5. SITE 317

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 30 November 1973 (1229Z)

Date Departed: 8 December 1973 (0327Z)

Time on Site: 182 hours, 58 minutes

Position:
Latitude: 11°00.09'S
Longitude: 162°15.78'W

Water Depth (sea level): 2598.0 corrected meters, echo sounding

Water Depth (rig floor): 2613.8 corrected meters, echo sounding

Bottom Felt at:
Hole 317: 2625.0 meters, drill pipe
Holes 317A and 317B: 2622.0 meters, drill pipe

Penetration: 943.5 meters

Number of Holes: 3

Number of Cores:
Hole 317: 3
Hole 317A: 34
Hole 317B: 45

Total Length of Cored Section:
Hole 317: 28.5 meters
Hole 317A: 313.5 meters
Hole 317B: 424.5 meters

Total Core Recovered:
Hole 317: 19.2 meters
Hole 317A: 163.3 meters
Hole 317B: 308.0 meters

Percentage Core Recovery:
Hole 317: 67.4%
Hole 317A: 52.1%
Hole 317B: 72.6%

Oldest Sediment Cored:
Depth below sea floor: 910.0 meters
Nature: Green and red volcanogenic siltstone and mudstone
Age: Older than Aptian-Barremian(?)
Measured velocity: 2.0-2.4 km/sec

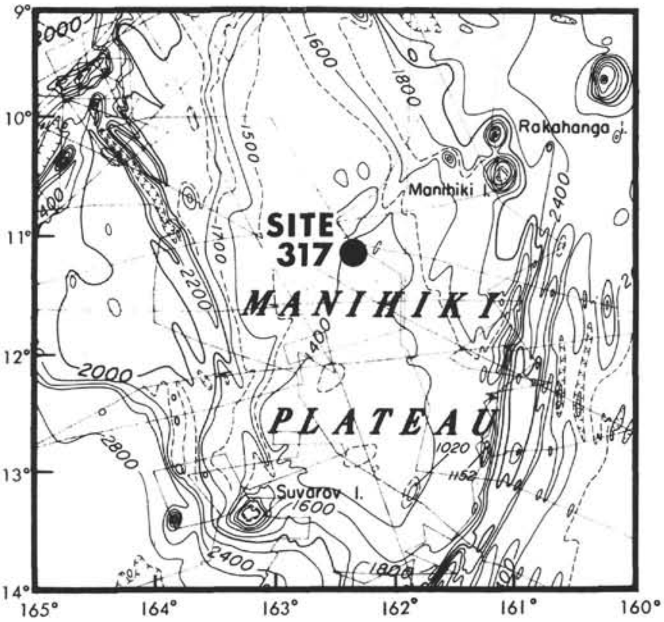

Figure 1. *Location of Site 317 on the Manihiki Plateau, plotted on a portion of the bathymetric chart of the South Pacific of Mammerickx et al. (1973).*

Basement:
Depth subbottom: 910.0 meters
Nature: Basalt
Velocity: 4.0-5.7 km/sec

Principal Results: The objective at this site was to core continuously the section in the central part of the Manihiki Plateau, approximately 80 miles southwest of Manihiki Island, where the precruise seismic profiles indicated a minimum of 800 meters of section. To avoid the time-consuming process of re-entry, we adopted a strategy of (1) washing down rapidly and spot coring sparingly to the harder Mesozoic section to minimize bit wear; (2) coring continuously to basement; and (3) tripping out and continuously coring the upper, softer section. The first hole, the attempted wash-down to Mesozoic rocks, was aborted on 30 November when a 6-in. bolt fell into the drill string and could not be retrieved. Hole 317A was spudded on 1 December and the thick Mesozoic section was successfully cored. Basaltic basement was reached and recovered. Hole 317B was spudded on 5 December, and successfully cored Pleistocene through Eocene rocks until 7 December, when the core barrel was again jammed by a metal and rubber part of the flow line valve. The section at Site 317, as reconstructed from all holes at this site, consists of 424.5 meters of late Pleistocene to early Eocene nannofossil and foraminiferal oozes, chalks, and cherts, continuously cored. The uncored gap of 129.5 meters, caused by foreign material above the core barrel latch, is probably occupied by strata of Paleocene age. From 554.0 to approximately 910 meters, the section consists of very early Tertiary or very Late Cretaceous sediments through Aptian-Bar-

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remian(?) chalk, chert, limestone, and siltstone to a depth of 677.5 meters, and a still older, thick, partially mollusk-bearing section of green and red volcanogenic mudstone, siltstone, and reworked breccia that extends to the basalt contact at about 910 meters. We then drilled 33.5 meters of basalt to a terminal depth of 943.5 meters, recovering 24.9 meters of basaltic rocks. In this interval, parts of 10 basalt flow units occur, four of which are separated by thin beds of red and green volcanogenic siltstone, indicating a history of partially overlapping volcanic flows and volcanogenic debris accumulation. Two flow units appear to contain more than one pyroxene and at least one contains feldspar phenocrysts, indicating that the flows are probably oceanic tholeiites. They are, however, uncommonly vesicular, and contain vesicle tubes up to 1 cm wide and 5 cm long. A simplified geological history of the Manihiki section as drilled can be summarized as follows:

1) Eruption of tholeiitic oceanic basalts in thin flow units, probably in unusually shallow water.

2) Possible isostatic uplift of the plateau following eruption of the major part of the volcanic masses.

3) Eruption of volcanic edifices that shed ash or erosional debris, or both over the area, partially overlapping the basalts in age, and extending into Aptian-Barremian(?) time; during this period the volcanogenic debris shows evidence of downslope movement and contains mollusks of types that may be indicative of moderate water depths.

4) Subsidence of the Manihiki Plateau, perhaps accompanied by erosion.

5) Deposition of a moderately thick section of pelagic sediments at a relatively modest rate, but in steady sequence, over the last 60 m.y.

Of the six reflectors identified on the acoustic profiles and sonobuoy records, the upper four at 0.070, 0.170, 0.225, and 0.395 sec are correlative with the "b," "c," "d," and "e" reflectors of Schlanger and Douglas (1974); the lower two at 0.600 and 0.870 sec are identified as the Santonian-Turonian boundary and the top of the basalt, respectively.

BACKGROUND AND OBJECTIVES

The objectives of Site 317 (Figure 1) were: (1) to determine the geological history of this major physiographic feature; (2) to compare the lithofacies developed here with time-correlative lithofacies developed on the Shatsky and Magellan rises to the north, and Ontong-Java Plateau to the west; and (3) to drill and core as deeply as time would permit into basement.

During precruise planning we felt that the objectives of the site could only be met through a program of continuous coring of a section, which, based on CATO-3 airgun profiles (Figure 2), showed an acoustic thickness of about 0.85 sec above basement. The proposed site was chosen to core an especially thick intrastratal lens-shaped basin on the CATO-3 track. Using reasonable velocities we estimated the depth to basement as 900 meters below a water depth of 2560 meters, and allocated 9 days of Leg 33 to this site. In the revised schedule, even though the leg had been shortened, we protected this time due to the priority of the site.

On approach, we reoccupied the CATO-3 profile at about 2315 hr (local) on 29 November (Figure 3), passed over planned site, and occupied it at 0229 hr (local) 30 November. Our own airgun records at the site (Figure 4) showed a depth to acoustic basement of 0.87 sec.

On drilling the section, we encountered basalt at approximately 910 meters, and, ultimately cored 766.5 meters of a total penetration depth of 943.5 meters. We thus were able to complete about 80% of objectives 1 and 2 above and to successfully complete objective 3. The major objectives of the site were completed when drilling was abruptly terminated due to operational difficulties at about 0600 hr (local) 7 December, and we departed at about 1730 hr (local) the same day, having spent about 7.6 days on site.

OPERATIONS

Predrilling Site Surveys

Although a number of stratigraphically interesting sites had been surveyed on the Manihiki Plateau (Figure 3) by the HIG (*Mahi*, May 1970) and the SIO-CATO-3 (*Melville*, Aug-Sept 1972) expeditions, the most attractive lay on the CATO-3 track at 1435Z, 4 September 1972 (Figures 2, 3) and it was decided to drill at that point. Accordingly, an intersection with the CATO-3 line was made at 2314 hr (local) 29 November 1973 (0914Z 30 November 1973, see Figure 3) and a course change to 143° was made to parallel the CATO-3 line. The similarity in seismic profiles (Figure 2d) indicated that *Glomar Challenger* was probably directly on the CATO-3 track. As the "white eye" of the downward convex lens of sediment between an upper flat-lying section and a deeper undulatory section appeared (Figures 2, 4), we decided to drill where the deepest reflection seen on the acoustic record bottomed out flat. We passed the site, proceeded on a course of 143°-144° for approximately 2.5 miles, turned to a nearly reciprocal course, ran back to the site and dropped the beacon at 1229Z on 30 November 1973. The average satellite navigation location of Site 317 is 11°00.09'S, 162°15.78'W. Reflectors seen in the *Glomar Challenger* records are at 0.07 (0.08 may be a doublet of the one at 0.07), 0.17, 0.22-0.23, 0.39, 0.40, 0.59, and 0.87 sec. The CATO-3 reflectors seen were at 0.17, 0.23, 0.40, 0.58, and 0.85 sec.

Sonobuoy Survey

A sonobuoy was launched as soon as practicable, at about 1300 hr (local) 30 November, and about 3 hr of records were obtained, but the drift rate was too slow to obtain useful data. A second sonobuoy was launched on departure from the site (see section on Departure). Interval velocities for the second sonobuoy were estimated using the inverse slope ratio method and are discussed in detail below.

The PDR depth of 1393 fathoms at Site 317 was corrected to 2598 meters (Matthew's Tables, Area 41), giving a derrick floor to mudline depth of 2613.8 meters. The drill pipe depth to bottom was 2625 meters for Hole 317, and 2622 meters for Holes 317A and 317B.

Drilling Program

Because of the thick section expected at Site 317, the desirability of continuous coring and the hope of recovery of a representative section of basalt at its base, use of re-entry capability was considered several days prior to our arrival at the site. Although the *Glomar*

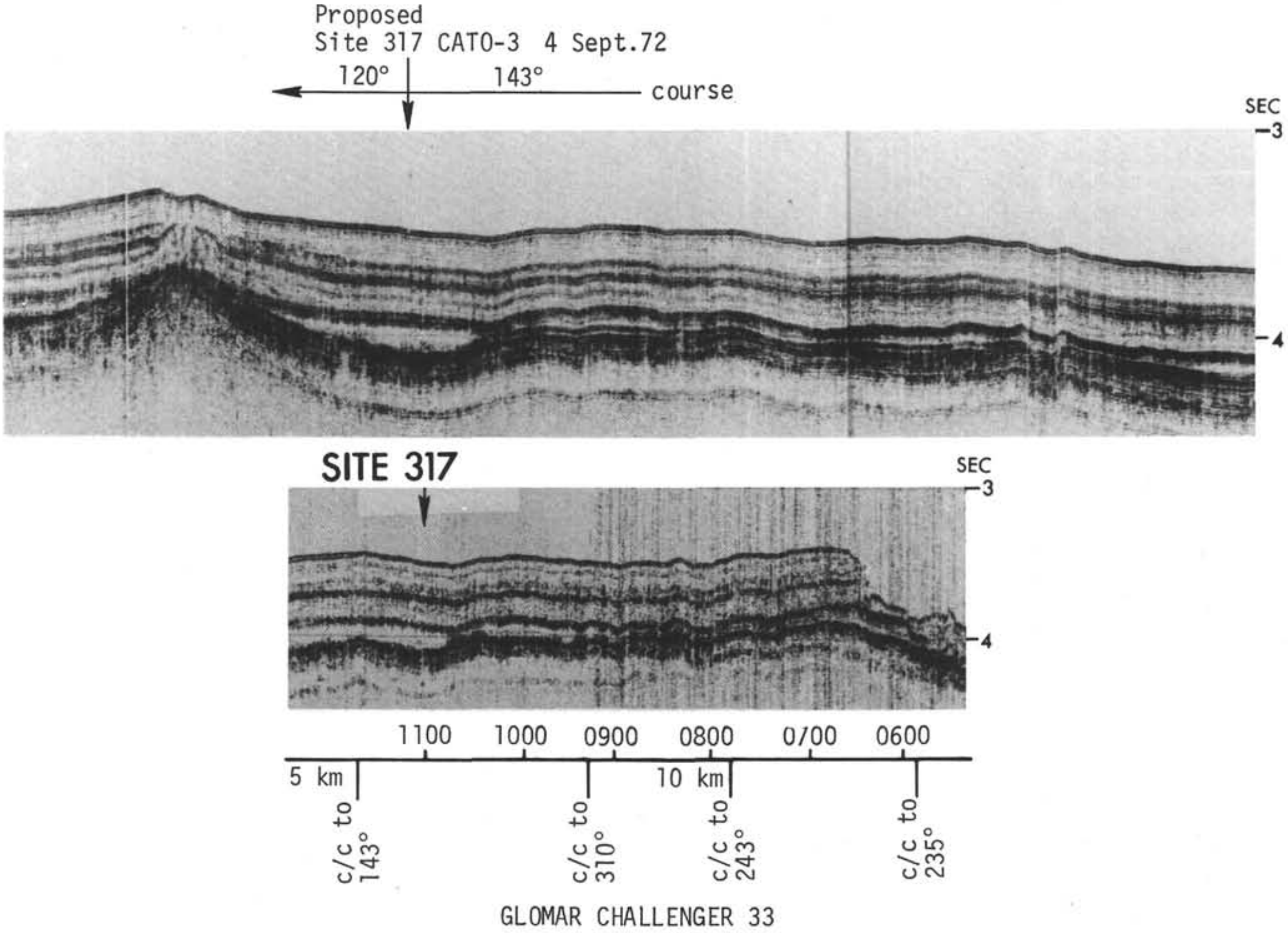

Figure 2. *Scripps Institute of Oceanography CATO-3 and* Glomar Challenger *Leg 33 seismic reflection profiles across Site 317.*

Challenger's Captain and Drilling Superintendent stressed the vessel's capability for re-entry, its difficulty, general awkwardness, and time-consuming features were at least equally stressed. After perusing records of past use of the re-entry device, we decided upon an alternate plan to ensure basement recovery: (1) to wash down through the soft oozes and chalks to presumably unwashable Mesozoic rocks as rapidly as possible to minimize bit wear; (2) to continuously core through the Mesozoic section and into basement; (3) to trip out, respud with a new bit, if that seemed necessary; and (4) to continuously core the upper, presumably Tertiary, section. Table 1 summarizes the results of the subsequent drilling.

Beacon drop was made at 1229Z on 30 November, and the string was lowered almost immediately. Hole 317 was spudded in at 1340 the same day in a drill-pipe water depth of 2625 meters, and a surface punch core was taken at 1350 (local), a spot core was taken in the interval 180.5-190.0 at 1727 (local), and a third spot core was attempted in the interval 342.0-351.5 meters. At 2000 (local) a 6-in. bolt from the pipe stabber was inadvertently dropped down the drill string, and attempts to latch the core barrel with the overshot device failed. Several attempts were made to retrieve the barrel, including the use of a mule shoe fishing device, but, at 2315 hr (local), it was decided to pull the entire string. The core barrel was finally recovered at 0430 hr (local) 1 December, the bolt removed, and the string was again lowered.

Hole 317A was spudded in at 1100 hr (local) 1 December in a drill pipe water depth of 2622 meters. We immediately washed down, taking one spot core in the interval 402-411.5 meters to remove a chert knob blocking the core catcher, and reached our coring depth at about 1500 (local). During this period, at about 1300 hr (local) we were alerted by the bridge of loss of position over the beacon, and withdrew two lengths of pipe before this was attributed to a computer positioning failure. The ship was then held in manual control and we were allowed to continue washing. At 1909 hr (local) we pulled our first core in the interval 554.0-563.5 meters, and continuously cored to a subbottom depth of 706.0 meters. At this point, we found ourselves in a monotonous section of very poorly fossiliferous volcanogenic sediments of unknown thickness, and, in the interest of time, alternately washed and cored to a depth of 905.5 meters. From this depth, we cored continuously, intersecting the first basalt flow at about 910 meters, and continuously cored to a depth of 943.5

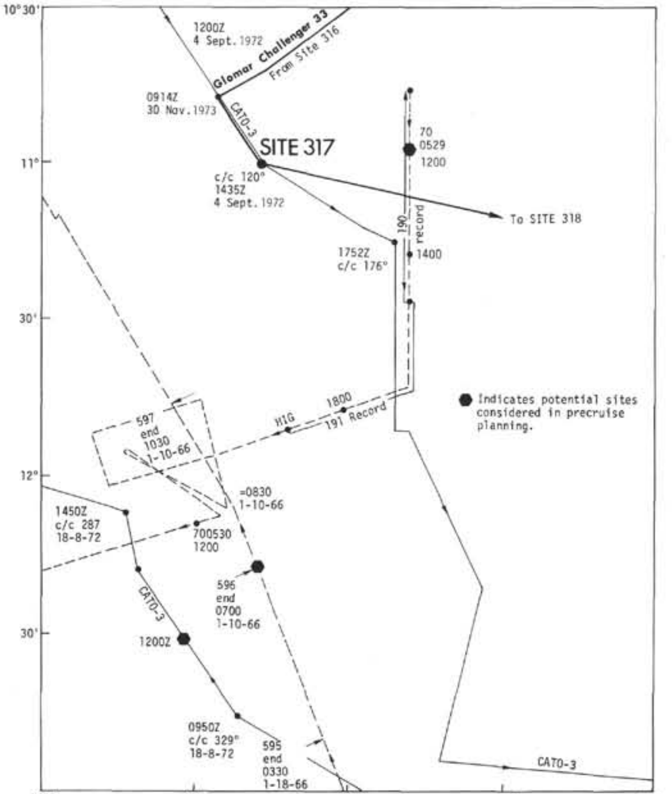

Figure 3. *Location of Site 317 and tracks of relevant surveys.*

meters, principally in basalt. At this time we felt the objectives of the hole had been completed. We retrieved the last core at 1240 hr (local) 4 December, and tripped out.

The bottom-hole assembly was magnafluxed, a special three-bumper sub assembly for use with the heave compensator was assembled, a new bit was installed, and the string was again lowered. Hole 317B was spudded in, again at a pipe depth of 2622 meters, at 0605 hr (local) on 5 December. The hole was offset 30.5 meters north and 52 meters east of Holes 317 and 317A. Continuous coring then proceeded to a subbottom depth of 424.5 meters, which was reached about 0500 hr (local) on 7 December. At that time difficulty was again encountered in retrieving the core barrel. Three retrieval trials were made, and three Otis pins were sheared. At 0930 hr a magnet was lowered in an attempt to retrieve metallic debris in the string. This also failed, and, at 1100 hr (local) the decision was made to pull out of the hole. At 1620 hr (local) the core barrel was retrieved on deck, and a piece of metal and rubber mud flow line valve, apparently introduced during pumping, was found to have jammed the core barrel latch. This jamming caused a recovery gap at Site 317 of approximately 130 meters in the section between Eocene and lowermost Tertiary or uppermost Cretaceous rocks.

In view of time considerations, and because the Eocene chert section with its attendant drilling problems would have to be crossed yet a third time in washing down to the uncored gap, it was decided to terminate drilling at this site.

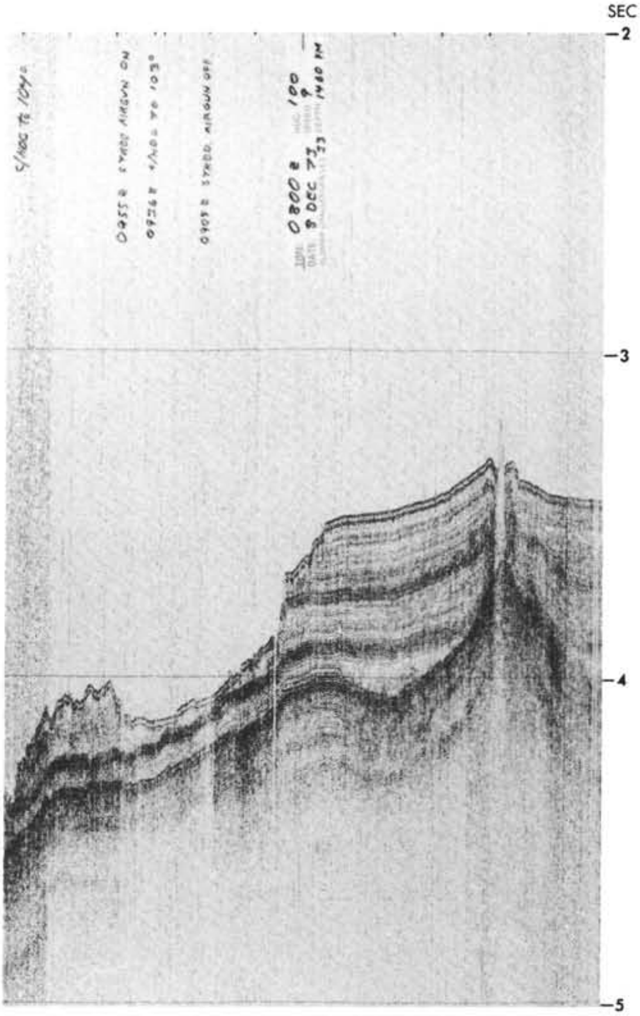

Figure 4a. Glomar Challenger *seismic reflection profile departing from Site 317 (see Figure 3 for lines of profiles).*

In our opinion, the drilling strategy worked very well, and might well be considered as an option to re-entry at similar sites elsewhere. The drilling rate in basalt was 5.4 m/hr, which we tend to attribute to encountering it with a sharp bit. Examination of bits from Hole 317A and 317B after recovery showed them to be in comparable condition—worn but still serviceable.

Heave Compensator

The heave compensator was again pronounced ready for action prior to our arrival at Site 317, and it was planned to (a) install the unit during the washing portion of the long hole to basement, removing the unit when continuous coring of harder deeper rocks began; and (b) use the unit in drilling and coring the second planned hole through the softer Tertiary section.

Accordingly, the heave compensator was installed just prior to spudding in Hole 317, followed the drill down until the pipe stabber bolt terminated the drilling, and was used during coring of the first and third intervals. It became immediately apparent that the apparatus causes delays during washing operations; indeed, it was, to our

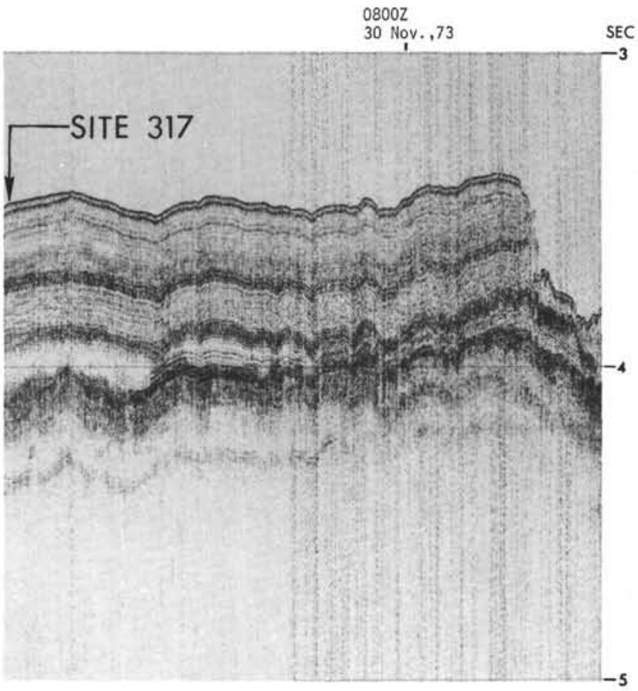

Figure 4b. Glomar Challenger *seismic reflection profile approaching Site 317 (see Figure 3 for lines of profile).*

knowledge, never intended for that purpose. First, it requires at least an hour to install and another hour to remove. Second, it occupies space in the line between the power sub and the traveling block, so that only one pipe section at a time, rather than two, can be inserted for wash intervals. Third, it increases drilling time and driller concentration, especially since it must be locked out between each pipe section added.

After withdrawal of the string from Hole 317, we asked, and received permission from the Cruise Operations Manager, to wash and drill Hole 317A without the heave compensator in place. For comparison, in Hole 317 the string was 11 meters off PDR bottom at 0905 hr (local) 30 November and reached a subbottom depth of 351.5 meters at 1800 hr (local), an elapsed time of nearly 9 hr. In Hole 317A, the same interval was washed in less than 3 hr, not counting the ultimate removal of the heave compensator or the delay caused in the second hole by the positioning computer failure.

In Hole 317B, the heave compensator was on line during the entire coring process until drilling was terminated by the blockage caused by pump debris. The first four cores were drilled successfully with the compensator, but Cores 5-8 were cut with the unit locked out because of an accumulator failure. Cores 9-45 were again cut with the heave compensator operating. Certain operational problems were easy to identify and may ultimately be remedied: (1) According to our present information, the compensator must be removed from the drill line if pitch exceeds 3°, because of excessive sway; this operation consumes an hour at minimum. (2) With the compensator installed, the man cage can neither reach the top of the compensator nor the ordinary rig level, which causes delays in core barrel retrieval. (3) The overshot must be hand fed through both the compensator and the power sub, at two levels in the derrick; in a high wind this becomes a difficult operation and further slows core barrel recovery. (4) Drillers experience difficulty in feeling bottom with the apparatus in operation. The drill pipe length to bottom in Hole 317 is probably in error on this account, and an attempt to core 6.5 meters in Hole 317B, Core 1, led to a recovery of 9.1 meters.

The compensator was in nearly continuous use during the coring of Hole 317B, however, and a coherent stratigraphic and paleontologic record was obtained. Because of the nature of the material cored, geological performance is difficult to evaluate at this time. Core recovery was very good (see Table 1), but the section drilled consisted principally of soft oozes that commonly give good recovery. It achieved no better recovery than the conventional method in the interbedded Eocene chert-chalk section.

In the monotonous ooze sections above the Eocene, we had little opportunity to evaluate the relative disturbance of sedimentary structures and stratigraphy. The little information we do have suggests the compensator does not eliminate the problem of inadvertently recoring soft units; for example, the punch core (Core 1, Hole 317B) was homogenized. The general opinion of several sedimentologists and paleontologists, after working with cores from this hole, is that core materials taken with the compensator were at least as disturbed as those taken by conventional methods. The reason for this is not clear; it is clear that further testing, both practical and instrumental, is necessary to adequately evaluate the performance of the unit.

Departure

Glomar Challenger departed Site 317 at 1730 hr (local) 7 December (0327Z 8 December), steamed on a course of 270° for about 2 n. mi., made a turn to starboard, dropped sonobuoy number two at 1807 hr (local), passed over the beacon, and proceeded toward Site 318 on a course of 104°.

LITHOLOGIC SUMMARY

Sedimentary Rocks

The following account is based on a study of a composite section comprising Holes 317, 317A, and 317B. The lithological units recognized are (Figure 5):

Unit 1 (0-303.5 m): This unit comprises grayish-orange, white, and bluish-white nannofossil-foraminifer and foraminifer-nannofossil ooze, firm ooze, and chalk. Chert is absent.

Unit 2 (303.5-647.0 m): This unit is characterized by various shades of gray and orange foraminifer-nannofossil and nannofossil ooze to chalk, and by the presence of reddish-brown and black vitreous cherts. Bivalves are common near the base of this unit. This unit is separated from Unit 1 at a level directly above the youngest chert.

Unit 3 (647.0-910.0 m): Greenish-black volcaniclastic sandstone and siltstone characterize this unit. Bivalves are also present in the upper part of Unit 3. The

TABLE 1
Coring Summary, Site 317

Core	Date (1973)	Time (local)	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovered (%)
Hole 317[a]							
1	30 Nov	1350	2625.0-2634.5	0-9.5	9.5	9.5	100
2	30 Nov	1727	2805.5-2815.0	180.5-190.0	9.5	9.2	94
3	1 Dec	0430	2967.0-2976.5	342.0-351.5	9.5	0.5	5
Total					28.5	19.2	67.4
Total Depth 351.5 m							
Hole 317A[b]							
1	1 Dec	1610	3024.0-3033.5	402.0-411.5	9.5	1.0	11
2	1 Dec	1909	3176.0-3185.5	554.0-563.5	9.5	1.5	16
3	1 Dec	2005	3185.5-3195.0	563.5-573.0	9.5	5.3	56
4	1 Dec	2145	3195.0-3198.0	573.0-576.0	3.0	CC	<1
5	1 Dec	2255	3198.0-3204.5	576.0-582.5	6.5	0.5	8
6	2 Dec	0010	3204.5-3214.0	582.5-592.0	9.5	1.6	17
7	2 Dec	0125	3214.0-3223.5	592.0-601.5	9.5	2.3	24
8	2 Dec	0300	3223.5-3233.0	601.5-611.0	9.5	0.6	7
9	2 Dec	0445	3233.0-3242.5	611.0-620.5	9.5	2.9	30
10	2 Dec	0715	3242.5-3252.0	620.5-630.0	9.5	3.8	40
11	2 Dec	0940	3252.0-3261.5	630.0-639.5	9.5	6.3	66
12	2 Dec	1225	3261.5-3271.0	639.5-649.0	9.5	8.1	85
13	2 Dec	1435	3271.0-3280.5	649.0-658.5	9.5	5;2	55
14	2 Dec	1655	3280.5-3290.0	658.5-668.0	9.5	5.2	55
15	2 Dec	1900	3290.0-3299.5	668.0-677.5	9.5	4.8	50
16	2 Dec	2040	3299.5-3309.0	677.5-687.0	9.5	7.0	72
17	2 Dec	2200	3309.0-3318.5	687.0-696.5	9.5	3.7	38
18	2 Dec	2330	3318.5-3328.0	696.5-706.0	9.5	1.8	20
19	3 Dec	0130	3337.5-3347.0	715.5-725.0	9.5	5.1	52
20	3 Dec	0310	3347.0-3356.5	725.0-734.5	9.5	4.4	45
21	3 Dec	0530	3356.5-3366.0	734.5-744.0	9.5	5.0	51
22	3 Dec	0730	3375.5-3385.0	753.5-763.0	9.5	7.3	77
23	3 Dec	0855	3385.0-3394.5	763.0-772.5	9.5	5.7	60
24	3 Dec	1025	3394.5-3404.0	772.5-782.0	9.5	6.5	68
25	3 Dec	1233	3413.5-3423.0	791.5-801.0	9.5	6.5	68
26	3 Dec	1440	3432.5-3442.0	810.5-820.0	9.5	6.3	66
27	3 Dec	1640	3451.5-3461.0	829.5-839.0	9.5	9.5	100
28	3 Dec	1910	3470.5-3480.0	848.5-858.0	9.5	8.1	85
29	3 Dec	2125	3489.5-3499.0	867.5-877.0	9.5	6.4	65
30	3 Dec	2350	3508.5-3518.0	886.5-896.0	9.5	6.0	62
31	4 Dec	0335	3527.5-3537.0	905.5-915.0	9.5	4.8	51
32	4 Dec	0645	3537.0-3546.5	915.0-924.5	9.5	8.7	88
33	4 Dec	0935	3546.5-3556.0	924.5-934.0	9.5	5.8	61
34	4 Dec	1240	3556.0-3565.5	934.0-943.5	9.5	5.6	59
Total					313.5	163.3	52.1
Total Depth 943.5 m							
Hole 317B[c]							
1	5 Dec	0640	2622-2628.5	0-6.5	6.5	9.1	140
2	5 Dec	0845	2628.5-2638.0	6.5-16.0	9.5	7.4	75
3	5 Dec	0955	2638.0-2647.5	16.0-25.5	9.5	7.5	76
4	5 Dec	1045	2647.5-2657.0	25.5-35.0	9.5	7.2	73
5	5 Dec	1140	2657.0-2666.5	35.0-44.5	9.5	8.5	86
6	5 Dec	1240	2666.5-2676.0	44.5-54.0	9.5	9.2	93
7	5 Dec	1350	2676.0-2685.5	54.0-63.5	9.5	7.5	76
8	5 Dec	1510	2685.5-2695.0	63.5-73.0	9.5	8.1	82
9	5 Dec	1610	2695.0-2704.5	73.0-82.5	9.5	9.0	92
10	5 Dec	1720	2704.5-2714.0	82.5-92.0	9.5	9.2	93
11	5 Dec	1820	2714.0-2723.5	92.0-101.5	9.5	3.6	38
12	5 Dec	1925	2723.5-2733.0	101.5-111.0	9.5	9.0	95
13	5 Dec	2030	2733.0-2742.5	110.0-120.5	9.5	9.5	100
14	5 Dec	2135	2742.5-2752.0	120.5-130.0	9.5	2.0	21
15	5 Dec	2230	2752.0-2761.5	130.0-139.5	9.5	CC	<1
16	5 Dec	2325	2761.5-2771.0	139.5-149.0	9.5	9.2	97
17	6 Dec	0020	2771.0-2780.5	149.0-158.5	9.5	0.8	8
18	6 Dec	0120	2780.5-2790.0	158.5-168.0	9.5	9.0	95
19	6 Dec	0215	2790.0-2799.5	168.0-177.5	9.5	9.0	95
20	6 Dec	0315	2999.5-2809.0	177.5-187.0	9.5	9.0	95
21	6 Dec	0415	2809.0-2818.5	187.0-196.5	9.5	CC	<1
22	6 Dec	0505	2818.5-2828.0	196.5-206.0	9.5	9.0	95

TABLE 1 – *Continued*

Core	Date (1973)	Time (local)	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovered (%)
23	6 Dec	0605	2828.0-2837.5	206.0-215.5	9.5	9.2	97
24	6 Dec	0700	2837.5-2847.0	215.5-225.0	9.5	9.5	100
25	6 Dec	0755	2847.0-2856.5	225.0-234.5	9.5	9.0	95
26	6 Dec	0855	2856.5-2866.0	234.5-244.0	9.5	3.0	32
27	6 Dec	0955	2866.0-2875.5	244.0-253.5	9.5	9.0	92
28	6 Dec	1055	2875.5-2885.0	253.5-263.0	9.5	9.2	93
29	6 Dec	1150	2885.0-2894.5	263.0-272.5	9.5	8.7	90
30	6 Dec	1245	2894.5-2904.0	272.5-282.0	9.5	9.0	95
31	6 Dec	1355	2904.0-2913.5	282.0-291.5	9.5	9.3	98
32	6 Dec	1450	2913.5-2923.0	291.5-301.0	9.5	7.5	77
33	6 Dec	1550	2923.0-2932.5	301.0-310.5	9.5	8.4	88
34	6 Dec	1655	2932.5-2942.0	310.5-320.0	9.5	9.0	95
35	6 Dec	1755	2942.0-2951.5	320.0-329.5	9.5	8.8	92
36	6 Dec	1915	2951.5-2961.0	329.5-339.0	9.5	9.4	99
37	6 Dec	2010	2961.0-2970.5	339.0-348.5	9.5	9.0	95
38	6 Dec	2115	2970.5-2980.0	348.5-358.0	9.5	6.1	64
39	6 Dec	2235	2980.0-2989.5	358.0-367.5	9.5	9.5	100
40	6 Dec	2340	2989.5-2990.0	367.5-377.0	9.5	7.7	81
41	7 Dec	0040	2999.0-3008.5	377.0-386.5	9.5	CC	<1
42	7 Dec	0155	3008.5-3018.0	386.5-396.0	9.5	3.7	39
43	7 Dec	0315	3018.0-3027.5	396.0-405.5	9.5	CC	<1
44	7 Dec		3027.5-3037.0	405.5-415.0	9.5	0.2	2
45	7 Dec	1640	3037.0-3406.5	415.0-424.5	9.5	CC	<1
Total					424.5	308.0	72.6

Total Depth 424.5 m

[a] Hole terminated due to inability to retrieve core tube caused by inadvertent dropping of a 6 inch bolt from the pipe stabber into the drill string.

[b] Hole terminated, objective achieved.

[c] Hole terminated due to inability to retrieve core barrel caused by metal-rubber debris from the flowline valve introduced into drill string.

contact between Units 2 and 3 is placed between the youngest volcanic sand and the oldest chert.

Unit 1—Varicolored Ooze and Chert (0-303.5 m)

The foraminifer-nannofossil and nannofossil-foraminifer oozes to chalks have colors that range through grayish-orange, very pale orange to white, and bluish-white. Orange colors characterize certain horizons, the white colors characterize others. Cores 1 through 16 in Hole 317B contain ooze and firm ooze. The $CaCO_3$ content of this entire unit is typically greater than 90% (Figure 5).

Chalk appears in Core 17B and is commonly present down to Core 33B. It is possible that the stratigraphic section between Cores 17 and 33 in Hole 317B was largely chalky and drilling disturbance has rendered the original constituents unrecognizable. Some "oozes" may therefore represent disaggregated chalks.

Foraminifers and nannofossils are the most common constituents of this unit. Radiolarians are rare, particularly in the near-surface cores. X-ray analysis of acid-insoluble fractions reveals the presence of clinoptilolite, barite, montmorillonite, potassium feldspar, plagioclase, and quartz. Fine fractions ($<2\mu m$) contain small amounts of gypsum (Cook and Zemmels, this volume). Sponge spicules were noted in a few samples. From Core 6B down, calcitic overgrowths on discoasters become noticeable, generally being more pronounced in whiter than in grayish-orange sediments. Certain white streaks in the grayish-orange sediment are pure nannofossil ooze. The grayish-orange pigment may be linked to ferruginous clay coatings observed around the foraminifers, which show solution effects. Apart from Cores 1 and 2 of Hole 317B, radiolarians are more abundant in the grayish-orange sediments.

Unit 2—Ooze, Chalk, Limestone, and Chert (303.5-647 m)

Sediments of this unit comprise foraminifer-nannofossil and nannofossil ooze, firm ooze, chalk, and limestone. Drilling disturbance has altered the original nature of the sediments. Various colors, including white, light gray, pinkish-gray, very pale orange, grayish-orange, greenish-gray, olive-gray, and brownish-black, typify this section, More clay-rich lithologies are darker in color. Claystones themselves are dark yellowish-brown and black. The $CaCO_3$ content in the upper part of this unit is similar to that of Unit 1, whereas in the lower, more clayey, part of Unit 2, the $CaCO_3$ content ranges from 5% to 99% (Figure 5).

The main constituents of this unit are nannofossils and foraminifers, with radiolarians (rarely as silica-filled molds), occasional sponge spicules, and clay as minor components. The nannofossils are frequently overcalcified. Fish debris is an important constituent in the black clays of Cores 5, 6, and 7 of Hole 317A. Noncalcareous components include palagonite altering to montmorillonite, mica, iron-manganese specks, clinoptilolite, and phillipsite. Minor amounts of potassium feldspars, plagioclase, and quartz are also present (Cook and Zemmels, this volume).

Thin sections of some chalks and limestones reveal a micritic matrix containing globigerinid foraminifers whose tests are completely filled by sparry calcite.

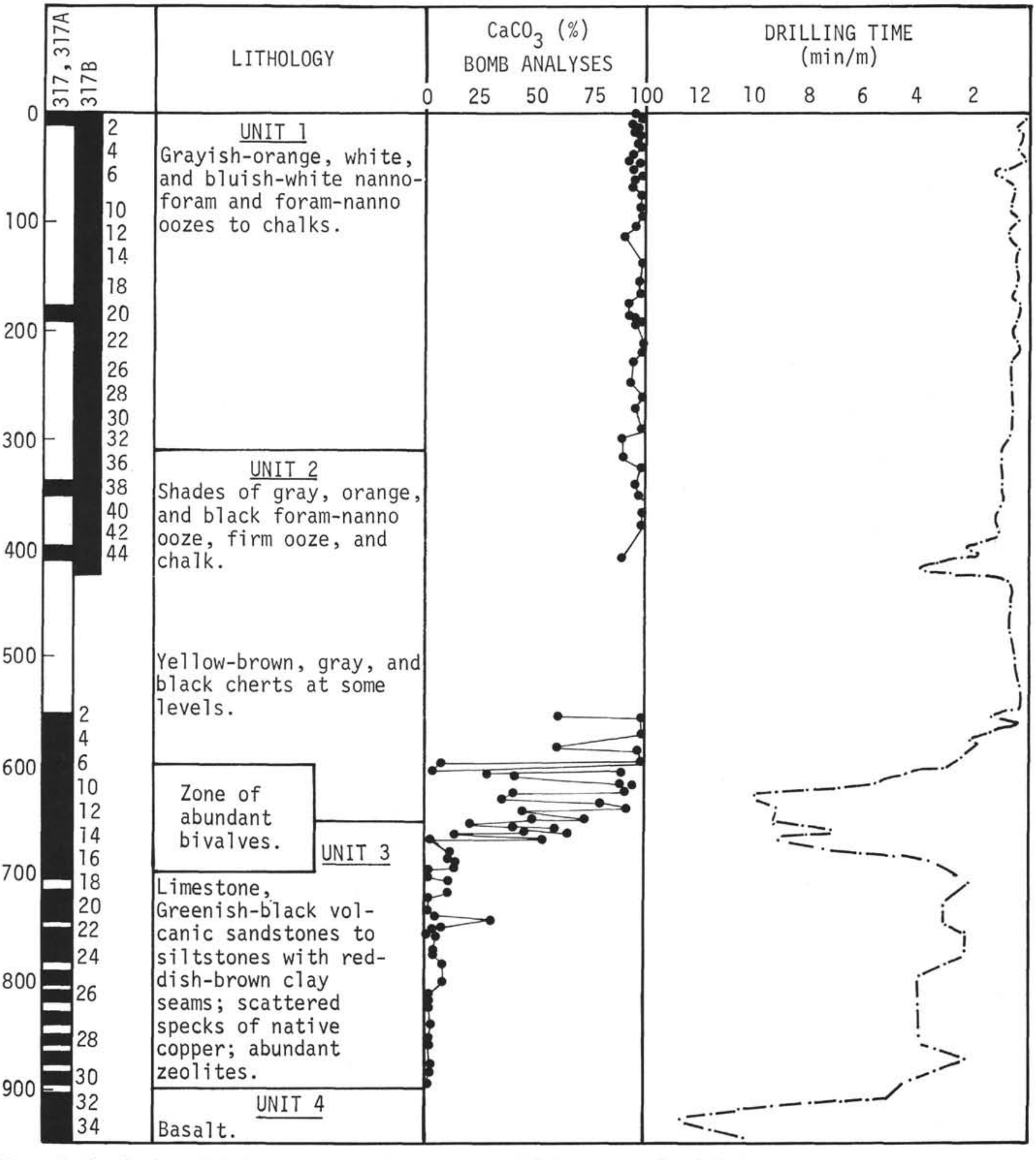

Figure 5. *Graphic log of lithologic units, carbonate content, and drilling rates at Site 317.*

Broken bivalve shells, whose original lamellar structure has been retained, occur in the lower levels of this unit.

Much of the unit is extensively burrowed, with the consequent production of "fucoids." Both light colored infillings surrounded by darker more clay-rich sediments, and dark colored infillings in lighter more lime-rich sediments are observable. Burrows are compacted to a certain extent; some contain pyrite. Subhorizontal solution seams occur locally. Evidence of soft-sediment deformation is present at some levels; differential slippage of layers locally has resulted in brittle fracture of the beds.

At two levels within this unit (in Sections 317A-6-2 and 317A-7-1) there are abrupt horizontal color changes from pinkish-gray above to dark yellowish-brown below, presumably corresponding to an oxidation-reduction boundary. This color boundary cuts across burrows and is clearly postdepositional. Some 65 cm below the color boundary in 317A-6-2, high concentrations of palygorskite were detected. At 317A-7-1, 61-70 cm, there are pinkish clasts (2-3 cm) of highly altered volcanic material coated by a thin (~10μm), black, ferromanganese crust. This level corresponds to a paleontological gap between the lower Turonian and Santonian.

The development of chert nodules is characteristic of the whole of this unit. These are colored various shades of yellow, orange, and brown to black. The darker cherts represent silicified claystones. In some claystones silicification is only partial. Black chert in Core 8, Hole 317A contains unreplaced *Inoceramus* prisms. These cherts are primarily composed of fine-grained cristobalite and/or quartz set with rare foraminifers. Some of the foraminifers have retained their original calcite shell and micrite filling; others have the shell wall replaced by silica while the filling remains as micrite; still others are entirely made over into a cluster of small silica blebs that roughly mimic the outline of a foraminifer.

Unit 3—Limestone and Volcaniclastic Sediment (647.0-910.0 m)

The upper levels of this unit are highly calcareous; the volcanic material occurs interbedded with greenish-gray, micritic, nannofossil limestones that contain sparite-filled foraminifers and whole and broken thin-shelled bivalves (shell width 10-100μm), generally oriented parallel to bedding. This is reflected in the $CaCO_3$ content which is up to 55% (Figure 5). Bivalves are abundant down to and including Core 16 of Hole 317A and occur as molds or as more or less complete shells. Radiolarians occur rarely. In these upper levels of Unit 3, there is abundant evidence of bioturbation with the production of "fucoid" burrows. Some silicified zones are present, but there is no vitreous chert.

In Cores 12 to 15 (Hole 317A), the greenish-black sandstones occur as poorly graded units, sometimes cross-laminated, and with burrowed tops. Separate "pulses" of volcanic grains are recognizable within one sandstone bed. Constituents of these horizons include palagonite altering to montmorillonite clay, plagioclase feldspars, pyroxenes, analcite with clay, and some micrite. These sediments contrast strongly with the overlying sediments by having $CaCO_3$ contents normally less than 10% (Figure 5).

In Core 16 and lower cores of Hole 317A, zones of breccias are widespread. These are manifested by centimeter-scale clasts of greenish-black siltstone to sandstone separated by reddish-brown and purple clay material. Vertical and subhorizontal fracturing of the volcanic sandstone-siltstone has taken place with differential movement on the plastic clay substratum. Brecciated zones are commonly at an angle of 5°-10° to the bedding and may change orientation across the width of core, suggesting some kind of slump fold.

Core 16A, Section 2 at 133 cm, an olive-black sandstone with pyritized burrows, was found to contain 28.7% organic carbon upon routine analysis. A recheck of this sample showed 30.5%. Just above and below this sample, at 126 and 150 cm, the sediments contain 0.05% and 0.87% organic carbon, respectively, This occurrence of high organic carbon is strata of Aptian age has been noted at Site 105 in the Atlantic (Hollister et al., 1972) and attributed to reducing conditions (see Jackson and Schlanger, this volume).

Reddish-brown clay seams and veins are particularly conspicuous in this unit and, as well as isolating angular clasts, typically form an anastomosing network within the greenish-black host rock. The seams are usually a few millimeters thick and often cross the whole width of the core. Investigation of the seams shows them to consist of essentially homogeneous clay, enriched in X-ray-amorphous iron oxide-hydroxides, but free of volcanic grains. The clay seams may themselves be involved in soft-sediment deformation, and show strong discordance relative to bedding.

Towards the base of the sedimentary section thin (~1 cm) graded units of greenish-black sandstones are particularly well developed. These beds are often deformed and exhibit angular distortion with crinkling of upper and lower contacts. Also prominent in the lower cores of Hole 317A are spherules a few millimeters in diameter that typically have greenish-black siltstone cores and reddish-brown rinds. A few spherules do not have the appearance of discrete clasts, as they blend into the host rock. Some are grouped together in beds; others are more randomly distributed. In 317A-29-2, 15-22 cm they occur in the finest fraction of a graded layer, suggesting in situ growth.

In the two cores immediately above basalt (317A-29 and -30) the greenish-black color gives way to dusky reddish-brown.

Particularly noteworthy in this unit, from Core 22, Section 2 downward, is the presence of small flecks and strands of native copper. These occur randomly in both red and green sandstone and siltstone layers. Because of the unusual nature of these occurrences, sediments from this section were subsequently analyzed by X-ray fluorescence on shore. Results of these analyses are presented in Table 2. It should be emphasized that these analyses represent a rapid survey to determine gross trends, relative amounts, and unusual concentrations of the elements tested for. As a consequence, error in concentration is estimated to be ±25% and possibly higher. Nevertheless, it is evident that the concentration of copper in these sediments, even though it is megascopically visible, is anomalously low, ranging from about 80 to 135 ppm; the average oceanic value being 345 ppm (Chester, 1965). The sediments also seem depleted in Ni and Mn with respect to oceanic values, but generally show enrichment in Cr and Fe.

Thin sections of the greenish-black volcaniclastic material between Cores 19 and 28 (Hole 317A) reveal that the principal component of these rocks is brown and green palagonite altering to montmorillonite. Minor chlorite, potassium feldspar, sanidine, and rare plagioclase and pyroxenes are accessories (Cook and Zemmels, this volume). The grains are welded together leaving minimal void space. Calcite is present locally as a poikilitic cement; analcite occurs both as cement and as discrete grains. At some levels, lenses (2-3 cm) of analcite crystals are visible macroscopically.

TABLE 2
X-ray Fluorescence Analyses of Hole 317A Cores

Core	Section	Interval[a] (cm)	Ag[b] (ppm)	Cr (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Mn (wt %)	Fe (wt %)	Ti (wt %)
13	1	Channel		64	66	77	76	0.13	2.1	–
17	3	Channel		174	93	134	97	0.13	11.5	0.88
22	2	Channel		210	100	125	90	0.12	10.9	0.74
23	3	Channel		129	121	122	88	0.14	9.9	0.71
24	4	Channel		199	105	118	92	0.15	10.2	0.71
25	5	Channel		204	99	135	89	0.16	9.6	0.72
27	1	Channel		225	105	122	86	0.18	9.1	0.65
28	1	Channel		303	142	120	88	0.16	9.6	0.72
30	4	Channel		222	104	114	91	0.15	9.6	0.63
22	2	91-92		219	104	115	84	0.14	13.0	0.79
23	1	127-128		193	104	135	87	0.16	8.5	0.76
24	4	65-66		187	91	94	90	0.15	10.9	0.71
25	5	30-31		191	87	104	76	0.13	11.4	0.73
28	1	120-121		200	100	122	93	0.16	10.6	0.72
28	2	34-35		212	91	120	81	0.16	9.4	1.07

[a] The first nine samples are channel samples taken along the outer edge of the core.

[b] Counts too low to be meaningful.

Igneous Rocks (910.0-943.5 m)

Basalt was encountered at a depth of about 910 meters below the sea floor in the uppermost part of Hole 317A, Core 31. It is directly overlain in the core by 25 cm of grayish-red and greenish-gray mudstone and siltstone of the type described in Core 30. The overlying sedimentary rocks are somewhat more indurated than similar rocks higher in the section, but this is no doubt due to diagenetic processes; the sediments show no evidence of having been baked. The contact was broken in the core barrel, but, if nearly in place, the sediments appear to have been transported and deposited on the flow surface. Basalt was drilled to a depth of 33.5 meters, yeilding 24.5 meters of core which appeared to contain parts of 10 flow units separated by three intervals of volcanogenic sediments. Missing intervals in the cores cannot be reconstructed with certainty, and it is possible, that still other sedimentary layers, or portions of altered, very vesicular, or clinkery basalt were washed away during the coring process. The stratigraphy of the section, from the top down is given below, as best we can reconstruct it.

Flow Unit 1, the uppermost basalt encountered, is only 0.35 meter thick. Its base is in broken contact with a thin (3 cm) baked nubbin of grayish-brown siltstone, and neither the base of Unit 1 nor the top of Unit 2 show chilled margins against the sedimentary rock. It is suspected that parts of all three units are missing from the core at this double contact. The portion of flow Unit 1 present in the core is a dark greenish-gray, partially altered, aphyric vesicular basalt. Vesicles average about 1.5 mm in diameter at the top, and become larger downward, averaging 2 × 5 mm at the base. All are irregular in shape, but rounded, and all are lined, and many filled by a greenish-black material that could not be identified onboard ship. A few vesicles near the top of the unit are filled with coarse calcite. Vesicles make up about 15% of the rock. The groundmass is very fine grained, appears intersertal in head-lens inspection, and most, if not all of the glass appears to be altered.

A portion of the top, and probably the base as well, of flow Unit 2 appears to be missing from the core. The portion retained is 0.60 meter thick, separated by broken contacts. At the top it is juxtaposed with baked red siltstone, at the base with friable greenish-gray siltstone, both apparently of volcanogenic origin. Unit 2 itself is a dark greenish-gray, partially altered, vesicular basalt that contains 0.5 mm microphenocrysts of pyroxene. Vesicles compose nearly 20% of the rock, ranging downwards in size from nearly 2 × 4 mm at the top to 4 × 8 mm at the base of the unit. Vesicles are filled near the top, and lined near the base, with greenish-black material. All have irregular shapes; many lie perpendicular to core walls, but near the base some stand vertically and appear to be incipient vesicle tubes. The unit differs from Unit 1, not only in vesicle size, but in the presence of about 10%-15% pyroxene microphenocrysts. In addition, the groundmass seems to be a little coarser and to contain less former glass.

A unit of greenish gray to grayish blue green siltstone about 10 cm thick appears at the base of flow Unit 2. The rock is somewhat more indurated than similar rocks higher in the section, but does not appear to be thermally metamorphosed at either top or bottom. Both contacts are broken, and although basalts above and below have different characteristics, neither shows a chilled facies against the siltstone. Again, some sections appear to be missing at this interval.

Flow Unit 3 is a dark greenish-gray, vesicular basalt, again containing pyroxene microphenocrysts, but in amounts less than 5%. Vesicles in this unit are rather evenly dispersed throughout, make up about 20% of the rock, average about 3 × 5 mm in size, but range up to 5 × 10 mm, and have irregular, vermicular, but rounded shapes. At the base of this unit vertical gas trails reach dimensions of 10 × 25 mm. All vesicles are lined, and most filled by greenish-black material, and a few are lined with coarse zeolites. The groundmass of this unit is very fine grained, and appears to be intersertal, although once-glassy areas appear dense and altered. A little scattered chalcopyrite was noted in the lower part of the unit. Flow Unit 3 has a minimum thickness of 125 meters.

The contact between flow Units 3 and 4, though broken in the core, appear to be in close proximity. The base of Unit 3 shows a diminuation of grain size near the contact, and the upper 10-20 cm of flow Unit 4 consists of medium bluish-gray, vesicular altered aphanitic material that appears to be largely altered glass. The central part of the unit is dark greenish-gray vesicular basalt with about 5% microphenocrysts of pyroxene. Vesicles average about 1 × 2 mm and make up about 10% of the central part of the flow, but near the top and bottom make up as much as 40% of the rock, and average 4 × 5 mm. A few vesicles are as large as 10 × 20 mm. All are lined with greenish-black material, but near the top of the flow contain blue-green material and calcite as well. Flow Unit 4 is about 1.1 meters thick, a figure that probably approximates its original thickness.

Flow Unit 5 has an altered, nonvesicular, formerly glass-rich top about 10 cm thick. The main body of this flow unit is a lighter greenish-gray than the flows above and is characterized by a bimodal distribution of vesicles, 5%-10% pyroxene microphenocrysts, and platy feldspars that locally have an orientation roughly perpendicular to the core axis. Vesicles make up about 10% of the rock and these consist mostly of 1 × 1 mm rounded, evenly spaced filled voids. However, scattered, much larger, and more irregular vesicles (up to 6 × 10 mm) occur throughout the unit. Flow Unit 5 is at least 6.3 meters thick, and although its upper contact is broken, the minimum estimate is probably close to its true thickness.

Flow Unit 6 is in tight contact with flow Unit 5 at the top, where both units show some evidence of chilling. Unit 6 lacks the bimodal vesicle distribution of Unit 5, contains fewer microphenocrysts, and its groundmass feldspars show much less inclination to occur in plate-like forms. An altered yellowish material in grains about a millimeter in diameter occurs at several horizons in this unit, and may represent a small proportion of altered olivine phenocrysts. Otherwise, flow Units 5 and 6 are quite similar. Unit 6 has a broken lower contact, and therefore, a minimum thickness of 7.7 meters. Again, this is very likely close to the true thickness of the flow unit.

At the base of flow Unit 6, a 55-cm-thick unit of red siltstone occurs. At the top of the unit, just beneath flow Unit 6, the siltstone is very dark red, apparently thermally metamorphased, and cut by veins of yellowish-gray chalky material. Downsection, the siltstone becomes less indurated, more grayish-red, and original bedding can be distinguished. The unit appears to lie conformably on flow Unit 7 beneath.

A marked change in the character of flow units occurs in flow Units 7-10. Each of these units is characterized by a very vesicular top, commonly showing evidence of alteration in the upper 10-20 cm. Vesicle size and abundance decrease downward in the flows, so that the lower parts are relatively dense. The upper, vesicular parts contain as much as 40% of vesicles up to 20 cm in diameter; the rock between these vesicles contains variable amounts of small plagioclase phenocrysts, and glomeroporphyritic clots of plagioclase and pyroxene set in a very fine grained, commonly glassy, groundmass. The lower parts of these flow units are much less vesicular (5%-10%), have much smaller vesicles (average size 1 mm), are aphyric, and have coarser groundmass materials. Not uncommonly, the groundmass feldspar in the lower, denser part of these flow units becomes platy, and, although locally perpendicular to the core axis, more commonly stands vertically, or nearly so. Flow Unit 7 has a minimum thickness of about 2 meters; Unit 8, 1 meter; Unit 9, 1.3 meters; and Unit 10, 1.6 meters.

Discussion

The presence, and suspected presence, of two pyroxenes in the upper flow units, along with their general mineralogy, suggest that the rocks have tholeiitic affinities. The presence of feldspar phenocrysts in the lower flows further suggests that the rocks are of oceanic rather than edifice type. The overall vesicularity of the rocks, the presence of "swiss cheese" tops on the lower flows, and the presence of vesicles as long as 5 cm suggest either that the flows were erupted in shallow water, or that the lavas contained unusually large amounts of gas.

The presence of volcanogenic siltstones between flow Units 1 and 2, 2 and 3, and 6 and 7 suggests that at least the waning phases of flow volcanism and the initial stages of accumulation of volcanogenic sedimentary debris overlapped in time. The character of the interbedded siltstones, where exposed, suggests they were deposited on cold basalt flow tops and overrun and baked by succeeding flows.

Preliminary description of the one flow unit cored beneath the Ontong-Java Plateau (Site 289; Andrews, Packham, et al., 1973) suggests similarity to those we cored at Manihiki. The Ontong-Java basalt is immediately overlain by volcanogenic sediments of Aptian age. The basalt differs in being more altered and in containing minor amounts of altered olivine phenocrysts, but it appears identical in texture, in the presence of small plagioclase phenocrysts, and in the suspected presence of two pyroxenes in the groundmass.

Winterer, Ewing, et al. (1973) cored basalt flows beneath Magellan Rise (Site 167) and found them to be overlain by late Tithonian to early Berriasian limestones containing volcanogenic detritus. Bass et al. (1973) discussed the basalts at Site 167 and concluded that although they might represent true oceanic tholeiites, they were more likely transitional between oceanic and edifice tholeiites, or perhaps distinctly alkaline. The basalts at Magellan Rise were, unfortunately, rather highly altered, making such subtle distinctions difficult.

Basaltic rocks have, to date, not been penetrated on Shatsky Rise (Larson, Moberly, et al., 1973), but Site 306 was terminated an estimated 80 meters above basement in Tithonian rocks very near the Tithonian-Berriasian boundary.

Thus it would appear that basalt basement ages are older at the more northerly Magellan and Shatsky rises than at the more southerly Ontong-Java and Manihiki plateaus. Basalts cored at three of the sites share the common characteristics of being vesicular, of containing phyric plagioclase, and of being of probably oceanic tholeiitic composition, or transitional towards that composition.

GEOCHEMICAL MEASUREMENTS

The results of *p*H, alkalinity, and salinity analyses of interstitial waters are summarized in Table 3, and graphically in Figure 6. Calcium carbonate content of the sediments is shown in Figure 5. Procedures for analysis are those routinely performed aboard *Glomar Challenger.*

pH Values

Surface seawater at this site has an average *p*H of 8.29 while that of the interstitial waters in the sediments ranges from 6.82 to 8.12 (Figure 6). There is a general downhole decrease in *p*H from about 7.5 in the surface sediments to 6.8 at a depth of 720 meters. Below this depth, between 720 and 820 meters, the *p*H rises from 6.8 to 8.1. The *p*H then decreases again to 7.2 at 890 meters (Figure 6).

Alkalinity

Values for alkalinity show a downhole decrease from 2.44 meq/kg in surface sediments to 0.20 meq/kg at a depth of 890 meters. Both the colorimetric and potentiometric titration techniques give very similar results (Figure 6).

Salinity

Salinities range from 35.5 °/₀₀ in surface sediments to 39.2 °/₀₀ at 821.5 meters (Figure 6).

The increase in *p*H and salinity which occurs between 720 and 777 meters corresponds approximately to the stratigraphic interval where native copper and abundant zeolites were first noticed.

$CaCO_3$

Downhole $CaCO_3$ trends are quite distinct at this site (Figure 5). $CaCO_3$ content of lithologic Unit 1, which is rich in biogenous calcareous components, is between 95% and 99%. The upper part of Unit 2 is also high in $CaCO_3$, but the basal portion becomes more clayey, and shows sharp fluctuations from 5% to 99% $CaCO_3$. The top of Unit 3 which is dominated by volcaniclastic sediments has occasional beds rich in bivalve fragments and void-filling calcite. These beds have $CaCO_3$ contents of 30% to 90%.Detrital components increase downhole, which is reflected in the consistently low $CaCO_3$ values in these beds. In these rocks, $CaCO_3$ values are generally less than 10% and commonly are as low as 1% (Figure 5).

PHYSICAL PROPERTIES

The physical properties methods, presentation on hole and core plots, presentation in tables, and definitions, are discussed briefly in the Physical Properties portion of the Site 315 report, and in detail in Appendix I of this volume, and there will not be elaborated upon here.

The GRAPE analog data are displayed in the core scale graphs only. Where the sediment was soft, the core liner completely filled, and the analog GRAPE data shore-based computer program required no diameter corrections, the data are plotted as a single solid line. Where the analog GRAPE scanned cores of hard rocks with varying diameter, the data are presented as two lines. The solid line is the routine analog data assuming a 6.61-cm diameter; that is, without diameter correction. This line is presented if anyone wishes to consult photographs, etc, measure diameters, and apply their own diameter correction for discrete intervals, or simply manipulate the data. The dotted line represents values that include correction for core diameter, applied as discussed in Appendix I of the present volume. Where the rock segments are very short, the data appear to be a series of peaks. Only the maximum density value of the peak in these cases represents good data, and the density values of the shoulders of the analog peaks should be ignored.

The GRAPE Special wet-bulk density, gravimetric wet-water content, porosity, sound velocity (perpendicular and parallel to bedding), absolute velocity

TABLE 3
Summary of Shipboard Geochemical Data

Sample (Interval in cm)	Depth Below Sea Floor (m)	*p*H		Colorimetric Titration Alkalinity (meq/kg)	Salinity (°/₀₀)	Combination Electrode *p*H	Potentiometric Titration Alkalinity
		Punch-in	Flow-through				
Surface Seawater		8.28	8.26	2.44	35.5	8.33	2.37
1B-0, 144-150	0	7.52	7.42	2.83	35.5	7.62	2.69
1-5, 144-150	7.5	7.41	7.47	2.54	35.5	7.52	2.79
3B-4, 144-150	22.0	7.38	7.25	2.83	35.5	7.56	2.78
9B-2, 0-10	74.5	7.41	7.46	2.83	35.5	7.55	2.91
16B-5, 144-150	147.0	7.39	7.44	2.64	35.5	7.54	2.86
2-4, 144-150	186.5	7.20	7.33	2.54	35.8	7.51	2.64
22B-5, 144-150	204.0	7.39	7.39	3.03	36.3	7.44	2.76
27B-4, 144-150	250.0	7.31	7.45	2.83	35.5	7.46	2.77
32B-4, 144-150	297.5	7.49	7.41	2.83	35.5	7.40	2.78
37B-3, 144-150	343.5	7.35	7.36	2.74	35.8	7.45	2.69
3A-2, 144-150	566.5	7.14	7.17	1.66	36.6	7.32	1.73
19A-3, 142-150	720.0	–	6.82	0.29	36.3	–	–
24A-3, 140-150	777.0	–	8.12	0.49	39.0	–	–
26A-2, 0-6	821.5	–	8.10	0.39	39.3	–	–
30A-2, 144-150	889.5	–	7.21	0.20	38.5	–	–

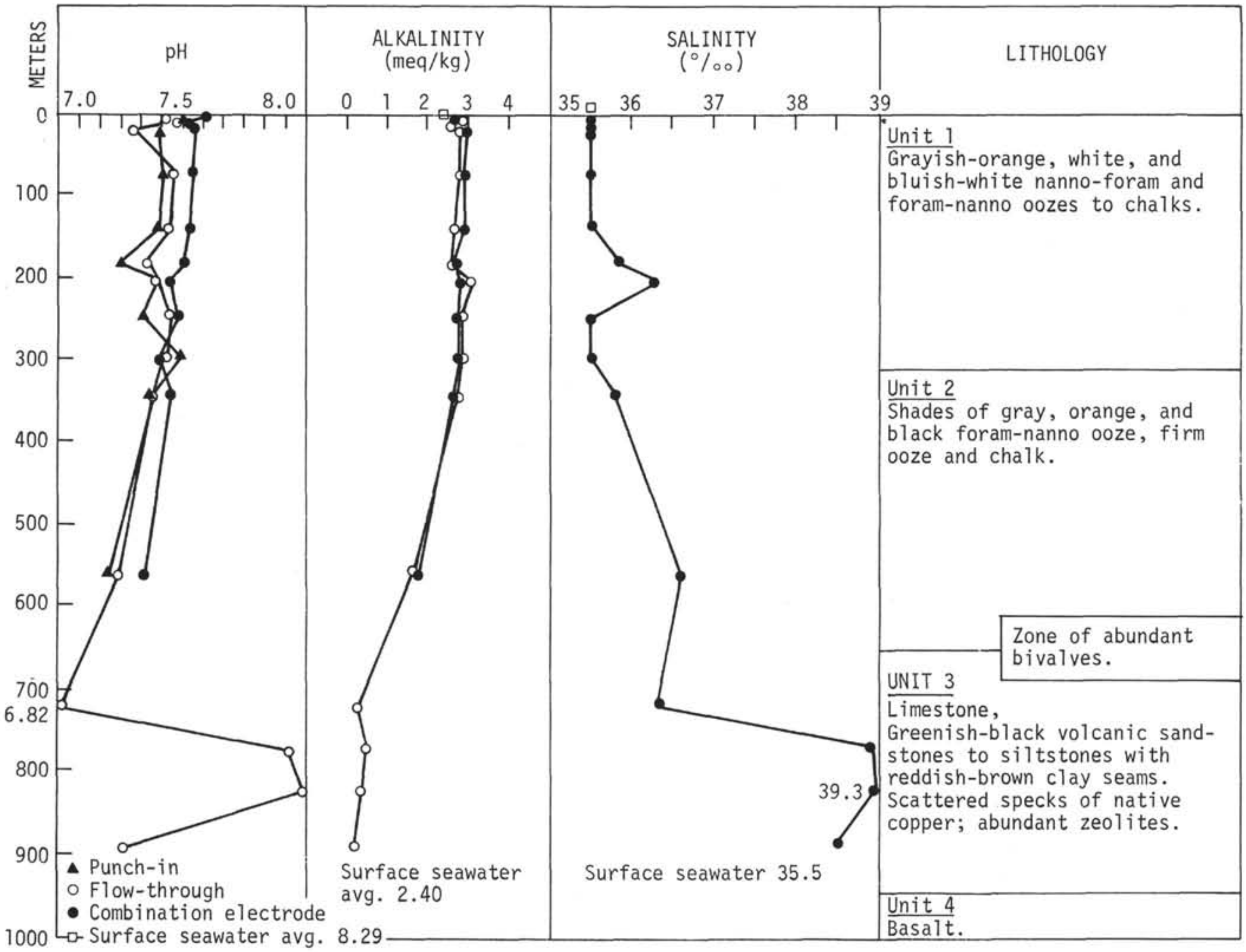

Figure 6. *Graphic log of shipboard* pH, *alkalinity, and salinity measurements at Site 317.*

anisotropy, percent velocity anisotropy, acoustic impedance, and reflection coefficients are presented in Table 4, with most of these parameters graphically displayed on a site scale (Figure 7). The physical properties data in the site report are primarily presented in tables and graphs and only briefly discussed. Detailed discussion and interpretation of the interrelationships of the laboratory physical properties data are presented in greater detail in Chapter 26 of this volume.

Results

Sound velocity, wet-bulk density, wet-water content, porosity, impedance, and reflection coefficients, were measured or calculated from ooze, chalk limestone, chert, and volcaniclastics from depths of 0 to 907 meters below the sea floor. Because of the prevailing shipboard sampling philosophy, only sound velocity and gamma-ray density properties were determined for basalt. Based on physical properties, the section at Site 317 can be divided into seven intervals. These intervals do not coincide precisely with the lithologic units described earlier or with paleontological time boundaries. Of course, the accuracy and resolution of physical properties within these intervals is a function of core spacing and the ability to retrieve unbiased and undisturbed lithologic samples. Boundaries between these intervals are indicated by dashed horizontal lines in Figure 7 and listed in Table 4. Lithology, depth interval, and typical values of the characteristic physical properties are given in Table 5.

The section recovered from 0 to 150 meters (interval 1) was completely disturbed by the drilling operation; it is not representative of in situ conditions and will not be discussed further. Interval 2 (150 to ~377 m) consists of drill-disturbed, firm "lumps" of Miocene to Eocene foram-nanno, and nanno ooze and chalk. This interval is characterized by low sound velocity, wet-bulk density, and acoustic impedance, and high wet-water content and porosity, compared to the third (3) physical property interval from ~377 to ~602 meters. The ~377 meter boundary is arbitrarily placed and may actually be at the 358-meter level, at the late Eocene-mid Eocene unconformity, and a corresponding accumulation rate change.

Interval 3, from ~377 to ~602 meters, consists of Eocene to Cretaceous foram nanno and nanno chalk with minor claystone and chert. This interval is distinguished from the fourth physical property interval

TABLE 4
Velocity-Density Parameters, Site 317

Sample (Interval in cm)	Depth in Hole (m)	Compressional Sound Velocity					"Special" Wet-Bulk Density[a] 2-min. count (g/cc)		Wet-Water Content Salt Cor. (%)	Porosity[b] (%)	Acoustic Impedance $\frac{g\ 10^5}{cm^2\ sec}$	Lithology
		∥ Beds (km/sec)	⊥ Beds (km/sec)	Anisotropy		Temp. (°C)	∥ Beds	⊥ Beds				
				∥-⊥ (km/sec)	(∥-⊥) ÷ ⊥ (%)							
Hole 317												
3-1, 140-142	343.40		1.619			22.0		1.654	41.24	68.21	2.68	Rad-rich foram nanno chalk
Hole 317A												
1-1, 122-124	403.22	1.764	1.725	+0.039	+ 2.26	23.0		1.887	25.51	48.14	3.26	Foram nanno chalk
2-1, 114-116	555.14	1.751	1.740	+0.011	+ 0.63	24.0		1.795	31.08	55.79	3.12	Clay-rich foram nanno chalk
5-1, 131-133	577.31	2.012	1.919	+0.093	+ 4.85	23.0		2.238	13.67	30.59	4.29	Clayey nanno chalk
6-1, 140-142	583.90	1.924	1.820	+0.104	+ 5.71	26.0		2.104	16.52	34.76	3.83	Clayey nanno chalk
6-2, 85-87	584.85	1.815	1.654	+0.161	+ 9.73	26.0	1.791	1.797	23.53	42.28	2.97	Claystone
7-1, 145-147	593.45	1.903	1.816	+0.087	+ 4.79	24.0	2.180	2.155	20.89	45.02	3.91	Clayey nanno chalk
7-2, 144-147	594.94	2.641				23.0	1.994		18.51	36.91	5.27[c]	Silicified claystone
8-1, 106-108	602.56	2.084	2.036	+0.048	+ 2.36	23.0	2.374	2.354	15.98	37.62	4.79	Foram nanno chalk
9-1, 101-102	612.01	2.892	2;760	+0.132	+ 4.78	22.0		2.554	6.94	17.72	7.04	Clay-rich foram nanno chalk
9-2, 97-99	613.47	2.865	2.666	+0.199	+ 7.46	22.0		2.426	8.24	19.99	6.47	Clay-rich nanno chalk
9-2, 138-141	613.88	4.224				22.0			1.10			Chert
10-1, 129-132	621.80	2.919				22.0	2.433		8.33	20.27	7.10[c]	Clayey nanno chalk
10-1, 132-134	621.82	2.981				22.0			9.80			Clayey nanno chalk
10-1, 135-137	621.85	2.981				22.0	2.428				7.24[c]	Clayey nanno chalk
10-2, 70-72	622.70	5.189				23.0			0.20			Chert
10-2, 124-126	623.24	2.065	2.017	+0.048	+ 2.38	22.0	1.949	1.923	20.74	39.88	3.88	Clay-rich micritic nanno limestone
10-3, 122-124	624.72	2.736	2.628	+0.108	+ 4.11	22.0		2.340	10.14	23.73	6.14	Clay-rich micritic nanno limestone
11-2, 3-5	631.53	2.408				22.0	2.030		16.11	32.70	4.89[c]	Foram-rich nanno micritic limestone
11-2, 100-102	632.50	3.226	3.120	+0.106	+ 3.40	22.0		2.579	6.68	17.23	8.05	Foram-rich nanno micritic limestone
11-3, 32-34	633.32	3.360	3.275	+0.085	+ 2.60	22.0		2.266	8.12	18.40	7.42	Nanno-micritic limestone
11-4, 140-143	635.90	2.555	2.479	+0.076	+ 3.07	21.0		2.188	15.60	34.13	5.42	Nanno micritic limestone
11-5, 128-130	637.28	3.061	2.938	+0.123	+ 4.19	21.0		2.447	8.83	21.61	7.19	Nanno micritic limestone
12-2, 23-26	641.23	3.115	2.950	+0.165	+ 5.59	22.0		2.528	5.80	14.66	7.46	Nanno micritic limestone
12-3, 80-90	643.34	3.671				21.0	2.509		9.40	23.58	9.21†	Nanno micritic limestone
12 4, 6-8	644.06	2.697	2.534	+0.163	+ 6.43	21.0		2.423	8.89	21.54	6.14	Nanno micritic limestone
12-5, 140-142	646.90	2.690	2.611	+0.079	+ 3.03	22.0		2.291	11.47	26.28	5.98	Nanno micritic limestone
12-6, 122-125	648.22	2.474	2.161	+0.313	+14.48	24.0	2.201	2.179	12.58	27.41	4.71	Micritic nanno limestone
13-1, 140-144	650.44	2.487				23.0	2.186	2.191	15.65	34.29		Nanno micritic limestone
13-2, 141-144	651.91	2.461	2.489	-0.028	- 1.12	23.0	1.941	1.912	24.89	47.59	4.76	Volcanic silty sandstone
13-4, 21-23	653.71	2.609	2.625	-0.016	- 0.61	23.0		2.031	19.68	39.97	5.33	Volcanic sandstone
14-1, 121-123	659.71	2.072	1.825	+0.247	+13.53	23.0		1.671	27.77	46.41	3.05	Volcanic nanno sandstone
14-2, 60-62	660.60	2.547	2.692	-0.145	- 5.39	23.0		2.021	17.79	35.95	5.44	Volcanic silty sandstone
14-4, 82-84	663.82	2.281	2.217	+0.064	+ 2.89	22.0	1.937	1.913	22.14	42.35	4.24	Volcanic silty sandstone
15-2, 101-103	670.51	2.731	2.662	+0.069	+ 2.59	22.0		1.916	23.18	44.41	5.10	Volcanic silty sandstone
15-3, 109-111	672.09	2.674	2.541	+0.133	+ 5.23	22.0		1.848	23.22	42.91	4.70	Volcanic sandy siltstone
16-1, 77-90	678.27	2.089	2.012	+0.077	+ 3.83	22.0		1.863	29.78	55.48	3.75	Volcanic sandy siltstone
16-2, 62-65	679.62	2.627	2.603	+0.024	+ 0.92	22.0		2.160	16.84	36.37	5.62	Sandy limestone
16-3, 60-63	681.10	1.983	1.856	+0.127	+ 6.84	22.0		1.732	32.84	56.88	3.21	Volcanic silty sandstone
16-4, 93-96	682.93	1.855	1.904	-0.049	- 2.57	22.0		1.778	32.92	58.53	3.39	Volcanic silty sandstone
16-5, 127-130	684.77	1.961	1.922	+0.039	+ 2.03	22.0		1.833	29.82	54.66	3.52	Silty sand
17-1, 121-123	688.21	2.053	1.928	+0.125	+ 6.48	22.0		1.833	30.68	56.24	3.53	Volcanic silty sandstone

17-2, 119-121	689.69	2.050	2.002	+0.048	+ 2.40	22.0		1.777	33.25	69.09	3.56	Volcanic silty sandstone
17-3, 47-49	690.47	1.969	1.855	+0.114	+ 6.15	22.0		1.823	32.70	59.61	3.38	Volcanic silty sandstone
18-2, 28-30	698.28	2.273	2.376	-0.103	- 4.34	22.0		1.874	28.52	53.45	4.45	Volcanic sandy siltstone
19-2, 141-143	718.41	2.024	1.968	+0.056	+ 2.85	22.0		1.831	29.02	53.14	3.60	Volcanic silty sandstone
19-3, 124-126	719.74	1.907	1.884	+0.023	+ 1.22	22.0		1.830	30.12	55.12	3.45	Volcanic sandstone
19-4, 126-128	721.26	1.974	1.893	+0.081	+ 4.28	22.0		1.865	31.30	58.37	3.53	Volcanic sandstone
20-1, 98-101	725.98	2.124	2.057	+0.067	+ 3.26	22.0		1.827	30.98	56.60	3.76	Volcanic sandy siltstone
20-2, 74-76	727.24	2.276	2.280	+0.004	- 0.18	21.5		1.910	29.79	56.90	4.35	Volcanic silty sandstone
20-3, 125-128	729.25	2.009	2.010	-0.001	- 0.05	21.0		1.900	30.25	57.48	3.82	Volcanic sandy siltstone
21-4, 135-137	740.35	1.940	1.768	+0.172	+ 9.73	21.0		1.762	32.38	57.05	3.12	Volcanic sandy siltstone breccia
22-1, 126-128	754.76	2.011	1.927	+0.084	+ 4.36	21.0		1.824	30.62	55.85	3.51	Volcanic sandy siltstone breccia
22-2, 123-125	756.23	2.035	2.001	+0.034	+ 1.70	21.0		1.938	25.99	50.37	3.88	Volcanic silty sandstone
22-3, 137-139	757.87	1.928	1.848	+0.080	+ 4.33	21.0		1.782	32.86	58.56	3.29	Volcanic silty sandstone
22-4, 115-117	759.15	1.992	1.936	+0.056	+ 2.89	22.0		1.894	26.09	49.41	3.67	Volcanic silty sandstone
22-5, 122-124	760.72	1.953	1.911	+0.042	+ 2.20	22.0		1.825	27.84	50.81	3.48	Volcanic silty sandstone
23-2, 115-118	765.65	2.061	1.971	+0.090	+ 4.57	22.0		1.913	27.16	51.96	3.77	Volcanic sandy siltstone
23-3, 29-31	766.29	2.022	2.043	-0.021	- 1.03	22.0		1.893	27.05	51.21	3.87	Volcanic sandy siltstone
23-4, 103-106	768.53	1.933	1.890	+0.043	+ 2.28	22.0		1.880	26.97	50.70	3.55	Volcanic silty sandstone
24-1, 88-92	773.35	2.738				22.0	2.105				5.76^c	Vein rock
24-2, 40-42	774.40	1.933	1.991	-0.058	- 2.91	22.0		1.848	31.43	58.08	3.68	Volcanic sandy siltstone
24-3, 134-136	776.84	2.051	2.025	+0.026	+ 1.28	22.0		1.800	28.62	51.52	3.65	Volcanic silty sandstone
24-4, 138-141	778.38	2.059	2.011	+0.048	+ 2.39	22.0		1.829	28.10	51.39	3.68	Volcanic sandy siltstone
24-5, 133-136	779.83	2.128	2.089	+0.039	+ 1.87	22.0		1.901	27.92	53.08	3.97	Volcanic sandy siltstone
25-1, 145-147	792.95	2.159	2.071	+0.088	+ 4.25	21.0		1.922	25.96	49.90	3.98	Volcanic sand-rich clayey siltstone
25-2, 139-142	794.39	1.894	1.891	+0.103	+ 5.45	21.0		1.857	29.75	55.25	3.51	Volcanic clay-rich sandy siltstone
25-3, 112-115	795.62	2.153	2.088	+0.065	+ 3.11	21.0		1.923	24.79	47.67	4.02	Volcanic sandy siltstone
25-4, 126-128	797.26	2.201	2.156	+0.045	+ 2.09	20.0		1.948	22.76	44.34	4.20	Volcanic clay-rich sandy siltstone
25-5, 90-92	798.40	2.034	1.952	+0.082	+ 4.20	21.0		1.806	29.18	52.70	3.53	Volcanic clay-rich sandy siltstone
26-1, 141-145	821.41	2.206	2.145	+0.061	+ 2.84	21.0		1.926			4.13	Volcanic sandy siltstone
26-2, 134-136	822.84	2.190	2.066	+0.124	+ 6.00	21.0		1.941	24.25	47.07	4.01	Volcanic sandy siltstone
26-3, 119-121	824.19	2.101	1.937	+0.164	+ 8.47	21.0		1.883			3.65	Volcanic clayey siltstone
26-4, 128-130	825.78	2.198	2.129	+0.069	+ 3.24	21.0		1.917	23.66	45.36	4.08	Volcanic silty claystone
26-5, 138-140	827.38	2.151	2.045	+0.106	+ 5.18	21.0		1.879	28.90	54.30	3.84	Volcanic clay-rich sandy siltstone
27-1, 113-115	831.13	2.252	2.170	+0.082	+ 3.78	21.0		1.940	25.28	49.04	4.21	Volcanic sand-rich clayey siltstone
27-2, 113-115	832.63	2.225	2.141	+0.084	+ 3.92	21.0		1.942	24.93	48.41	4.16	Volcanic clayey siltstone
27-4, 134-136	835.84	2.140	2.039	+0.101	+ 4.95	21.0		1.954	24.91	48.67	3.98	Volcanic sand-rich clayey siltstone
27-5, 128-130	837.28	2.100	1.999	+0.101	+ 5.05	21.0		1.876	25.11	47.11	3.75	Volcanic silty claystone
27-6, 122-125	838.72	2.367	2.200	+0.167	+ 7.59	21.0		1.970	23.65	46.59	4.33	Volcanic clayey siltstone
28-1, 97-99	849.47	2.303	2.209	+0.094	+ 4.26	21.0		1.970	22.97	45.25	4.35	Volcanic silty claystone
28-2, 66-68	850.66	2.363	2.274	+0.089	+ 3.91	21.0		1.955	21.61	42.25	4.45	Volcanic silty claystone
28-3, 33-35	851.83	2.289	2.126	+0.163	+ 7.67	21.0		1.989	24.32	48.37	4.23	Volcanic clayey siltstone
28-4, 29-32	853.29	2.055	1.882	+0.173	+ 9.19	21.0		1.888	27.07	51.11	3.55	Volcanic silty claystone
28-5, 42-44	854.92	2.255	2.132	+0.123	+ 5.77	21.0		1.921	23.20	44.57	4.10	Volcanic clayey siltstone
28-6, 118-120	857.18	2.201	2.078	+0.123	+ 5.92	21.0		1.922	23.85	45.84	3.99	Volcanic clayey siltstone
29-2, 81-83	869.81	2.174	2.070	+0.104	+ 5.02	20.0		1.945	26.00	50.57	4.03	Volcanic clayey siltstone
29-3, 73-75	871.23	2.166	2.041	+0.125	+ 6.12	20.0		1.929	23.93	46.16	3.94	Volcanic clayey siltstone
29-4, 56-58	872.56	2.211	2.112	+0.099	+ 4.69	20.0		1.955	23.18	45.32	4.13	Volcanic clayey siltstone
29-5, 95-97	874.45	2.223	1.986	+0.237	+11.93	20.0		1.940	26.65	51.70	3.85	Volcanic sand-rich clayey siltstone
30-1, 126-128	887.76	2.478	2.303	+0.175	+ 7.60	21.0		2.000	21.72	43.44	4.61	Volcanic silty claystone
30-2, 24-26	888.24	2.099	1.937	+0.162	+ 8.36	21.0		1.953	25.10	49.02	3.78	Volcanic clayey siltstone
30-3, 25-28	889.75	2.339	2.142	+0.197	+ 9.20	21.0		1.989	22.18	44.11	4.26	Volcanic clayey siltstone
30-4, 54-56	891.54	2.344	2.239	+0.105	+ 4.69	21.0		2.013	18.64	37.52	4.51	Volcanic silty claystone
31-1, 130-135	906.80	2.167				21.0						Volcanic silty claystone
31-1, 135-137	906.85	2.024				21.0						Volcanic clayey siltstone
31-1, 138-145	906.91	4.015				21.0	2.542				10.21^c	Basalt
31-2, 70-80	907.75	4.090				21.0	2.576				10.54^c	Piece 11 – basalt

TABLE 4 – *Continued*

Sample (Interval in cm)	Depth in Hole (m)	Compressional Sound Velocity					“Special” Wet-Bulk Density[a] 2-min. count (g/cc)		Wet-Water Content Salt Cor. (%)	Porosity[b] (%)	Acoustic Impedance $\frac{g\ 10^5}{cm^2\ sec}$	Lithology
		∥ Beds (km/sec)	⊥ Beds (km/sec)	Anisotropy		Temp. (°C)	∥ Beds	⊥ Beds				
				∥−⊥ (km/sec)	(∥−⊥) ÷ ⊥ (%)							
31-3, 62-75	909.18	4.724				21.0	2.724				12.87^c	Piece 11 – basalt
31-4, 118-125	911.22	4.880				21.0	2.727				13.30^c	Piece 13 – basalt
32-1, 140-150	916.45	4.924				21.0	2.735				13.47^c	Piece 6 – basalt
32-2, 39-51	916.95	4.919				21.0	2.742				13.49^c	Piece 4 – basalt
32-3, 100-116	919.00	4.947				21.0	2.716				13.44^c	Piece 11 – basalt
32-5, 75-87	921.80	4.828				21.0	2.755				13.30^c	Piece 2 – basalt
32-6, 0-15	922.56	4.548				21.0	2.682				12.20^c	Piece 1 – basalt
33-1, 82-91	925.35	5.264				21.0	2.840				14.95^c	Piece 11 – basalt
33-2, 133-150	927.40	5.481				21.0	2.836				15.54	Piece 6 – basalt
33-3, 138-150	928.91	3.024				21.0	2.312				6.99^c	Volcanic clayey siltstone
33-4, 138-150	930.42	4.541				22.0	2.715				12.33^c	Piece 26 – basalt
34-1, 20-43	934.30	4.695				21.0	2.727				12.80^c	Piece 2 – basalt
34-2, 27-39	935.82	4.534				21.0	2.709				12.28^c	Piece 8 – basalt
Hole 317B												
17-1, 115-117	150.15	1.600	1.604	-0.004	- 0.25	22.0		1.846	38.78	71.59	2.96	Foram nanno chalk, disturbed
19-3, 52-54	171.52	1.605				21.0			39.50			Foram nanno chalk, disturbed
19-4, 104-106	173.54	1.614				22.0			37.51			Foram nanno chalk, disturbed
22-3, 124-127	200.74	1.702				21.0	1.839		27.60	50.76	3.13^c	Foram nanno firm ooze, disturbed lump
24-1, 135-140	216.85	1.525				22.0	1.741		36.36	63.30	2.66^c	Foram nanno firm ooze, disturbed lump
24-4, 140-143	221.40	1.576				22.0	1.553		34.49	53.56	2.45^c	Foram nanno firm ooze, disturbed lump
24-6, 58-61	223.58	1.592				22.0			37.01			Foram nanno firm ooze, disturbed lump
27-5, 128-131	251.28	1.585				22.0	1.770		34.03	60.23	2.81^c	Foram nanno firm ooze, disturbed lump
28-5, 105-110	260.55	1.563				22.0	1.745		34.33	59.90	2.73^c	Nanno firm ooze, disturbed lump
33, CC	310.50	5.116				21.0						Chert
42-2, 140-141	389.40	1.828				22.0			26.53			Nanno chalk
42-2, 141-145	389.42	5.107				22.0			1.29			Chert
44-1, 135-140	406.85	1.976				22.0	1.976		18.78	37.11	3.90^c	Foram nanno chalk
44-1, 140-145	406.91	5.023				22.0	2.525		1.42	3.59	12.69^c	Chert

[a] ρ_g & ρ_{gc} = 2.70 for sed. rocks, 2.65 for cherts, and 2.86 for basalt.

[b] Porosity = (salt corrected wet-water content) X (wet-bulk density).

[c] Horizontal.

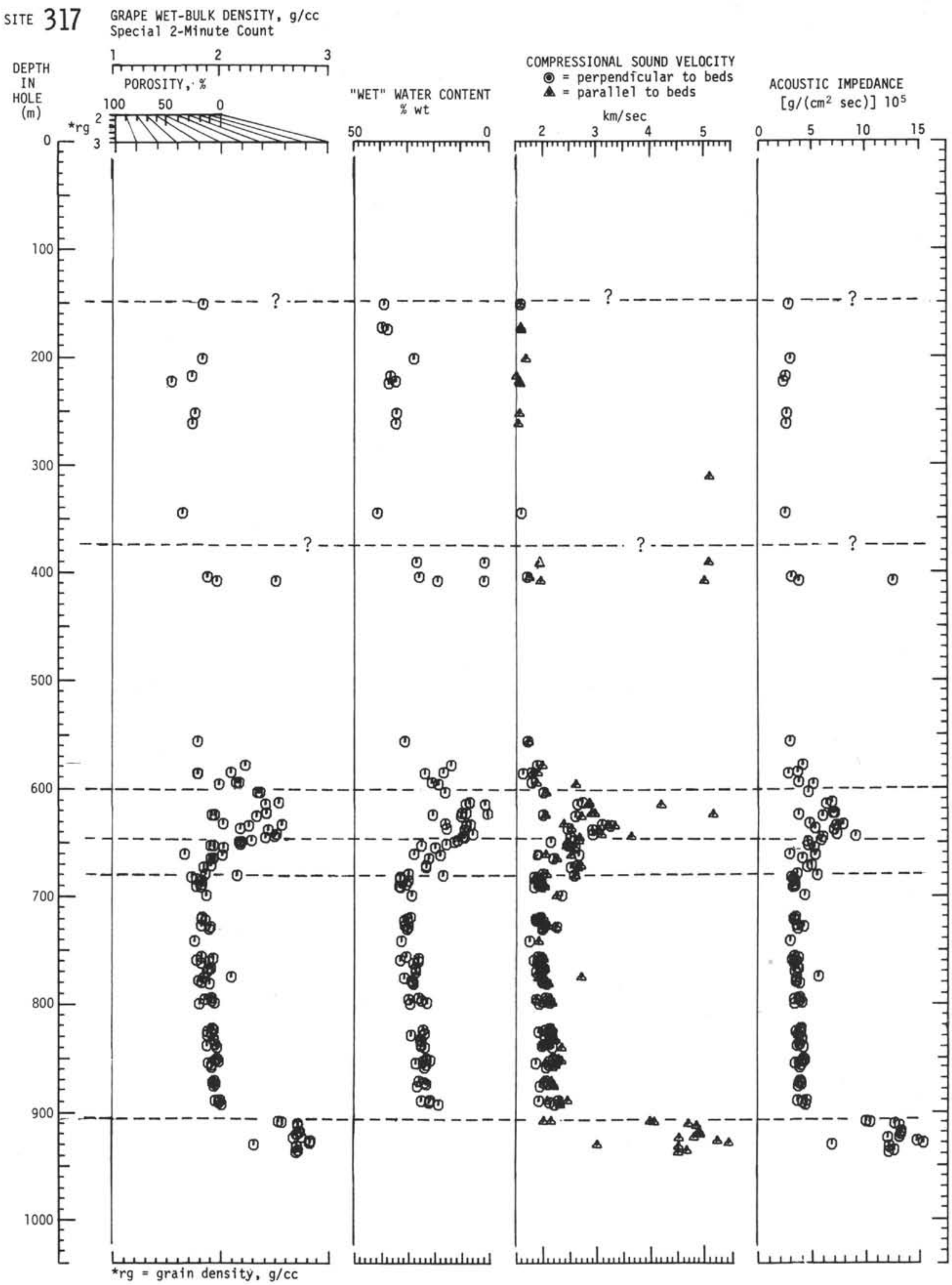

Figure 7. *Summary of physical properties at Site 317. GRAPE analog data, both corrected and uncorrected for actual core diameter, are presented at the end of this chapter.*

TABLE 5
Site 317 Summary of Stratigraphic Grouping on the Basis of Rock Physical Properties (Lab Temperature and Pressure)

Lithology	Depth (m)	Cores	Typical Wet-Bulk Density (g/cc)	Typical Wet-Water Content (wt %)	Typical Porosity (vol %)	Typical Sound Velocity (km/sec)	Typical Acoustic Impedance $\frac{g\ 10^5}{cm^2\ sec}$	Typical Reflection Coefficient at Boundary (no chert)
Ooze	0-150	1B-16B	Sediment too disturbed to make proper physical property measurements					
Drill disturbed lumps of foram nanno, and nanno firm ooze and chalk: Miocene to Eocene	~150 to ~377	17B-33B	1.55-1.84 disturbed	28-41 disturbed	53-71 disturbed	1.52-1.70 disturbed	2.5-3.2	0.09
Foram nanno and nanno chalk; Minor claystone and chert: Eocene to Cretaceous	~377 to ~602	42B 1A-7A	1.8-2.2 (chert 2.5)	13-31 (chert 1.4)	30-56 (chert 3.5)	1.65-2.00 (chert 1.5)	3.0-4.0 (chert 12.7)	0.10
Nanno micritic limestone; Minor chalk, claystone, and chert: Cretaceous (Cenozoic, Albian, Barremian Aptian?)	~602 to ~645	8A-12A	2.20-2.58 (low = 1.9)	0.2-20	14-40	2.6-3.3V 2.7-3.7H (low = 2.0) (chert 4.7 to 5.1)	3.9-7.4	0.20
Volcaniclastics with interbedded limestone Cretaceous (Barremian-Aptian?)	~645 to ~680	12A-16A	1.7-2.3 decreasing downward	12-30 increasing downward	26-55 increasing downward	2.0 and decreasing downward	3.1-6.0 decreasing downward	0.27
Volcaniclastics and minor mineralization zones: Cretaceous?	~680 to 906.9	16A-31A	1.75-2.00 increasing downward	19-32 decreasing downward	37-58 decreasing downward	1.85-2.34H 1.80-2.20V increasing downward	3.2-4.5 increasing downward	0.39
Basalt with minor clastic interbed (data for dense basalt only)	906.9 to ~936	31A-34A	2.54-2.84			4.0-5.5	10.2-15.5	

Note: H = horizontal; V = vertical.

(~602 to ~645 m) by its significantly lower wet-bulk density, sound velocity, and acoustic impedance, and higher wet-water content and porosity. The boundary at 602 meters is arbitrary and could also be located within the interval 575 to 610 meters; 602 meters was selected on the basis of what appears to be a basic increase in wet-bulk density, sound velocity, impedance, and a decrease in wet-water content and porosity. As there are not many cores from 400 to 570 meters, the 602-meter boundary is subjective because it is difficult to determine "statistical" variations. This boundary also could correlate with the Maestrichtian-Campanian boundary at 576 meters at which level the 0.60-sec reflector is assumed to be.

This fourth interval (~602 to ~645 m) is characterized by high velocity, impedance, wet-bulk density, and low wet-water content and porosity. It is basically Cretaceous limestone with minor chalk, claystone, and chert. The lower boundary at 645 meters is placed where the typical wet-bulk density, impedance, and, to a lesser extent, velocity, show a distinct decrease, and wet-water content an increase with depth.

interval 5 (~645 to ~680 m) is characterized by decreasing wet-bulk density, acoustic impedance, and to a lesser extent, sound velocity, and increasing wet-water content and porosity. These changes are caused by limestones and interbedded volcaniclastics, with the frequency of interbedded volcaniclastics increasing with depth. The lower boundary at ~680 meters is placed at the level where the volcaniclastics become the basic lithology, and wet-bulk density, impedance, and sound velocity are low, become constant, or reverse their trend with depth. Wet-water content and porosity are high at the ~680 meter boundary and slightly decrease with increasing depth interval 6 (~680-906.9 m).

The top of interval 7 at 906.9 meters is the top of basalt. Physical characteristics change drastically across this boundary. Sound velocity, wet-bulk density, and impedance increase markedly.

Discussion

Basalt velocities were determined for the hard and denser portions and excluded the obviously vesicular basalts. Densities for the vesicular basalt (and velocity if it had been measured) would not have been representative of in situ conditions as the pore water had drained out. Densities and velocities of the vesicular basalt should be measured after resaturation.

The reflection coefficients calculated are only typical of what may be present at the boundaries of major units. The few that are calculated are not an indication of the location or number of such impedance mismatches.

In general, sedimentary rocks have higher velocity parallel rather than perpendicular to bedding. Anisotropy seems to be smaller at this site than at other sites, perhaps caused by being in a different geomorphic province. The Tertiary sediments have anisotropies of 9 to 2%, while the Cretaceous sedimentary rocks have anisotropies between 0 and 12%. The limestones above 680 meters and the volcaniclastics between 680 and 800 meters had a typical velocity anisotropy of 0 to 6%.

The velocity anisotropy and the low velocity strata under the high velocity limestones are significant when interpreting refraction profiles and comparing refraction profiles with reflection profile data.

CORRELATION OF REFLECTION PROFILE WITH DRILLING RESULTS

The acoustic stratigraphy in the vicinity of Site 317 is shown on the reflection profiler records obtained by *Glomar Challenger* (Figures 2 and 4). Six prominent subbottom reflectors are traceable on these records:

1) A weak reflector (a doublet) at 0.07-0.08 sec above a relatively transparent layer.

2) A reflector at 0.17 sec, at the top of an interval about 0.05 sec thick with several internal reflectors.

3) A strong reflector at 0.225 sec, at the top of an acoustically rather opaque unit about 0.05 sec thick, with internal reflectors, lying on a more transparent unit extending from 0.28 sec down to 0.395 sec.

4) A strong reflector at 0.395 sec, at the top of a rather opaque unit about 0.07 sec thick. Beneath the opaque layer is a layer varying in thickness from a knife edge to about 0.10 sec that is very transparent where it is thickest (e.g., at Site 317), and includes internal reflectors where thinner (e.g., between 0700 and 1100 hr on Figure 4).

5) A very prominent reflector at 0.60 sec, defining the top of an opaque unit about 0.17 sec thick (i.e., very dense in the upper 0.06 sec and less dense below). Beneath this layer is a more transparent layer extending down to about 0.87 sec, including local internal reflectors (e.g., between 0600 and 0800 hr in Figure 3). The thickness of section between the 0.60-sec reflector and acoustic basement (reflector 6) varies regionally from about 0.40 sec to the vanishing point, and the 0.60 reflector itself appears to be at an angular unconformity (Winterer et al., 1974).

6) A good reflector at 0.87 sec, traceable across most of the High Plateau part of the Manihiki Plateau (Winterer et al, 1974). This is the deepest reflector consistently identifiable over the High Plateau, and is taken as acoustic basement. At a few places, a possible reflector about 0.5 sec below acoustic basement can barely be discerned, but these deep fuzzy reflections are not traceable over more than a few tens of kilometers at the most.

Several of the reflectors crop out in steep escarpments along the walls of valleys in the general area of Site 317. An escarpment was crossed at about 0630 hr 30 November (Figure 4), and on that slope can be seen the outcropping of the reflectors at 0.07, 0.17, and 0.225 sec. Another escarpment with outcropping reflectors is shown at about 0800 hr 8 December (Figure 4). No evidence of erosion of the stratigraphic section is seen in the profiler records at Site 317 itself.

Two sonobuoys were released near Site 317. The first, relased while the ship was positioned over the site itself, gave a very clear record, but the distance traveled by the buoy was only about 2 km, and the record is therefore not very useful for determining interval velocities. The second buoy, released about 2 miles west of Site 317, was monitored for about 1 hr while the ship steamed along a course of 103°, directly back over the drill site, at a speed of about 7 knots. This record (Figure 8) yields the following interval velocities:

2-Way Reflection Time Below Sea Floor (sec)	Average Velocity From Sea Floor to Reflector (km/sec)	Deduced Depth To Reflector (m)	Interval Velocity of Unit Above Reflector (km/sec)
0.60	1.82	546	1.82
0.87	2.05	891	2.55

Taking the sonobuoy results together with the results of drilling, a plausible sequence of acoustostratigraphic units can be erected (Table 6). The major acoustic stratigraphic units are summarized in Figure 9, alongside the reflection profiler record taken during approach to the site.

Several criteria were used in choosing certain depths in the drill hole as corresponding to the various reflectors seen on the seismic profile. For the first reflector, at 0.07 sec, a reasonable range of velocities would lie in the interval 1.55 to 1.70 km/sec, which gives a depth range of 54 to 60 meters. Based on the velocities at Sites 64 and 72 (Winterer et al., 1971; Tracey et al., 1971) for young calcareous sediments, and taking into account the zeolitic nature of the uppermost sediments at Site 317, a velocity of 1.65 km/sec was assumed. This places the reflector within the white calcareous oozes, about 15 meters above a change in slope of the curve showing rate of accumulation (Figure 10), from slower accumulation below to faster accumulation above. The sediments just above the break in slope are white, while those just below are slightly darker in color. The change in acoustic impedance that gives rise to the sound reflection would thus appear to be associated with some change in properties of the white (more rapidly deposited) sediments. Perhaps these sediments contained at the time of their burial a larger fraction of easily dissolved calcium carbonate than the more slowly deposited darker colored sediments, giving the white oozes a greater diagenetic potential (Schlanger and Douglas, 1974).

A similar change can be seen between Cores 15 and 16 in Hole 317B), at a depth of about 140 meters, where white ooze lies above yellowish and brownish oozes and where there is a change in the rate of sediment accumulation (Figure 10) from slower below to faster above. Recovery was poor in Core 15, and the actual color contact was not sampled. The ooze in Core 16 is firm, while that in Core 15 (and in shallower cores as well) is soft. This change in consolidation makes it seem reasonable to accept 140 meters as the most plausible depth to the reflector seen at 0.17 sec on the profiler record. If the reflector were any shallower, the interval velocity would fall at the rate of about 0.01 km/sec per meter of depth change.

The next reflector, at 0.225 sec, is picked as the top of Core 22 of Hole 317B, and 197 meters, on the basis of a change from brownish above to whitish below. No marked change in rate of accumulation or degree of consolidation was observed here (Figure 10), but the reflector cannot reasonably be placed much deeper (for exam-

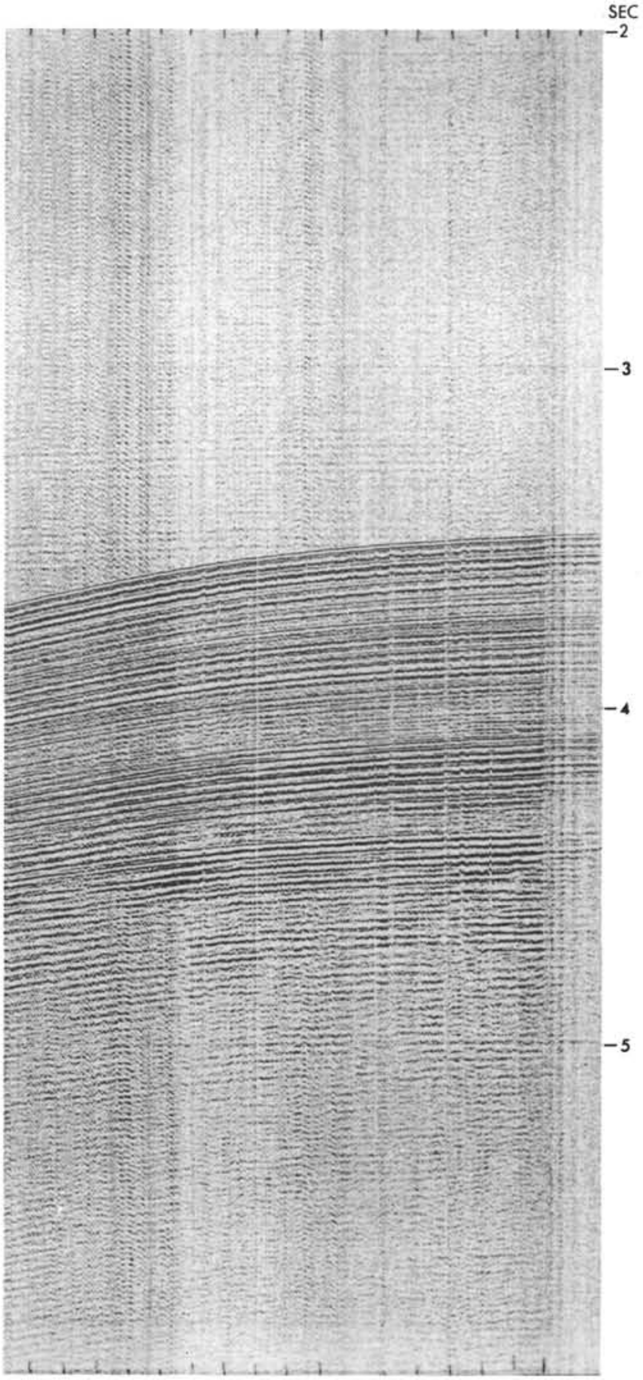

Figure 8. Glomar Challenger *sonobuoy record obtained at Site 317.*

ple, at the change in accumulation rate at about 215 m) without a corresponding increase in interval velocity. Although the deduced velocity of 2.07 km/sec is already high for firm ooze or soft chalk, we have no assurance that the disturbed biscuits of sediment in the cores are representative of the in situ sediments.

The reflector at 0.395 sec is most plausibly associated with the unconformity in the middle Eocene at 358 meters, between Cores 38 and 39 of Hole 317B. Below this contact the chalks contain abundant chert, while above, chert is very sporadic. The interval velocity for the unit between 197 and 358 meters is calculated to be 1.89 km/sec, which is lower by about 0.2 km/sec than that of the interval above it (140-197 m). Inspection of the profiler record (Figure 9) shows two subunits within the interval from 0.225 to 9.395 sec: a more opaque unit from 0.225 to 0.280 sec, and a more transparent unit from 0.280 to 0.395 sec. If we associate this change from more opaque to more transparent with the change in accumulation rate and the color change from white to brownish at 253 meters (between Cores 27 and 28 of Hole 317B), we deduce interval velocities of 2.04 km/sec for the upper and 1.83 km/sec for the lower subunit.

The location of the 0.60 reflector is a problem; a possibility is that the change from Maestrichtian chalk to fairly hard Campanian claystone, at 576 meters (Core 4 of Hole 317A), represents a change in acoustic impedance sufficient to account for the reflector. Another possibility is that the hiatus at 592 meters between Cores 6 and 7, which represents a major lithologic change, causes the reflector. Neither of these depths agrees with the sonobuoy data.

There can be but little doubt about the reflector at 0.87 sec. The top of the basalt was cored at 910 meters, and although a few thin layers of sedimentary rock were cored between flow units, the change in average acoustic impedance at the top of the basalt is very large (Figure 7). The relatively low interval velocity of 2.57 km/sec calculated for the unit between 563 and 910 meters actually averages the velocities of two subunits: (1) an upper unit, from 563 to about 675 meters, where velocities as measured in the laboratory are typically between 2.0 and 2.5 km/sec. The upper unit consists largely of limestone with minor volcaniclastic sediments as interbeds, changing progressively downward to volcaniclastic sediments with only minor limestone. Limestone is nearly absent below 675 meters. These changes can be seen graphically in the graphs of $CaCO_3$ content and drilling rate (Figure 5). On the reflection profiler record (Figure 9), an upper opaque unit and a lower more transparent unit can be seen between the reflectors at 0.60 and 0.87 sec. Using 0.06 sec as the thickness of the opaque subunit and a boundary at 675 meters, an interval velocity of 3.73 km/sec is calculated for the upper limestone unit, and 2.24 km/sec for the lower volcaniclastic unit.

Four of the upper reflectors at 0.070, 0.170, 0.225, and 0.395 sec, correspond almost exactly in terms of their ages, based on nannofossil and foraminifer zones, to the "b," "c," "d," and "e" reflectors of Schlanger and Douglas (1974) previously identified over a wide area of the near equatorial Pacific ranging from Site 72 through the Magellan Rise (Site 167) and west to Site 64 on the Ontong-Java Plateau (see Table 6).

PALEONTOLOGY

Biostratigraphic Summary

A nearly continuous, southern mid-latitude, fossiliferous sequence was recovered in the 680 meters of calcareous sediment that overly 225 meters of sparsely fossiliferous volcanogenic sediments and basalt at Site

TABLE 6
Acoustistratigraphic Units at Site 317

Two-Way Reflection Time Below Sea Floor (sec)	Depth Below Sea Floor (meters)	Lithology of Interval Above Reflector	Average Velocity From Sea Floor to Reflector (km/sec)	Interval Velocity (km/sec)	Age-Zone of Reflectors at 317	Schlanger-Douglas Reflector (1974)	Core
0.070	58	Calcareous ooze	1.65[a]	1.65[a]	NN12 5–6 m.y. (Mio.-Plio. boundary)	"b" 5–6 m.y.	317B-7
0.170	140[b]	Ooze	1.65	1.65	NN6-NN7 12 m.y.	"c" 12–14 m.y.	317B-15 to 16
0.225	197[c]	Firm ooze and chalk	1.75	2.07	*G. Trilobus/ G. Kugleri* 21 m.y.	"d" 21–26 m.y.	317B-22 (top)
0.395	358[d]	chalk and cherty chalk	1.81	1.89	Upp. Eocene Low. Eocene 41–47 m.y.	"e" 43–44 m.y.	317B-38-39 boundary
0.600	576[e] 592	cherty chalk	1.92[e]	2.13[e]	Maestrichtian-Campanian		317A-4 base or between Core 6A & 7A at 592
0.870	910[f]	limestone, cherty limestone; volcanogenic claystone and sandstone	2.09	2.57[g] 2.47[g]	Santonian- or Turonian Top of basalt.		317A-31

[a] Assumed v based on considerations of lithology and comparison with shallow reflector v's at Sites 64 and 167.

[b] 140-meter depth selected on the basis of a color change from white above to brownish below and a change from soft to firm ooze; see text.

[c] 197-meter depth selected on the basis of a color change from brownish above to white below; see text.

[d] Placed at unconformity that marks upper limit of abundant chert.

[e] Placed at chalk-brown stiff claystone entact at base of Core 317A-4 or between Cores 6A & 7A @ 592.

[f] Top of basalt.

[g] These two values are based on interval alternatives of 563 to 910 and 576 to 910 meters.

317. The only major part of the section missing is that between 425 and 555 meters, encompassing Paleocene and ?uppermost Cretaceous sediments, which were not cored due to operational considerations.

Nannofossils are present in all cores down to 675 meters, but are generally poorly preserved below the upper Miocene. Foraminifers occur abundantly in the Cenozoic and Maestrichtian and are generally well preserved. Below the Maestrichtian, however, foraminiferal representation is poor, consisting of sporadic, poorly preserved benthonic foraminifers of little chronologic significance. Foraminifers were not found below Core 14 of Hole 317A (~670 m). Radiolarians are present only from the upper Oligocene through upper Miocene, but preservation is not good and some zonal intervals were not recognized. Poorly preserved, calcified radiolarians of quality not sufficient for reliable identification occur in the Cretaceous of Hole 317A, Cores 8 through 11.

Stratigraphically, the lowest recorded fossils at Site 317 are molluscs, which occur in Cores 10-13 and 16 in Hole 317A, and comprise valves, fragments, and spat of *Inoceramus* varieties. These have been collected for further shore-based examination (see Kauffman, this volume).

Probably as a result of the location of Site 317 below the central water mass throughout much of its history, the depositional rate is somewhat low and nearly linear from the beginning of the Cenozoic, and averages roughly 10 m/m.y. The Cretaceous sequence, in contrast, is extremely condensed, with a net accumulation rate, including compaction effects, of slightly more than 1 m/m.y. The principal inflection in the rate curve occurs at the Cretaceous/Tertiary boundary (see Figure 10). The deposition rate of the basalt-volcanogenic sequence is uncertain due to lack of age data, but is probably relatively high. The only visible interruptions in deposition at Site 317 since the Early Cretaceous are possible disconformities between the middle Campanian and Santonian, Santonian and lower Turonian, and the middle and upper Eocene; but in essence, deposition has been slow and continuous.

Cenozoic Foraminifers

Foraminifers are abundant and generally well preserved in the Cenozoic sediments cored at Site 317, and provide an outstanding reference section of marly continuous deposition in middle southern latitudes. The only intervals that are not well represented are the lower middle Eocene (Cores 42B-45B) where recovery was mainly of chert, and portions of the middle Miocene, where poor recovery obliterates the *Globorotalia fohsi s.l.* to *G. mayeri s.l.* interval (Cores 14B, 15B, and 17B). In addition to the continuously cored Cenozoic interval of Hole 317B, additional Cenozoic samples were obtained in Cores 1 (Pleistocene) and 2 (lower Miocene) of Hole 317. Material in Cores 1 (upper Miocene or lower middle Eocene) and 2 (lower Eocene or Cretaceous) of Hole 317A are not representative of the age of the nominally cored intervals, but probably represent sediment unintentionally recovered from the overlying interval through which the bit was washed.

Foraminifer assemblages have, in general, all been affected by carbonate dissolution, but not seriously enough to preclude zonal assignment. Preservation is excellent in the lower middle, and lower upper Eocene, then declines to very poor in the uppermost Eocene. Preservation is slightly better in the lowermost Oligo-

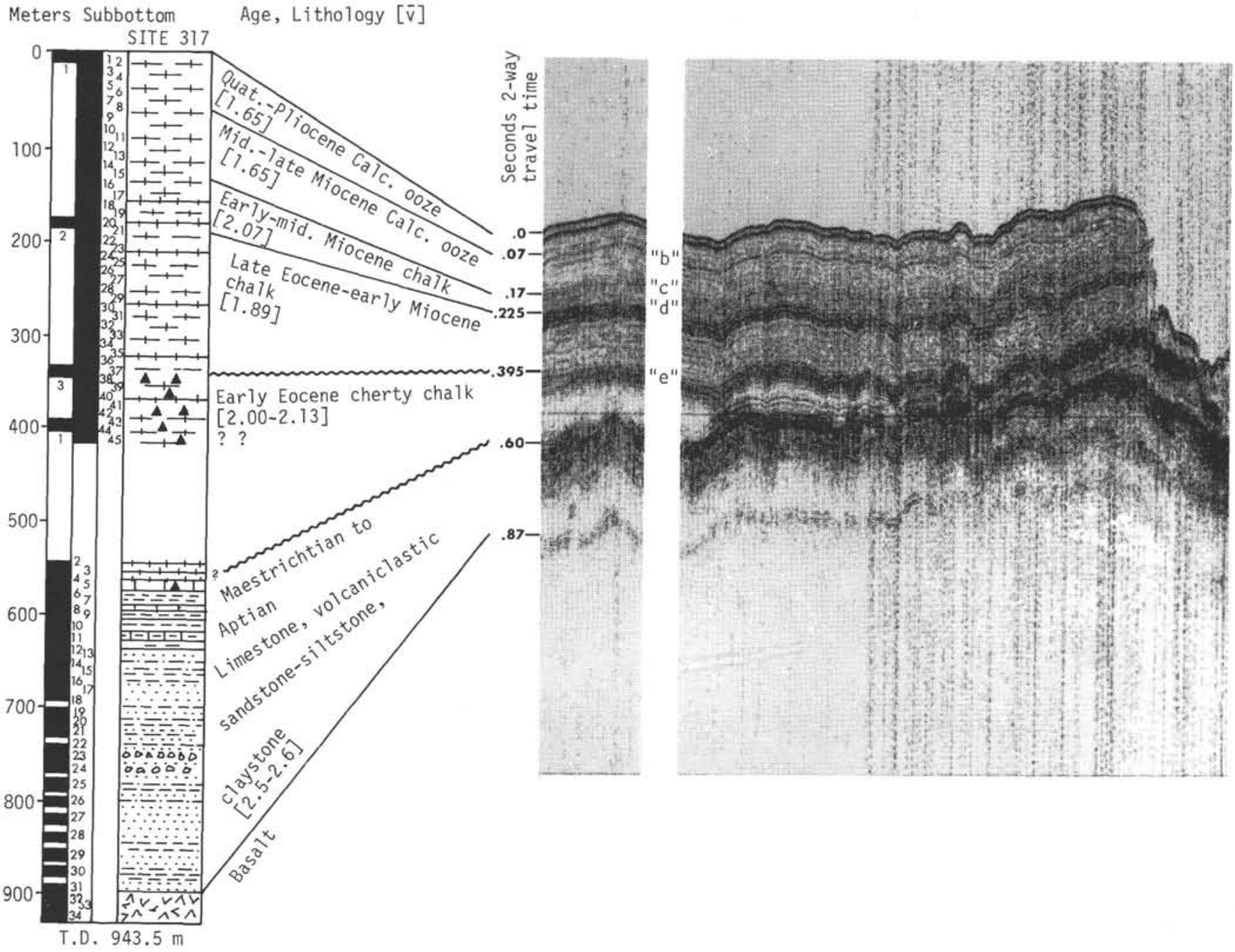

Figure 9. *Correlation of* Glomar Challenger *seismic reflection profile and the section drilled at Site 317.*

cene, improved in the middle Oligocene, and remains good to the top of the section (with the exception of a slight decline in the upper lower Miocene).

Eocene

The upper Eocene (*Globigerapsis mexicana* and *Globorotalia cerroazulensis* Zones) lies disconformably on the middle Eocene (*Globigerapsis kugleri* and *Globorotalia lehneri* zones) with the *Orbulinoides beckmanni* and *Truncorotaloides rohri* zones missing. The assemblages of the middle Eocene and the lower part of the *G. mexicana* Zone are nearly identical to the Trinidad assemblages described by Bolli (1957). Preservation, however, becomes increasingly poor toward the Eocene/Oligocene boundary, until what remains in the uppermost Eocene is a dissolution residue of heavy walled forms and common *Hantkenina* spines as pointed out by Jenkins (1964).

Oligocene

A zonal sequence nearly identical to that proposed by Bolli (1957, 1966) is seen in the Oligocene of this site. The lowest Oligocene is encompassed by the overlap in the ranges of *Pseudohastigerina ampliapertura* interval, at the top of which the marker disappears (*G. ampliapertura* is generally very scarce and seems to be seriously affected by solution; only partially fragmental specimens were seen). This is overlain by Bolli's undefined interval (which probably corresponds to Blow's (1969) *G. selliitapuriensis*, P.18/19 zones), followed by the *Globorotalia opima*, *"G. ciperoensis,"* and lower *G. kugleri* zones. *G. opima* is extremely scarce and *G. ciperoensis* is absent, probably for ecological reasons.

Miocene-Pliocene

This part of the section is fairly orthodox and follows the Bolli zonation. The only problem lies in recognizing the upper Miocene *Globorotalia acostaensis* Zone, owing to the extreme scarcity of the marker. The lower boundary, as presently drawn, is tentative and may have to be revised, or alternatively, a new scheme for subdivision of the *Globorotalia menardii*/*G. acostaensis* interval may have to be devised. The scarcity of *G. acostaensis* is probably due to ecological reasons; the species, along with the related *G. humerosa* and *G. dutertrei* seem to prefer highly productive areas (for example, they are dominant in the faunas of the Panama Basin cored during DSDP Leg 16 (van Andel, Heath, et al., 1973) and would not be expected to be common in the central water mass under which Site 317 is located.

Pleistocene

The base of the Pleistocene is drawn at the last occurrence of *Globorotalia limbata* (= right-coiling *G. menardii s.l.*). The Pleistocene is tentatively zoned by means of two species of "*Globoquadrina*." Most of the lower part of the Pleistocene is characterized by common *G. pseudofoliata,* an interval in which *G. conglomerata* is absent. The latter species appears near the top of Core 1 of Hole 317 and continues to the top. There is a short overlap of the two species; hence, the base of the *G. conglomerata* Zone is drawn at the first occurrence of the marker species, and is roughly equivalent to the base of the *Gephyrocapsa oceanica* nannofossil Zone.

Globigerinoides fistulosus is extremely abundant and well developed in the upper Pliocene and lower Pleistocene of Site 317, as has been previously noted by Kierstead et al. (1979). In addition, the small biserial (probably planktonic) *Bolivina* (renamed *Streptochilus* by Brönnimann and Resig, 1971) *tokelauae* is common in middle Miocene to upper Pleistocene sediments of Site 317.

Mesozoic Foraminifers

Foraminiferal faunas from Hole 317A are closely related to lithology, which includes Maestrichtian chalk and limestone, clays and clayey chalks of questionable age, Albian-Aptian lemestones, and basal, volcanogenic clastics.

Cretaceous foraminifers were encountered first in Sample 2A, CC, which yielded a mixed Maestrichtian fauna. The horizon is associated with a drilling break.

Samples from Core 3A contain nominate species from all three Maestrichtian foraminiferal zones, suggesting slow and unstable sedimentation that is compatible with the short Maestrichtian interval of 9.5 meters.

The dark clays yield little or no foraminiferal material, consisting of small recrystallized benthonics. The upper part of this interval, Cores 5A-6A, appears to be Campanian or younger. The lower part, Cores 7A-9A, appears to be Albian, except for possibly a few meters of Santonian in uppermost Core 7A.

The Aptian-Albian carbonates are distinguished by faunas of large, long-ranging lagenids. However planktonics are present, indicating the *Ticinella roberti* and *Hedbergella trocoidea* zones, the *Globigerinelloides algerianus* Zone, and the *Leupoldina cabri* Zone.

The basal unit becomes increasingly volcanogenic and very few foraminiferal residues were recovered below Core 12A, although pelecypod and ostracode remains are sporadically common through Core 15A.

Calcareous Nannoplankton

Three holes were drilled at Site 317, encompassing a sequence from upper-lower Cretaceous (approx. 675 m, Core 15, Hole 317A) to Recent, with the exception of the Paleocene, which is most likely present in the missing interval between 450 and 550 meters. Cores 16A to 30A are barren of calcareous nannoplankton, and at approximately 910 meters basalt (Core 31, Hole 317A) was encountered, in which coring terminated at 943.5 meters (Core 34, Hole 317A).

Three survey cores were taken in Hole 317. Core 1 from just below sea floor contains Quaternary calcareous nannoplankton (Zones NN19 to NN21). Core 2, from a depth of approximately 185 meters, yielded nannoplankton of the uppermost Oligocene/lowest Miocene Zone NN1, with *Coccolithus abisectus* present. In Core 3, recovered from a depth of approximately 300 meters, calcareous nannoplankton of the upper Eocene Zone NP20 were found in chalk attached to a piece of chert recovered in the core catcher; this is overlain by an obviously misplaced 50 cm of sediments containing NN1 nannoplankton.

In Hole 317A, a survey core taken at approximately 410 meters yielded calcareous nannoplankton indicative of the middle Eocene Zone NP15, overlain by some 10 cm of misplaced lowest upper Miocene (Zone NN9). From about 560 meters downward, the sequence contained lower Maestrichtian fossils (Cores 2 and 3), with approximately 60 cm of misplaced lower Eocene (nannoplankton Zone NP12) above them (Core 2), to Barremian-Aptian (?) in Cores 10 through 15. The calcareous nannoplankton in all Cretaceous cores, with the exception of those in part of the Maestrichtian, are badly preserved; assemblages are, for the most part, diminished by solution; in the lower cores *Watznaueria barnesae* and *Parhabdolithus embergeri* are the only remaining identifiable species. In the Maestrichtian-Albian interval *Tetralithus trifudus, Tetralithus aculeus, Marthasterites furcatus, Micula staurophora, Eiffellithus turriseiffeli, Lithastrinus floralis,* and *Deflandrius cretaceus* were among species used for age determination. Unconformities might be present between the middle Campanian and the Santonian and lower Turonian (Core 7/Core 8), but due to low recovery and an obviously condensed section, this can not be confirmed. Below Core 9, the sediments do not contain *Deflandrius cretaceus* nor *Cruciellipsis cuvillieri*, which are reported as being solution resistant. The interval between the last occurrence of *Cruciellipsis cuvillieri* and the first occurrence of *Deflandrius cretaceus* is thus assigned to the Barremian and Aptian; however, Cores 10 to 15 may not represent this entire interval. Cores 16 to 30, Hole 317A, below which basalt was encountered, proved to be barren of calcareous nannoplankton.

In Hole 317B, the upper section from the sea floor to approximately 425 meters was sampled in 45 cores. All nannoplankton zones from Recent NN21 to upper Eocene NP20 (Core 38 at approximately 360 m) were recovered with the exception of Zones NN19, a part of NN18, and Zone NN8. In Core 35, the Eocene/Oligocene boundary as indicated by Zones NP20/NP21 was penetrated three times; this is being investigated further, but may have been caused by surging of the heave compensator. Between Cores 38 and 39 an unconformity may be present inasmuch as a reduced Zone NP17/18 (Core 38) overlies Zone NP16 (Core 39). Below Core 40, the recovery dropped to a minimum as abundant chert layers occur at various depths. Also, nannofossils in this interval show solution effects and heavy calcite overgrowth in certain genera, making age assignments less reliable. The preservation of calcareous nannoplankton is poor at least up to the upper Miocene, with a slight improvement in the Oligocene interval. In the higher parts of the upper Miocene, and in the lower Pliocene, preservation is moderate improving to good in the upper Pliocene and Quaternary. Several species, such as *Helicopontosphaera ampliaperta* in the Miocene, *Helicopontosphaera recta* in the Oligocene, as well as *Zygolithus dubius* in the Eocene, are missing in the tropical Pacific, as previously noted in the Leg 7 report (Martini and Worsley, 1971).

Radiolaria

Radiolarians are common and well preserved only within the upper Miocene through upper Oligocene section at Site 317 (Cores 7-27, Hole 317B; depth 54-254 m). Poorly preserved and nondiagnostic radiolarian debris is present in the Quaternary and Pliocene intervals. Radiolarians are absent below the upper Oligocene sediments, except for some calcified and poorly preserved radiolarians in the Upper Cretaceous material of Cores 8 through 11, Hole 317A (601-640 m). These specimens are insufficiently preserved for reliable shipboard identification.

The following radiolarian zonal boundaries can be identified in the Cenozoic material examined from Site 317. The base of the Quaternary lies between the core catchers of Cores 2 and 3, Hole 317B (16.0-25.5 m). The *Pterocanium prismatium* and *Spongaster pentas* zones were not sufficiently represented to be identified. The base of the *Stichocorys peregrina* Zone lies between 317B-8, CC and 317B-9-1, 70-72 cm (74.0m). The base of the *O. penultima* Zone lies between 317B-10-5, 70-72 cm and 317B-10-6, 70-72 cm (90-91 m). The base of the *O. antepenultima* Zone lies between 317B-12-3, 70-72 cm and 317B-12-4, 70-72 cm (105.0-106.5 m). The base of the *Cannartus petterssoni* Zone lies between the core catchers of Cores 14B and 15B (130.0-139.5 m). The base of the *Dorcadospyris alata* Zone lies between 317B-19-2, 70-72 cm and 317B-19-3, 70-72 cm (171-172.5 m). The base of the *Calocycletta costata* Zone is between 317B-19-4, 70-72 cm and 317B-19-5, 70-72 cm (174.0-175.5 m). The base of the *Calocycletta virginis* Zone lies between 317B-24-3, 70-72 cm and 317B-24-4, 70-72 cm (229.0-230.5 m). The base of the *Lychnocanoma elongata* Zone lies between the core catcher of Core 25B and 317B-26-2, 70-72 cm (234.5-237 m). The base of the *Dorcadospyris ateuchus* Zone lies in the interval below 317B-28-3, 70-72 cm. Radiolarians are absent below this depth at Site 317B.

The abundance of siliceous organisms in only a limited part of the stratigraphic column at this site (upper Oligocene through upper Miocene) may have significant paleoclimatic implications regarding circulation and productivity in the South Pacific during the Tertiary.

Molluscs and Other Macroinvertebrates

Molluscs were found in Cores 10-13 and 16 of the Cretaceous part of Hole 317A. The first occurrences were noted in Core 10, Section 1. They are fairly common in Core 11 (Sections 3 to 5), Core 12 (Sections 1, 2, 5, and 6), and Core 13 (Sections 1 to 3). The last specimens were encountered in Core 16, Section 2, below all occurrences of representatives of other fossil groups.

Several factors prohibit precise age determination and regional correlations based on the macroinvertebrates from Hole 317A. Most are not well enough preserved to allow specific determination, and the age ranges of genera, where determinate, are commonly too long to be useful in precise dating. The ranges of some genera, previously recorded only from Late Cretaceous of younger rocks, are extended into the Early Cretaceous on the basis of material contained in these samples, further detracting from the use of genera as age indicators. In addition, many of the species present are undescribed, and for these only a few can be referred to known species groups, and thus to somewhat restricted age ranges. Most correlations are with Australia. A paucity of pre-Aptian systematic study on southern Pacific Cretaceous biotas also detracts from our ability to identify, date, and correlate these fossils.

By combining the age ranges of genera and species groups present at each level, and by choosing as an age for each level the range of overlap of these date (or the most reliable data if there are major preservational differences between taxa), a general age has been assigned to each collection from Hole 317A. The majority of data indicates that all samples are of Early Cretaceous age, and some data are no more specific than this. The best dates are obtained from comparison of Hole 317A bivalves with known species groups of the genera *Aucellina, Maccoyella,* and *Pseudavicula.* These data are summarized below. For a detailed treatment of the macroinvertebrates from Hole 317A, reference is made to Kauffman (this volume).

Core 10, Section 1, Interval 145 cm may be as old as Barremian and as young as early late Albian; closest relations seem to be with lower to middle Albian *Aucellina*. Other fossils in Core 10 only indicate a Lower Cretaceous age.

Core 11 contains molluscs suggesting a Valanginian to lower Ablian age at the top of the fossiliferous interval (Section 3, Interval 134-137 cm), a probably Neocomian (Valanginian) age in the middle of this interval (Section 4, Interval 50-56 cm, Neocomian-Senonian; Section 5, Interval 6-12 cm, Valanginian), and strangely, a probable Albian age based on *Aucellina* cf. *A. gryphaeoides* near the base (Section 5, Interval 89-96 cm).

Core 12 is dated as Lower Cretaceous, probably Albian (based on *Aucellina* sp. cf. *A. gryphaeoides*) in the upper part (Section 1 through Section 6, interval 43-47 cm), and late Aptian or lower Albian below this.

Core 13 has only a few taxa suggesting a Lower Cretaceous age above Section 2, 78 cm level. Section 2, Interval 78-83 cm indicates Valanginian through Albian age (probably pre-Albian), and Section 3, Interval 90-93 cm suggests an upper Aptian through upper Albian age.

Core 16 contains no diagnostic fossils other than to suggest a Cretaceous age.

The above summary must be applied with caution for reasons previously stated. It is suggested that good microfossil dating from these sediments would be more reliable at the present time than dating based on mollusca. It should be noted, however, that early indications of Barremian through Aptian nannofossils in these sediments (S. Schlanger, personal communication, 1974) are generally compatible with molluscan dating, except where Albian dates are obtained by comparisons of *Aucellina* sp. cf. *A. gryphaeoides* occurrences with those of Queensland, Australia cited for identical forms by Day (1968).

ACCUMULATION RATES

Good, though incomplete, accumulation rate data were obtained at this site. Data are incomplete for two parts of the section: (1) the uncored interval between lower Eocene and Maestrichtian sediments, and (2) the thick section of volcanogenic sediments at the bottom of the hole which are barren of datable fossils for nearly 200 meters above basaltic basement. For the upper interval we can only interpolate between cored sections; for the lower interval it is possible to interpolate between the lowest fossil date (lower/upper Aptian boundary, 107 m.y.) and the potassium-argon date for basaltic basement (probable age of crystallization, 100-120 m.y.; see Lanphere and Dalrymple, this volume).

Accumulation rates, as presently determined, are shown in Figure 10, Rates since the end of the hiatus marking the middle/late Eocene boundary have been moderate, but nearly linear, and average about 10 m/m.y. The Upper Cretaceous sequence is, in contrast, quite condensed, with a net accumulation rate of a little more than one m/m.y. (including compaction). The Lower Cretaceous volcanogenic sequence appears to have been fairly rapidly deposited, as the interpolated average rate could be as high as 87 m/m.y. if the minimum age of 110 m.y. for basement is used. Sedimentary structures within this sequence support relatively rapid deposition for this unit (see Lithology section for relevant data bearing on this part of the stratigraphic column).

SUMMARY AND CONCLUSIONS

Site 317 was drilled at the preplanned site along the CATO-3 track in 2622 meters of water on the relatively flat surface of the Manihiki Plateau. Three holes were drilled although our original strategy called for two. The first hole was to be washed down through the soft upper oozes in order to reach and core the deeper, harder rocks, including basement, with a fresher bit; the second

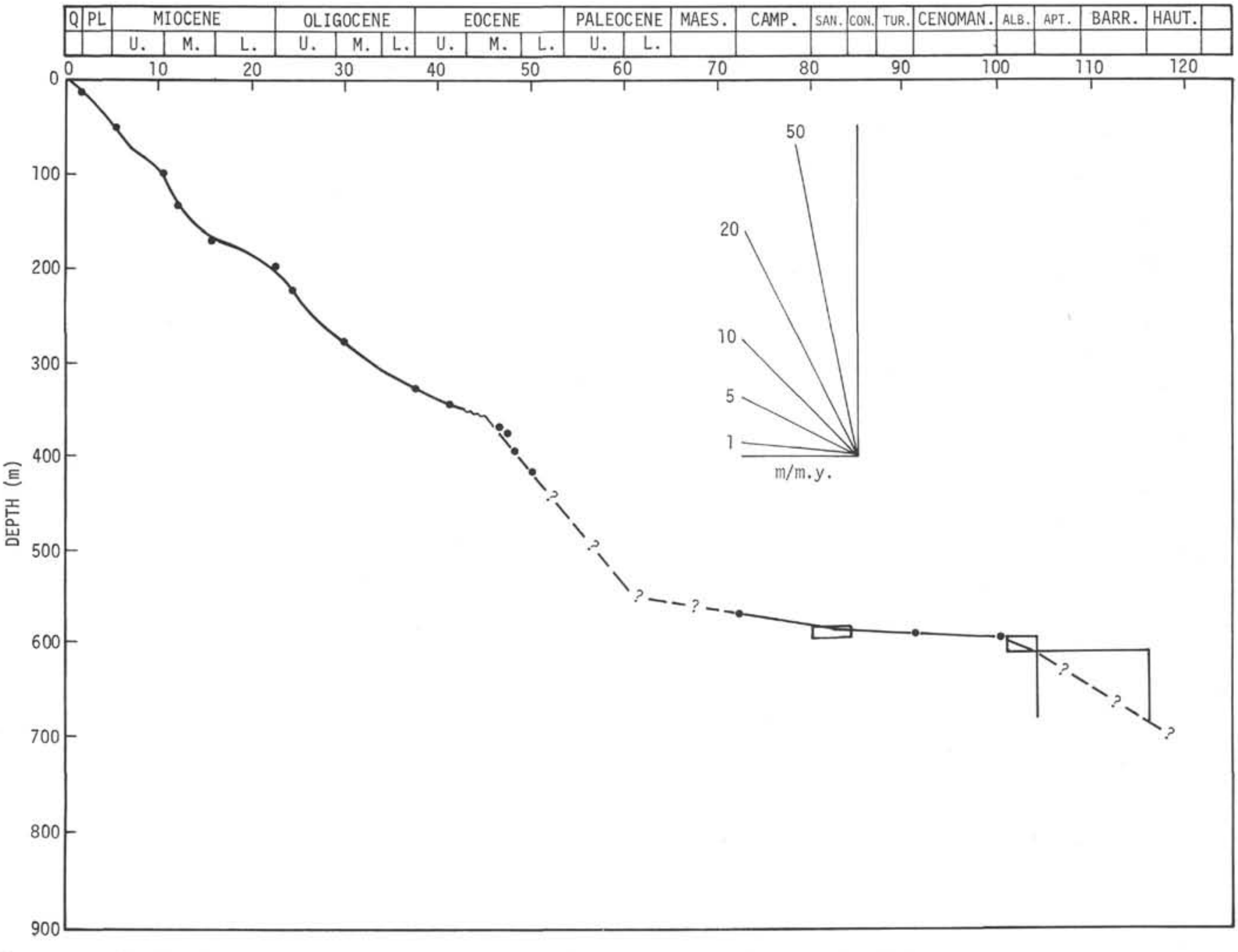

Figure 10. *Graphic log showing lithology, age, and rate of sediment accumulation at Site 317.*

hole was to core the upper section after a round trip to change the assumedly worn bit, Unfortunately, the first hole, 317, had to be aborted, a round trip made, and be respudded after a bolt fell into the drill pipe making recovery of the core barrel impossible. The second hole, 317A, did penetrate to the basalt basement and was almost completely cored from 554.4 meters to 943.5 meters, the last 33.5 meters being in basalt. Our initial objective of continuously coring the entire column was frustrated when the third hole, 317B, had to be aborted at a depth of 424.5 meters due to the jamming of the core barrel by a piece of a mud flow line valve that was pumped into the drill pipe. However, of a composite total drilled depth of 943.5 meters, 766.5 meters were cored; most of the uncored section lay in the 130-meter gap between the beginning of continuous coring of Hole 317A at 554.0 meters subbottom depth and the termination of Hole 317B at a subbottom depth of 424.5 meters. The missing section may be of Paleocene age.

The geologic column drilled on the Manihiki Plateau was divided into four lithologic units:

1) Nannofossil-foraminiferal and foraminiferal-nannofossil ooze, firm ooze, and chalk; grayish-orange, white, and bluish-white (0-303.5 m). The unit ranges in age from middle Oligocene to Quaternary. The $CaCO_3$ content of this unit is uniformly high. The entire section was deposited at an average rate of about 10 m/m.y.

2) Foraminiferal-nannofossil and nannofossil ooze and chalk gray to orange in color; this unit is characterized by the presence of dark reddish-brown and black vitreous cherts (303.5-647.0 m) and ranges in age from middle Oligocene to Aptian. At approximately 580-590 meters in Hole 317A there are distinct breaks that mark a lithologic change. The $CaCO_3$ content drops off sharply close to the hiatus between the Santonian and Turonian-Cenomanian boundary. The drilling rate decreases markedly; density of the sediments increases and porosity decreases. A prominent reflector at 0.60 sec corresponds to this depth. The lowest portion of Unit 2 is bivalve-bearing. Accumulation rates in the Cretaceous parts of this unit may have been as low as 1 m/m.y.

3) Volcaniclastic sandstone and siltstone, possibly originally vitric tuffs or eroded and redeposited sediments, greenish-black, and bivalve-bearing in their upper part (647.0-910.0 m). This unit is of Aptian age at its top but is barren of fossils towards the base.

4) Basalt, vesicular, greenish-gray; probably of the oceanic tholeiite variety (910.0-943.5 m).

Unit 1 is of purely pelagic origin but contains sedimentary intervals of two distinct colors, white to bluish-white and grayish-orange. The white intervals were deposited at a higher rate than the grayish-orange intervals (see Figure 10). These color breaks are related to acoustistratigraphic reflectors at 0.07, 0.17, and 0.225 sec in the post-Eocene chert section, as discussed below. The presence of lower Oligocene to Eocene chert in Unit 2 is characteristic of this stratigraphic interval in the Pacific basin and may be related to high productivity in the surface waters. The appearance of prominent chert beds at approximately 350 meters depth and the presence of a hiatus in the middle to upper Eocene section at 358 meters is probably responsible for the 0.395-sec reflector. Bivalves found in the basal part of Unit 2 and in the top of Unit 3 are of uncertain paleontological significance, although they might be interpreted as indicative of the presence of intermediate water depths in the area in Albian-Aptian time. Unit 3 shows very strong evidence of resedimentation due to downslope movement. Evidently basement relief prior to Aptian time was still sufficiently rugged to initiate slumping and turbidity current activity.

Specks of native copper occur within the volcaniclastic sediments in the lower 150 meters of Unit 3. To date, oceanic metal-bearing sediments have only been found on active rise crests (Bostrom and Peterson, 1966) in relatively localized areas of high heat flow in the Red Sea (Degens and Ross, 1969), and in widespread sediments overlying basaltic basement away from active rise crests (von der Borch and Rex, 1970; von der Borch et al., 1971; Cook, 1971, 1972; Cronan et al., 1972). This latter type of metal-bearing sediment forms a widespread diachronous unit in the equatorial Pacific with copper contents on the order of 10-650 ppm (Cook, 1971, 1972). These sediments are interpreted to be of hydrothermal origin and to have originated on active rise crests. The origin of the metal-bearing sediments at Site 317 in unknown, other than they appear to be probably of a hydrothermal nature. It is interesting to note that chalcopyrite was observed in the basalts that underlie the mineralized volcanogenic rocks.

A total of six prominent reflectors can be distinguished on the profiler records near Site 317:

1) A weak reflector at 0.07 sec (58 m depth);

2) A moderate reflector at 0.17 sec (140 m depth);

3) A strong reflector at 0.225 sec (197 m depth);

4) A strong reflector at 0.395 sec (358 m depth);

5) A very strong reflector at 0.60 sec (576 or 592 m depth);

6) A good reflector at 0.87 sec (910 m depth).

The upper four reflectors at 0.07, 0.17, 0.225, and 0.395 sec correlate with the "b," "c," "d," and "e" reflectors of Schlanger and Douglas (1974; see Table 6 of the present report) previously identified over a wide area of the equatorial Pacific ranging from Site 72 through the Line Islands to the Magellan Rise and west to the Ontong-Java Plateau. A Site 317 study of the color changes and accumulation rate deflections associated with these upper four reflectors suggests that stratigraphic intervals that contain a section of rapidly deposited white oozes overlying darker colored, more slowly deposited sediments result in the impedance difference that produces these reflectors. The thickness of the section between the 0.60-sec reflector and acoustic basement (the 0.87-sec reflector) varies across the plateau from zero to about 0.40 sec; the 0.60-sec reflector then appears to be at an angular unconformity (Winterer et al., 1974); and lies at a subbottom depth of 576 meters, which is not far from the Santonian-Turonian unconformity at a depth of 592 meters. The 0.87-second reflector that can be traced across the plateau (Winterer et al., 1974) is the top of the basalt basement at a depth of 910 meters at this site.

The geological history of the Manihiki Plateau as derived from the drilling results began with the extrusion of extremely vesicular tholeiitic basalts probably of oceanic rather than edifice type. A section of bivalve-bearing, but as yet undated, sediments 240 meters thick, lies between the basalt and calcareous sediments dated as being Aptian-Barremian in age, greater than 107 m.y.B.P. If these barren sediments are weathered ash, eruptive volcanism could have persisted to Aptian time; if the barren section is originally volcanogenic material eroded from previously erupted rocks, active volcanism could have ceased at a much earlier date. Following the eruptive and probably erosional phases, the plateau subsided and became a site of pelagic sedimentation. The lack of any in-place or transported shallow-water fossils is somewhat puzzling inasmuch as the vesicularity of the basalt suggests relatively shallow water, and some parts of the plateau must have had seamounts projecting above the general level of the flows. The islands around the rim of the plateau, such as Manihiki, Danger, and Suvarow, apparently kept apace with rising sea level and became atolls. Perhaps none of the topographic highs near the drill site supported a shallow-water benthonic fauna that could have supplied calcareous skeletal debris in turbidite beds.

The plateau has been receiving sediments since Early Cretaceous time. Late Cretaceous accumulation rates are very low, averaging slightly more than 1 m/m.y. Although hiatuses occur between middle Campanian and Santonian, Santonian and lower Turonian, and middle and upper Eocene, deposition at this site has been essentially slow and continuous. The angular unconformity at the Santonian-Turonian boundary, which is close to the location of the 0.60-sec acoustic reflector, marks a major event in the history of the plateau. If the 0.60-sec reflector is indeed at the Santonian-Turonian boundary, one could postulate a period of uplift following Turonian time. This uplift raised the plateau well above the foraminiferal solution depth, allowing the relatively rapid accumulation of calcareous sediments. In and above the Maestrichtian, foraminifers are abundant and well preserved; below the Maestrichtian they occur only as poorly preserved benthonic types. Another possible interpretation is that the plateau "grew" into shallower water due to the outpouring of a thick pile of basalt (Winterer et al., 1974). In that event, the angular unconformity is actually at the Cretaceous-Tertiary boundary, or since the lens of sediment not cored in the 130-meter coring gap may be Paleocene, at the Paleocene-Eocene boundary. According to this interpretation the formation of the unconformity would have taken place following Paleocene time; by then the plateau was shallower than the foraminiferal solution depth and pure carbonates would dominate the sedimentation regime.

One of the major objectives of drilling the Manihiki Plateau was to complete the drilling of the four major rises or plateaus in the Pacific—the Shatsky (drilled on Legs 6 and 32), the Magellan (drilled on Leg 17), the Ontong-Java (drilled on Legs 7 and 30), and, finally, the Manihiki. A brief comparison of the four areas is given below.

The comparative characteristics of the basalt basement below the Shatsky and Magellan rises and the Ontong-Java and Manihiki plateaus may be summarized as follows:

Rise or Plateau	Basement Composition	Age and Overlying Sediments
Magellan	Might be oceanic tholeiites; might be transitional between oceanic and edifice tholeiites; perhaps alkaline	Overlain by late Tithonian to early Berriasian (up to 135 m.y.B.P.) sediments
Shatsky	Not reached	80 meters below sediments of Tithonian-berriasian (up to 135 m.y.B.P.)
Ontong-Java	Olivine-bearing probable oceanic tholeiite	Overlain by volcanogenic sediments of Aptian age (105-110 m.y.B.P.)
Manihiki	Two pyroxene-bearing oceanic tholeiite	Overlain by volcanogenic sediments of somewhat greater age than Aptian-Barremian (>107 m.y.B.P.)

The Magellan and Shatsky basement rocks are older than those of the Ontong-Java and Manihiki plateaus. All of the basalts however, are vesicular, contain phyric plagioclase, and are probably of oceanic tholeiite composition or transitional to that composition. The Manihiki Plateau and the Magellan Rise also share the characteristic of having prominent basement ridges over which older sediments drape; some of these ridges on the Manihiki Plateau break the surface of even the youngest sediments, and may have provided the topographic relief necessary for the production of turbidites and slump structures in the Cretaceous sediments. Similar turbidite and slump features mark the Cretaceous section on the Magellan Rise. It appears that the Cretaceous topography on these two oceanic plains was quite rugged.

Overall, the section drilled at Site 317 is most similar to that drilled at Site 289 on the Ontong-Java Plateau. There, eruptions of probable tholeiitic basalt flows took place during or prior to early Aptian time (Andrews, Packham et al., 1973); a period of deposition of vitric tuff followed, and was superseded by biogenic sedimentation. Except for some difference in the location of hiatuses, the Cenozoic sections are similar at both sites and dominated by calcareous biogenic sediments. Radiolarians at the Ontong-Java Plateau site became abundant during the late Eocene, whereas at the Manihiki Plateau, they contributed markedly to the sediments from late Oligocene to late Miocene time.

On the other hand, the stratigraphic sections at Magellan Rise drilled on Leg 17, Site 167 (Winterer, Ewing, et al., 1973) and Shatsky Rise (Larson, Moberly, et al., 1973) show marked contrasts to that of the Manihiki Plateau. The Magellan Rise basement formed at an earlier time than the Manihiki basement and the crest of the Magellan Rise itself has been shallower than the foraminiferal solution depth since its origin; the entire section of 1185 meters of sediment is almost entirely made up of limestone, chert, chalk, and calcareous ooze. The Shatsky Rise (Larson, Moberly, et al., 1973) at Site 305 is capped by a sedimentary column that extends from Quaternary to Barremian-Aptian at a subbottom depth of 579 meters, and consists (with some hiatuses) of carbonate-rich, chert-bearing sediment—shale was first noted in rocks of undifferentiated Early Cretaceous age at a subbottom depth of 588.5 meters. At Site 305 Cretaceous strata occur at a subbottom depth of 9.5 meters. From that point to the total depth of 467.5 meters, the section ranges in age from Albian to Tithonian and is made up entirely of carbonate and silica-rich sediments; shales were not noted.

The Magellan Rise is supposed to record an equatorial crossing at 25-30 m.y.B.P. (Winterer, Ewing, et al., 1973), and Shatsky Rise is reported to have crossed at about 90 m.y.B.P. (Larson, Moberly, et al., 1973). In contrast, the Ontong-Java and Manihiki plateaus appear never to have crossed the equator, but they do record changes from sections low in calcium carbonate to relatively pure carbonate sections; at Manihiki this change occurs near the Campanian-Maestrichtian boundary approximately 72 m.y.B.P.; at Ontong-Java the sediments were being deposited deeper than the foraminiferal solution depth (FSD) but above the nannofossil solution depth (NSD) in Early Cretaceous time (Aptian?).

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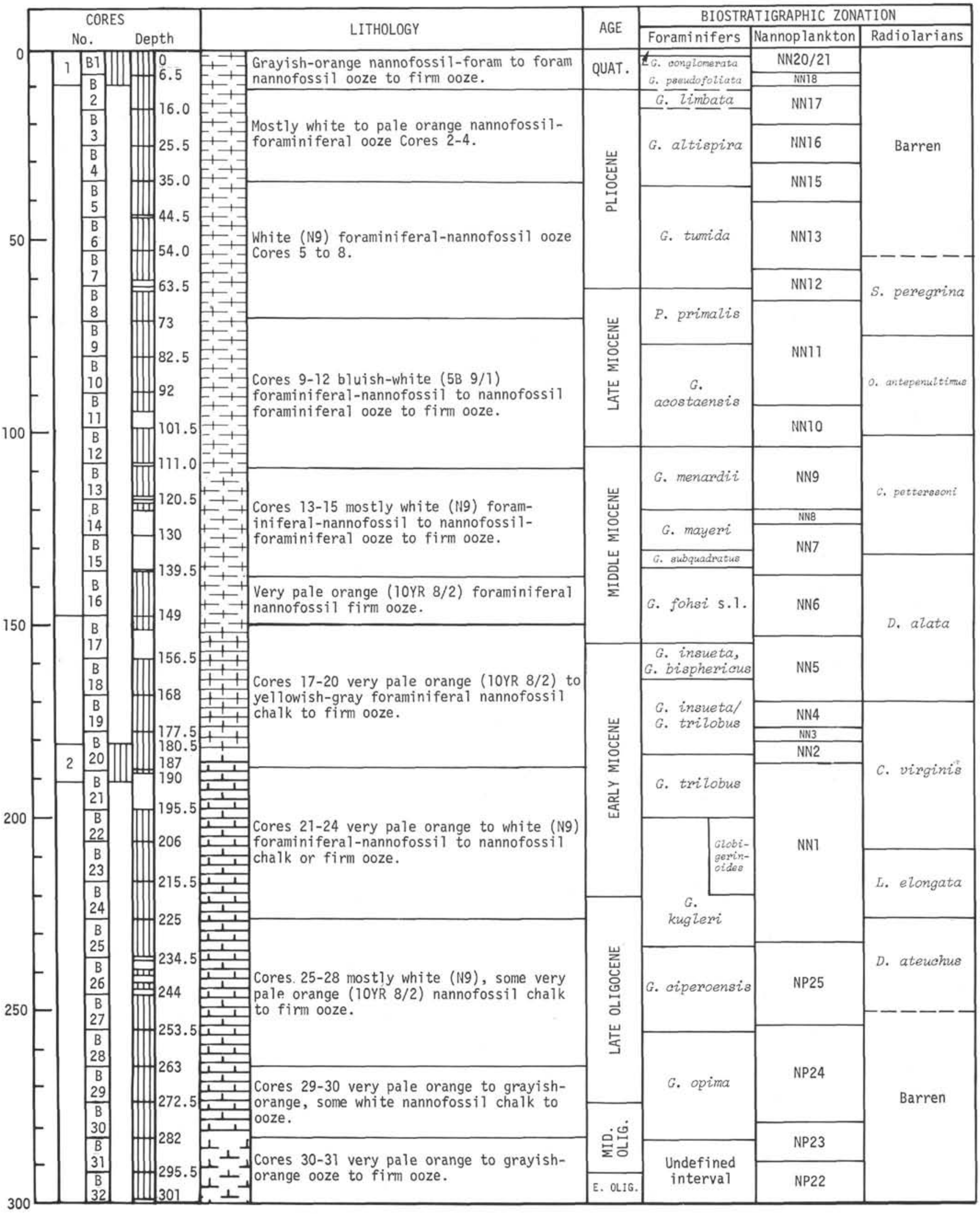


Grayish-orange nannofossil-foram to foram nannofossil ooze to firm ooze.

Mostly white to pale orange nannofossil-foraminiferal ooze Cores 2-4.

White (N9) foraminiferal-nannofossil ooze Cores 5 to 8.

Cores 9-12 bluish-white (5B 9/1) foraminiferal-nannofossil to nannofossil foraminiferal ooze to firm ooze.

Cores 13-15 mostly white (N9) foraminiferal-nannofossil to nannofossil-foraminiferal ooze to firm ooze.

Very pale orange (10YR 8/2) foraminiferal nannofossil firm ooze.

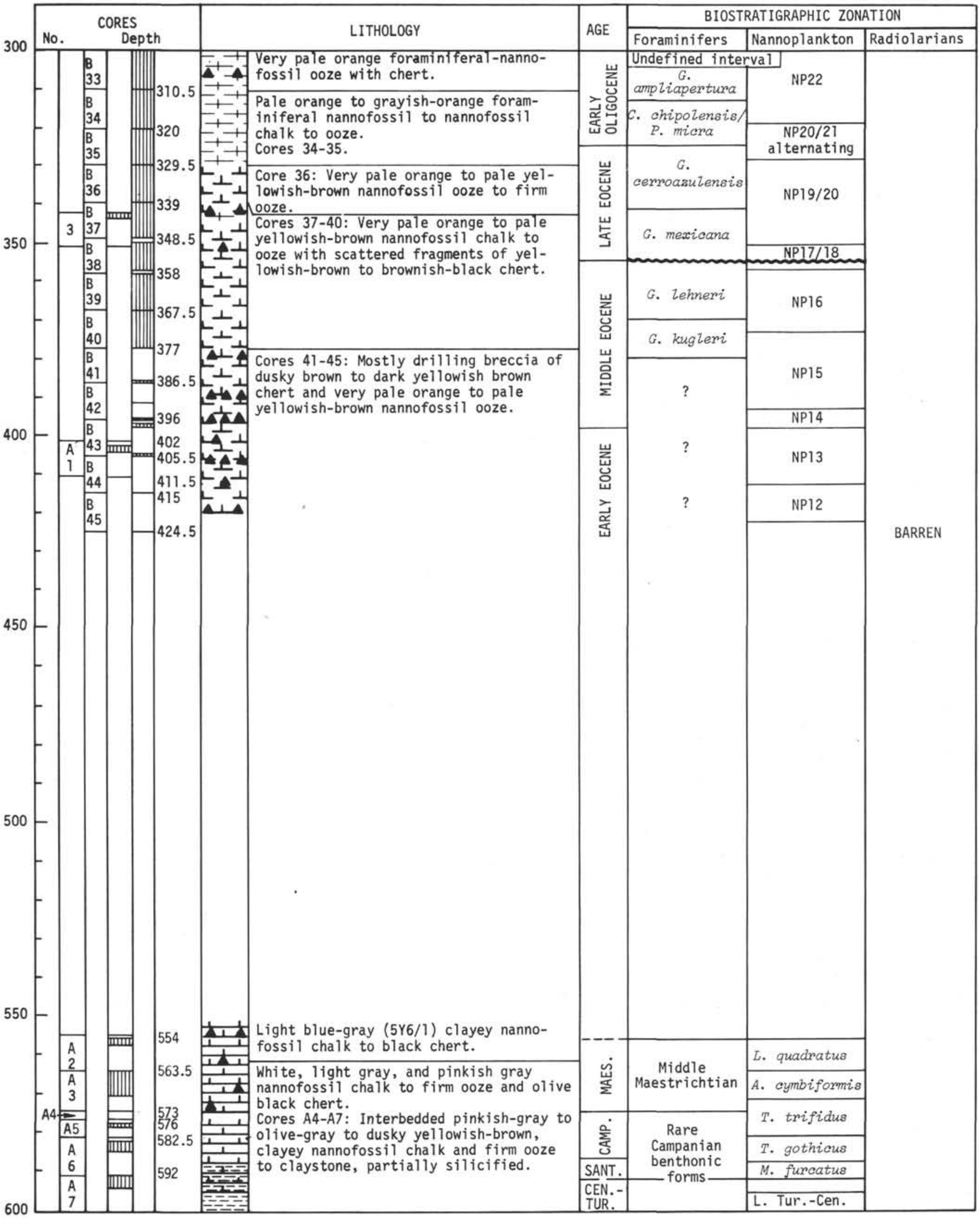
Cores 17-20 very pale orange (10YR 8/2) to yellowish-gray foraminiferal nannofossil chalk to firm ooze.

Cores 21-24 very pale orange to white (N9) foraminiferal-nannofossil to nannofossil chalk or firm ooze.

Cores 25-28 mostly white (N9), some very pale orange (10YR 8/2) nannofossil chalk to firm ooze.

Cores 29-30 very pale orange to grayish-orange, some white nannofossil chalk to ooze.

Cores 30-31 very pale orange to grayish-orange ooze to firm ooze.



Very pale orange foraminiferal-nannofossil ooze with chert.

Pale orange to grayish-orange foraminiferal nannofossil to nannofossil chalk to ooze.
Cores 34-35.

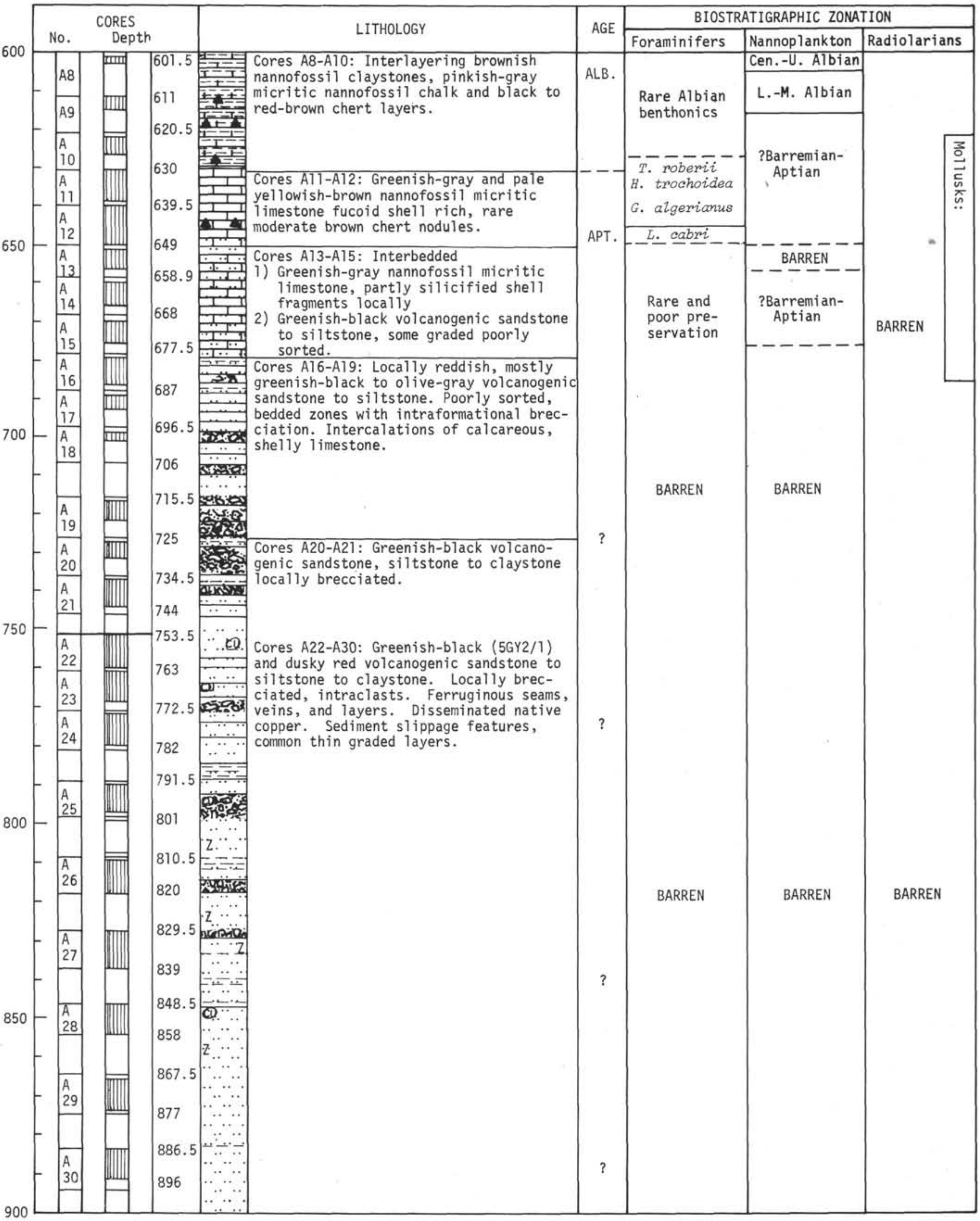
Core 36: Very pale orange to pale yellowish-brown nannofossil ooze to firm ooze.

Cores 37-40: Very pale orange to pale yellowish-brown nannofossil chalk to ooze with scattered fragments of yellowish-brown to brownish-black chert.

Cores 41-45: Mostly drilling breccia of dusky brown to dark yellowish brown chert and very pale orange to pale yellowish-brown nannofossil ooze.

Light blue-gray (5Y6/1) clayey nannofossil chalk to black chert.

White, light gray, and pinkish gray nannofossil chalk to firm ooze and olive black chert.
Cores A4-A7: Interbedded pinkish-gray to olive-gray to dusky yellowish-brown, clayey nannofossil chalk and firm ooze to claystone, partially silicified.



Cores A8-A10: Interlayering brownish nannofossil claystones, pinkish-gray micritic nannofossil chalk and black to red-brown chert layers.

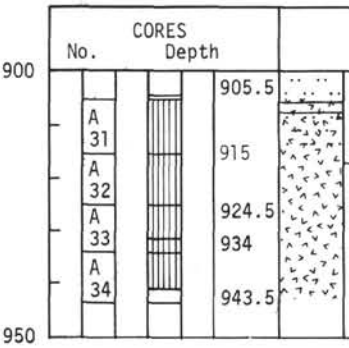
Cores A11-A12: Greenish-gray and pale yellowish-brown nannofossil micritic limestone fucoid shell rich, rare moderate brown chert nodules.

Cores A13-A15: Interbedded
1) Greenish-gray nannofossil micritic limestone, partly silicified shell fragments locally
2) Greenish-black volcanogenic sandstone to siltstone, some graded poorly sorted.

Cores A16-A19: Locally reddish, mostly greenish-black to olive-gray volcanogenic sandstone to siltstone. Poorly sorted, bedded zones with intraformational brecciation. Intercalations of calcareous, shelly limestone.

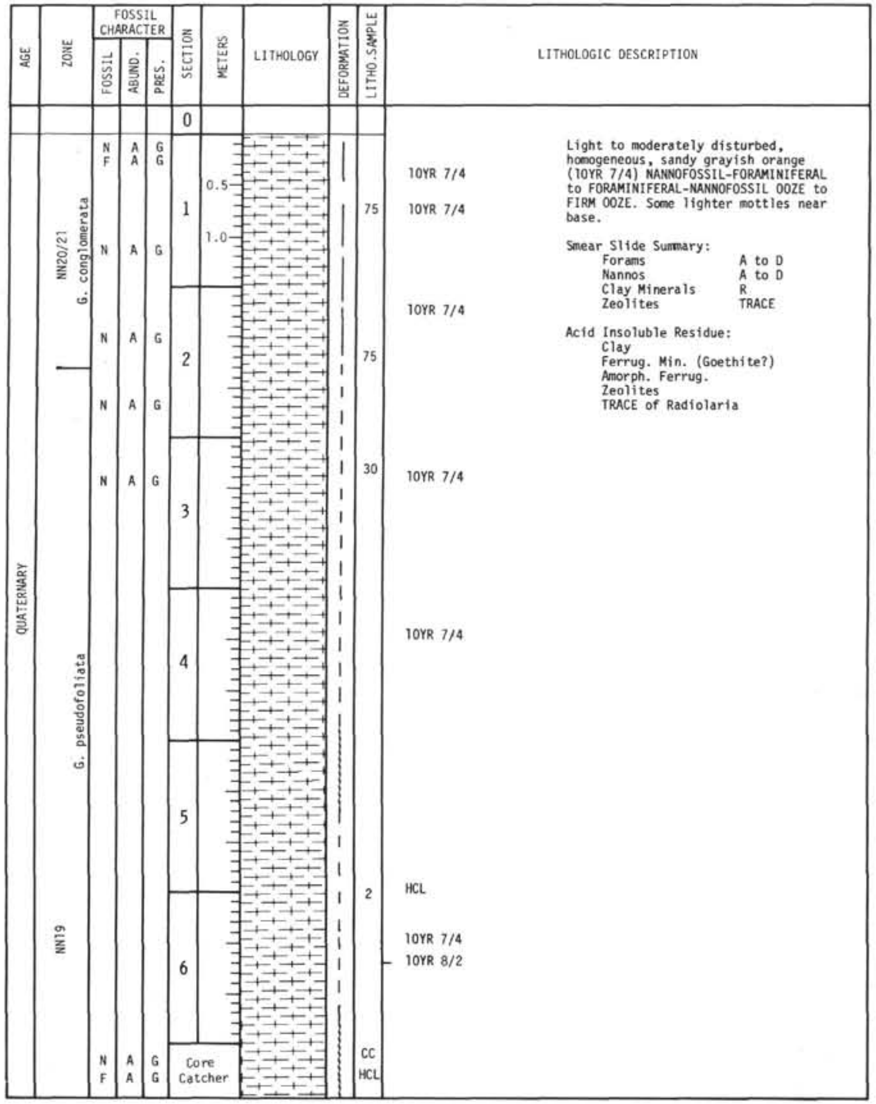
Cores A20-A21: Greenish-black volcanogenic sandstone, siltstone to claystone locally brecciated.

Cores A22-A30: Greenish-black (5GY2/1) and dusky red volcanogenic sandstone to siltstone to claystone. Locally brecciated, intraclasts. Ferruginous seams, veins, and layers. Disseminated native copper. Sediment slippage features, common thin graded layers.



				BIOSTRATIGRAPHIC ZONATION		
CORES No.	CORES Depth	LITHOLOGY	AGE	Foraminifers	Nannoplankton	Radiolarians
A 31	905.5 915	Four discrete flow units of greenish-gray vesicular basalt over ash and interlayered by grayish-red and grayish-green hard volcanogenic sandstone.	?	BARREN	BARREN	BARREN
A 32	924.5	Cores A32-A33 basalt. Dark greenish-gray to greenish-gray basalt, aphric, vesicular zeolitic with microphenocrysts, glassy to fine-grained; 6 flow units with some cóntact chilling.				
A 33	934					
A 34	943.5					

Site 317 Hole Core 1 Cored Interval: 0.0-9.5 m

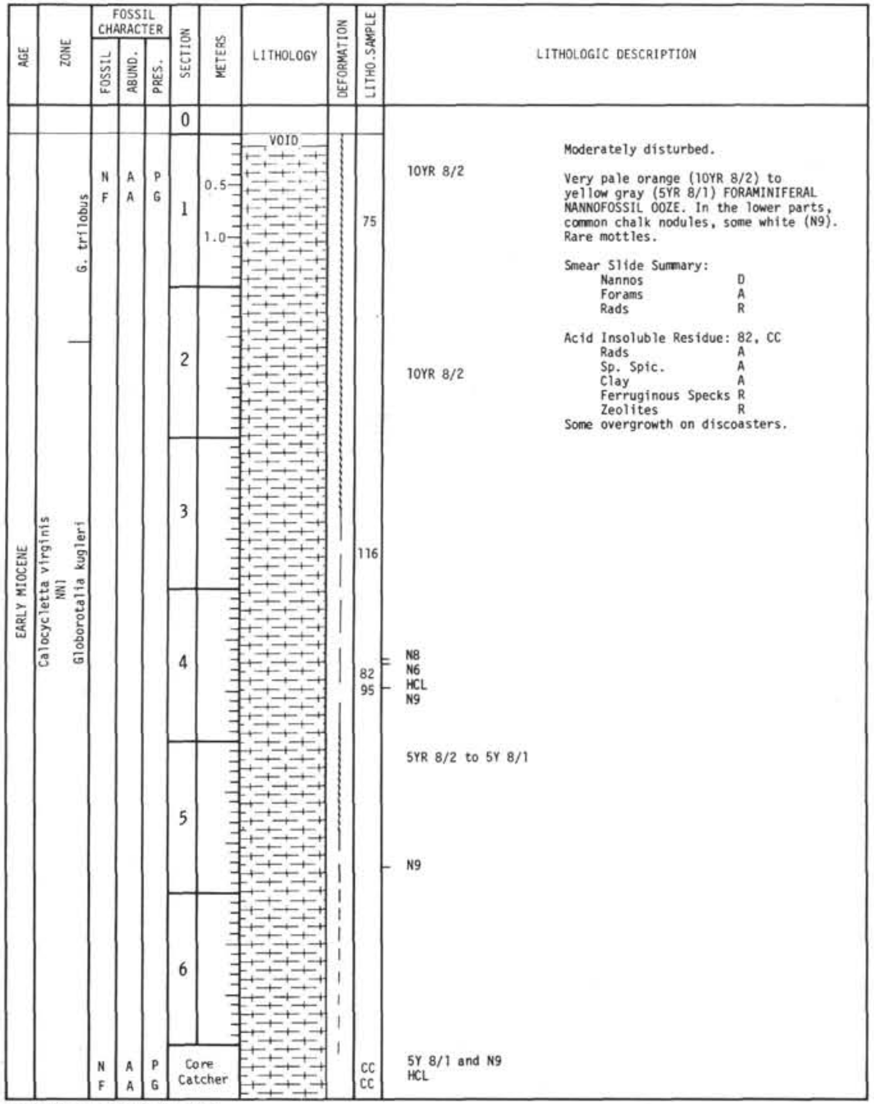


Light to moderately disturbed, homogeneous, sandy grayish orange (10YR 7/4) NANNOFOSSIL-FORAMINIFERAL to FORAMINIFERAL-NANNOFOSSIL OOZE to FIRM OOZE. Some lighter mottles near base.

Smear Slide Summary:	
Forams	A to D
Nannos	A to D
Clay Minerals	R
Zeolites	TRACE

Acid Insoluble Residue:
- Clay
- Ferrug. Min. (Goethite?)
- Amorph. Ferrug.
- Zeolites
- TRACE of Radiolaria

Site 317 Hole Core 2 Cored Interval: 180.5-190.0 m



Moderately disturbed.

Very pale orange (10YR 8/2) to yellow gray (5YR 8/1) FORAMINIFERAL NANNOFOSSIL OOZE. In the lower parts, common chalk nodules, some white (N9). Rare mottles.

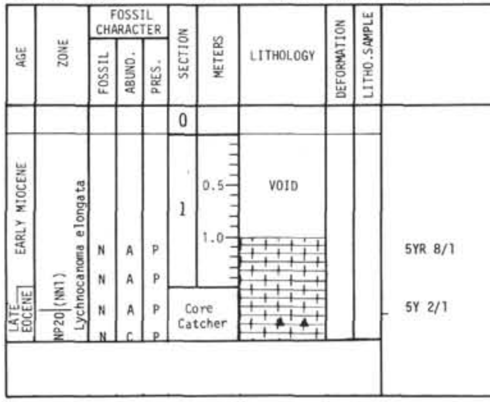
Smear Slide Summary:	
Nannos	D
Forams	A
Rads	R

Acid Insoluble Residue:	82, CC
Rads	A
Sp. Spic.	A
Clay	A
Ferruginous Specks	R
Zeolites	R

Some overgrowth on discoasters.

Explanatory notes in Chapter 1

Site 317 Hole Core 3 Cored Interval: 342.0-351.5 m



LITHOLOGIC DESCRIPTION

Pinkish gray (5YR 8/1) FORAMINIFERAL-NANNOFOSSIL CHALK with some faint mottles elongate parallel to bedding.

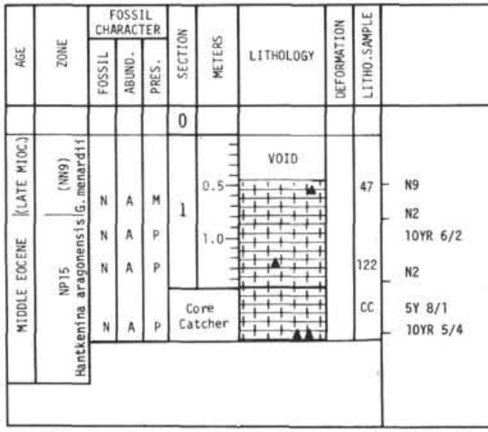
Fragments of olive black (5Y 2/1) chert in core catcher. Some chalk with ferruginous patina.

Smear Slide Summary:

Nannos	D
Forams	A
Rads	R
Sp. Spic.	R
Clay	R

Some overgrowth on discoasters and coccoliths.

Site 317 Hole A Core 1 Cored Interval: 402.0-411.5 m



LITHOLOGIC DESCRIPTION

Pale yellowish brown (10YR 6/2) FORAMINIFERAL-NANNOFOSSIL CHALK.

Entensively burrowed (fucoids); commonly light infills dark.

Some white (N9) foraminiferal nannofossil chalk zones.

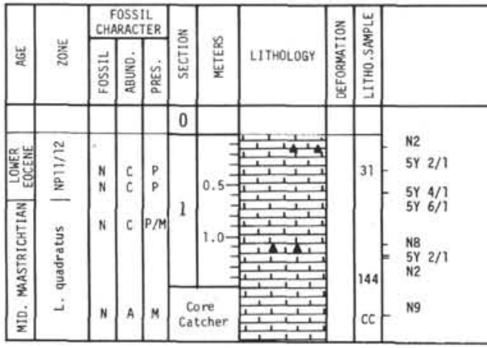
Grayish black (N2) and reddish brown (10YR 5/4) CHERT nodules.

Smear Slide Summary:

Nannos (coccos+Discos)	D
Forams	C
Clay	R to C
Rads	TRACE

Some overgrowth on discoasters.

Site 317 Hole A Core 2 Cored Interval: 554.0-563.5 m



LITHOLOGIC DESCRIPTION

Light olive gray (5Y 6/1) CLAYEY NANNOFOSSIL CHALK.

Some clay-rich darker layers with more conspicuous burrowing, local solution seams.

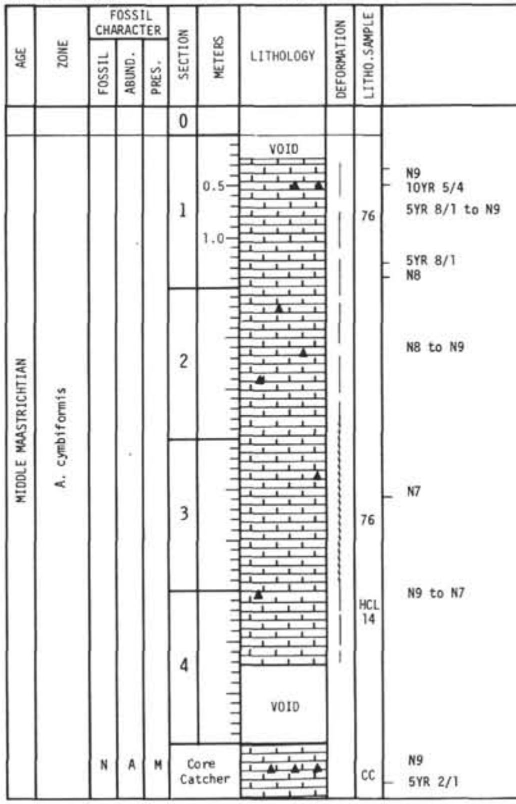
Black chert.

Smear Slide Summary:

Nannos	D
Forams	R
Clay	R to C

Some overcalcification of discoasters.

Site 317 Hole A Core 3 Cored Interval: 563.5-573.0 m



LITHOLOGIC DESCRIPTION

Very light gray (N8) white (N9) and pinkish gray NANNOFOSSIL FIRM OOZE.

Lightly mottled, some chalky zones.

Olive black (5Y 2/1) to brownish black (5YR 2/1) chert, some millimeter-sized pieces scattered throughout the core.

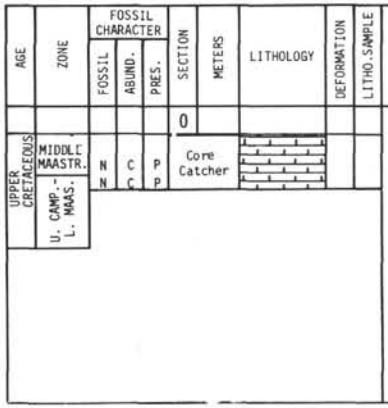
Smear Slide Summary:

Nannos	D to 99%
Forams	R to C
Micrite	R to C
Clay	R

Moderately poor preservation of nannos with some overgrowth.

Acid Residue: 14
Clay and some fine (<2μm) opaques.

Site 317 Hole A Core 4 Cored Interval: 573.0-576.0 m



LITHOLOGIC DESCRIPTION

Fragments of dusky yellowish brown CLAYEY NANNOFOSSIL FIRM OOZE. Friable, mottled, burrowed.

Smear Slide Summary:

Nannos	A to D
Clay	C to A
Micrite	C
Fe/Mn-Minerals	R

Palagonite in acid residue

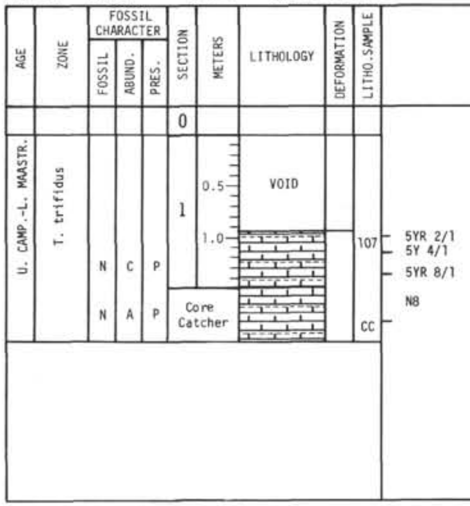
and

white (N9) nannofossil chalk.

Nannos	D

Explanatory notes in Chapter 1

Site 317 Hole A Core 5 Cored Interval: 576.0-582.5 m



LITHOLOGIC DESCRIPTION

1) Brownish black (5YR 2/1), olive gray (5Y 4/1) and pinkish gray (5YR 8/1) CLAYEY NANNOFOSSIL CHALK.

Clay-rich seam, extensively burrowed, with fucoids and solution seams.

2) Core catcher: Very light gray (N8) NANNOFOSSIL CHALK.

Smear Slide: 1-107

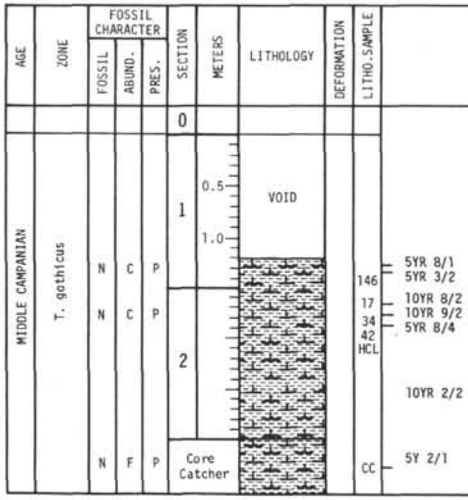
Nannos	D
Clay	C
Fish Debris	R
Dark Specks	R

Smear Slide: CC

Nannos	D
Clay	R to C

Nannofossils moderately to poorly preserved.

Site 317 Hole A Core 6 Cored Interval: 582.5-592.0 m



LITHOLOGIC DESCRIPTION

Pinkish gray (5YR 8/1) to dark yellowish brown (10YR 4/2) CLAYEY NANNOFOSSIL CHALK

and

dusky yellowish brown (10YR 2/2) NANNOFOSSIL CLAYSTONE to CLAYSTONE.

Bioturbated, mod. deformed burrows, dark to light infills.

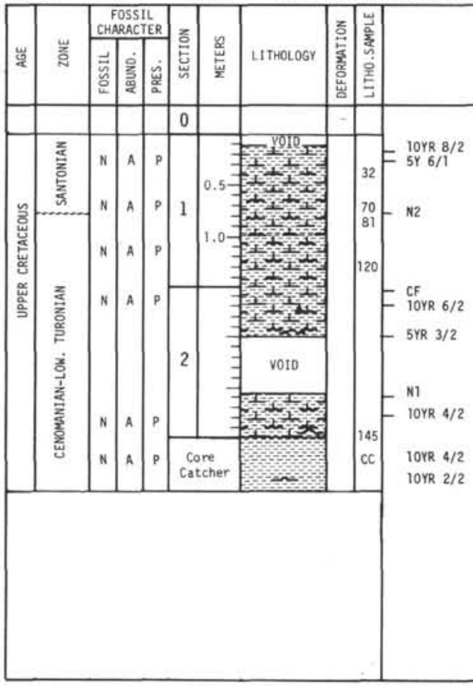
Color change boundary cross cuts primary burrows.

Smear Slide Summary:

Nannos	C to D
Clay, brown-Fer.	D
Micrite	R to C
Zeolites	TRACE to R
Fish Debris	R to C
Iron Ore Minerals	R

Downward decrease of calcite.

Site 317 Hole A Core 7 Cored Interval: 592.0-601.5 m



LITHOLOGIC DESCRIPTION

1) Mostly interbedded light olive gray (5Y 6/1) to very pale orange (10YR 8/2) CLAYEY NANNOFOSSIL CHALK.

Burrowed, some local soft sediment deformation, laminated layers, intrabed brittle failure.

Smear Slide Summary: 1-32, 1-120

Nannos	D to A
Micrite	C
Clay	C
Rads	TRACE

2) And dark yellowish brown (10YR 4/2) to black (N1) NANNOFOSSIL CLAYSTONE to CLAYSTONE.

Partially silicified.

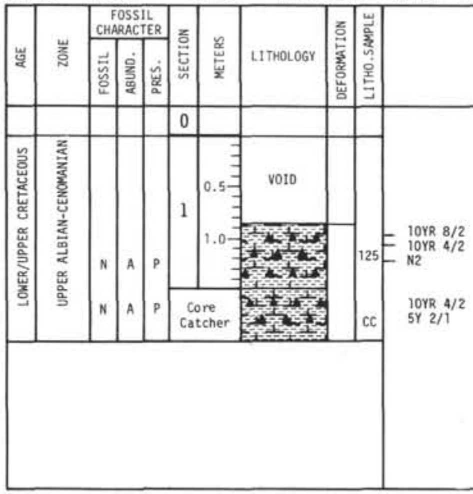
Smear Slide Summary: 1-81, 2-14, 2-145

Clay	D
Nannos	R to C
Zeolite	R
Fe/Mn Specks	C
Fish Debris	R to C
Rads	R

Radiolaria as silica infilled, chalcedonic molds.

Smear Slide 1-70: clasts of Fe/Mn coated altered igneous material: pinkish, clay (D), palagonite (C), alterine volc. minerals (R), micrite (R).

Site 317 Hole A Core 8 Cored Interval: 601.5-611.0 m



LITHOLOGIC DESCRIPTION

Interlayering of partly silicified dark yellowish brown (10YR 4/2) NANNOFOSSIL CLAYSTONE and black replacement chert layers containing large calcite fragments of INOCERAMUS shell-prism layers and very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL CHALK.

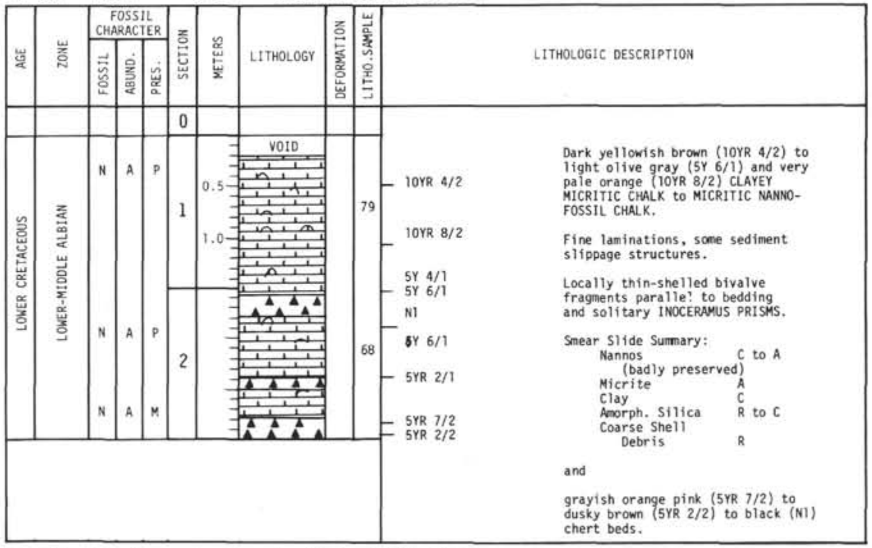
Smear Slide Summary:

8-125:	
Nannos	D
Forams	C
Micrite	C
Clay	R
Amorph. Silica	R
CC:	
Clay	D
Nannos	R to C
Fe-Material	R
Rads	R
Chert Silica	

Rads: silica infilled.

Explanatory notes in Chapter 1

Site 317 Hole A Core 9 Cored Interval: 611.0-620.5 m



Dark yellowish brown (10YR 4/2) to light olive gray (5Y 6/1) and very pale orange (10YR 8/2) CLAYEY MICRITIC CHALK to MICRITIC NANNOFOSSIL CHALK.

Fine laminations, some sediment slippage structures.

Locally thin-shelled bivalve fragments parallel to bedding and solitary INOCERAMUS PRISMS.

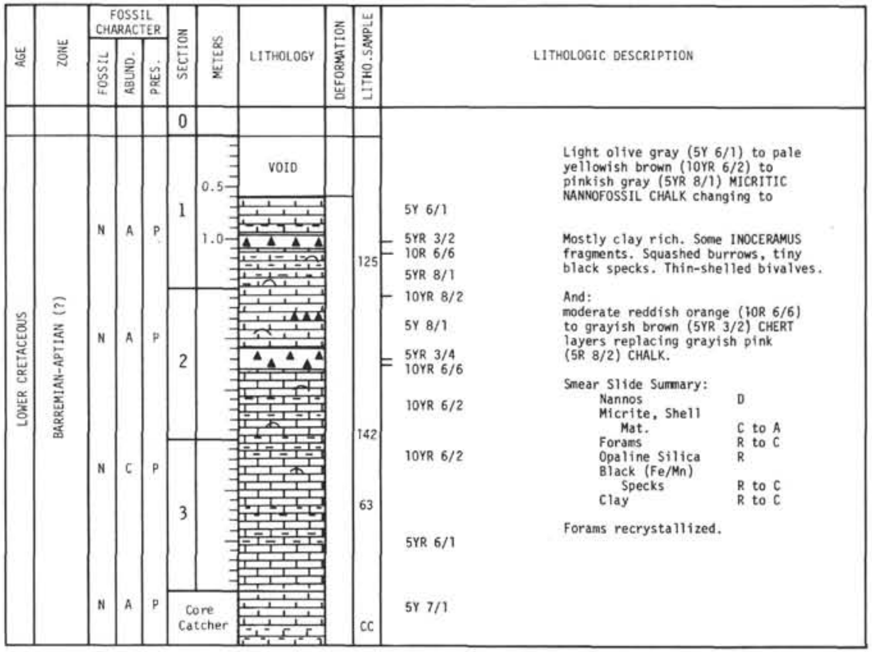
Smear Slide Summary:

Nannos (badly preserved)	C to A
Micrite	A
Clay	C
Amorph. Silica	R to C
Coarse Shell Debris	R

and

grayish orange pink (5YR 7/2) to dusky brown (5YR 2/2) to black (N1) chert beds.

Site 317 Hole A Core 10 Cored Interval: 620.5-630.0 m



Light olive gray (5Y 6/1) to pale yellowish brown (10YR 6/2) to pinkish gray (5YR 8/1) MICRITIC NANNOFOSSIL CHALK changing to

Mostly clay rich. Some INOCERAMUS fragments. Squashed burrows, tiny black specks. Thin-shelled bivalves.

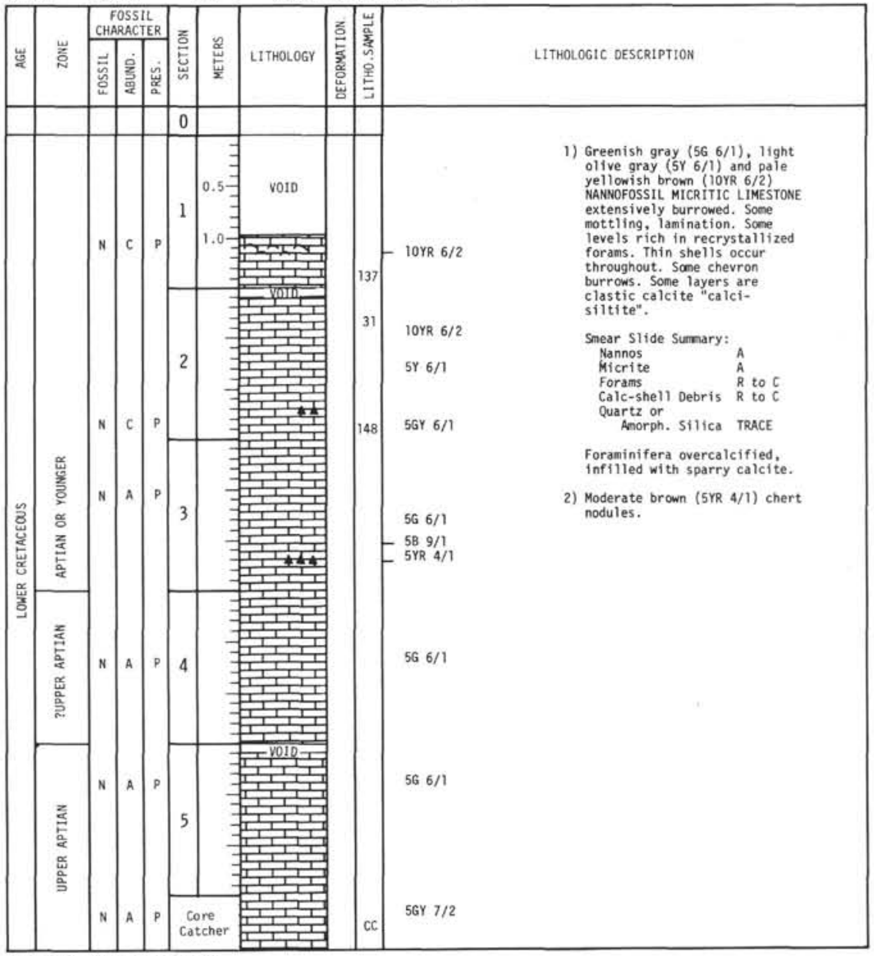
And:
moderate reddish orange (10R 6/6) to grayish brown (5YR 3/2) CHERT layers replacing grayish pink (5R 8/2) CHALK.

Smear Slide Summary:

Nannos	D
Micrite, Shell Mat.	C to A
Forams	R to C
Opaline Silica	R
Black (Fe/Mn) Specks	R to C
Clay	R to C

Forams recrystallized.

Site 317 Hole A Core 11 Cored Interval: 630.0-639.5 m



1) Greenish gray (5G 6/1), light olive gray (5Y 6/1) and pale yellowish brown (10YR 6/2) NANNOFOSSIL MICRITIC LIMESTONE extensively burrowed. Some mottling, lamination. Some levels rich in recrystallized forams. Thin shells occur throughout. Some chevron burrows. Some layers are clastic calcite "calcisiltite".

Smear Slide Summary:

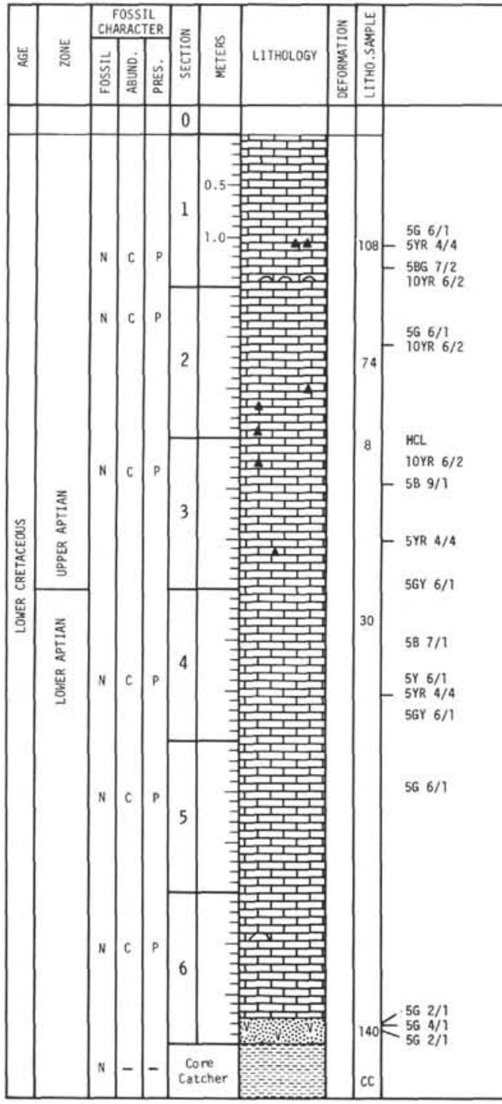
Nannos	A
Micrite	A
Forams	R to C
Calc-shell Debris	R to C
Quartz or Amorph. Silica	TRACE

Foraminifera overcalcified, infilled with sparry calcite.

2) Moderate brown (5YR 4/1) chert nodules.

Explanatory notes in Chapter 1

Site 317 Hole A Core 12 Cored Interval: 639.5-649.0 m



LITHOLOGIC DESCRIPTION

1) Mostly greenish gray (5G 6/1), some yellowish brown (10YR 6/2) to light olive gray (5Y 6/1) NANNOFOSSIL MICRITIC LIMESTONE fucoid type (chondrites) burrow mottled, local foram and thin-shelled bivalve material. Local, silicification fronts. INOCERAMUS prisms.

2) Moderate brown (5YR 4/4) chert nodules. Silication fronts in limestone.

Smear Slide Summary:

Nannos	A
Micrite	A
Forams	R to C
Rads	R to C
Clay	R

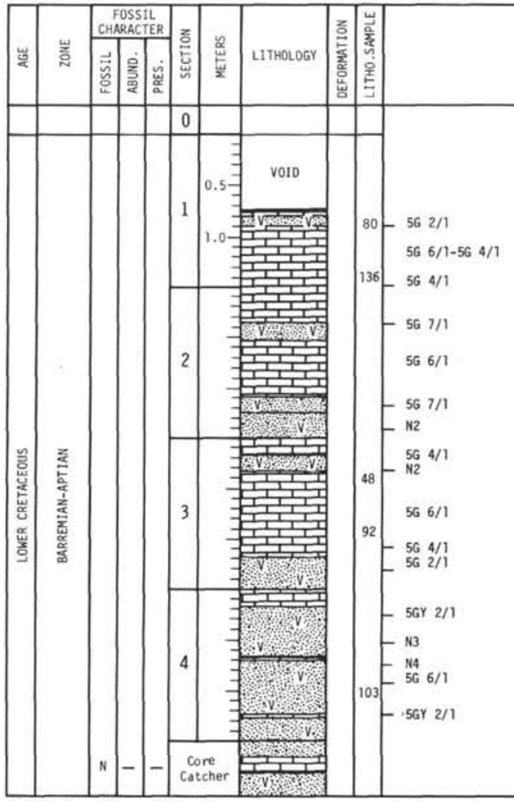
Acid Residues: (A) Radiolaria infilled with quartz, opaline silica grains, clay grain aggregates.

3) At base: first appearance of greenish black (5G 2/1) volcanogenic sand.

Smear Slide: 6-140

Palagonite	D
Clay (isolated)	C to A
Heavys	R
Clear Grains (Zeolite)	R
Vitric Fragments	N <1.5

Site 317 Hole A Core 13 Cored Interval: 649.0-658.5 m



LITHOLOGIC DESCRIPTION

Interbedded

1) Greenish gray (5G 6/1) to dark greenish gray (5G 4/1) NANNOFOSSIL MICRITIC LIMESTONE, partly silicified. Foram-rich, rare shell-rich layers. Fucoid burrows. Locally clay-rich.

Smear Slide Summary:

Nannos	A to D
Micrite	A to D
Clay	R
Foram (Recryst.)	R to C
Volcanic Minerals	R

Acid Residue:
Clay cemented by amorph-microcrystalline silica.

and

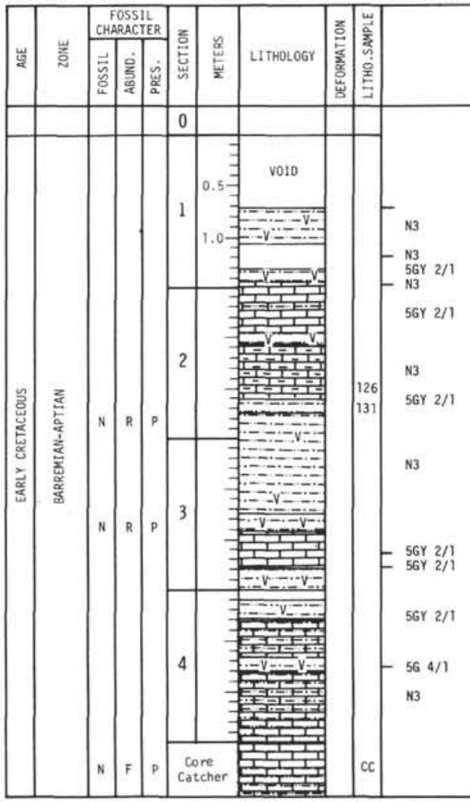
2) Greenish black (5GY 2/1) to dark gray (N2) volcanogenic sandstone to siltstone. Some graded beds poorly sorted, locally burrowed. Partly calcareous. Angular grains.

Smear Slide Summary:

Palagonite	D
Plag and Pyroxene	R
Calcite	O to R
Zeolite	R

Explanatory notes in Chapter 1

Site 317 Hole A Core 14 Cored Interval: 658.5-668.0 m



LITHOLOGIC DESCRIPTION

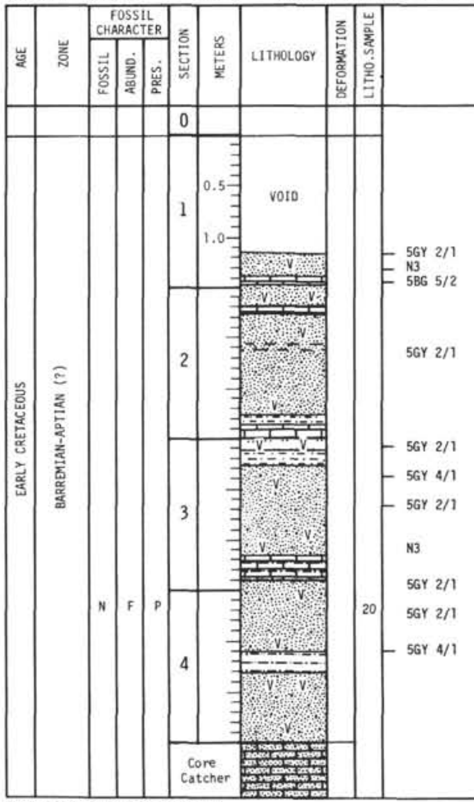
Interbedded greenish black (5GY 2/1) CLAYEY MICRITIC LIMESTONE fucoid burrows, mottled, locally foram-rich or with thin shelled fragments. and dark gray (N2-N3) to greenish black volcanogenic sandstone to claystone.

Some grading, not conspicuous, poorly sorted. Rarely calcareous. Partly burrowed. Rare current X-laminations.

Smear Slide Summary:

1)	Micrite	A
	Forams	C to A
	Nannos	R
	Rads	R
	Palagonite	R to C
	Microcrystalline Qtz.	R
	(fossils badly preserved)	
2)	Palagonite	A to D
	Altered Volc. Minerals	R to C
	Fe Opaque Minerals	R
	Zeolites	R
	Crypto. Crystalline Silica	R to A

Site 317 Hole A Core 15 Cored Interval: 668.0-677.5 m



LITHOLOGIC DESCRIPTION

Dark gray (N3) to greenish black (5GY 2/1) VOLCANOGENIC SANDSTONE to SILTSTONE.

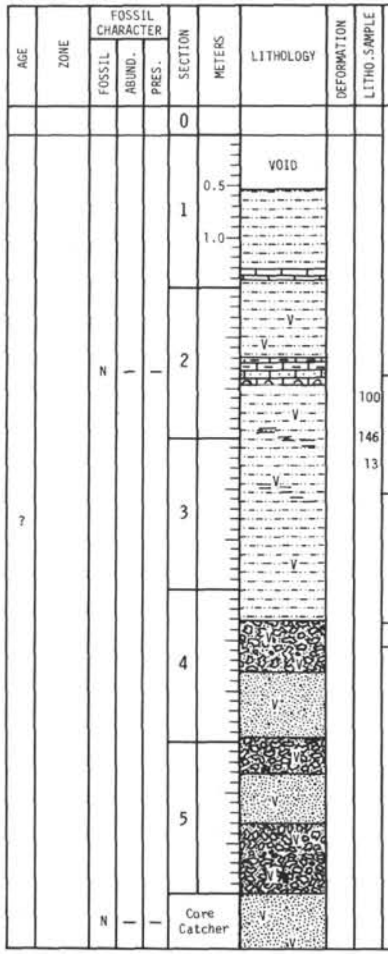
Tops of faintly graded units burrowed, lighter color (5GY 4/1) and calcareous. Poorly sorted, angular grains. Intercalated are rare calcareous layers with shell material.

Smear Slide Summary:

Palagonite	A to D
Micrite	R to A
Clay	C to A
Zeolite	R
Altered Volc. Minerals	R
Amorph. Silica	R

Explanatory notes in Chapter 1

Site 317 Hole A Core 16 Cored Interval: 677.5-687.0 m



LITHOLOGIC DESCRIPTION

5GY 2/1 to 5G 2/1 •

N3

5Y 2/1

PYRITE

5YR 2/1

5G 2/1

5G 2/1

10R 2/2

5GY 2/1
5YR 6/1

5R 4/2

5Y 3/2
5GY 2/1

5G 2/1

Greenish black (5G 2/1) to olive gray (5GY 4/1) VOLCANOGENIC SANDSTONE to SILTSTONE.

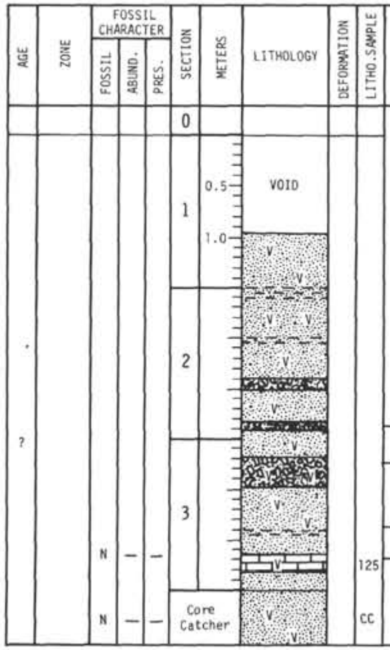
Some levels calcareous, poorly sorted. Interbedded with: brecciated zones of intraformational material, locally dusky red (5R 2/6) or medium bluish gray (5B 5/1) contorted beds, some burrows with coarse pyrite.

And:
bioclastic coquina 2-80 small spherules (4-90).

Smear Slide Summary:

Palagonite	A to D
Zeolite (analcime)	C to A
Altered Volc. Min.	R
Clay, Fe Specks, Ferrug.	R to C

Site 317 Hole A Core 17 Cored Interval: 687.0-696.5 m



LITHOLOGIC DESCRIPTION

5G 2/1

5GY 4/1

5RP 4/2

5G 2/1

N2

N3

Mostly greenish-black (5G 2/1) VOLCANOGENIC SANDSTONE to SILTSTONE.

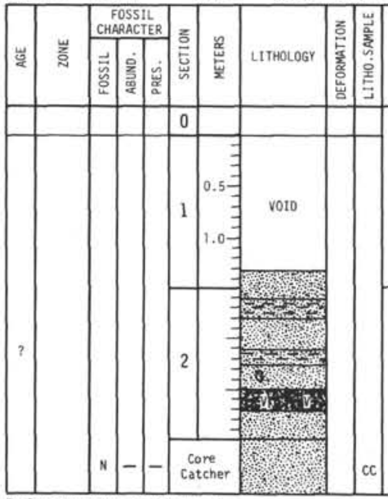
Thin- to thick-bedded, some brecciated zones with 1-5 cm intraclasts locally, matrix altered to grayish red purple (5RP 4/2).

Rare calcareous beds some with small (2mmφ) spherules.

Smear Slide Summary:

Palagonite	D to A
Zeolites (analcite)	R to A
Clay	C to A
Micrite	NIL to A
Nannofossils	TRACE
Altered Volc. Min.	R

Site 317 Hole A Core 18 Cored Interval: 696.5-706.0 m



LITHOLOGIC DESCRIPTION

5G 2/1

5G 2/1

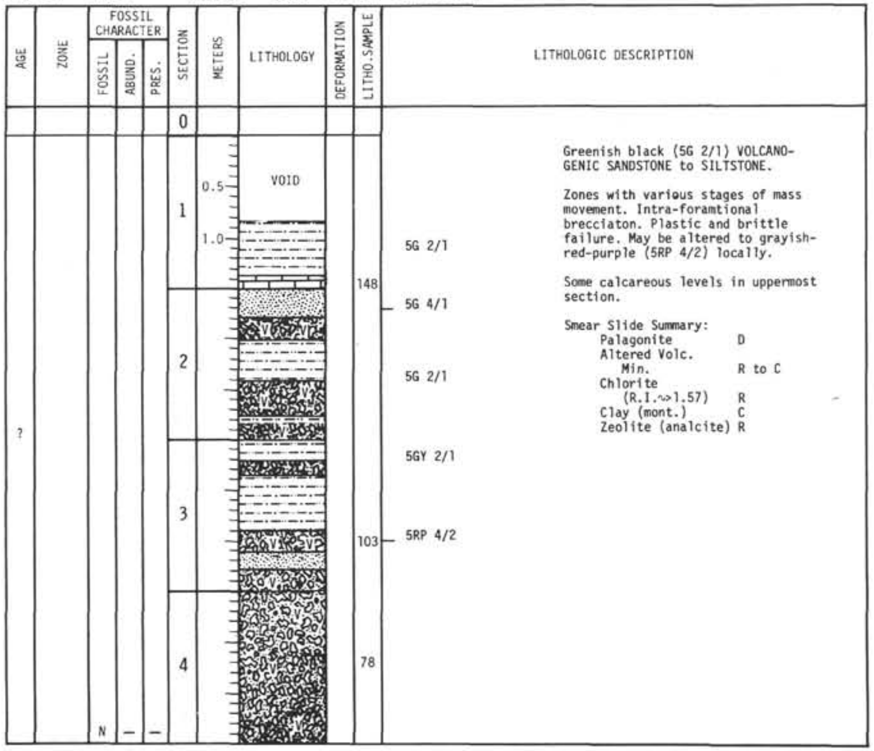
Greenish black (5G 2/1) VOLCANOGENIC SANDSTONE to SILTSTONE. Several stages of mass movement and brecciation visible: incipient to complete.

Smear Slide: CC

Palagonite	D
Clay	C to A
Zeolites (analcite)	R
Iron ore, Opaques	TRACE to R
Altered Leucocrats	R

Explanatory notes in Chapter 1

Site 317 Hole A Core 19 Cored Interval: 715.5-725.0 m



Greenish black (5G 2/1) VOLCANOGENIC SANDSTONE to SILTSTONE.

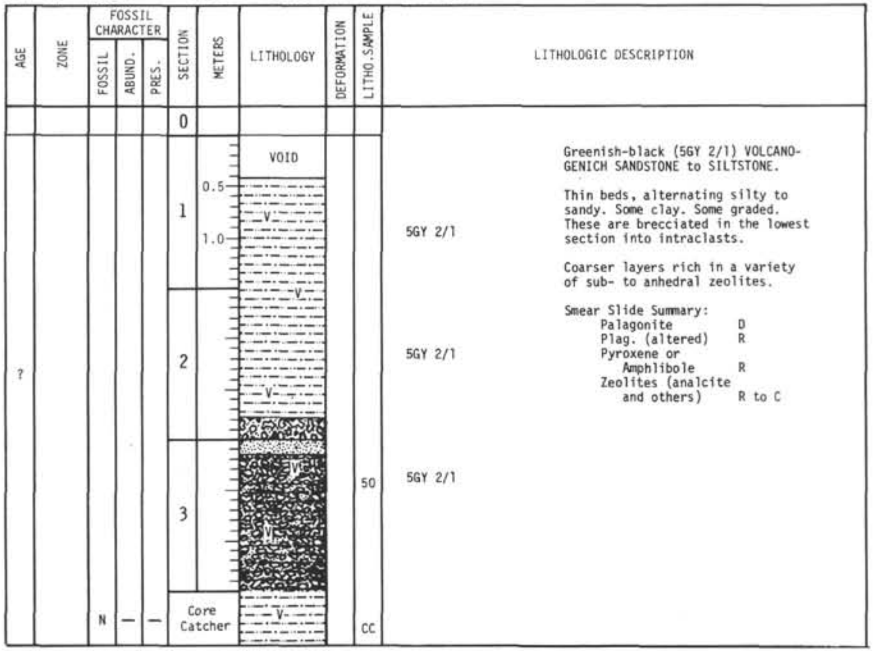
Zones with various stages of mass movement. Intra-foramtional brecciaton. Plastic and brittle failure. May be altered to grayish-red-purple (5RP 4/2) locally.

Some calcareous levels in uppermost section.

Smear Slide Summary:

Palagonite	D
Altered Volc. Min.	R to C
Chlorite (R.I.~>1.57)	R
Clay (mont.)	C
Zeolite (analcite)	R

Site 317 Hole A Core 20 Cored Interval: 725.0-734.5 m



Greenish-black (5GY 2/1) VOLCANOGENICH SANDSTONE to SILTSTONE.

Thin beds, alternating silty to sandy. Some clay. Some graded. These are brecciated in the lowest section into intraclasts.

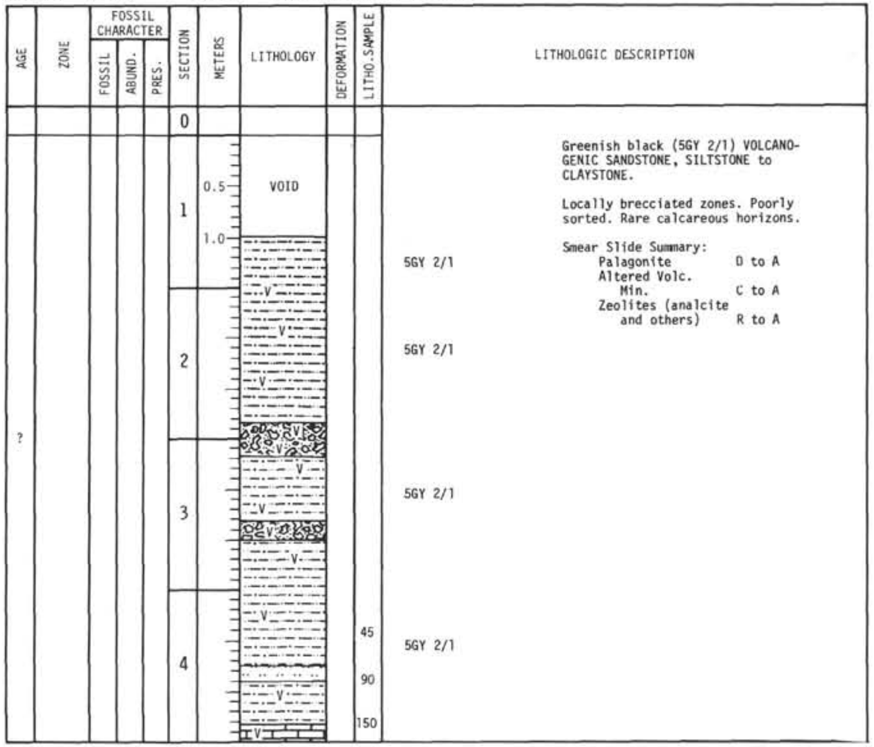
Coarser layers rich in a variety of sub- to anhedral zeolites.

Smear Slide Summary:

Palagonite	D
Plag. (altered)	R
Pyroxene or Amphibole	R
Zeolites (analcite and others)	R to C

Explanatory notes in Chapter 1

Site 317 Hole A Core 21 Cored Interval: 734.5-744.0 m



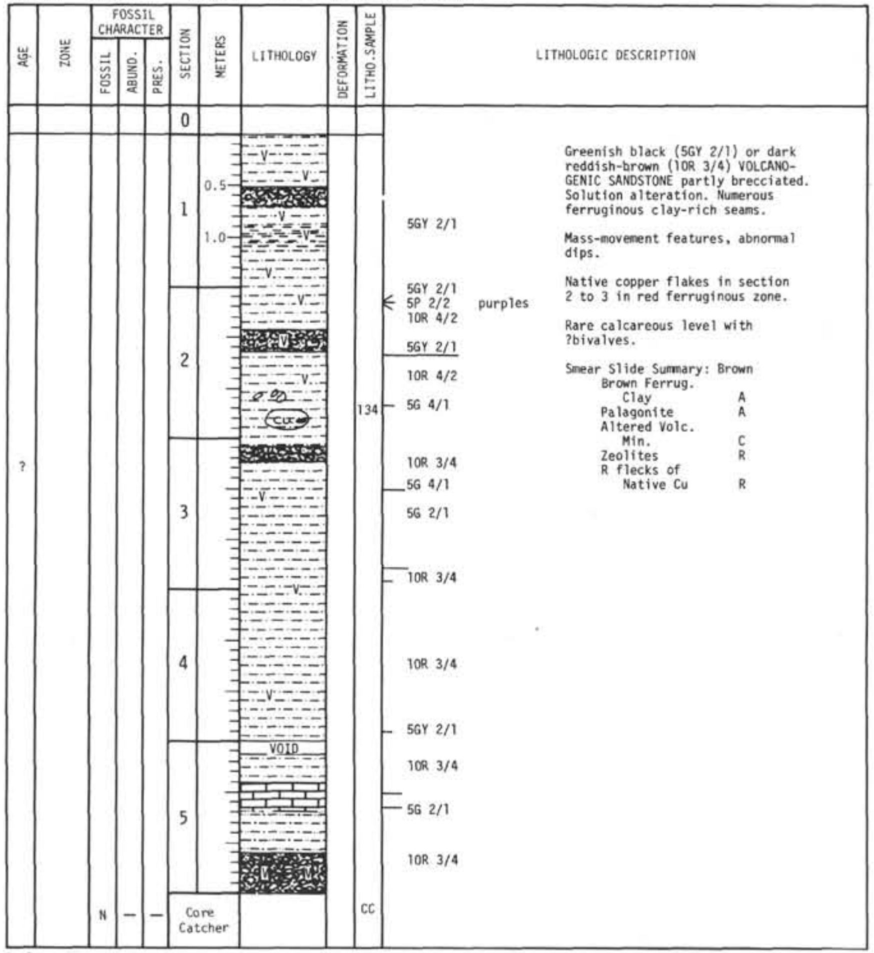
Greenish black (5GY 2/1) VOLCANOGENIC SANDSTONE, SILTSTONE to CLAYSTONE.

Locally brecciated zones. Poorly sorted. Rare calcareous horizons.

Smear Slide Summary:

Palagonite	D to A
Altered Volc. Min.	C to A
Zeolites (analcite and others)	R to A

Site 317 Hole A Core 22 Cored Interval: 753.5-763.0 m



Greenish black (5GY 2/1) or dark reddish-brown (10R 3/4) VOLCANOGENIC SANDSTONE partly brecciated. Solution alteration. Numerous ferruginous clay-rich seams.

Mass-movement features, abnormal dips.

Native copper flakes in section 2 to 3 in red ferruginous zone.

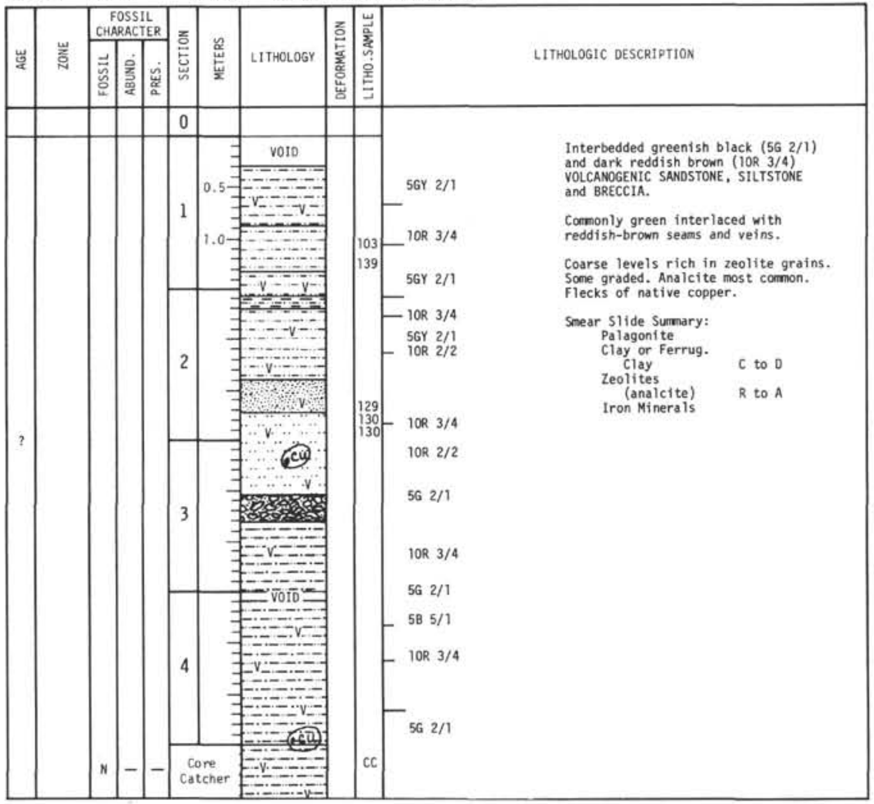
Rare calcareous level with ?bivalves.

Smear Slide Summary: Brown

Brown Ferrug. Clay	A
Palagonite	A
Altered Volc. Min.	C
Zeolites	R
R flecks of Native Cu	R

Explanatory notes in Chapter 1

Site 317 Hole A Core 23 Cored Interval: 763.0-772.5 m



Interbedded greenish black (5G 2/1) and dark reddish brown (10R 3/4) VOLCANOGENIC SANDSTONE, SILTSTONE and BRECCIA.

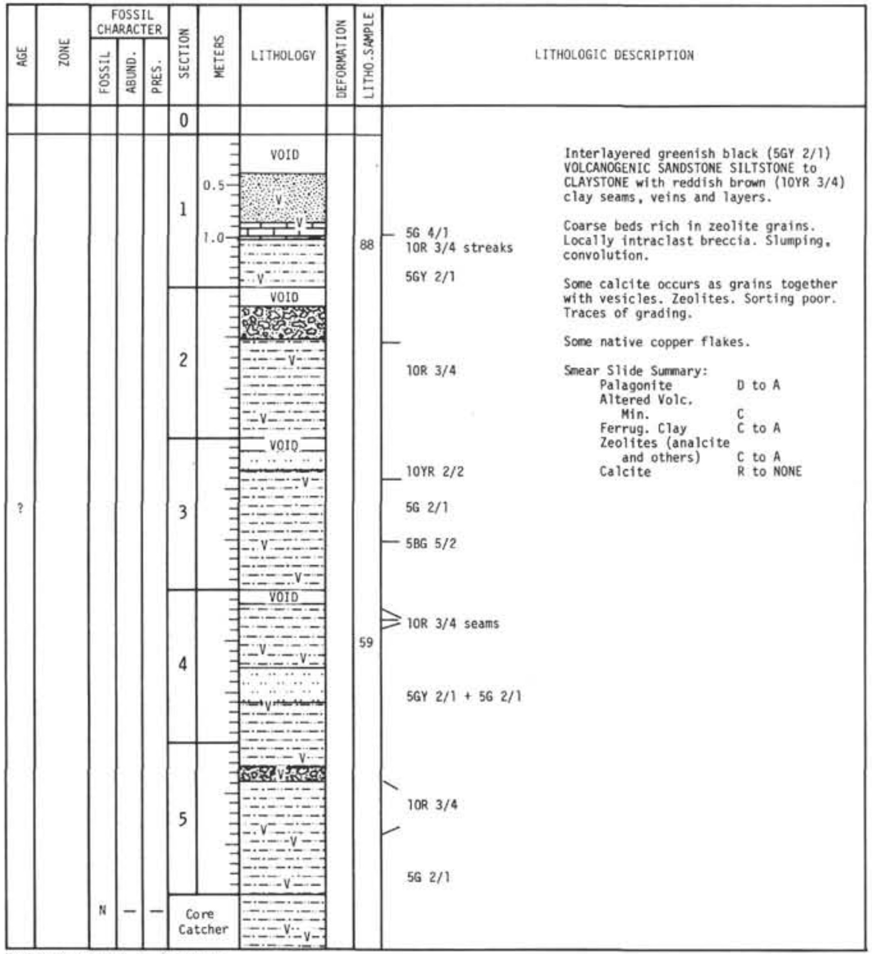
Commonly green interlaced with reddish-brown seams and veins.

Coarse levels rich in zeolite grains. Some graded. Analcite most common. Flecks of native copper.

Smear Slide Summary:

Palagonite	
Clay or Ferrug. Clay	C to D
Zeolites (analcite)	R to A
Iron Minerals	

Site 317 Hole A Core 24 Cored Interval: 772.5-782.0 m



Interlayered greenish black (5GY 2/1) VOLCANOGENIC SANDSTONE SILTSTONE to CLAYSTONE with reddish brown (10YR 3/4) clay seams, veins and layers.

Coarse beds rich in zeolite grains. Locally intraclast breccia. Slumping, convolution.

Some calcite occurs as grains together with vesicles. Zeolites. Sorting poor. Traces of grading.

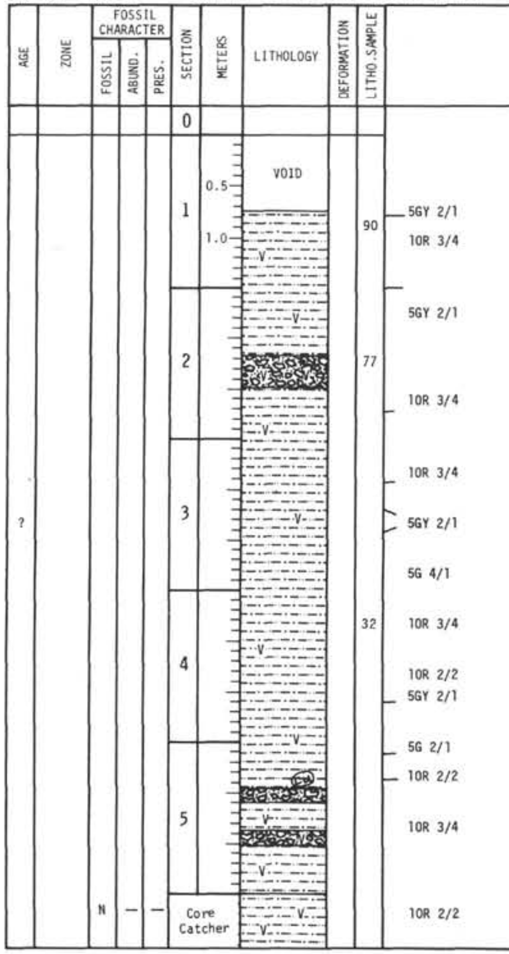
Some native copper flakes.

Smear Slide Summary:

Palagonite	D to A
Altered Volc. Min.	C
Ferrug. Clay	C to A
Zeolites (analcite and others)	C to A
Calcite	R to NONE

Explanatory notes in Chapter 1

Site 317 Hole A Core 25 Cored Interval: 791.5-801.0 m



LITHOLOGIC DESCRIPTION

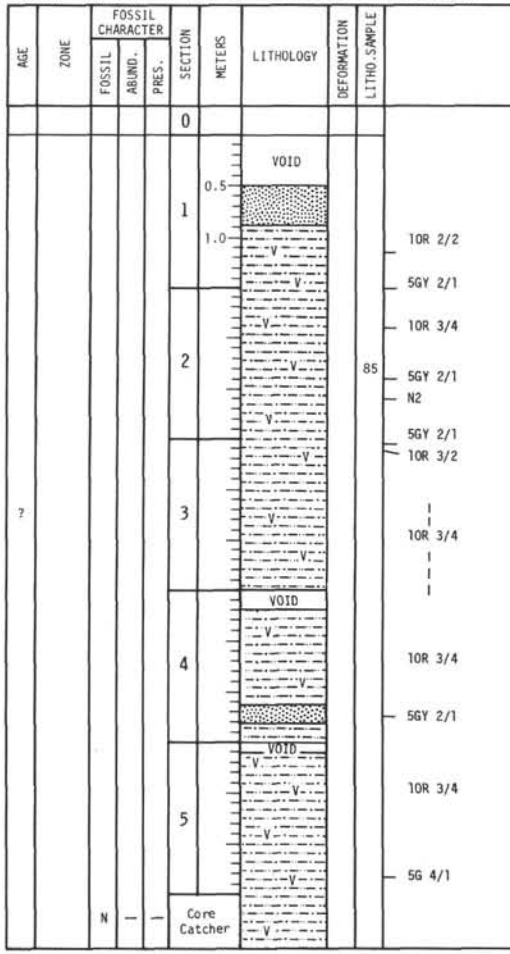
Greenish black (5GY 2/1) to dusky reddish brown (10R 3/4) VOLCANOGENIC SANDSTONE, SILTSTONE and FERRUGINOUS CLAY.

Some brecciated inter layers. Sandy beds rich in vesicle calcite. Zeolite suite as detrital grains. Locally graded, deformation structures. Grains of native copper.

Smear Slide Summary:

Palagonite Grains	D
Clay (ferrug.)	A to D
Zeolite (Most analcite)	R to C
Calcite	R
Calorite	R
Altered Volc. Min.	R

Site 317 Hole A Core 26 Cored Interval: 810.5-820.0 m



LITHOLOGIC DESCRIPTION

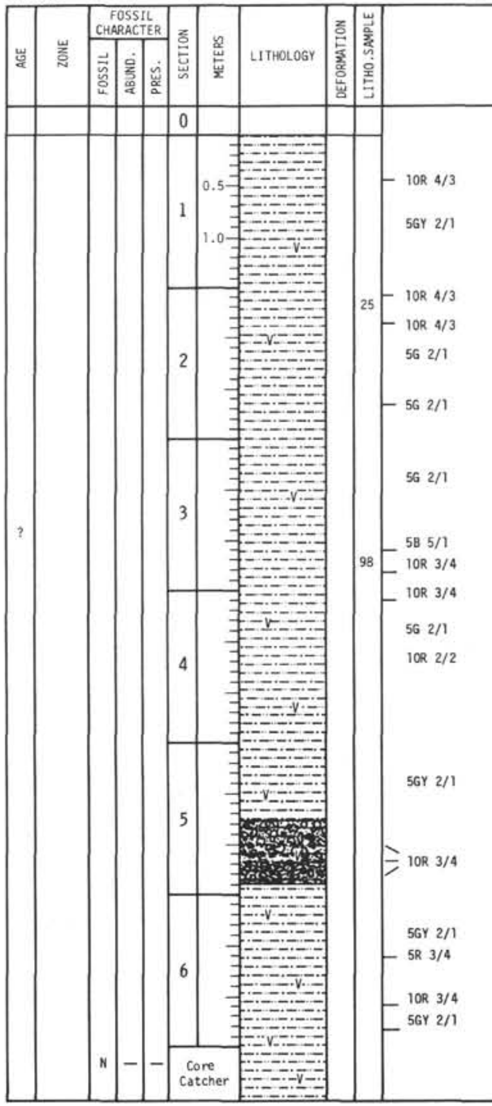
As above.

Greenish black (5GY 2/1) to dusky reddish brown (10R 3/4) VOLCANOGENIC SANDSTONE, SILTSTONE and FERRUGINOUS CLAY.

Greenish colors more common in sandier beds.

Explanatory notes in Chapter 1

Site 317 Hole A Core 27 Cored Interval: 829.5-839.0 m



LITHOLOGIC DESCRIPTION

As above.

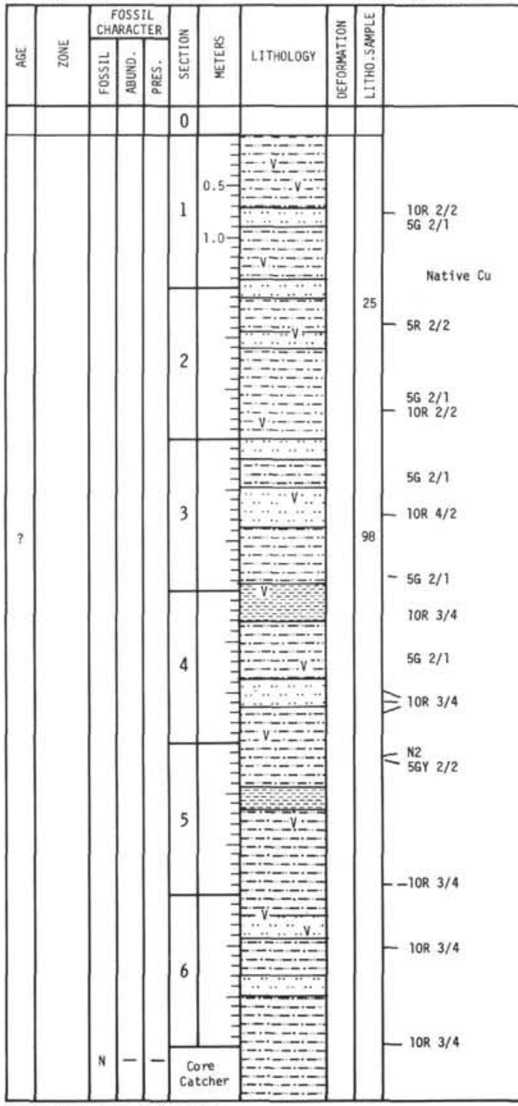
Greenish black (5GY 2/1) and dusky red-brown (10R 3/4) VOLCANOGENIC SANDSTONE, SILTSTONE to CLAYSTONE.

Locally breccia produced by extensive veining of the greenish black SILTSTONE. Sandstone grains angular to subangular.

Smear Slide Summary: 3-98

Palagonite	C to A
Clay	C to A
Zeolite (analcite +)	C
Calcite	V. RARE
Volc. Minerals	C

Site 317 Hole A Core 28 Cored Interval: 848.5-858.0 m



LITHOLOGIC DESCRIPTION

Greenish black (5GY 2/1) VOLCANOGENIC SANDSTONE, SILTSTONE to CLAYSTONE fewer reddish layers. More incising veins + seams of dusky red brown (10R 3/4) clay.

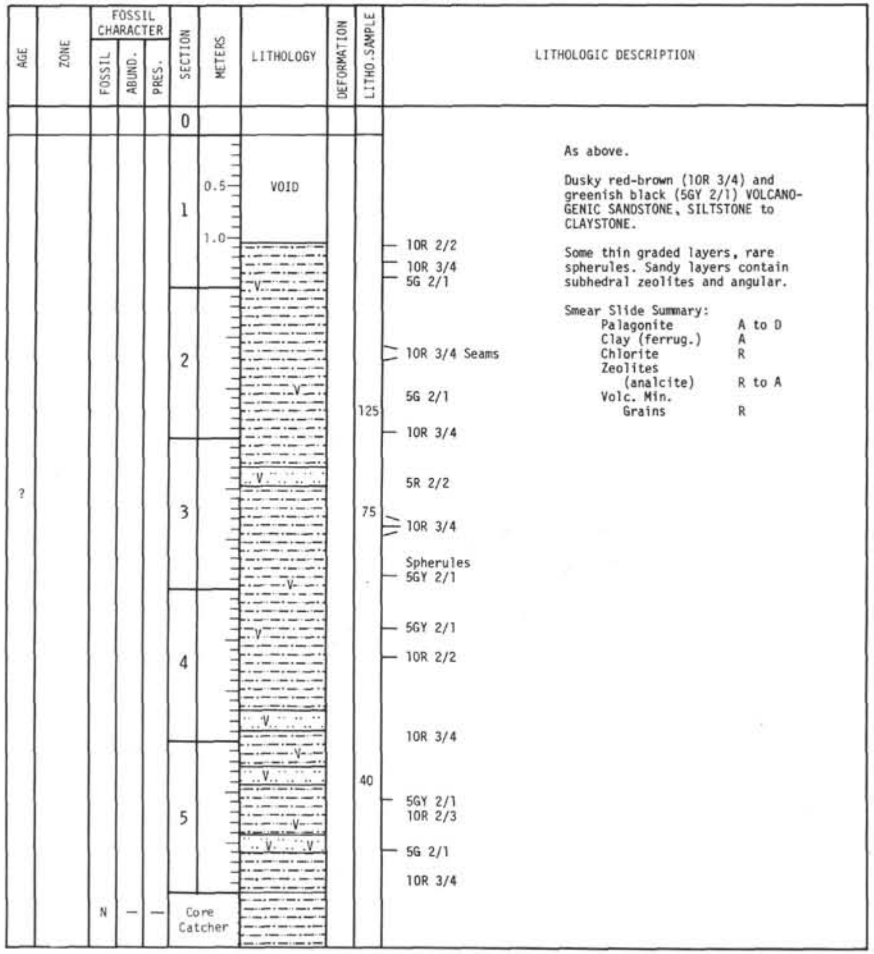
Many thin graded beds, 1 to 5 cm thick. Burrowed ironspecks, zeolite rich.

Smear Slide Summary:

Clay	C to A
Palagonite	C to A
Zeolite (analcite)	C
Calcite	V. R
Volc. Minerals	C
Fe Opaques	R

Explanatory notes in Chapter 1

Site 317 Hole A Core 29 Cored Interval: 867.5-877.0 m



As above.

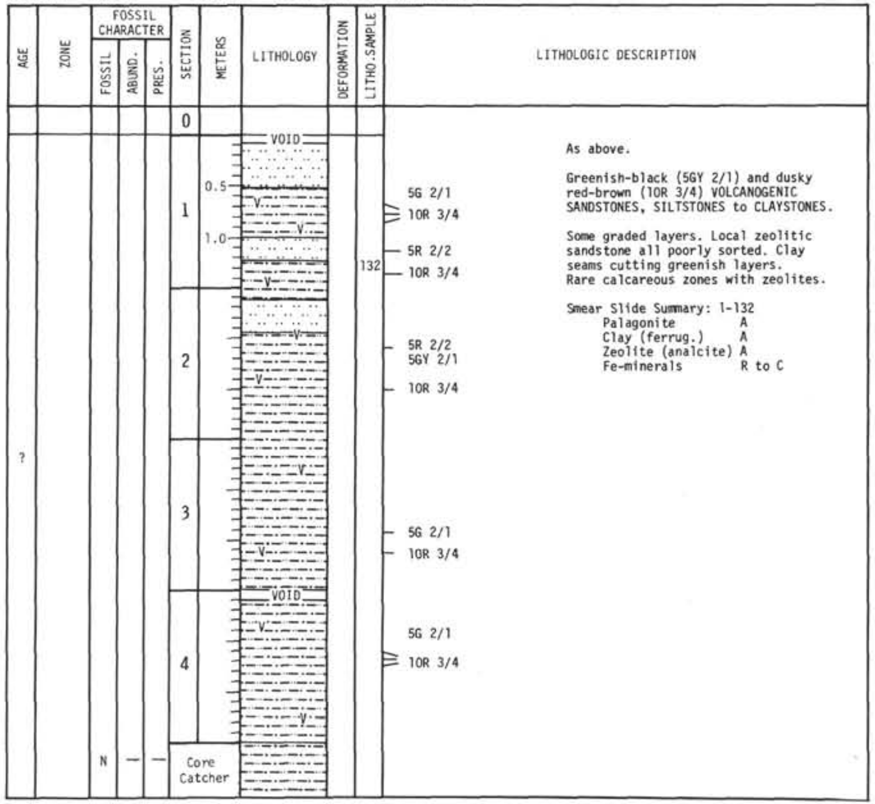
Dusky red-brown (10R 3/4) and greenish black (5GY 2/1) VOLCANOGENIC SANDSTONE, SILTSTONE to CLAYSTONE.

Some thin graded layers, rare spherules. Sandy layers contain subhedral zeolites and angular.

Smear Slide Summary:

Palagonite	A to D
Clay (ferrug.)	A
Chlorite	R
Zeolites (analcite)	R to A
Volc. Min. Grains	R

Site 317 Hole A Core 30 Cored Interval: 886.5-896.0 m



As above.

Greenish-black (5GY 2/1) and dusky red-brown (10R 3/4) VOLCANOGENIC SANDSTONES, SILTSTONES to CLAYSTONES.

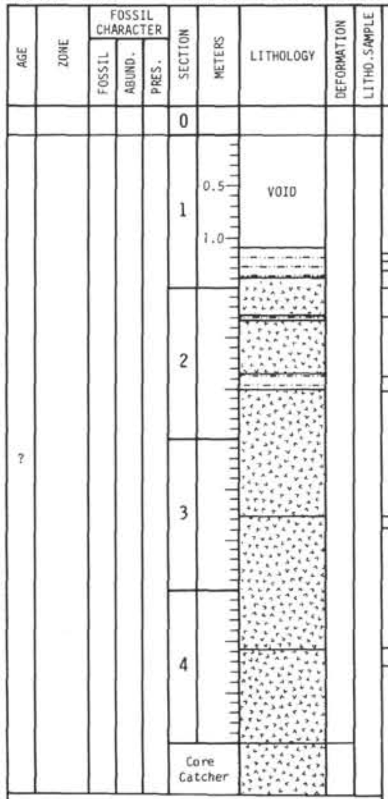
Some graded layers. Local zeolitic sandstone all poorly sorted. Clay seams cutting greenish layers. Rare calcareous zones with zeolites.

Smear Slide Summary: 1-132

Palagonite	A
Clay (ferrug.)	A
Zeolite (analcite)	A
Fe-minerals	R to C

Explanatory notes in Chapter 1

Site 317 Hole A Core 31 Cored Interval: 905.5-915.0 m



LITHOLOGIC DESCRIPTION

10R 4/2
5G 5/2
10YR 4/2
1
5YR 3/2
5G 4/1
2
5G 6/1
3
5B 5/1
4
5G 6/1

<u>1 - 110 to 137 cm:</u>
Grayish red (10R 4/2) and grayish green VOLCANOGENIC SILTSTONE.

BASALT: Basalts are all probable ocean floor tholeiites. Circled numbers are flow units.

<u>40 cm Flow Unit 1</u>:
Dark greenish gray (5G 4/1) basalt. Aphyric, vesicular (15%) some zeolite-filled. Fine-grained, altered groundmass. No chilled margins. Vesicles 1.5 to 2.5 mm, irregular, rounded lined. Some filled with green matter.

Flow Units 1 and 2 and 3 separated by grayish brown (5YR 3/2), grayish blue-green (5BG 5/2) volcanogenic siltstone. Indurated, baked.

<u>60 cm Flow Unit 2</u> as 1 above dark greenish gray vesicular basalt. Vesicles (20%) smaller, near top; those near the base partially lined with coarse white zeolites. Pyroxene phenocrysts common. Fine grained near contact.

<u>120 cm Flow Unit 3</u> as above but phenocrysts rare, evenly dispersed vesicles (20%) lined, most with greenish fillings. Groundmass fine grained, altered. Chalcopyrite?

<u>110 cm Flow Unit 4</u> as above, finer grain size near contacts, med. bluish gray (5B 5/1) aphanitic, vesicular upper contact, 40% near contact.

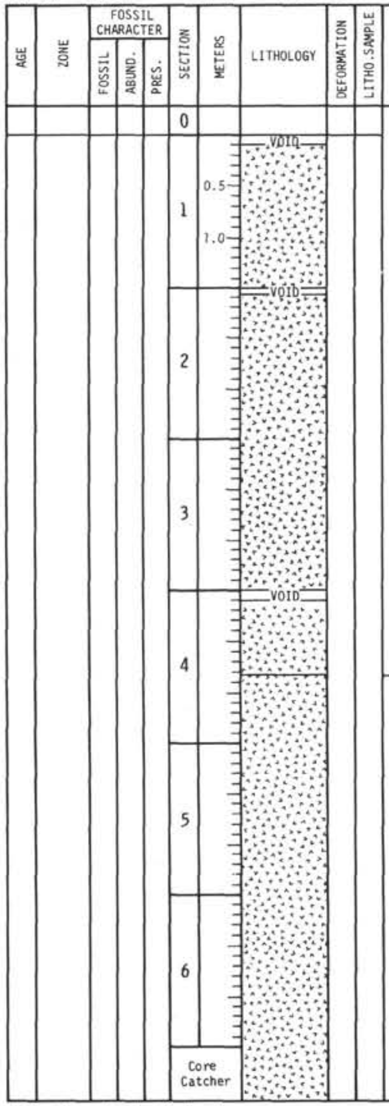
Flow Unit 5 (upper part), vesicles, (10%) 1 x 1 mm pyroxene microphenocrysts, glassy lighter greenish gray (5G 6/1).

Thin Section: CC

Basalt, vesicles, (0.6-4 cm) rounded, filled with zeolites, vesicles filled with green fibrous material.	9.0%
Augite Microphenocrysts	12.5%
Groundmass Augite	15.0%
Groundmass Pigeonite	10.0%
Groundmass Plagioclase	40.0%
Groundmass Glass	12.5% (altered)
Opaques	<5.0%

Texture diabasic to intersertal

Site 317 Hole A Core 32 Cored Interval: 915.0-924.5 m



LITHOLOGIC DESCRIPTION

5G 4/1
5GY 6/1
5

See above continued.

<u>Flow Unit 5</u> (lower part) 4.5 meters dark greenish-gray (5G 4/1) to greenish gray (5G 6/1) basalt. Glassy to fine grained, phenocryst-rich. Vesicular, (10%) most 1 x 1 mm, rounded, locally irregular up to 6 x 10 mm, lined, some zeolite-filled. Five to ten percent pyroxene microphenocrysts and common platy feldspars oriented core axis.

4-82 cm to core catcher
<u>Flow Unit 6</u> (upper part) 4.5 m greenish gray (5G 6/1) basalt aphyric, vesicular 1 to 3 mm, up to 10 cm near top contact. Irregular. Lined with greenish black (5GY 2/1), vesicles mostly filled. Groundmass glassy at top, texture diabasic to intersertal. Coarsens downward to .2 to .3 mm. Feldspars stubby lath shaped, many orient to core barrel. Veins along fractures. Vesicles mostly zeolite filled, some calcite.

Thin Section: CC Middle Flow Unit 6
Vesicular-vuggy basalt with augite phenocrysts and diabasic to intersertal texture.
Vesicles, as 31-CC, zeolite or calcite filled.
Microphenocrysts - clino pyroxene (augite)
Groundmass - augite and pigeonite aggregates with lathlike-feldspar, glass altered opaques concentrated near glass.

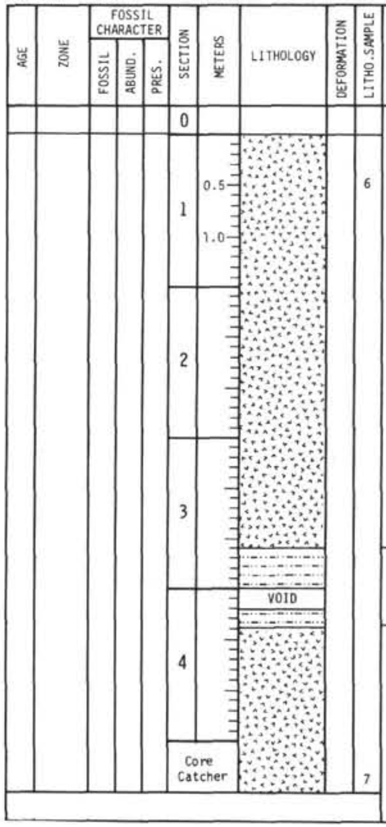
5GY 6/1

Vesicles (filled)	9.0%
Augite Microphenocrysts	12.5%
Groundmass Augite	15.0%
Groundmass Pigeonite	10.0%
Groundmass Plag.	40.0%
Altered Glass	~12.5%
Opaques	<5.0%

6

Explanatory notes in Chapter 1

Site 317 Hole A Core 33 Cored Interval: 924.5-934.0 m



LITHOLOGIC DESCRIPTION

5G 6/1
6

0 to 3-110 cm
Bottom of Flow Unit 6 greenish gray (5G 6/1) basalt vesicular, aphyric, fine grained similar to core 32-6, and 36-5. Highly fractured, veined and altered in upper part. Slightly grayer color and finer grained no glassy margin.

3-110 to 4-38 cm
Dark red (5R 2/6) volcanogenic siltstone to claystone separating 2 basalt flow units. Baked contacts. Highly indurated. Cut by yellowish gray (5Y 7/2) calcareous veins. Irregular bedding.

5R 2/6

4-38 cm to core catcher
Upper part Flow Unit 7 dark greenish gray (5G 4/1) basalt. Aphyric, vesicular: vesicles large 2 x 2 mm to 6 x 6 mm. Irregular, uneven distribution mostly filled, greenish black. Some zeolite. Vesicles spherical to rounded. Groundmass fine to intergranular to intersertal. Glass badly altered. Rare calcite veins.

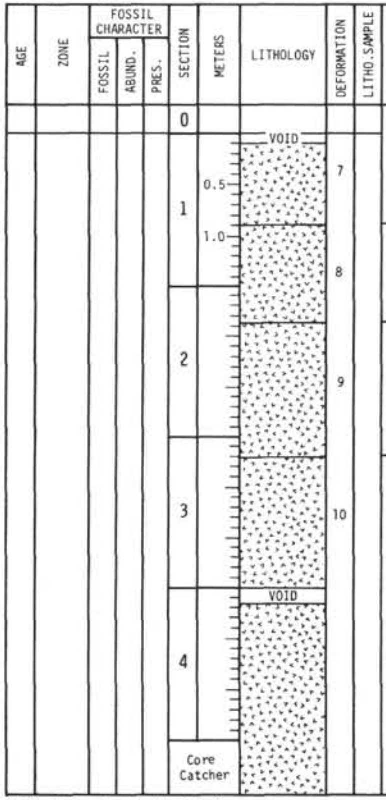
Thin Section: CC
Vesicular basalt, intersertal groundmass. Chilled texture within slide.

5G 4/1
7

Vesicles .6-1.75 mm, flattened, dark green fibrous to granular filling, some calcite, fine-coarse.

Vesicles	5-11%
Groundmass Augite	34-35%
Groundmass Plagioclase	40-40%
Groundmass Glass	15-20%
Opaques	<5-<5%

Site 317 Hole A Core 34 Cored Interval: 934.0-943.5 m



LITHOLOGIC DESCRIPTION

5GY 6/1
7

Flow Units 7 , 8 , 9 , 10
Greenish gray (5G 6/1) to dark greenish gray (5G 4/1) vesicular basalts. Altered contacts, glassy, some chloritized.

5GY 4/1
8

Basalt aphyric, vesicular, large in upper parts (5-10 mm) decreasing downward. Irregular. Mostly filled with greenish black. Some zeolitic, more near center. Common feldspar laths. Small feldspar phenocrysts. Light blue green vesicle filling near contacts.

9

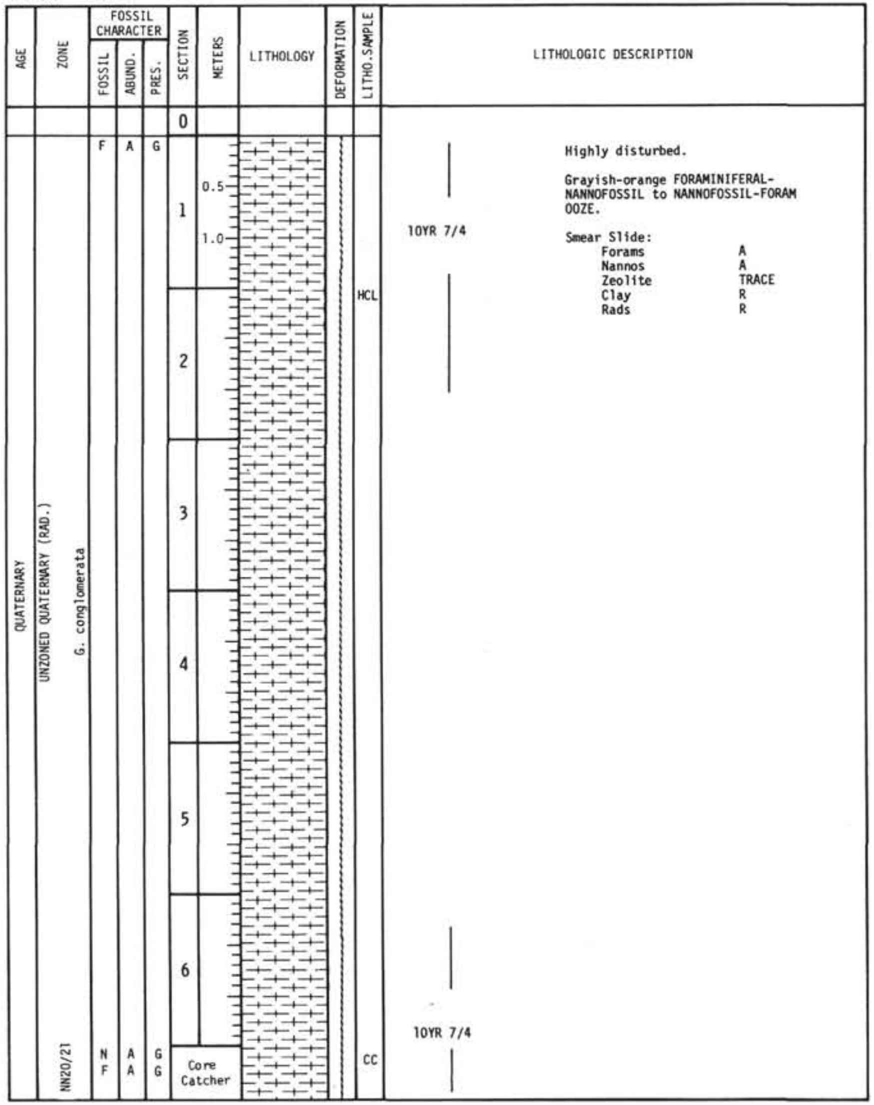
Thin Section: CC
Vesicular basalt with plagioclase microphenocrysts, glomeroporphyritic fine intragranular groundmass. Some glass. Vesicles - irregular, rounded. Vuggy, elongate core. All filled with fibrous to granular blue green material. Some zeolitic or calcitic.

Vesicles (filled)	7.0%
Plagioclase Phenocrysts	7.5%
Plag-rich Aggregates	6.0%
Cpx-rich Aggregates	3.5%
Groundmass Plagioclase	35.0%
Groundmass Pyroxene	35.0%
Glass	3.0%
Opaques	3.0%

10

Explanatory notes in Chapter 1

Site 317 Hole B Core 1 Cored Interval: 0.0-6.5 m



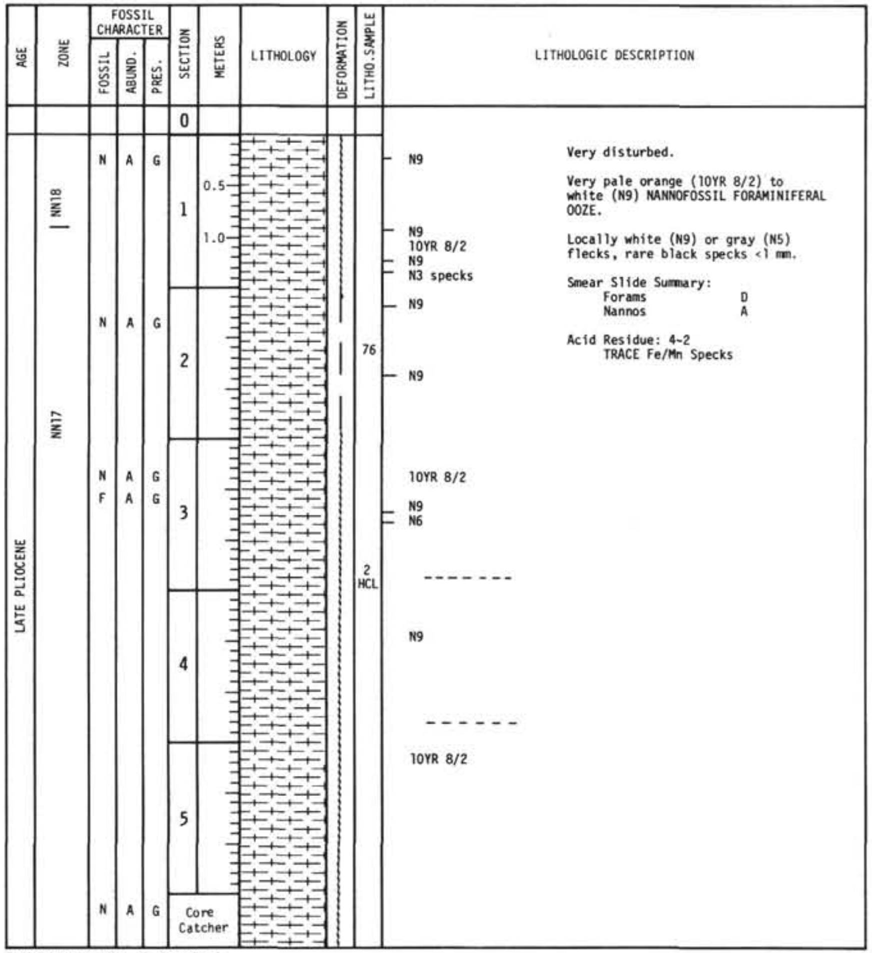
Highly disturbed.

Grayish-orange FORAMINIFERAL-NANNOFOSSIL to NANNOFOSSIL-FORAM OOZE.

Smear Slide:

Forams	A
Nannos	A
Zeolite	TRACE
Clay	R
Rads	R

Site 317 Hole B Core 2 Cored Interval: 6.5-16.0 m



Very disturbed.

Very pale orange (10YR 8/2) to white (N9) NANNOFOSSIL FORAMINIFERAL OOZE.

Locally white (N9) or gray (N5) flecks, rare black specks <1 mm.

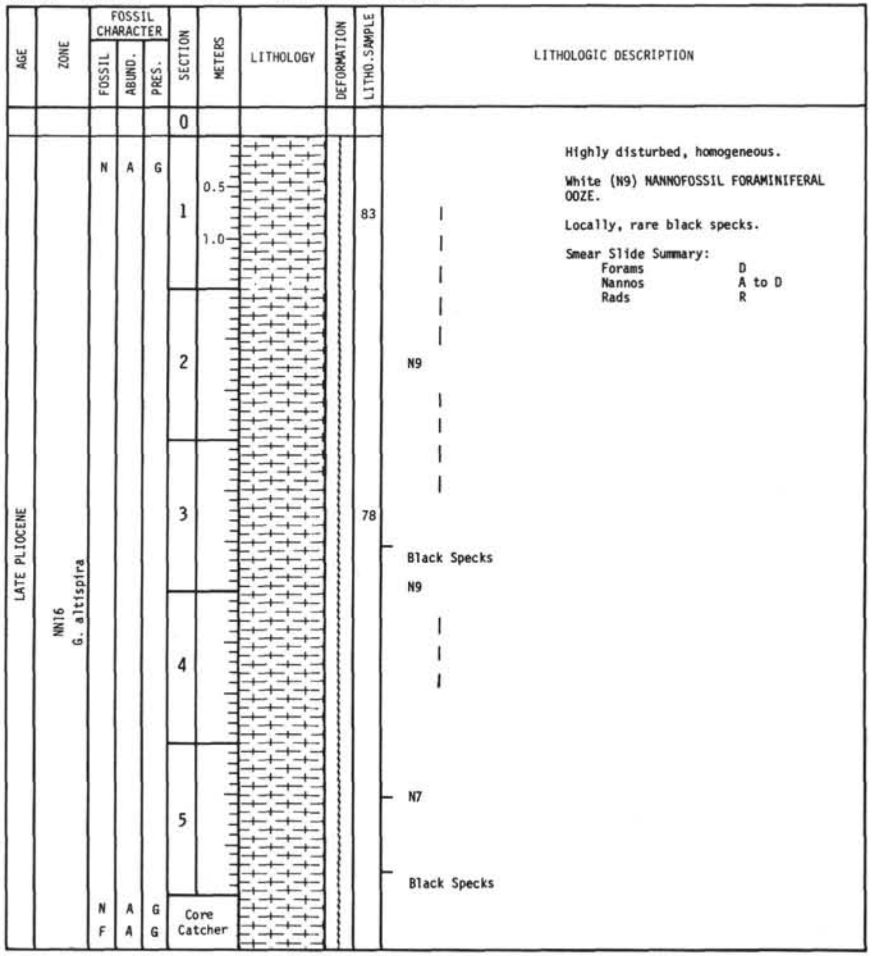
Smear Slide Summary:

Forams	D
Nannos	A

Acid Residue: 4-2
TRACE Fe/Mn Specks

Explanatory notes in Chapter 1

Site 317 Hole B Core 3 Cored Interval: 16.0-25.5 m



Highly disturbed, homogeneous.

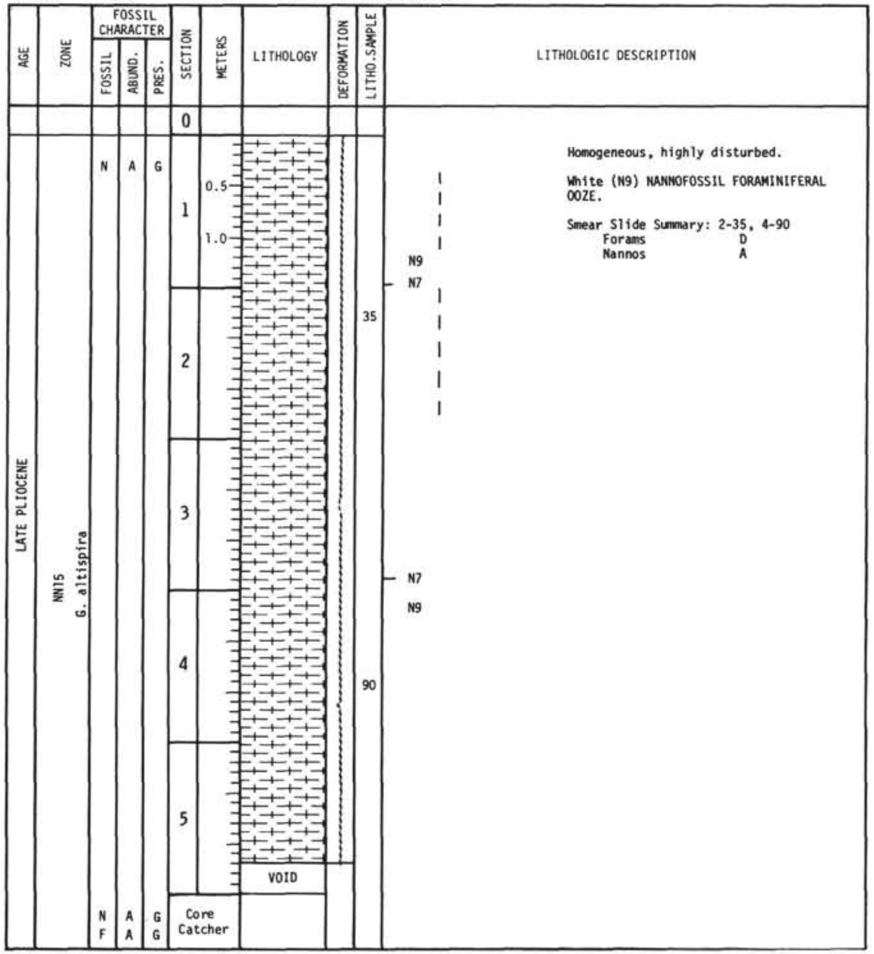
White (N9) NANNOFOSSIL FORAMINIFERAL OOZE.

Locally, rare black specks.

Smear Slide Summary:

Forams	D
Nannos	A to D
Rads	R

Site 317 Hole B Core 4 Cored Interval: 25.5-35.0 m



Homogeneous, highly disturbed.

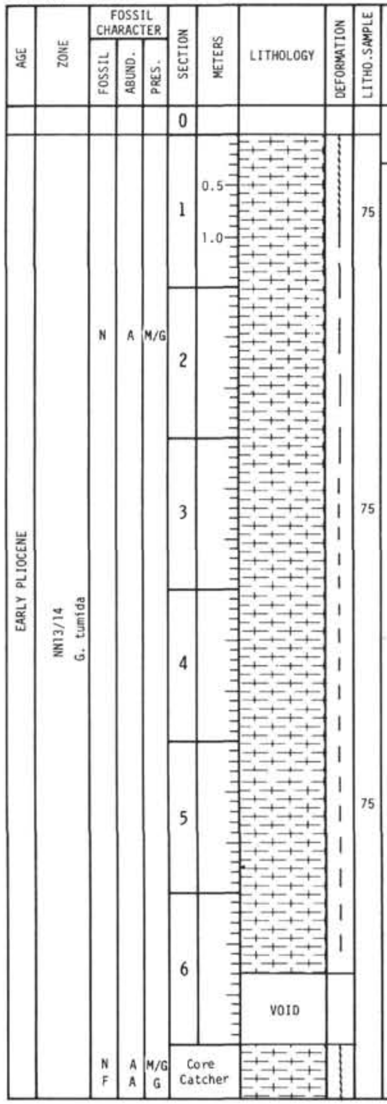
White (N9) NANNOFOSSIL FORAMINIFERAL OOZE.

Smear Slide Summary: 2-35, 4-90

Forams	D
Nannos	A

Explanatory notes in Chapter 1

Site 317 Hole B Core 5 Cored Interval: 35.0-44.5 m



LITHOLOGIC DESCRIPTION

Black Specks

N9

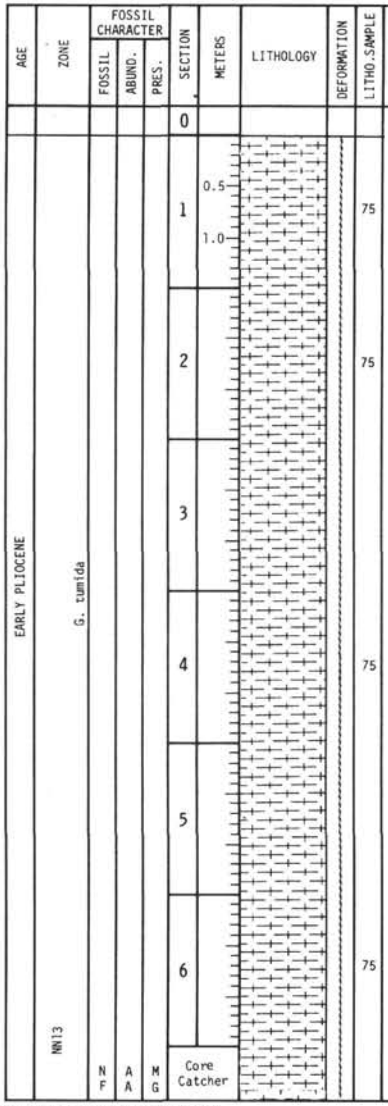
N9

Homogeneous, white (N9) FORAMINIFERAL NANNOFOSSIL OOZE.

Smear Slide Summary:

Nannos	D
Forams	A
(locally ~50%)	

Site 317 Hole B Core 6 Cored Interval: 44.5-54.0 m



LITHOLOGIC DESCRIPTION

N9

N9

N9

N9

Intenseively disturbed homogeneous.

White (N9) FORAMINIFERAL NANNOFOSSIL OOZE.

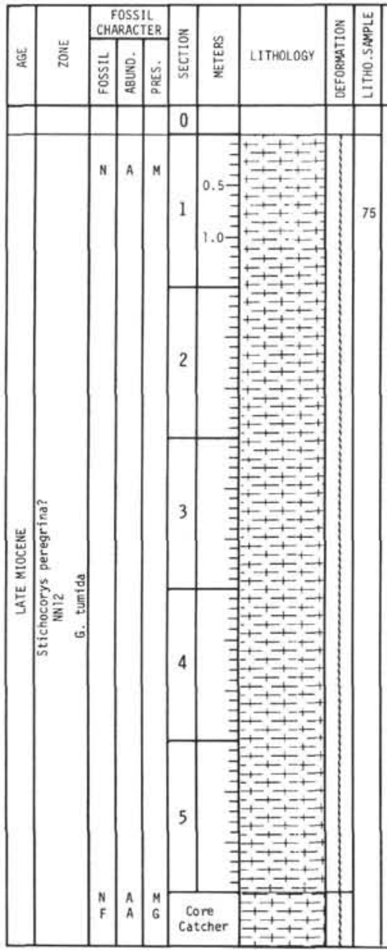
Smear Slide:

Nannos	D
Forams	A
Rads	R

Some slight overgrowth on nanno-discoasters.

Explanatory notes in Chapter 1

Site 317 Hole B Core 7 Cored Interval: 54.0-63.5 m



LITHOLOGIC DESCRIPTION

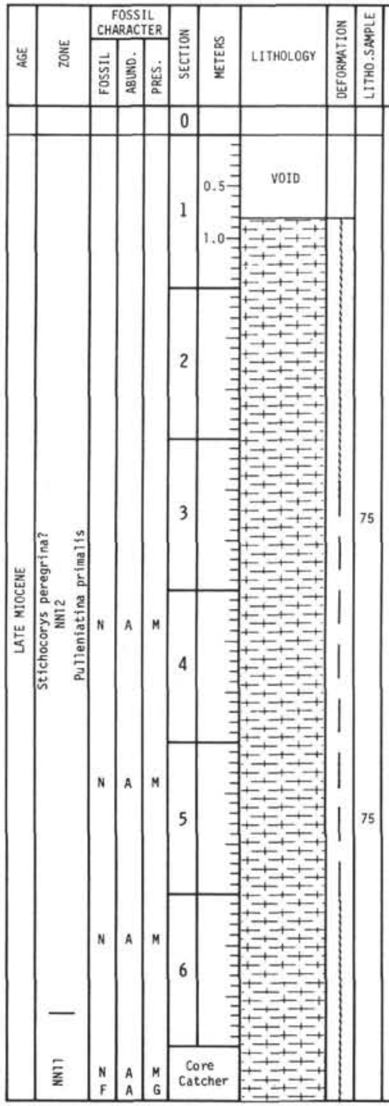
N9 N9 N9 N9 N9

Highly disturbed, homogeneous.

White (N9) FORAMINIFERAL NANNOFOSSIL OOZE.

Smear Slide: 1-75
Nannos D
Forams A

Site 317 Hole B Core 8 Cored Interval: 63.5-73.0 m



LITHOLOGIC DESCRIPTION

N9 N9 N9 N9

Highly to moderately disturbed, homogeneous.

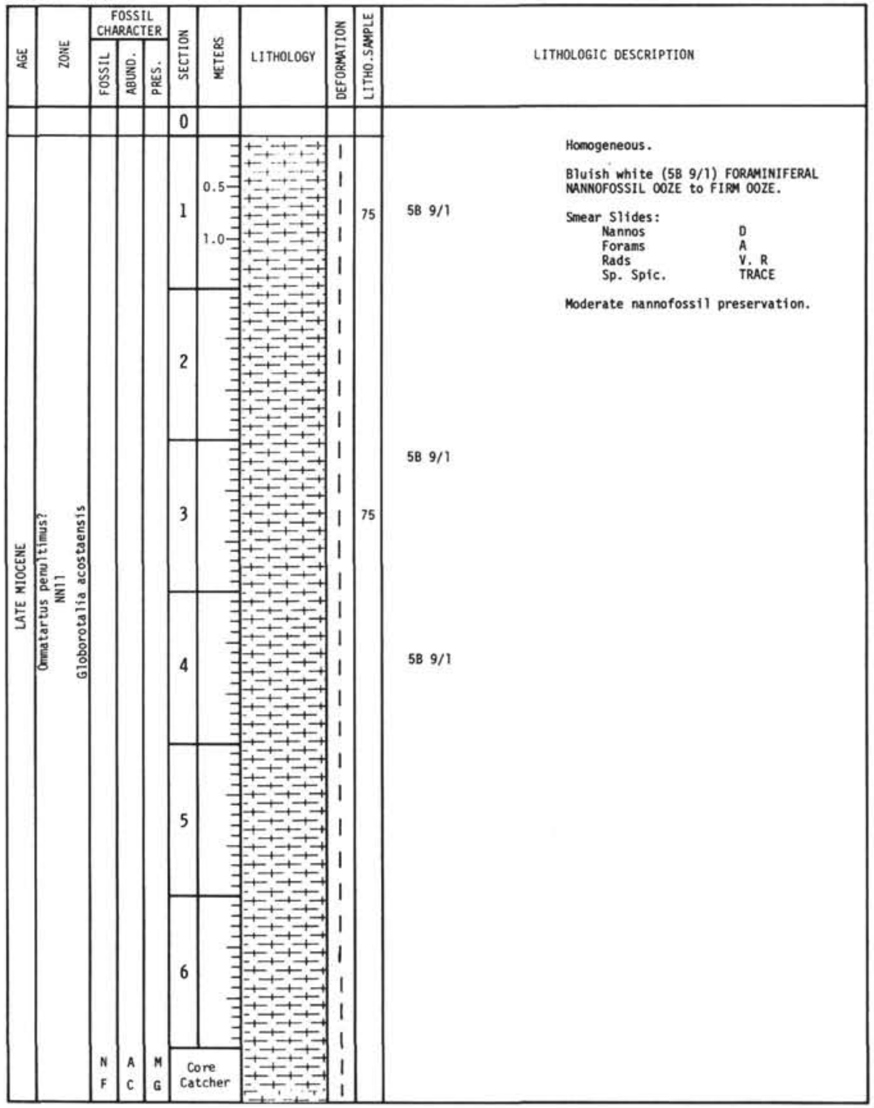
White (N9) FORAMINIFERAL NANNOFOSSIL OOZE to FIRM OOZE.

Smear Slide Summary:
Nannos D to A
Forams A
Clay TRACE

Discoasters slight overgrowth.

Explanatory notes in Chapter 1

Site 317 Hole B Core 9 Cored Interval: 73.0-82.5 m



Homogeneous.

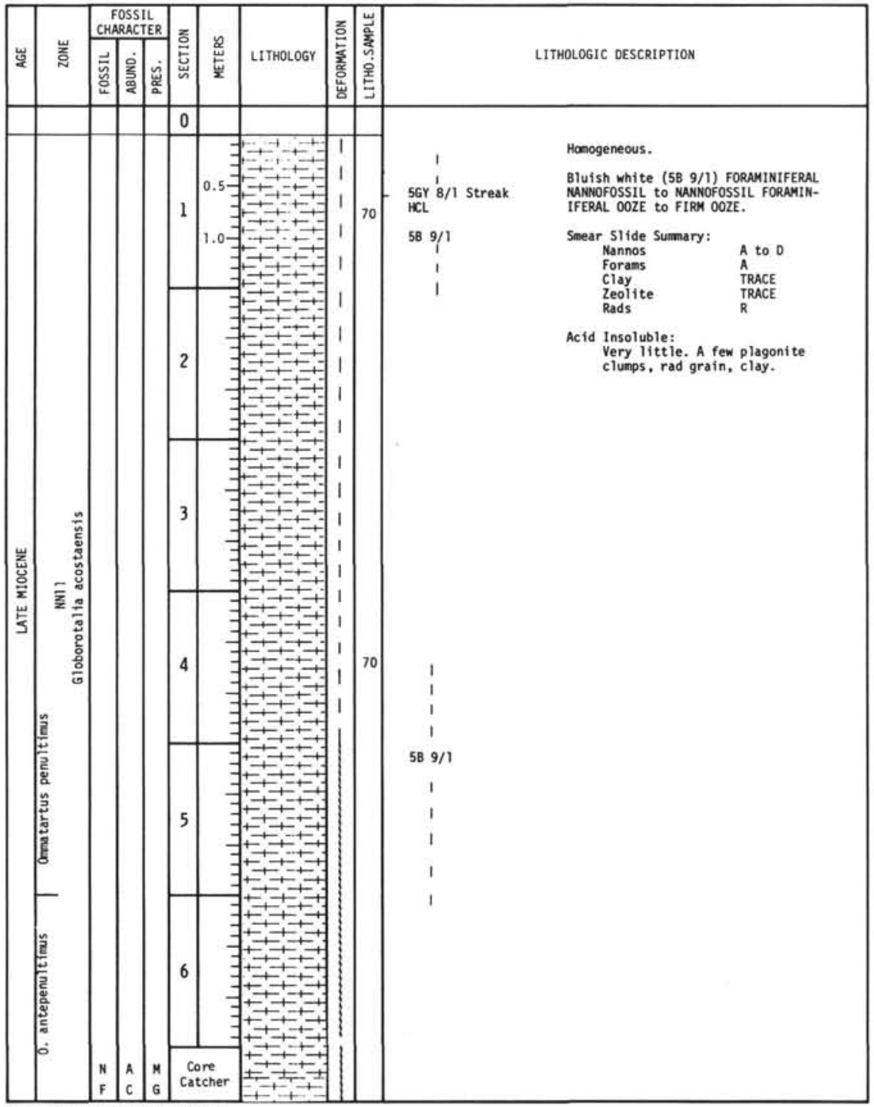
Bluish white (5B 9/1) FORAMINIFERAL NANNOFOSSIL OOZE to FIRM OOZE.

Smear Slides:

Nannos	D
Forams	A
Rads	V. R
Sp. Spic.	TRACE

Moderate nannofossil preservation.

Site 317 Hole B Core 10 Cored Interval: 82.5-92.0 m



Homogeneous.

Bluish white (5B 9/1) FORAMINIFERAL NANNOFOSSIL to NANNOFOSSIL FORAMINIFERAL OOZE to FIRM OOZE.

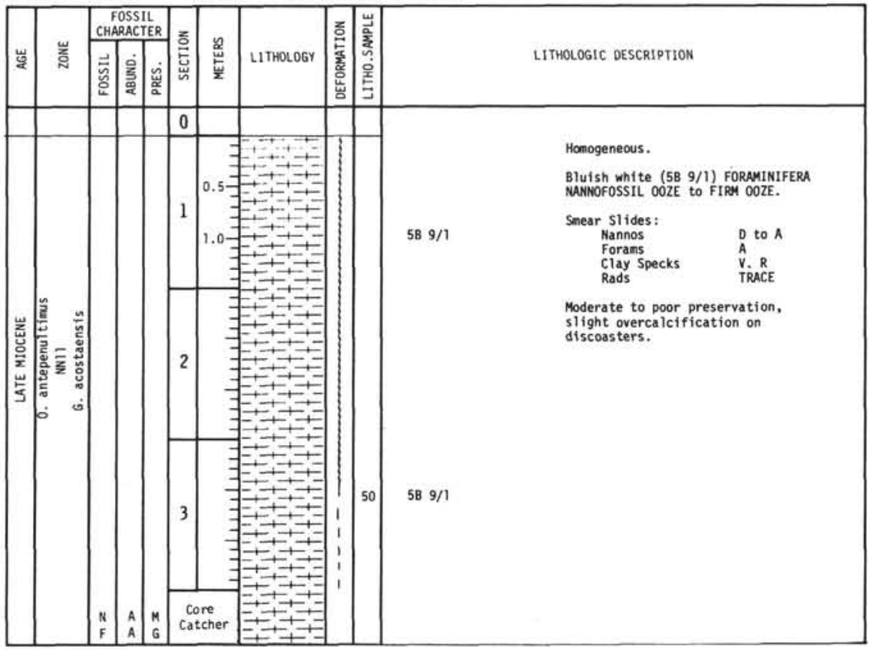
Smear Slide Summary:

Nannos	A to D
Forams	A
Clay	TRACE
Zeolite	TRACE
Rads	R

Acid Insoluble:
Very little. A few plagonite clumps, rad grain, clay.

Explanatory notes in Chapter 1

Site 317 Hole B Core 11 Cored Interval: 92.0-101.5 m



Homogeneous.

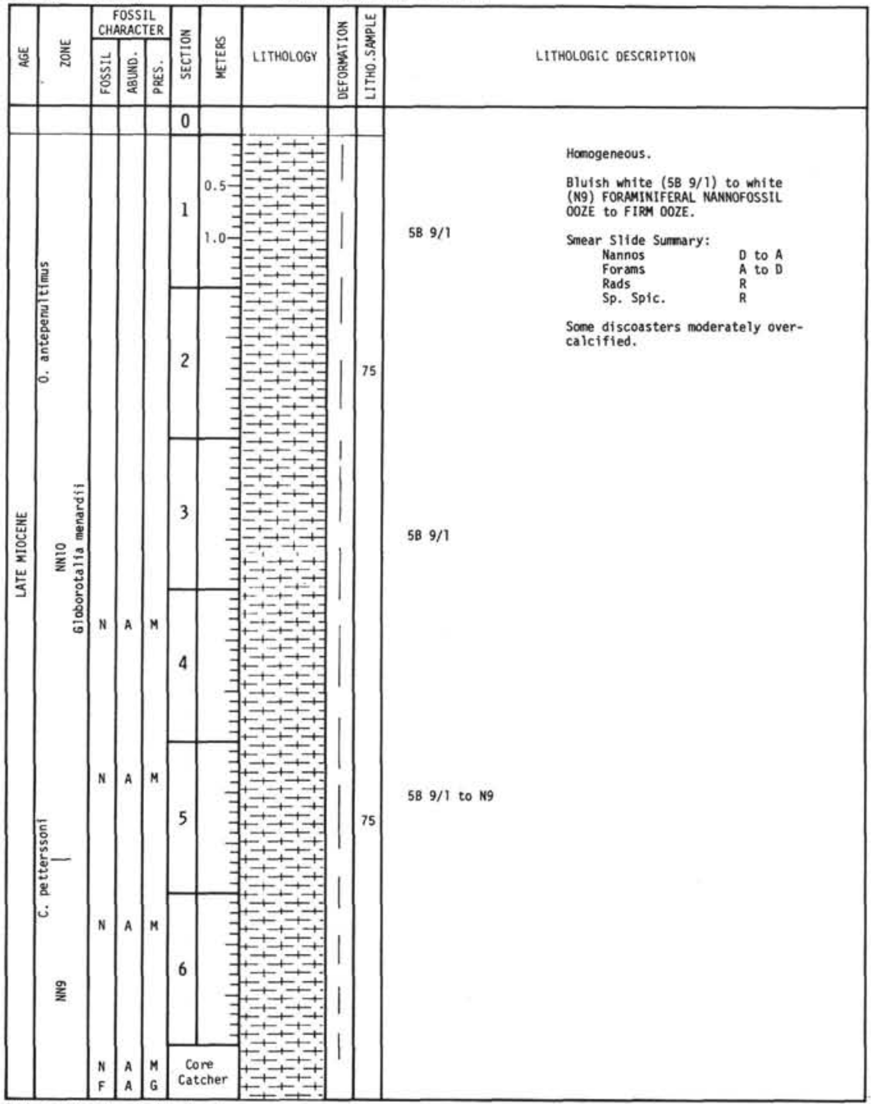
Bluish white (5B 9/1) FORAMINIFERA NANNOFOSSIL OOZE to FIRM OOZE.

Smear Slides:

Nannos	D to A
Forams	A
Clay Specks	V. R
Rads	TRACE

Moderate to poor preservation, slight overcalcification on discoasters.

Site 317 Hole B Core 12 Cored Interval: 101.5-111.0 m



Homogeneous.

Bluish white (5B 9/1) to white (N9) FORAMINIFERAL NANNOFOSSIL OOZE to FIRM OOZE.

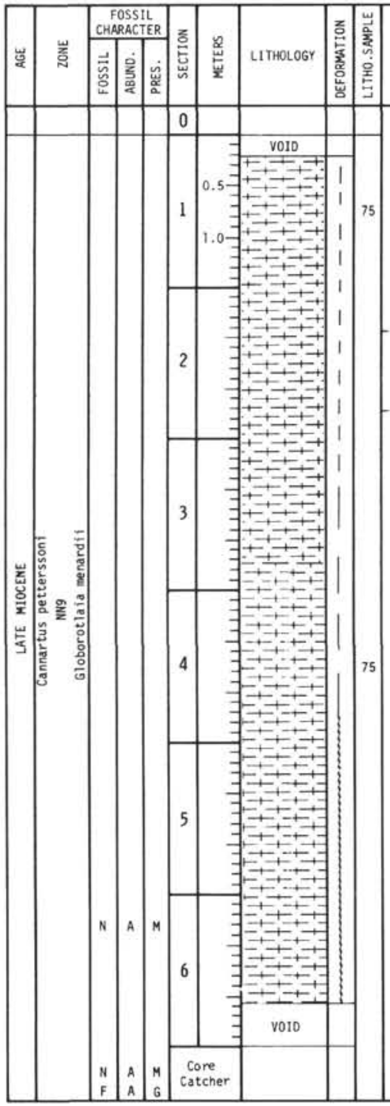
Smear Slide Summary:

Nannos	D to A
Forams	A to D
Rads	R
Sp. Spic.	R

Some discoasters moderately overcalcified.

Explanatory notes in Chapter 1

Site 317 Hole B Core 13 Cored Interval: 111.0-120.5 m



N9

N7

N7

10YR 8/2 to N9

10YR 8/2 to N9

LITHOLOGIC DESCRIPTION

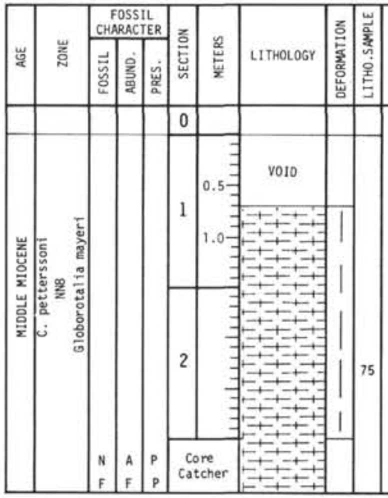
Homogeneous.

White (N9) to very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL to NANNOFOSSIL FORAMINIFERAL FIRM OOZE.

Smear Slides: 1-75, 4-75

Nannos	D
Forams	A
Rads	R
Clay Min.	TRACE
Sp. Fragments	?

Site 317 Hole B Core 14 Cored Interval: 120.5-130.0 m



N9

N9

LITHOLOGIC DESCRIPTION

Moderately disturbed.

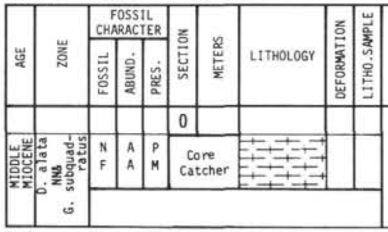
Homogeneous, white (N9) FORAMINIFERAL NANNOFOSSIL OOZE to FIRM OOZE.

Smear Slide: 2-75

Nannos	A to D
Forams	A (D)
Rads	R

Nannos mod. to poorly preserved, some overcalcification.

Site 317 Hole B Core 15 Cored Interval: 130.0-139.5 m



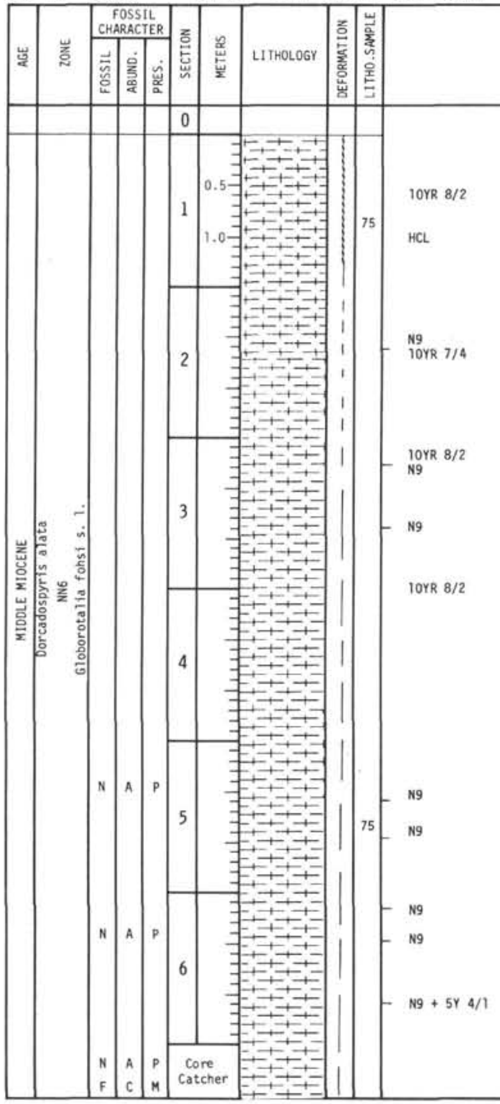
N9

LITHOLOGIC DESCRIPTION

White (N9) FORAMINIFERAL NANNOFOSSIL OOZE.

Explanatory notes in Chapter 1

Site 317 Hole B Core 16 Cored Interval: 139.5-149.0 m



Moderately disturbed, homogeneous.

Very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL FIRM OOZE with blotches and mottles of white (N9) to olive gray (5Y 4/1).

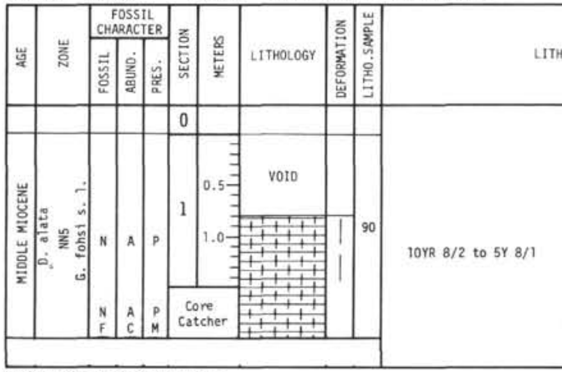
Smear Slide Summary:

Nannos	D
Forams	A
Micrite	R
Rads	V. R

Moderate discoaster overcalcification. Nannos becoming less distinct.

Acid Residue:
Mostly Radiolarian fragments, spines, clay ~>1.57 and ferruginous matter.

Site 317 Hole B Core 17 Cored Interval: 149.0-158.5 m



Homogeneous, very pale orange (10YR 8/2) to yellowish gray (5Y 8/1) FORAMINIFERAL NANNO-OFFSIL CHALK.

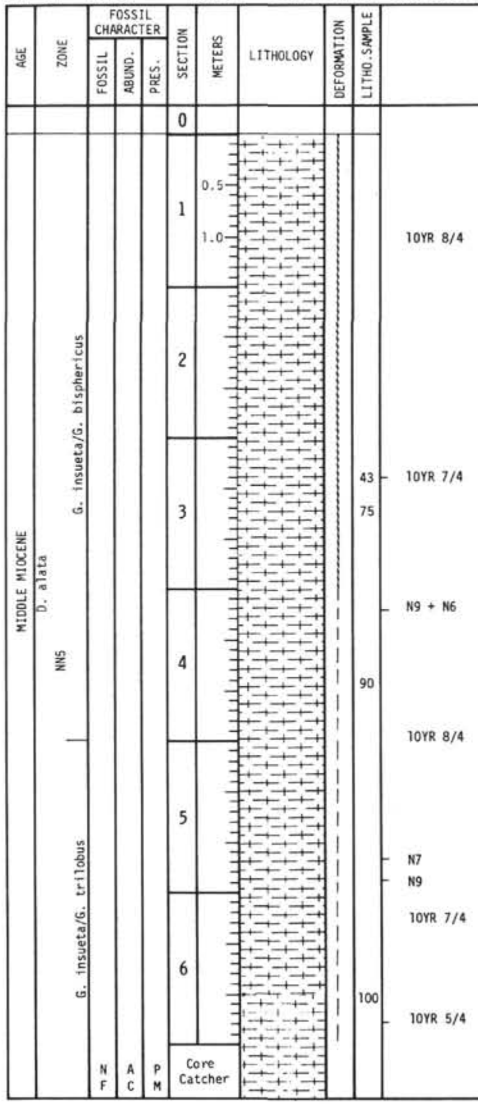
Smear Slide: 1-90

Nannos	D
Forams	C to A
Rads	R
Micrite	R

Notable decrease in forams, while increase in micrite and overcalcification of discoasters.

Explanatory notes in Chapter 1

Site 317 Hole B Core 18 Cored Interval: 158.5-168.0 m



LITHOLOGIC DESCRIPTION

Highly to moderately disturbed.

Light grayish orange (10YR 8/4) to grayish orange (10YR 7/4) FORAMINIFERAL-NANNOFOSSIL FIRM OOZE with periodic chalk nodules (drilling disturbance?).

Streaks and mottles of gray and white.

Smear Slides: 2-43, 2-75, 2-90

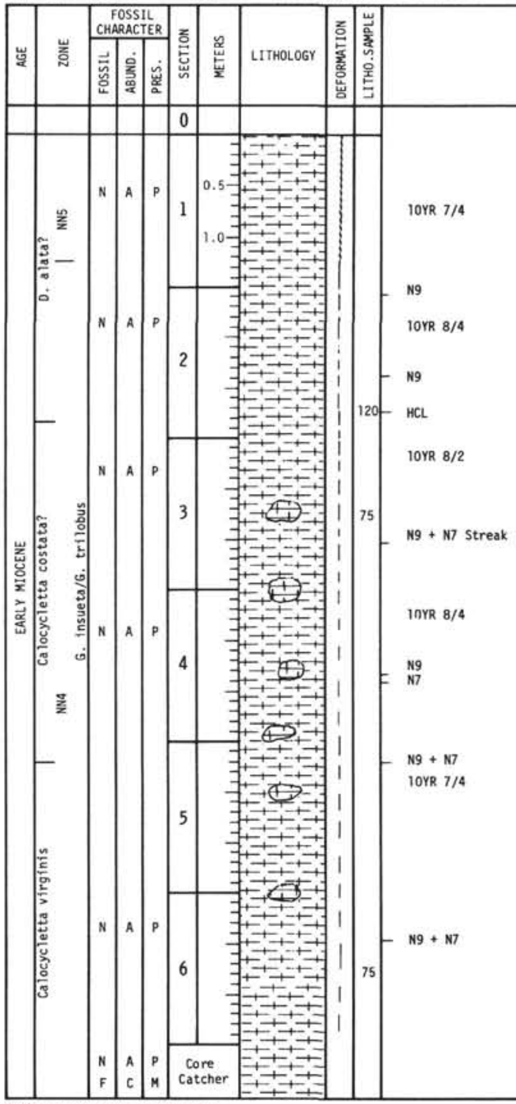
Nannos	D
Forams	C (A)
Rads	R
Clay Mins.	R

Preservation of nannos slightly improved.

Smear Slide: 6-100 mod. yellow brown (10YR 5/4)

Nannos	D
Rads	C
Forams	C
Sp. Spic.	R
Fish Debris	+
Micrite	R

Site 317 Hole B Core 19 Cored Interval: 168.0-177.5 m



LITHOLOGIC DESCRIPTION

Moderately to lightly disturbed.

Very pale orange (10YR 8/2) to grayish orange (10YR 7/4) FORAMINIFERAL NANNOFOSSIL FIRM OOZE (with scattered chalk nodules). Local gray to white (N9) mottles and streaks.

Smear Slide Summary:

Nannos	D
Forams	C
Micrite	R to C
Rads	R to C
Clay	R
Sp. Spic.	0 to R
Silicofl.	0 to R

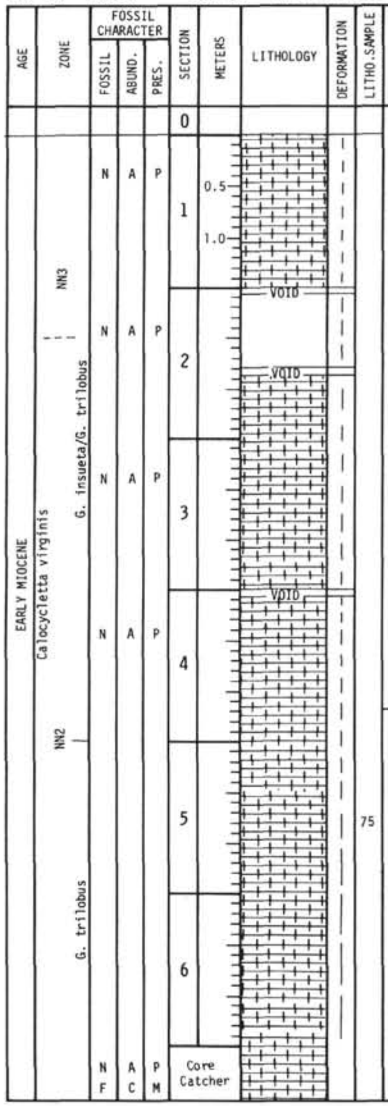
Discoasters almost totally overcalcified.

Acid Residue: 2-120

Rads, sponge spics, ferrug. matter clay + fine grained heavy mins.

Explanatory notes in Chapter 1

Site 317 Hole B Core 20 Cored Interval: 177.5-187.0 m



LITHOLOGIC DESCRIPTION

10YR 8/2

10YR 8/2

N7 + N9 mottle

10YR 8/2

Homogeneous, moderately disturbed.

Very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL FIRM OOZE with 2-4 cm ϕ regularly occurring chalky biscuits*. Some scattered light gray (N7) to white (N9) mottles.

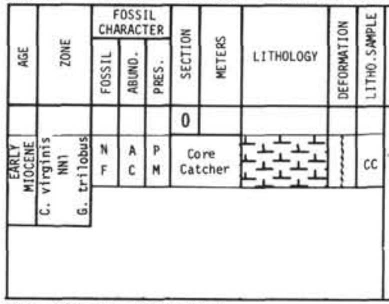
*The chalky biscuits are the clearest remnant of actual lithological state of induration. The rest having been disturbed by drilling.

Smear Slides: 5-75

Nannos	D
Forams	C to A
Rads	R
Sp. Spic.	TRACE

Discoasters considerably overgrown giving considerable "micrite" background.

Site 317 Hole B Core 21 Cored Interval: 187.0-196.5 m



LITHOLOGIC DESCRIPTION

10YR 8/2

Disturbed, highly.

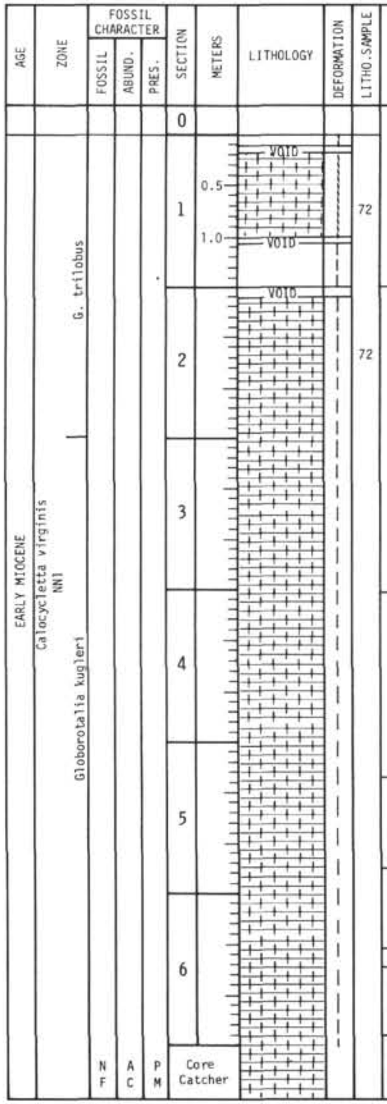
Very pale orange (10YR 8/2) NANNOFOSSIL OOZE.

Smear Slide:

Nannos	D
Forams	R to C
Rads	R (fragments)
Silicofl.	TRACE

Explanatory notes in Chapter 1

Site 317 Hole B Core 22 Cored Interval: 196.5-206.0 m



LITHOLOGIC DESCRIPTION

10YR 8/2

N9

N9

N9 to 10YR 8/2

10YR 8/2

N9

10YR 6/2

N9

N9

10YR 8/2

Highly to lightly disturbed.

White (N9) to very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL FIRM OOZE and CHALKY NODULES or BEDS interpreted as drilling artifacts of real bed character.

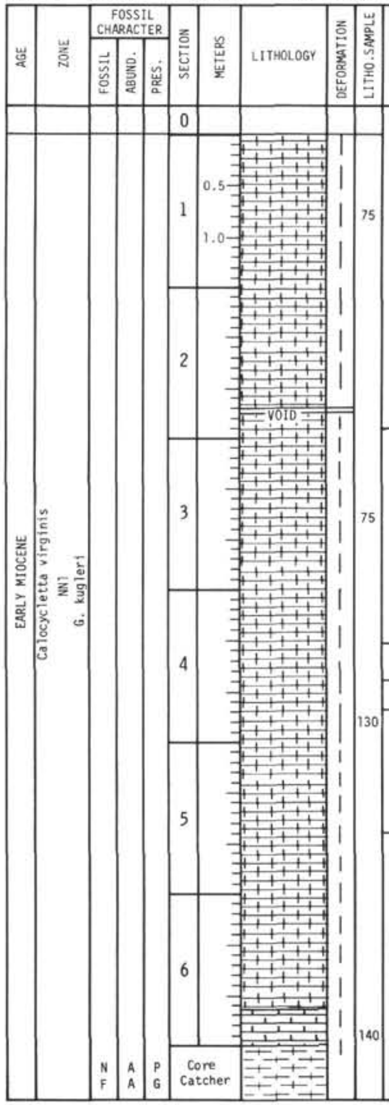
Pale orange (10YR 6/2) darker in section 6.

Smear Slides:

Nannos	D
Forams	C
Rads	R

Foram chambers still commonly as unfilled void space.

Site 317 Hole B Core 23 Cored Interval: 206.0-215.5 m



LITHOLOGIC DESCRIPTION

10YR 8/2

10YR 8/2

N9

N7

N9

N9

10YR 8/2

N9

N9

10YR 8/2

N9

N9

Slightly disturbed, homogeneous.

Very pale orange (10YR 8/2) to white (N9) FORAMINIFERAL-NANNOFOSSIL FIRM OOZE to CHALK.

Slightly darker in spots, scattered rare mottles.

Smear Slides: 3-75, 1-75, 4-130

Nannos	D
Forams	C to A
Rads	R
Sp. Spic.	TRACE

Smear Slide: 6-140 Nanno-Chalk

Nannos	D
Forams	R to C
Rads	V. R

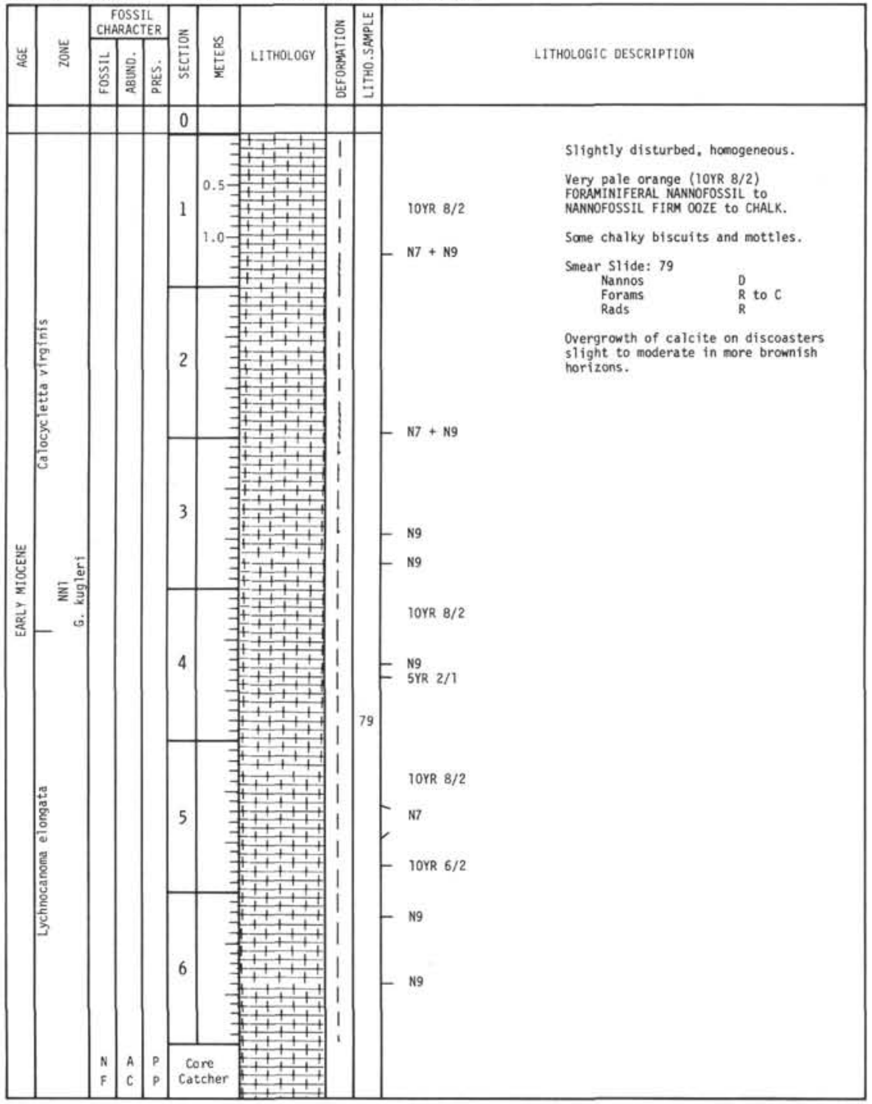
Preservation of nannos moderate to poor; moderate discoaster overcalcification.

In general whiter zones have fewer forams.

Acid Residue:
Mostly a few Radiolaria fragments and some ferruginous clay. Some Rads with dark coatings.

Explanatory notes in Chapter 1

Site 317 Hole B Core 24 Cored Interval: 215.5-225.0 m



Slightly disturbed, homogeneous.

Very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL to NANNOFOSSIL FIRM OOZE to CHALK.

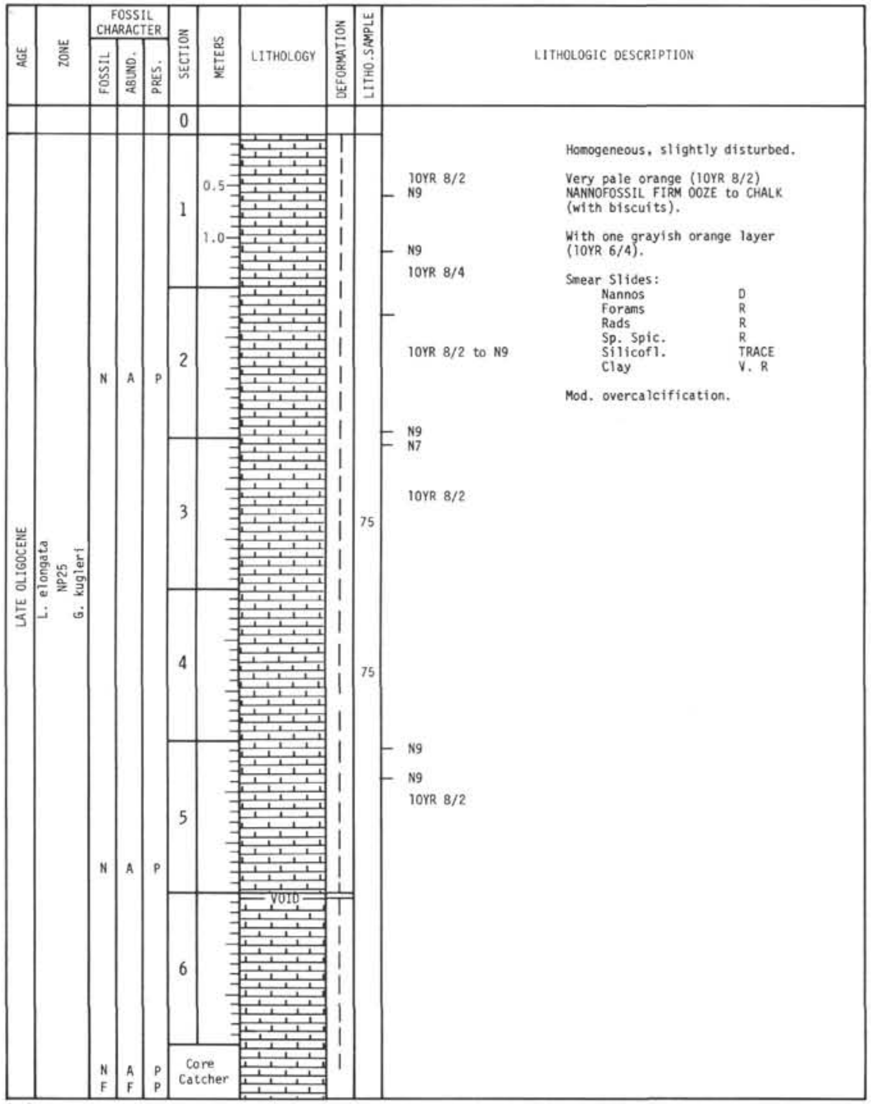
Some chalky biscuits and mottles.

Smear Slide: 79

Nannos	D
Forams	R to C
Rads	R

Overgrowth of calcite on discoasters slight to moderate in more brownish horizons.

Site 317 Hole B Core 25 Cored Interval: 225.0-234.5 m



Homogeneous, slightly disturbed.

Very pale orange (10YR 8/2) NANNOFOSSIL FIRM OOZE to CHALK (with biscuits).

With one grayish orange layer (10YR 6/4).

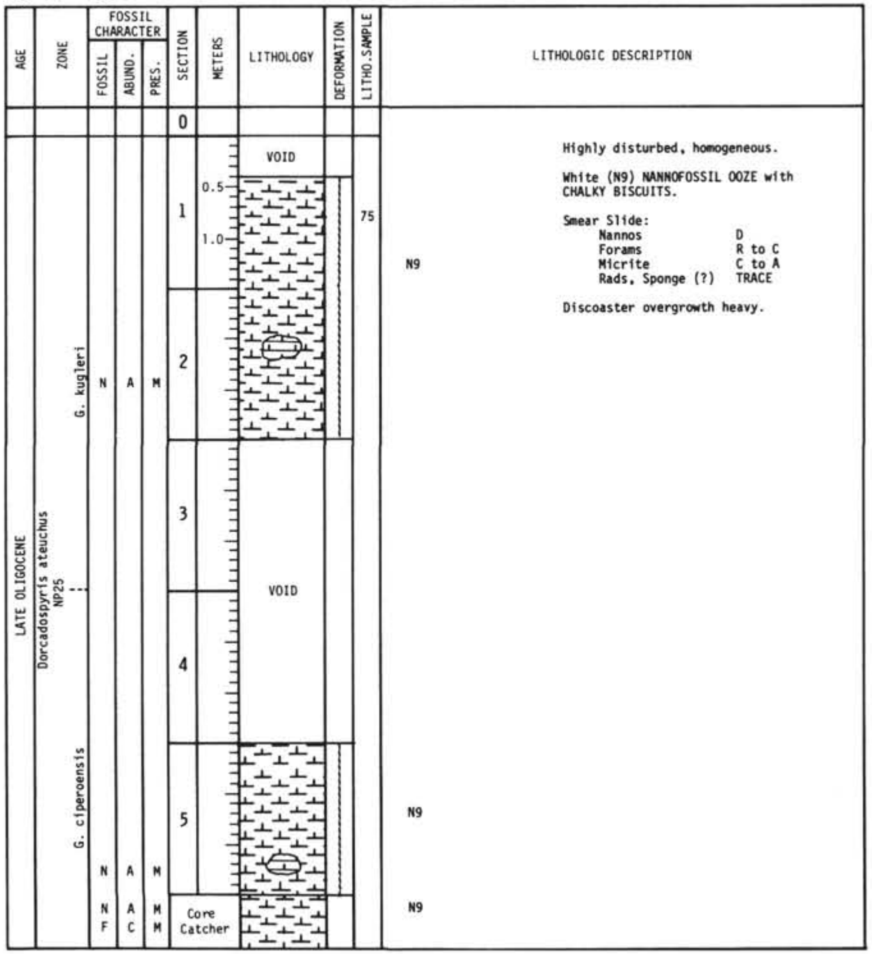
Smear Slides:

Nannos	D
Forams	R
Rads	R
Sp. Spic.	R
Silicofl.	TRACE
Clay	V. R

Mod. overcalcification.

Explanatory notes in Chapter 1

Site 317 Hole B Core 26 Cored Interval: 234.5-244.0 m



Highly disturbed, homogeneous.

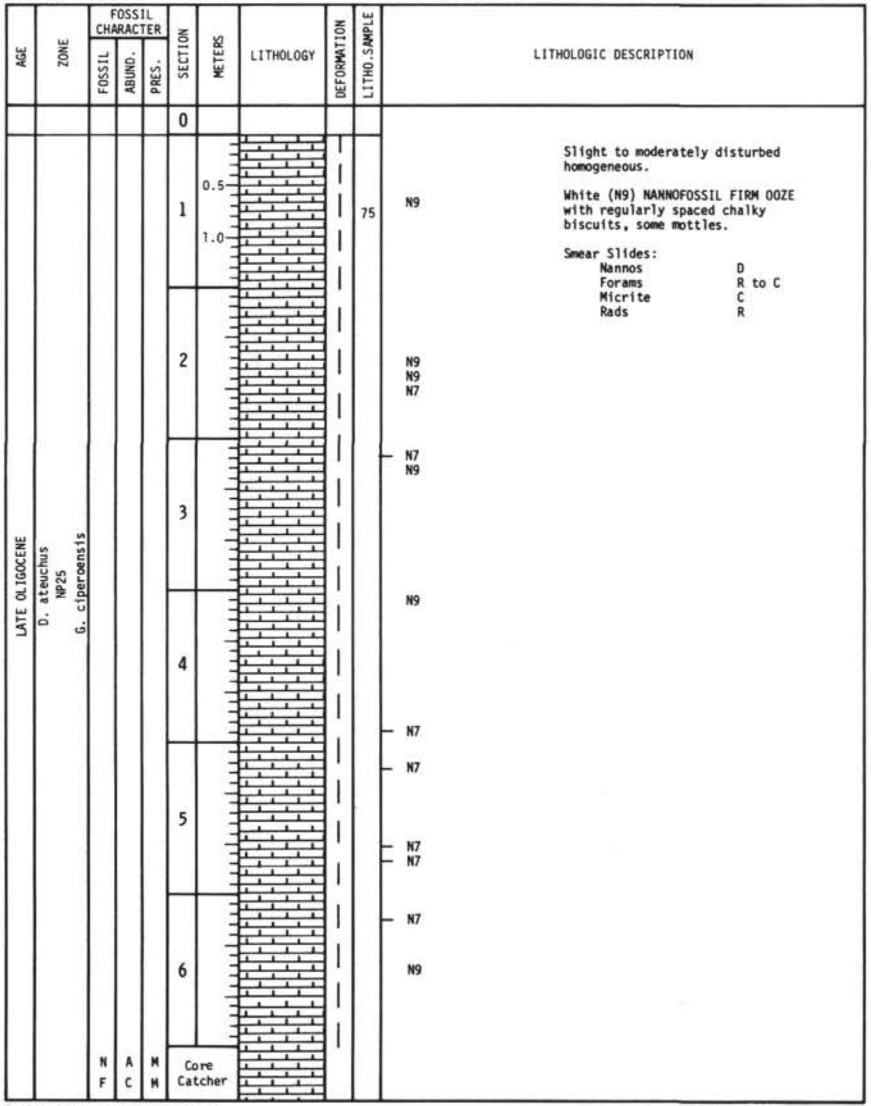
White (N9) NANNOFOSSIL OOZE with CHALKY BISCUITS.

Smear Slide:

Nannos	D
Forams	R to C
Micrite	C to A
Rads, Sponge (?)	TRACE

Discoaster overgrowth heavy.

Site 317 Hole B Core 27 Cored Interval: 244.0-253.5 m



Slight to moderately disturbed homogeneous.

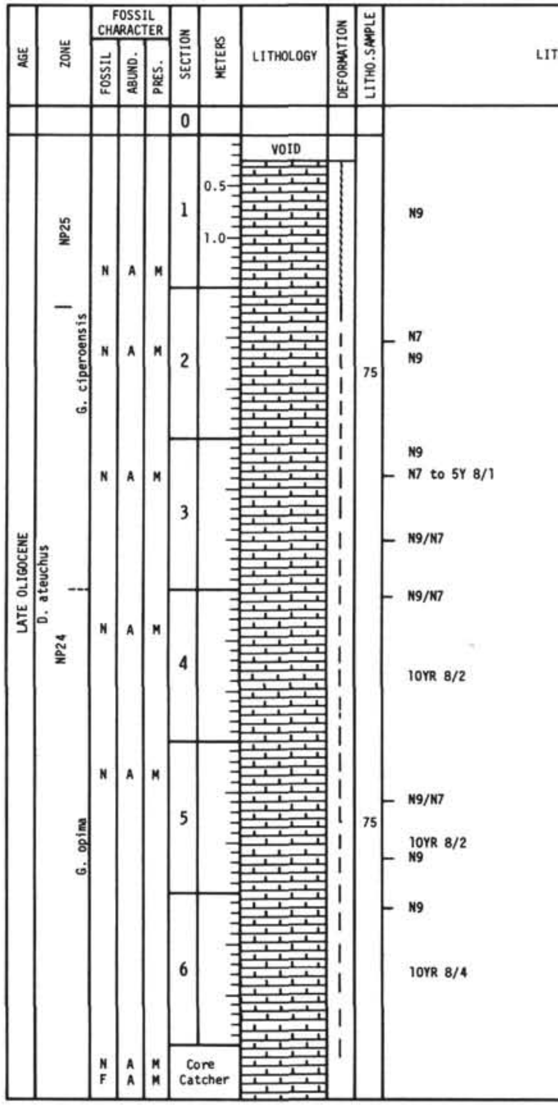
White (N9) NANNOFOSSIL FIRM OOZE with regularly spaced chalky biscuits, some mottles.

Smear Slides:

Nannos	D
Forams	R to C
Micrite	C
Rads	R

Explanatory notes in Chapter 1

Site 317 Hole B Core 28 Cored Interval: 253.5-263.0 m



LITHOLOGIC DESCRIPTION

Mod-light disturbed, uniform.

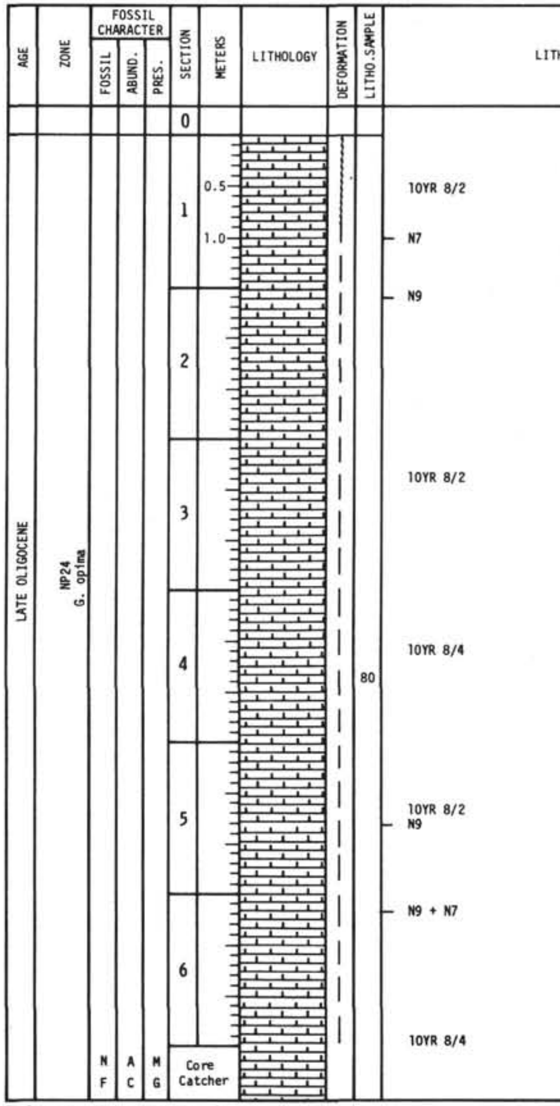
White (N9), gradually darker to very pale orange (10YR 8/2) to grayish orange (10YR 8/4) NANNOFOSSIL FIRM OOZE to CHALK.

Some mottles, locally.

Smear Slides:

Nannos	D
Forams	R to C
Rads	R
Clay	TRACE (in darker)

Site 317 Hole B Core 29 Cored Interval: 263.0-272.5 m



LITHOLOGIC DESCRIPTION

Highly to slightly disturbed, mostly homogeneous.

Very pale orange (10YR 8/2) to grayish orange (10YR 8/4) NANNOFOSSIL OOZE to CHALK.

Color change gradual, conspicuous solution of coccoliths and overcalcification of discoasters.

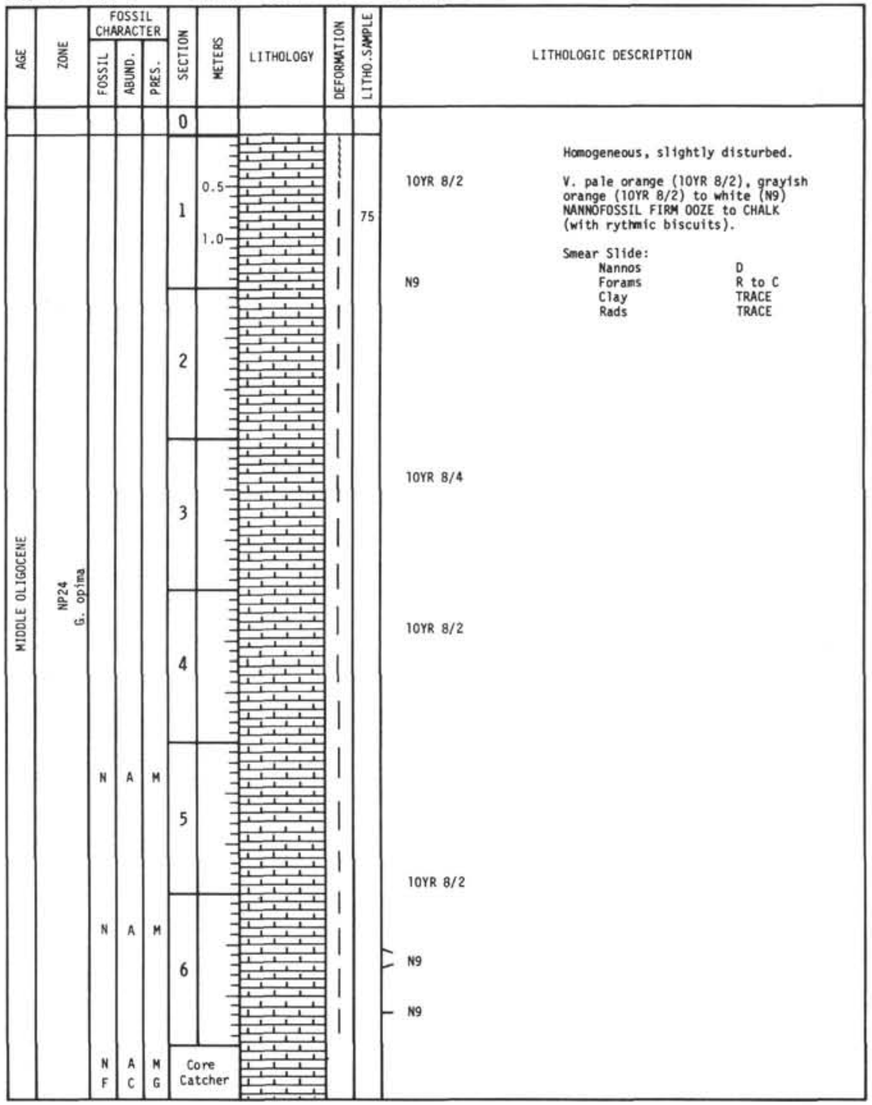
Smear Slide:

Nannos	D
Micritic Calcite	C
Forams	R

Acid Residue:
Very little clay with at least some ∿>1.57, zeolites. L. slow prisms, small ∿10μm. Ferruginous matter + Fe/Mn mineral specks.

Explanatory notes in Chapter 1

Site 317 Hole B Core 30 Cored Interval: 272.5-282.0 m



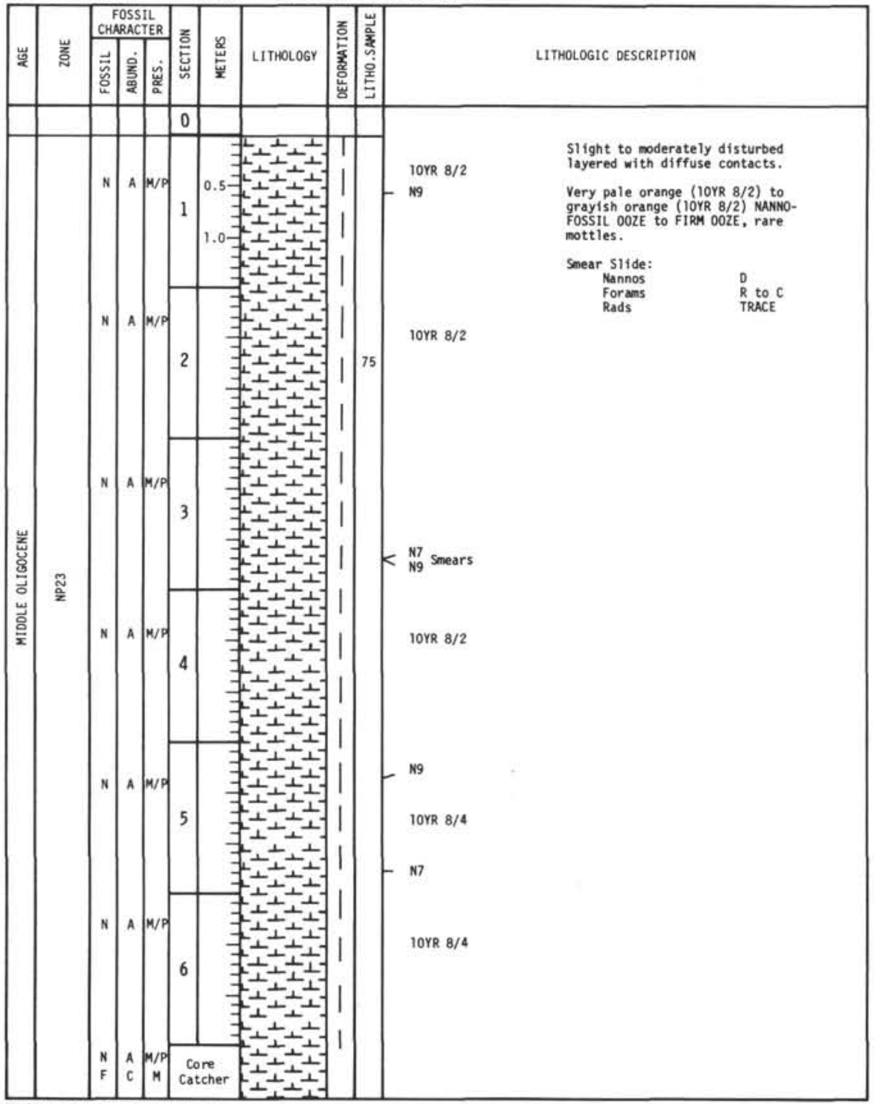
Homogeneous, slightly disturbed.

V. pale orange (10YR 8/2), grayish orange (10YR 8/2) to white (N9) NANNOFOSSIL FIRM OOZE to CHALK (with rythmic biscuits).

Smear Slide:

Nannos	D
Forams	R to C
Clay	TRACE
Rads	TRACE

Site 317 Hole B Core 31 Cored Interval: 282.0-291.5 m



Slight to moderately disturbed layered with diffuse contacts.

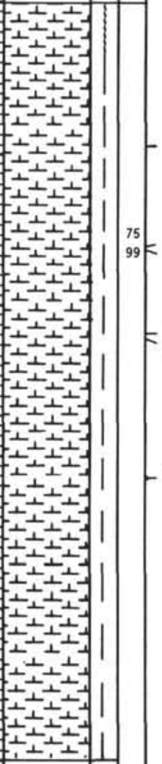
Very pale orange (10YR 8/2) to grayish orange (10YR 8/2) NANNOFOSSIL OOZE to FIRM OOZE, rare mottles.

Smear Slide:

Nannos	D
Forams	R to C
Rads	TRACE

Explanatory notes in Chapter 1

Site 317 Hole B Core 32 Cored Interval: 291.5-301.0 m

AGE	ZONE	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
					0					
LOWER OLIGOCENE	NP23	N	A	M/P	1	0.5 1.0				10YR 8/2 N9
		N	A	M/P	2				75 99	N9 N7 10YR 8/2
		N	A	M/P	3					N7 N9
		N	A	M/P	4					N9
		N	A	M/P	5					10YR 8/2
		N F	A C	M M	Core Catcher					10YR 8/2

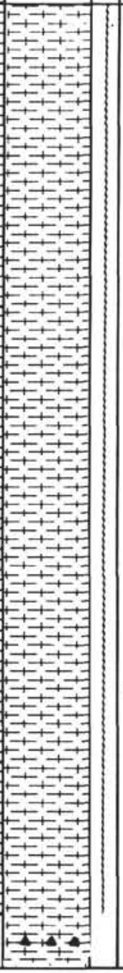
Moderately disturbed, homogeneous.

Very pale orange (10YR 8/2) NANNOFOSSIL OOZE, rare light mottles.

Smear Slide: 2-75
Nannos D
Forams R to C

Smear Slide: 2-95 gray splotch.
(foram nanno ooze)
Nannos D
Forams C
Rads R

Site 317 Hole B Core 33 Cored Interval: 301.0-310.5 m

AGE	ZONE	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
					0					
EARLY OLIGOCENE	NP23 *Globigerina ampliapertura*	N	A	P	1	0.5 1.0				10YR 8/2
		N	A	P	2					
		N	A	P	3					10YR 8/2
		N	A	P	4					
		N	A	P	5				75	
		N	A	P	6					
		N F	A C	P M	Core Catcher					

Highly disturbed, homogenized.

Very pale orange (10YR 8/2) FORAMINIFERAL-NANNOFOSSIL OOZE.

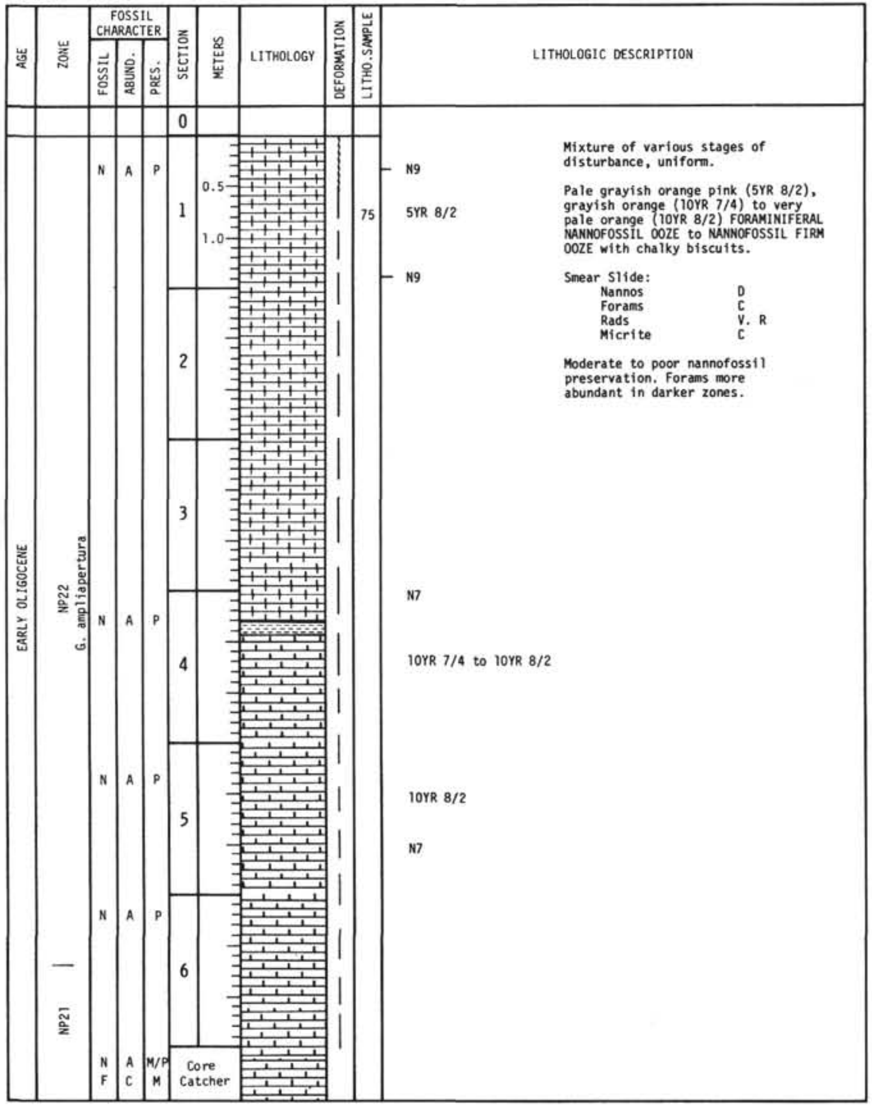
Pale yellowish brown (10YR 6/2) to moderate yellowish brown chert fragment, dense, translucent, in core catcher.

Smear Slide:
Nannos D
Micrite C
Forams C

Moderate overcalcification, many separate nanno-platelets.

Explanatory notes in Chapter 1

Site 317 Hole B Core 34 Cored Interval: 310.5-320.0 m



Mixture of various stages of disturbance, uniform.

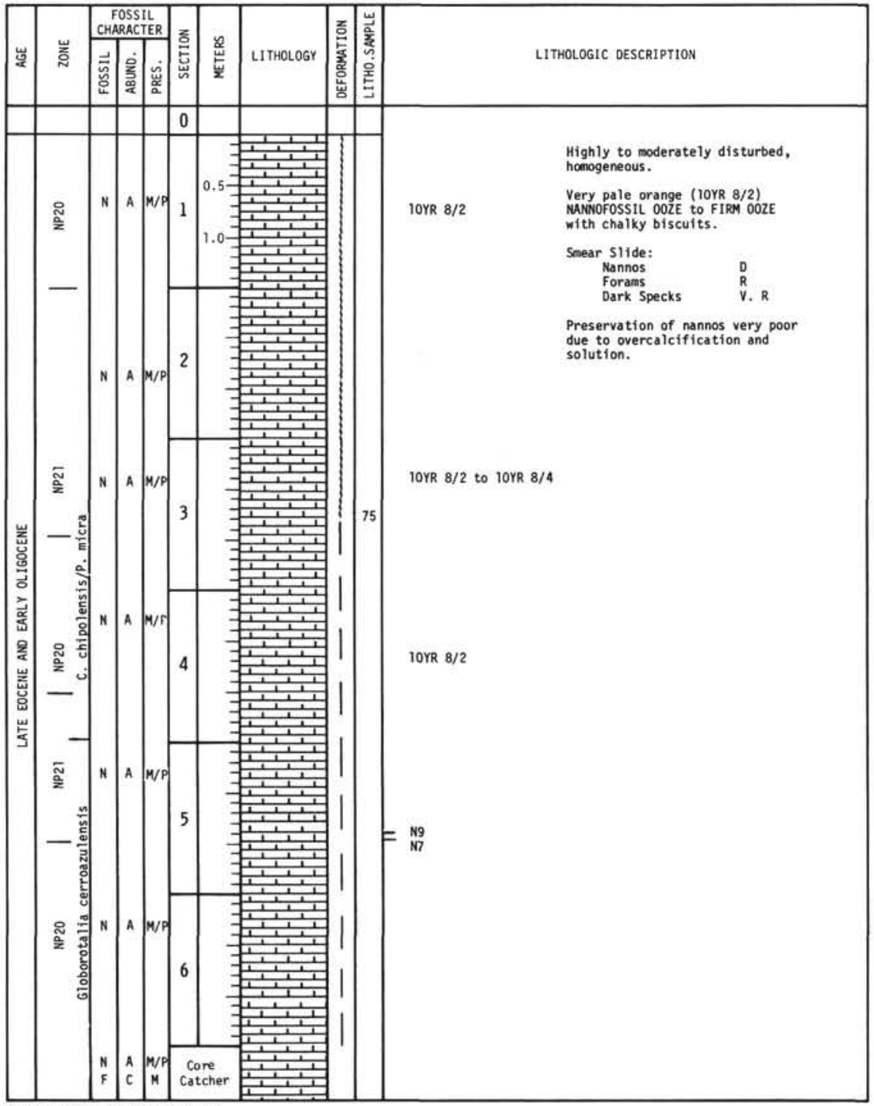
Pale grayish orange pink (5YR 8/2), grayish orange (10YR 7/4) to very pale orange (10YR 8/2) FORAMINIFERAL NANNOFOSSIL OOZE to NANNOFOSSIL FIRM OOZE with chalky biscuits.

Smear Slide:

Nannos	D
Forams	C
Rads	V. R
Micrite	C

Moderate to poor nannofossil preservation. Forams more abundant in darker zones.

Site 317 Hole B Core 35 Cored Interval: 320.0-329.5 m



Highly to moderately disturbed, homogeneous.

Very pale orange (10YR 8/2) NANNOFOSSIL OOZE to FIRM OOZE with chalky biscuits.

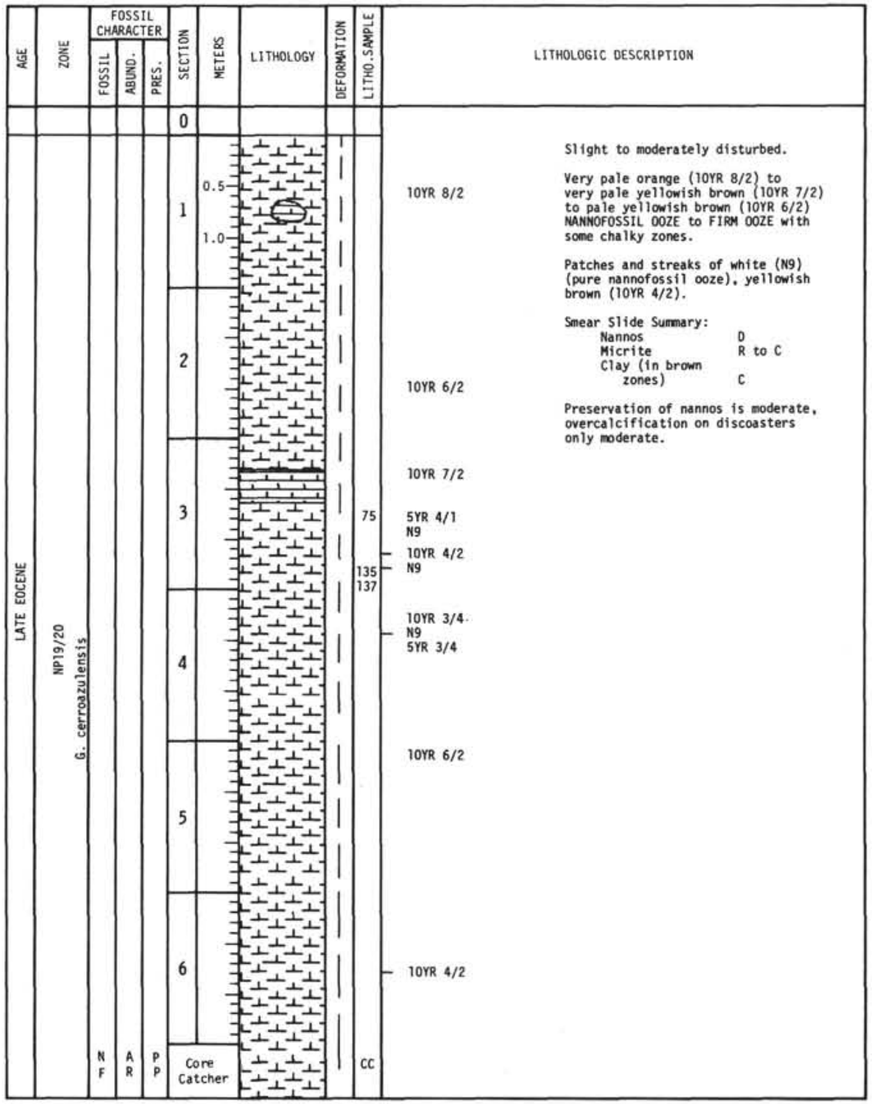
Smear Slide:

Nannos	D
Forams	R
Dark Specks	V. R

Preservation of nannos very poor due to overcalcification and solution.

Explanatory notes in Chapter 1

Site 317 Hole B Core 36 Cored Interval: 329.5-339.0 m



Slight to moderately disturbed.

Very pale orange (10YR 8/2) to very pale yellowish brown (10YR 7/2) to pale yellowish brown (10YR 6/2) NANNOFOSSIL OOZE to FIRM OOZE with some chalky zones.

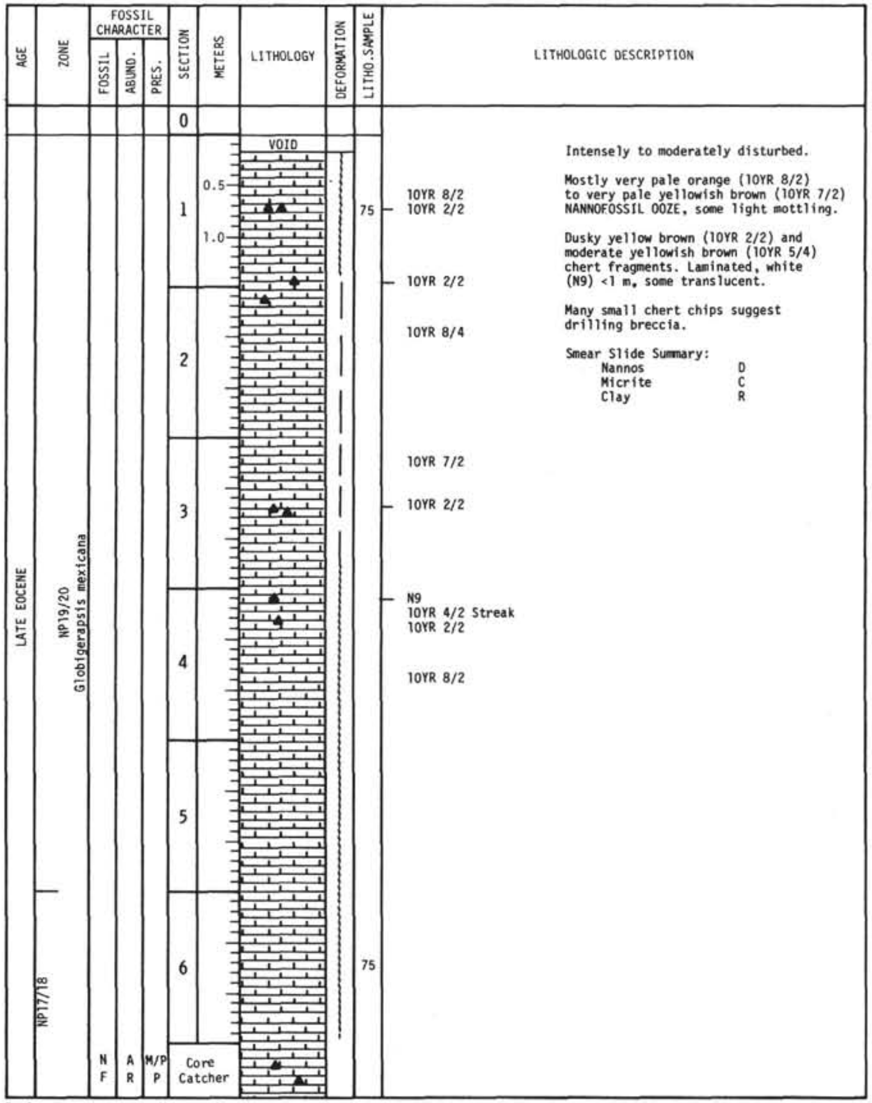
Patches and streaks of white (N9) (pure nannofossil ooze), yellowish brown (10YR 4/2).

Smear Slide Summary:

Nannos	D
Micrite	R to C
Clay (in brown zones)	C

Preservation of nannos is moderate, overcalcification on discoasters only moderate.

Site 317 Hole B Core 37 Cored Interval: 339.0-348.5 m



Intensely to moderately disturbed.

Mostly very pale orange (10YR 8/2) to very pale yellowish brown (10YR 7/2) NANNOFOSSIL OOZE, some light mottling.

Dusky yellow brown (10YR 2/2) and moderate yellowish brown (10YR 5/4) chert fragments. Laminated, white (N9) <1 m, some translucent.

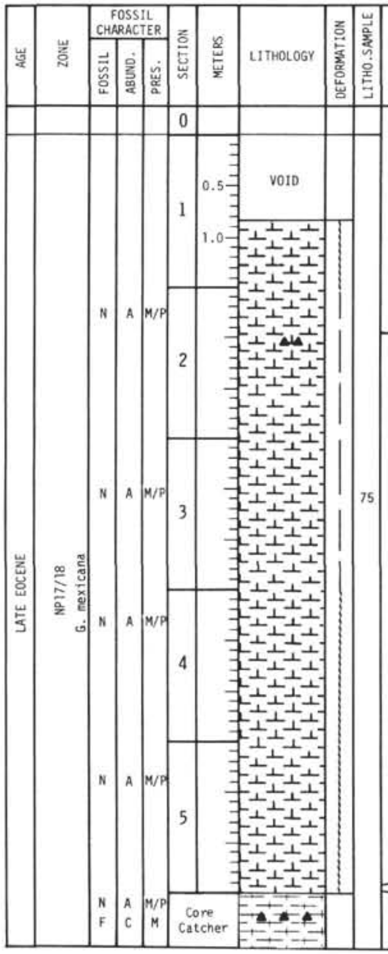
Many small chert chips suggest drilling breccia.

Smear Slide Summary:

Nannos	D
Micrite	C
Clay	R

Explanatory notes in Chapter 1

Site 317 Hole B Core 38 Cored Interval:348.5-358.0 m



LITHOLOGIC DESCRIPTION

Highly disturbed.

Very pale orange (10YR 8/2)
1) NANNOFOSSIL OOZE with much finely ground-up chert chips.

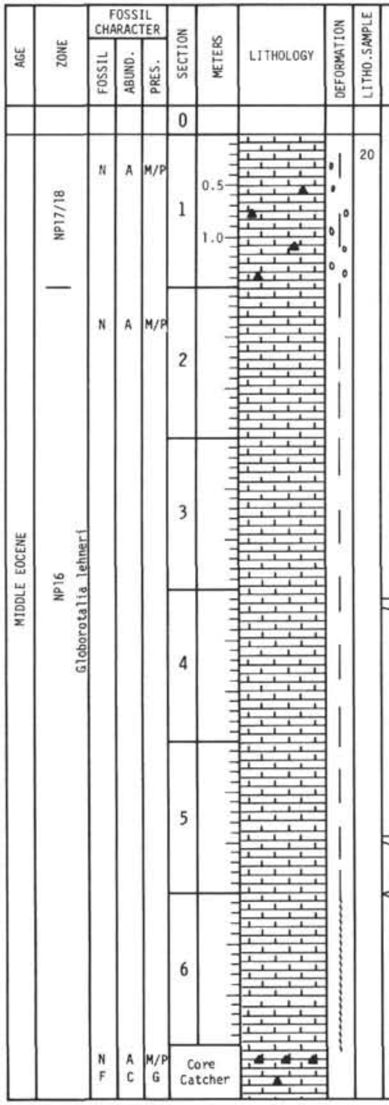
Brownish black (5YR 2/1)
2) CHERT NODULE with CHALK PATINA, splotches of light gray (N7).

Smear Slide Summary:

Nannos	D
Micrite	C
Forams	R to C
Rads	TRACE

Scattered sand-size calcite grains.

Site 317 Hole B Core 39 Cored Interval:358.0-367.5 m



LITHOLOGIC DESCRIPTION

Moderate to highly disturbed.

Pale yellowish brown (10YR 6/2) changing to very pale yellowish brown (10YR 7/2) NANNOFOSSIL OOZE to CHALK. Some mottles and streaks with scattered broken chips of mod. dusky yellowish brown (10YR 2/2) chert. Core catcher: brownish black (5YR 2/1) chert. Vitreous, millimeter thick chalky, white (N9) patina.

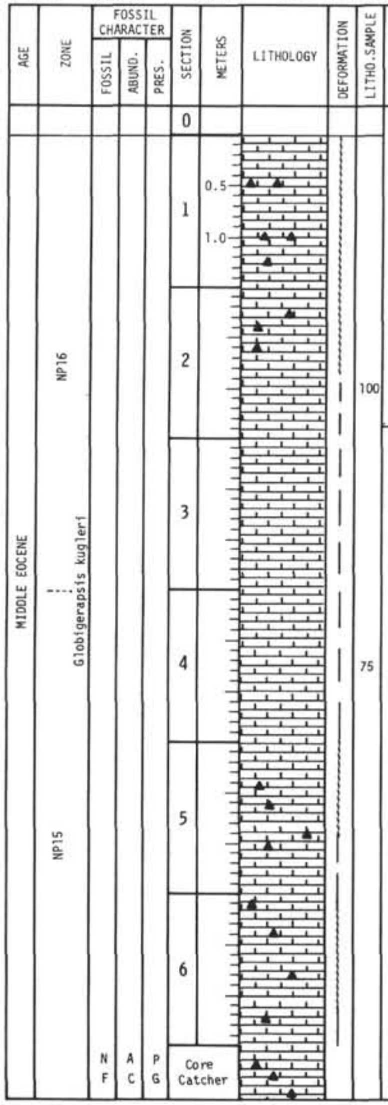
Smear Slide:

Nannos	D
Clay	V. R
Fe-Specks	R
Zeolites	TRACE

Discoasters only mod-slight overcalcification.

Explanatory notes in Chapter 1

Site 317 Hole B Core 40 Cored Interval: 367.5-377.0 m



LITHOLOGIC DESCRIPTION

10YR 7/2
10YR 2/2
5YR 2/1
10YR 7/2
10YR 6/1
10YR 7/4
N9
10YR 4/2
10YR 8/4
HCL
10YR 7/4
5YR 5/6 + 10YR 5/4

Highly disturbed.

Very pale yellowish brown (10YR 7/2) to grayish orange (10YR 7/4) to light grayish orange (10YR 8/4) NANNOFOSSIL OOZE to CHALK.

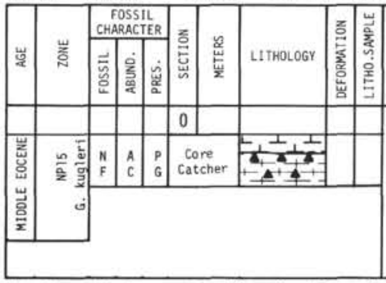
Some sections are a hash of dusky yellowish brown (10YR 2/2) to brownish black (5YR 2/1) crushed chert chips.

Smear Slide Summary:

Nannos (poorly preserved)	D
Forams	R
Sand-size Calcite Grains	R
Micrite	R to C
Clay	TRACE

Acid Residue:
Only chert chips and a little ferruginous clay.

Site 317 Hole B Core 41 Cored Interval: 377.0-386.5 m



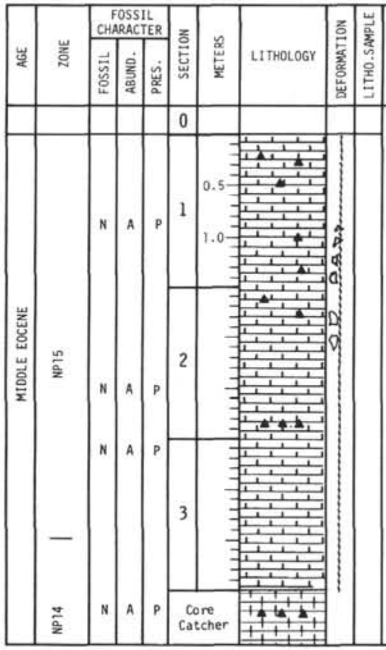
LITHOLOGIC DESCRIPTION

10YR 6/6

Dusky brown (5YR 2/2) to dark yellowish brown (10YR 4/2) CHERT FRAGMENTS, up to 5 cm ϕ with halo of dark yellowish orange (10YR 6/6) and mod. reddish brown (10R 4/6).

In contact with silicified very pale orange (10YR 8/2) NANNOFOSSIL CHALK.

Site 317 Hole B Core 42 Cored Interval: 386.5-396.0 m



LITHOLOGIC DESCRIPTION

10YR 7/4
10YR 8/2
10YR 2/2
10YR 8/2
10YR 6/2

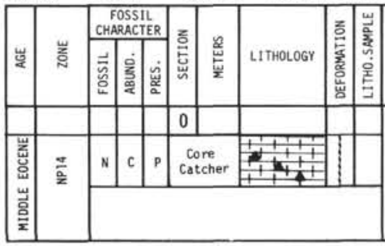
Drilling breccia + highly disturbed.

0-3 m:
Slush of very pale orange (10YR 8/2) NANNOFOSSIL OOZE and grayish brown (5YR 3/2) to dusky brown (10YR 2/2) CHERT.

3-4.5 m:
Highly disturbed pale yellowish brown NANNOFOSSIL OOZE + CHALK, some hand specimen sized chunks of dusky brown (10YR 2/2) CHERT with silicified pale orange (10YR 8/2) CHALK remnants.

Core catcher:
Three pieces of brownish black (5YR 2/1) CHERT with pods and lenses of very pale orange (10YR 8/2) CHALK and SILICIFIED CHALK. Some zones of olive gray (5Y 4/1) SILICIFIED CHALK.

Site 317 Hole B Core 43 Cored Interval: 396.0-405.5 m

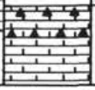


LITHOLOGIC DESCRIPTION

Dusky yellowish brown (10YR 2/2) CHERT NODULES with small (1-2 mm) zones of (N8) gray unreplaced CHALK. Patina of very light gray (N8) CHALK.

Explanatory notes in Chapter 1

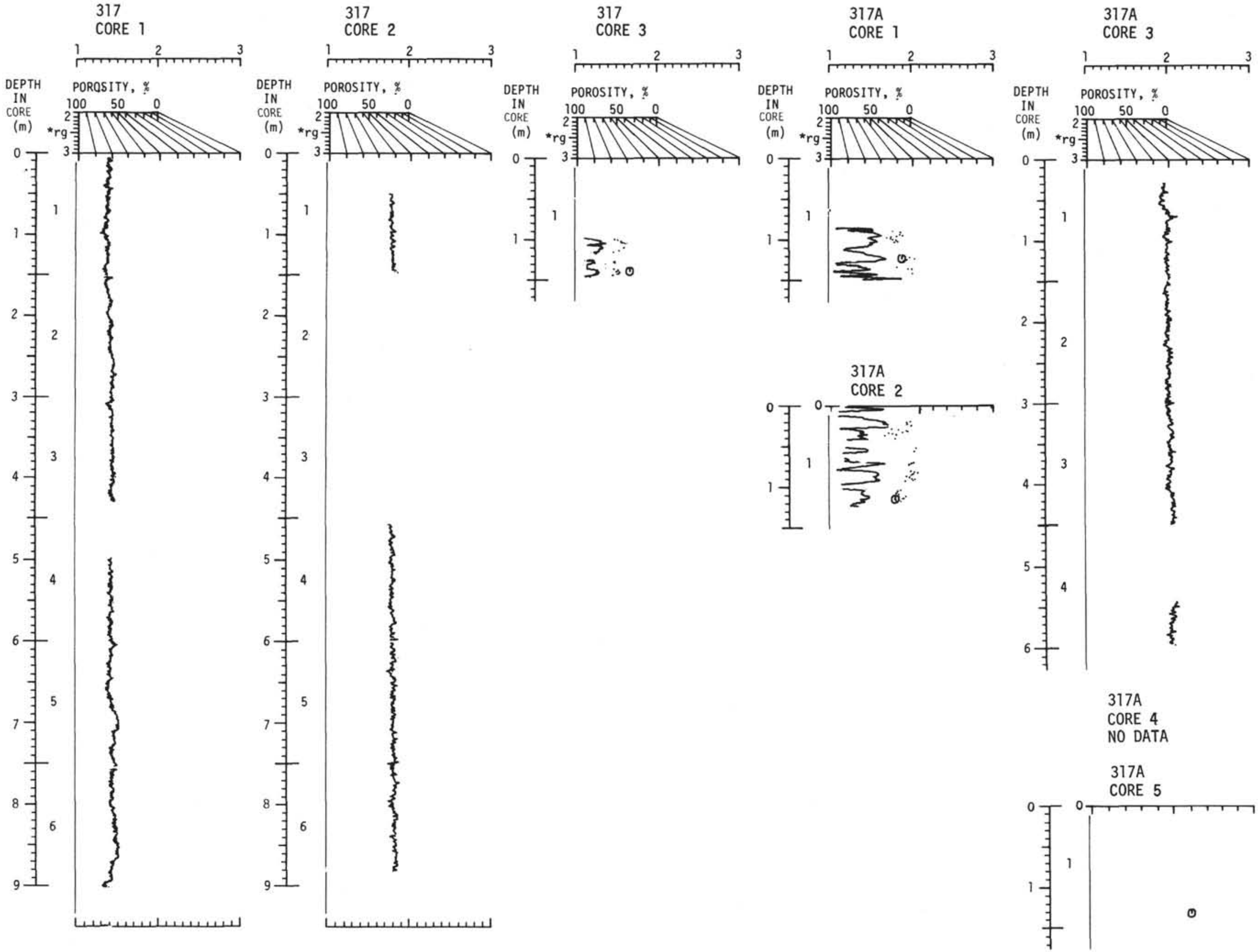
Site 317 Hole B Core 44 Cored Interval: 405.5-415.0 m

AGE	ZONE	FOSSIL CHARACTER			SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
		FOSSIL	ABUND.	PRES.						
					0					
EARLY EOCENE	NP13				1	0.5 1.0	VOID 			10YR 2/2 Three pieces. 1) Dusky yellowish brown (10YR 2/2) CHERT with moderate orange pink (5YR 8/4) chalky zones and a light gray (N8) chalk patina. 2) Light olive gray (5Y 6/1) CHALK with olive black chert layers (5Y 2/1) at the base. 3) Moderate brown (5YR 4/4) to dark yellowish brown (10YR 4/2) CHERT.
		N	C	P	Core Catcher					

Site 317 Hole B Core 45 Cored Interval: 415.0-424.5 m

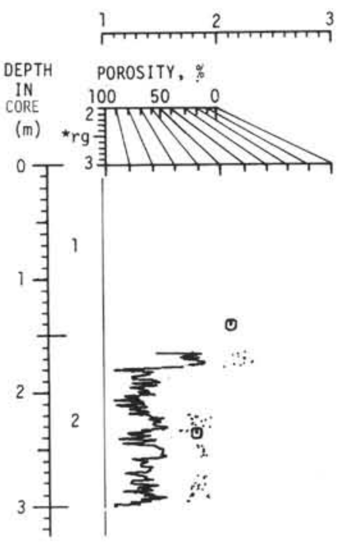
AGE	ZONE	FOSSIL CHARACTER			SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
		FOSSIL	ABUND.	PRES.						
					0					
E. EOCENE	NP11/12	N	C	P	Core Catcher					A few brown chert chips retrieved from the catcher.

Explanatory notes in Chapter 1

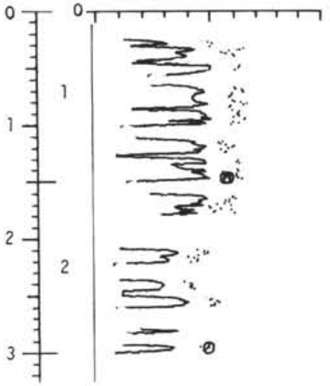


NOTE: The upper scale is GRAPE Wet-Bulk Density (1.0 to 3.0 g/cc): solid lines (——) are GRAPE analog data assuming a 6.61 cm core diameter; dotted lines (. . . . .) are GRAPE analog data adjusted for actual core diameter; circled (⊖) dots are the wet-bulk density calculated from two-minute counts on a stationary sample; the porosity nomogram allows a porosity scale to be determined by selecting the proper grain density (r_g) and extrapolating horizontally.

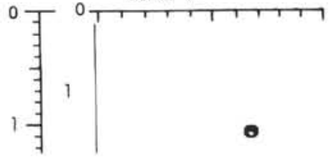
317A
CORE 6



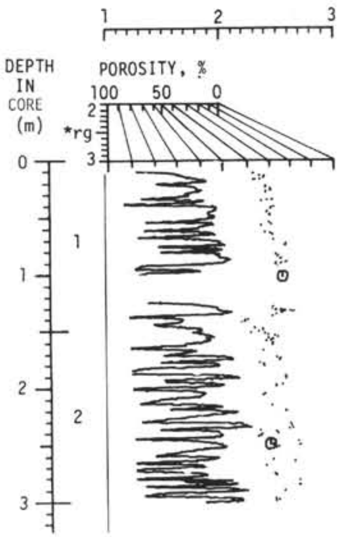
317A
CORE 7



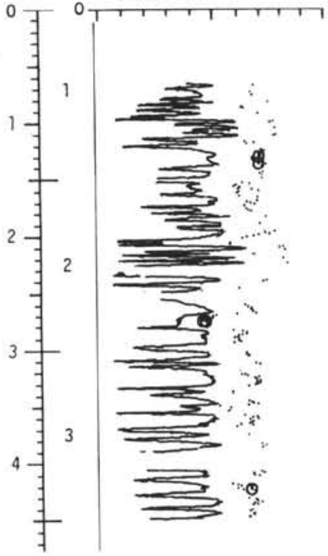
317A
CORE 8



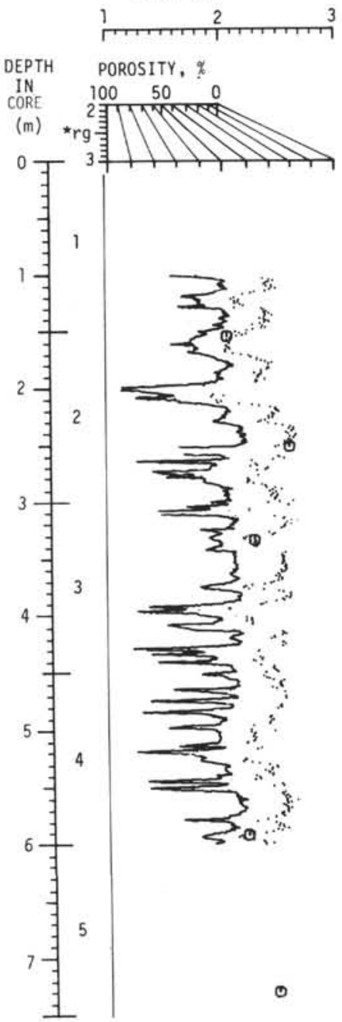
317A
CORE 9



317A
CORE 10



317A
CORE 11



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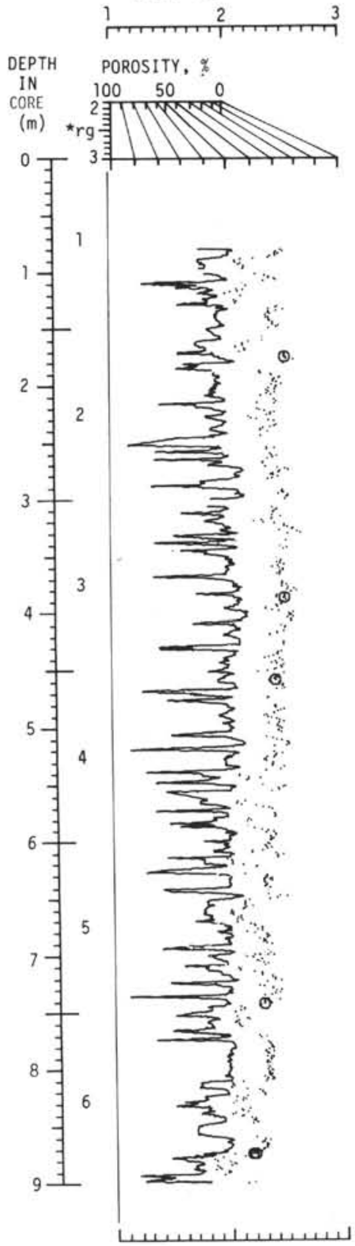
CORE 12



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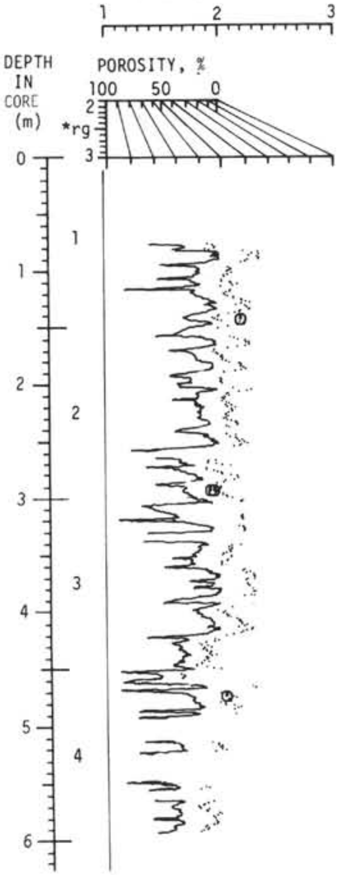
CORE 13



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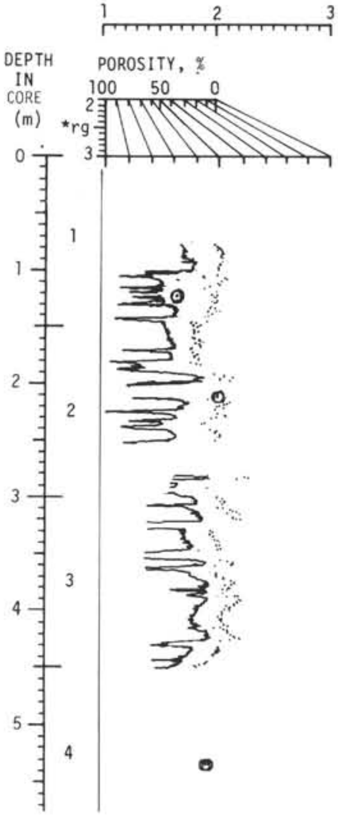
CORE 14



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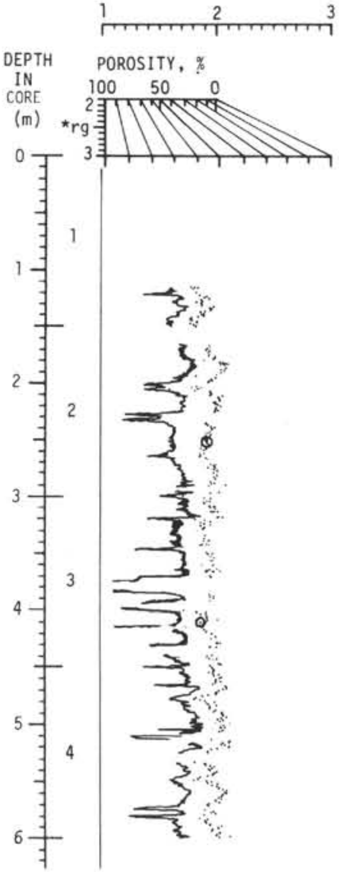
CORE 15



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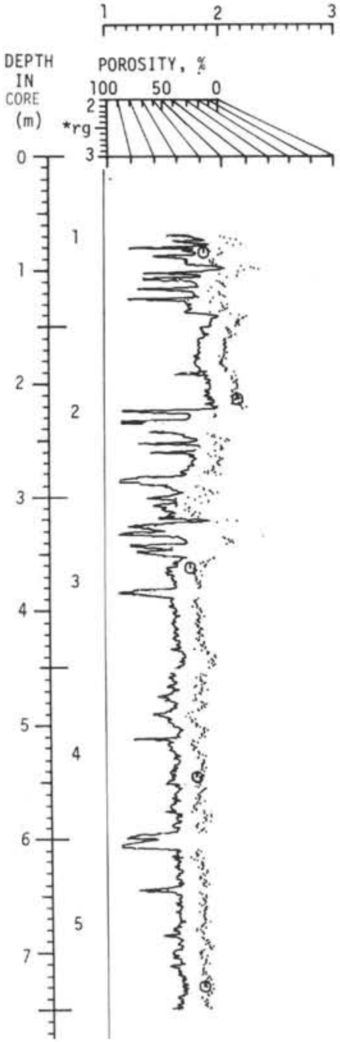
CORE 16



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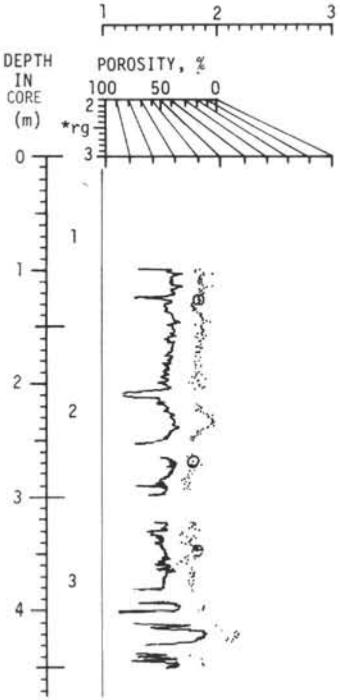
CORE 17



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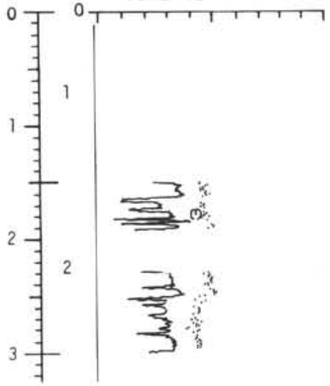
CORE 18



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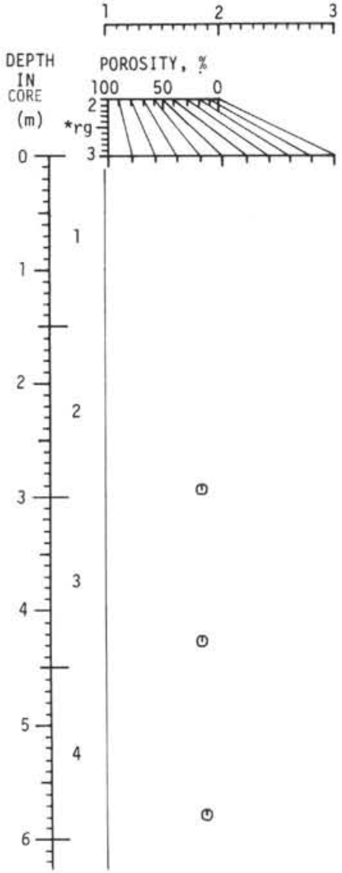
CORE 19



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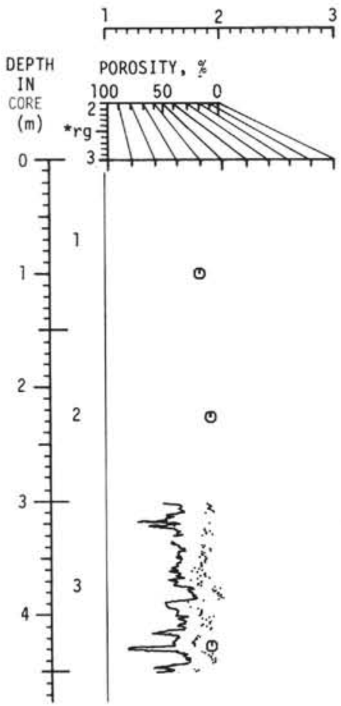
CORE 20



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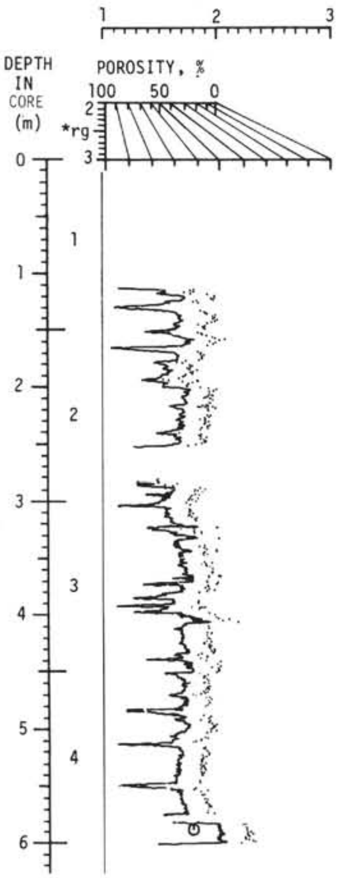
CORE 21



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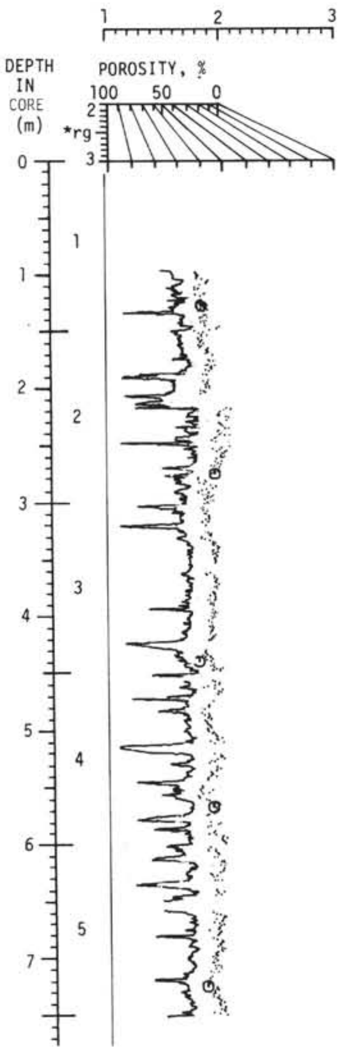
CORE 22



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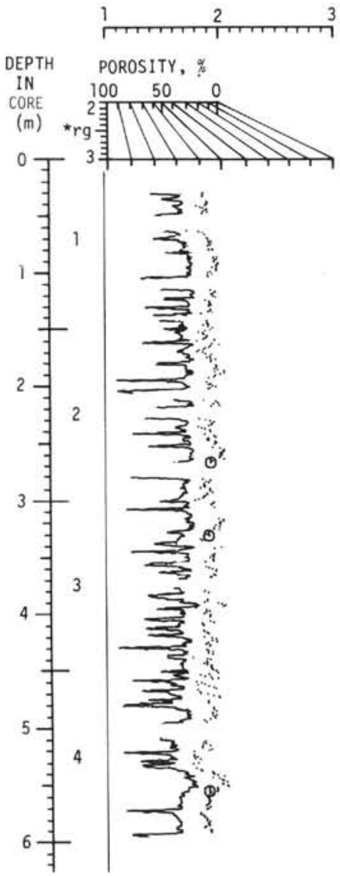
CORE 23



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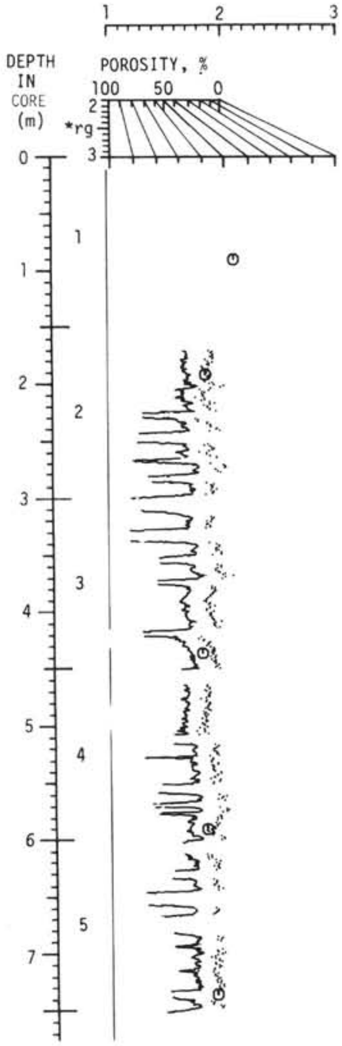
CORE 24



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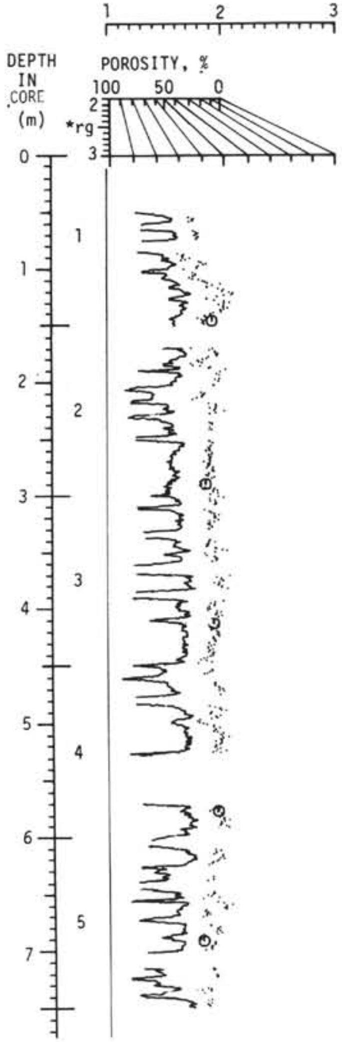
CORE 25



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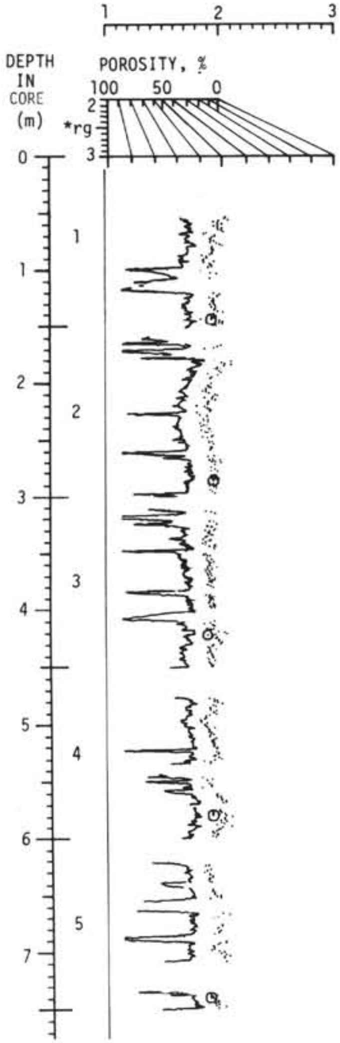
CORE 26



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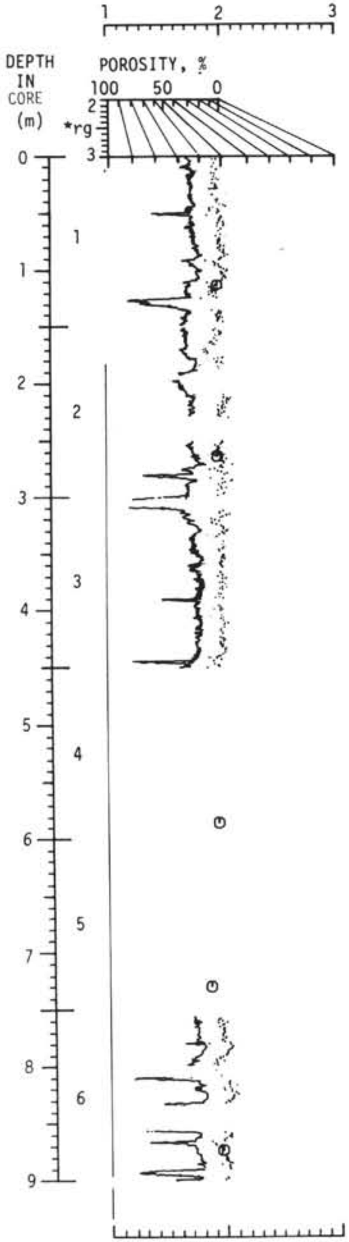
CORE 27



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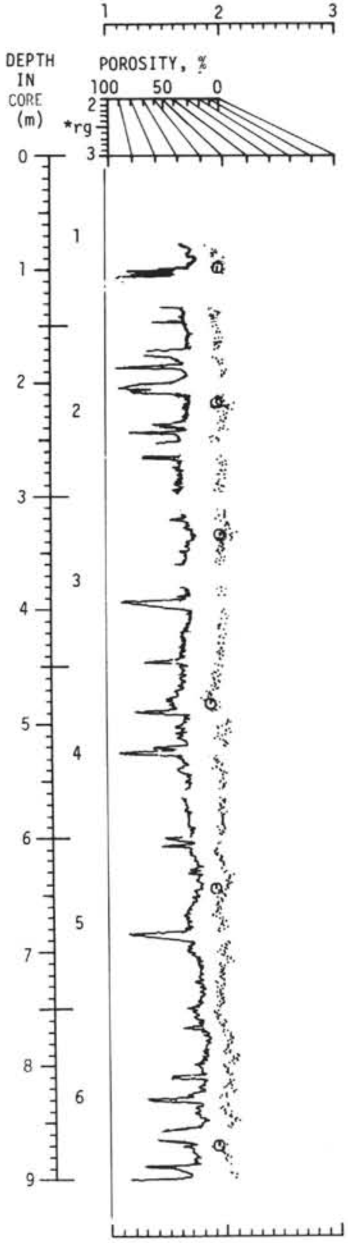
CORE 28



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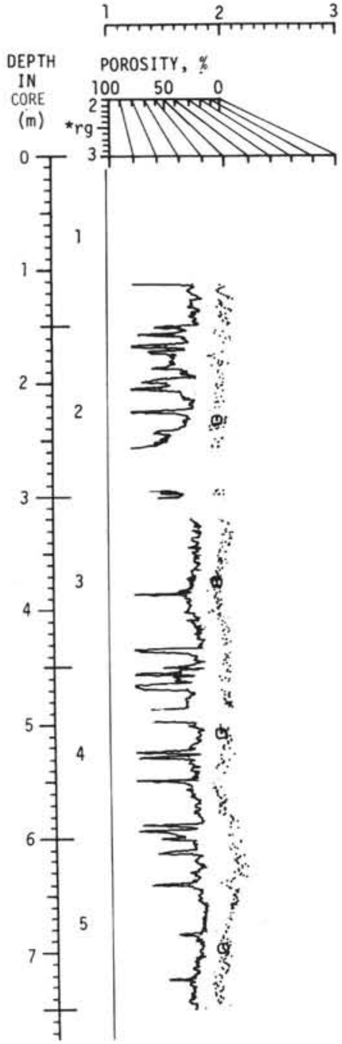
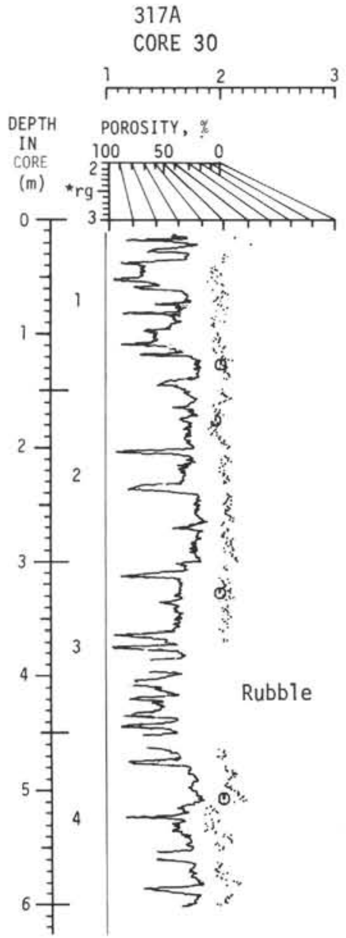
CORE 29





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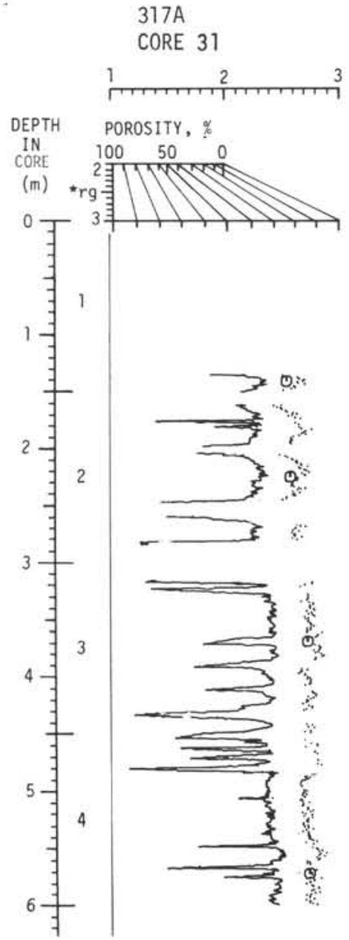
CORE 30



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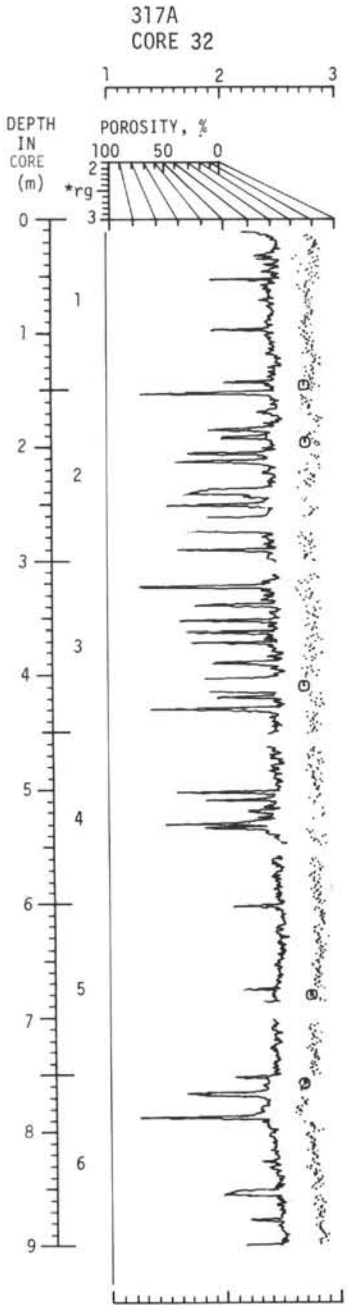
CORE 31



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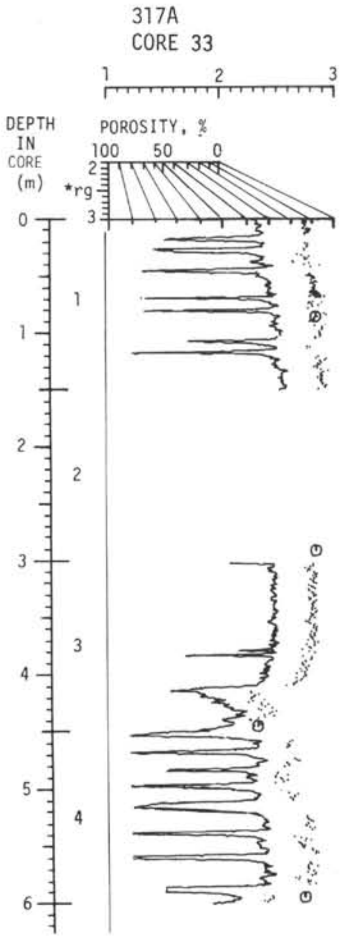
CORE 32



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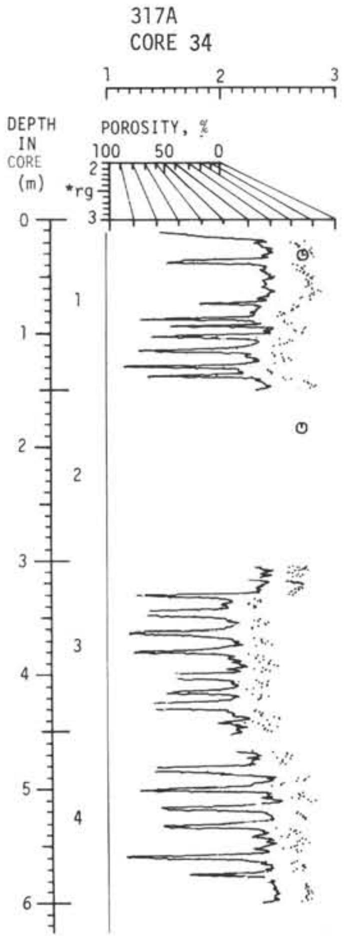
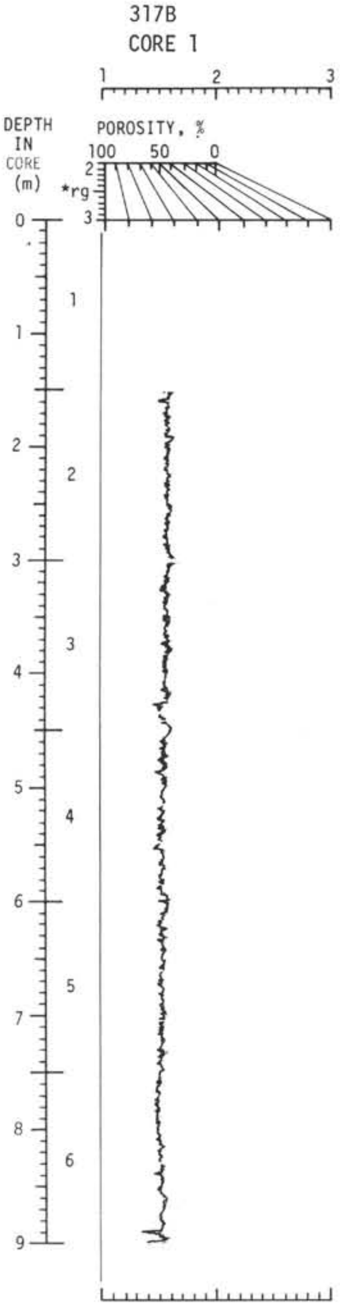
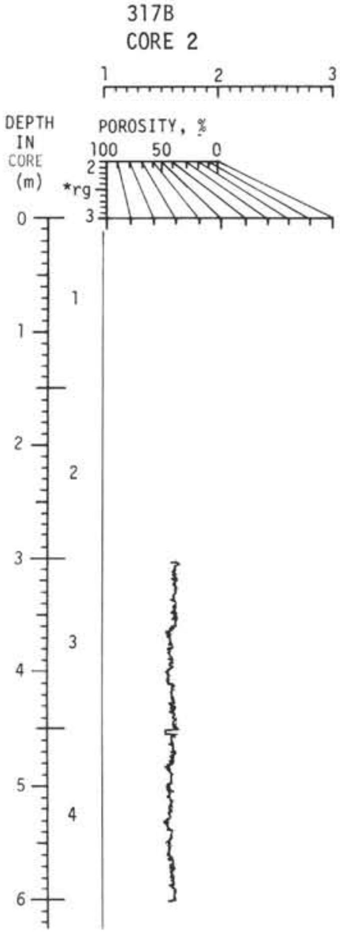
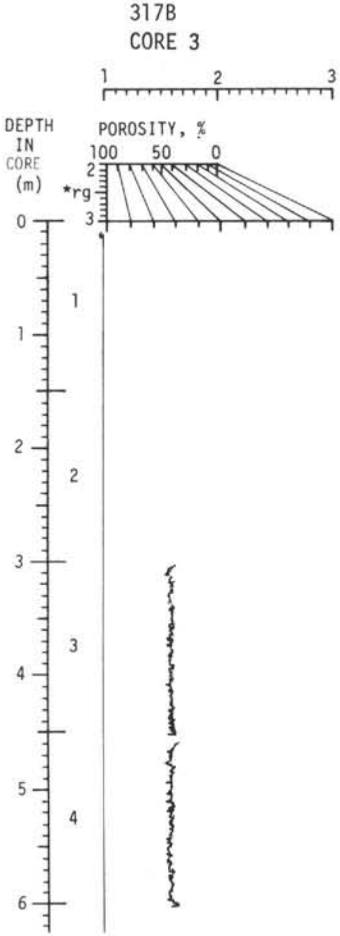
CORE 33

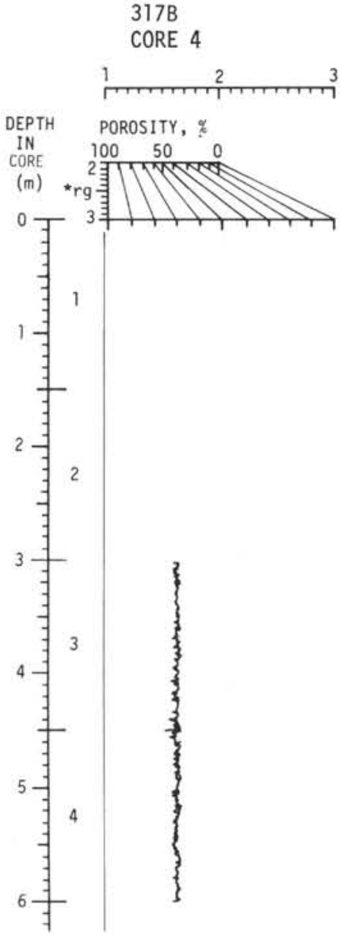


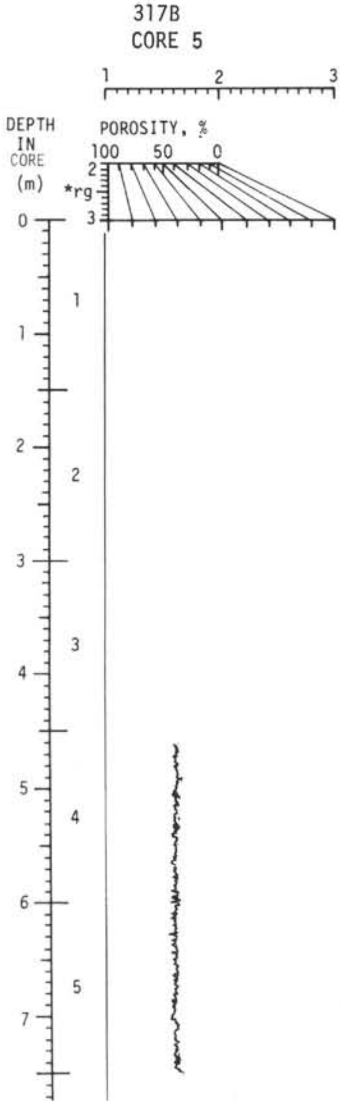
317A
CORE 34

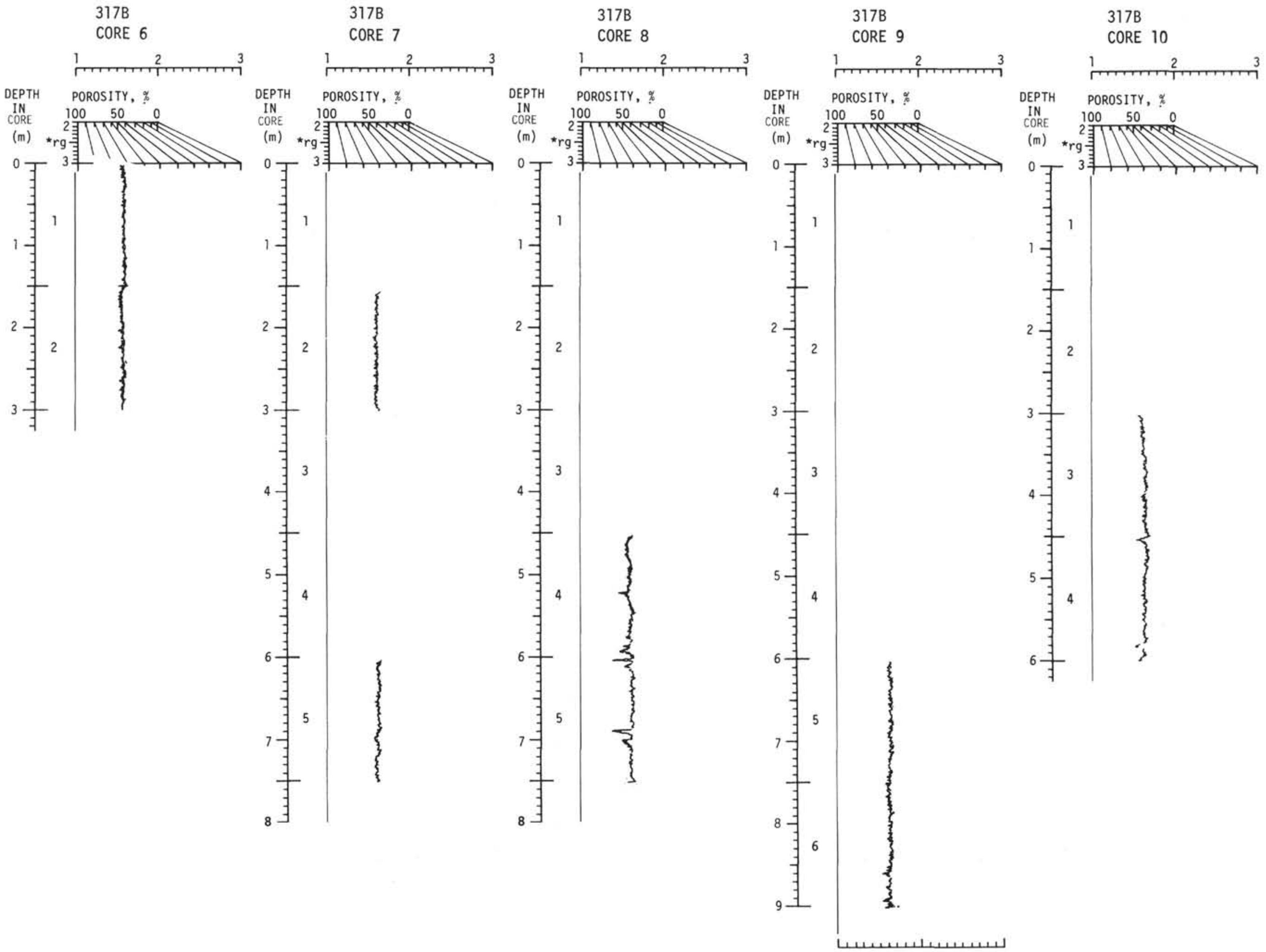

317B
CORE 1
1
2
3
DEPTH IN CORE (m)
POROSITY, %
100
50
0
2
*rg
3
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6


317B
CORE 2
1
2
3
DEPTH IN CORE (m)
POROSITY, %
100
50
0
2
*rg
3
0
1
2
3
4
5
6
1
2
3
4

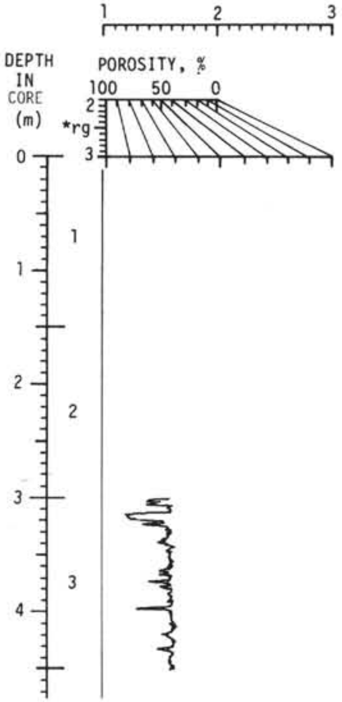

317B
CORE 3
1
2
3
DEPTH IN CORE (m)
POROSITY, %
100
50
0
2
*rg
3
0
1
2
3
4
5
6
1
2
3
4


317B
CORE 4
1
2
3
DEPTH IN CORE (m)
POROSITY, %
100
50
0
2
*rg
3
0
1
2
3
4
5
6
1
2
3
4

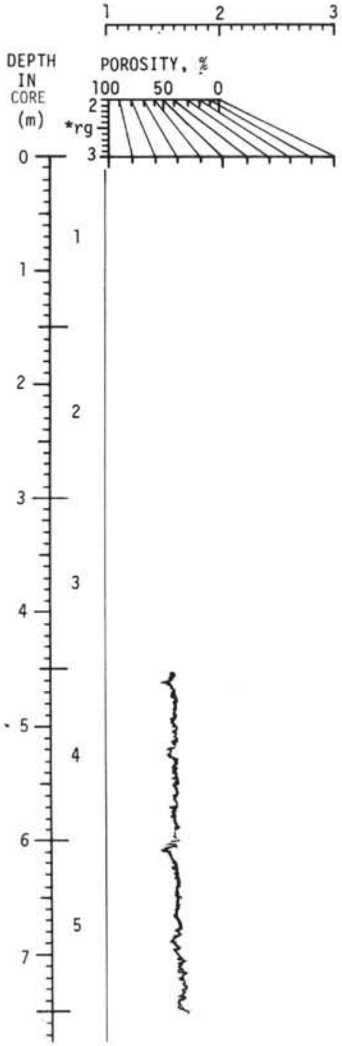

317B
CORE 5
1
2
3
DEPTH IN CORE (m)
POROSITY, %
100
50
0
2
*rg
3
0
1
2
3
4
5
6
7
1
2
3
4
5


317B
CORE 6
317B
CORE 7
317B
CORE 8
317B
CORE 9
317B
CORE 10
1
2
3
DEPTH
IN
CORE
(m)
POROSITY, %
100
50
0
*rg
2
3
0
1
2
3
4
5
6
7
8
9

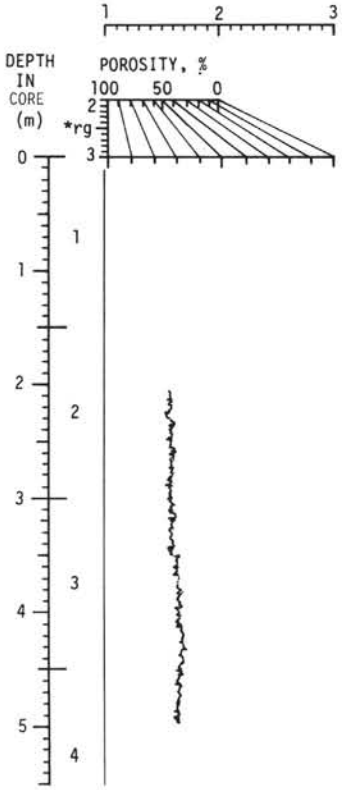
317B
CORE 11



317B
CORE 12



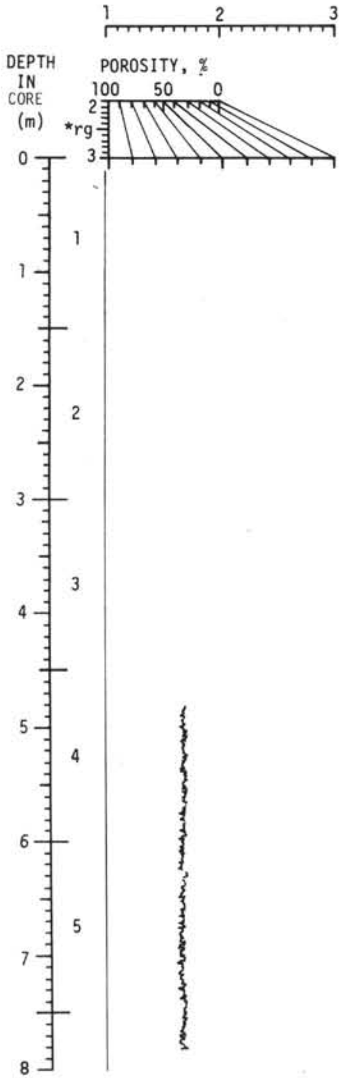
317B
CORE 13



317B
CORE 14
NO DATA

317B
CORE 15
NO DATA

317B
CORE 16



317B
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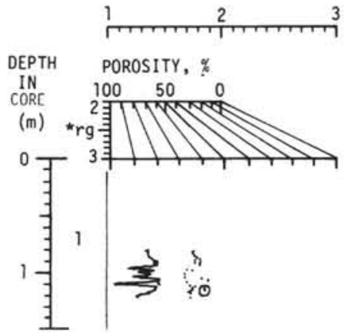

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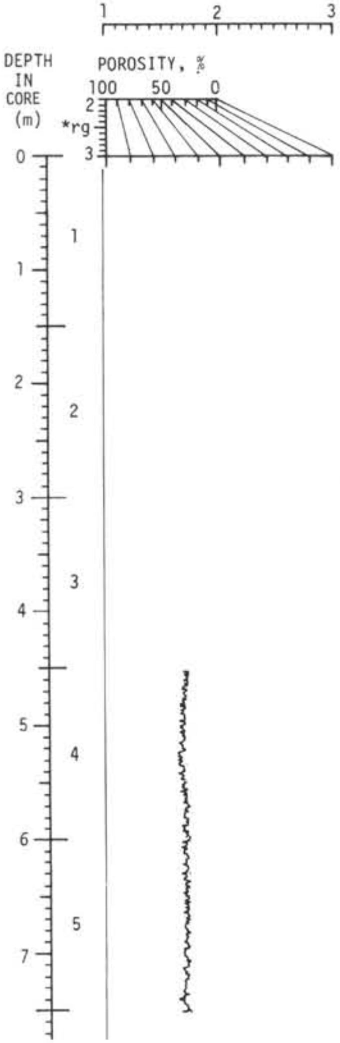
CORE 18



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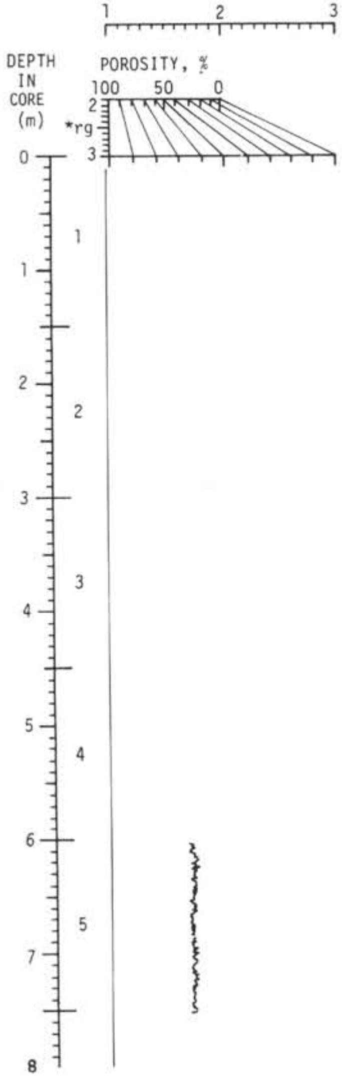
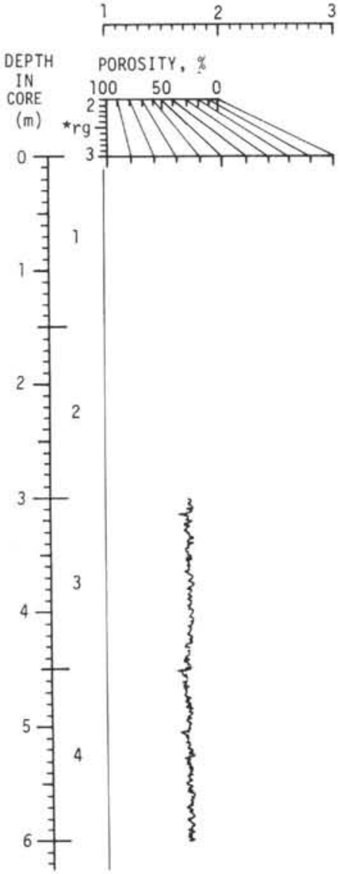
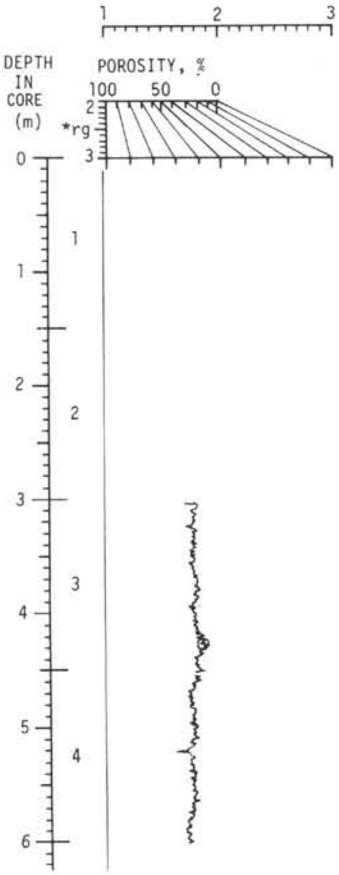


317B
CORE 20

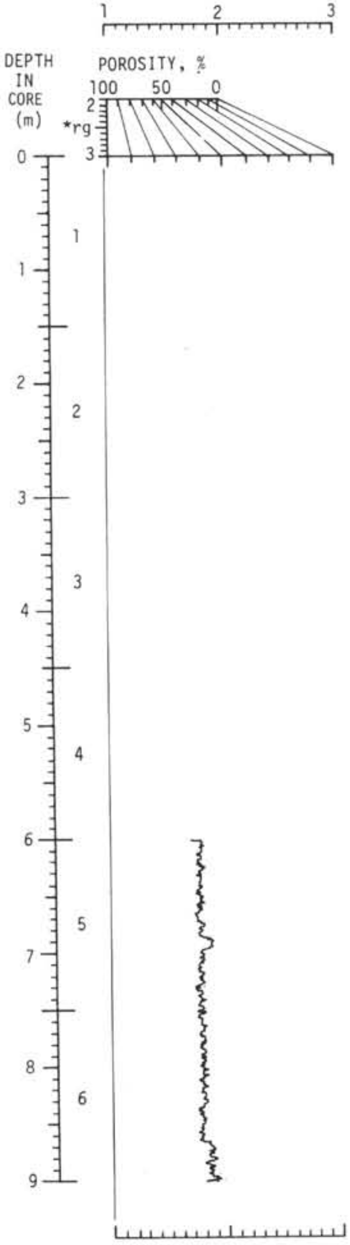


317B
CORE 21
NO DATA

317B
CORE 22



317B
CORE 23



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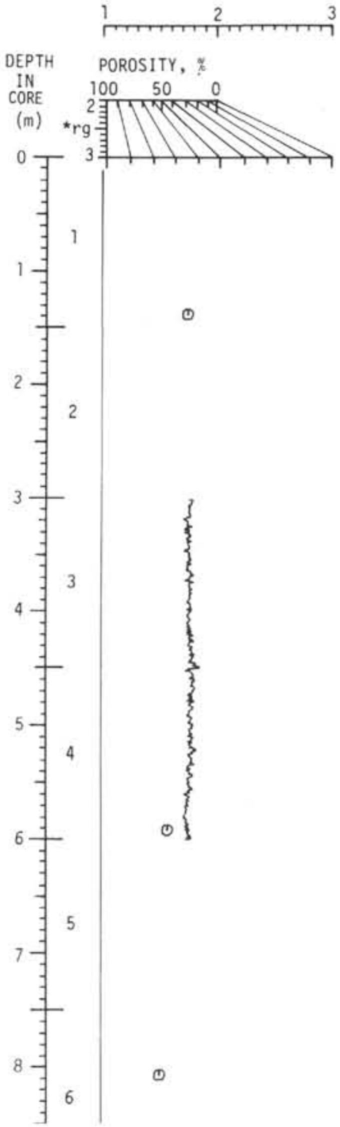
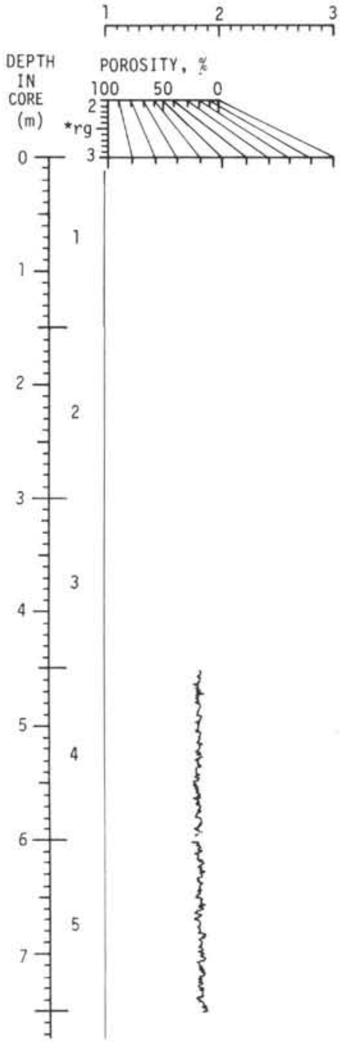
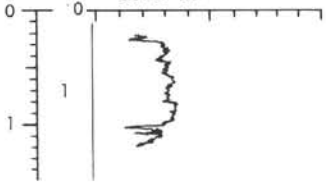
CORE 24



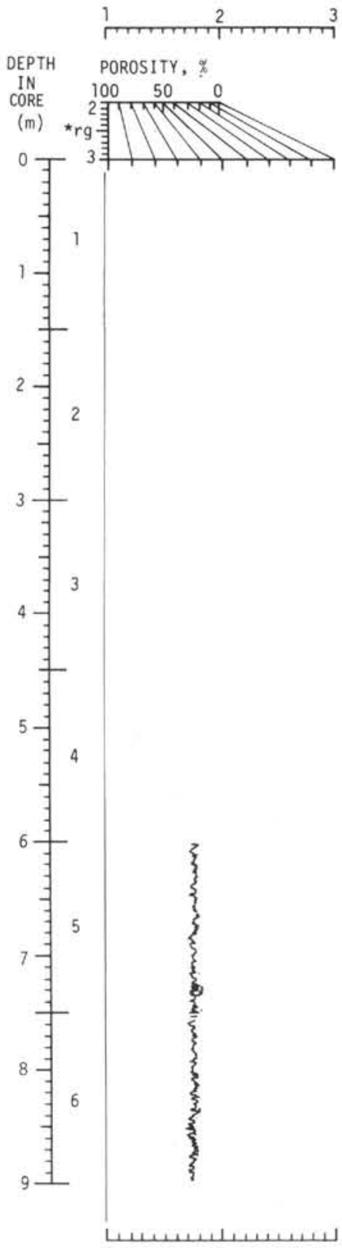
317B
CORE 25



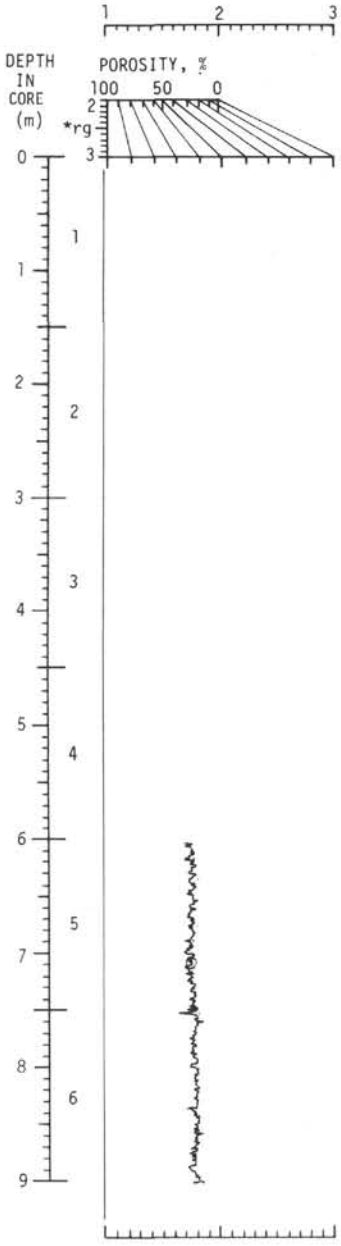
317B
CORE 26



317B
CORE 27



317B
CORE 28



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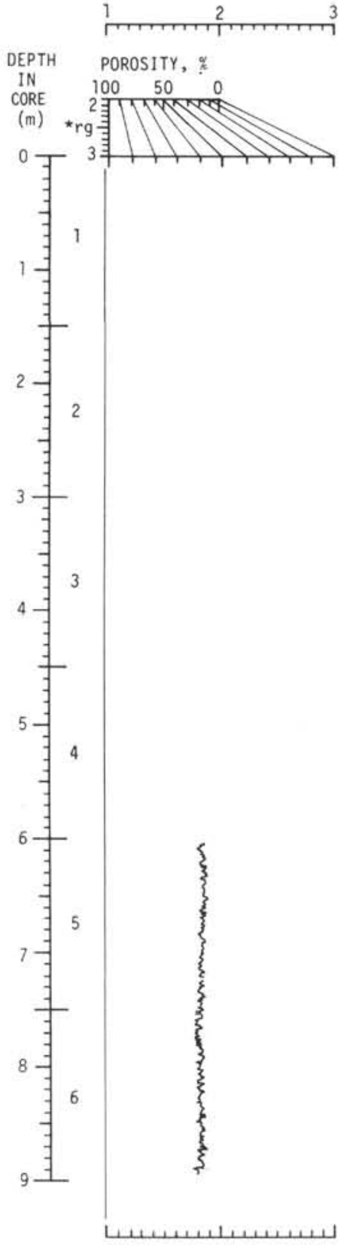
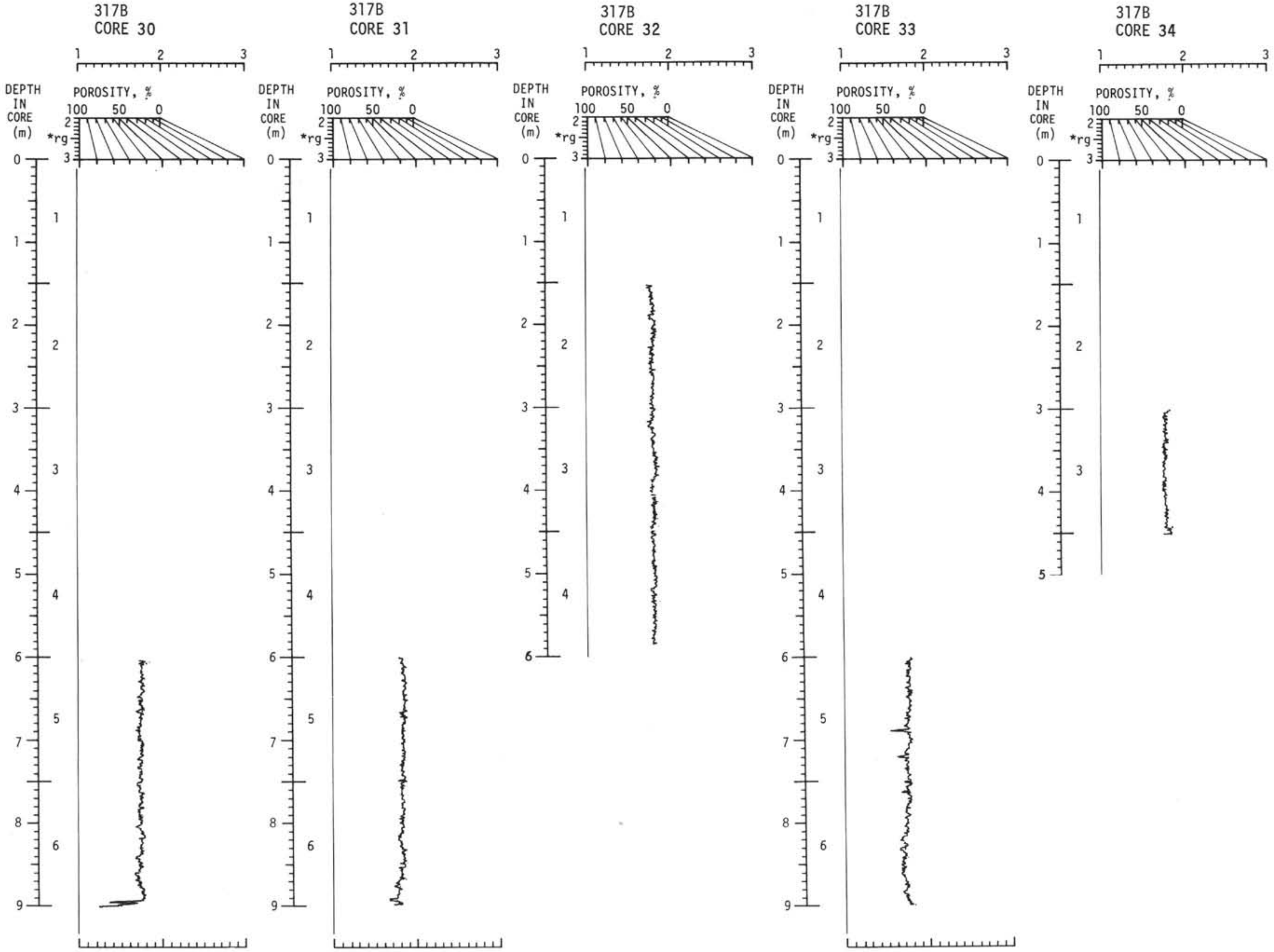
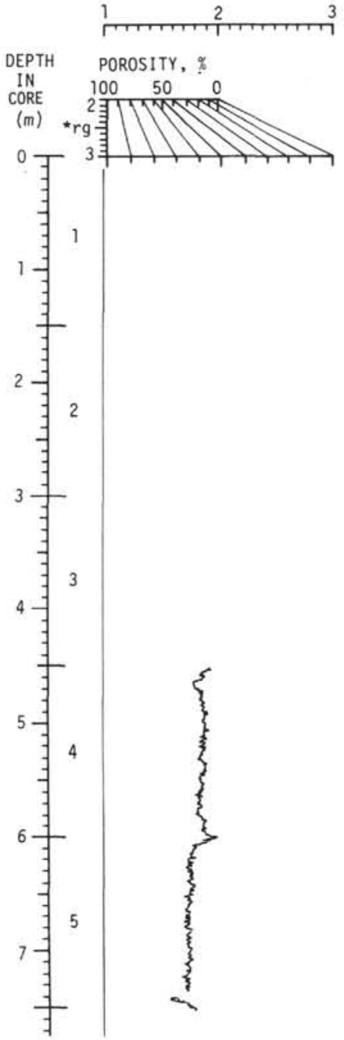
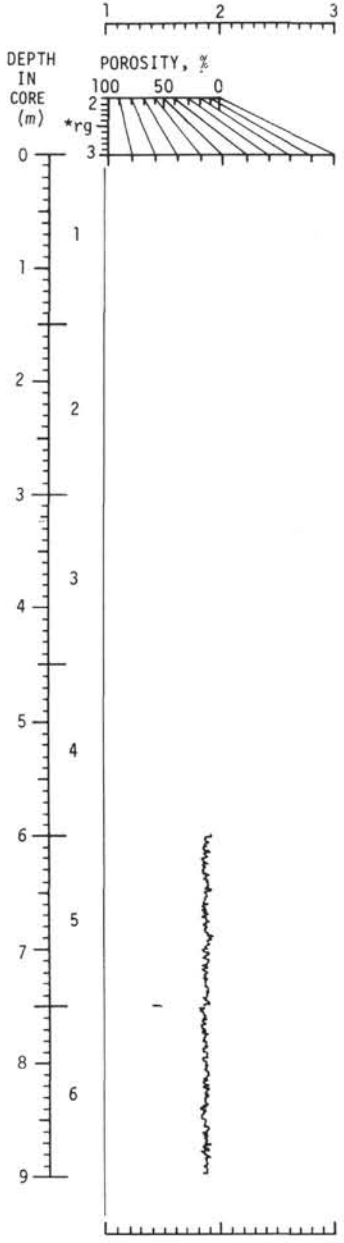



317B
CORE 30
317B
CORE 31
317B
CORE 32
317B
CORE 33
317B
CORE 34
1
2
3
DEPTH
IN
CORE
(m)
POROSITY, %
100
50
0
*rg
0
1
2
3
4
5
6
7
8
9

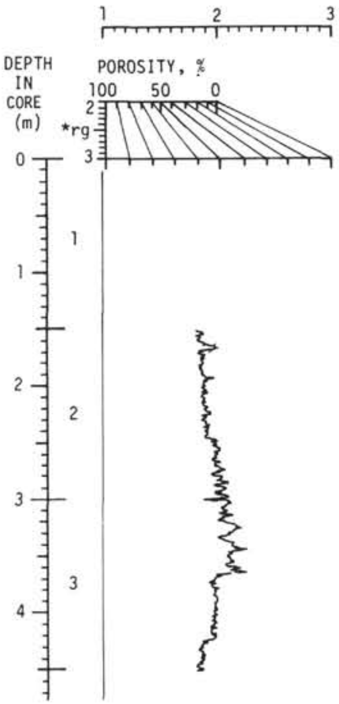
317B
CORE 35



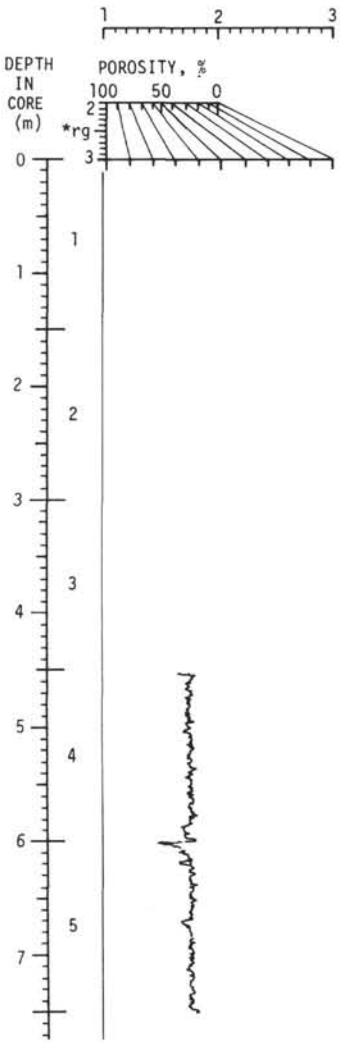
317B
CORE 36



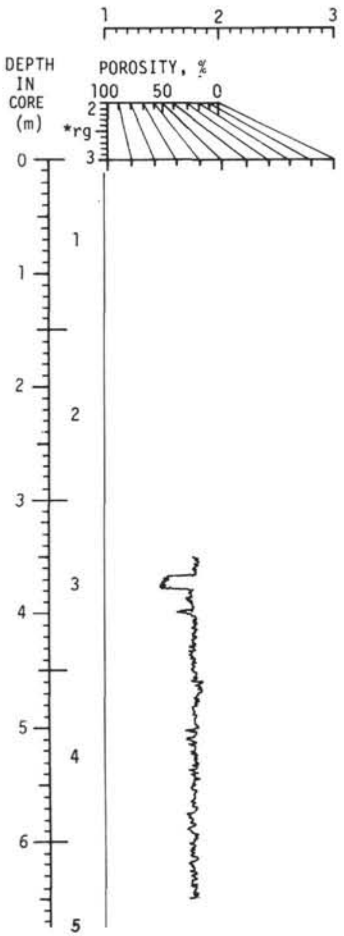
317B
CORE 37



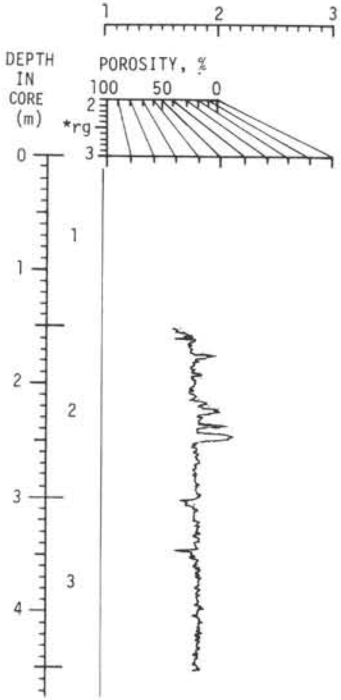
317B
CORE 38



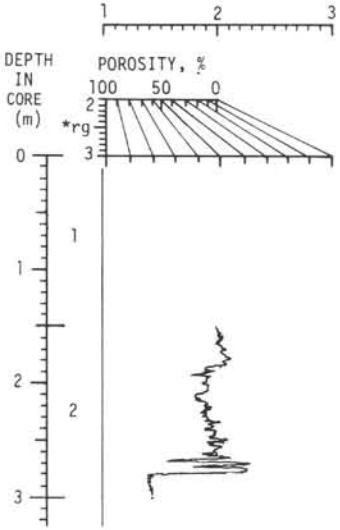
317B
CORE 39



317B
CORE 40



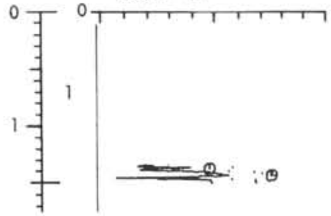
317B
CORE 42

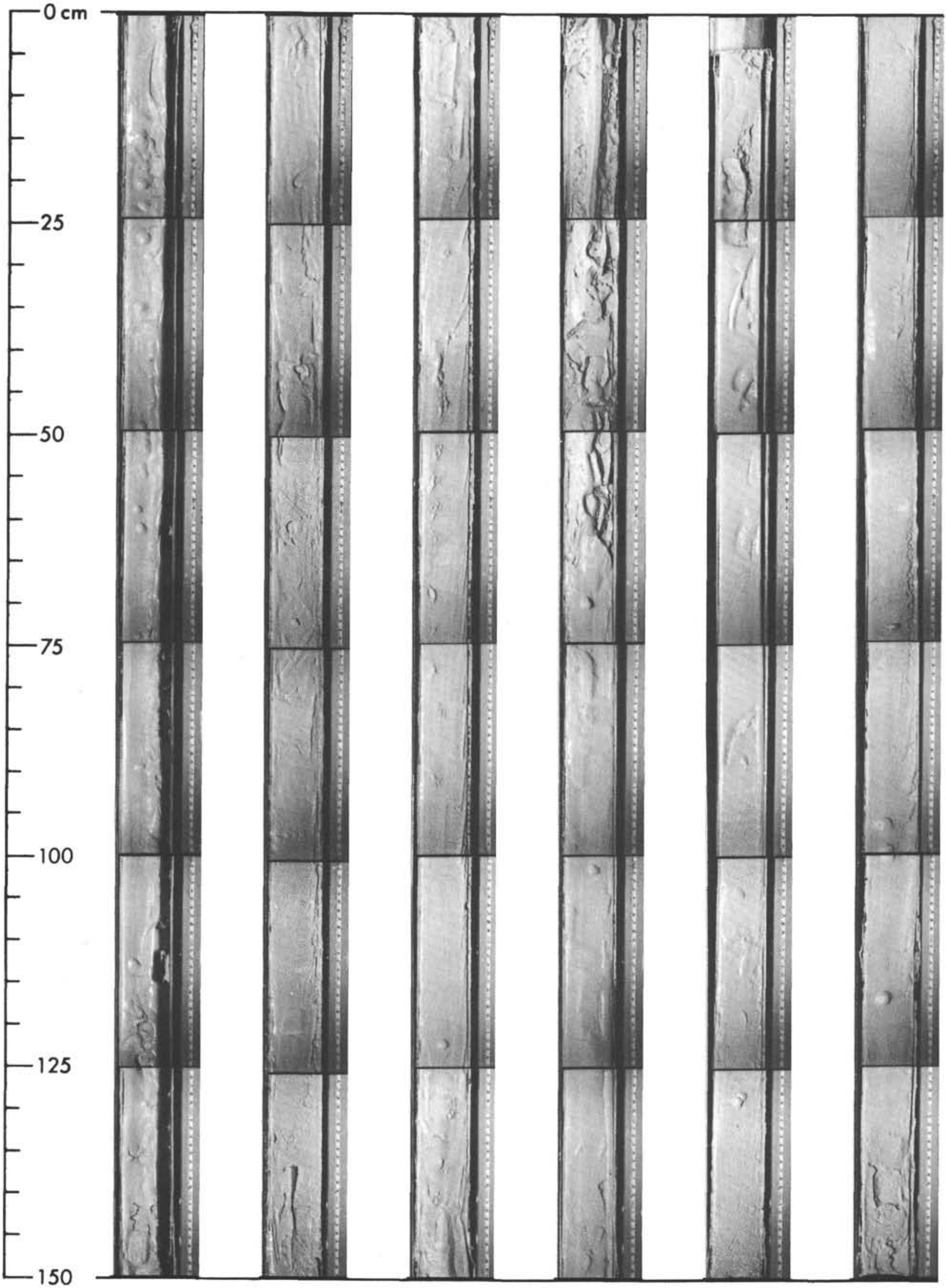


317B
CORE 43
NO DATA

317B
CORE 41
NO DATA

317B
CORE 44





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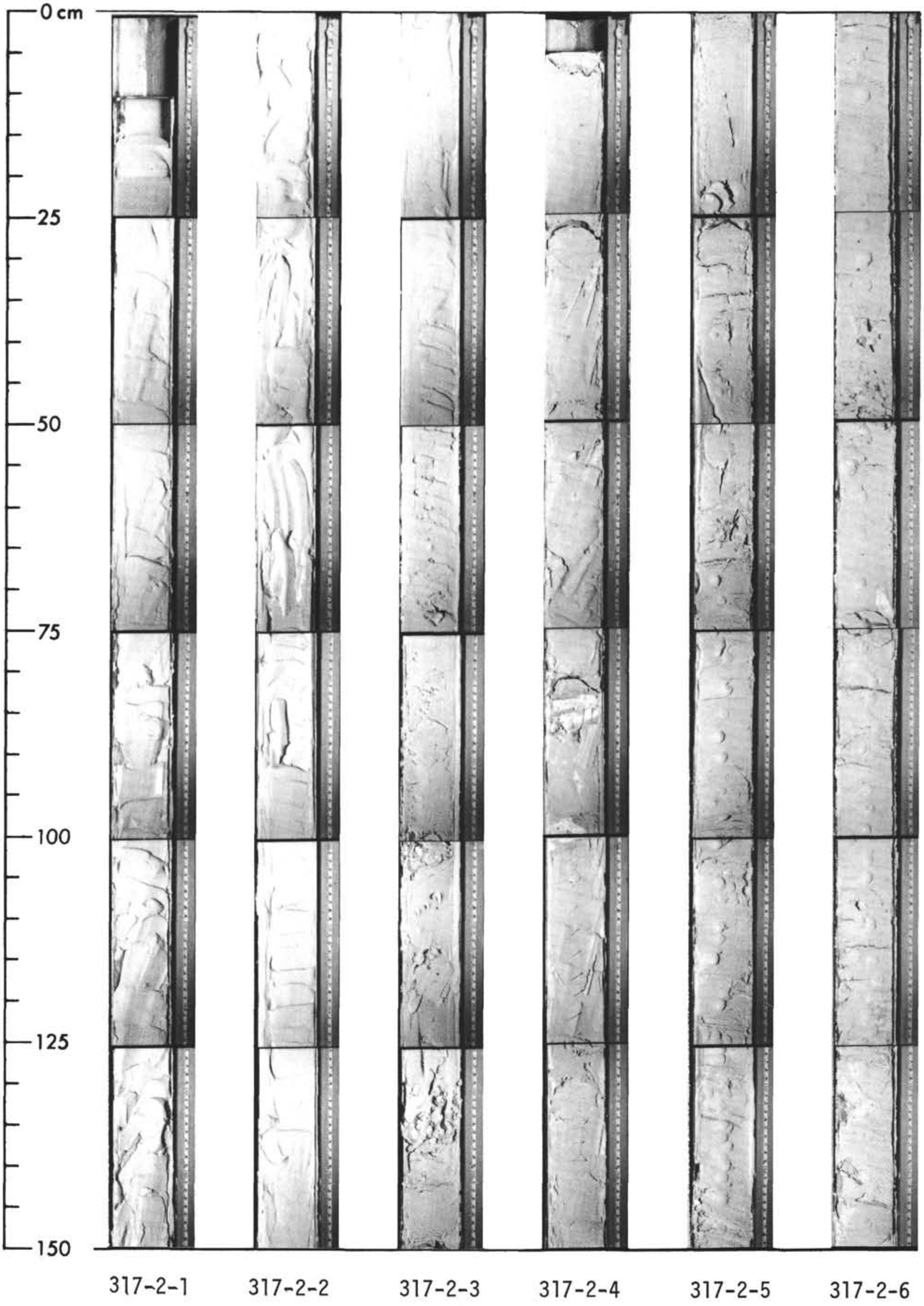
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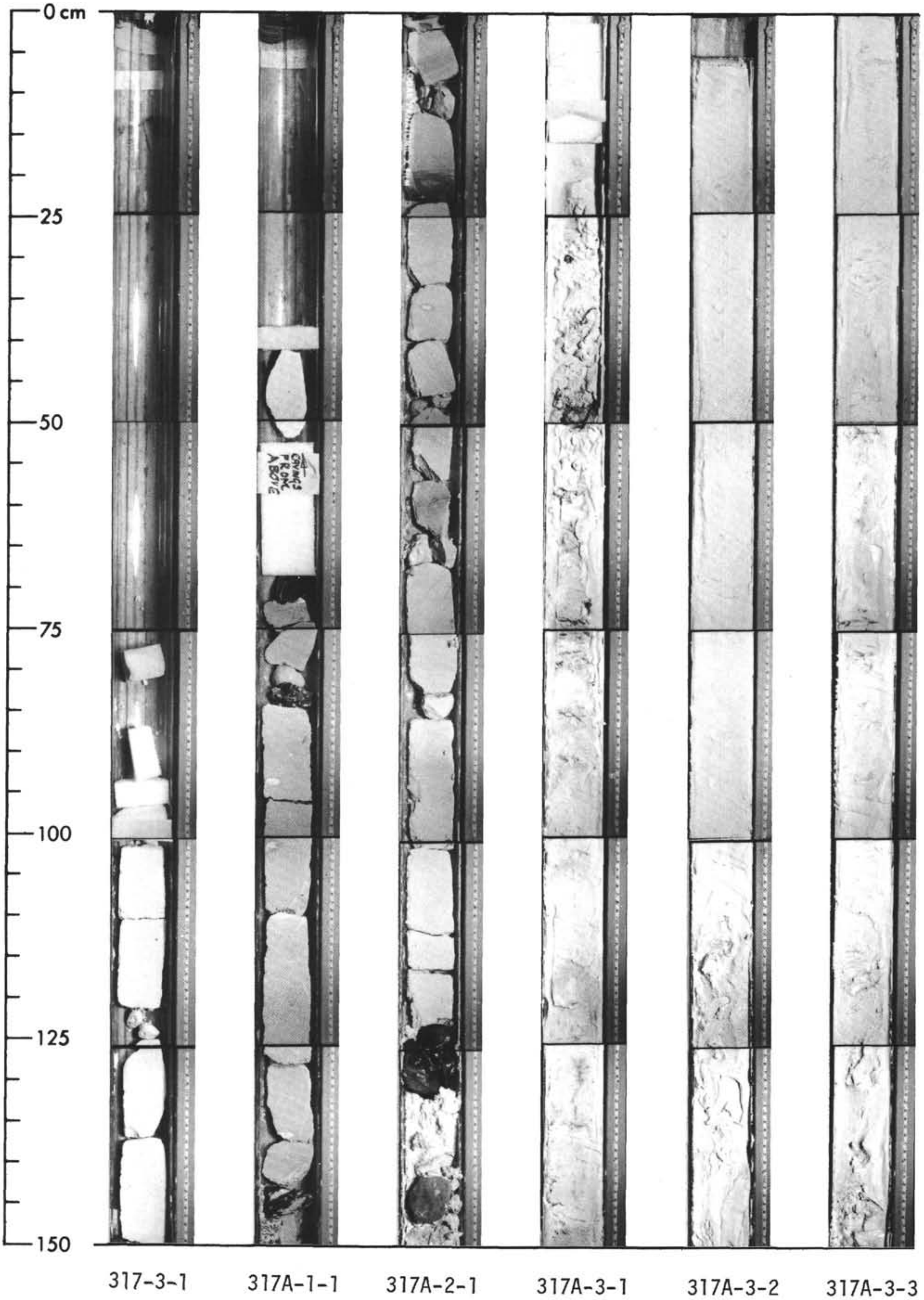
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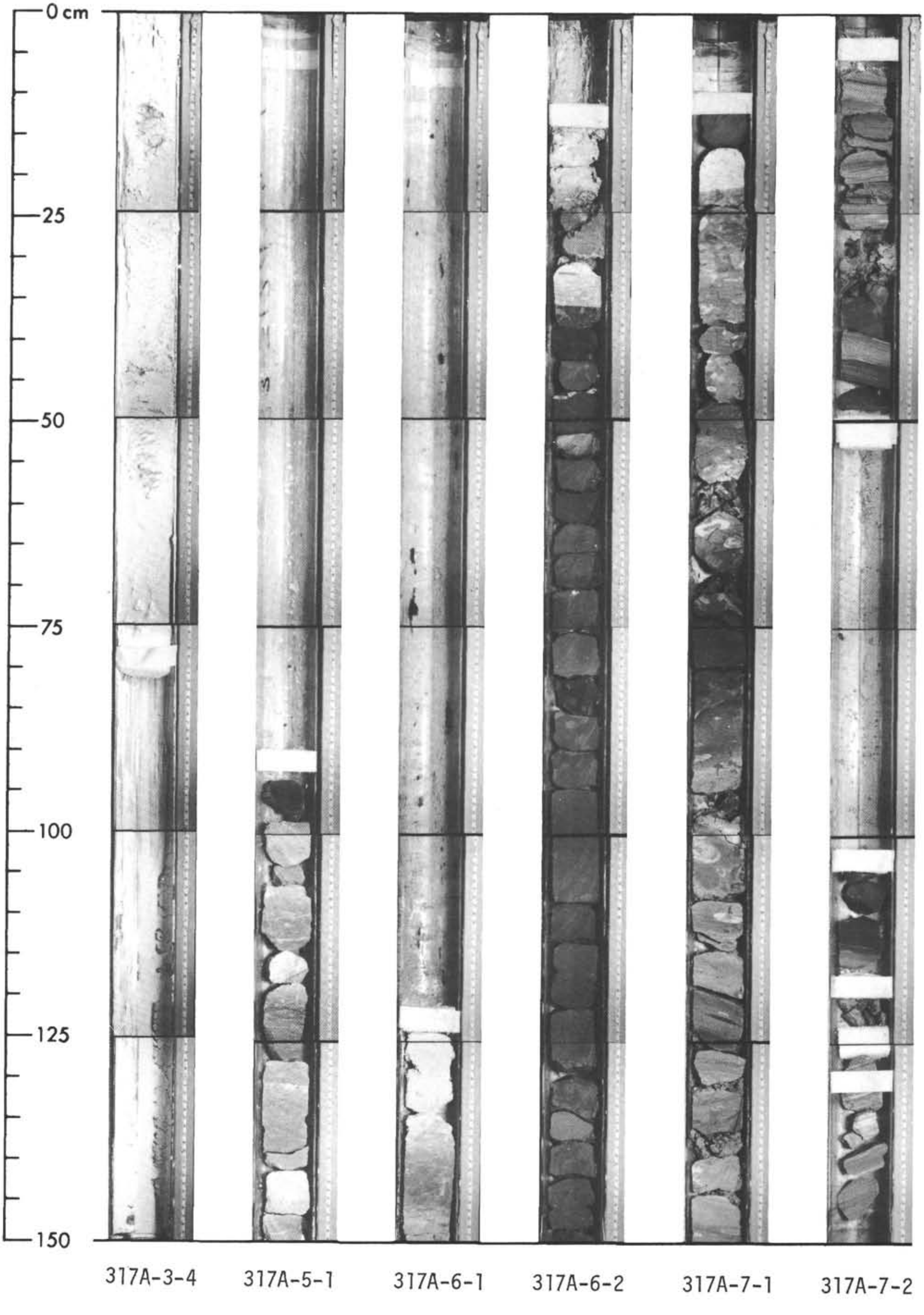
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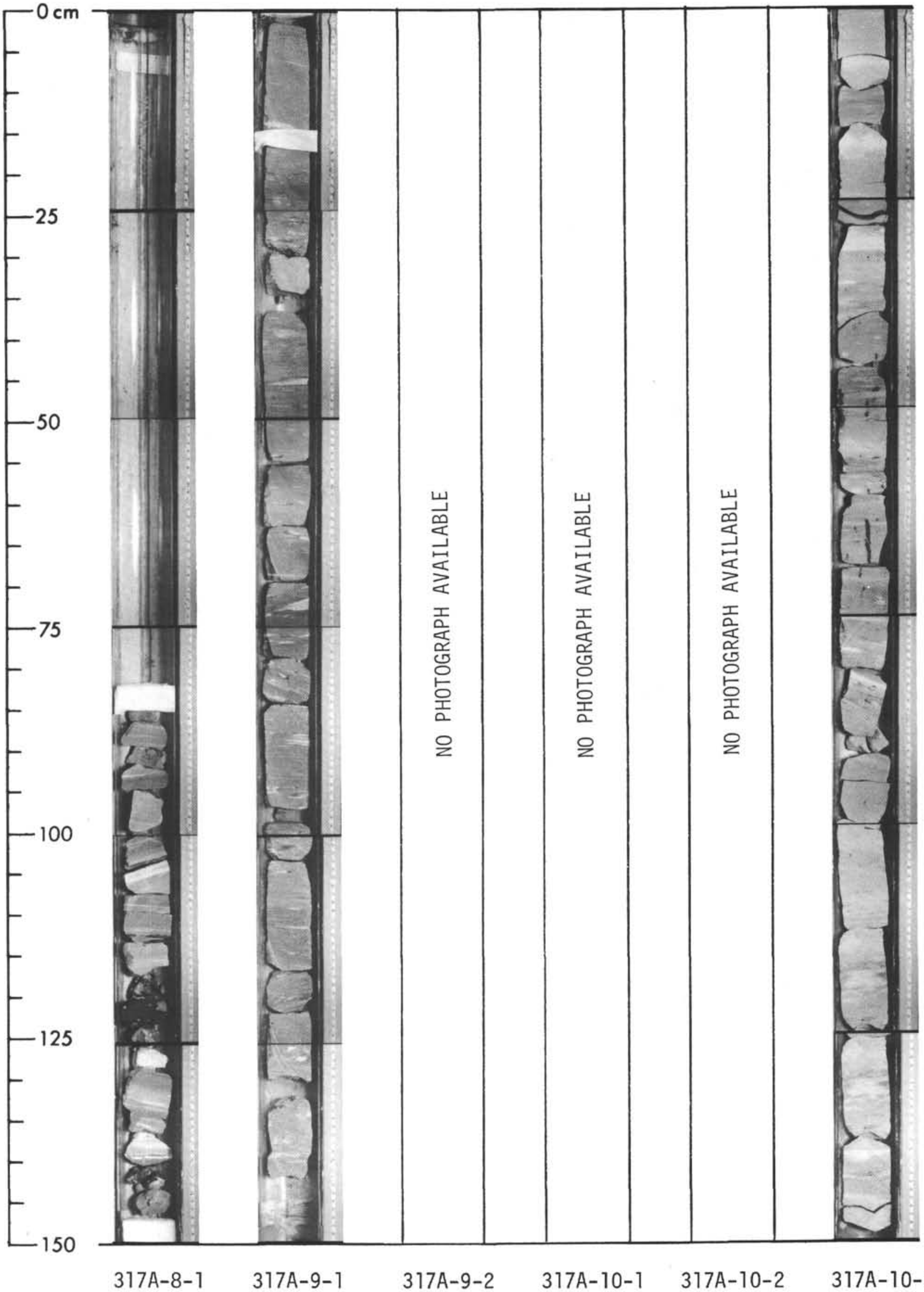
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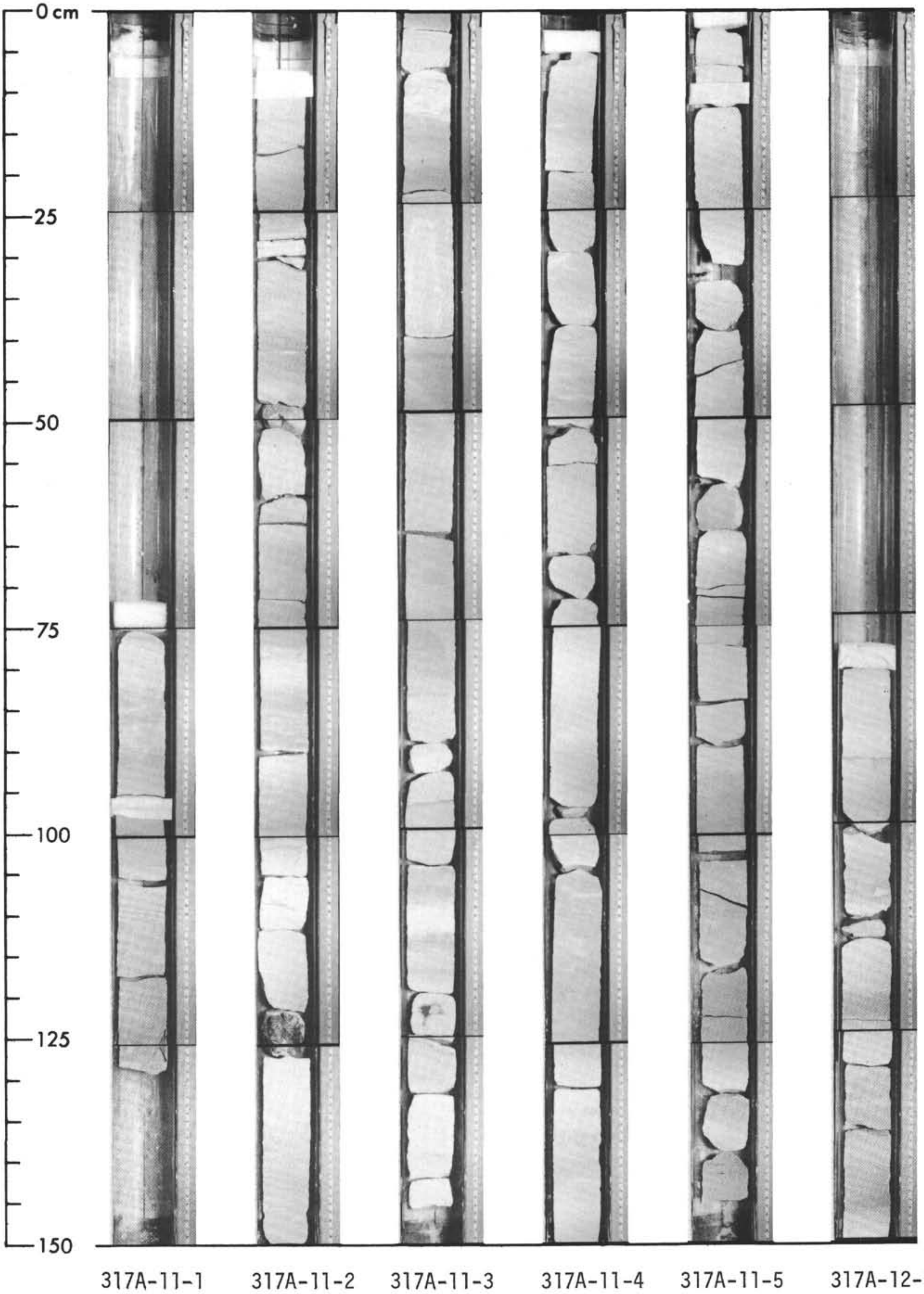
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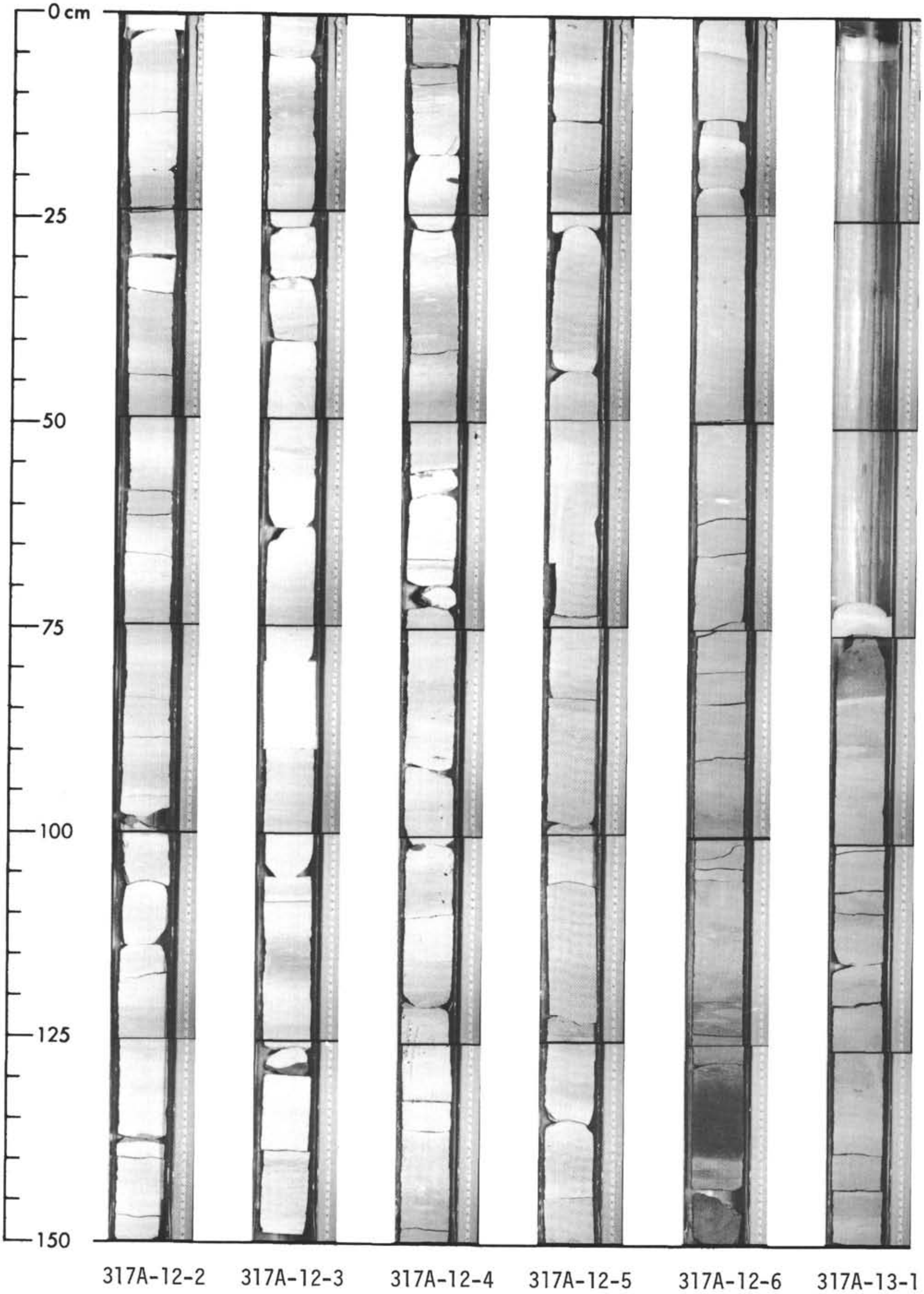
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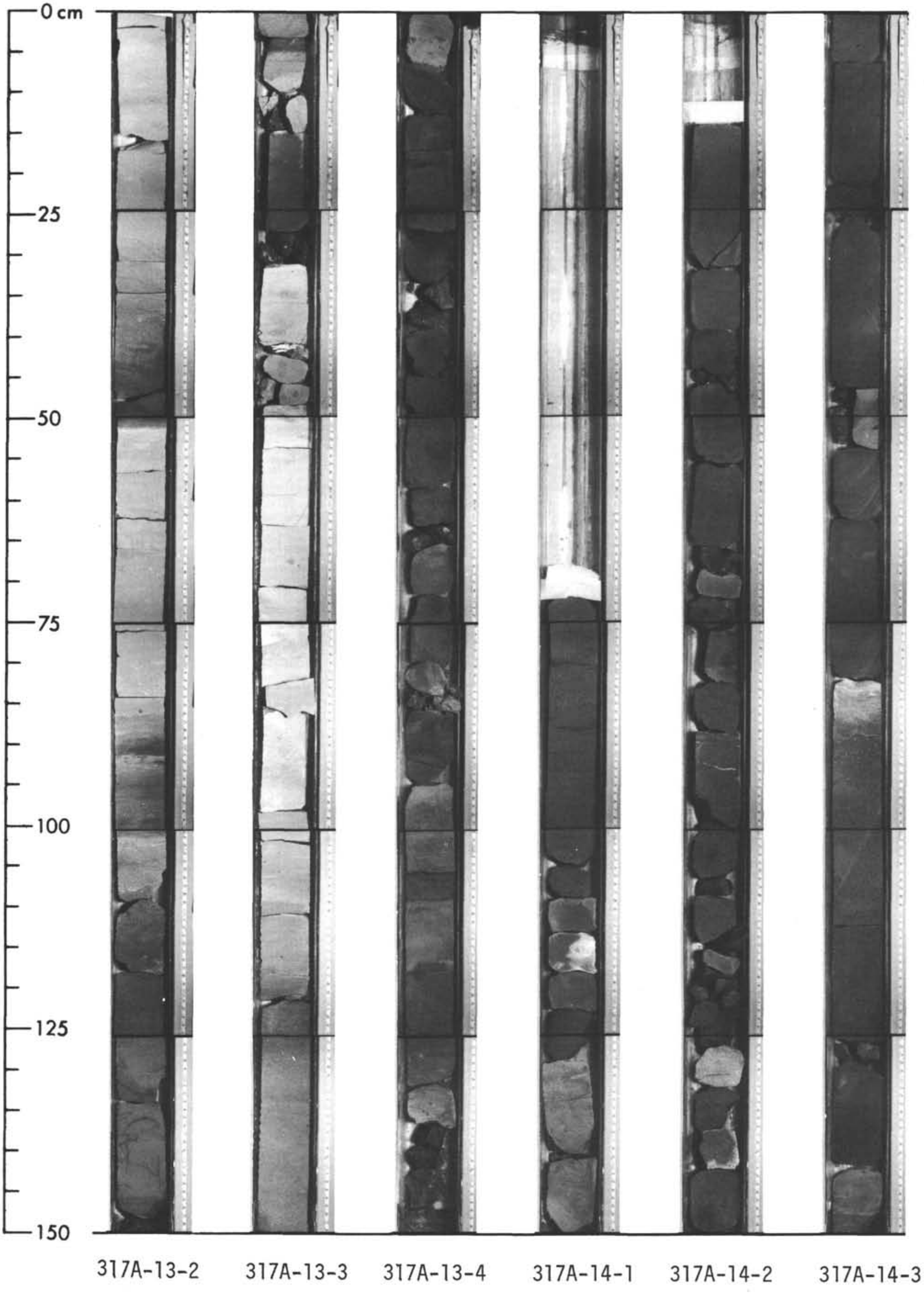
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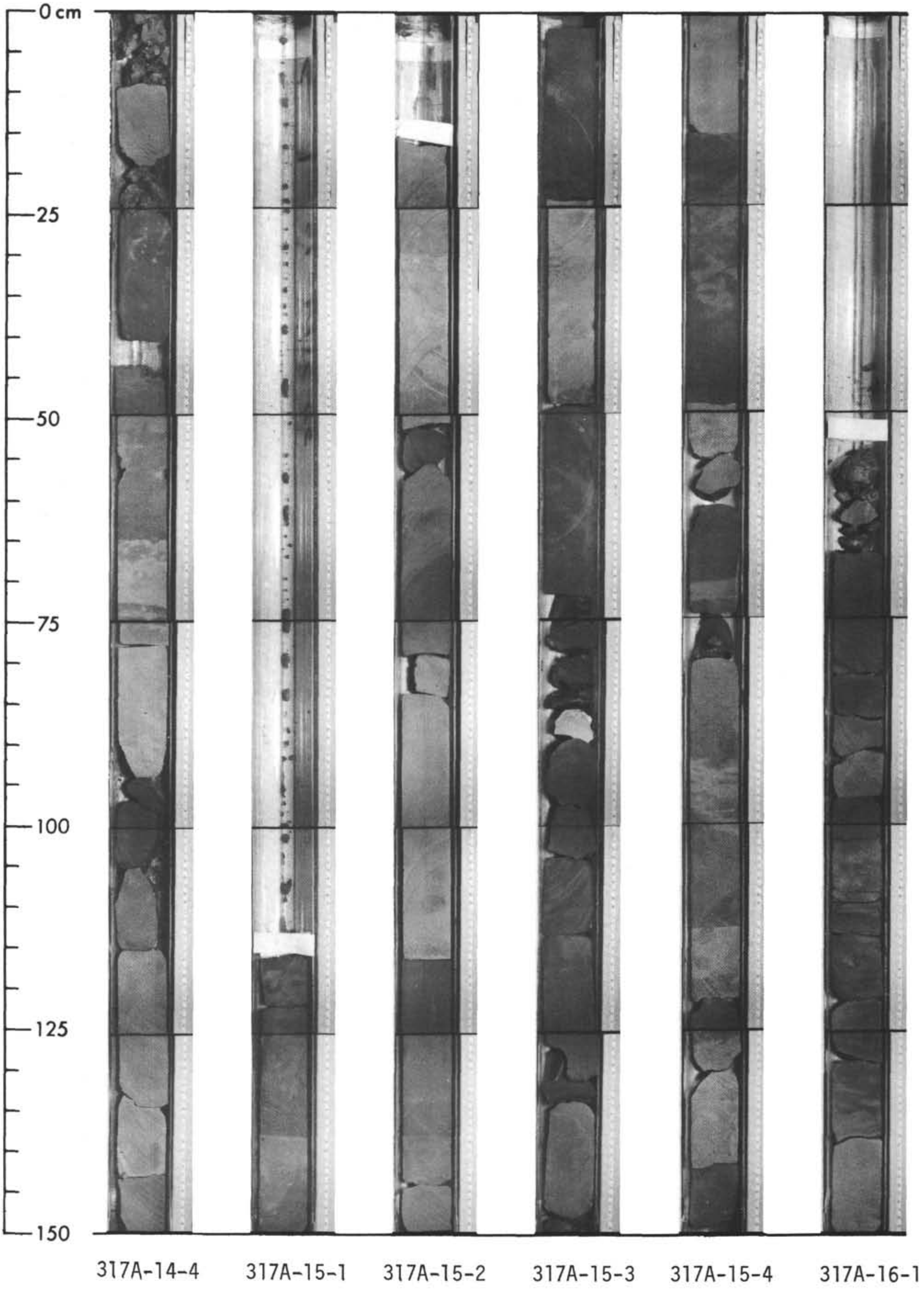
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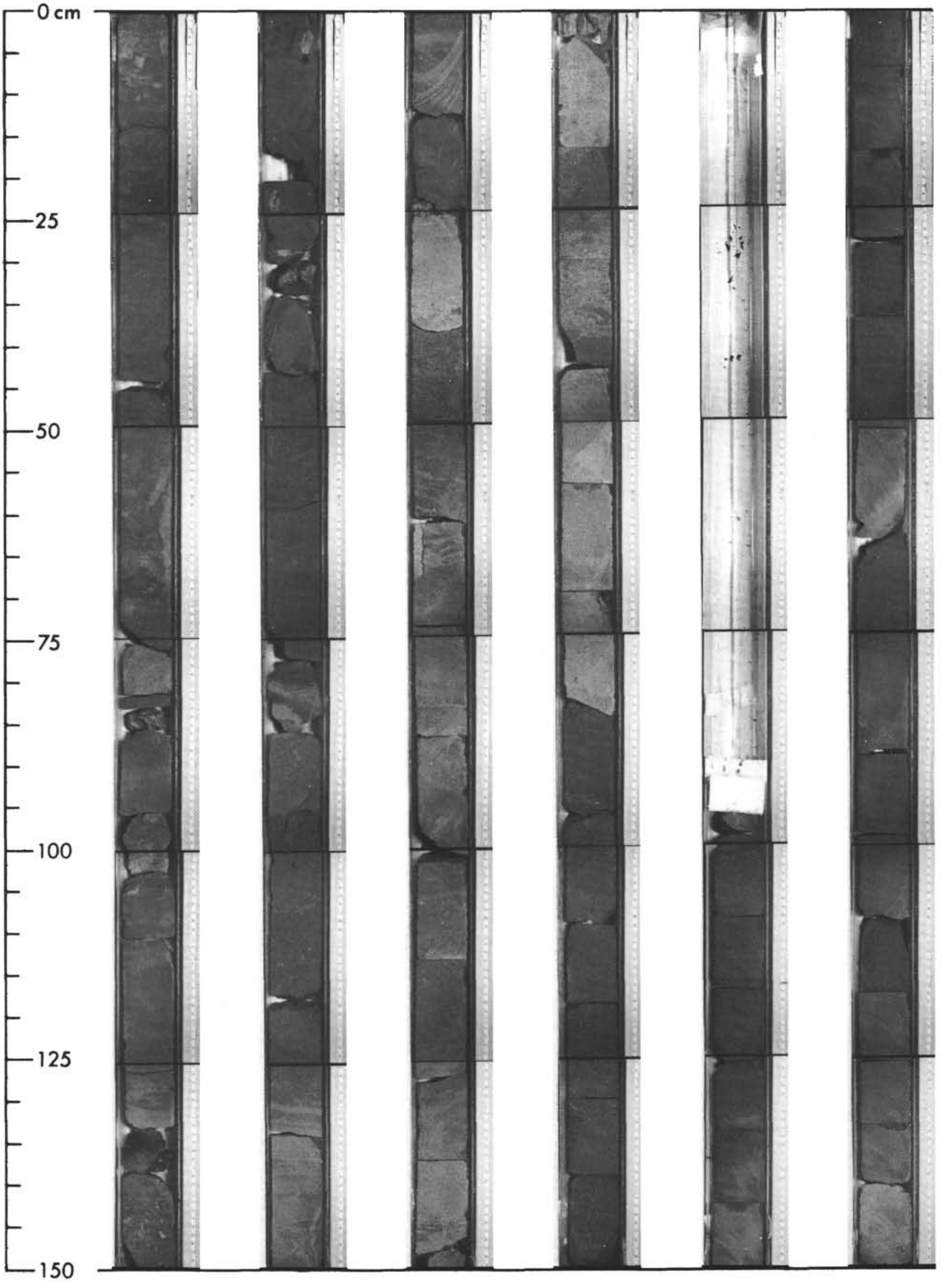
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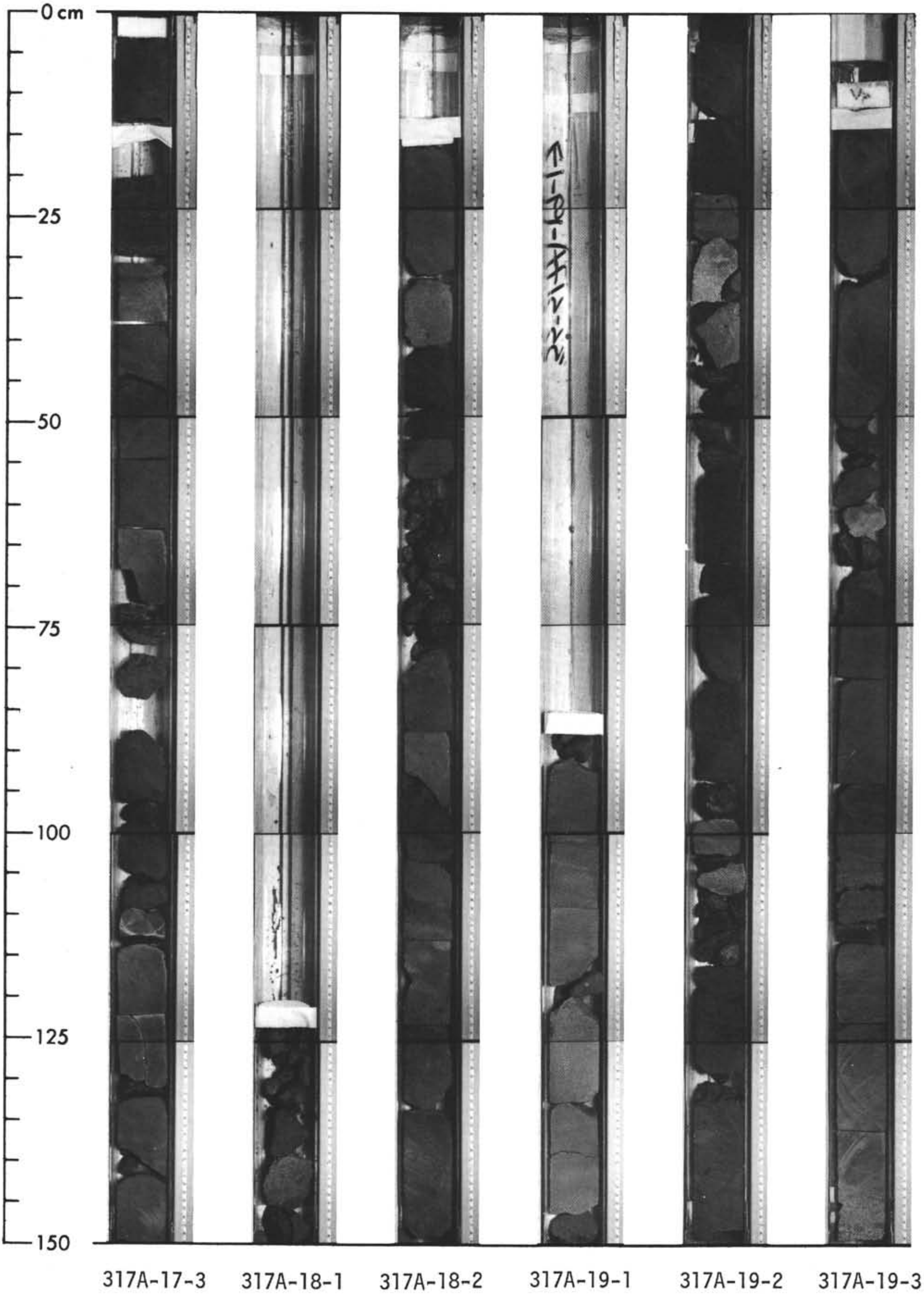
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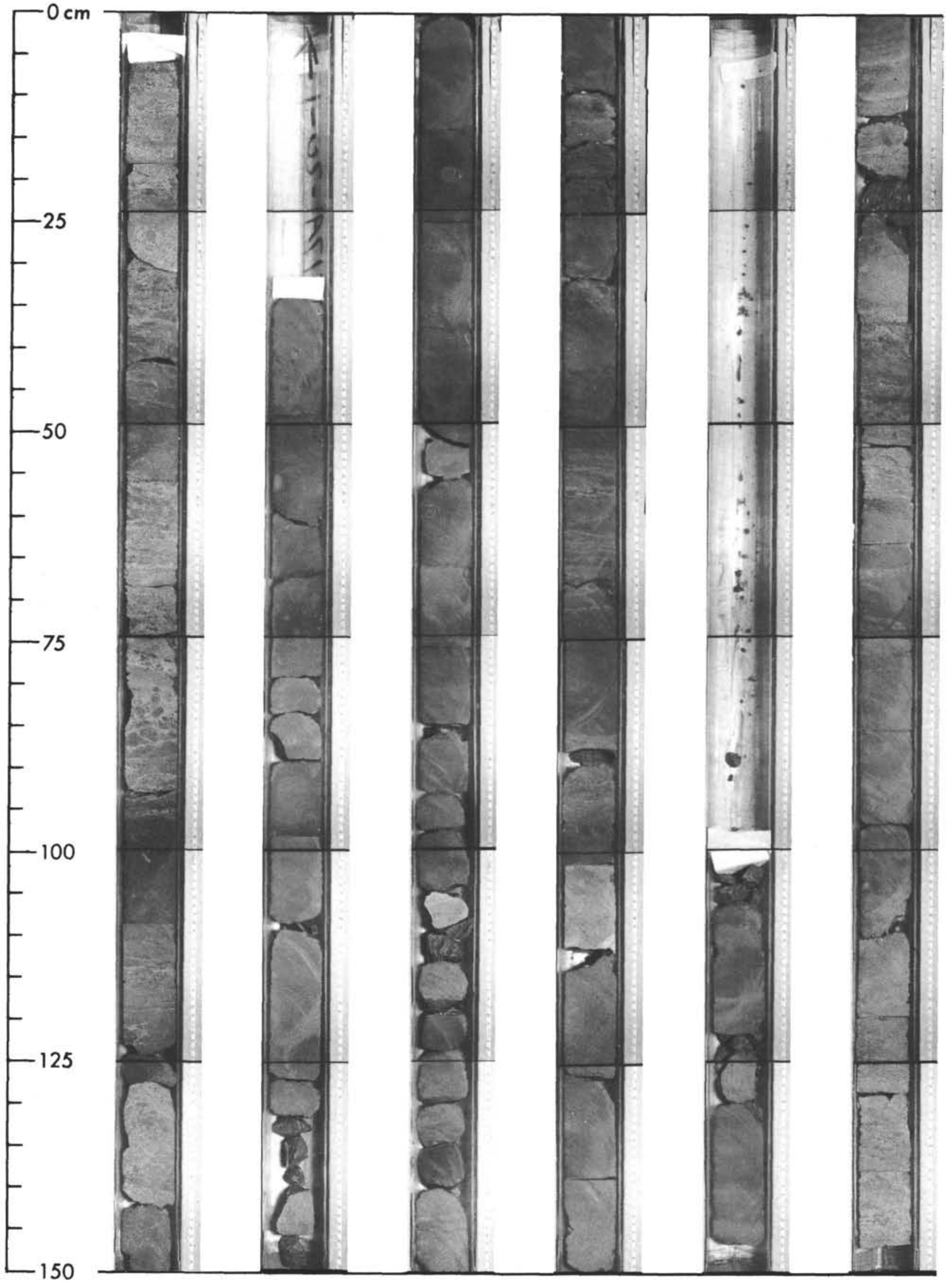
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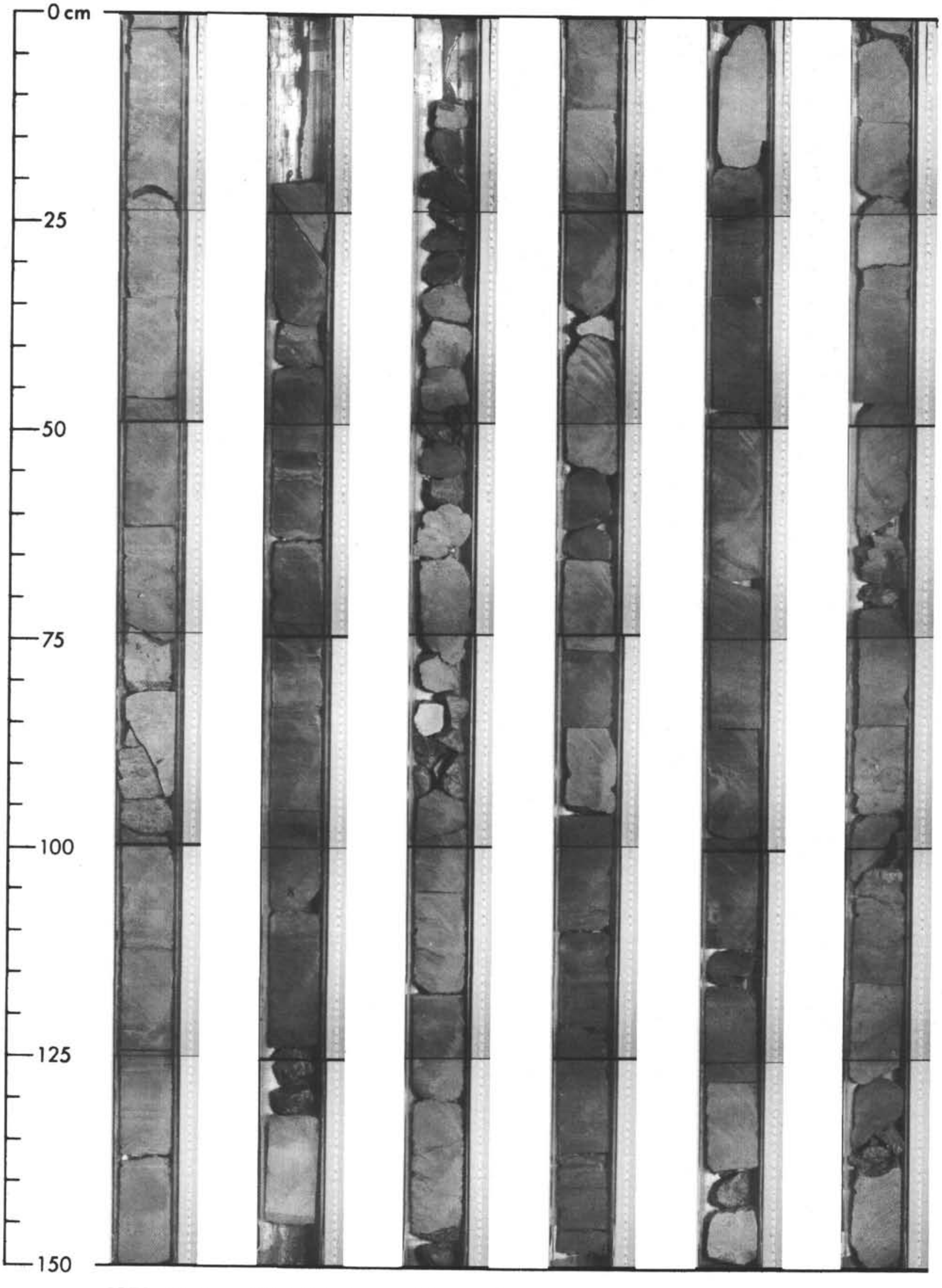
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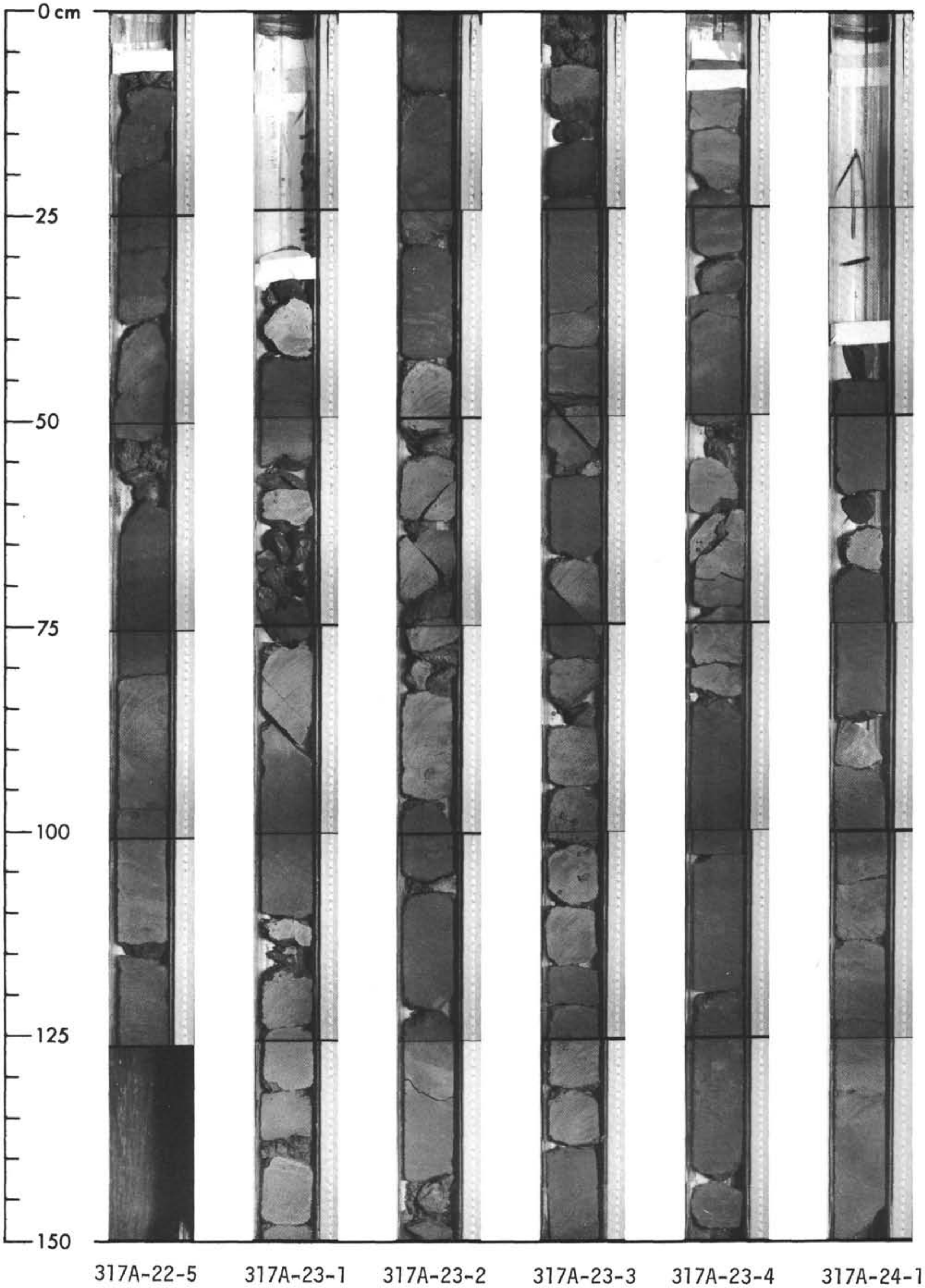
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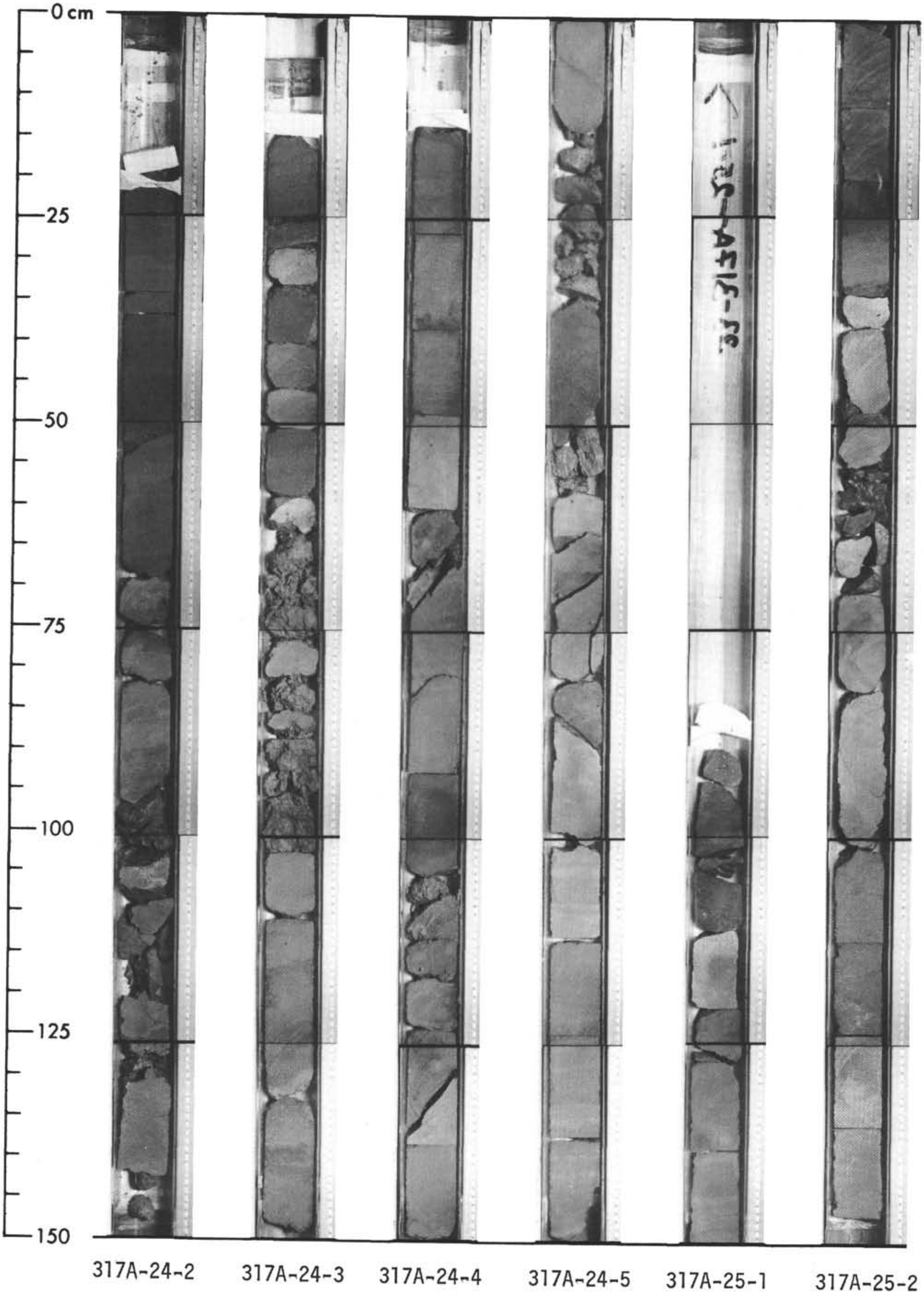
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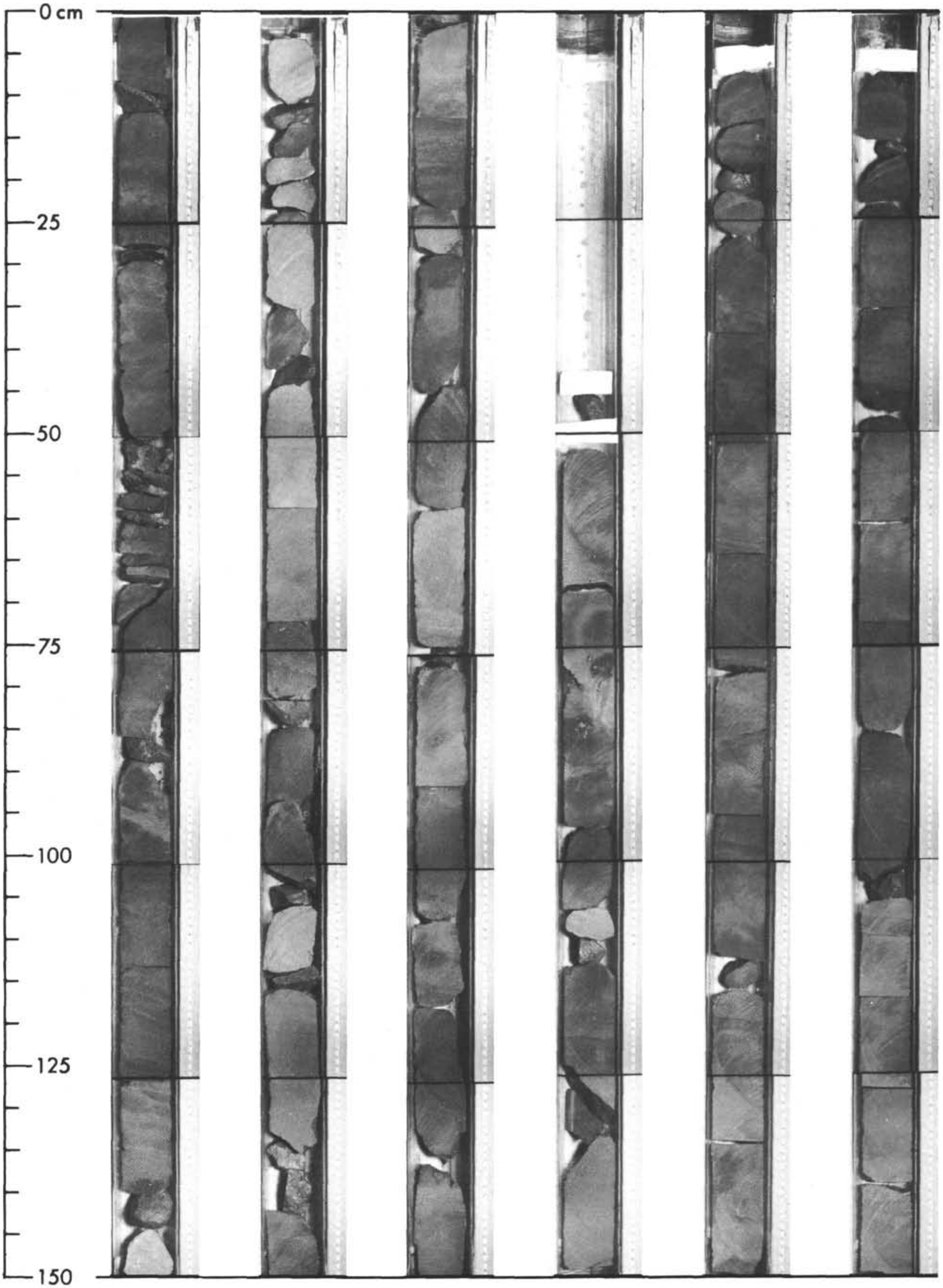

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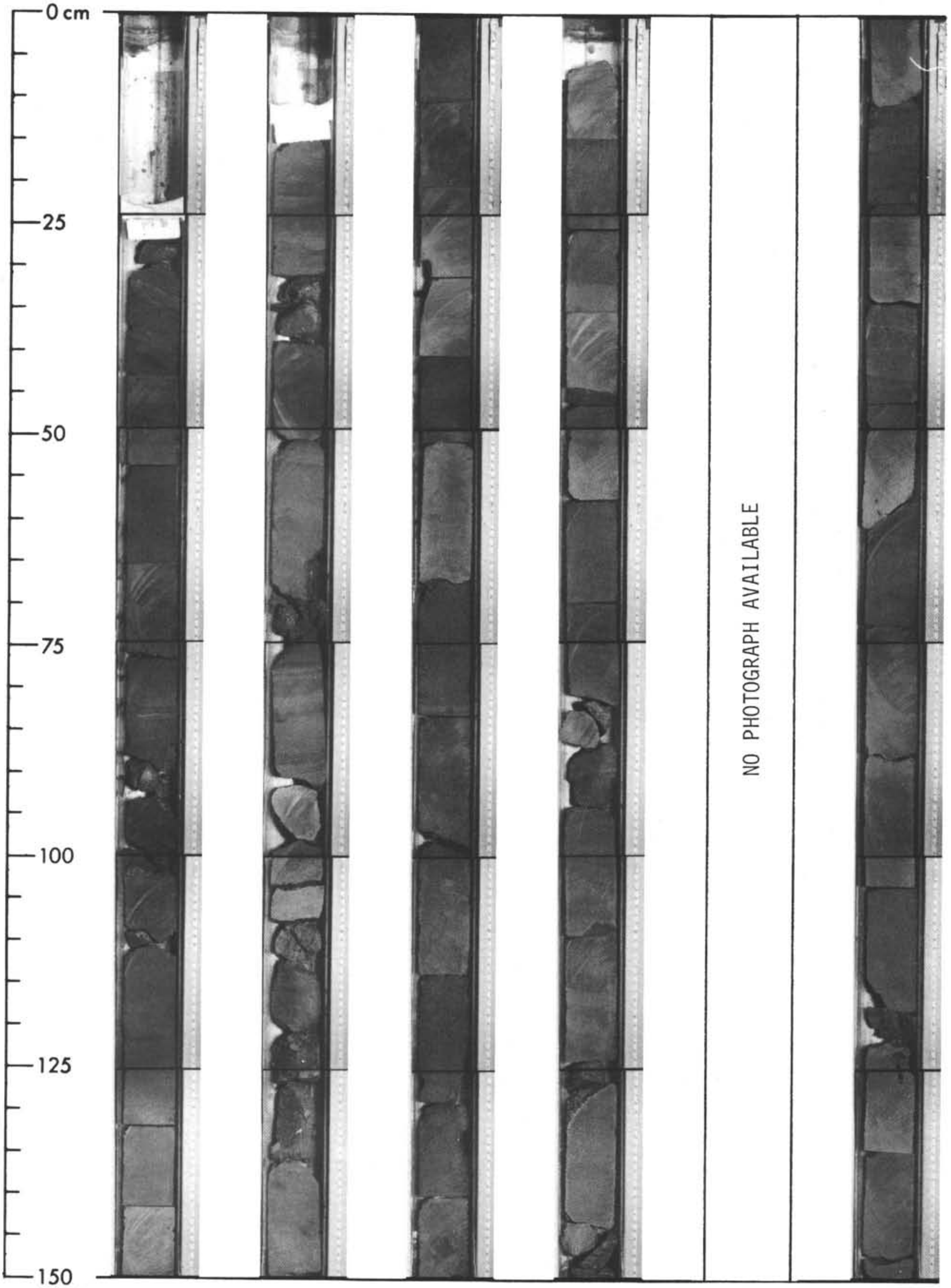
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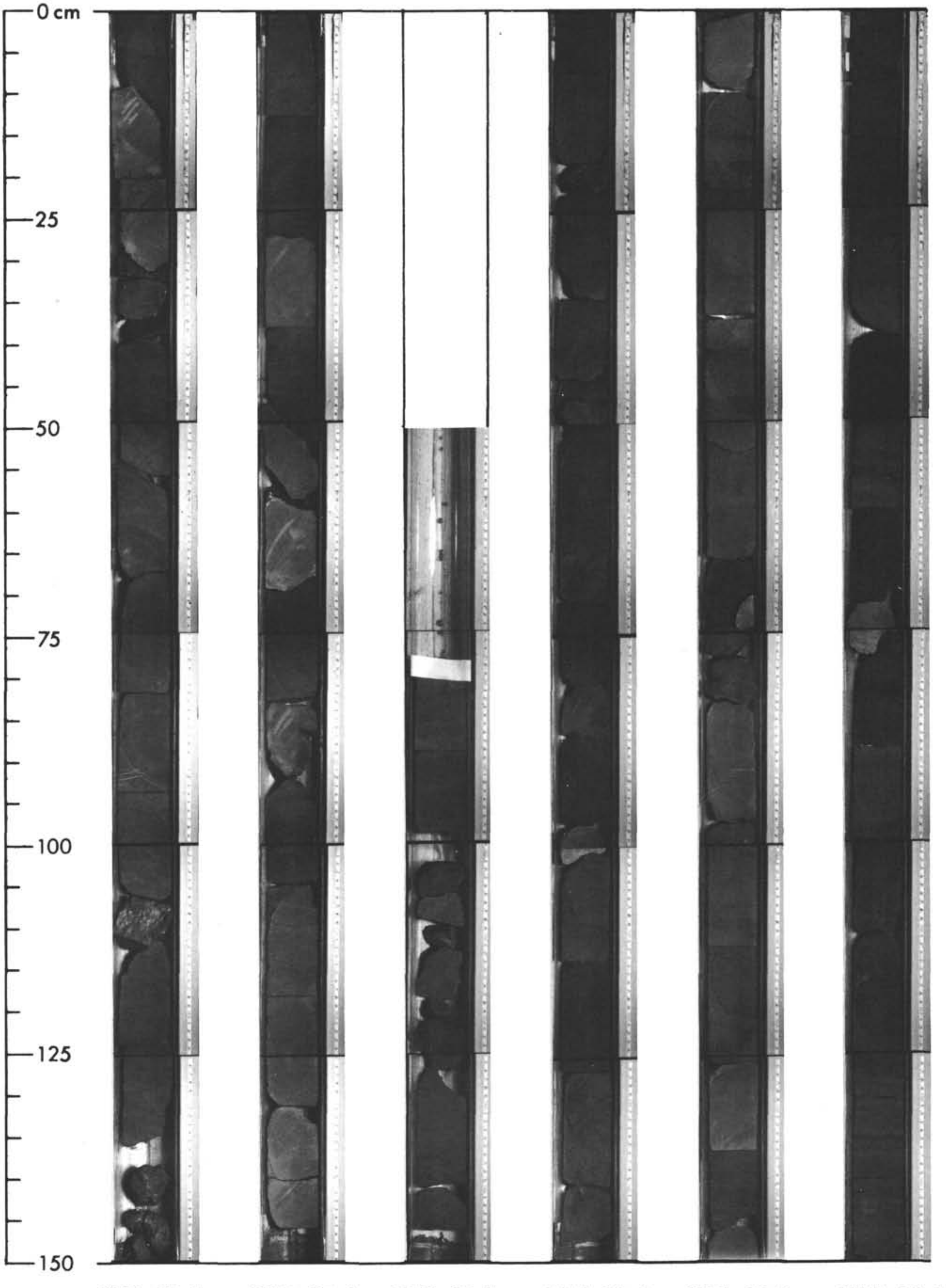
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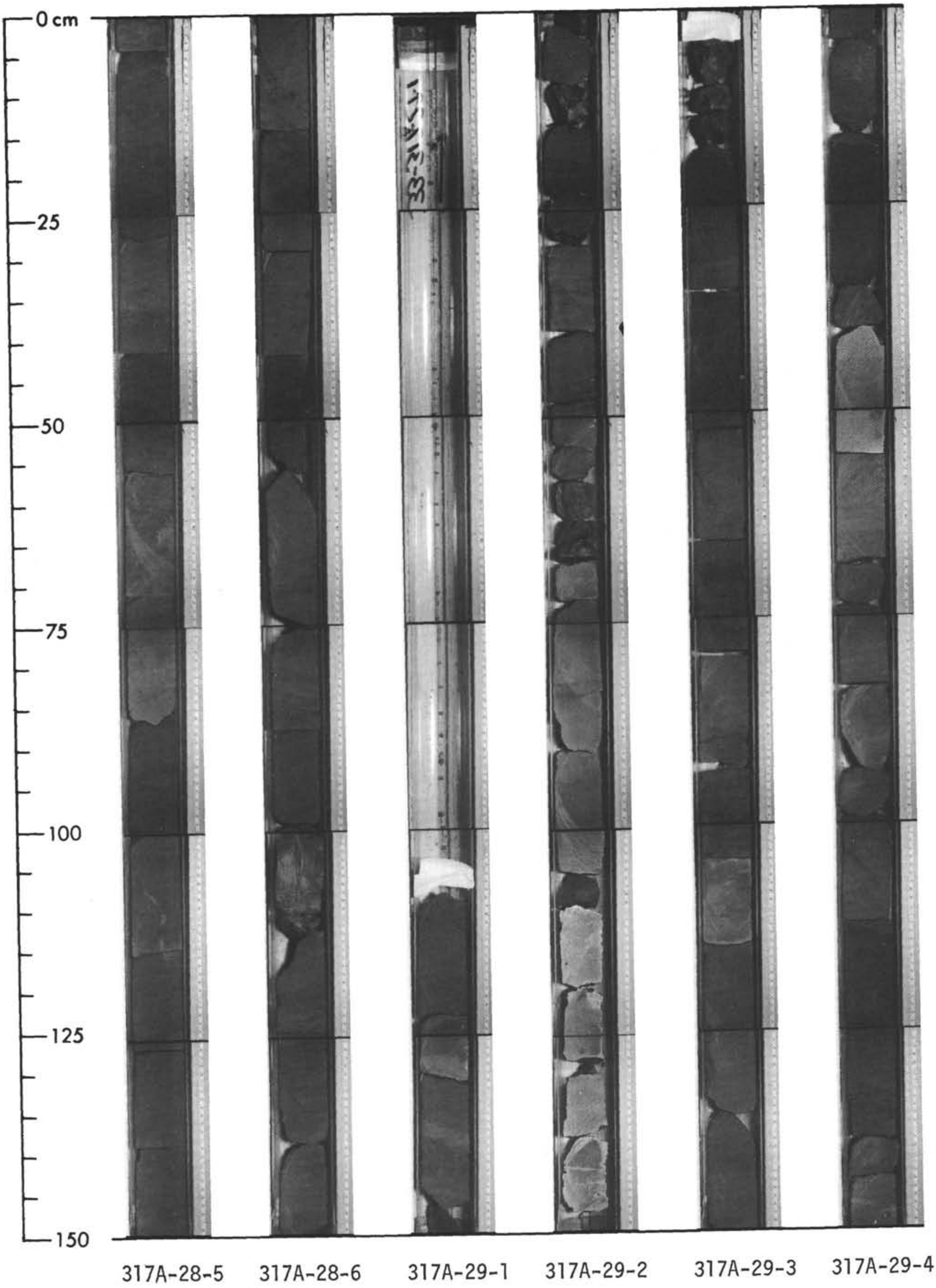
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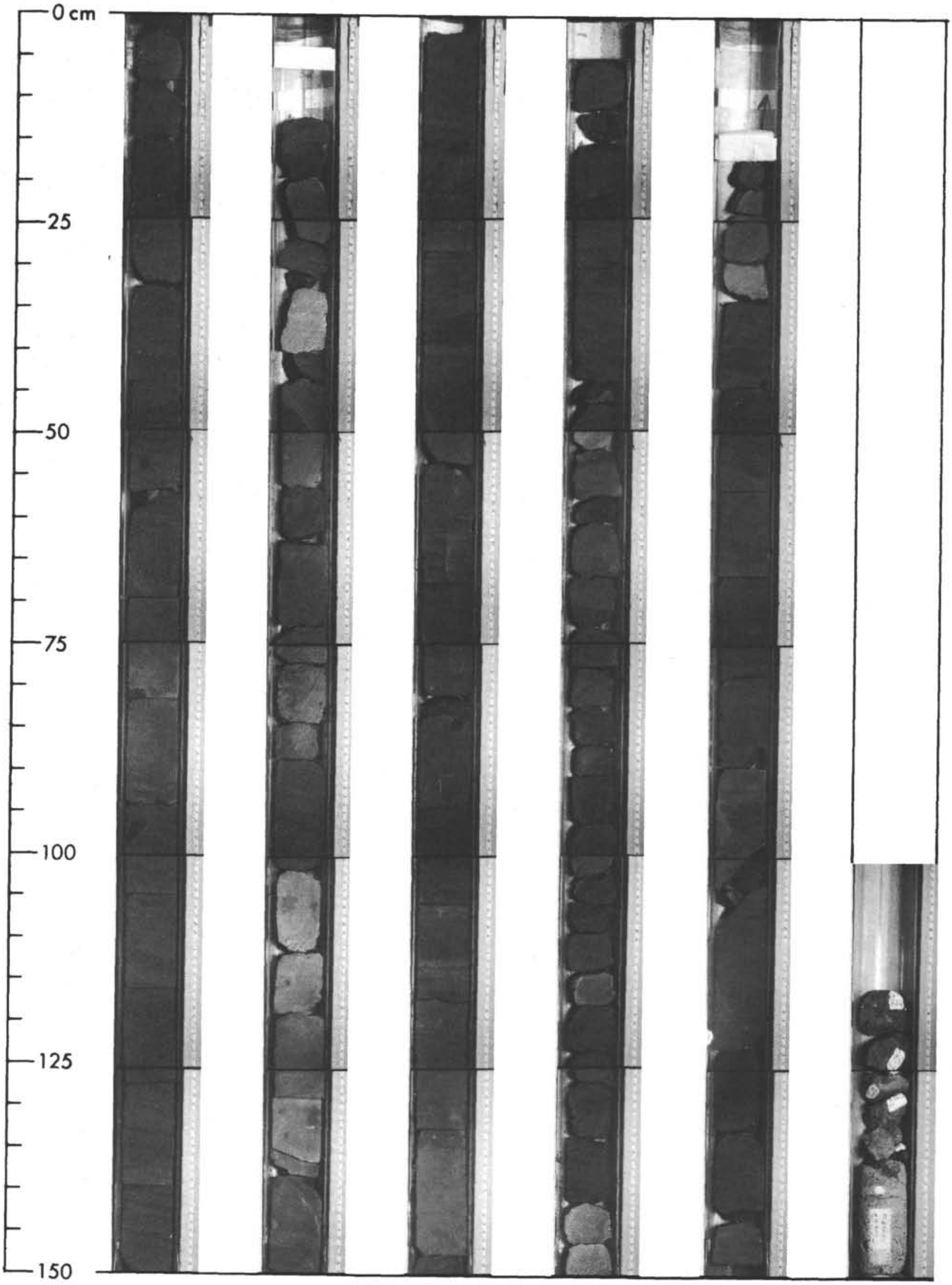
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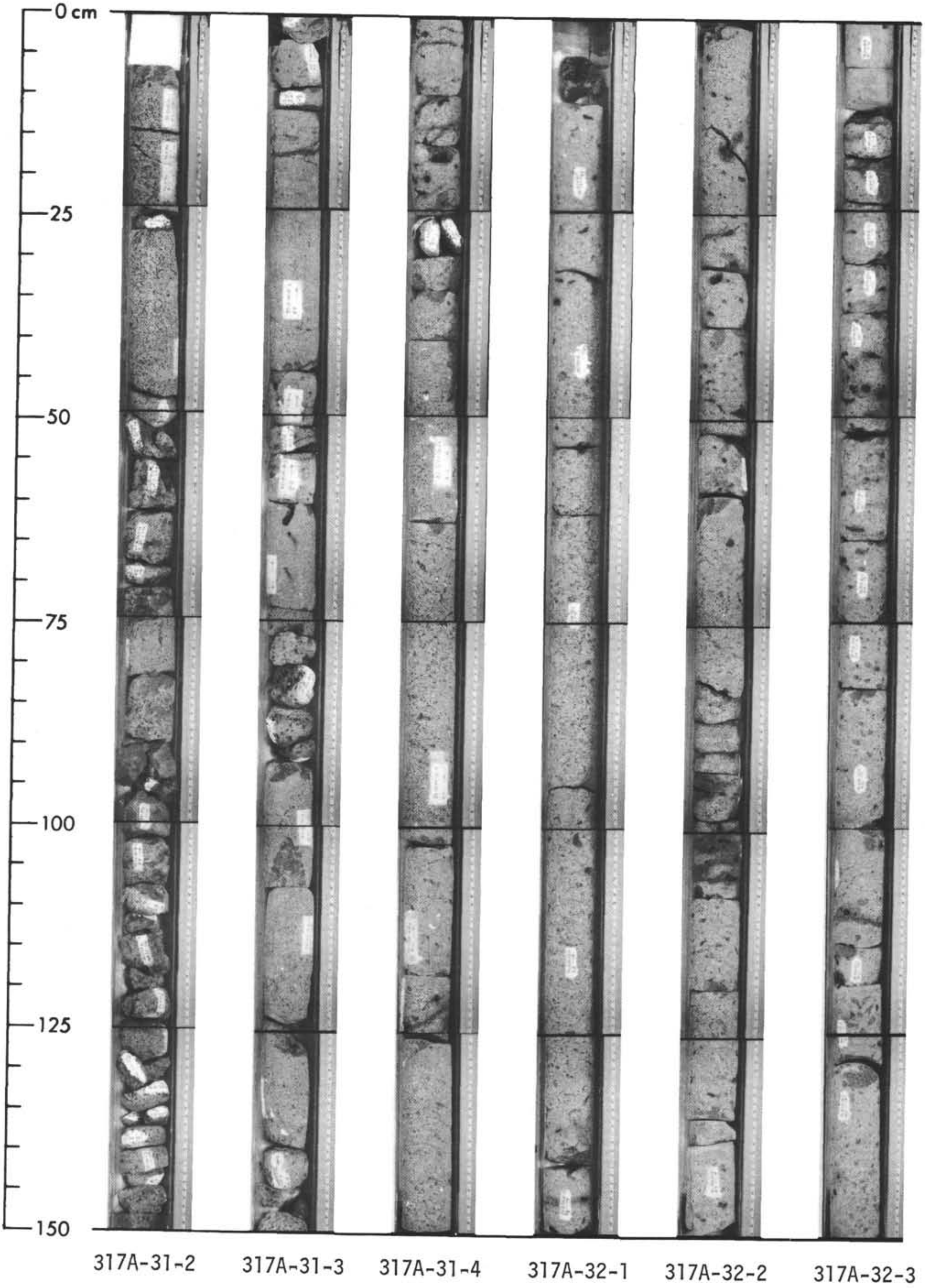
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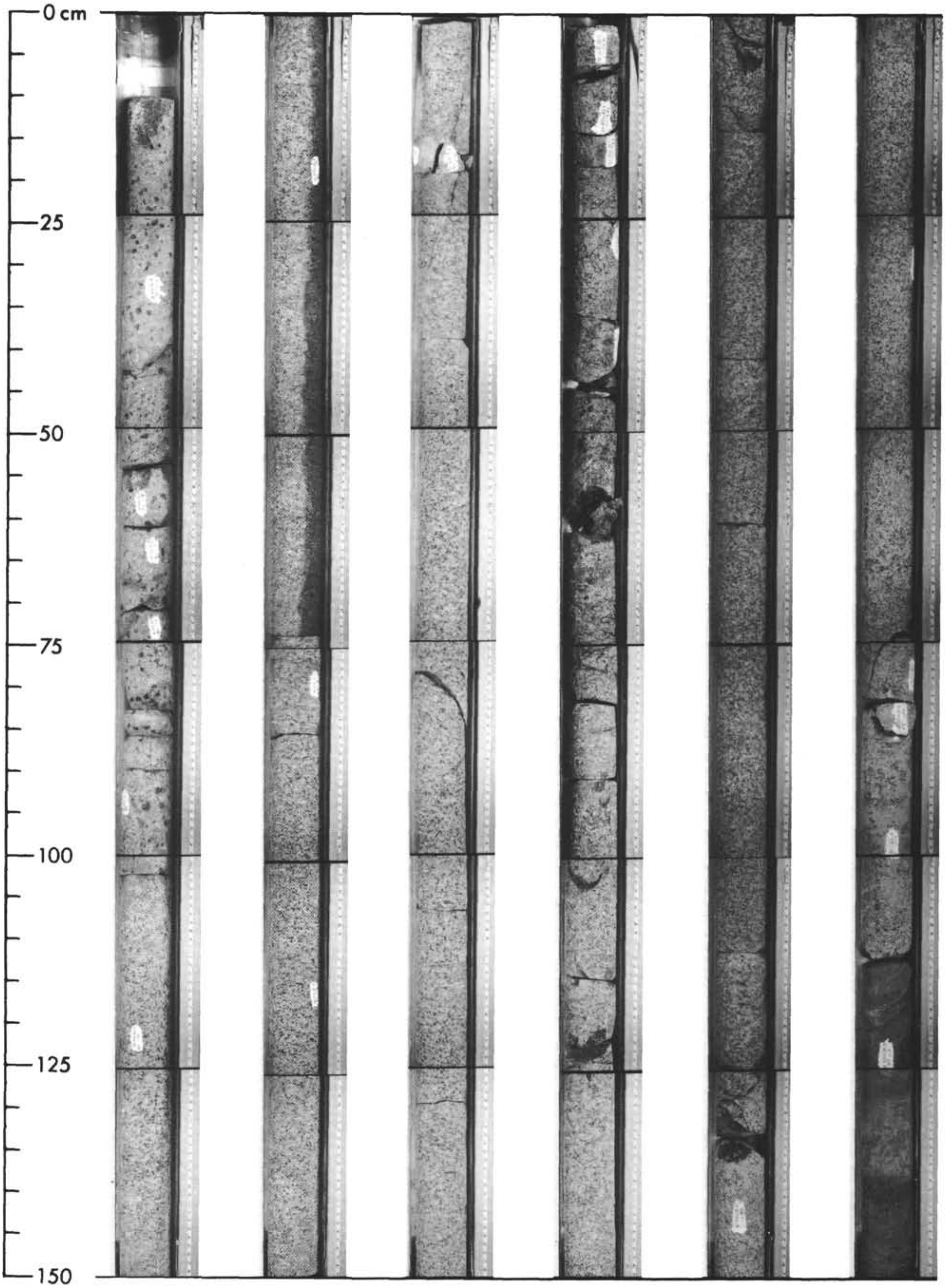
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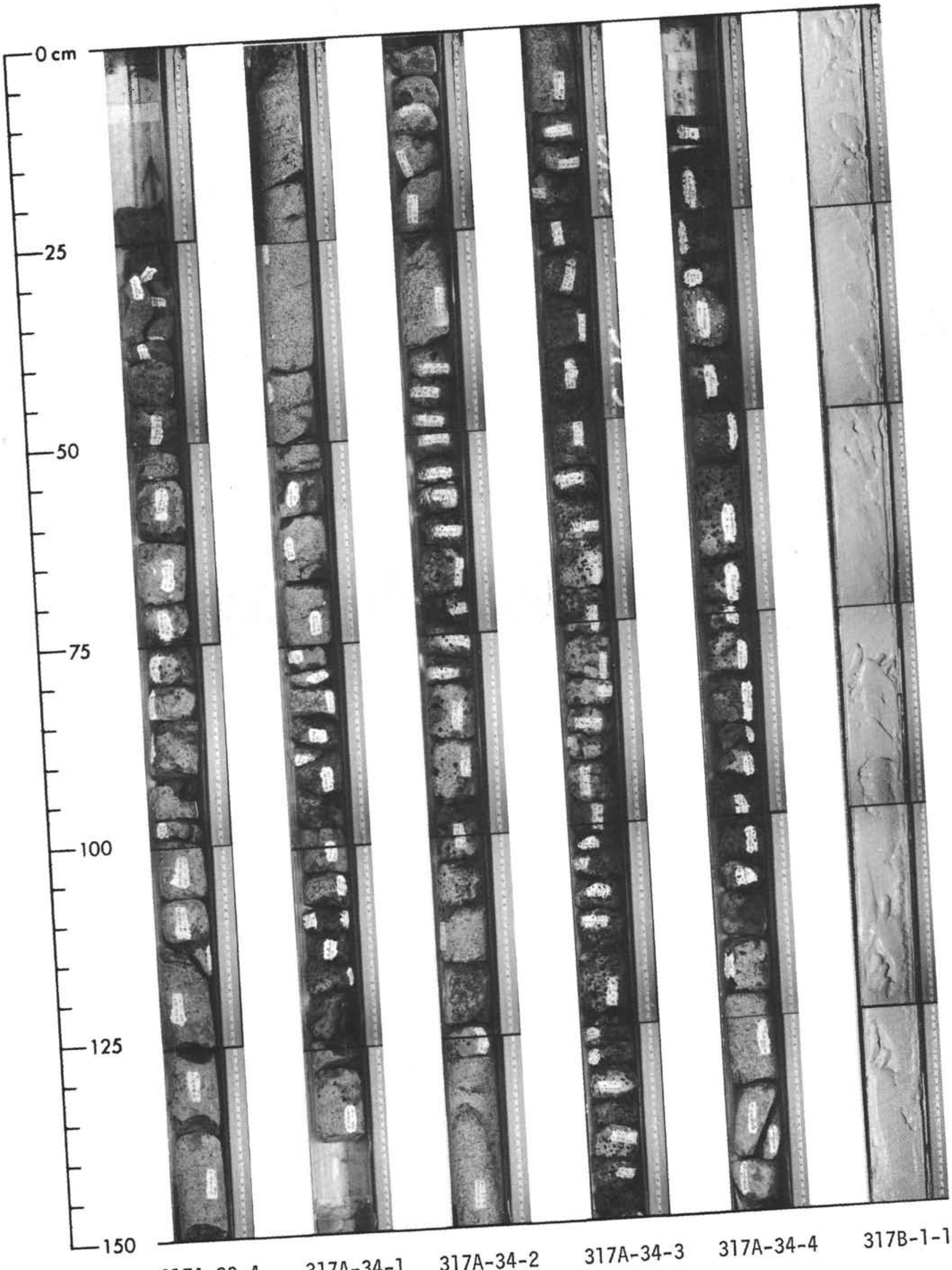
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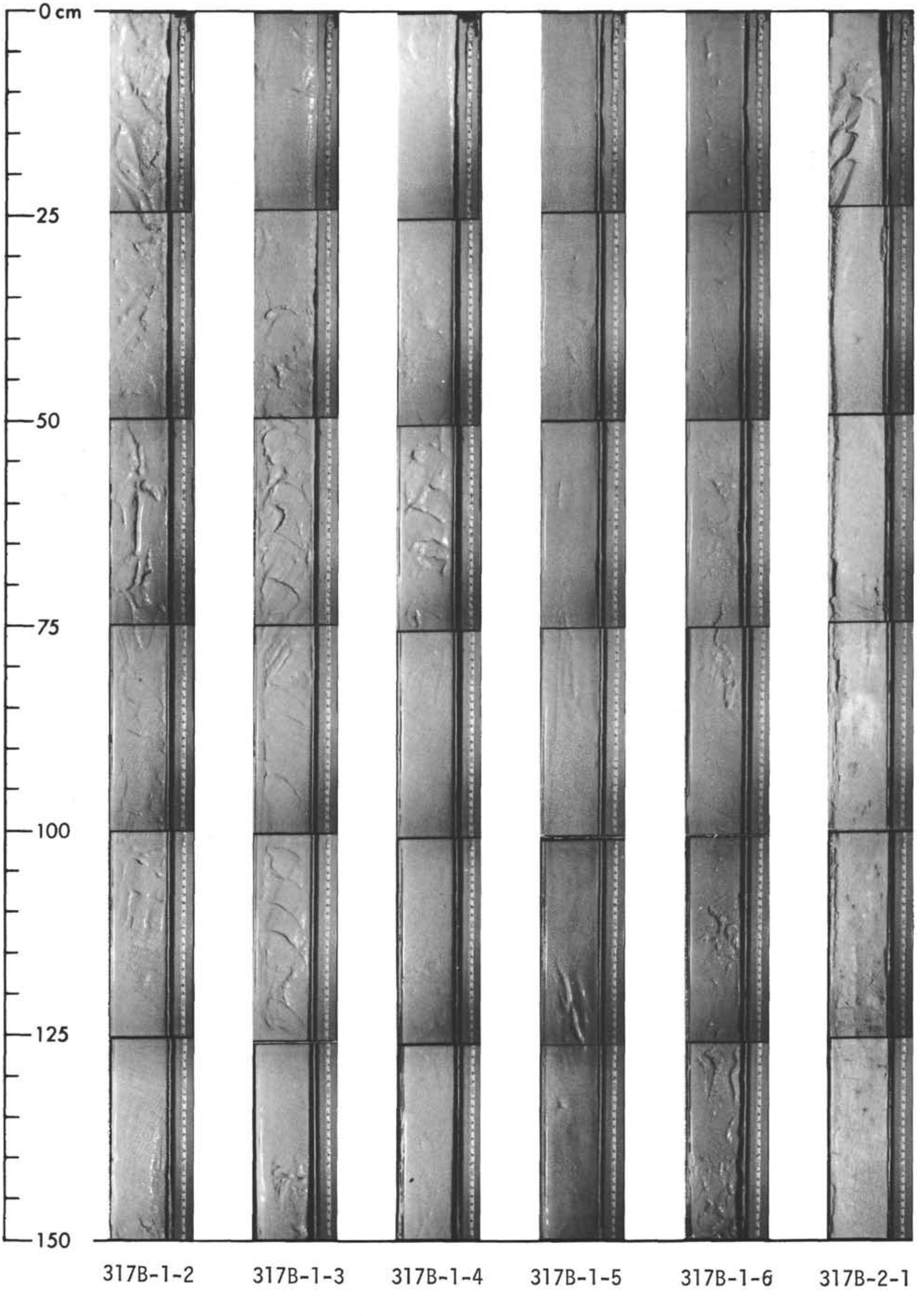
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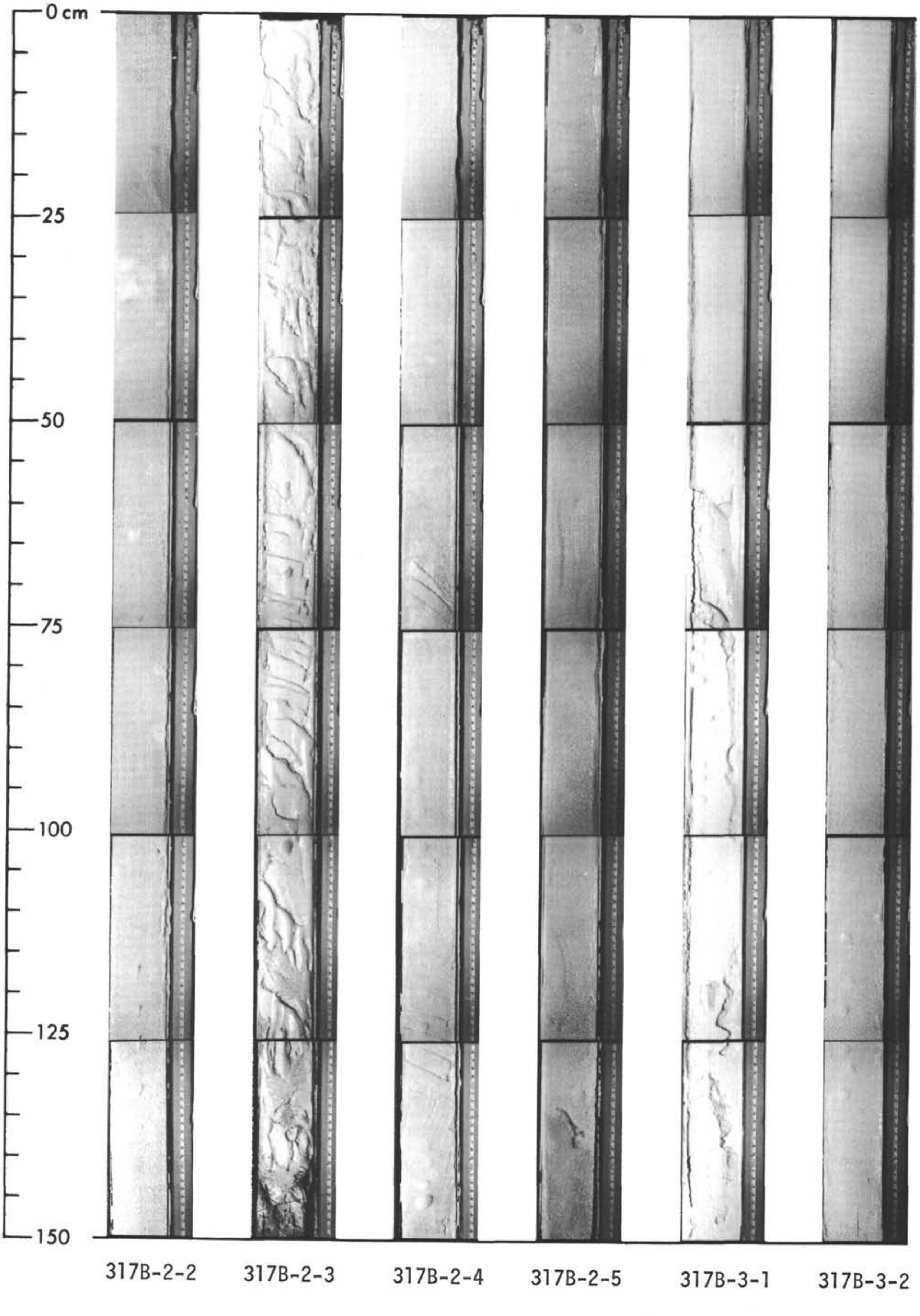
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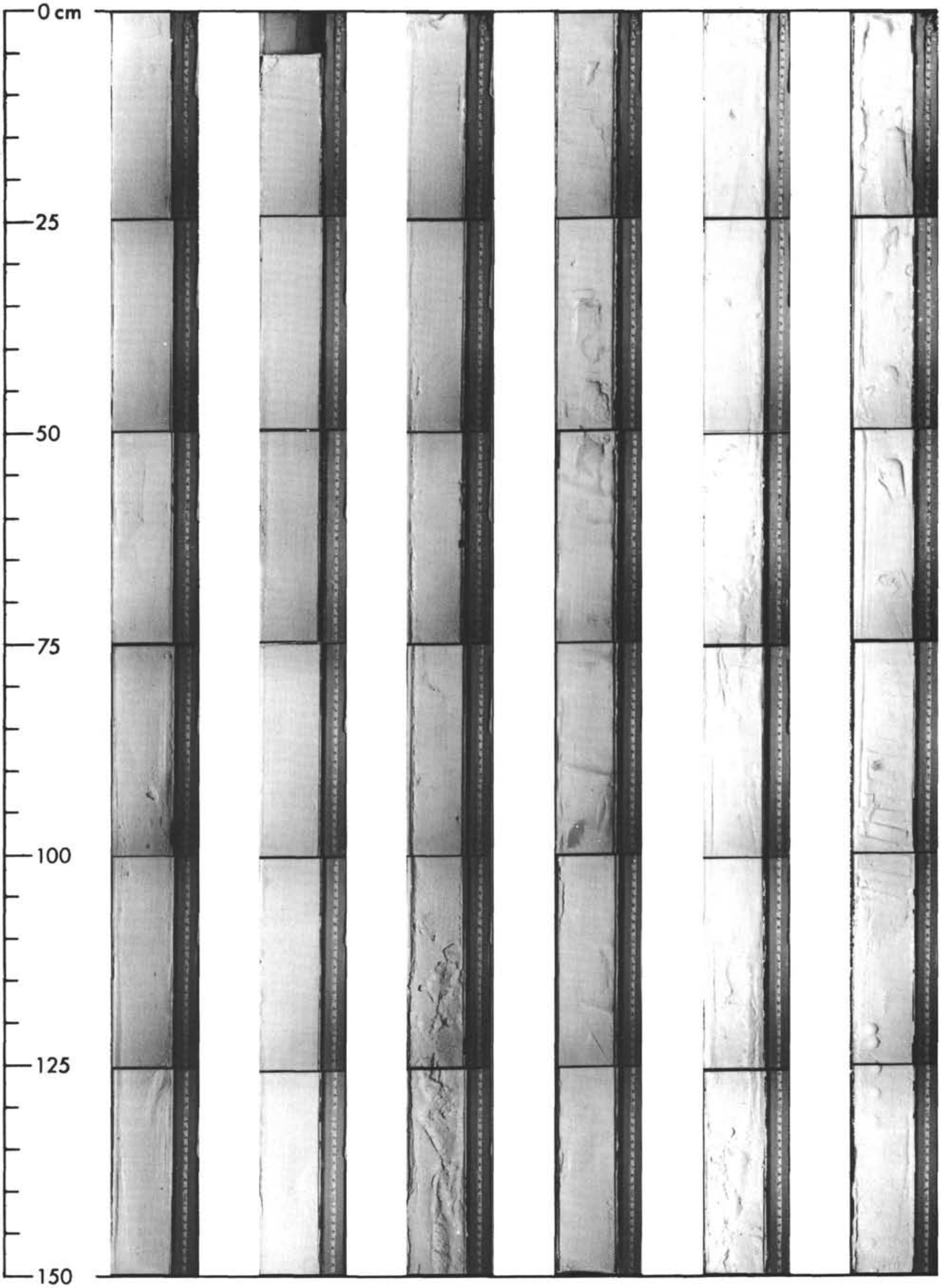
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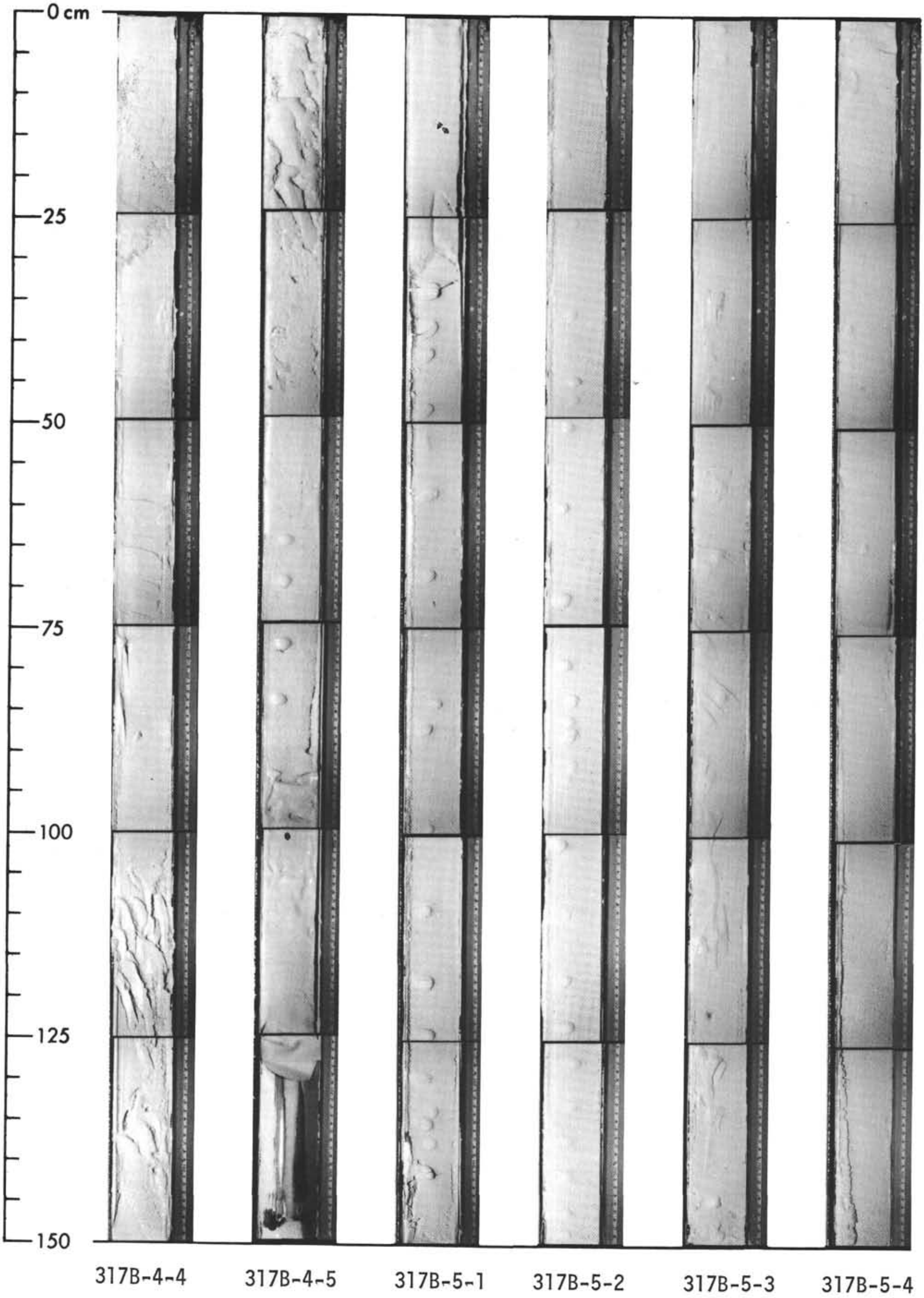
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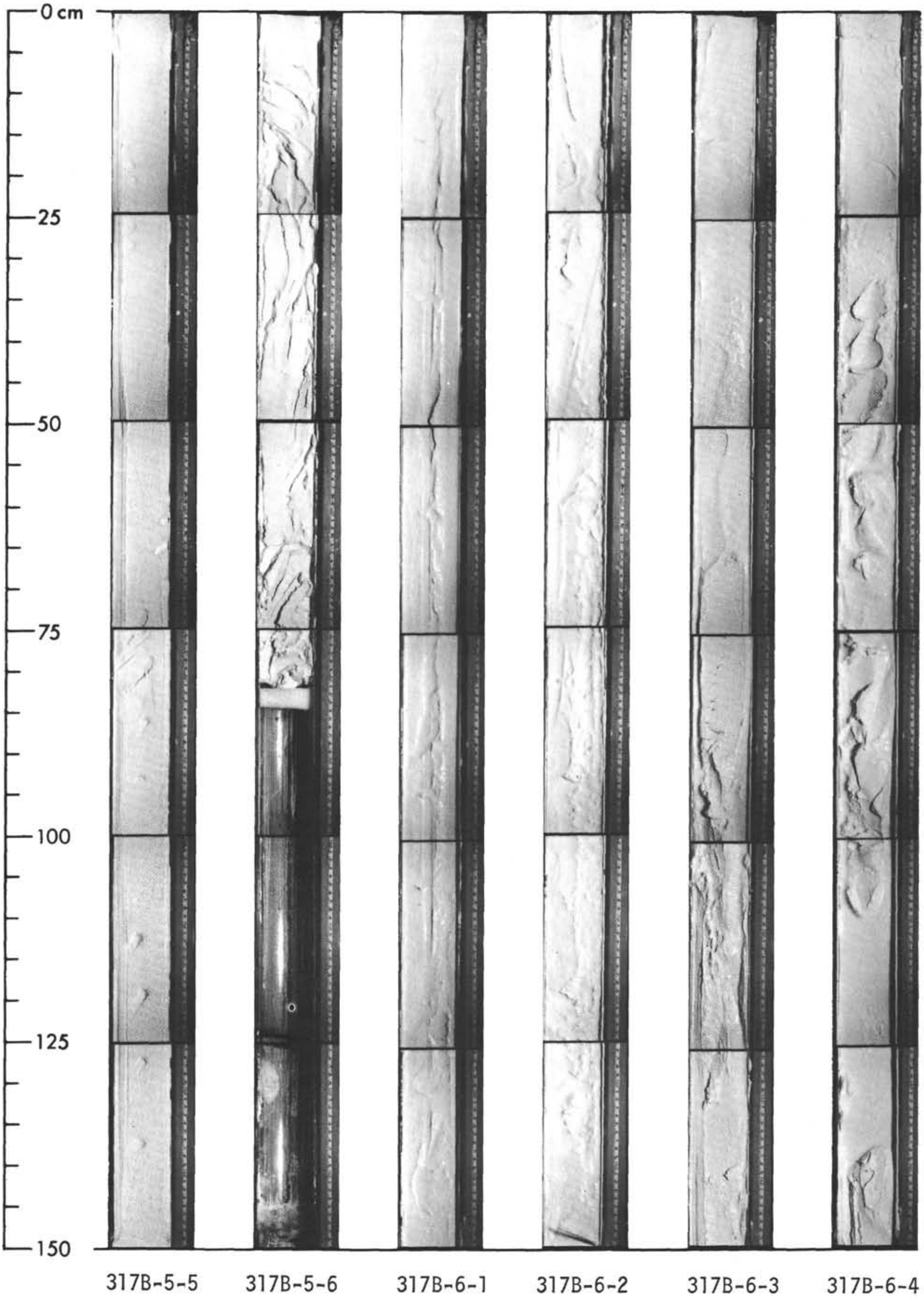
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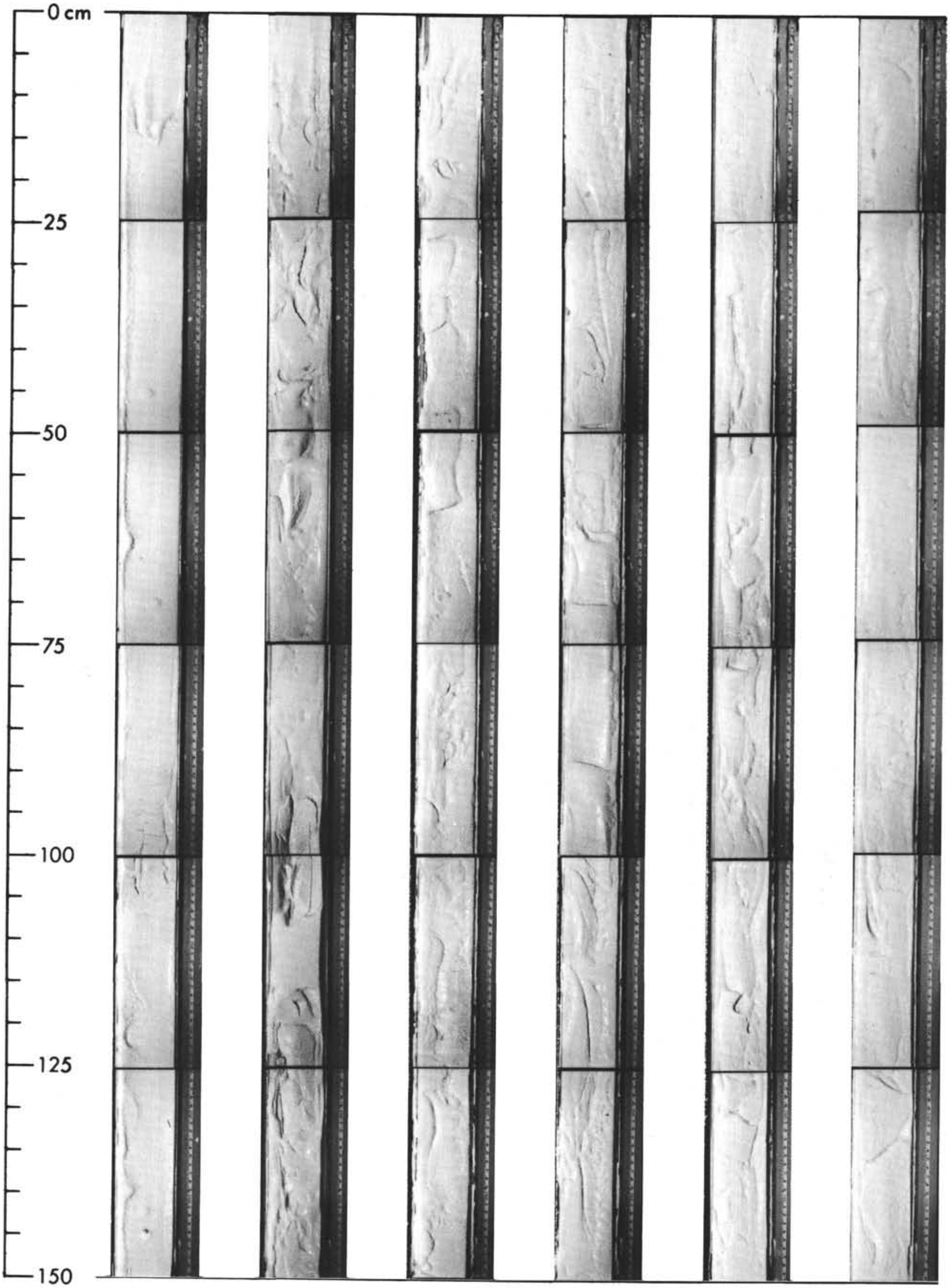
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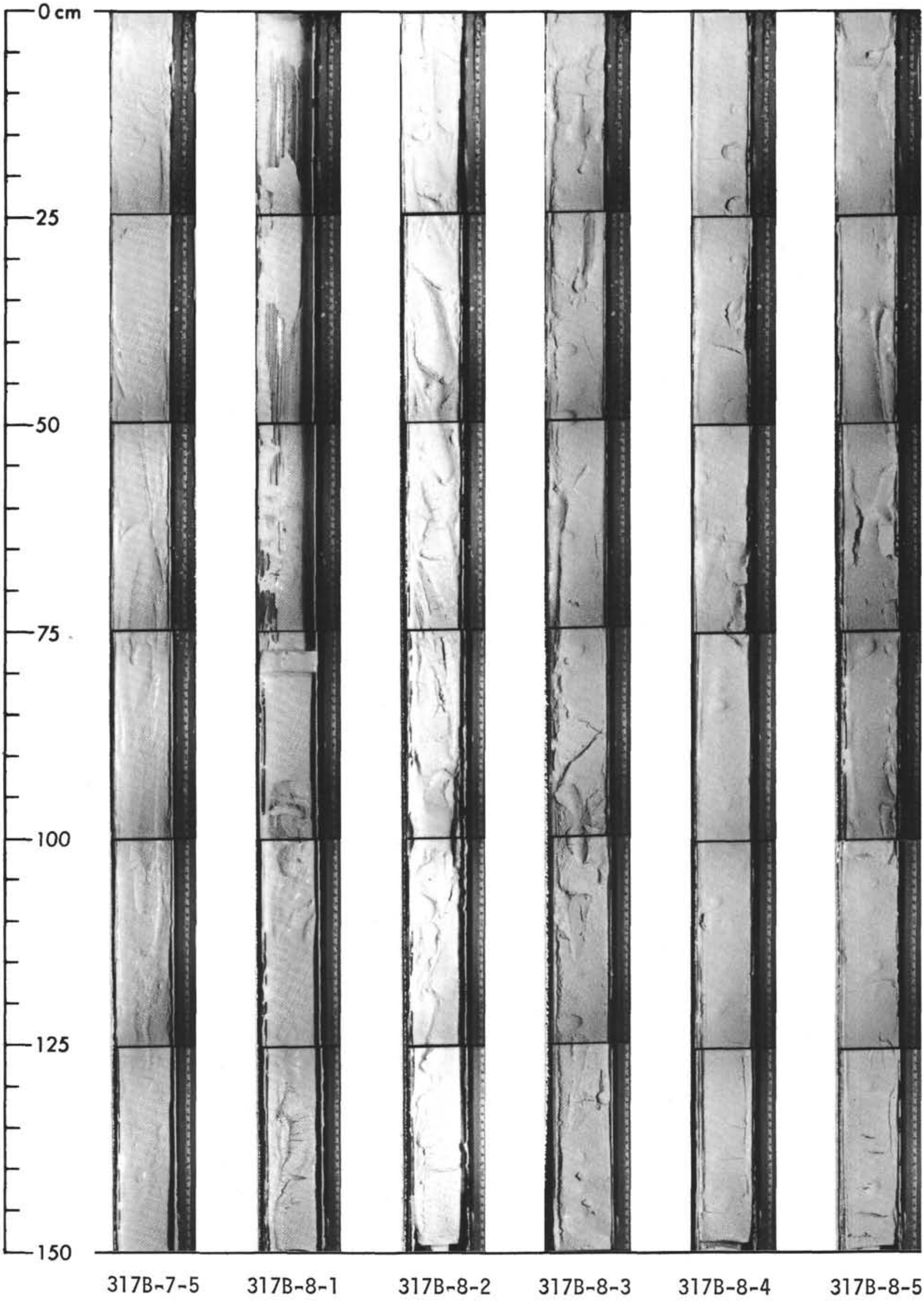
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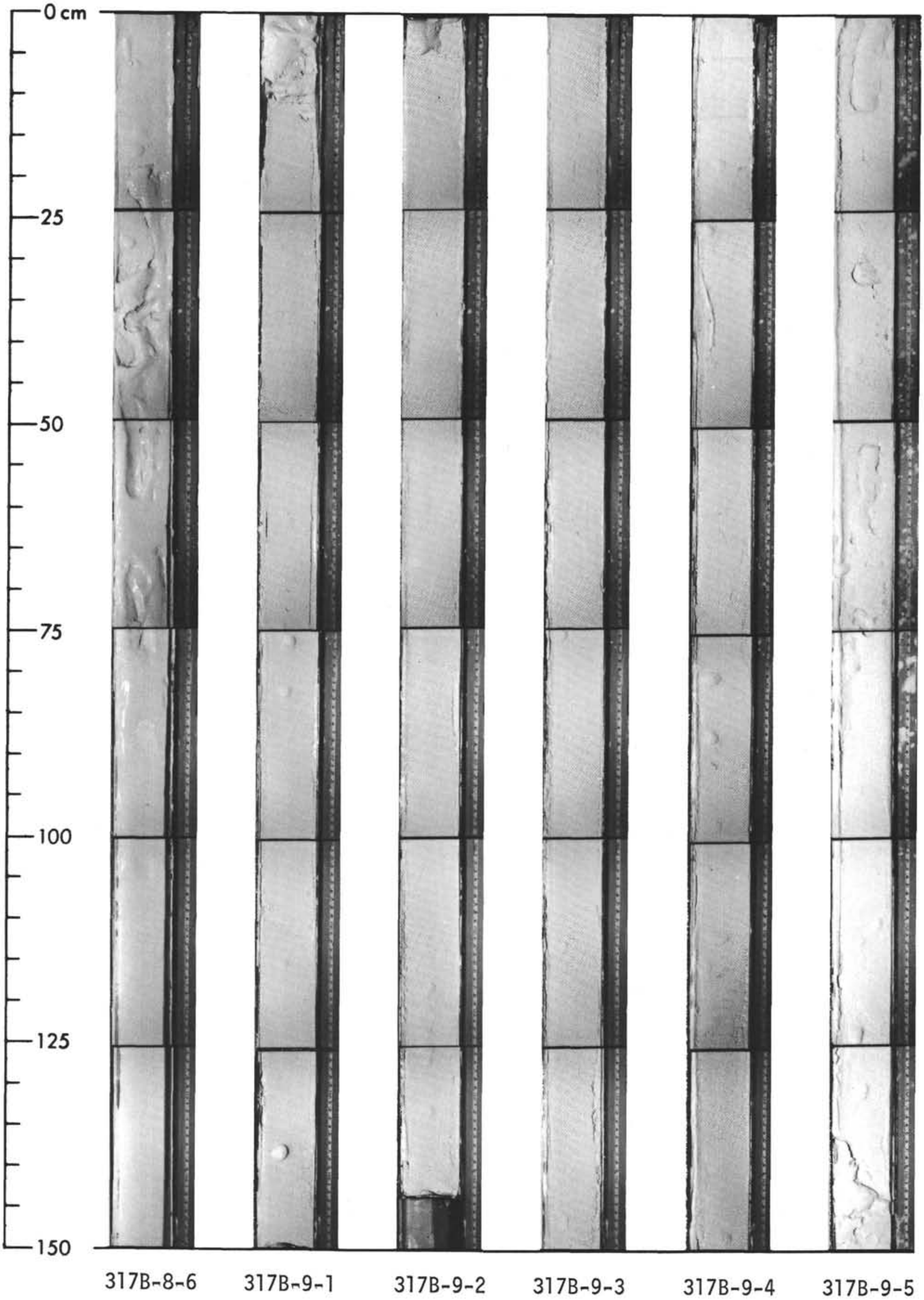
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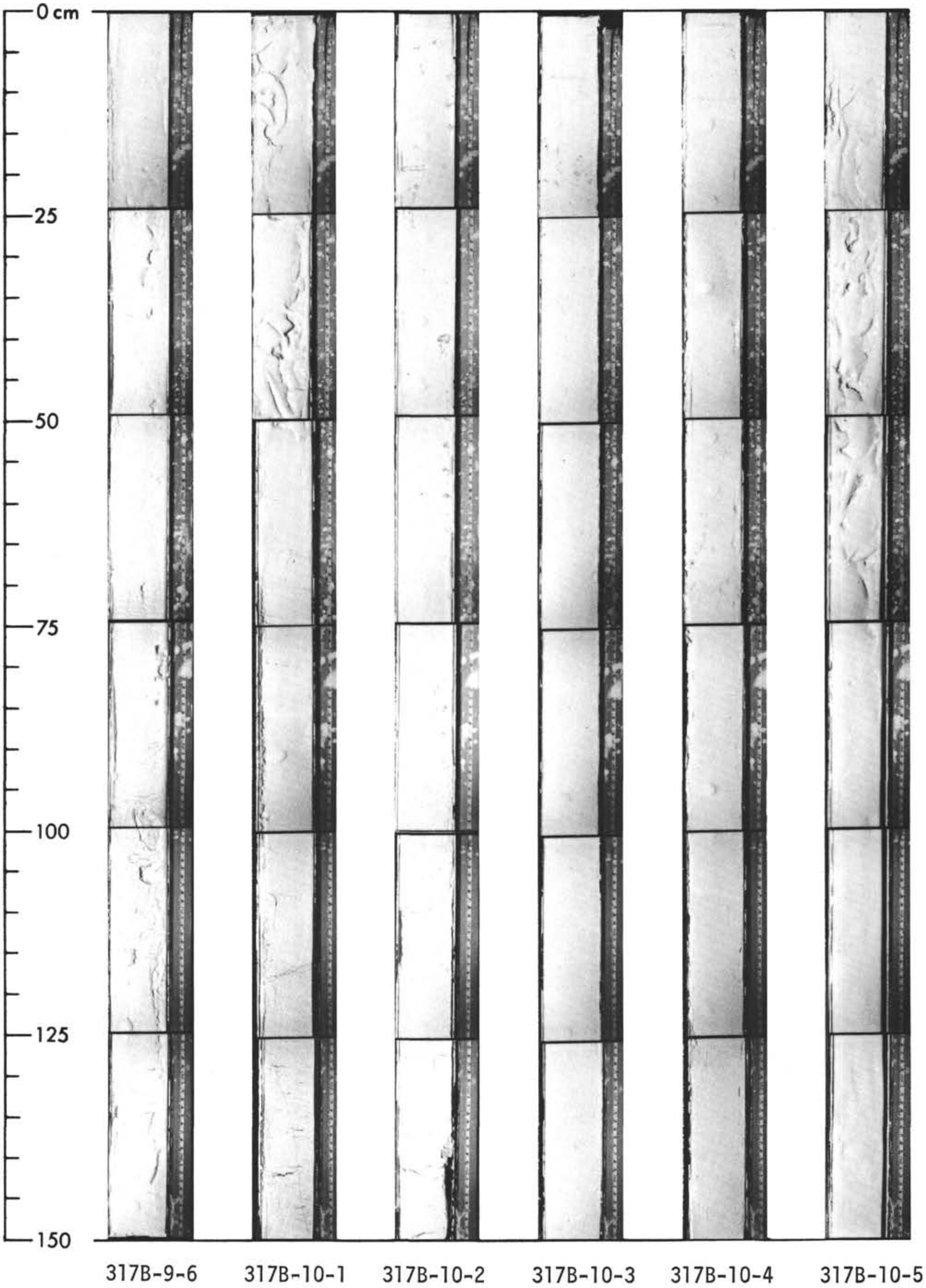
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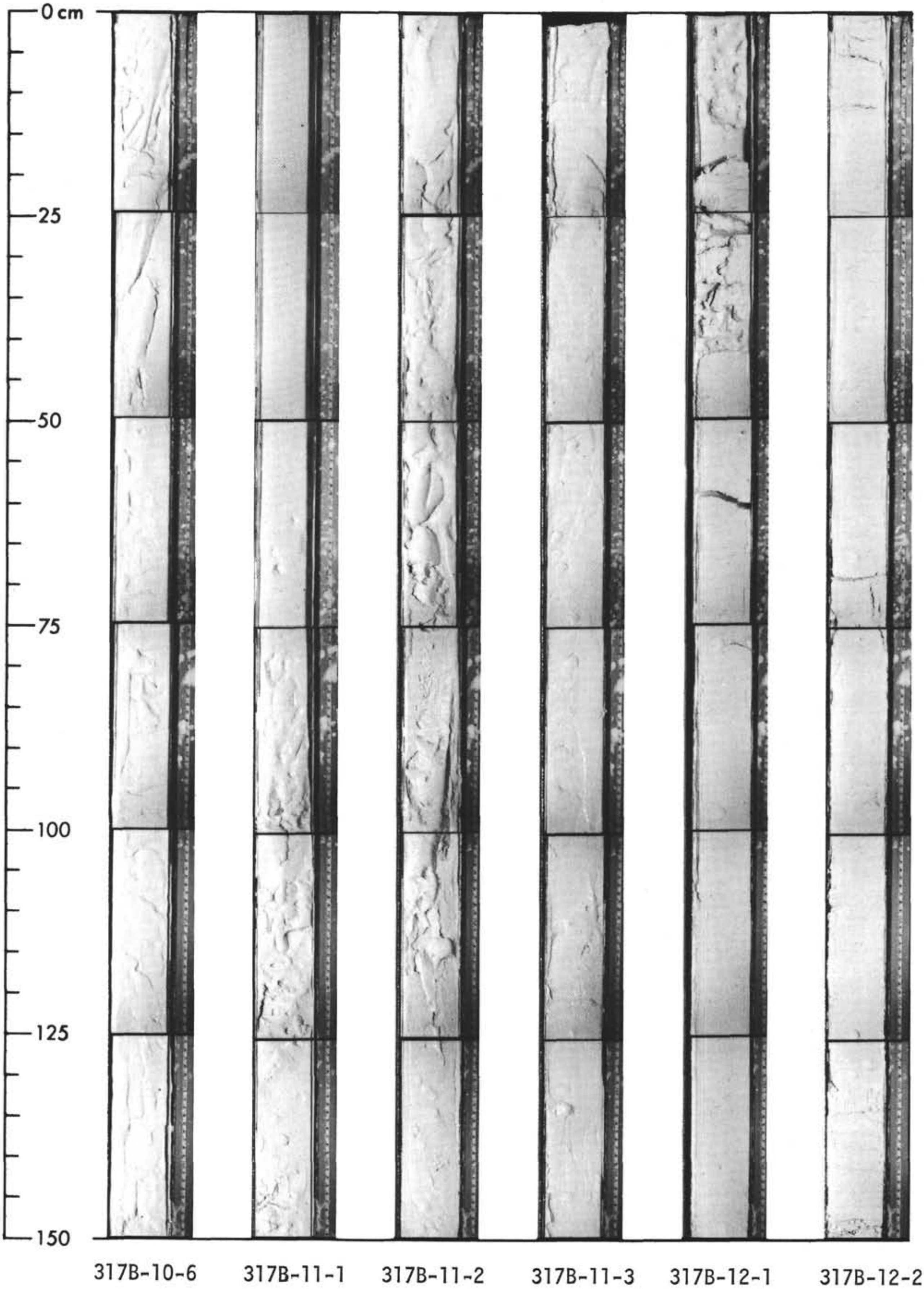
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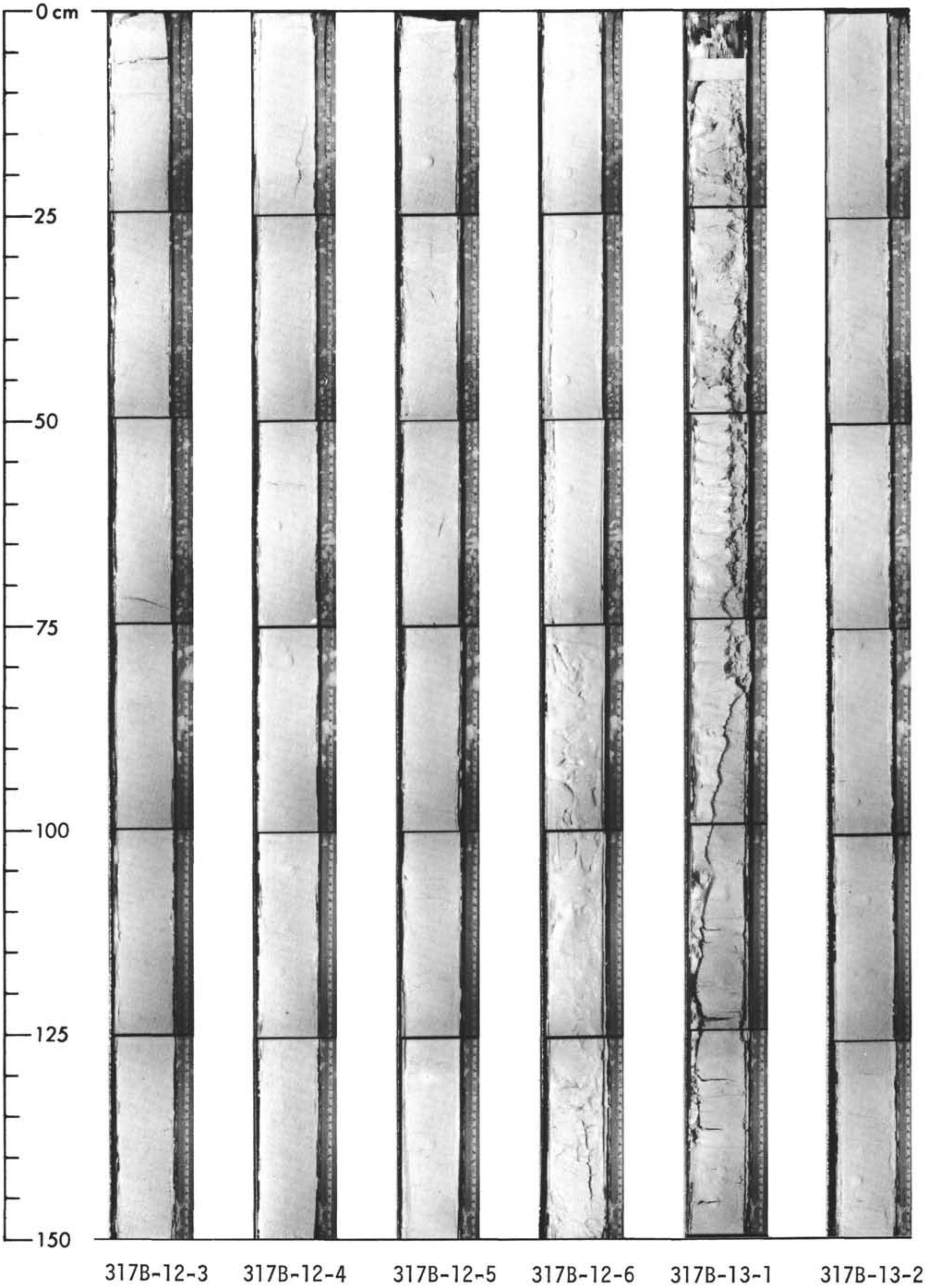
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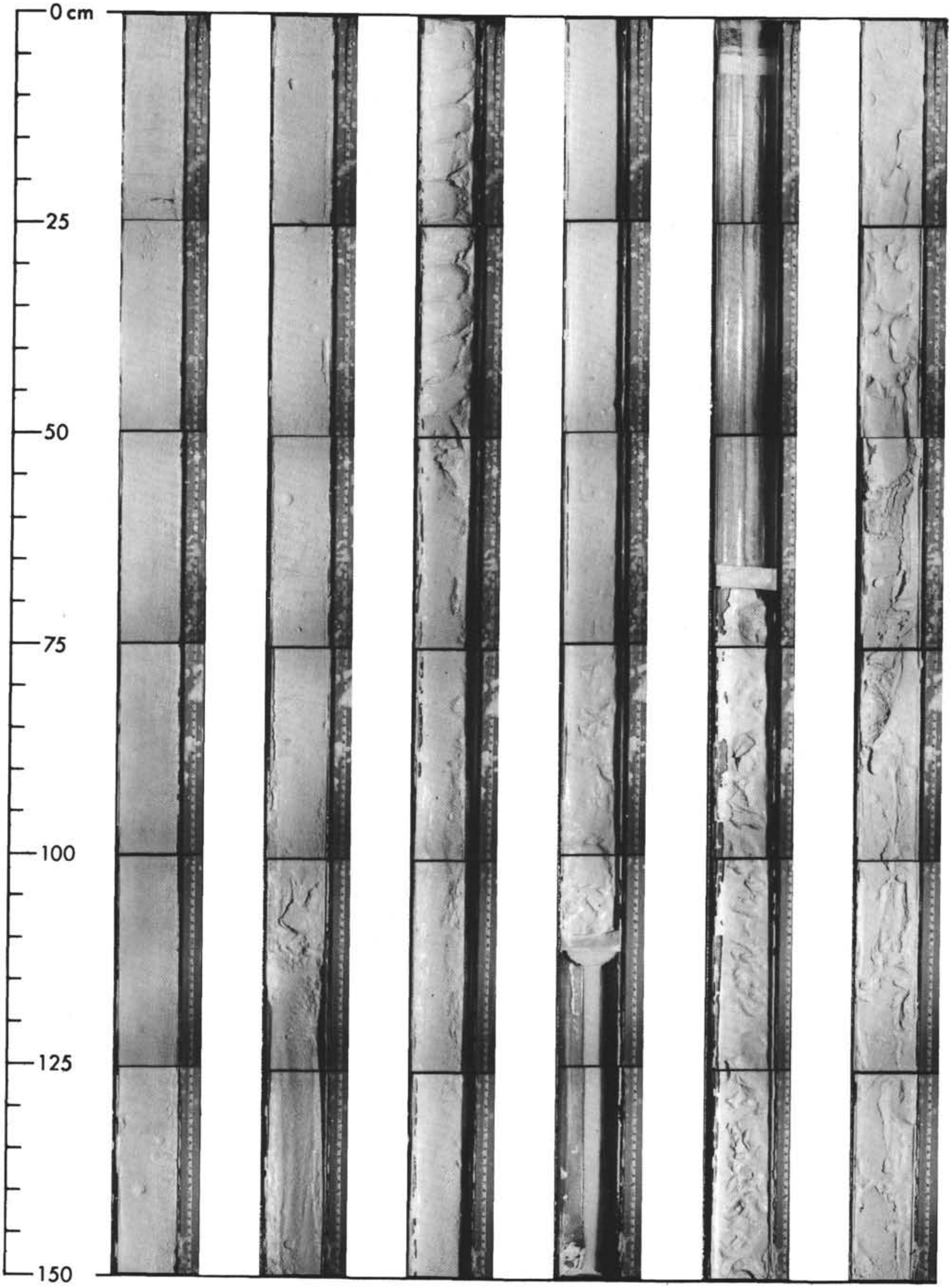

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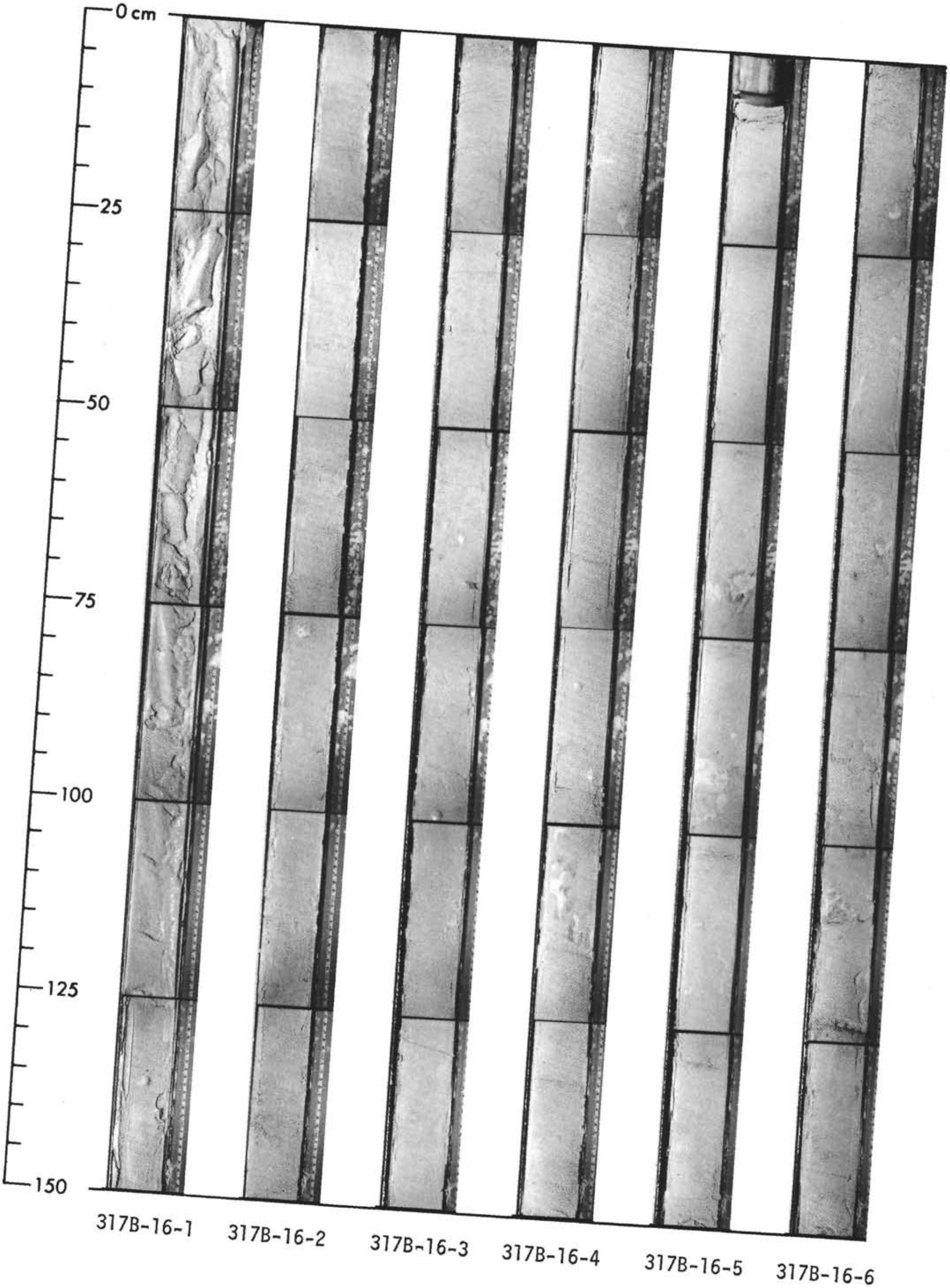
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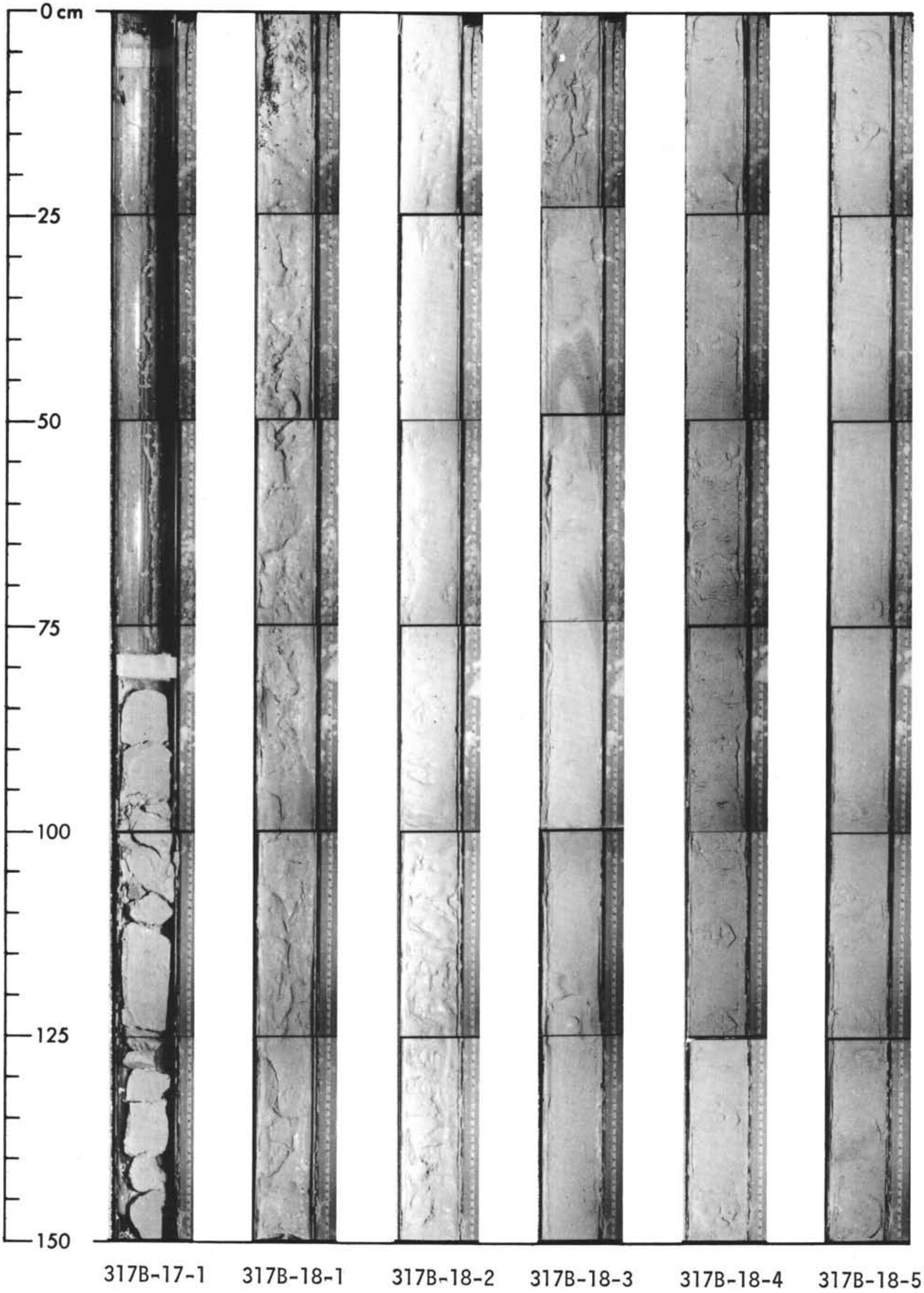
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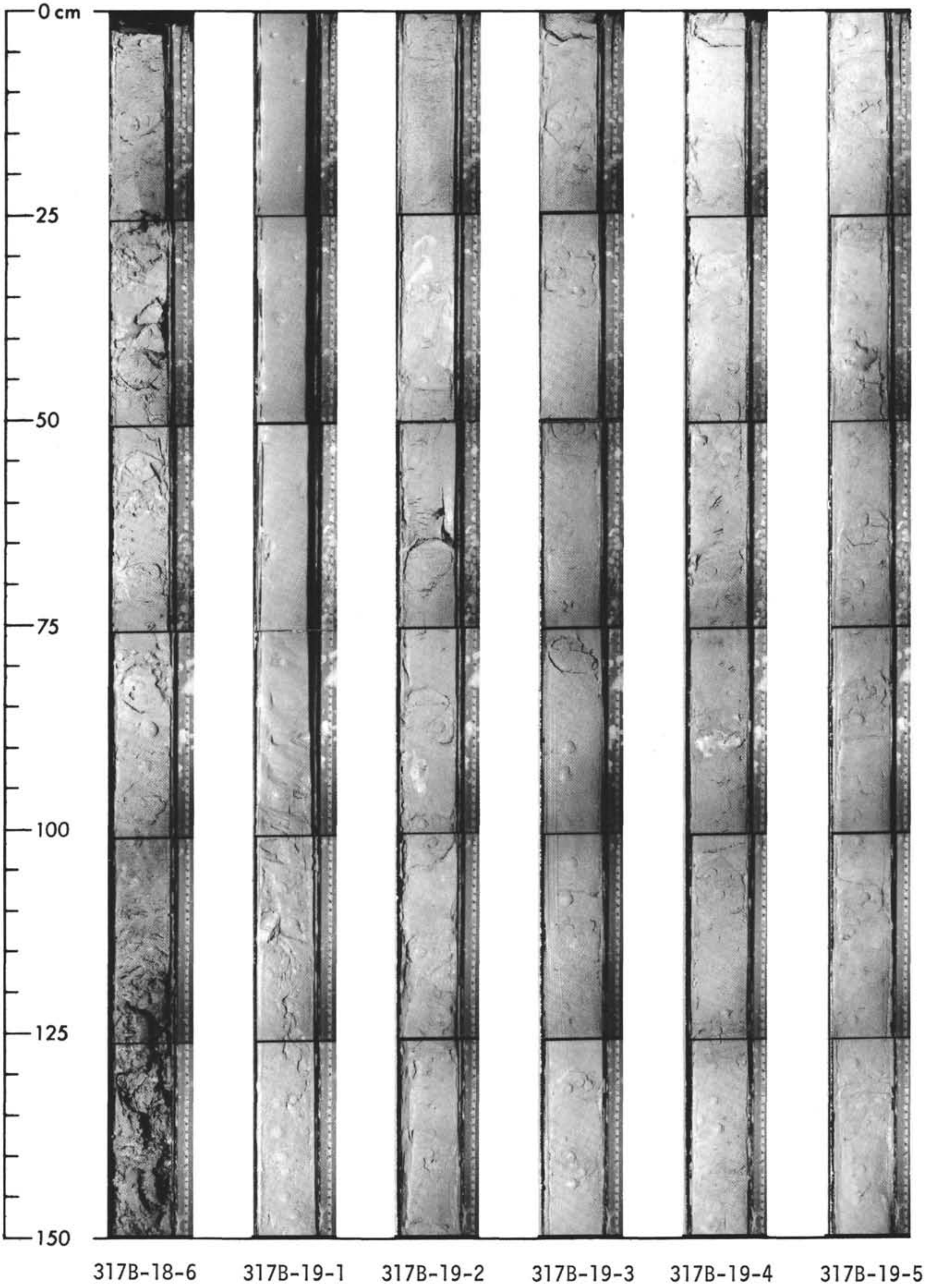
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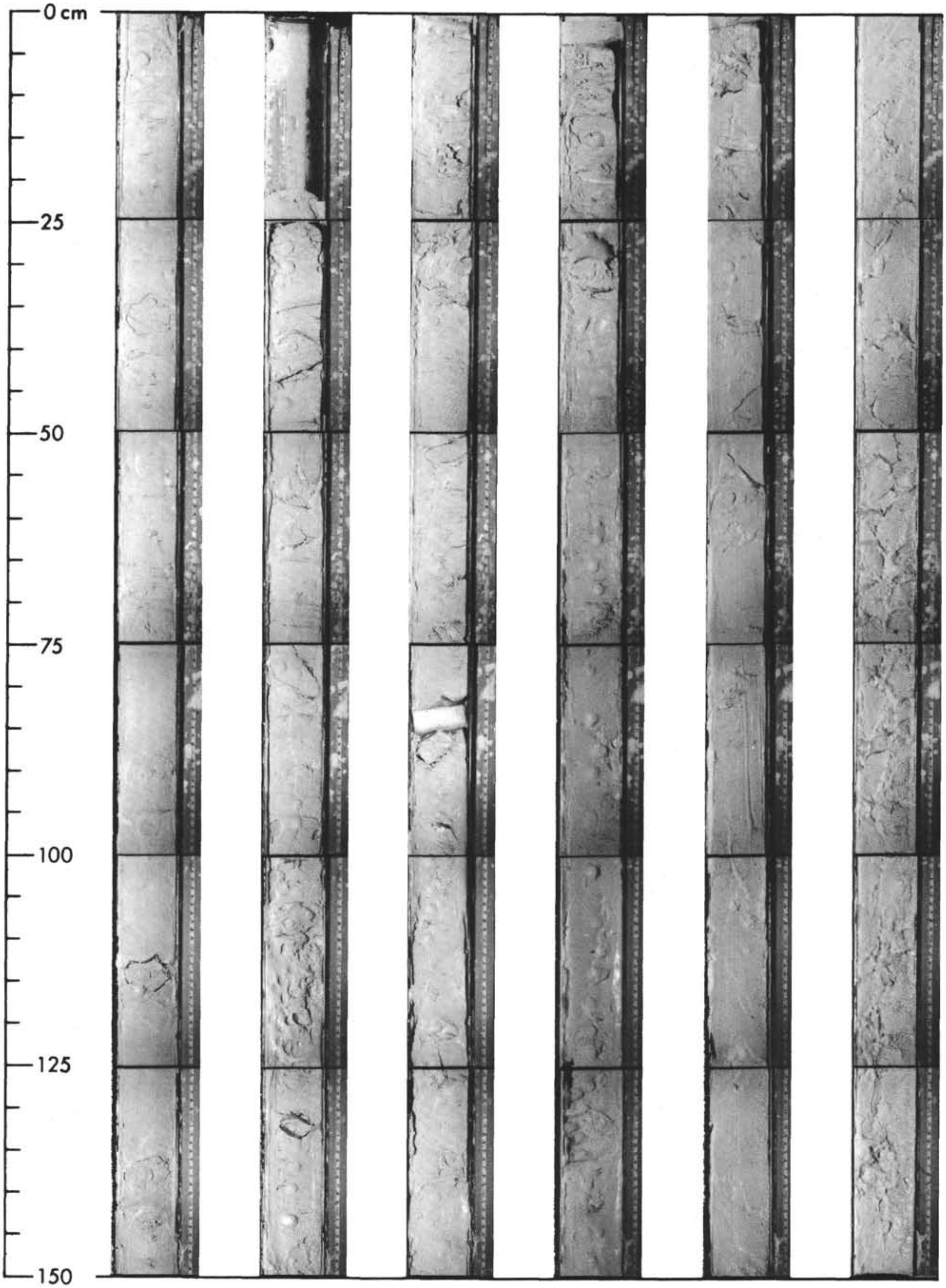

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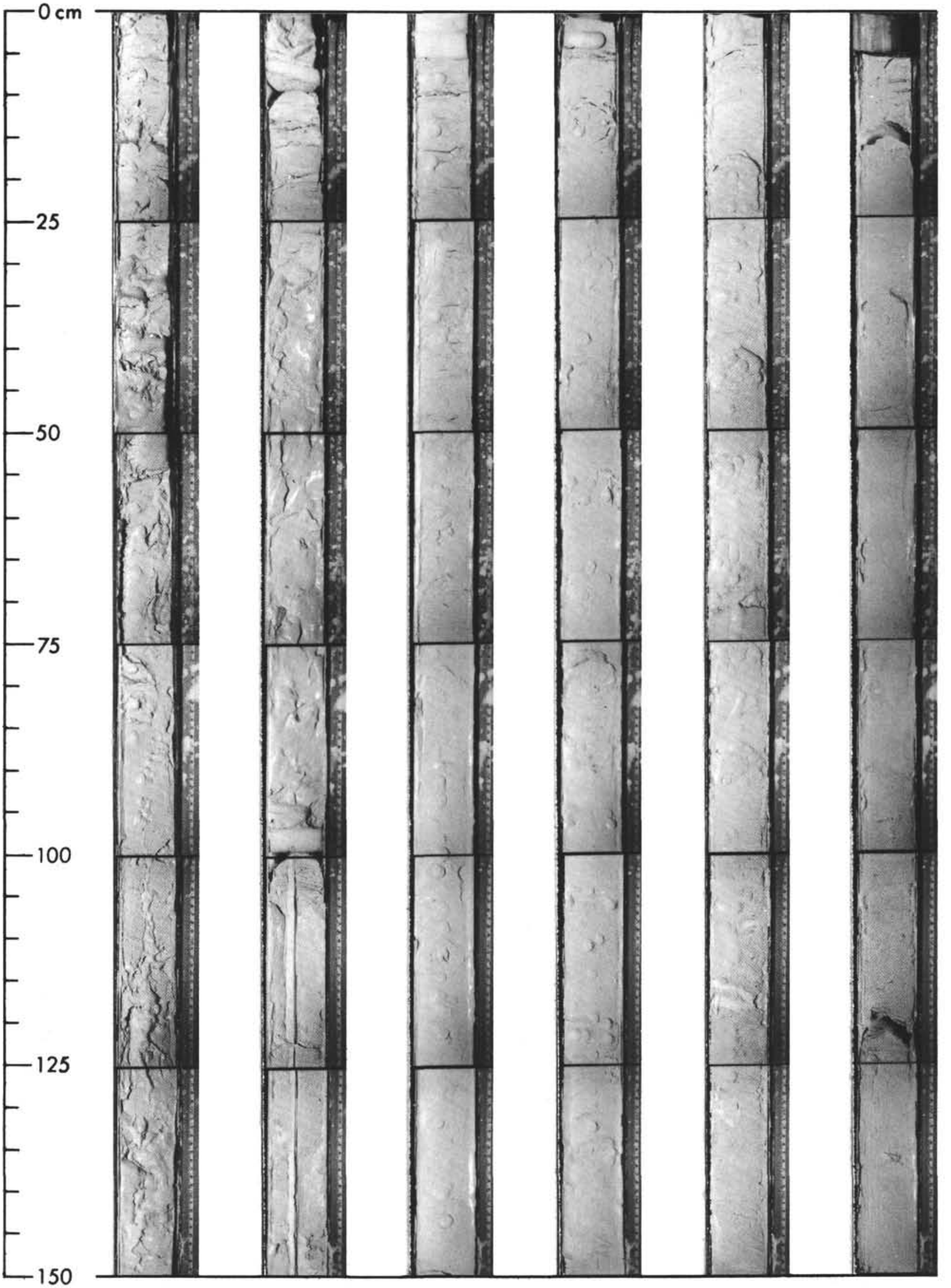
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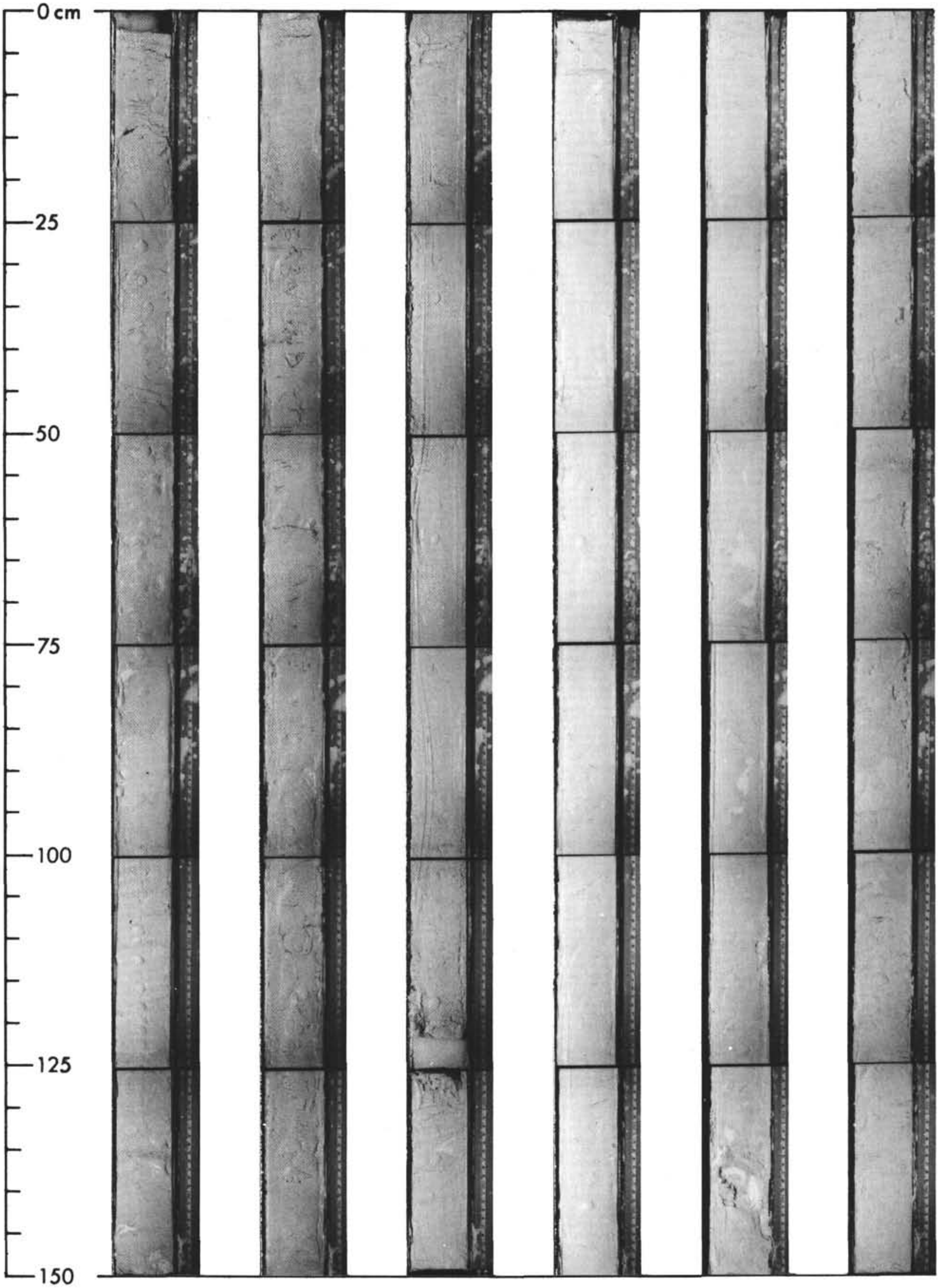

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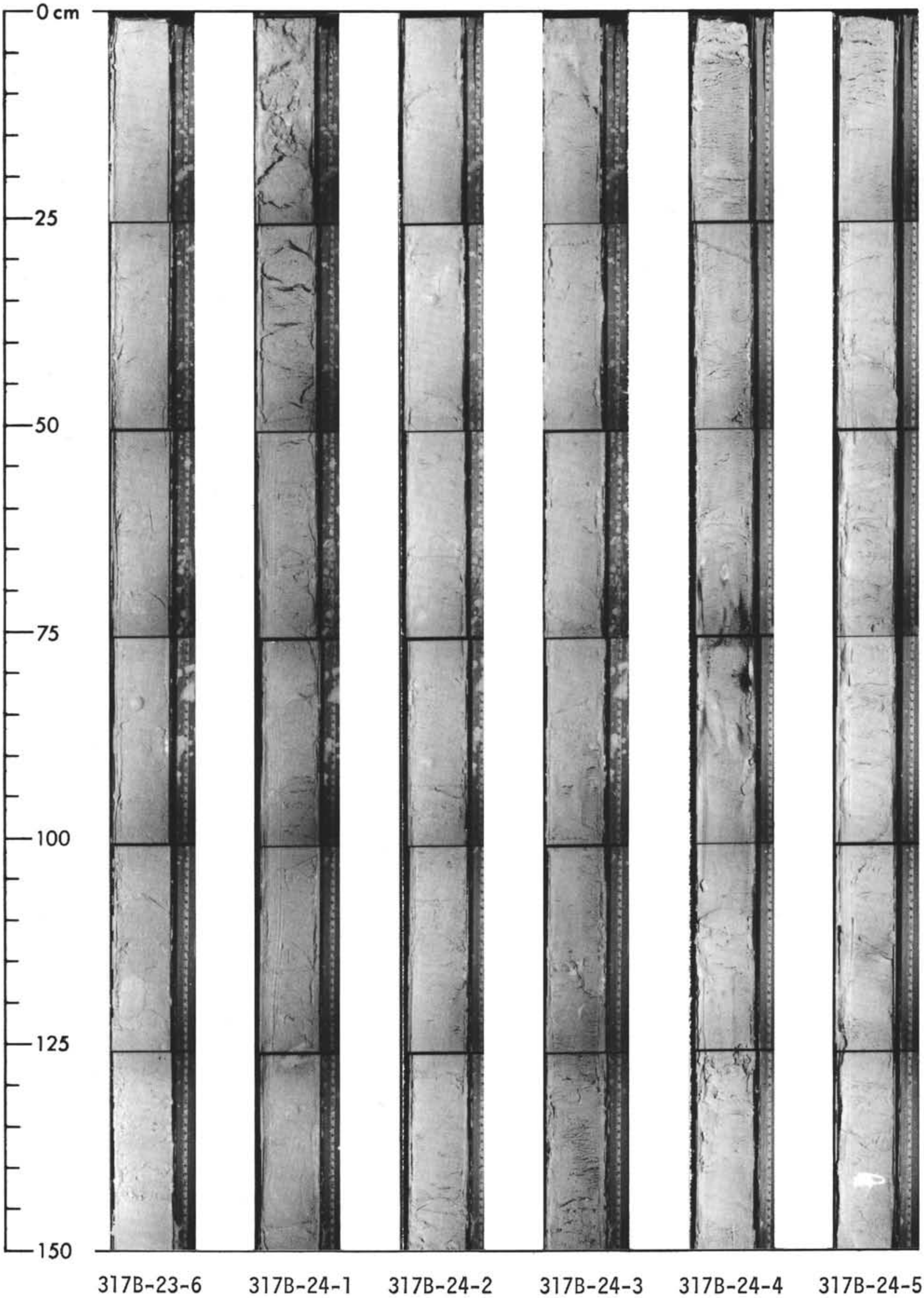
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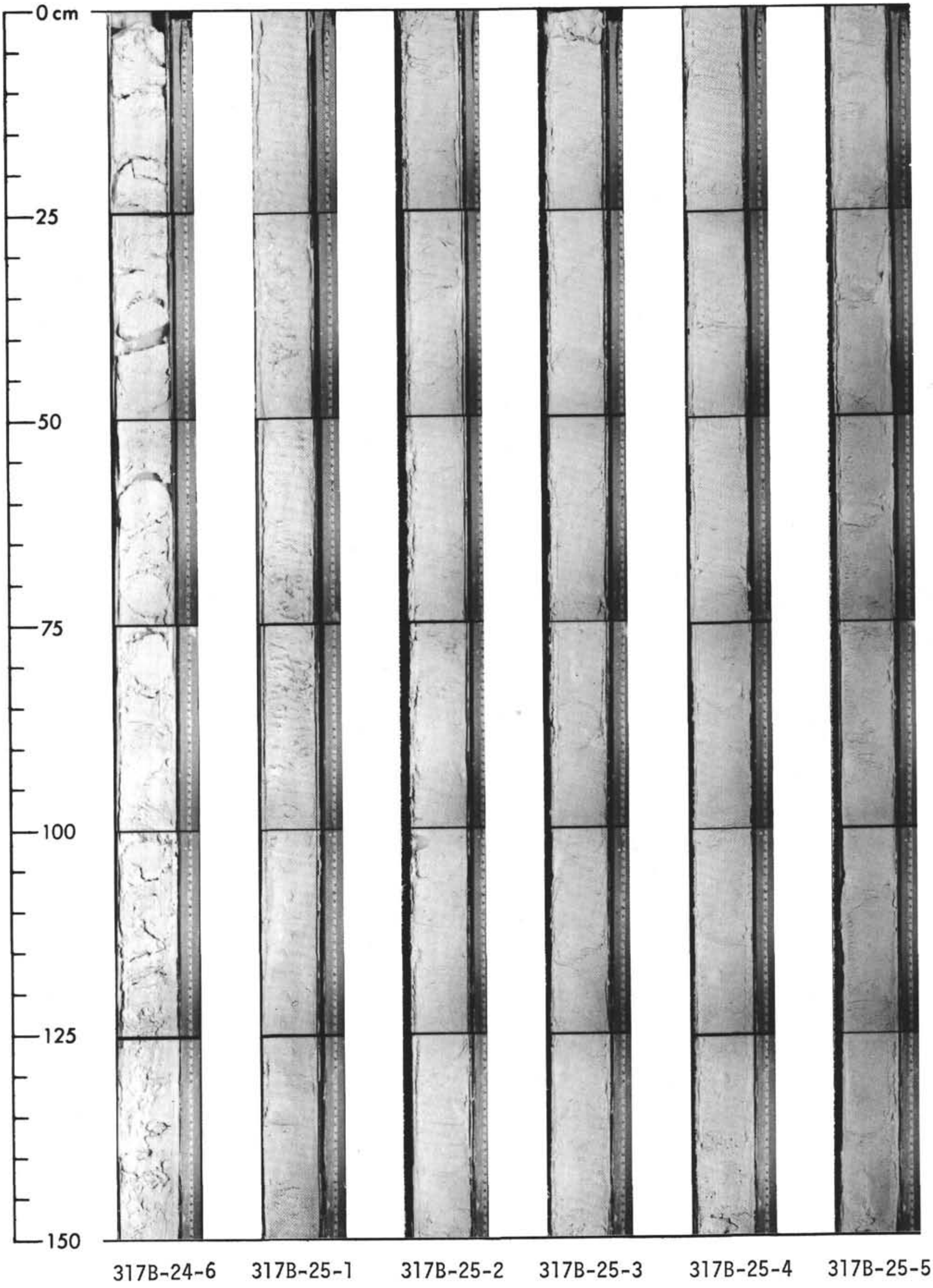
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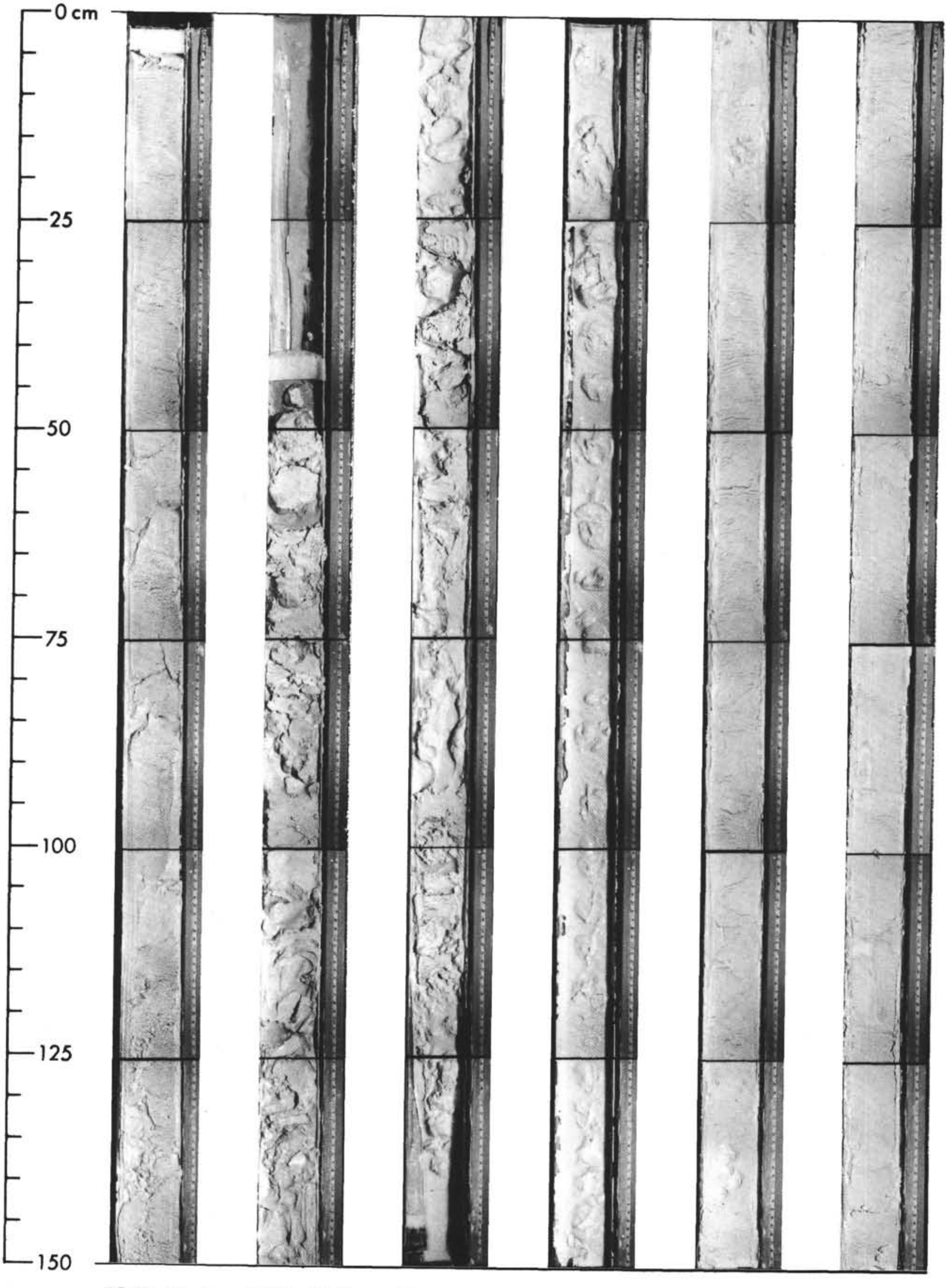
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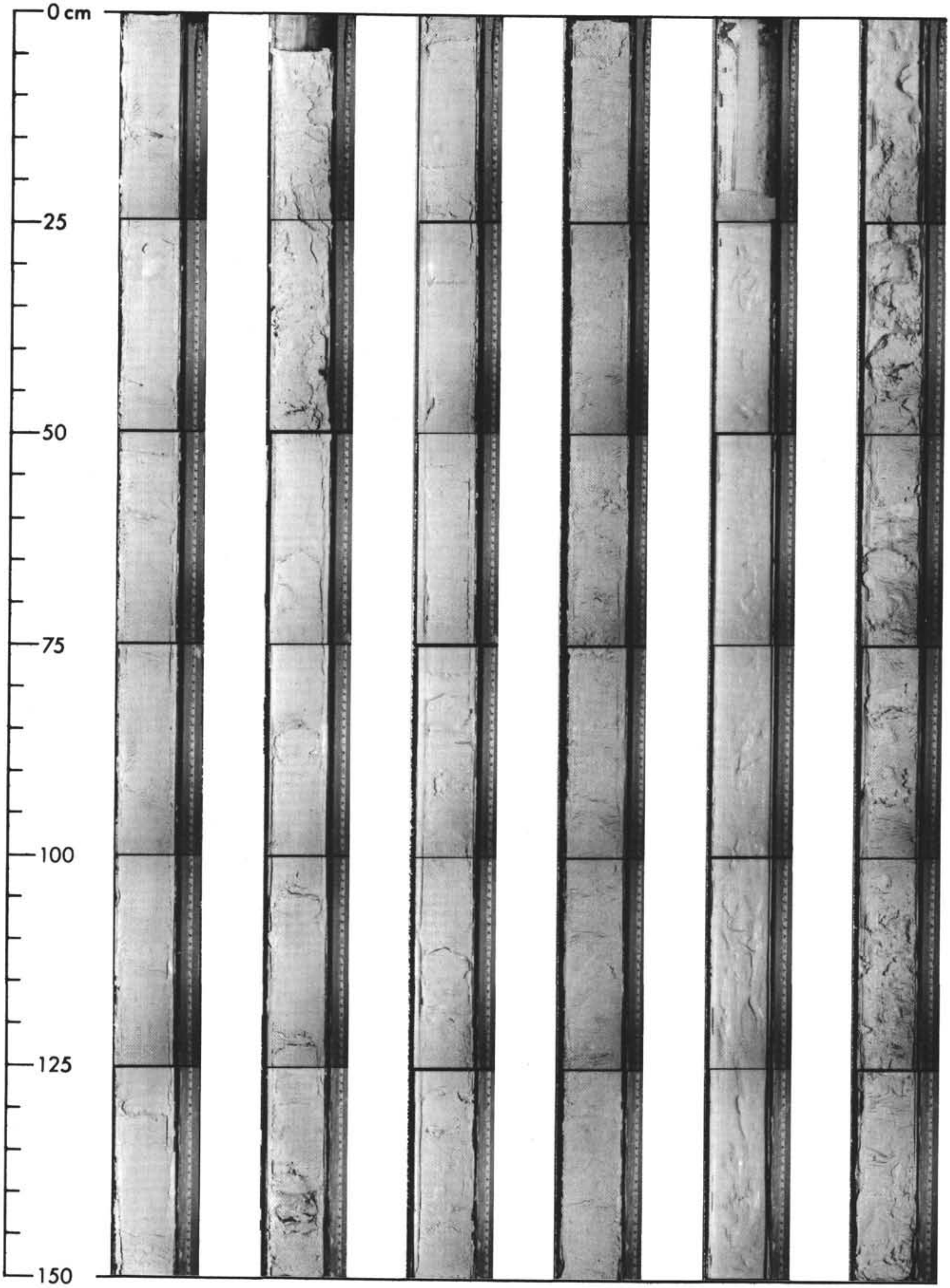
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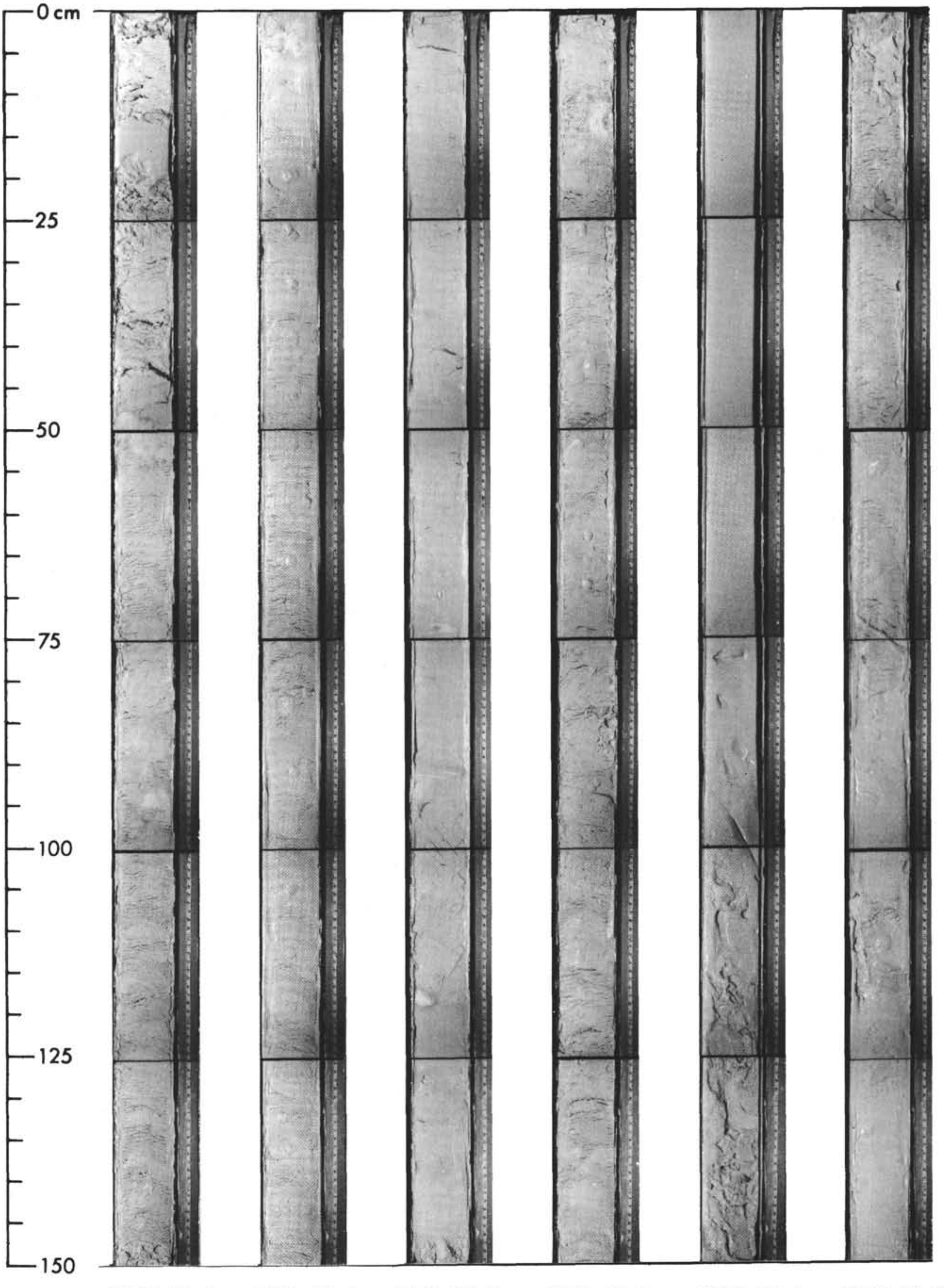
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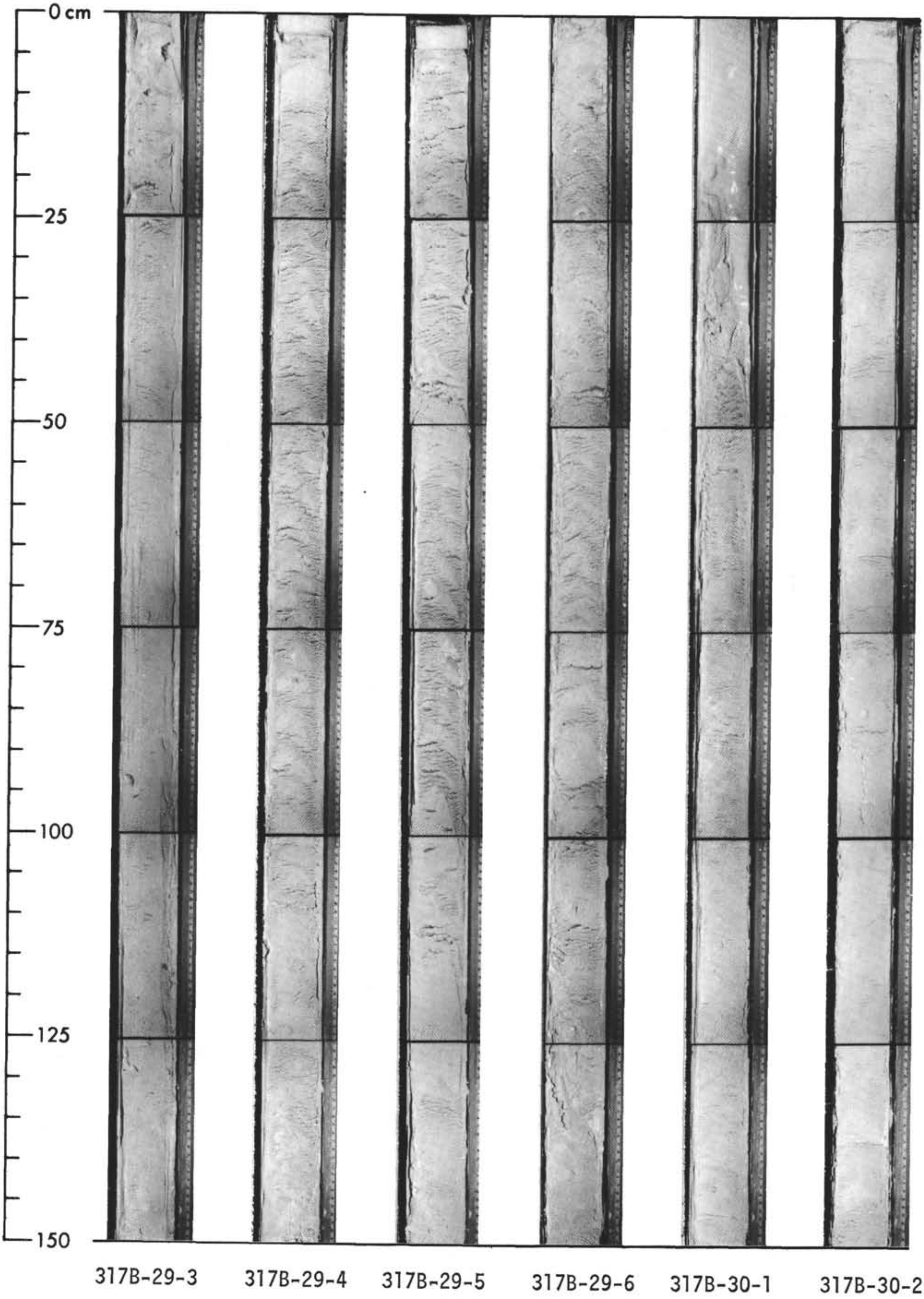
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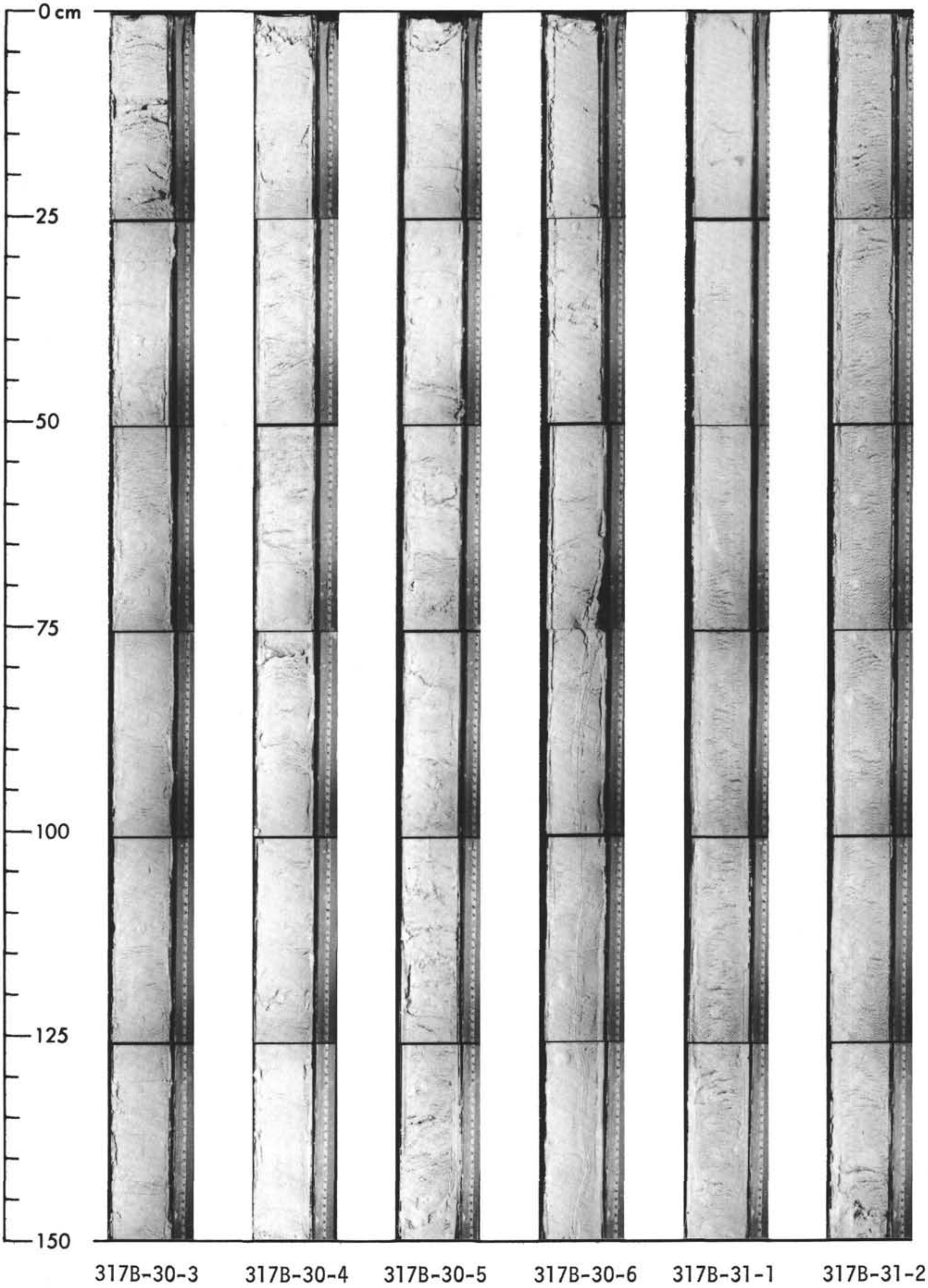
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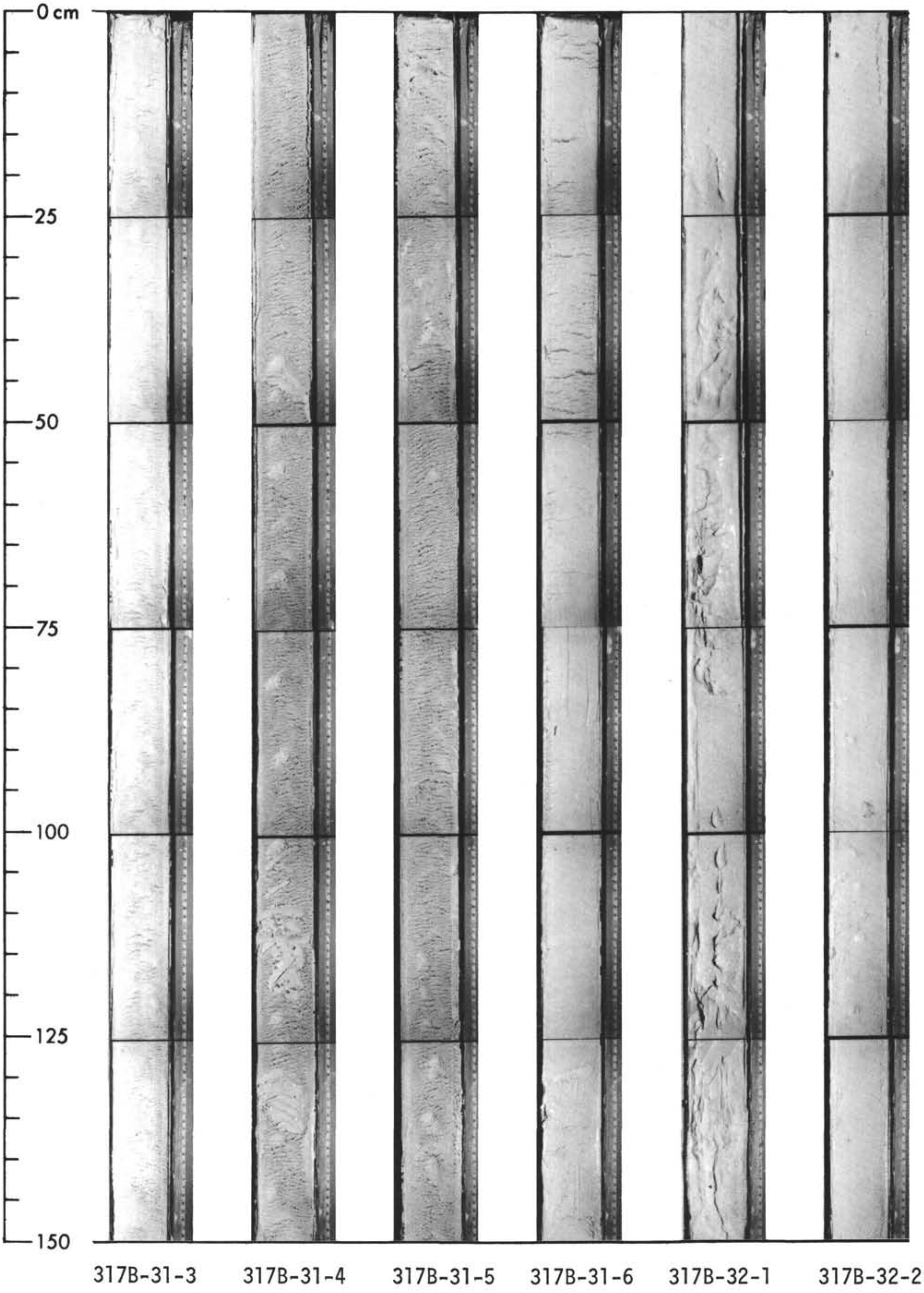
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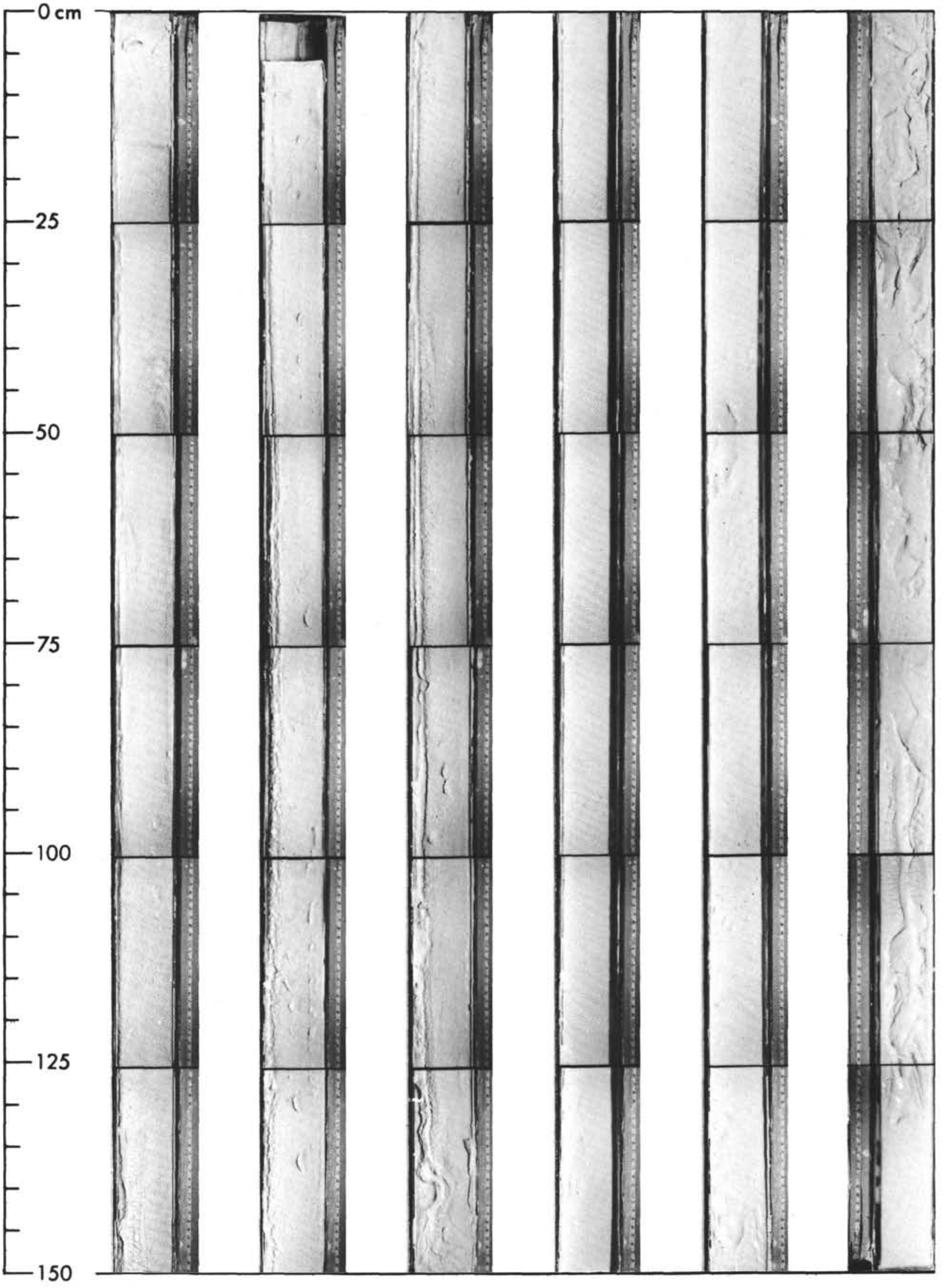
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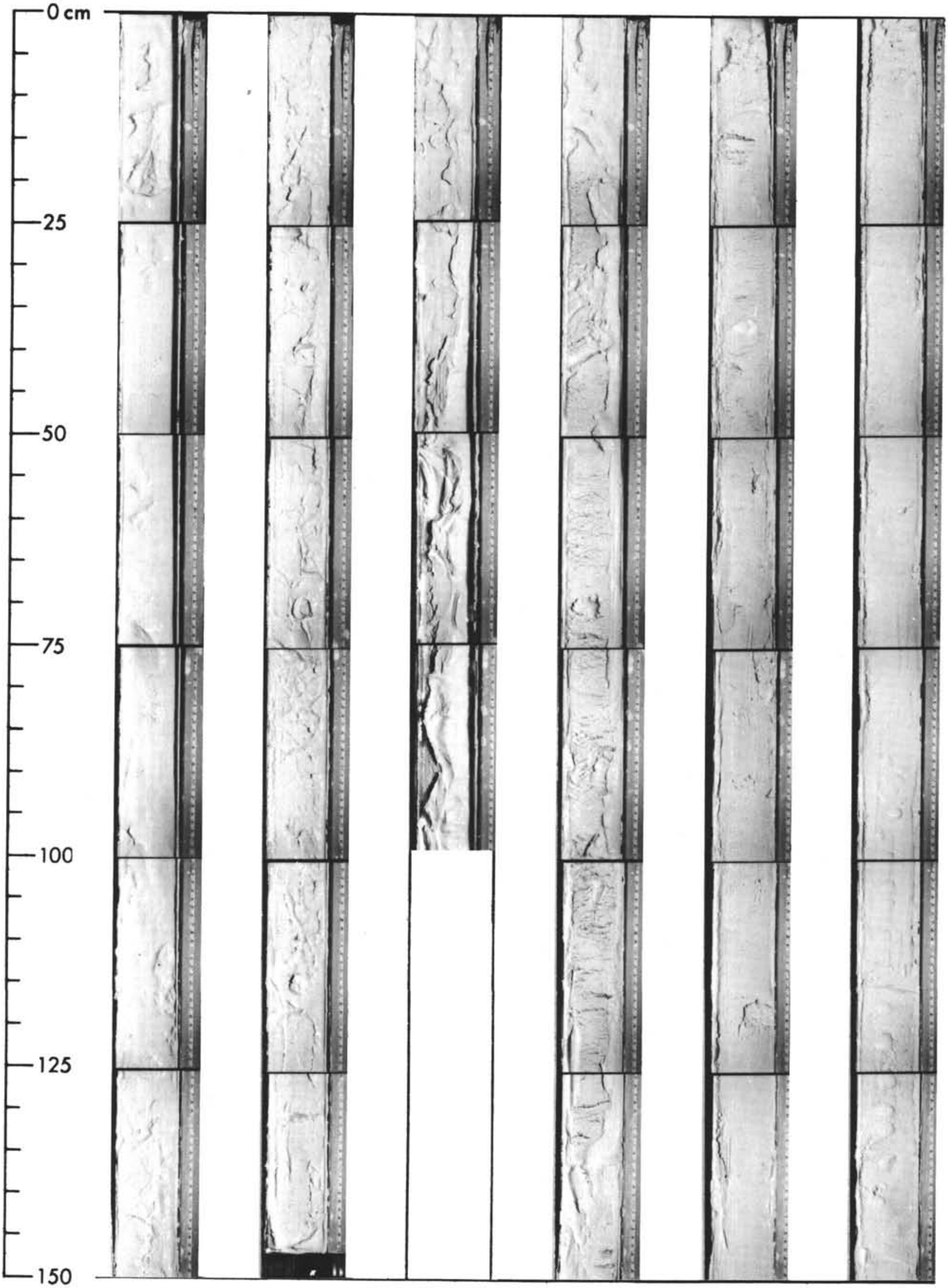

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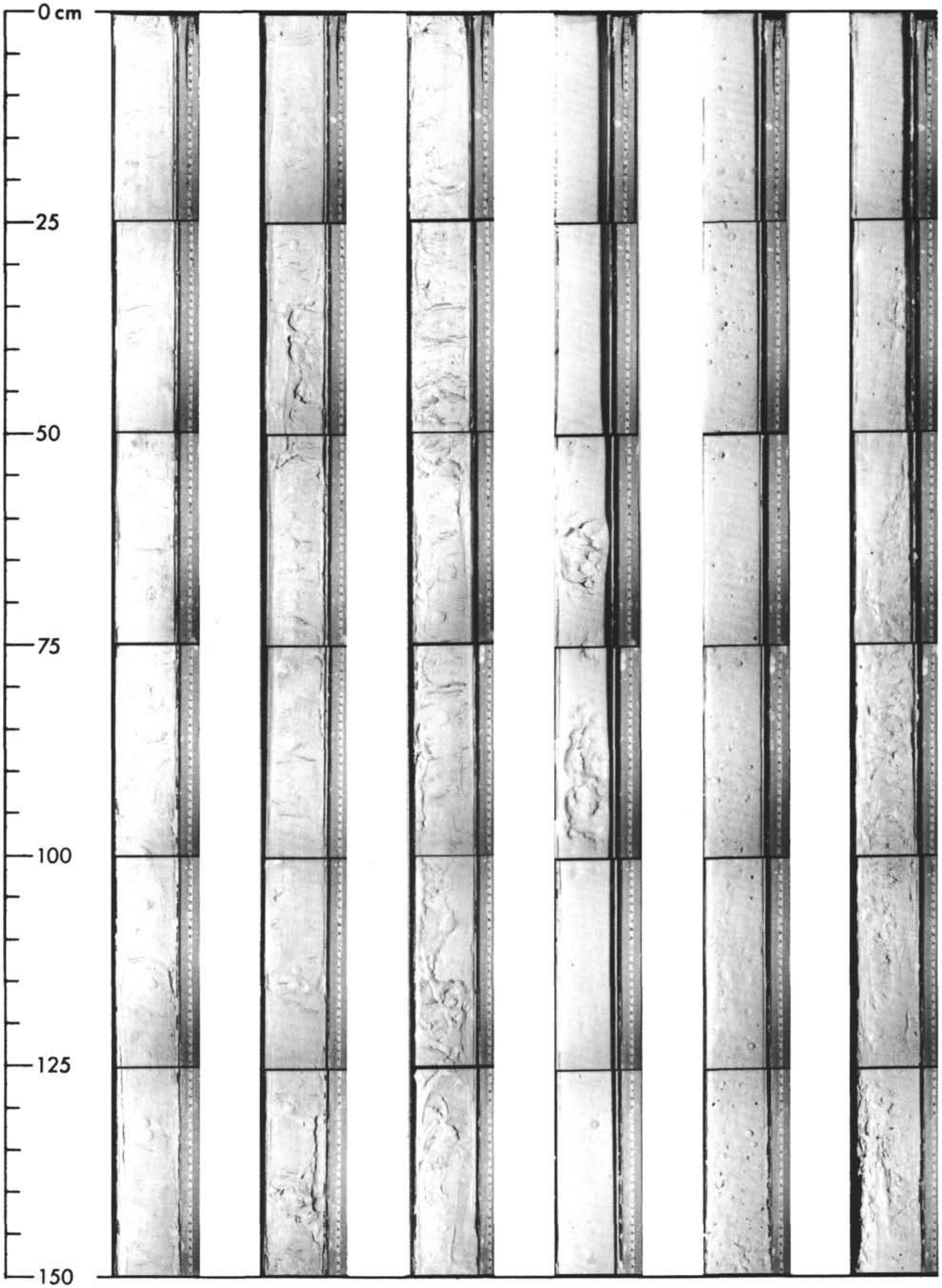

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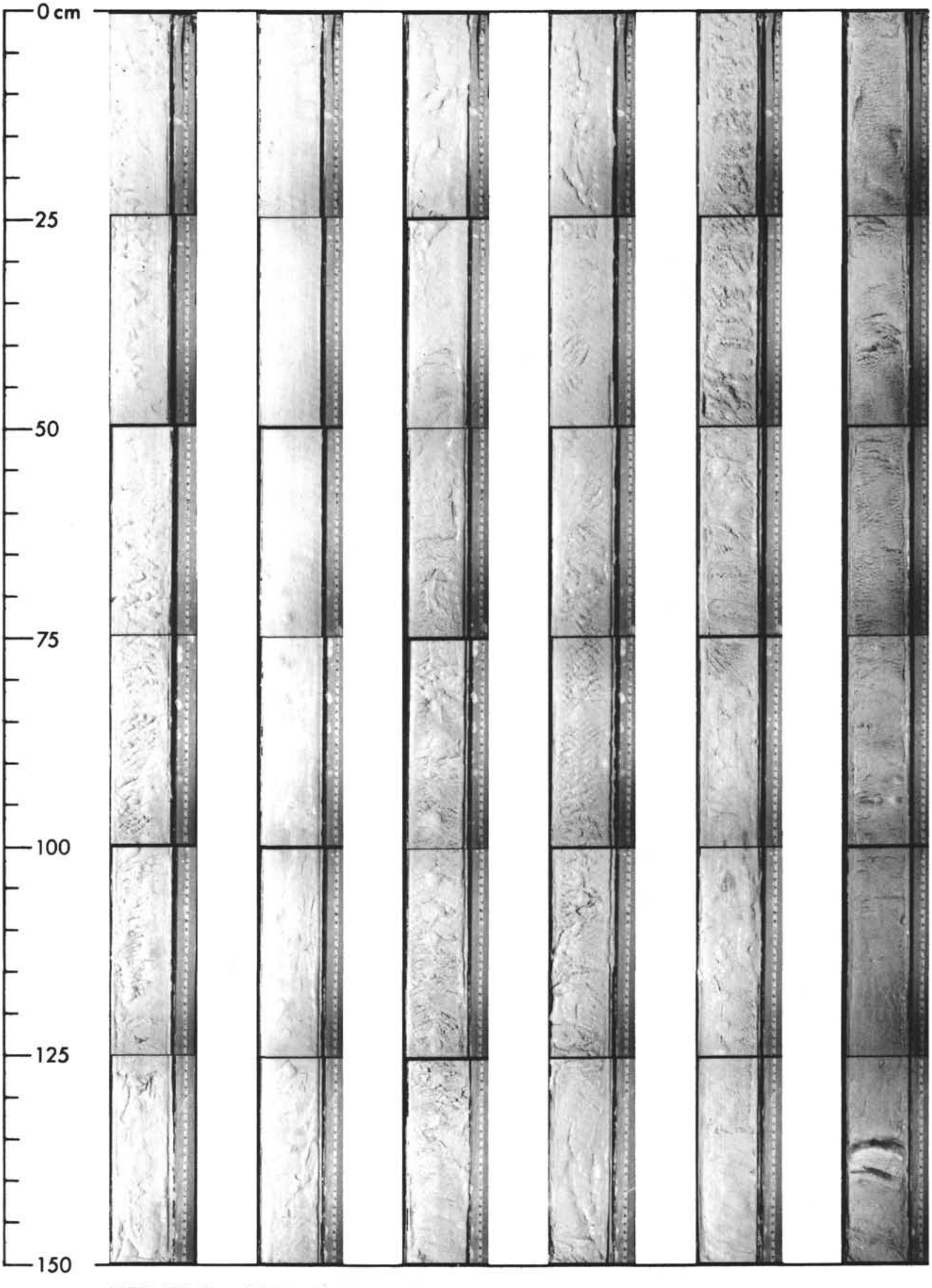
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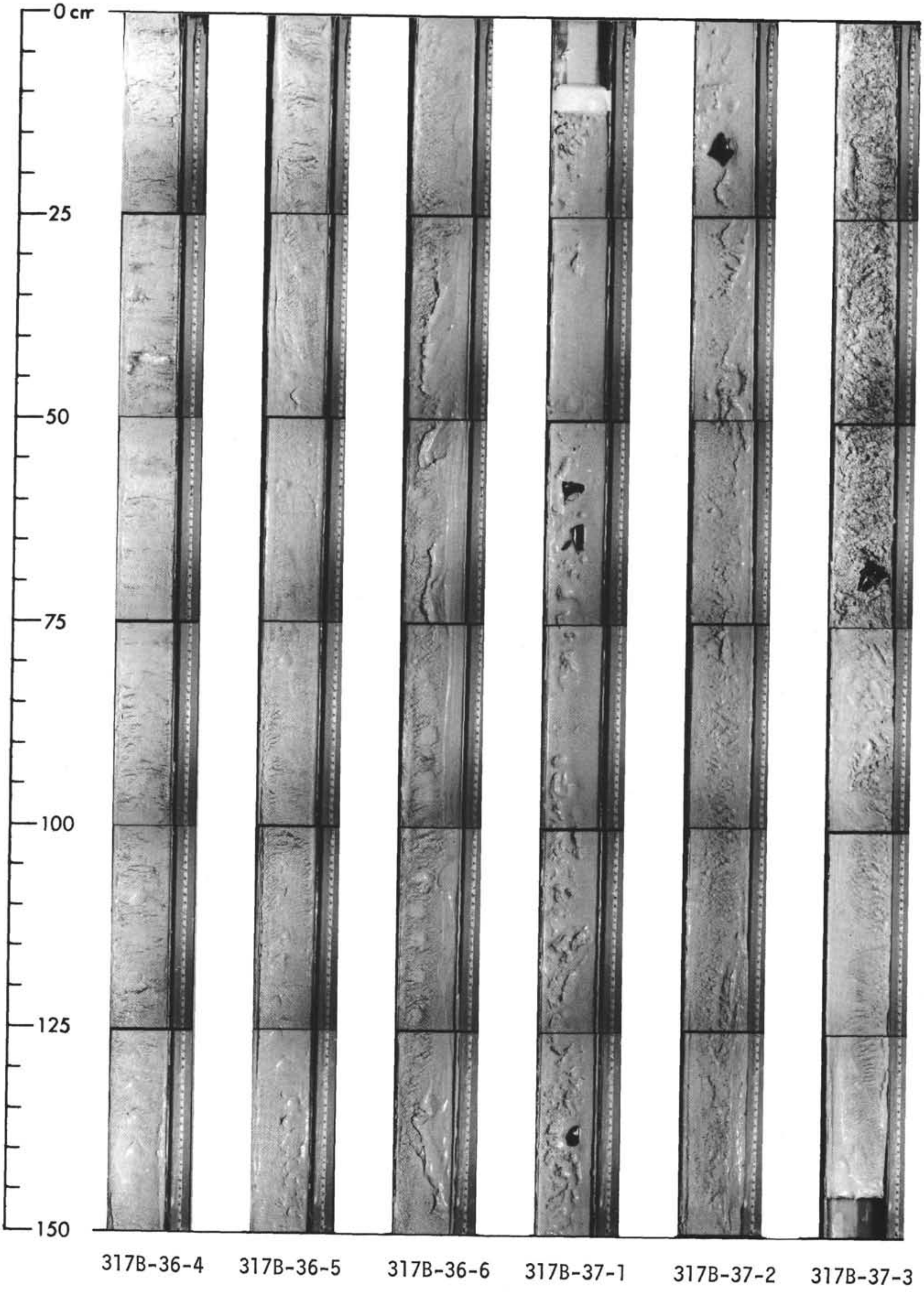
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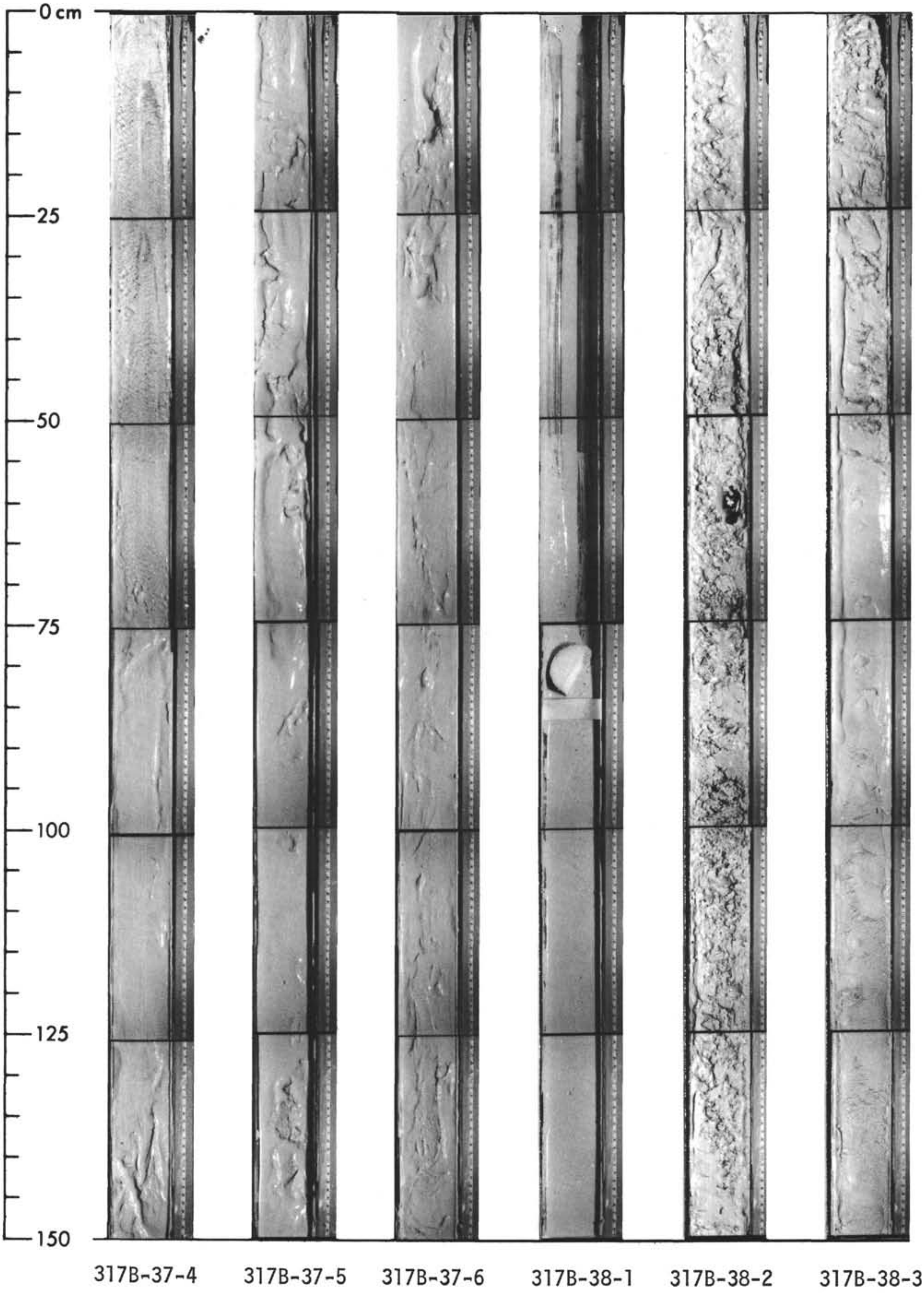
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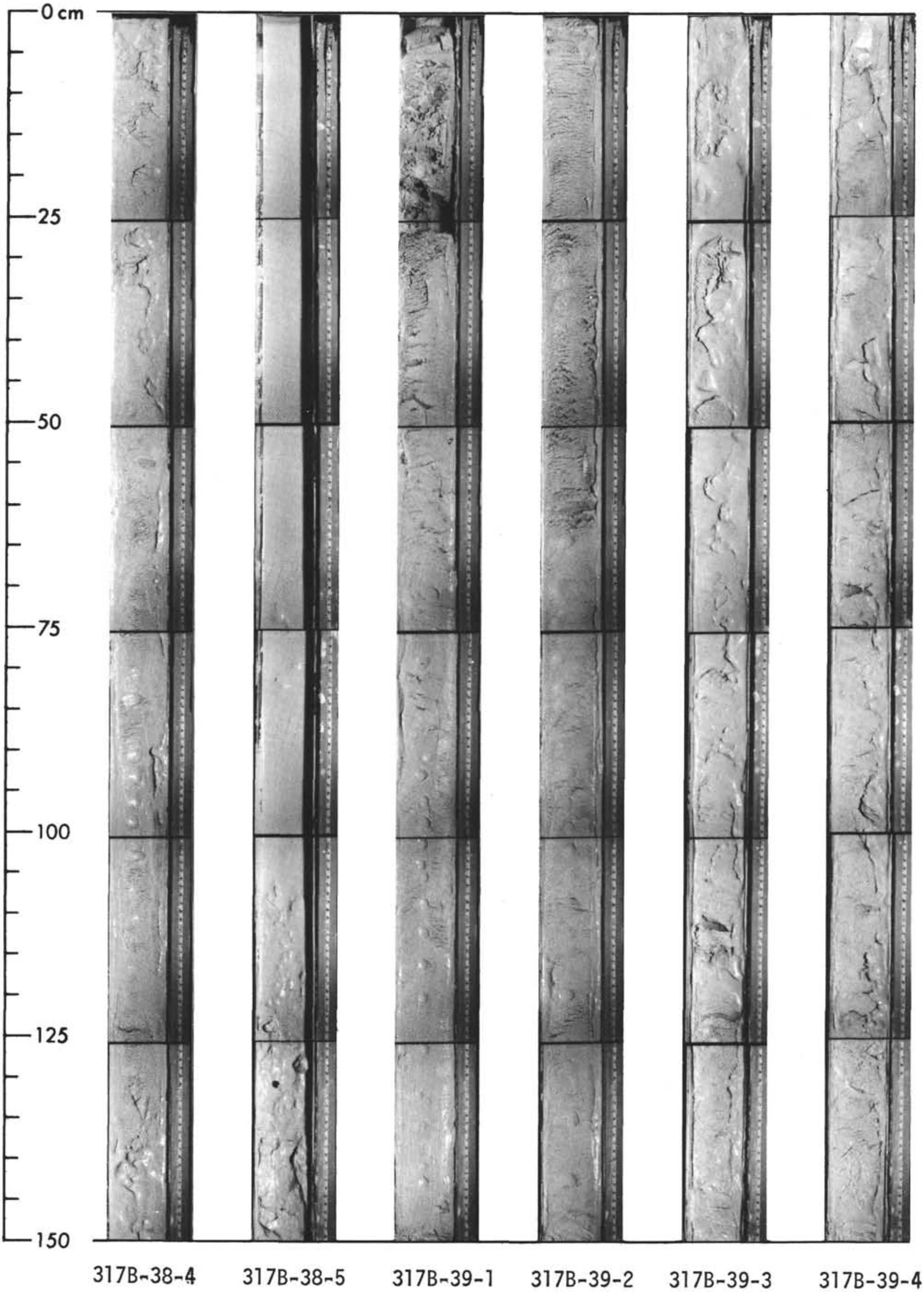
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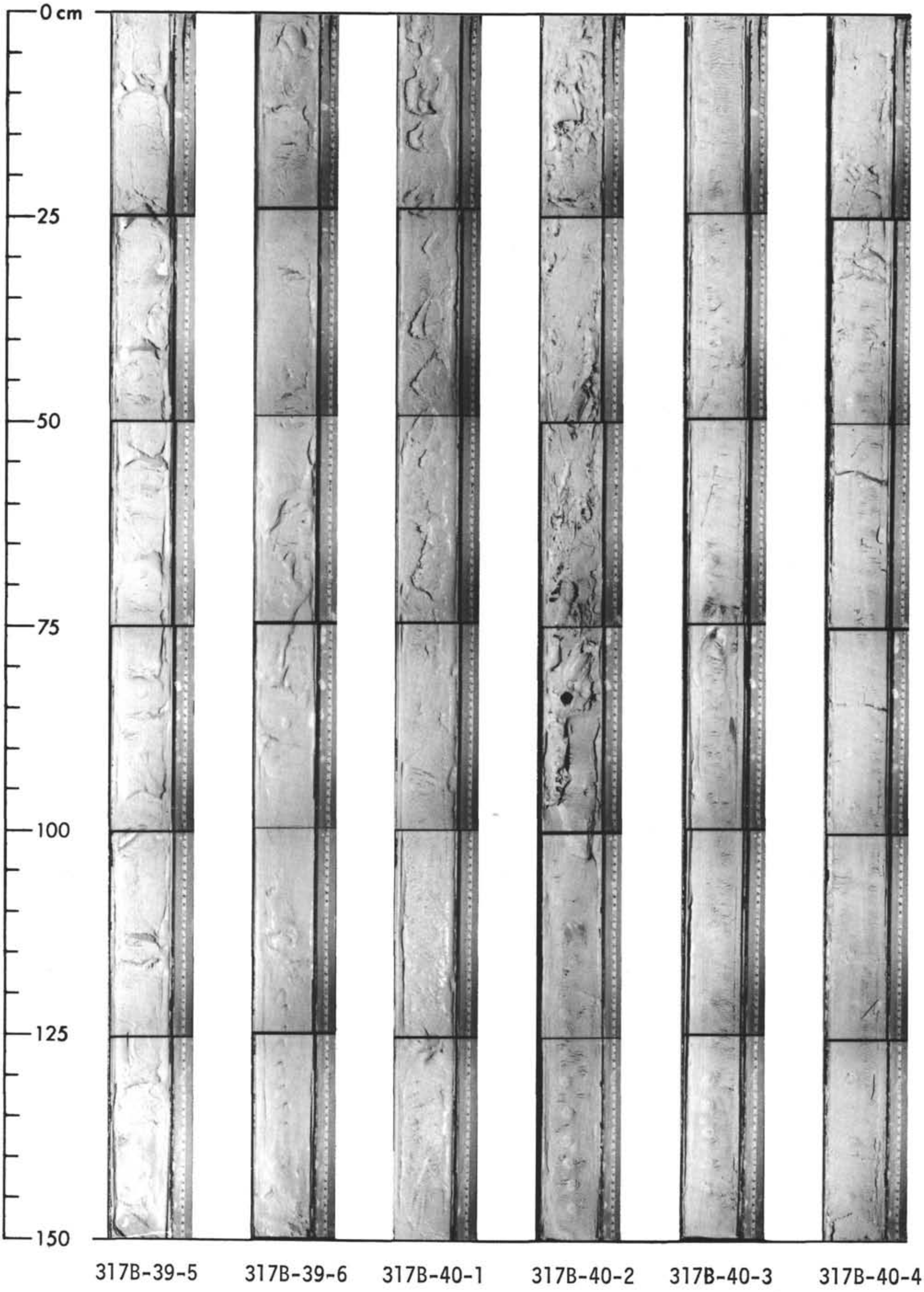
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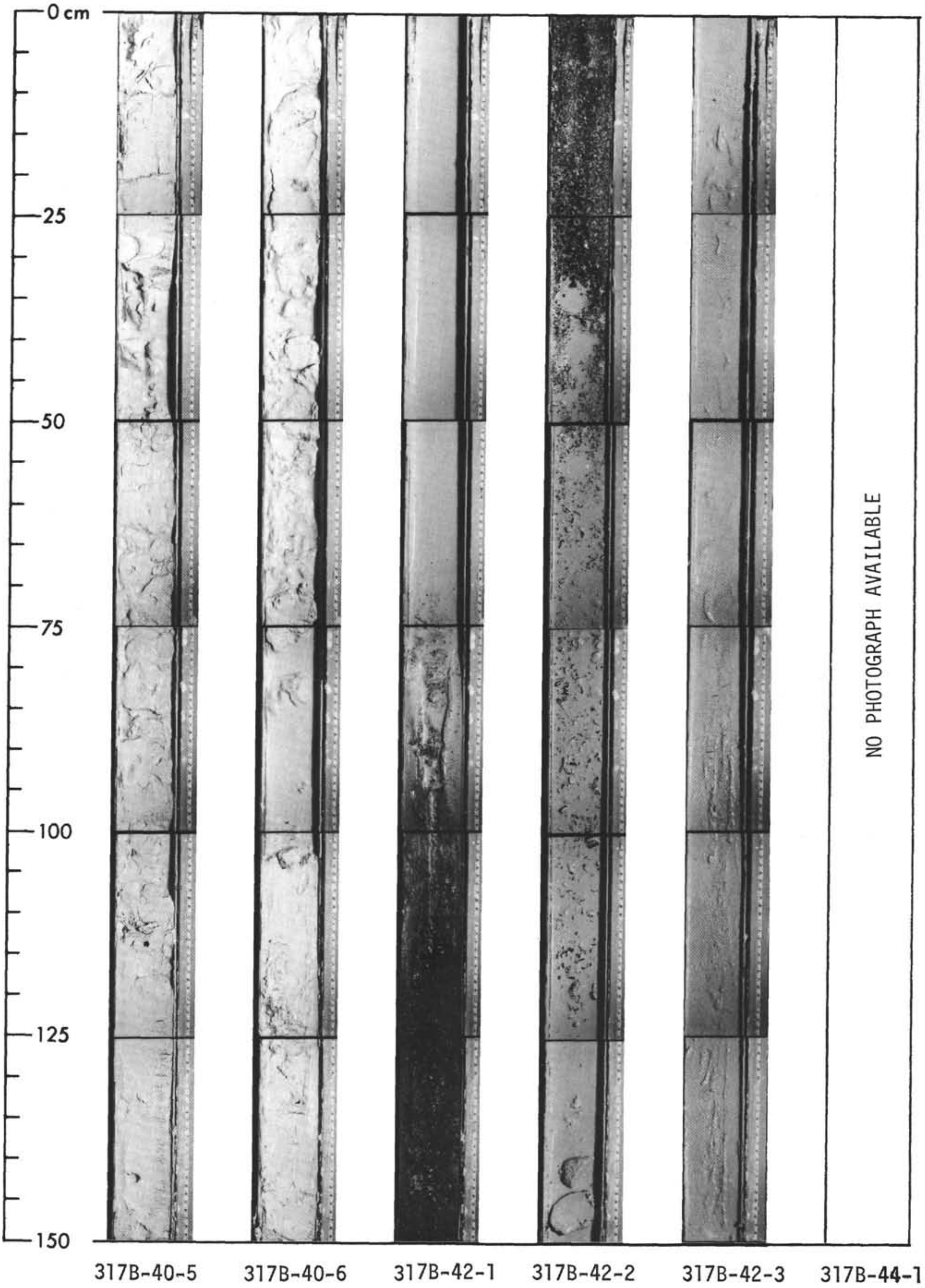
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NO PHOTOGRAPH AVAILABLE
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317B-42-3
317B-44-1