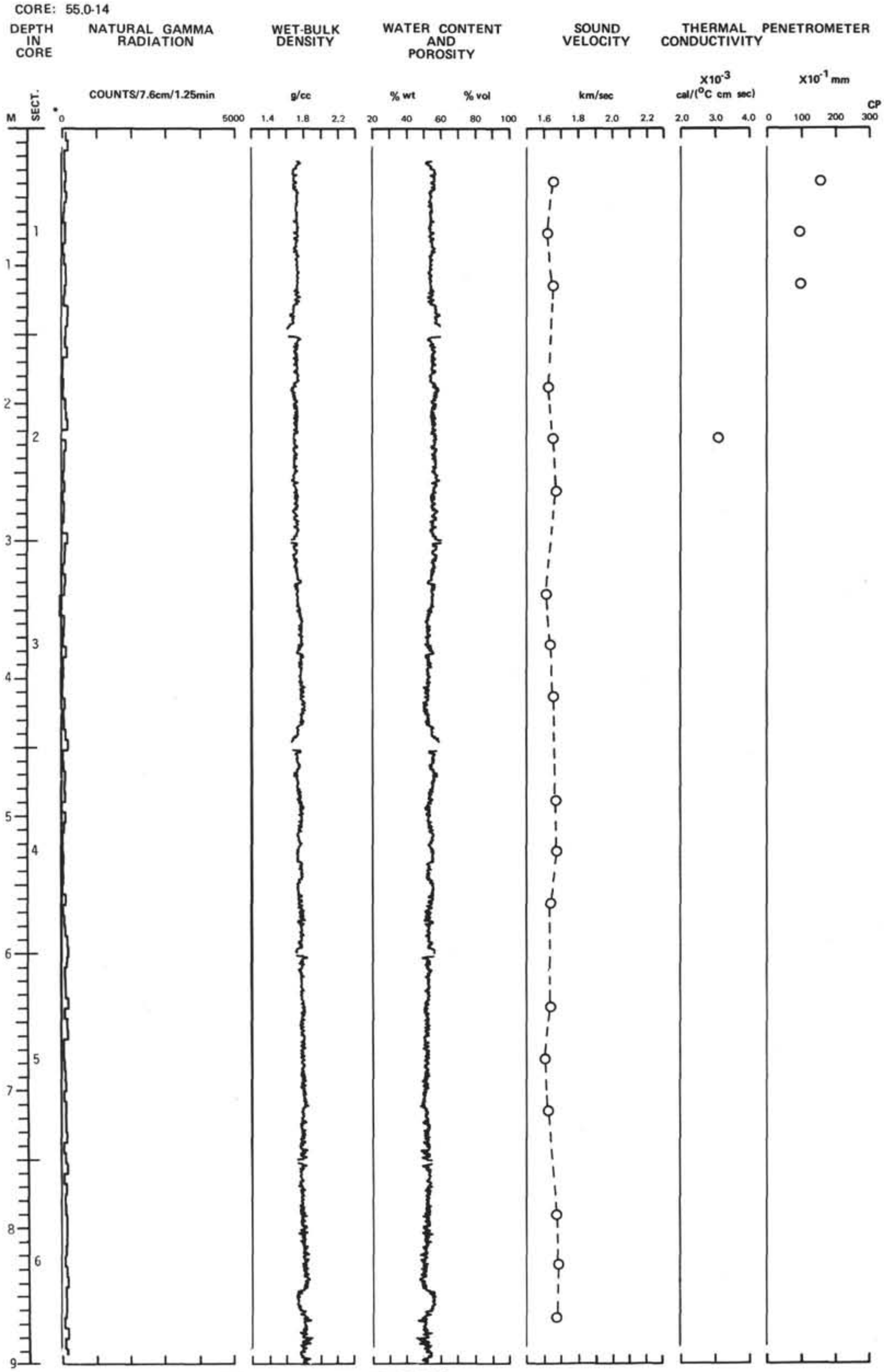


Figure 33. *Summary of physical properties in Hole 55.0 Core 14.*

LEG 6 HOLE 55.0

CORE 1 DEPTH 0.0-9.1 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Throughout the core (except the core-catcher sample) Pleistocene assemblages of planktonic Foraminifera were found - numerous *Pulleniatina obliquiloculata, Globorotalia tumida, G. cultrata, G. truncatulinoides, G. dutertrei, Sphaeroidinella dehiscens, Globigerinoides conglobatus, G. ruber, G. sacculifera* together with less frequent *Candeina nitida, Globorotalia crassaformis, G. inflata, Globigerina calida praecalida, G. digitata praedigitata.* The core-catcher sample contains rare *Globorotalia tosaensis, G. truncatulinoides.* It is either the top of Pliocene or the lowermost layers of Pleistocene.	Pleistocene assemblages are present in all samples but the core-catcher sample. *Gephyrocapsa oceanica* is present in the upper four core sections, becoming more abundant toward the top. Other species present in these *Gephyrocapsa oceanica* Zone assemblages include *Ceratolithus cristatus, Coccolithus doronicoides, Cyclococcolithina leptoporus, Cyclolithella annula, Helicopontosphaera kamptneri,* and *Rhabdosphaera clavigera.* Also present are a few reworked specimens of *Ceratolithus rugosus, Discoaster brouweri, D. challengeri,* and *D. pentaradiatus.* Lower Pleistocene, *Coccolithus doronicoides* Zone assemblages are present in the lower two core sections. The core-catcher sample contains the upper Pliocene *Discoaster brouweri* Zone with *C. rugosus, Cyclococcolithina macintyrei, D. brouweri, D. pentaradiatus,* and *D. surculus.*	Radiolaria are rare in this core. The assemblage is from the lower Miocene. Judging from a much younger age based on calcareous microfossils and the absence of Radiolaria of intermediate ages, the Radiolaria appear to have been contributed from nearby outcrops. TOP: not examined. BOTTOM: *Stichocorys wolffii, Calocycletta costata, Cannartus prismaticus, Cyrtocapsella cornuta,* and *Dorcadospyris simplex.*

Figure 34. *Summary of biostratigraphy in Hole 55.0 Core 1.*

LEG 6 HOLE 55.0

CORE 2 DEPTH 9.1-18.3 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
All assemblages of planktonic Foraminifera belong to the upper part of Pliocene - abundant *Globorotalia tumida tumida*, *G. cultrata*, *G. acostaensis humerosa*, *Pulleniatina obliquiloculata*, *Globigerinoides conglobatus*, *G. fistulosus*, *G. ruber*, *G. sacculifera*, *Orbulina universa* together with common *Globorotalia inflata*, *G. crassaformis*, *G. dutertrei*, *G. multicamerata*, *G. hirsuta*, *Candeina nitida*, *Hastigerina siphonifera*.	This core contains assemblages of the upper upper Pliocene *Discoaster brouweri* Zone. Among the discoasters, in the upper four core sections, *Discoaster brouweri* [3- and 6-rayed forms] is completely dominant, whereas *D. challengeri*, *D. pentaradiatus*, and *D. surculus* are present in substantial numbers only in the lower two core sections. Additional characteristic species in the core are *Ceratolithus rugosus*, *Coccolithus* sp. cf. *C. macintyrei*, and *Helicopontosphaera kamptneri*. A Pleistocene assemblage present at the very top of the core is presumed to have resulted from cave-in during retrieval of core 1.	Radiolaria are rare in this core. Two species are commonly found in Quaternary and Pliocene assemblages. Other species are from the lower Miocene. In the absence of species of intermediate ages, the Miocene Radiolaria appear to have been contributed from nearby outcrops. TOP: not examined. BOTTOM: *Panartus tetrathalamus* and *Spongaster tetras* (Quaternary ?). *Calocycletta costata*, *C. virginis*, *Stichocorys wolffii*, and *Cyrtocapsella cornuta* (lower Miocene).

Figure 35. *Summary of biostratigraphy in Hole 55.0 Core 2.*

LEG 6 HOLE 55.0

CORE 3 DEPTH 18.3-27.4 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Assemblages of the lower part of Pliocene were found in sections 6-4. They consist of *Sphaeroidinella dehiscens, Globorotalia tumida tumida, G. crassaformis, G. acostaensis humerosa, G. acostaensis pseudopima, G. inflata, G. multicamerata, G. hirsuta, G. cultrata, Pulleniatina obliquiloculata, Globigerinoides conglobatus, G. ruber, G. fistulosus, G. sacculifera, Globigerina eggeri, Globoquadrina altispira.* Sections 3-1 are transitional layers between the lower and upper parts of Pliocene. They contain the first rare *Globorotalia tosaensis* together with last *Globoquadrina altispira.*	Upper Pliocene assemblages of the *Discoaster brouweri* Zone are present throughout the core. Species present include *Ceratolithus rugosus, Cyclococcolithina leptoporus, C. macintyrei, Discoaster brouweri, D. challengeri, D. pentaradiatus, D. surculus, Helicopontosphaera kamptneri,* and *H. sellii.*	Radiolaria are rare in this core. The species present indicate a lower Miocene age. Judging from much younger ages based on calcareous microfossils and the absence of Radiolaria of intermediate age, the Radiolaria appear to have been contributed from nearby outcrops. TOP: not examined. BOTTOM: *Calocycletta costata, Stichocorys wolffii, Cyrtocapsella cornuta, Cannartus mammiferus,* and *Dorcadospyris dentata.*

Figure 36. *Summary of biostratigraphy in Hole 55.0 Core 3.*

LEG 6 **HOLE** 55.0
CORE 4 **DEPTH** 27.4-36.6 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Throughout the core assemblages are typical for the *Globorotalia menardii* Zone, upper Middle Miocene (Tortonian stage). Planktonic Foraminifera are represented by abundant *Globorotalia menardii, Orbulina universa, Globigerina nepenthes, G. bulloides, G. parabulloides, G. concinna, Sphaeroidinellopsis grimsdalei, S. rutschi, S. subdehiscens, Globigerinoides bollii, G. obliquus, G.* ex gr. *sacculifera* together with *Globorotalia lenguaensis, G. pseudopachy derma, Globigerinita glutinata, Hastigerina siphonifera, Globigerina globorotaloidea.*	The assemblage throughout the core represents the upper *Discoaster neohamatus* Zone, or lower upper Miocene. *Discoaster quintatus* which is abundant at the top of the core is less common lower in the core and is absent at the base. Other species present in the core are *Cyclococcolithina leptoporus, C. macintyrei, Discoaster brouweri s.l., D. challengeri, D. neohamatus, D. pentaradiatus, D. quintatus,* and *Triquetrorhabdulus rugosus.*	Radiolaria are rare in this core. The species present are from the lower Miocene. Judging from upper Miocene ages based on calcareous microfossils and on the lack of Radiolaria of middle Miocene age, the Radiolaria appear to have been contributed from a nearby outcrop. TOP: not examined. BOTTOM: *Dorcadospyris simples, Stichocorys wolffii,* and *Calocycletta virginis.*

Figure 37. *Summary of biostratigraphy in Hole 55.0 Core 4.*

LEG 6 HOLE 55.0

CORE 5 DEPTH 36.6-45.7 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
All assemblages of planktonic Foraminifera belong to the *Globorotalia menardii* Zone, upper Middle Miocene (Tortonian stage). The most numerous are *Orbulina universa*, *Globigerina nepenthes*, *Sphaeroidinellopsis grimsdalei*, *S. rutschi*, *S. subdehiscens*, *Globoquadrina altispira*. They associate with *Globorotalia menardii*, *G. pseudopachyderma*, *Globigerinoides bollii*, *Globigerina bulloides*, *G. concinna*, *G. parabulloides*, *G. decoraperta*, *Globoquadrina dehiscens*, *G. larmeui obesa*.	Assemblages of the *Discoaster neohamatus* Zone are present through all but the lower half meter of the core where *Discoaster hamatus* Zone assemblages are present. The contact between these zones is considered to be the upper to middle Miocene boundary. Species from the upper part of the core include *Cyclococcolithina leptoporus*, *C. macintyrei*, *Discoaster challengeri*, *D. neohamatus*, *D. pentaradiatus*, *D.* sp. cf. *D. surculus*, *Reticulofenestra pseudoumbilica*, and *Triquetrorhabdulus rugosus*. Species from the bottom of the core include *Catinaster calyculus*, and *Discoaster hamatus*.	No Radiolaria.

Figure 38. *Summary of biostratigraphy in Hole 55.0 Core 5.*

LEG 6 HOLE 55.0

CORE 6 DEPTH 45.7-54.9 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Assemblages of the *Globorotalia fohsi* Zone, lower Middle Miocene, were traced throughout the core, except the top. They include *Candorbulina universa, Biorbulina bilobata, Globorotalia fohsi, G. peripheroacuta, G. praemenardii, G. mayeri, Sphaeroidinellopsis grimsdalei, S. rutschi, Globoquadrina altispira, Globigerina concinna.* The top sample belongs to the *Globorotalia menardii* Zone, upper Middle Miocene, and is characterized by numerous *Orbulina universa, Globorotalia menardii, G. mayeri, Globigerina bulloides, Sphaeroidinellopsis grimsdalei, Sph. subdehiscens, Globoquadrina altispira.*	Samples from the top of the core contain *Catinaster coalitus* and are assigned to the *Catinaster coalitus* Zone or upper middle Miocene. The remainder of the core contains middle middle Miocene assemblages characterized by irregular calcite overgrowths that limit species distinctions. Species present include *Cyclococcolithina leptoporus, Discoaster brouweri s.1., D. challengeri, D.* sp. aff. *D. challengeri, Reticulofenestra pseudoumbilica,* and *Triquetrorhabdulus rugosus.*	Radiolaria are fairly abundant in this core. The presence of curved and flattened orosphaerid spines suggests a middle Miocene age for the formation of the sediment. Most of the species are from the lower middle Miocene and lower Miocene and may be reworked or contributed from nearby outcrops, or both. TOP: *Stichocorys delmontense, Calocycletta costata, Stichocorys wolffii, Dorcadospyris alata, D. simplex,* and *Calocycletta virginis.* BOTTOM: *Stichocorys delmontense, S. wolffii, Cannartus laticonus, Dorcadospyris alata, Calocycletta costata, Cyrtocapsella cornuta,* and *C. japonica.*

Figure 39. *Summary of biostratigraphy in Hole 55.0 Core 6.*

LEG 6 HOLE 55.0

CORE 7 DEPTH 54.0-64.0 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Very rich assemblages of the *Globorotalia fohsi* Zone, lower Middle Miocene, were established throughout the core. Planktonic foraminifers are represented by numerous *Sphaeroidinellopsis grimsdalei, S. rutschi, Globoquadrina dehiscens, G. altispira, Globorotalia mayeri, G. obesa, Globigerinoides trilobus,* common *Candorbulina universa, Globorotalia fohsi, G. peripheroacuta, G. praemenardii, Globigerinoides subquadratus, Globigerina concinna, G. foliata* and rare *Biorbulina bilobata, Globigerinoides irregularis, Globigerinopsis aquasayensis.*	Assemblages of this core are transitional from middle to lower middle Miocene. Among the placoliths, *Cyclococcolithina neogammation* gradually replaces *C. leptoporus* and *Reticulofenestra pseudoumbilica,* in samples taken downward through the core. Rare specimens of *Sphenolithus heteromorphus* are also present only in the lower part of the core and suggest together with the occurrence of *Discoaster deflandrei* the affinity of the assemblages to the *Sphenolithus heteromorphus* Zone of the lower middle Miocene.	Radiolaria are abundant throughout this core. Most of the species represent the lower middle Miocene *Dorcadospyris alata* Zone. A few rare species may represent reworking from the lower Miocene or contribution from nearby outcrops. TOP: *Stichocorys delmontense, Cannartus laticonus, Calocycletta costata, C. virginis, Dorcadospyris alata, Cyrtocapsella cornuta, C. virginis, Dorcadospyris alata, Cyrtocapsella cornuta, C. japonica, C. tetrapera,* and *Stichocorys wolffii.* BOTTOM: *Stichocorys delmontense, S. wolffii, Dorcadospyris alata, Calocycletta costata, C. virginis, Cannartus laticonus, Cyrtocapsella cornuta,* and *C. tetrapera.*

Figure 40. *Summary of biostratigraphy in Hole 55.0 Core 7.*

LEG 6 **HOLE** 55.0

CORE 8 **DEPTH** 64.0-73.2 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
The lowermost part of this core (sections 6 - 5) is characterized by foraminifers of the *Globigerinatella insueta* Zone, upper Lower Miocene. Other sections (4 - 1) of the core contain foraminifers of the *Globorotalia fohsi* Zone, lower Middle Miocene. Bottom: *Globigerinoides trilobus, G. diminuta, G. bisphaerica, Globorotalia peripheroronda, G. obesa, Globoquadrina dehiscens, G. altispira, Sphaeroidinellopsis grimsdalei,* very rare *Globigerinatella insueta* and *Praeorbulina transitoria.* Top: *Sphaeroidinellopsis grimsdalei, S. rutschi, Globorotalia peripheroacuta, G. mayeri, Globigerinoides irregularis, Globigerina concinna, Globoquadrina dehiscens, G. altispira,* rare *Candorbulina universa.*	All samples from this core are assignable to the lower middle Miocene *Sphenolithus heteromorphus* Zone. Discoasters, in the assemblages examined, are poorly preserved. *Discoaster deflandrei* is present, but *D. brouweri s.l.*, and *D. challengeri s.l.* are most common. *Cyclococcolithina neogammation* and *Sphenolithus heteromorphus* are common to abundant.	This core contains assemblages of the lower middle Miocene *Dorcadospyris alata* Zone in the upper and middle parts and assemblages of the upper lower Miocene *Calocycletta costata* Zone in the lower part. TOP: *Stichocorys delmontense, Dorcadospyris alata, Cannartus laticonus, Cyrtocapsella cornuta, Calocycletta costata,* and *Dorcadospyris dentata.* BOTTOM: *Calcycletta costata, Stichocorys wolffii, S. delmontense, Cyrtocapsella cornuta, Dorcadospyris dentata, D. simplex, Cannartus violina,* and *C. mammiferus.*

Figure 41. *Summary of biostratigraphy in Hole 55.0 Core 8.*

LEG 6 **HOLE** 55.0

CORE 9 **DEPTH** 73.2-82.3 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
This core contains planktonic Foraminifera typical for the *Globigerinatella insueta* Zone, upper Lower Miocene. The assemblages include numerous *Globigerinoides trilobus, G. subquadratus, Globoquadrina dehiscens, G. altispira, G. langhiana, Globigerina bollii, G. foliata, G. falconensis,* less frequent *Globorotalia obesa, G. siakensis, G. peripheroronda, Globigerinoides diminuta, G. bisphaerica* and very rare *Globigerinatella insueta* and *Praeorbulina transitoria.* Seemingly it is the upper subzone of the *G. insueta* Zone (with *Praeorbulina*).	Lower middle Miocene assemblages of the lower *Sphenolithus heteromorphus* Zone are found throughout this core. Species present include *Cyclococcolithina leptoporus* [small], *C. neogammation, Discoaster brouweri s.l., D. deflandrei, Sphenolithus heteromorphus.* Discoasters are poorly preserved.	This core contains Radiolaria representing the upper lower Miocene *Calocycletta costata* Zone. TOP: not examined. BOTTOM: *Calocycletta costata, Stichocorys wolffii, S. delmontense, Cyrtocapsella cornuta, Cannartus violina, C. tubarius, Dorcadospyris simplex, D. dentata,* and *Calocyletta virginis.*

Figure 42. *Summary of biostratigraphy in Hole 55.0 Core 9.*

LEG 6 HOLE 55.0

CORE 10 DEPTH 82.3-91.4 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
The assemblages of the *Globigerinatella insueta* Zone, upper Lower Miocene, were traced throughout the core. Planktonic Foraminifera are represented by numerous *Globigerinoides trilobus*, *Blogoquadrina langhiana*, *G. altispira*, *G. dehiscens*, *Globigerina foliata*, *G. bollii*, *G. falconensis*, *Globorotalia saikensis*, *G. obesa*, *G. peripheroronda* and rare *Globigerinatella insueta*. Section 6 belongs to the lower subzone (without *G. bisphaerica)*. All other sections with comparatively rare *G. bisphaerica* correspond evidently to the middle subzone (without *Praeorbulina)*.	Upper lower Miocene assemblages of the *Helicopontosphaera ampliaperta* Zone are present throughout the core. Species present include, *Cyclococcolithina neogammation*, *Discoaster deflandrei*, *D. perplexus*, and *Sphenolithus heteromorphus*.	The assemblages contained in this core are of the upper lower Miocene *Calocycletta costata* Zone. TOP: *Stichocorys wolffii*, *Calocycletta costata*, *Dorcadospyris simplex*, *Cyrtocapsella cornuta*, *Cannartus tubarius*, *C. violina*, and *C. prismaticus*. BOTTOM: *Calocycletta costata*, *Stichocorys wolffii*, *Calocycletta virginis*, *Cyrtocapsella cornuta*, *Cannartus tubarius*, *C. violina*, *Stichocorys delmontense*, *Dorcadospyris simplex*, *D. dentata*, *D. forcipata*, and *Lychnocanium bipes*.

Figure 43. *Summary of biostratigraphy in Hole 55.0 Core 10.*

LEG 6 HOLE 55.0

CORE 11 DEPTH 91.4-100.6 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
This core includes sediments of the upper part of the *Globigerinita dissimilis* Zone (lower Lower Miocene) and the lower part of the *Globigerinatella insueta* Zone (upper Lower Miocene). The *Globigerinita dissimilis* Zone (sections 6 - 4) is characterized by *G. dissimilis, G. stainforthi, Globigerina venezuelana, G. pseudoedita, G. bradyi, Globoquadrina praedehiscens, G. altispira globosa,* rare *Globigerinoides trilobus.* For the *Globigerinatella insueta* Zone (sections 3 - 1) are typical *Globoquadrina dehiscens, G. altispira, G. quadraria, G. langhiana, Globigerina falconensis, G. foliata,* numerous *Globigerinoides trilobus, G. subquadratus.*	This core is transitional upper lower to lower lower Miocene with *Sphenolithus heteromorphus* restricted to the upper part of the core and *Discoaster* sp. cf. *D. druggii* and *Orthorhabdus serratus* occurring in most samples through the lower four sections of the core. Other species occurring include *cyclococcolithina neogammation, Discoaster deflandrei, D. perplexus, Helicopontosphaera parallela, Sphenolithus* sp. aff. *S. belemnos,* and *S. moriformis.* The assemblages of the lower part of the core are assigned to the *Discoaster druggii* Subzone of the *Triquetrorhabdulus carinatus* Zone.	Radiolarian species in this core represent the lower lower Miocene *Calocycletta virginis.* The boundary between this zone and the upper lower Miocene *C. costata* Zone presumably occurs near the top of this core. TOP: *Stichocorys wolffii, Calocycletta virginis, Cyrtocapsella cornuta, Dorcadospyris simplex, D. dentata, Dannartus tubarius, C. violina, C. prismaticus,* and *C. mammiferus.* BOTTOM: *Stichocorys wolffii, Calocycletta virginis, Cyrtocapsella cornuta, D. japonica, Dorcadospyris simplex, Cannartus tubarius,* and *C. prismaticus.*

Figure 44. ***Summary of biostratigraphy in Hole 55.0 Core 11.***

LEG 6 **HOLE** 55.0

CORE 12 **DEPTH** 103.3-112.5 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Foraminifera of the core catcher and Section 6 indicate the *Globorotalia kugleri* Zone of lower Lower Miocene (or upper Upper Oligocene in Bolli's zonal scale, 1957) - *Globorotalia kugleri, G. siakensis, Globigerina bradys, G. juvenilis, G. woodi, G. angustiumbilicata* and rare *Globigerinoides trilobus primordius, Globigena venezuelana.* all other sections contain microfauna of the *Globigerinita dissimilis* Zone (Lower Miocene) - *G. dissimilis, G. stainforthi, Globigerinoides trilobus trilobus, Globoquadrina praedehiscens, Globigerina venezuelana, G. bradyi, Globorotalia minutissima.*	Assemblages in this core lack *Discoaster druggii* and *Orthorhabdus serratus* and are transitional between the more distinctive assemblages of the upper and lower *Triquetrorhabdulus carinatus* Zone. Species present include *cyclococcolithina neogammation, Discoaster deflandrei, D. perplexus, Sphenolithus* sp. aff. *S. belemnos, S. moriformis,* and *Triquetrorhabdulus carinatus.*	The boundary between the lower Miocene *Calocycletta virginis* Zone and the approximately upper *Oligocene Lychnocanium bipes* Zone occurs near the bottom of this core. TOP: *Calocycletta virginis, Cyrtocapsella cornuta, C. tetrapera, Cannartus prismaticus, Lychnocanium bipes, Dorcadospyris ateuchus, Cannartus tubarius,* and *Cyrtocapsella japonica.* BOTTOM: *Lychnocanium bipes, Dorcadospyris ateuchus, Cannartus prismaticus, C. tubarius, Cyrtocapsella cornuta, C. tetrapera,* and *C. japonica.*

Figure 45. *Summary of biostratigraphy in Hole 55.0 Core 12.*

LEG 6 HOLE 55.0

CORE 13 DEPTH 112.5-121.6 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
This core contains assemblages of planktonic Foraminifera typical for the *Globorotalia kugleri* Zone of lower Lower Miocene (or upper Upper Oligocene in Bolli's zonal scale, 1957) - abundant *Globorotalia kugleri*, *Globigerina juvenilis*, *G. bradyi*, *G. angustiumbilicata* in association with *Cassigerinella chipolensis*, *Globorotalia siakensis*, *G. brevispira*, *G. pseudokugleri*, *Globigerina woodi*, *G. venezuelana*, *G. tripartita*, *Globoquadrina praedehiscens*.	Upper upper Oligocene assemblages of the lower *Triquetrorhabdulus carinatus* Zone are present throughout the core. Species present include *Coccolithus* sp. aff. *C. bisectus*, *Cyclococcolithina neogammation*, *Discoaster deflandrei*, *Helicopontosphaera obliqua*, *H. parallela*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, *S.* sp. [undescribed], and *Triquetrorhabdulus carinatus*.	This core contains a Radiolarian assemblage of the approximately upper Oligocene *Lychnocanium bipes* Zone. TOP: *Lychnocanium bipes*, *Dorcadospyris ateuchus*, *Cyrtocapsella cornuta*, and *Cannartus prismaticus*. BOTTOM: *Lychnocanium bipes*, *Dorcadospyris ateuchus*, *Cannartus tubarius*, *C. prismaticus*, *Cyrtocapsella cornuta*, *C. tetrapera*, and *C. japonica*.

Figure 46. *Summary of biostratigraphy in Hole 55.0 Core 13.*

LEG 6 HOLE 55.0

CORE 14 DEPTH 121.6-130.8 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
Throughout the core assemblages of planktonic foraminifers consist of abundant *Globorotalia kugleri*, *Globigerina bradyi*, *G. juvenilis*, *Cassigerinella chipolensis*, less numerous *Globigerina angustiumbilicata*, *G. tripartita*, *G. praebulloides* and rare *Globigerina venezuelana*, *G. woodi*, *Globigerinita dissimilis*, *Globoquadrina praedehiscens*, *Globorotalia siakensis* - the *Globorotalia kugleri* Zone of lower Lower Miocene (or upper Upper Oligocene in Bolli's zonal scale, 1957).	Upper upper Oligocene assemblages of the lower *Triquetrorhabdulus carinatus* Zone are present throughout the core. Species present include *Coccp;otjis* sp. aff. *C. bisectus*, *Cyclococcolithina neogammation*, *Discoaster deflandrei*, *Helicopontosphaera parallela*, *Sphenolithus* sp. aff. *S. belemnos*, *S. moriformis*, and *Triquetrorhabdulus carinatus*.	This core contains Radiolaria of the approximately upper Oligocene *Lychnocanium bipes* Zone. TOP: *Dorcadospyris ateuchus*, *Cannartus prismaticus*, *Cyrtocapsella cornuta*, and *Lychnocanium bipes*. BOTTOM: *Dorcadospyris ateuchus*, *Cannartus prismaticus*, *Cyrtocapsella cornuta*, *C. tetrapera*, and *Lychnocanium bipes*.

Figure 47. *Summary of biostratigraphy in Hole 55.0 Core 14.*

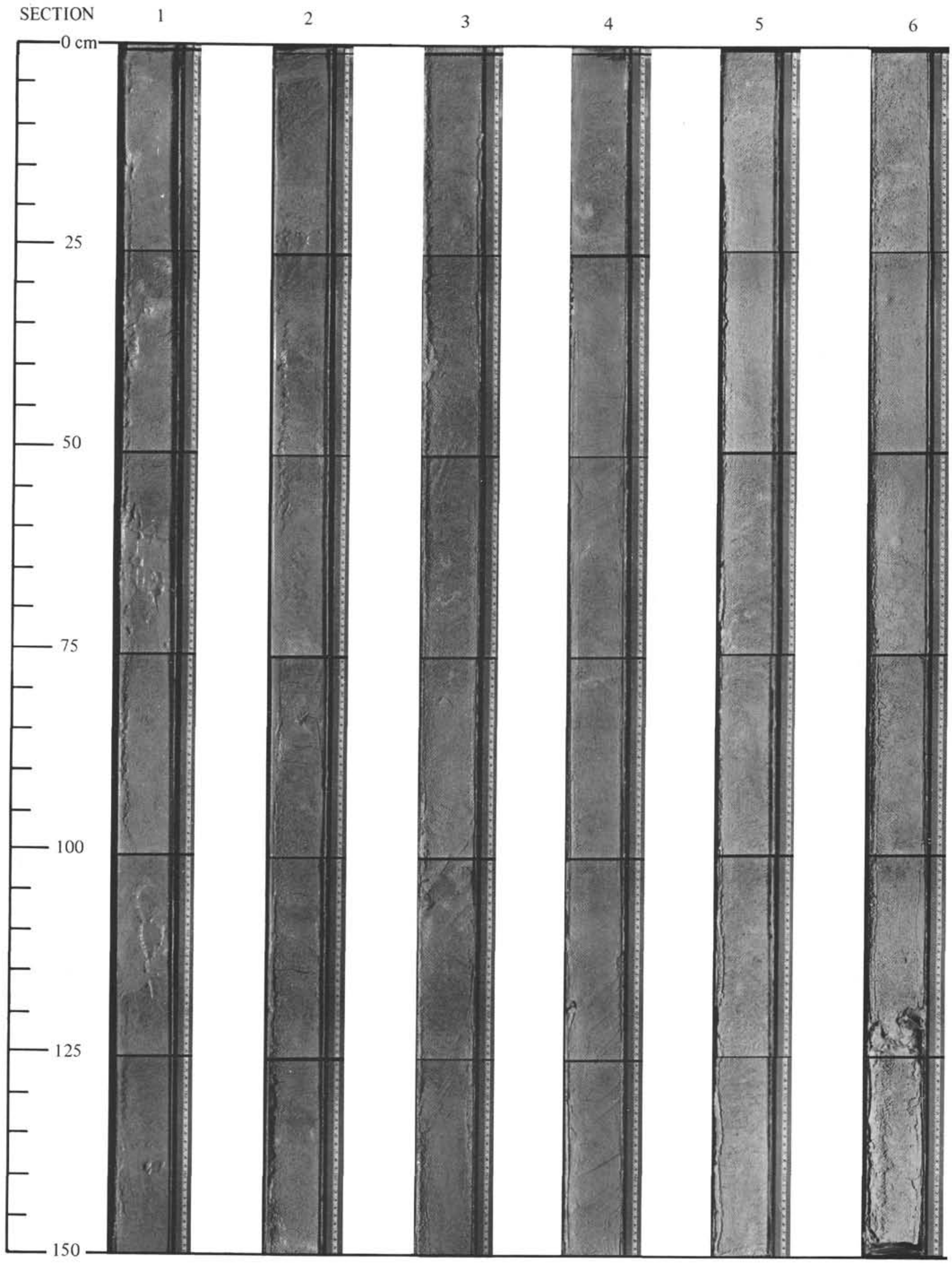


Plate 1. *Photographs of Hole 55.0 Core 1.*

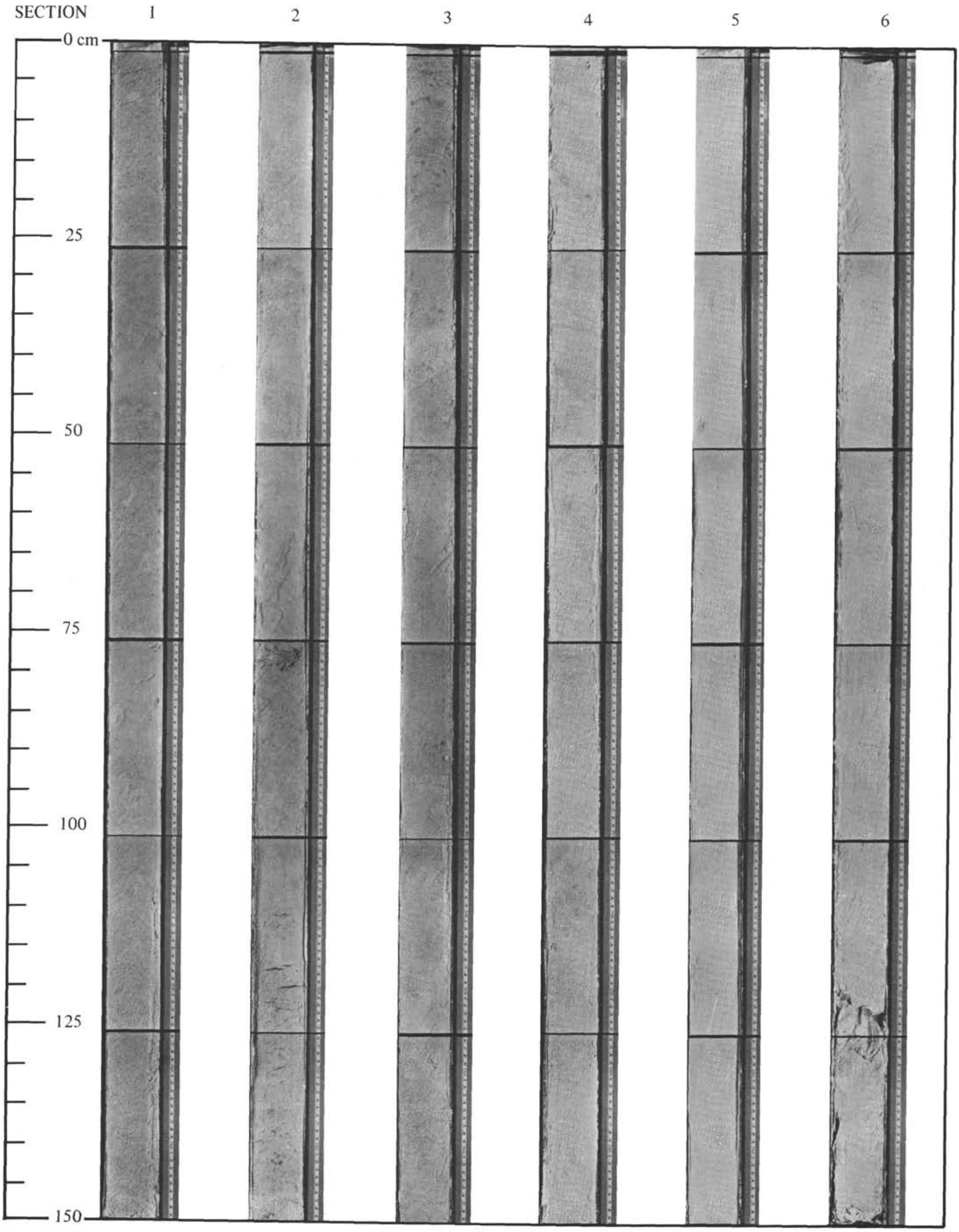


Plate 2. *Photographs of Hole 55.0 Core 2.*

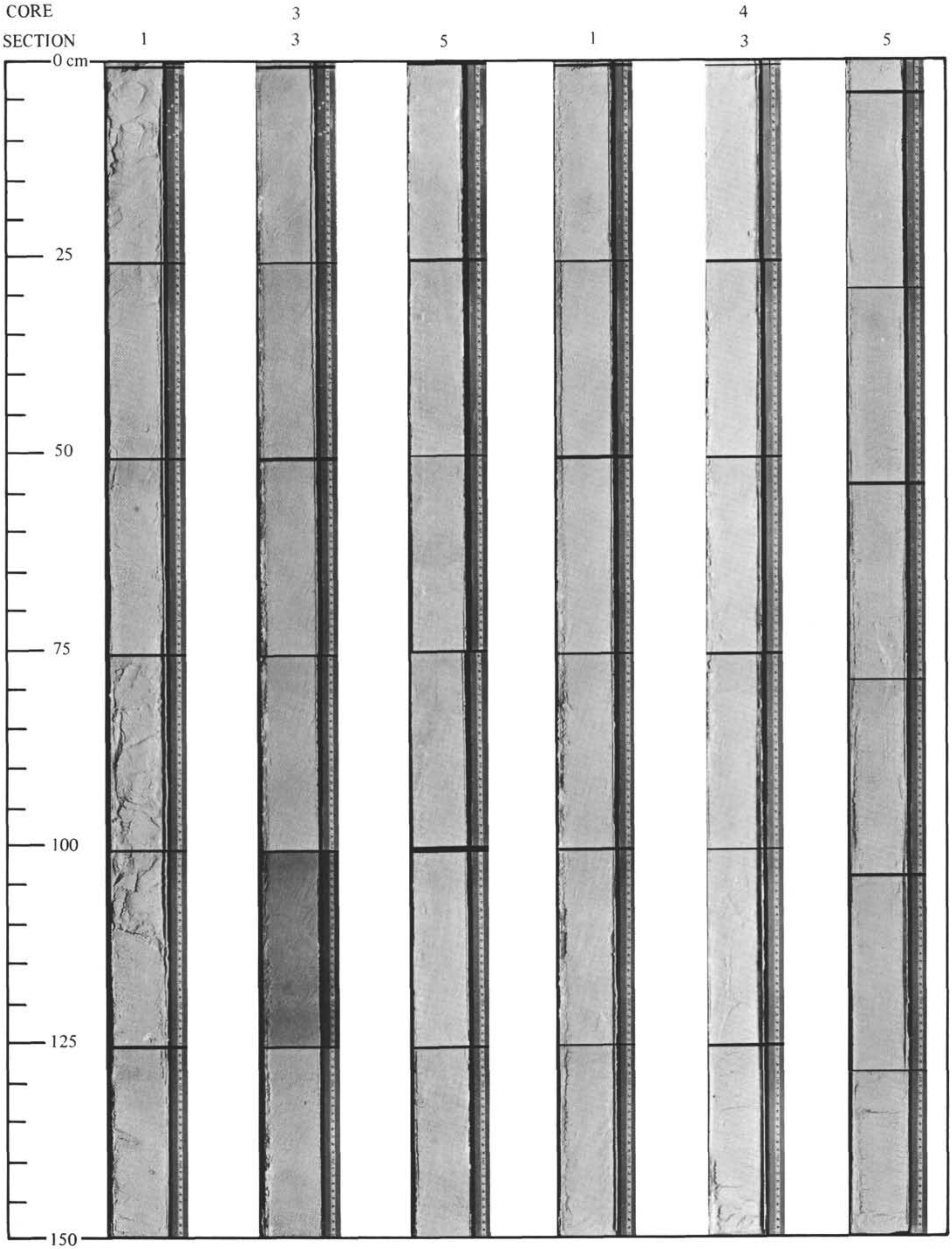


Plate 3. *Photographs of Hole 55.0 Cores 3 and 4.*

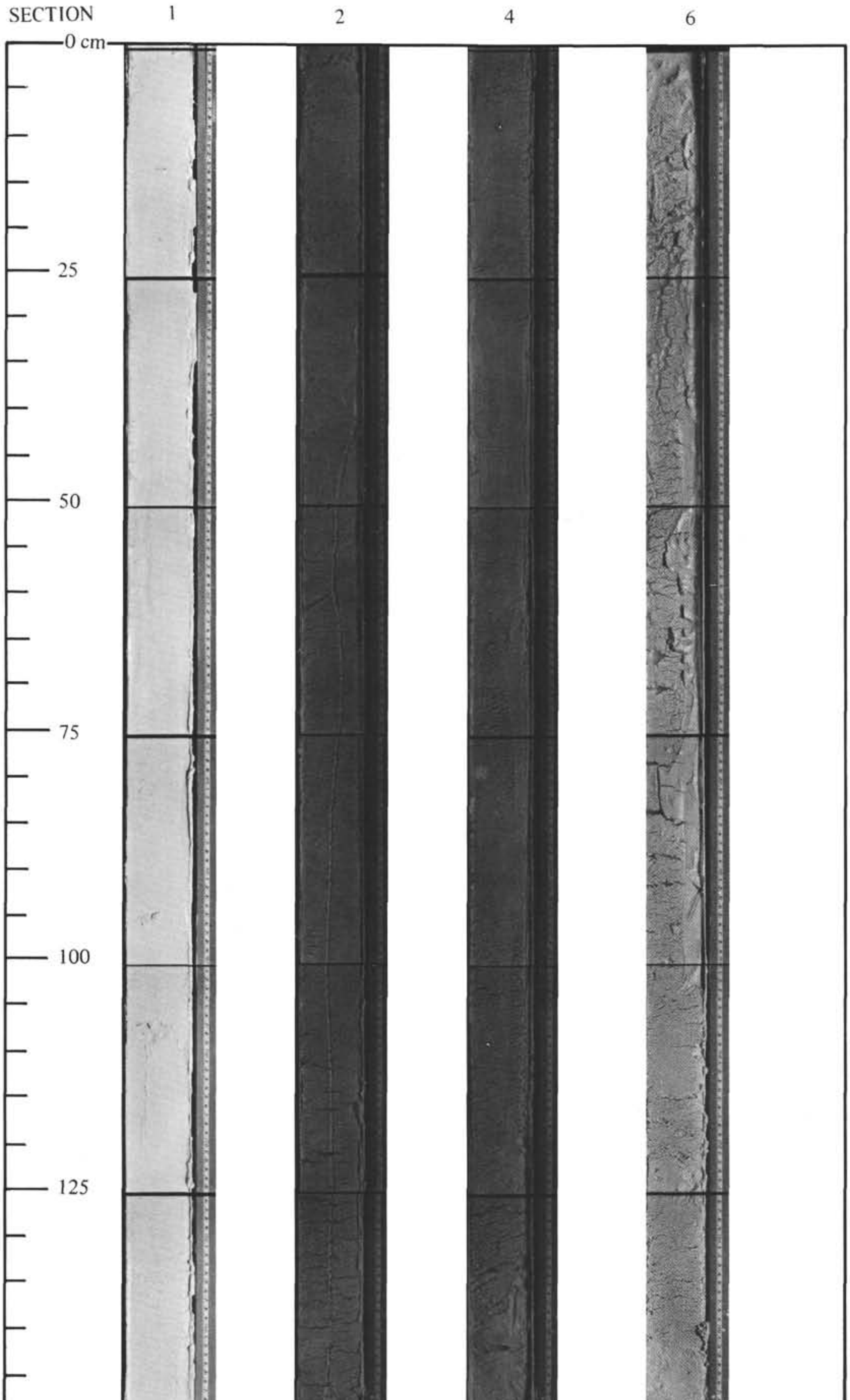


Plate 4. *Photographs of Hole 55.0 Core 5.*

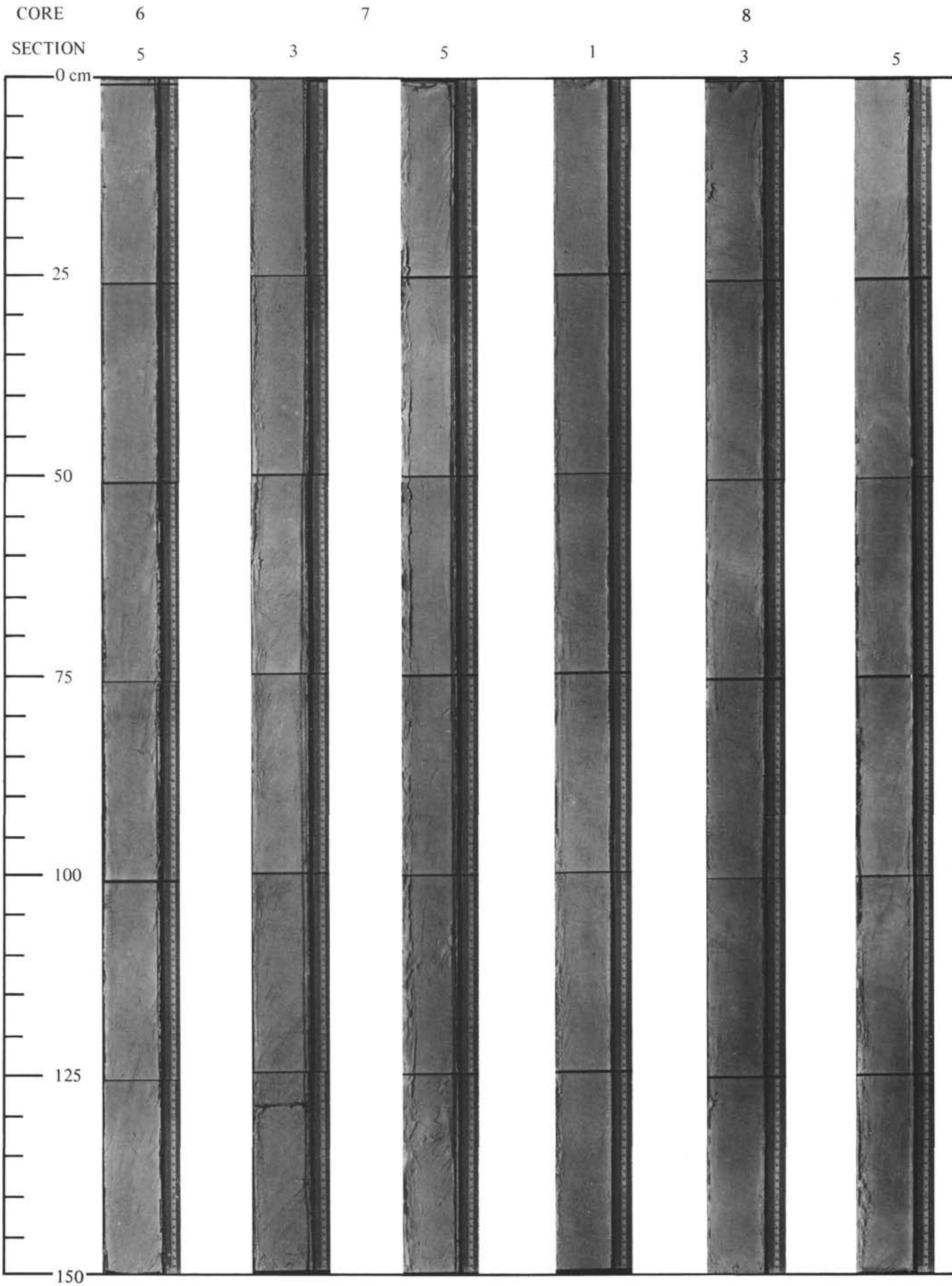


Plate 5. *Photographs of Hole 55.0 Cores 6, 7 and 8.*

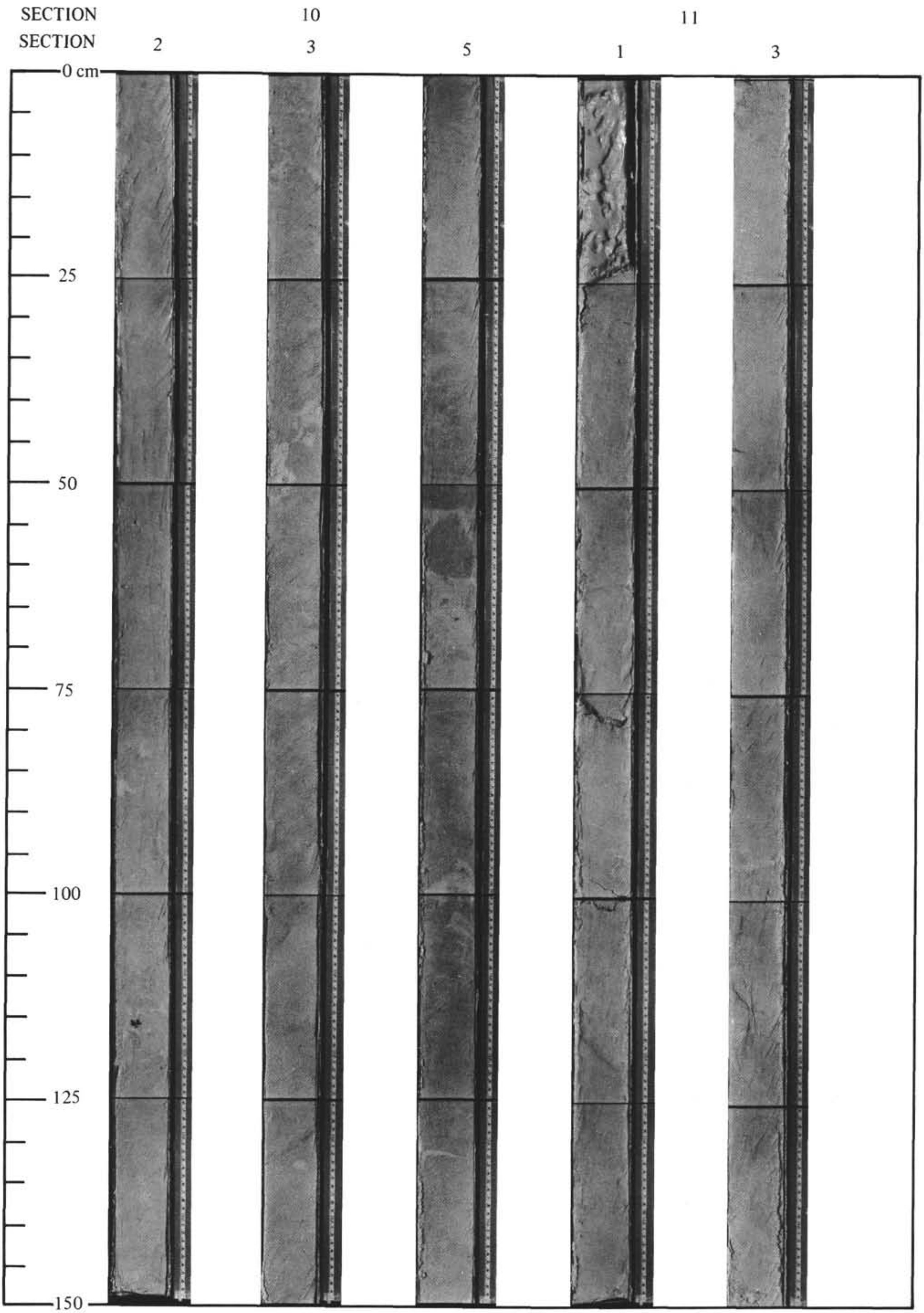


Plate 6. *Photographs of Hole 55.0 Cores 10 and 11.*

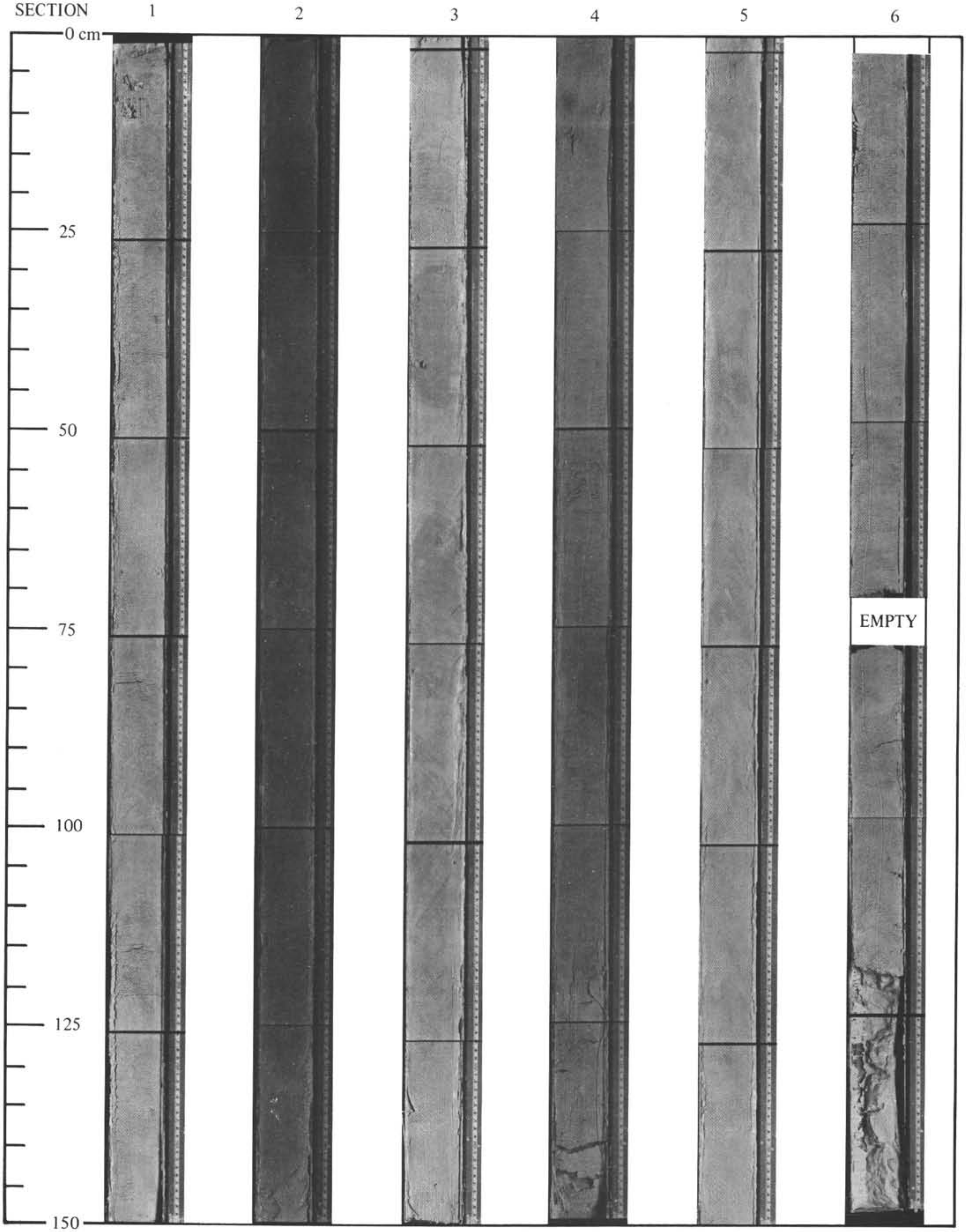


Plate 7. *Photographs of Hole 55.0 Core 12.*

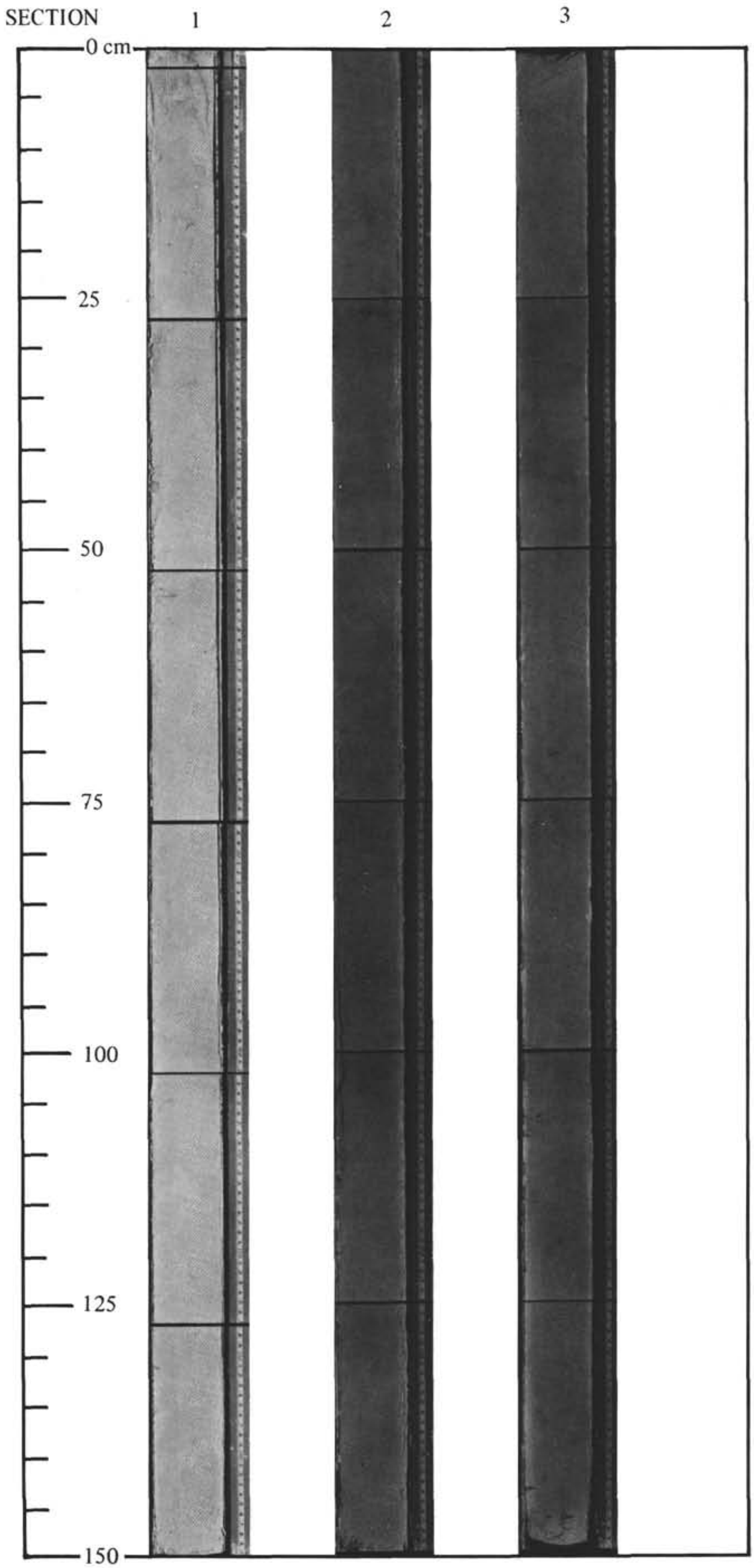


Plate 8. *Photographs of Hole 55.0 Core 13.*