4. SITE 286

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 7 May 1973 (2000)

Date Departed: 11 May 1973 (2000)

Time on Site: 96 hours

Position:
Latitude: 16°31.92′S
Longitude: 166°22.18′E

Water Depth (from sea level): 4465 corrected meters (echo sounding)

Bottom Felt at: 4484 meters (drill pipe)

Penetration: 706 meters

Number of Holes: 1

Number of Cores: 41

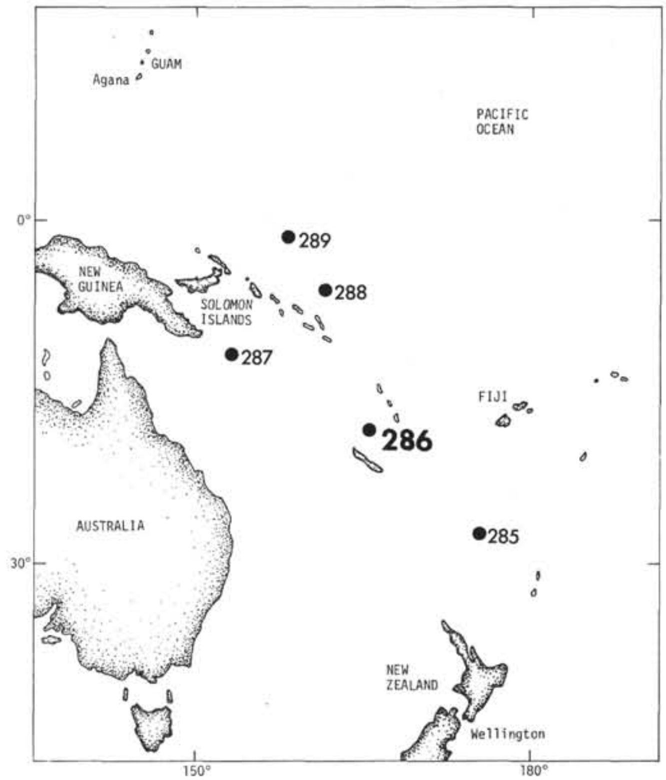
Total Length of Cored Section: 383 meters

Total Core Recovered: 170.4 meters

Percentage of Core recovery: 44.5%

Oldest Sediment Cored:
Depth below sea floor: 649 meters
Nature: Altered ash
Age: Middle Eocene

Basement:
Depth below sea floor: 0.68 sec (reflection time)
Depth below sea floor: 649 meters (drilled)
Average velocity to basement: 1.91 km/sec
Nature: Basalt intruded by gabbro



Principal Results: Gabbro (706-659 m) intrusive into extrusive basalt (659-649 m). This basement is overlain by middle to upper Eocene vitric siltstones, vitric sandstones, and volcanic conglomerate (649-197 m); upper Eocene to upper Oligocene nanno ooze and chalk (197-83 m); ?Miocene "red clay" and Pliocene-Pleistocene glass-shard ash (83 m—sea floor). Site 286 is located at the foot of the slope from Malekula in a gap between the North and South New Hebrides trenches. Basaltic flows associated with the formation of the sea floor extruded in middle Eocene time were followed by an interval of rapid sedimentation, probably in the form of a submarine fan at the base of a volcanic ridge with active andesitic volcanism, until near the end of the Eocene. Sea-floor depth was above the foram solution depth. Volcanic activity declined sharply during the late Eocene. Late Eocene and Oligocene mainly biogenic sediments with minor ash were deposited on a subsiding sea floor. By latest Oligocene time, the depths were below both foram and nanno solution depths where clay and glass shard ash accumulated. No Eocene-Oligocene discontinuity was detected at this site. A period of non-deposition or erosion intervened before the Pliocene, followed in Pliocene and Pleistocene time by a continuous influx of glass shard ash from fairly distant sources. Reworked fossils including shallow-water benthonic neritic species of Miocene and Pliocene age near the top of the section suggest erosion of nearby older shelf deposits (on the New Hebrides or Loyalty Islands) during the Pleistocene. The basalt flows at the bottom of the hole were intruded by a thick gabbroic sill.

BACKGROUND AND OBJECTIVES

This site is located in the gap between the North and South New Hebrides trenches near the foot of the slope down from Malekula (100 km west of the island) at 16°32′S, 166°22′E, and 370 km north of Mare in the

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Loyalty Islands (Figure 1). The site was selected on a seismic reflection line of the R/V *Kana Keoki* (27 October 1971) parallel to the New Hebrides island chain (Figure 2).

Both shallow and deep focus earthquakes are common beneath the gap in the trench (Dubois, 1971), suggesting that if the elimination of the trench near Malekula is the result of a collision, it occurred very recently. The geology of Malekula (Mitchell and Warden, 1971) comprises ?pre-Miocene red mudstones, lower Miocene andesitic volcanics, and carbonates overlain unconformably by volcaniclastics, tuffs, and carbonates. Pliocene boulder beds and cross-bedded sandstones overlie the Miocene sediments and pass up conformably into calcareous sediments. The youngest rocks are Pleistocene reef limestones in terraces; these have been uplifted on Malekula to 500 meters above sea level.

It has been suggested (e.g., Mitchell and Warden, 1971) that the New Hebrides lay much farther to the east and as the Fiji Plateau formed (?upper Miocene to the present) the arc has moved to the west, accompanied by subduction along the New Hebrides Trench. If this is so then the site is located on crust that was continuous with (physiographically at least) the South Fiji Basin.

The main objectives at the site were:

1) To determine when detritus was first shed into this basin from Malekula and thereby determine when the trench was destroyed and whether the island has moved into its present position in relatively recent time.

2) To determine the time of generation of the sea floor and compare it with that of the South Fiji Basin.

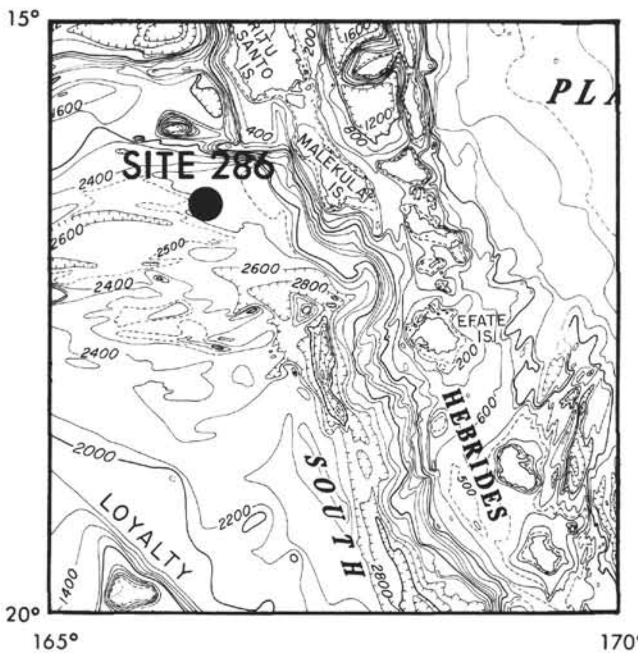

Figure 1. *Location of Site 286 in the New Hebrides Basin. Contours are in fathoms. (Bathymetric map by Mammerickx, et al., 1971; Bathymetry of the South Pacific, Chart 12: Scripps Institution of Oceanography, La Jolla, California.)*

These results could shed some light on the Oligocene emplacement by obduction of the ultramafic bodies on New Caledonia.

OPERATIONS

Site 286 was approached along a track skirting the western flank of the South New Hebrides Trench (Figure 1) and parallel to one of the available survey tracks for the area. The final site was selected in what appeared to be the most complete sedimentary section where influence of island derived (New Hebrides) sediments might be expected. Figure 3 shows the approach profile and beacon drop point. North of the site a well-filled channel appears to feed sediments from the island arc.

The site was occupied at 2000, 7 May 1973, and the first core was on deck at 0645, 8 May. Intervals of 9.5 meters (one pipe joint) were alternately cored and washed (Table 1). Forty-one cores were cut—six of these in the basalt and diabase bodies at the base of the hole. Coring was terminated at a depth of 706 meters subbottom in a coarsely crystalline diabase.

A sonobuoy profile (Figure 4) was shot on site for seismic correlation.

LITHOLOGY

Site 286 (water depth 4465 m) was cored every other 9.5 meters to a depth of 649 meters, and continuously from that point to the final subbottom depth of 706 meters. A total of 41 cores was recovered, with a recovery rate of 44.5%. A summary of each core is given at the end of the chapter, and plotted in Figure 14.

The lithologic sequence is subdivided into five units (Figure 5), three of which are sedimentary rocks and two igneous. The youngest sediments preserved in the cores are Pleistocene; the oldest are middle Eocene. The upper igneous unit probably predates the overlying middle Eocene sedimentary rocks, and the lowest igneous unit may postdate them. Sediment composition, as determined from smear slides, is given in Appendix A and plotted in Figure 6. Grain size, carbon-carbonate, and X-ray determination data for each site are in chapters collectively dealing with those subjects for Leg 30 elsewhere in this volume.

These units are, in descending order:

Unit 1 (0-83 m): Glass shard ash that is rich in Radiolaria, nannofossils, micarb, and clay. Two subunits are recognized, as follows:

1A (0-64 m): Glass shard ash rich in Radiolaria, nannofossils, and micarb. Pliocene to Pleistocene.

1B (64-83 m): "Abyssal red clay" composed of glass shard ash and zeolite and micronodule-rich clay. Fossils are rare; a small flora of coccoliths from Core 286-5, Section 4 is possibly late Oligocene, but these may be reworked. A Miocene age is postulated.

Unit 2 (83-197 m): Nanno ooze and nanno chalk, mixed with accessory to moderate amounts of glass shard ash. Upper Eocene to upper Oligocene.

Unit 3 (197-649 m): Vitric siltstone, vitric sandstone, and volcanic conglomerate. Middle to upper Eocene. Three subunits are recognized as follows:

3A (197-330 m): Upper vitric siltstone;

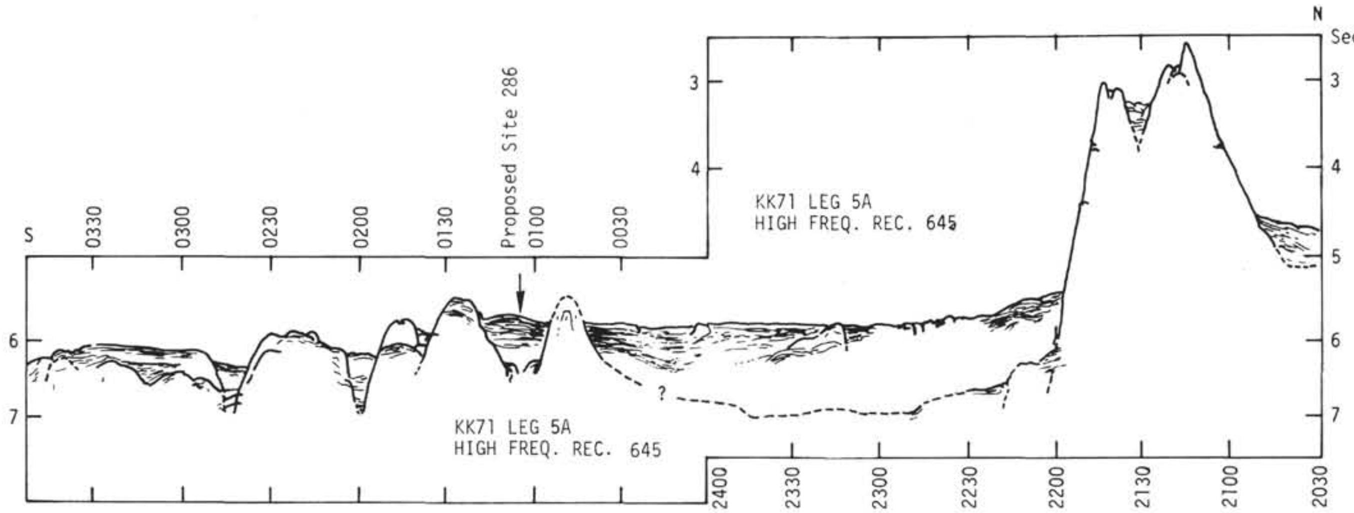

Figure 2. *Tracing of seismic line on which proposed Site 281 was located (R/V Kana Keoki, 1971, Leg 5A, high frequency record, Hawaii Institute of Geophysics).*

3B (330-411 m): Volcanic conglomerate;

3C (411-649 m): Lower vitric siltstone with minor vitric sandstone and very minor volcanic conglomerate.

Unit 4 (649-659 m): Basalt.

Unit 5 (659-706 m): Intrusive gabbro.

Unit 1

This unit, recovered from Cores 286-1 through 286-5, is 83 meters thick and consists dominantly of glass shard ash with interbedded intervals of ash-bearing to ash-rich radiolarian, nanno, and micarb oozes, as well as those containing clay, zeolites, and micronodules. Radiolarian ooze is restricted to Core 286-1; nanno ooze occurs most abundantly in Cores 286-2 and 286-3; micronodules are abundant in Core 286-2; and zeolites and clay are most abundant in Core 286-5.

The sediment throughout is highly disturbed by drilling and no sedimentary structures were observed. Its color is dominantly brown, with minor amounts of yellowish-brown and grayish-brown. Two subunits are recognized.

Subunit 1A

This subunit, recovered from Cores 286-1 through 286-4, consists of 64 meters of glass shard ash with Radiolaria-rich intervals in Core 286-1, and nanno ooze and micronodule-rich intervals in Cores 286-2 and 286-3. Pliocene fossils occur at the base of Core 286-4.

Subunit 1B

This subunit, recovered only from Core 286-5, is a micronodule-bearing glass shard glass and micronodule and zeolite-bearing clay. Oligocene fossils occur in the lower part of this unit (Core 286-5, CC), but these may be reworked. Miocene nannofossils were found in Cores 286-5 and 286-6. It is remotely possible that the upper, unfossiliferous portion of Core 286-5, as well as the uncored 9.5 meters between Cores 286-5 and 286-4, could contain an entire condensed Miocene section, but this presumes the lowest rate of sedimentation known for abyssal red clays. Such a low rate seems unreasonable in view of the great amount of volcanic activity that characterizes the Miocene in this general region. It is more likely that there is a hiatus in the stratigraphic record at this site at the base of Subunit 1A, and that the deposition of Subunit 1B has been discontinuous.

Unit 2

This unit, recovered from Cores 286-6 through 286-11, is 114 meters thick and is characterized by nanno ooze in the upper two-thirds and its semilithified equivalent, nanno chalk in the lower one-third. Small amounts (generally less than 10%) of glass shard ash are present throughout the unit, but in Cores 286-9 and 286-10, and core catcher of Core 286-11, ash is more abundant, and constitutes 45% of the rock in sequences up to 2 meters thick. Semilithified equivalents of ash in Cores 286-10 and 286-11 are designated vitric tuffs.

Minor constituents of Unit 2 include beds rich in radiolarians, sponge spicules, and "micarb."

Sediments in Unit 2 are characterized by moderate to intense drilling deformation, with the amount of disturbance decreasing downward. Change in consolidation from stiff to semilithified occurs between Cores 286-9 and 286-10.

The sediment is dominantly yellowish-brown, with minor yellowish- and grayish-brown intervals. Bioturbation and mottling of the sediment ranges from moderate to intense; types of burrows observed include both *Chondrites* and *Zoophycos*.

Unit 3

This unit comprises a very thick (452 m) sequence of volcanogenic sedimentary rocks, including vitric siltstone, vitric sandstone, and volcanic conglomerate. Sedimentary structures, including graded beds and microlaminations, are common and indicate deposition of the sediment by currents. Degree of consolidation

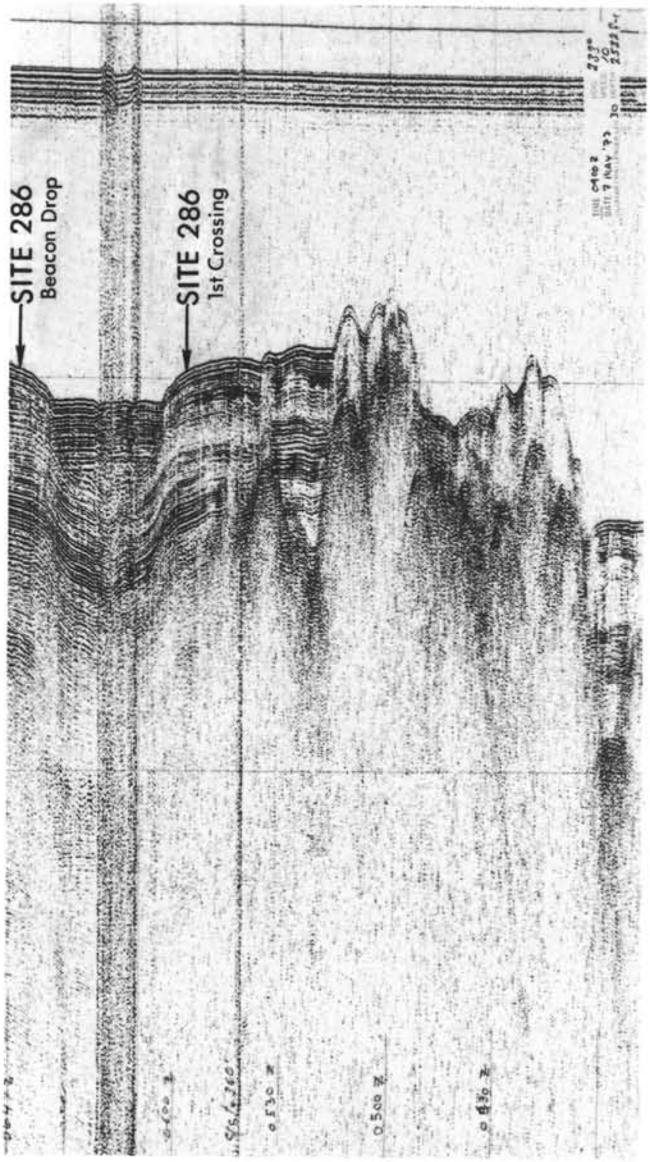

Figure 3. *Seismic profile taken on D/V* Glomar Challenger *on approach to Site 286.*

ranges from semilithified to lithified, although altered rocks at the base of the unit are soft to semilithified.

The amount of drilling disturbance in general is slight; however, recovery rate was fairly low, and few continuous sedimentary sequences are available. The rocks originally were deposited in complex cycles involving basal sandstone units with overlying siltstones characterized mainly by parallel microlaminations, minor micro-cross-laminations, and bioturbation. Because of the highly fragmental nature of the recovered material, few of these cycles can now be observed. Probably, sandstone units are poorly represented in the cores, as the coarser grained sands were apparently removed by the coring operation. Only within the conglomeratic part of the sequence is recovery sufficient to adequately characterize the sedimentary rocks.

Three subdivisions are recognized in Unit 3; an upper vitric siltstone subunit; a middle volcanic conglomerate subunit; and a lower vitric siltstone and minor vitric sandstone and volcanic conglomerate subunit.

Subunit 3A

This subunit was recovered from Cores 286-12 through 286-18 and is 133 meters thick. It consists dominantly of gray to greenish-gray vitric siltstone, vitric sandy siltstone, and rare beds of nanno-rich vitric tuff and vitric sandstone. Parallel and micro-cross-lamination are common in the coarser grained intervals, and moderate to intense bioturbation is prevalent in the finer grained intervals. Nannofossils generally are present in amounts of 10%-20%. Thickness of sandstone beds ranges from several millimeters to several centimeters.

Subunit 3B

This subunit was recovered from Cores 286-19 through 286-22 and is 81 meters thick. It consists of lithified, greenish-gray conglomerate composed of volcanic rocks, pumice, and volcanic glass, set in a silty to coarse-grained volcanic wacke matrix. Conglomerate clasts comprise over 50% of the rock, range in size from granules to small pebbles up to 3 cm long, and are subangular to subrounded. A detailed petrographic description of this subunit is presented in Stoeser (this volume).

Bedding is not present, and there is no indication of sorting or reworking by currents. Grain size appears to be generally uniform throughout the sequence, except near the top and in the lower one-third of the subunit where thin beds of coarse-grained sandstone occur.

Although bedding is not present, a very crude fabric is produced by flat or blade-shaped clasts that tend to lie with their long axis oriented in the horizontal plane.

Fossils occur scattered throughout the conglomerate, and they are particularly abundant in Core 286-22. Most fossils belong to *Amphistegina*, a long-ranging shallow-water foraminifera. Others identified include fragments of bivalves and an algal oncolite, which also is a shallow-water form.

Little or no nonvolcanic terrigenous debris is present within the conglomerate, but very few fragments of sedimentary rock similar to that occurring in Subunit 3C were observed. Deposition probably occurred by mass-flow.

Subunit 3C

This subunit, recovered from Cores 286-23 to 286-35, is 238 meters thick and consists of vitric siltstone, with minor vitric sandstone and very minor volcanic conglomerate similar to that of Subunit 3B. Graded sandstone beds are more abundant in this unit than in Subunit 3A, but it is doubtful that the recovered record truly reflects their abundance. Both siltstone and sandstone beds exhibit a variety of sedimentary structures, including parallel and micro-cross-lamination, intense bioturbation, and convolute lamination. Granules and pebbles of pumice are scattered throughout the sequence, and biogenic components are scarce. Thickness of sandstone beds ranges from several centimeters to about 1 meter.

TABLE 1
Coring Summary, Site 286

Core	Date (May 1973)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Recovered Length (m)	Recovery (%)
1	8	0645	4484.0-4491.0	0.0-7.0	7.0	7.0	100
2	8	0750	4500.5-4510.0	16.5-26.0	9.5	8.6	91
3	8	0910	4519.5-4529.0	35.5-45.0	9.5	7.0	74
4	8	1015	4538.5-4548.0	54.5-64.0	9.5	0.9	9
5	8	1145	4557.5-4567.0	73.5-83.0	9.5	6.3	66
6	8	1320	4576.5-4586.0	92.5-102.0	9.5	6.1	64
7	8	1510	4595.5-4605.0	111.5-121.0	9.5	9.5	100
8	8	1715	4614.5-4624.0	130.5-140.0	9.5	4.2	44
9	8	1840	4633.5-4643.0	149.5-159.0	9.5	7.1	75
10	8	2010	4652.5-4662.0	168.5-178.0	9.5	5.6	59
11	8	2140	4671.5-4681.0	187.5-197.0	9.5	1.1	12
12	8	2305	4690.5-4700.0	206.5-216.0	9.5	1.8	19
13	9	0045	4709.5-4719.0	225.5-235.0	9.5	1.8	19
14	9	0225	4728.5-4738.0	244.5-254.0	9.5	2.3	24
15	9	0355	4747.5-4757.0	263.5-273.0	9.5	1.0	11
16	9	0520	4766.5-4776.0	282.5-292.0	9.5	2.2	23
17	9	0640	4785.5-4795.0	301.5-311.0	9.5	6.9	73
18	9	0800	4804.5-4814.0	320.5-330.0	9.5	2.2	23
19	9	0915	4823.5-4833.0	339.5-349.0	9.5	0.9	9
20	9	1045	4842.5-4852.0	358.5-368.0	9.5	1.8	19
21	9	1215	4861.5-4871.0	377.5-387.0	9.5	2.3	24
22	9	1420	4880.5-4896.0	396.5-406.0	9.5	5.6	59
23	9	1555	4899.5-4909.0	415.5-425.0	9.5	1.9	20
24	9	1745	4918.5-4928.0	434.5-444.0	9.5	1.8	19
25	9	1932	4937.5-4947.0	453.5-463.0	9.5	5.2	55
26	9	2110	4956.5-4966.0	472.5-482.0	9.5	4.8	51
27	9	2235	4975.5-4985.0	491.5-501.0	9.5	1.7	18
28	10	0005	4994.5-5004.0	510.5-520.0	9.5	2.2	23
29	10	0130	5013.5-5023.0	529.5-539.0	9.5	6.5	68
30	10	0255	5032.5-5042.0	548.5-558.0	9.5	1.0	11
31	10	0425	5051.5-5061.0	567.5-577.0	9.5	2.5	26
32	10	0600	5070.5-5080.0	586.5-596.0	9.5	2.9	31
33	10	0735	5089.5-5099.0	605.5-615.0	9.5	2.2	23
34	10	0905	5108.5-5118.0	624.5-634.0	9.5	4.6	48
35	10	1105	5127.5-5133.0	643.5-649.0	5.5	1.4	25
36	10	1420	5133.0-5142.5	649.0-658.5	9.5	1.6	17
37	10	1820	5142.5-5152.0	658.5-668.0	9.5	7.6	80
38	10	2220	5152.5-5161.0	668.0-677.5	9.5	6.5	68
39	11	0140	5161.5-5171.0	677.5-687.0	9.5	6.7	71
40	11	0535	5171.0-5180.5	687.0-696.5	9.5	8.0	84
41	11	0905	5180.5-5190.0	696.5-706.0	9.5	9.1	96
Total					383.0	170.4	44.5

Sandstone beds are especially abundant in Cores 286-26 and 286-29. In the former, reverse grading (upward coarsening) from fine-grained sandstone to granule conglomerate is well developed and is indicative of slurry flow. The normally graded sandstones were probably deposited by turbidity currents. Thin beds of conglomerate occur in Cores 286-23, 286-25, 286-26, and 286-29; conglomerate in Core 286-23 contains a pebble of andesite 5 cm long.

The basal part of Subunit 3C is extensively altered to a pink, clay and iron oxide-bearing rock in which sedimentary structures, such as parallel laminae and bioturbations, are locally preserved. Alteration appears to involve removal of calcite and change in clay minerals from beidellite and minor chlorite to dominantly montmorillonite, together with alteration of some plagioclase to clay minerals. These changes are thought to be the result of reactions between the sediment and warm, low *p*H waters emanating from the underlying gabbro sill. Less intense alteration can be observed in the overlying siltstones of Cores 286-34 and 286-33, and perhaps higher. This alteration consists of a change of color from olive-gray to dark greenish-gray and is most intense in areas of higher porosity, such as sand-filled burrows. The alteration has probably been produced by reaction of the feldspar and glass in the sediments with warm slightly acid waters that emanated from the gabbro (Unit 5) that intruded the pillow basalt (Unit 4) (see Jones and Bassett, this volume).

Unit 4

Basalt was encountered at 649.2 meters. This 10.2-meter-thick basalt is overlain by pink altered sediments and underlain by gabbro. The basalt consists of alternating zones of dense black fresh vitrophyric basalt with feathery quench pyroxene and 5%-10% olivine phenocrysts (less than 1 mm in diameter), and brown variolitic basalt with variolitic structures up to 2 cm in diameter (Figure 7). This unit is interpreted as an extrusive flow.

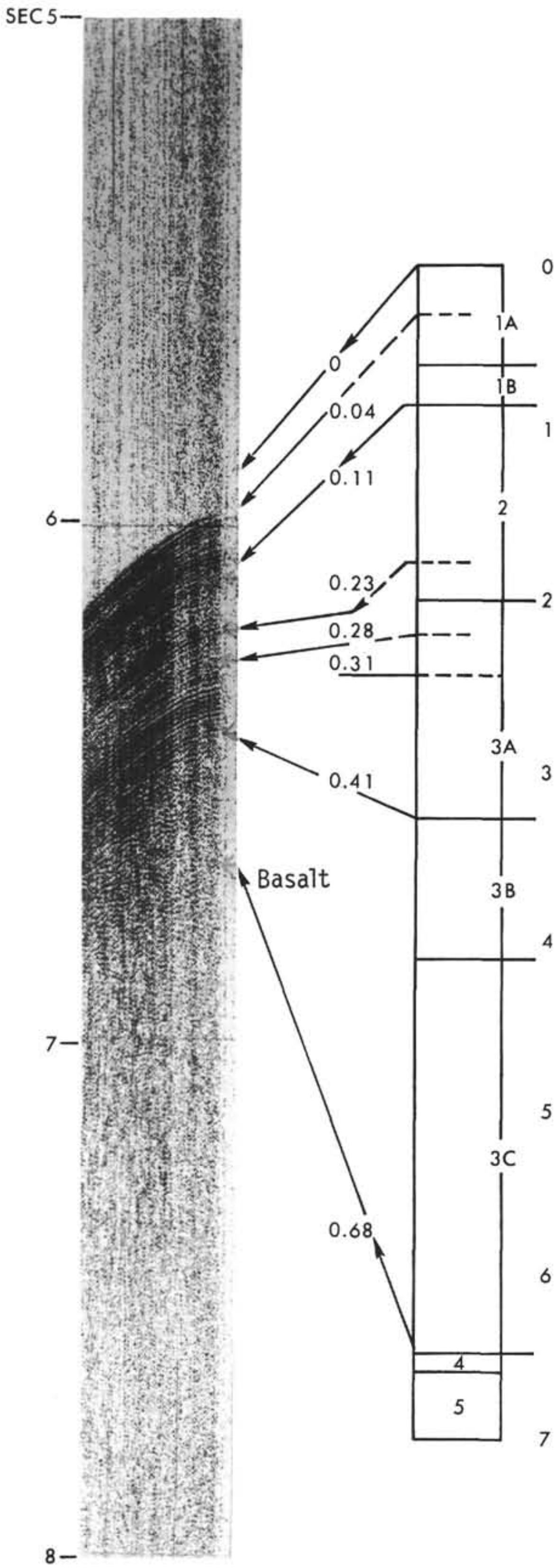

Figure 4. *On-site sonobuoy profile taken at Site 286 with column showing correlation of reflectors with lithologic units.*

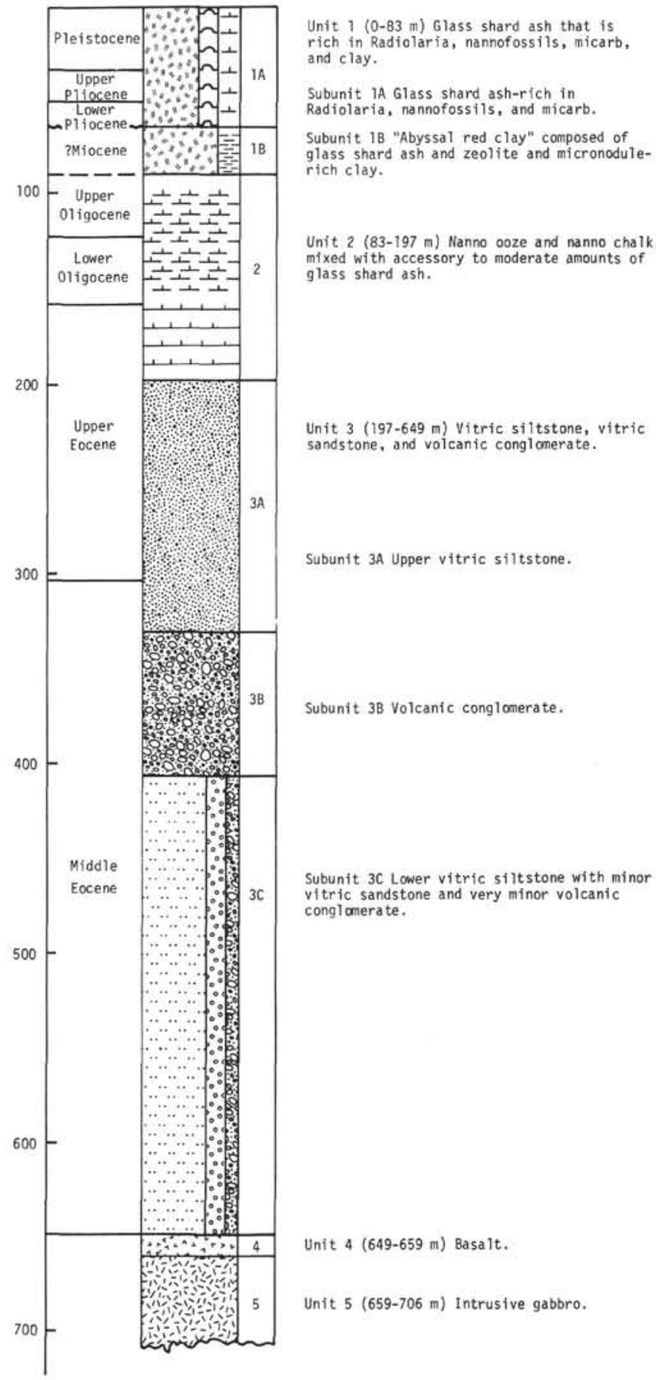

Figure 5. *Stratigraphic column for Site 286.*

Unit 5

Gabbro was encountered immediately beneath the basalt of Unit 4 (Figure 7). The hole bottomed in this unit after penetrating 46.8 meters of gabbro. The chill zone of the gabbro consists of: (1) 1.5 mm of sideromelane, which apparently had been extruded from within the gabbro unit; (2) 5 cm of fine-grained variolitic basalt with feathery microlites and hollow plagioclase; and (3) approximately 0.8 meters of diabase which coarsens downwards and grades into the

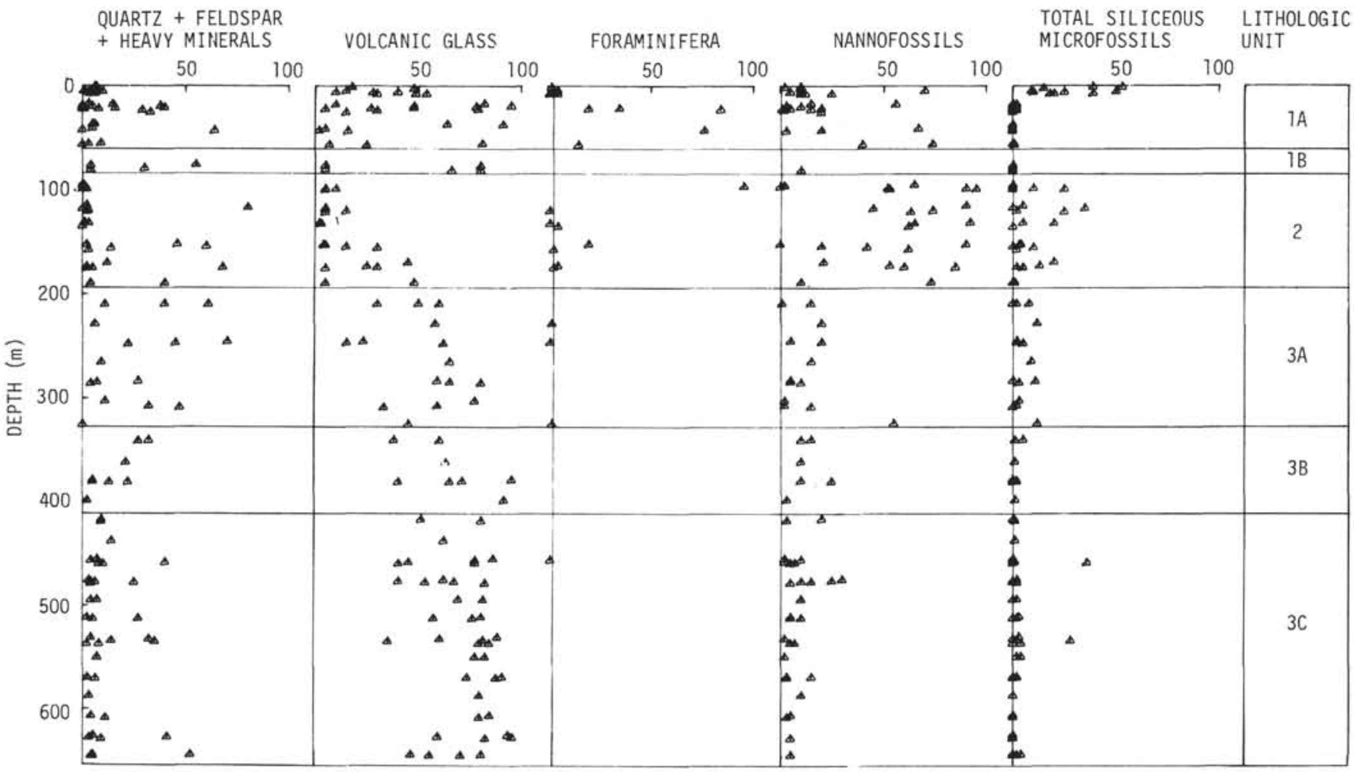

Figure 6. *Sediment compositions as determined by smear slides.*

gabbro. The gabbro has a maximum average grain size of 3.5 mm and consist dominantly of (in decreasing order of abundance) plagioclase, augite, pigeonite, and magnetite.

Both Units 4 and 5 are discussed in detail by Stoeser (this volume).

Preliminary Interpretation

The grain size and volcanogenic nature of the sediments in Unit 3 imply derivation from a nearby andesitic source (see Stoeser and Klein, this volume). Deposition commenced (?) directly on basaltic flows (?) of Unit 4 in middle Eocene time, with the formation of a submarine fan at the base of a volcanic ridge. Sedimentation rates were initially very high (over 200 m/m.y.), suggesting persistent active volcanism until near the end of the Eocene. Deposition of the siltstone-sandstone sequences probably was by turbidity currents in relatively deep water, but above the foram solution depth for Subunit 3C and near that depth for Subunit 3A. The nonbedded conglomerates of Subunit 3B may have been formed by debris flow. They originated in shallow water, as evidenced by the abundance of shallow-water fossils present, but came to rest in deeper water where bottom currents were too weak to winnow out the medium-grained components. Deposition of these rocks was extremely rapid, and their presence suggests a period of extremely active, nearby volcanism.

Volcanic activity declined sharply during the late Eocene and Oligocene, as the sediments deposited then are mainly biogenic. Small but persistent amounts of ash throughout Unit 2, however, indicate sporadic volcanism from sources more distant than those for Unit 3. Deposition mostly occurred below the foram solution depth and above the nanno solution depth.

Renewed volcanism in late Oligocene or Miocene time is indicated by the glass shard ash sediments of Subunit 1B, which were deposited below both the foram and nanno solution depths. The absence of Miocene sediments suggests a long period of nondeposition or erosion before the Pliocene sediments of Subunit 1A were deposited. The abundance of glass shard ash through Subunit 1A implies fairly continuous volcanic activity through the Pliocene and Pleistocene, but from fairly distant sources.

Reworked fossils of Miocene and Pliocene age occur in the upper part of Unit 1 (Core 286-2 of Pleistocene age). Some of these fossils are shallow-water, benthonic neritic species. Their presence suggests that older shelf deposits nearby (on New Hebrides or Loyalty Islands) were eroded during the Pleistocene and their faunas redeposited in deep water. Significantly, the portion of Core 286-2 that contains the reworked fossils is rich in clay, which perhaps was also derived from nearby land.

Comparison With Site 285

The sequence of lithologic units recorded from Site 286 is remarkably similar to that from Holes 285 and 285A, particularly with regard to the sedimentary rocks, and probably the igneous rocks as well. A major difference is seen, however, in the timing of events. At both sites, the lowest sedimentary unit cored comprises

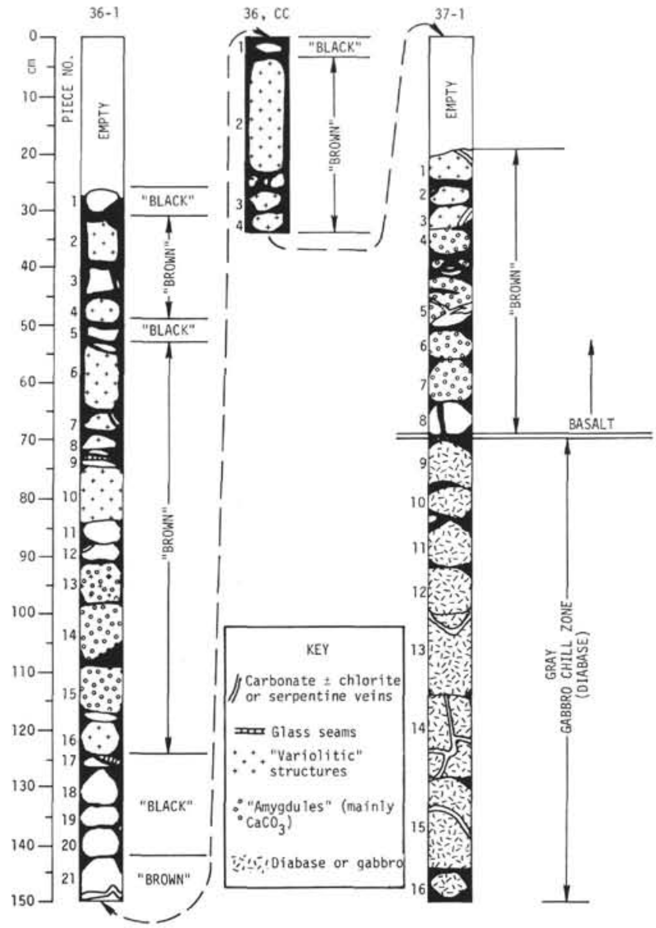

Figure 7. *Sketch of Cores 286-36-1 and 286-37-1. Extrusive basalt (Unit 4) and the upper part of intrusive gabbro (Unit 5).*

volcanogenic sediments deposited in fairly deep water by turbidity currents. Some of the sediments at Site 286 are coarser grained than at Site 285 and indicate a closer source area for that site. Andesitic volcanism provided the sediment for both sites, with deposition commencing in middle Eocene at Site 286 and middle Miocene at Site 285. Following deposition of the volcanogenic turbidites, volcanism waned, and similar biogenic deposits accumulated at each site. These are late Eocene to Oligocene at Site 286 and late Miocene to Pliocene at Site 285. The uppermost units differ somewhat, being a Pliocene to Pleistocene glass shard ash at Site 286, and a Pleistocene red clay at Site 285. Deposition of the thick Miocene turbidites of Site 285 is represented by a hiatus or unconformity at Site 286.

A preliminary assessment of the geologic history at both sites suggests that each has gone through a similar cycle following formation of the basin that involved: (1) rapid deposition in deep water of volcanogenic andesitic sediments; (2) waning of volcanism (perhaps due to cessation of subduction in nearby trench) with deposition of biogenic deposits; followed by (3) basin subsidence.

A gross similarity in basement rocks can be suggested, in that basic intrusives occur at the two sites although the record is still very obscure. The glassy basalt at Site 286 may represent the original crust created at the time of basin formation (early Eocene?). This unit was intruded by gabbro while the basalt was still glassy and undevitrified. Sufficient time had elapsed, however, to permit accumulation of at least a few tens of meters of Eocene sediment on top of the basalt.

The later histories of the two areas are divergent. At Site 285, subsidence led to deposition below the nanno solution depth by Pliocene time, and deposition has remained below that depth until Holocene time. In contrast, maximum subsidence below the nanno solution depth was achieved in Oligocene time at Site 286, and moderate uplift above that depth occurred in the Miocene or early Pliocene time. Deposition has remained above the nanno solution depth until Holocene time.

The intrusion of basic magma at both places may be the result of incipient spreading that occurred long after the initial basins were formed.

GEOCHEMICAL MEASUREMENTS

The results of *p*H, alkalinity, and salinity measurements on interstitial water from cores taken at Site 286 are plotted in Figure 8 and tabulated in Table 2. Patterns are more irregular than those seen at Site 285, probably due in part to the larger number of cores taken at Site 286. The transition from nanno ooze to volcanic sediments at 197 meters is marked (as at Site 285) by an increase in *p*H values near or above 8.0, and by a decrease in alkalinity values. Although the sequence at this site is very similar to that at Site 285, the trends of alkalinity and *p*H in the lower part of the sequence differ. Here the *p*H reaches a maximum in the upper part of the volcanogenic sequence and then declines slightly; at Site 285 it increases downwards. After reaching a minimum value in the upper part of the volcanogenic sequence at Site 286, the alkalinity increases slightly with depth; at Site 285 it maintains a low value throughout the volcanogenic succession. The salinity remains nearly constant at Site 286, but increases with depth at Site 285. X-ray data indicate that the sediments of the volcanogenic units of Site 286 contain less carbonate and more feldspar than the volcanogenic sediments of Site 285 which in addition contain significant quantities of clinoptilolite. The differences in carbonate content and diagenetic patterns probably account for the contrasted geochemical properties of the two sites.

PHYSICAL PROPERTIES

Sonic velocity, wet-bulk density, and porosity were measured in samples taken from each cored sediment interval at Site 286 and acoustic impedance and grain density were calculated. The results are graphically displayed in Figure 9. Methods and procedures employed in the sampling and determinations were the same as those established for Site 285, with one exception—multiple syringe samples were obtained wherever possible, and the average density and porosity values were taken as representative of each section sampled in this manner. Again every attempt was made to avoid sampling areas affected by coring disturbances. Velocities of basalt and

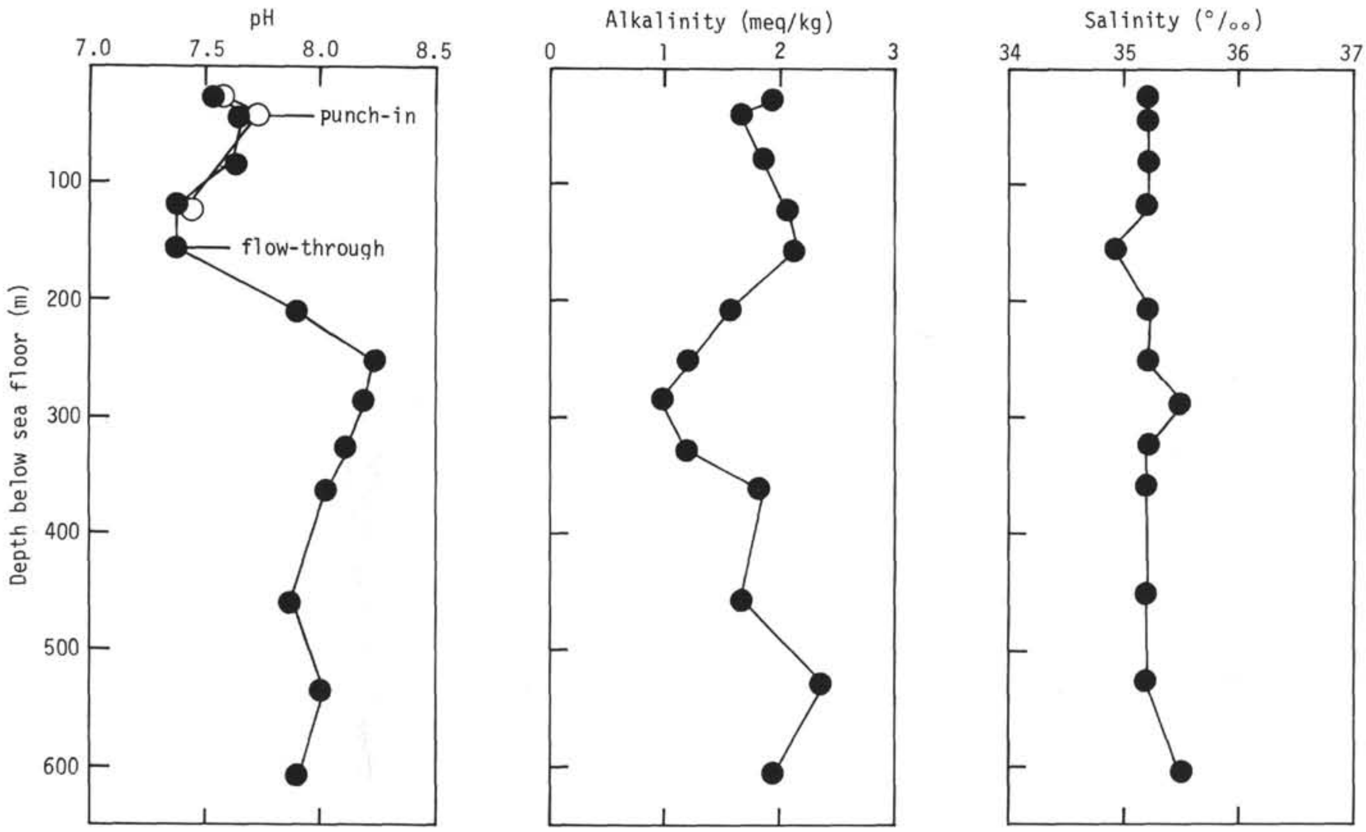

Figure 8. *Graphic summary of geochemical data taken at Site 286.*

TABLE 2
Summary of Shipboard Geochemical Measurements, Site 286

Sample (Interval in cm)	Depth Below Sea Floor (m)	Lab Temp (°C)	*p*H Punch-in/ Flow-through	Alkalinity (meq/kg)	Salinity (°/oo)
Surface seawater			8.38/8.37	2.38	35.8
2-5, 144-150	23.94-24.00	22.0	7.56/7.53	1.96	35.2
3-4, 144-150	41.44-41.50	22.2	7.71/7.67	1.66	35.2
5-4, 144-150	79.44-79.50	21.6	– /7.61	1.86	35.2
7-5, 144-150	118.94-119.00	22.3	7.41/7.38	2.05	35.2
9-4, 144-150	155.44-155.50	22.5	– /7.37	2.15	34.9
12-1, 0-5	206.50-206.55	22.5	– /7.88	1.56	35.2
14-2, 144-150	247.44-247.50	22.2	– /8.23	1.22	35.2
16-1, 144-150	264.94-265.00	21.9	– /8.19	0.98	35.5
18-3, 144-150	324.94-325.00	22.0	– /8.12	1.17	35.2
20-2, 144-150	361.44-361.50	22.0	– /8.03	1.86	35.5
25-1, 130-135	454.80-454.85	21.3	– /7.87	1.66	35.2
29-1, 144-150	530.94-531.00	21.3	– /8.00	2.35	35.2
33-1, 140-144	606.90-606.94	21.3	– /7.90	1.96	35.5

gabbro were also measured as at Site 285 and the results are presented versus depth below the top of the basalt in Figure 10.

Excellent correlation is observed between all three measured parameters (velocity, density, and porosity) shown in Figure 9. Density and porosity are almost mirror images, with velocity in general paralleling density, suggesting strong internal consistency. Density ranges between 1.35 and 2.07 g/cc and porosity ranges between 84% and 36%. Grain density excursions plotted in the upper part of Figure 9 although not as extreme as those seen in the curve for Site 285, are still large and still appear to reflect errors in the syringe volumetric determinations. The values for grain density fluctuate, but in general decrease from around 2.85 g/cc near the top of the hole to below 2.4 g/cc at about 530 meters

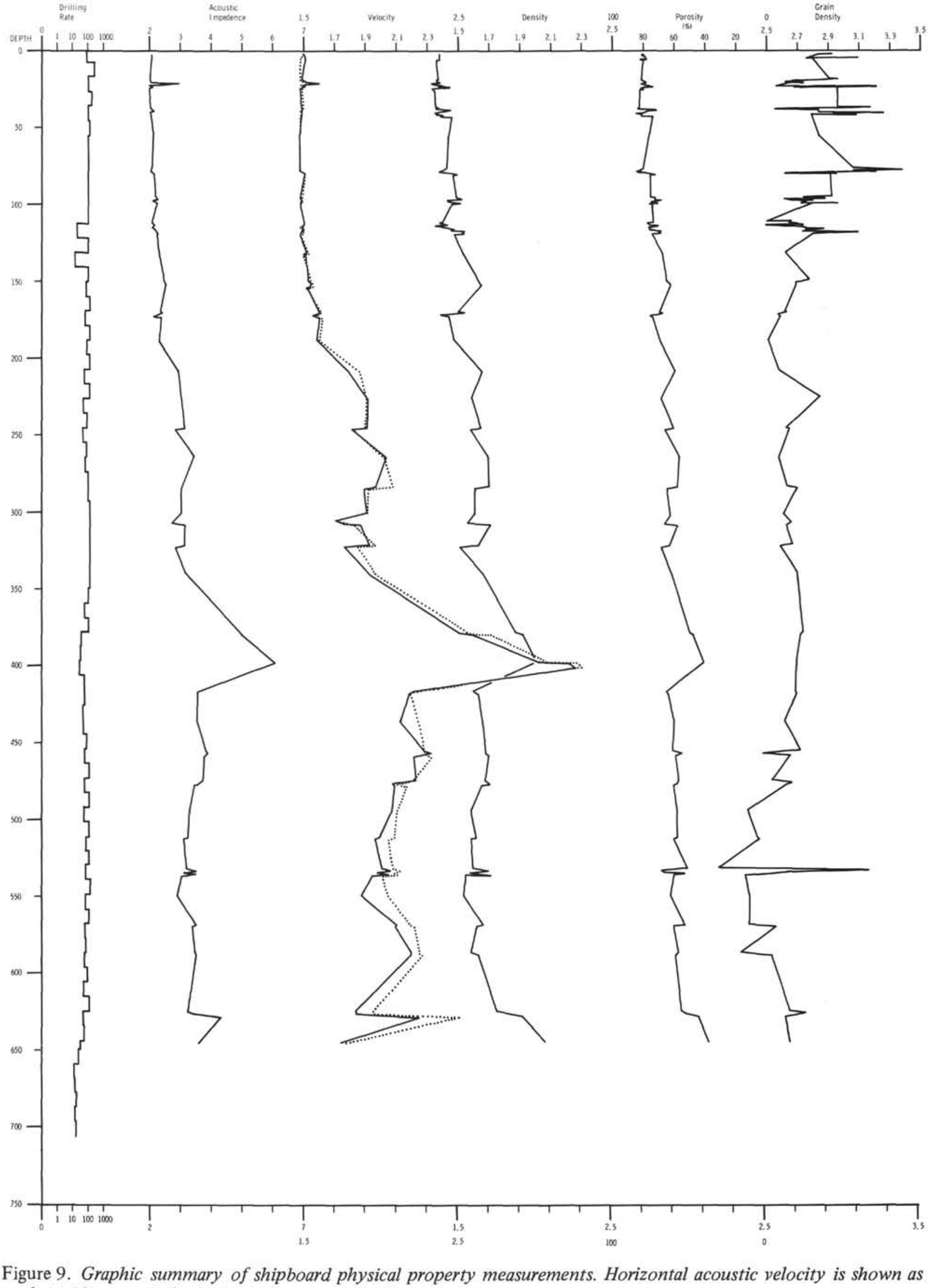

Figure 9. *Graphic summary of shipboard physical property measurements. Horizontal acoustic velocity is shown as dotted line; vertical velocity is shown as solid line.*

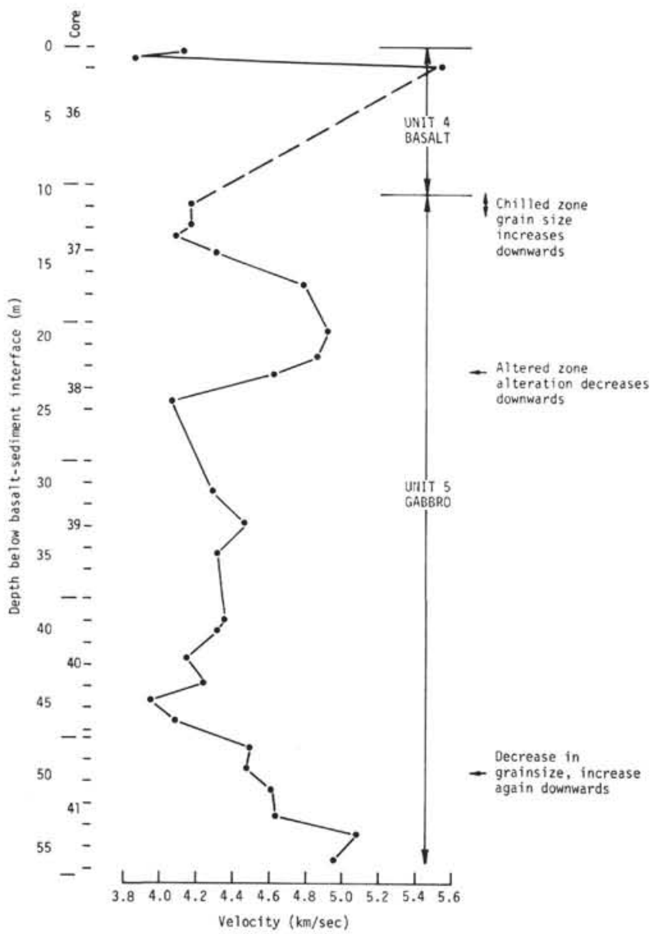

Figure 10. *Acoustic velocity measurements for Unit 4 (basalt) and Unit 5 (gabbro).*

and then increase to around 2.65 g/cc at the base of the sedimentary sequence. A thick low velocity zone extends to about 120 meters below the sea floor, similar to that found at Site 285. As was also the case at Site 285, sedimentary velocity anisotropy at Site 286 is conspicuous in the lower part of the sedimentary column with horizontal velocity again higher than vertical velocity. The anisotropy definitely becomes established below 475 meters beneath the ocean floor. Differences in velocity range near 0.1 km/sec attaining at one point a separation greater than 0.25 km/sec, or more than 10%. Whereas the amount of horizontal versus vertical velocity anisotropy appears to be due more to the effects of compaction, the magnitude of velocity excursions appears to be controlled to a greater extent by lithologic changes. Vertical velocity values were used in each case to calculate the amount of acoustic impedance.

The volcanic ash comprising the bulk of Unit 1 is characterized by a relatively consistent low velocity and rather small density and porosity gradients. Velocity initially averages less than 1.5 km/sec, remaining below this value, except for a slight positive velocity-density excursion accompanied by a sharp contrast in acoustic impedance and correlates with a micronodule-rich zone at about 20 meters depth to a depth of 80 meters below the sea floor. Within Unit 2, which ranges from nanno ooze to nanno chalk (between 85 and 197 m), velocities gradually increase to about 1.6 km/sec coincident with a gradual increase in acoustic impedance accompanied by mild oscillations in density and porosity. Below Unit 2 and within Subunit 3A (a vitric, often sandy siltstone) velocity and density increase markedly producing a strong contrast in acoustic impedance, coincident with a decrease in porosity. Velocity averages about 1.9 km/sec, and density and porosity average about 1.65 g/cc and 60% respectively, with all three of these curves becoming noticeably more oscillatory. Maximum velocity, density, and acoustic impedance are observed coincident with a minimum porosity in the volcanic conglomerate comprising the bulk of Subunit 3B. At the base of this unit, at about 400 meters subbottom within the well-indurated conglomerate (Core 286-22-4), velocities and densities exceed 3.2 km/sec and 2.0 g/cc, respectively, with porosity dropping to less than 40%. Downward, below the conglomerate, a marked change in physical properties occurs near the top of the vitric siltstone of Subunit 3C. Here density decreases and porosity increases abruptly, returning to levels observed in the vitric siltstone of Subunit 3A (above the conglomerate). Velocity and acoustic impedance also drop sharply, but not to the level characteristic of Subunit 3A, perhaps reflecting the presence of minor amounts of volcanic conglomerate contained within Subunit 3C or, alternatively, suggesting a greater degree of cementation (or welding) of grain boundaries, or both. Velocity and density continue to decrease downward, along with acoustic impedance, reaching a minimum below the middle of Subunit 3C (550 m subbottom) where the gradient reverses. At the base of the column (base of Subunit 3C) within 25 meters of basalt, large excursions are seen in all the physical property curves and a sharp contrast in acoustic impedance occurs. Velocity initially rises sharply, only to abruptly fall back within the range of values found for the clay and altered vitric siltstone overlying the basalt. Porosity continues to gradually decrease downward in Subunit 3C with a few mild excursions.

Velocities measured in the basalt and underlying intrusive gabbro (Figure 10) correlate well with both lithology and degree of alteration. Basalt velocities range from less than 3.9 to more than 5.5 km/sec (Core 286-36-1). The lower velocities characterize the brown-stained variolitic basalt, whereas the high velocity is associated with the black, dense, fine-grained basalt. In the underlying gabbro, velocity also varies considerably with grain size and degree of alteration. Low velocities (around 4.1 km/sec) are observed at the base of and immediately below the gabbro chill zone (Cores 286-37-1 and 286-37-2) increasing with depth in the gabbro to about 4.9 km/sec (Core 286-38-1) approximately 10 meters below the top of the gabbro (20 m below the basalt sediment interface). A sharp drop in velocity occurs about 14 meters into the gabbro (Core 286-38-4) which correlates with a sudden increase in alteration. From that point down, velocity gradually increases coincident with a decrease in alteration and an increase in grain size until the gradient reverses within the top of Core 286-40 (about 28 m into the gabbro or about 38 m below the top of the basalt). The subsequent decrease in velocity may be due to an increase in quantity or size of filled vugs reported to occur throughout the gabbro. At about 38 meters below the top of the gabbro (48 m below the top of the basalt) an abrupt increase in velocity occurs (from 4.1 to 4.5 km/sec) coincident with a sudden drop in grain size. From this point downwards velocity increases rapidly to a maximum value of over 5.0 km/sec near the base of the cored gabbro interval.

CORRELATION OF REFLECTION PROFILE WITH DRILLING RESULTS

Seismic data from underway and on-site sonobuoy profiles correlate well with lithologic and physical breaks. Strong reflectors occur at 0.11, 0.31, 0.41, and 0.68 sec, and moderate reflectors at 0.04, 0.23, and 0.28 sec (see Figure 4 annotated sonobuoy profile). Using the velocity profile (see Physical Properties section), these correspond to depths of 83 meters (0.11), 244 meters (0.31), 340 meters (0.41), and 650 meters (0.68) for the strong signals; and 30 meters (0.04), 174 meters (0.23), and 244 meters (0.28) for the moderate strength reflectors.

The 0.11-sec reflector marks the top of Unit 2 and a small excursion in velocity, density, and porosity. The 0.23-sec signal is marked also by sharp excursions in physical properties about 20 meters above the top of Subunit 3A. The top of the high velocities in the conglomerates of Subunit 3B is marked by the 0.41-sec reflector, and the 0.68-sec reflector marks the surface of the basalt extrusive at the base of the hole. The basalt/gabbro boundary cannot be resolved, the separation being only 4×10^{-3} sec at the measured velocities.

The reflectors at 0.04, 0.23, and 0.28 sec represent velocity, density, and porosity excursions within Subunits 1A and 3A.

PALEONTOLOGY

Biostratigraphic Summary

The microfossils from the 35 sediment cores at this site represent a section from Pleistocene to upper middle Eocene, in which the Miocene is doubtfully represented (Figure 14). Biostratigraphy is complicated by a scarcity of planktonic foraminifera. Nannofossils are more abundant throughout the hole, but they too are absent or very poor at certain horizons. Wherever possible, the internal evidence of Site 286 forams and nannoplankton has been supplemented by constructing Radiolaria tie lines between Sites 286 and 289 and extrapolating Site 289 foram zones along these lines into Site 286.

The youngest fossiliferous sediments examined in Hole 286 are in Sample 286-1-1, 110-111 cm and are of Pleistocene age, belonging to the *Gephyrocapsa oceanica* Zone (nanno). Reworked mid-Tertiary nannoplankton occur in the sample.

Nannoplankton determinations place the Pleistocene-Pliocene boundary between Samples 286-2, CC and 286-3-4, 95-96 cm, Cores 286-3-2 and 286-3-3 being barren. The boundary is drawn at the incoming of *Gephyrocapsa* cf. *caribbeanica* sample in 286-2, CC, the first appearance of *Gephyrocapsa* in the hole. Foraminifera determinations suggest a higher position for the boundary: between Sample 286-2-6, 14-16 cm with *Globorotalia tosaensis* and *G. multicamerata*, and 286-2-3, 30-32 cm with *Globoquadrina dutertrei*. Strong evidence exists, however, that the Pliocene fauna of Sample 286-2-6, 14-16 cm is derived. Reworked middle Miocene and Pliocene nannoplankton are detectable in 286-2-6 and 286-2-4 (and in other samples) and derived foraminifera of latest early Pliocene and early early Pliocene ages (3.04-3.7 m.y.) are found in Sections 286-2-5 and 286-2-4. The nannoplankton positioning of the boundary is therefore adopted here.

Cores 286-4 and 286-3 have a mixed Pliocene-Miocene-Oligocene nannoflora. The early/late Pliocene boundary may lie between the possible *Discoaster tamalis* Zone flora of Sample 286-3, CC and the *Ceratolithus rugosus* Zone flora of 286-4-1.

However, a foraminifera fauna with *G. altispira* and right-coiled *P. primalis* but lacking *S. seminulina* (younger than 3.0 m.y.) occurring in Sample 286-3, CC suggests that this sample is of late Pliocene age. The boundary is placed between Cores 286-3 and 286-4. Both foraminifera and nannoplankton sequences recovered from the site may in fact contain a gap coincident with the positioning of the intra-Pliocene boundary and possibly accounted for by the uncored interval between Samples 286-3, CC and 286-4-1. Due to incomplete recovery in Core 286-4, this interval could be as much as 17.5 meters.

Foraminifera and nannoplankton determinations both suggest that Core 286-4-1 is lower Pliocene. The underlying 9.5 meters is uncored and the upper 4.5 meters of Core 286-5 is unfossiliferous, a 14.0-meter section of the hole being thus undated.

Rare nannoplankton possibly belonging to the topmost Oligocene are present in Sample 286-5, CC, and reworked fossils including Miocene nannofossils occur in Sections 286-5-4 and 286-5-5. Core 286-6 is unquestionably late Oligocene with a *Sphenolithus ciperoensis* Zone nannoflora and with *Globigerina selli* and *Globorotalia siakensis* in Sample 286-6-3, 23-25 cm.

Thus very considerable uncertainty exists over the dating of the segment below Sample 286-4, CC and above 286-6-1. The top of the Oligocene (top of Chattian Stage) is drawn just below Sample 286-5, CC. Core 286-5 is taken to be some part of the Miocene (or younger), but the greater part of the Miocene is considered to be either condensed between Samples 286-4, CC and 286-5, CC, or, in part cut out by a discontinuity across which Oligocene and Miocene nannoplankton were reworked into Core 286-4.

The advantage of considering Core 286-5 to be Miocene (or younger) rather than late Oligocene is that a uniform, low depositional rate results for the homogeneous segment of glass-free nanno ooze from Samples 286-6-1 through 286-9-2.

Radiolaria tie lines between Sites 286 and 289 show that Core 289-100 containing the P19-P20 boundary (Rupelian-Chattian boundary) correlates with some part of the uncored interval between Cores 8 and 7 of Site 286. Further, the junction between *R. hillae* and *S. predistentus* Zones, identified in Core 289-100 also lies between 286-7, CC and 286-8. The junction between *S. predistentus* and *S. distentus* (nanno) zones, considered to be intra-Chattian, is between 286-7, CC and 286-7-6.

The Oligocene-Eocene boundary is difficult to delineate precisely on the evidence of foraminifera, but seems to fall between Sample 286-8-2, 80-82 cm bearing the Zone P18, lowest Oligocene, fauna of *Globigerina tapuriensis* and Sample 286-9-3, 80-82 cm which contains uppermost Eocene (P17) species *Globigerinita globiformis* and *Globigerina pera.* Radiolaria tie lines between Sites 286 and 289 provide confirmation that at least the lower half of Core 286-9 belongs to P16 (equivalent to Core 289-102) while the lower half of Core 286-8 is immediately below the P19 level of Core 289-101. P17 is probably largely confined to the uncored interval between Cores 286-8 and 286-9, and the P17/P18 boundary (Eocene/Oligocene boundary) almost certainly lies within this interval. The nannoplankton show that Samples 286-9-1, 55-56 cm through 286-9-5, 45 cm and possibly Core 286-8 belong to the *Cyclococcolithina formosa* Zone.

The upper Eocene-middle Eocene junction can be recognized by the foraminifera only insofar that it must lie above Core 286-23, CC, which contains only long-ranging species known from Zones P11 through P14.

The basal upper Eocene Zone P15 is undetected, and Zone P11 forms are found reworked in Core 286-19, CC. Radiolaria tie lines between Sites 286 and 289 show that the P14/15 boundary (Lutetian/Bartonian: middle Eocene/upper Eocene boundary) between Cores 289-108 and 289-107 must lie between Section 286-17-2 and Sample 286-16, CC. There is substantial agreement with the nannoplankton which suggests a slightly lower position for the boundary between Samples 286-17-2, 97-98 cm and 286-17-1, 15-16 cm—the junction between *Discoaster saipanensis* Zone and *Discoaster barbadiensis* Zone. The position is adopted.

The oldest fossiliferous sediments are still of middle Eocene age. Foraminifera in Sample 286-30, CC have a known maximum range from P11 through P13. Cores 4 through 286-32-1 belong to the combined *C. reticulata-D. saipanensis* zones and the final segment with adequate floras—Section 286-32-2 through Sample 286-33, CC—possibly to the *R. umbilica* Zone. The lowest adequate Radiolaria fauna of Sample 286-31, CC is of the *Podocyrtis mitra* Zone, apparently above the top of *Podocyrtis ampla.* It seems highly probable that the lowest, unfossiliferous segment of sediments is still within the middle Eocene.

Thicknesses of biostratigraphic units at Site 286 appear to be very largely determined by volcanogenic content. The expansion of the incomplete Lutetian by volcanic siltstones, sandstones, and conglomerates is obvious: biogenic components make only a minor contribution to sediment bulk. More than half the Bartonian thickness consists of the Subunit 3A vitric siltstones, again dominantly volcanogenic sediments, the remainder of the succession consisting of Unit 2 "nanno-ooze." A very rough average Bartonian sedimentation rate is 20 m/m.y. By far the greatest part of Bartonian time, however, is probably represented by ooze. If the upper, nanno-ooze section of Bartonian is considered to represent all the Bartonian, the sedimentation rate is of the order of 7.6 m/m.y. for this segment considered separately. This, however, is not a realistic figure for the Site 286 "nanno-ooze" as a whole. The "ooze" segment (Unit 2) is inhomogeneous. Smear-slide data show an abrupt decline in dilution by volcanic glass in Core 286-9. The glass-poor segment extends to the top of Core 286-6 and is virtually coextensive with the proved Rupelian and Chattian (i.e., Oligocene). Considering Core 286-5 to be Miocene (see above) very rough estimates of sedimentation rate for the Oligocene stages are 4.9 m/m.y. and 5.1 m/m.y., respectively. Change in rate from the glass-rich upper Bartonian ooze to the glass-poor Oligocene ooze is striking.

By chance, the date of onset of glass-poor ooze deposition is approximately coincident with the age of the youngest sediments preserved below the Eocene-Oligocene vacuity at Site 289, so that the faunal succession unpreserved at Site 289 is present in only an abnormally thin development at Site 286.

Water depth changes at Site 286 can tentatively be deduced from abundance and preservation of calcareous fossils. The scarcity of planktonic foraminifera throughout Lutetian, Bartonian, Rupelian, and Chattian (Cores 286-35 through 286-6) might suggest deposition close to or below foram solution depth for this entire column. Only benthonic forms were preserved due to rapid burial in the "shelf" sediments of volcanic origin which accompanied their transport to the depositional surface. The allegedly hemipelagic *Isthmolithus recurvus* nanno Zone floras seem to replace the truly pelagic *Discoaster barbadiensis* Zone floras in Sections 286-9-5 through 286-17-1, but this could be due to a masking of the sparse pelagic flora by "shelf" contributions in displaced sediments. The absence of planktonic foraminifera suggests that the sea floor was actually below carbonate compensation depth during this period. The bathymetric maximum appears to be recorded in Core 286-5, largely devoid of both nannofossils and foraminifera, but insufficiently coarse for the absence of fossils to be explicable in terms of dilution by inorganic detritus.

This maximum is essentially coincident with the return of volcanic glass-rich sediment (Subunit 1A) which persists to the Plio-Pleistocene. If Miocene exists at Sites 286 it must be restricted to Cores 5 and 4 (see above). Thus, the Miocene should have been deposited during a period of glass-rich sedimentation and relatively high accumulation rate. It is necessary to invoke some agency other than extreme depth to explain its minimal thickness or possible total absence. The hypothesis of mass removal of Miocene sediments by slumping in late Miocene or earliest Pliocene time at least avoids the necessity of invoking strongly erosional bottom currents during the period of probable maximum water depth.

By late Pleistocene time the depositional surface appears to have lain above both nanno and planktonic foram solution depth.

Reworking of calcareous fossils is evident throughout the succession, but no anomalies appear to occur in the Radiolaria sequence. Littoral to neritic benthonic foraminifera displaced into bathyal or abyssal depths are persistent in the Eocene and lower Pleistocene sequences, indicating significant reworking of sediments from shallow water. Reworked Oligocene and Miocene foraminifera are absent, perhaps suggesting some physical barrier to the introduction of reworked foraminiferal shallow-water sediments during this period. More probably the extinction of adjacent volcanic centers at the end of the Eocene, clearly recorded in the Site 286 column, saw the end of the island-margin environments where the earlier littoral-neritic supply had originated. Reworking of nannoplankton appears to have continued.

The occurrence of early Lutetian planktonic foraminifera in the conglomeratic facies of the late Lutetian sequence points to the break-up by volcanic activity of preexisting sediment layers of early Lutetian date and incorporation of their fragments in the late Lutetian deposits.

Foraminifera

Foraminifera assemblages and characteristics allow four biostratigraphically defined intervals to be distinguished in the cored sequence from Site 286. They are as follows:

Middle Early Pliocene-Quaternary—Cores 286-1 to 286-4

Warm-water planktonic foraminiferal faunas occurring commonly in most of the samples examined allow correlation of this unit rather precisely with the combined paleomagnetic and planktonic foraminiferal zonal scheme established in the equatorial Pacific sediments by Hays et al. (1969). Because of the complications of interpretation introduced by the presence of extensively reworked planktonic foraminifera throughout Core 286-2, the interpreted biostratigraphic positions of the examined samples are plotted against the magnetic time scale (Figure 11).

Sample 286-1, CC is correlated with the uppermost Matuyama Series by the presence of sinistrally coiled populations of both *Pulleniatina finalis* and *Globorotalia menardii, Sphaeroidinella dehiscens*, and *Globorotalia truncatulinoides*. Samples 286-2-1, 130-132 cm through 286-2-3, 30-32 cm all contain *G. truncatulinoides* as well as a dextrally coiled population of genus *Pulleniatina*, and are placed between the Olduvai and Jaramillo events of the Matuyama Series. Planktonic foraminifera from Samples 286-2-4, 140-141 cm through 286-2-6, 14-16 cm indicate an inverted stratigraphic succession with the upper lower Pliocene fauna of Sample 286-2-5, 17-18 cm overlying upper upper Pliocene faunas of Sample 286-2-6, 14-16 cm. It should be noted, however, that the foraminiferal faunas in the inverted stratigraphic sequence are in fact all found in pockets or layers of foraminiferal sand scattered in the largely yellowish-brown glass shard ash of Core 286-2.

The nannofossil flora in the foraminifera-barren Sample 286-2, CC indicates that its position is still within the lower Pleistocene. Therefore, there is a strong indication that even the upper Pliocene foraminifera of Sample 286-2-6, 14-16 cm are also of reworked origin. Additional evidence of the reworked origin of these

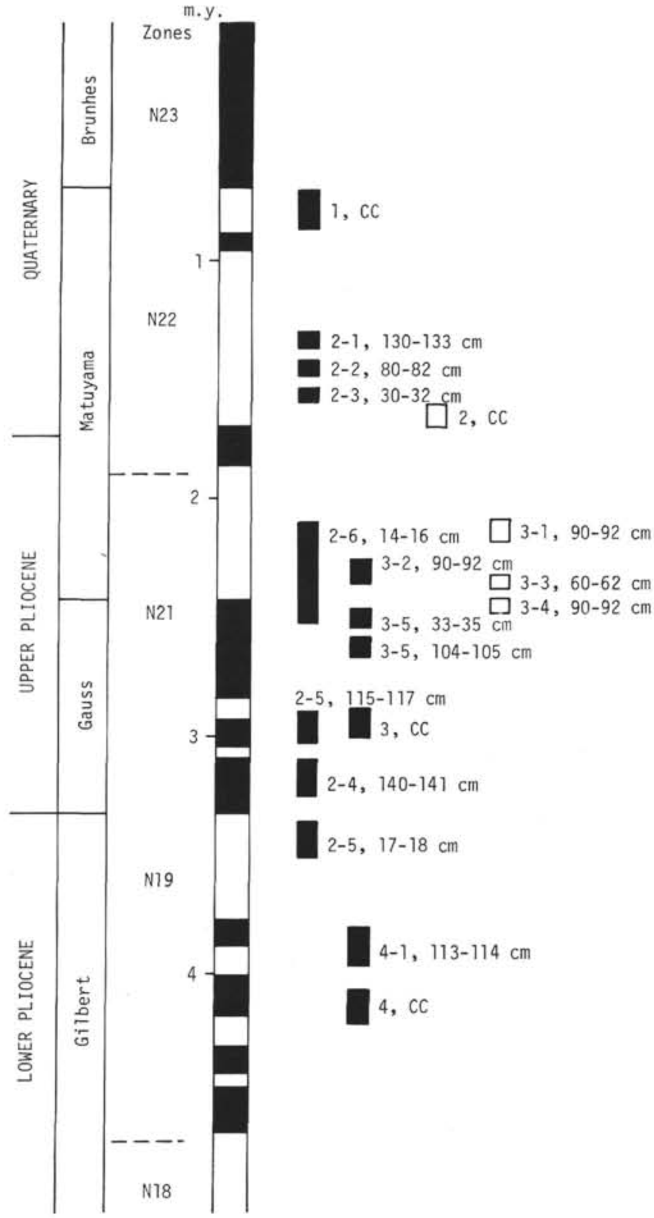

Figure 11. *The interpreted position of examined samples relative to geomagnetic time-scale. Filled-in blocks are samples containing age-diagnostic foraminifera and open blocks indicate samples barren of planktonic foraminifera. The vertical extent of blocks indicates the degree of uncertainty involved in the foraminifera-determined ages. Positions of open blocks are only approximately determined in considering ages of samples which are juxtaposed with the barren sample.*

planktonic faunas comes from the presence of a few but typical neritic benthonic species such as *Elphidium crispum* in the planktonic assemblages of Core 286-2.

Core 286-3 is correlated with the lower Matuyama-Gauss Series (upper Pliocene) by the presence of *Globorotalia multicamerata, Globorotalia tosaensis*, dextrally coiled population of genus *Pulleniatina*, and

Globigerinoides fistulosus. *Globoquadrina altispira* in Sample 286-3, CC indicate that the base of Core 286-3 reached a level between Kaena and Mammoth events of the Gauss Series. Two samples from Core 286-4 contain *Globigerina nepenthes, Globorotalia margaritae, Sphaeroidinellopsis seminulina,* and sinistrally coiled population of genus *Pulleniatina*, and are correlated with an interval below the top of Cochiti event but above the C_1 event of the Upper Gilbert Series (lower Pliocene).

Foraminifera-barren Interval (Age Indeterminate)—Core 286-5

This unit covers most of Core 286-5 and is entirely barren of foraminifera. In sample 286-5, CC a single specimen of planktonic foraminifera *Catapsydrax dissimilis* was found together with badly corroded bryozoan skeletons and calcareous algae. The lack of calcareous planktonic microfossils in this unit and the strong corrosion evident on bryozoans and algae suggest deposition below the calcium carbonate compensation depth.

Late Eocene-Oligocene—Samples 286-6-2, 91-92 cm to 286-9, CC and the Underlying Foraminiferabarren Sequence, From Samples 286-10-1, 80-82 cm to 286-16, CC

In this unit, age-diagnostic planktonic foraminifera occur only at three levels; namely Samples 286-6-3, 23-25 cm; 286-8-2, 80-82 cm; and 286-9-3, 80-82 cm. *Globigerina sellii* and *Globorotalia siakensis* occur jointly in Sample 286-6-3, 23-25 cm and are used to establish the late Oligocene (P21 Zone) age for the sample. Blow (1969) records that the ranges of these species overlap only within his P21 Zone. Sample 286-8-2, 80-82 cm contains *Globigerina tapuriensis* together with *Catapsydrax dissimilis, Globigerina glavisi,* and *G. pseudovenezuelana*, and is assigned to the lowest Oligocene Zone P18 (*G. tapuriensis* Zone). Sample 286-9-3, 80-82 cm includes *Globigerinita globiformis, Globigerina pseudovenezuelana*, and *Globigerina pera*, and the concurrent occurrence of these taxa is shown by Blow (1969) to range from P14 Zone (uppermost middle Eocene) to P16 (upper Eocene).

A conspicuous presence of displaced shallow-water (neritic-upper bathyal) benthonic foraminifera is noted, in association with deep-water (middle-lower bathyal) species, in Samples 286-6-3, 23-25 cm, 286-7-2, 113-115 cm, and 286-8-1, 140-142 cm. Neither benthonic nor planktonic foraminifera are present in Samples 286-13, CC through 286-16, CC.

Middle Eocene—Cores 286-17 (?) to 286-30 and the Underlying Foraminifera-barren Sequence From Cores 286-31 to 286-35.

Except in Sample 286-17-4, 108-111 cm, which consists of vitric siltstone, foraminifera are found exclusively in sandy volcanic conglomerates interbedded with vitric sandy siltstone and siltstone. Search for foraminifera in siltstones was totally unsuccessful. Planktonic foraminifera from Sample 286-17-4, 108-111 cm are mostly composed of well-preserved small species having a delicate test. The assemblage includes *Chiloguembelina cubensis, C. martini, Pseudohastigerina micra, P. barbadoensis*, and other globorotalids of possibly as yet undescribed species. The Bartonian-Lutetian age assigned to this sample cannot be refined any closer due to the lack of other diagnostic species. Within this unit only Sample 286-19, CC yielded age-diagnostic planktonic foraminiferal species. The joint occurrence of *Truncorotaloides rohri, Acarinina densa, A. bullbrooki, "Globigerinoides" higginsi*, and *Globorotalia spinulosa* indicates a correlation of this sample with the lower Lutetian Zone P11. However, nannofossils and Radiolaria occurring within or near this sample show the P11 age to be too old for this level. In light of the presence of abundant displaced shallow-water benthonic foraminifera in this unit, this lower Lutetian fauna is regarded also of reworked origin.

Other longer ranging middle Eocene planktonic foraminiferal species occur in various species combination in Samples 286-20, CC; 286-21-2, 140-144 cm; 286-22-2 64-71 cm; 286-23, CC; 286-26-3, 38-40; 286-26-4, 134-136 cm; and 286-30, CC. In all the samples, specimens of benthonic foraminifera are more numerous than those of planktonic forms. Benthonic foraminifera alone are found in Samples 286-21, CC and 286-23-2, 47-49 cm. Most of the benthonic foraminiferal assemblages in this unit are dominated by taxa whose still-living relatives are distributed exclusively in littoral and inner neritic depths. Typical littoral-neritic forms such as *Asterigerina* and *Amphistegina* are commonly found, in association with upper-middle bathyal forms such as *Lagena* and *Stilostomella*, in Samples 286-19, CC; 286-20, CC; 286-21-2, 140-144 cm; 286-21, CC; 286-22-2, 64-71 cm; 286-23, CC; 286-26-3, 38-40 cm; 286-26-4, 134-136 cm; and 286-30, CC. One noteworthy aspect of the benthonic foraminifera is the occurrence in Sample 286-21-2, 140-144 cm of *Lepidocyclina*, a genus of larger foraminifera which has proved to be a very useful marker for the stratigraphic correlation of shallow-marine sediments of Eocene to Miocene ages throughout the world.

Calcareous Nannofossils

Autochthonous calcareous nannofossils recovered range in age from middle Eocene to Quaternary. Substantial parts of the nannostratigraphic record are absent due to discontinuous coring, occurrence of barren intervals, incomplete recovery, and/or existence of stratigraphic breaks.

The Pliocene-Quaternary sediments are represented by Cores 286-1 to 286-4. These sediments contain obvious reworked nannofossil elements derived from sources as old as the Paleogene. In most cases, reworking masks the original composition of the assemblages and zonal assignment becomes rather uncertain and largely tentative.

Gephyrocapsa oceanica is noted down to Core 286-2-4, and this allows correlation with the *Emiliania huxleyi-Gephyrocapsa oceanica* zonal interval. The remaining part of Core 286-2 belongs to the lower Pleistocene *Gephyrocapsa caribbeanica* Zone.

The Pleistocene-Pliocene boundary is drawn between Samples 286-2, CC and 286-3-4, 95-96 cm. Sample 286-2, CC (Pleistocene) is immediately above the noncored 9.5-meter interval. Sample 286-3-4, 95-96 cm is of late Pliocene age; superjacent Samples 286-3-1, 106-107 cm; 286-3-2, 30-31 cm; 286-3-2, 120-121 cm; 286-3-3, 30-31 cm; and 286-3-3, 120-121 cm are barren.

Samples 286-3-4, 95-96 cm and 286-3-5, 2 cm are tentatively placed in the *Discoaster brouweri* Zone. Samples 286-3-5, 120-121 cm and 286-3, CC are provisionally assigned to the "*Discoaster*" *pentaradiatus* and *Discoaster tamalis* zones, respectively. Collectively, Core 286-3 is placed in the *Discoaster triradiatus-Pseudoemiliania lacunosa* zonal interval, and therefore is essentially of late Pliocene age.

Samples 286-4-1, 120-121 cm to 286-4, CC contain nannofossil assemblages correlative with the lower Pliocene *Ceratolithus rugosus* Zone. The presence of *Reticulofenestra scissura* in Sample 286-4-1, 120-121 cm and *Sphenolithus heteromorphus* in Sample 286-4, CC, indicates sources of reworking as old as the Eocene-Oligocene and Miocene.

Core 286-5 represents sedimentation near or below the nannofossil solution depth; the entire core is either barren of contains only residual nannofossil elements. Samples 286-5-1, 140-141 cm, 286-5-2, 30-31 cm, 286-5-2, 120-121 cm, 286-5-3, 30-31 cm, 286-5-4, 120-121 cm, and 286-5-5, 30-31 cm are devoid of nannofossils and therefore their age is indeterminable. However, Samples 286-5-4, 13-14 cm and 286-5-5, 120-121 cm contain extremely sparse nannofossil residues characterized by long-rayed discoasters of Miocene affinity. In Sample 286-5-4, 13-14 cm *Discoaster* sp. aff. *D. variabilis*, *Discoaster* sp. cf. *D. neohamatus* together with *Reticulofenestra scissura* (Oligocene; presumed reworked) occur indicating a middle Miocene age as a possible maximum age. Sample 286-5-5, 120-121 cm contains, besides sparse long-rayed discoasters, *Cyclicargolithus abisectus*, *Coccolithus*? *pelagicus*, *Sphenolithus moriformis*, and *Discoaster* sp. aff. *D. druggii*, and a (possible early) Miocene age seems reasonable. In Sample 286-5, CC *Cyclicargolithus abisectus*, *C. floridanus*, *Discoaster* sp. aff. *D. trinidadensis*, *Reticulofenestra* sp., *Sphenolithus moriformis*, *S. predistentus* and *S. ciperoensis* are identified. The assemblage is poorly preserved, and assignment to the late Oligocene *Sphenolithus ciperoensis* Zone is adopted.

The thin segment (ca. 19 m) between the lower Pliocene Core 286-4, CC and the upper Oligocene Core 286-5, CC containing the entire Miocene invites the suggestion of an intra-Miocene hiatus.

In contrast to the residual assemblage extracted from Sample 286-5, CC, the nannofossils in Sample 286-6-1, 150 cm are abundant and of moderately good preserva- . The assemblage is characterized by the presence of *Reticulofenestra scissura*, *Cyclicargolithus abisectus*, *C. floridanus*, *Triquetrorhabdulus carinatus*, *Sphenolithus ciperoensis*, *Zygrhabdolithus bijugatus*, and *Discoaster saundersi* and is readily assignable to the upper Oligocene *Sphenolithus ciperoensis* Zone.

Samples 286-6-2, 15-16 cm; 286-6-3, 30-31 cm; 286-6-4, 30-31 cm; 286-6-4, 121-122 cm; and 286-6, CC essentially contain the same assemblage as that found in Sample 286-6-1, 150 cm and therefore are assigned to the *Sphenolithus ciperoensis* Zone. The first appearances upsequence of *Sphenolithus distentus* and *S. ciperoensis* are in Samples 286-7-6, 120-121 cm and 286-6, CC respectively. The intervening segment is therefore largely assigned to the *Sphenolithus distentus* Zone.

The nannofossils encountered in Sample 286-7, CC are typical of the *Sphenolithus predistentus* Zone. Core 286-8 is found to fall within the lower Oligocene *Reticulofenestra hillae* Zone. The segment comprising Samples 286-9-1 to 286-9-5, 45-46 cm belongs to the basal Oligocene *Cyclococcolithina formosa* Zone.

The sediments represented by Samples 286-9-5, 65-66 cm to 286-17-1, 15-16 cm contain the association of *Isthmolithus recurvus* and *Discoaster saipanensis* and are therefore readily assignable to the upper Eocene *Discoaster barbadiensis* Zone. The upper-middle Eocene boundary drawn at the top range of *Chiasmolithus grandis* is between Samples 286-17-1, 15-16 cm and 286-7-2, 97-98 cm.

The segment including Samples 286-17-2, 97-98 cm to 286-32-1, 30-31 cm contains common to frequent nannofossils of moderately good preservation and is assigned to the combined *Discoaster saipanensis-Cyclicargolithus reticulatus* zones. Differentiation between these zones in Site 286 material is difficult due to the sporadic occurrence of *Chiasmolithus solitus*. Samples 286-3-2, 43-44 cm and 286-33, CC contain rare, poorly preserved nannofossils and are tentatively assigned to the middle Eocene *Reticulofenestra umbilica* Zone. Cores 286-34 and 286-35 are devoid of nannofossils and therefore their age is indeterminable.

Near-shore forms occurring in the middle-upper Eocene part of the sequence are concentrated at several levels. Their presence suggests transportation from shallow depositional environments, probably through turbulent water followed by rapid burial at the site. This interpretation is consistent with the high rates of sedimentation for the middle-upper Eocene part of the sequence.

Radiolaria

Radiolaria faunas adequate for biostratigraphic purposes are patchily distributed at Site 286, many samples revealing only traces of useful species or proving virtually barren. Throughout the greater part of the site even the richer assemblages are strongly diluted by volcanic glass, pumice, mineral grains, and siliceous aggregates so that slides are unsatisfactory. Tabulated frequencies cannot be directly compared with those recorded at other sites, as Site 286 samples yield far fewer specimens.

Among the Site 286 specimens processed, only Sample 286-1, CC yielded common Radiolaria. Cores 286-2 through 286-6 are essentially barren on the evidence of core-catcher samples, yielding only very occasional highly dissolved specimens. Absence of Radiolaria in this segment is probably due to solution associated with extreme water depth and very low depositional rates. Reasonably abundant but never common Radiolaria occur in Cores 286-7-2 through 286-12-2, though abundance is lower in Cores 9 and 10. In Samples 286-12, CC through 286-15, CC reasonably abundant specimens are confined to Sections 286-14-1 and 286-14-2. Comparatively rich faunas return in Cores 286-17-1 through 286-17-4. Samples from Cores 286-17-5 through 286-24, CC proved either barren or revealed very poor faunas, slightly richer samples occurring in Cores 286-18-1 and 286-23, CC. Reasonably abundant Radiolaria are found in practically all Samples 286-25, CC through 286-30, CC. Sparse Radiolaria are present in Section 286-31-2 and Sample 31, CC, Section 31-1 being barren, and these are the lowest useful faunas encountered at the Site.

Fluctuating abundance of Radiolaria below 286-6, CC is almost certainly due to variation in the degree of dilution by volcanic debris.

In Core 286-1 Radiolaria are preserved in ashy ooze; in Cores 286-7, 286-8, and 286-9-2 in very slowly accumulated, brown nanno ooze; in 286-9, CC through 286-11, CC in more rapidly accumulated, brown nanno ooze and chalk, rich in volcanic glass. Lower in the hole Radiolaria are preserved in siltstones and sandstones rich in volcanic debris and rapidly or very rapidly accumulated.

Zonal Allocation

Samples 286-31, CC through 286-21, CC belong to the *Podocyrtis mitra* Zone. The lowest fauna is apparently above the range of *Podocyrtis ampla*, the highest apparently below the morphotypic base of *Podocyrtis chalara*. The true top of the *P. mitra* Zone is thus higher than 286-21, CC.

Cores 286-17-3 and 286-17-4 apparently represent a high level in the *Podocyrtis chalara* Zone, above the morphotypic top of *P. mitra*. The *Podocyrtis geotheana* Zone is apparently unrepresented and the species has not been recognized at Site 286.

Cores 286-17-2 through 286-11, CC belong to the *T. bromia* Zone, OS.35. *T. bromia* Zone, OS.34, is represented by Samples 286-10, CC through 286-9-2; Sample 286-8, CC apparently belongs to *T. bromia* Zone, OS.33.

The base of the *Theocyrtis tuberosa* Zone, OS.32, apparently lies between Samples 286-8, CC and 286-8-3. Core 286-7 belongs to *T. tuberosa* Zone, OS.30.

Sample 286-1, CC almost certainly belongs to the *Ommatartus tetrathalmus* Zone, OS.1.

For tabulation of Radiolaria see Holdsworth (this volume).

SEDIMENTATION RATES

As at Site 285 the sedimentation rate shows a general decline upwards from (on corrected thicknesses) an initial rate of about 230 m/m.y., but there are 12 perturbations in the upper part of the curve (Figure 1, Table 3). As the supply of volcaniclastic sediment declined so the depositional rate decreased to about 80 m/m.y. in Subunit 3A and 16 m/m.y. in the late Eocene to early early Oligocene segment of Unit 2. In the late early Oligocene the sedimentation rate dropped to about 3 m/m.y. Little of the sediment of this segment is represented in the cores, but in Samples 286-7, CC and 286-8, CC the only foraminifera present are benthonic forms only.

The sedimentation rate increased slightly in the remainder of Unit 2 averaging about 6 m/m.y. The rate is still low for biogenic ooze and planktonic foraminifera are rare. The calcium carbonate values are low and the sediment is mostly yellowish-brown. The sediment was probably deposited close to the depth of total solution of nannofossils. The underlying section was probably deposited below that depth.

In Subunit 1B the sedimentation rate reached a minimum of 2 m/m.y., assuming an 8 m.y. hiatus between Subunits 1A and 1B. The presence of reworked older forms and rare shallow-water fossils (bryozoans and algae) indicates transportation and probably intermittent sedimentation in this abyssal clay.

The sedimentation rate increased again in the upper part of Unit 1 being 8 m/m.y. from 45 to 64 meters and 18 m/m.y. from 0 to 45 meters. The influx of volcanic ash and shallow-water-derived forms are taken as indicative of the derivation of sediment from the New Hebrides Islands to the east. The reversal of sequences noted in the Paleontology section in Core 186-2 could be the result of slumping or reworking; in either case the sedimentation rate has been increased.

The time scale used in this section is that compiled by Vincent (1974).

SUMMARY AND CONCLUSIONS

Summary

The following five lithologic units were sampled at Site 286. These units are, in descending order:

Unit 1 (0-83 m): Glass shard ash that is rich in Radiolaria, nannofossils, micarb, and clay. Two subunits are recognized, as follows:

Subunit 1A: Glass shard ash rich in Radiolaria, nannofossils, and micarb. Pliocene to Pleistocene.

Subunit 1B: "Abyssal red clay" composed of glass shard ash and zeolite and micronodule-rich clay. Fossils are rare, but a small flora of coccoliths from Core 286-5-4 indicates an Oligocene age. These fossils may be reworked and a Miocene age is postulated.

Unit 2 (83-197 m): Nanno ooze and nanno chalk, mixed with accessory to moderate amounts of glass shard ash. Upper Eocene to Oligocene.

Unit 3 (197-649 m): Vitric siltstone, vitric sandstone, and volcanic conglomerate. Middle-upper Eocene. The subunits are recognized as follows:

Subunit 3A (197-230 m): Upper vitric siltstone;

Subunit 3B (230-31m): Volcanic conglomerate;

Subunit 3C (311-649 m): Lower vitric siltstone with minor vitric sandstone and very minor volcanic conglomerate.

Unit 4 (649-659 m): Basalt.

Unit 5 (659-706 m): Intrusive gabbro.

The sedimentation rate during the deposition of Unit 3 was high, commencing at around 230 m/m.y. for Subunits 3B and 3C and declining to about 80 m/m.y. for Subunit 3A. These units were deposited above the foram and nanno solution depths. In the late Eocene and Oligocene when Unit 2 accumulated, the supply of ash decreased upwards and most of the sediments were deposited between the foram and nanno solution

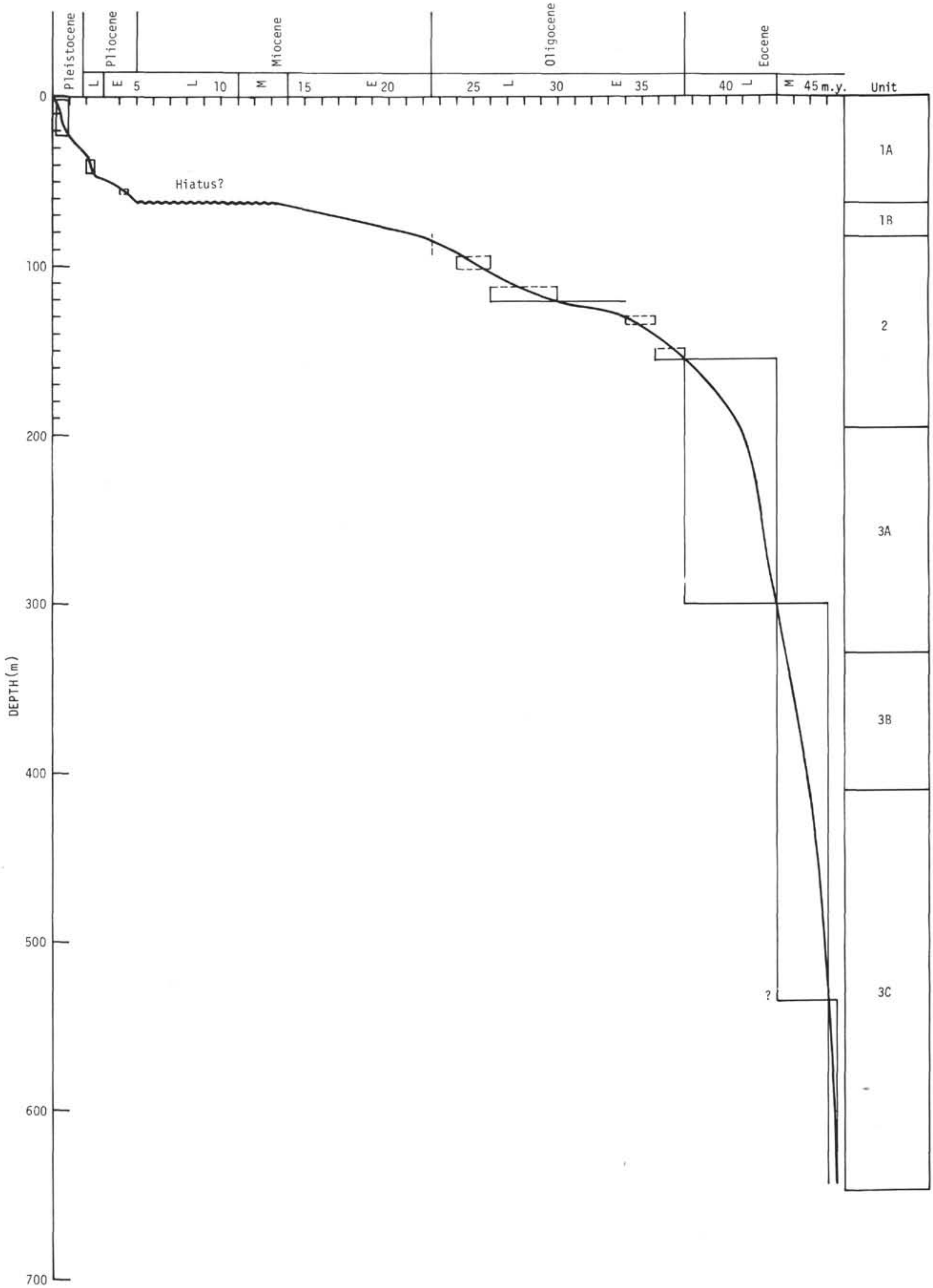

Figure 12. *Sediment accumulation curve for Site 286 based on nannofossil age determinations. (Time scale of Vincent, 1974.)*

TABLE 3
Sedimentation Rates, Site 286

Unit	Age (m.y.)	Depth (m)	Interval Thickness (m)	Porosity (%)	Thickness Corrected to 80% (m)	Sedimentation Rate (m/m.y.) Observed Thickness	Sedimentation Rate (m/m.y.) Thickness Corrected to 70% Porosity
1A	0-2.5	0-45	45	80	45	18	18
	2.5-5	45-64	19	79	20	7.6	8.0
1B	(?13-?22)	64-83	19	79	20	(2.1)	(2.2)
2	?22-30	83-121	38	75	48	4.8	6.0
	30-34	121-130	9	71	13	2.3	3.3
	34-40.7	130-197	67	68	107	10	16
3A	40.7-43.8	197-330	133	62	253	45	80
3B	43.8-44.8	330-411	81	61[a]	158	80	160
3C	44.8-47	411-649	238	58	500	110	230

Note: Values in parentheses based on an assumed gradient of the sediment accumulation curve.
[a]Porosity of conglomerate unit interpolated.

depths. The accumulation rate was at first about 16 m/m.y. then declined to around 3 m/m.y. and increased to about 6 m/m.y. at the time that the site passed below the nanno solution depth into an abyssal clay sequence at about the end of the Oligocene. Abyssal clay deposition may have continued through most of the Miocene but if deposited was largely eroded off before the deposition of the early Pliocene to Pleistocene glass shard ash (Unit 1) which accumulated initially at a rate of 8 m/m.y., increasing to 18 m/m.y.

Reworked fossils have been found at a number of levels in the cores. The coarse conglomeratic unit contains a mixture of planktonic and benthonic foraminifera. The benthonic forams include forms found in the littoral to inner neritic zone. Shell fragments, bryozoans, and algal fragments were also found. The oldest planktonic foram assemblage located occurs in this unit (Sample 286-19, CC); it belongs to Zone P11 (46.5-48 m.y.) while the enclosing strata are assigned to the *Discoaster saipanensis* Zone (43-44.5 m.y.). Upper and middle bathyal forams were noted in cores down to 550 meters, but not at lower levels of Subunit 3C. Shallow-water displaced forams were not noted in Subunit 3A, but were again reported in Unit 2. Corroded bryozoans and calcareous algae were found in the base of Subunit 1B (286-5, CC). Reworked Oligocene nannofossils occur in the same unit immediately above this.

Subunit 1A contains a variety of reworked planktonic forams which are derived from sediment contemporaneous with the formation, (early Pliocene to Quaternary) and occasional neritic forms were located. The nannofossil assemblages include forms derived from sediment of comparable age, but also include forms from the Miocene and Eocene-Oligocene.

Discussion

Site 286 is located in a tectonically complex region, about 55 km west of the boundary of the Pacific and India plates. In this region, the plate boundary is marked seismically by an easterly dipping Benioff Zone (Dubois, 1971) and bathymetrically by the North and South New Hebrides trenches that lie to the west of the New Hebrides Islands. Both the trenches and the island chain trend 20°W of North. To the south of the site are the Loyalty Islands and southwest of them is the island of New Caledonia, both of which trend about 50°W of North. At the southern end of the Loyalty Islands the sea floor slopes down into the South New Hebrides Trench, thus isolating a wedge-shaped area of sea floor in which Site 286 is located.

Between Malekula (New Hebrides Islands) and the site, the sea floor slopes gently downwards to the west. There is a gap in the continuity of the trench between the islands of Malekula and Espiritu Santo, but there is no gap in the seismicity (Dubois, 1971). West of these islands the east-west ridges of the wedge-shaped area of sea floor, in which Site 286 is located, trend into the New Hebrides Island chain. The Scripps Bathymetric Map of the South Pacific (see Figure 1) shows the site to be located 90 km to the south of the crest of an east-west ridge that shallows to under 3000 meters. To the north of this is a narrow trough and north of this again is a broad ridge shallowing to 700 meters. South of Site 286 the sea floor deepens to 5000 meters in a series of steps over a distance of 90 km, and then rises irregularly to the Loyalty Islands. The depression according to the Scripps map connects with the northern end of the South New Hebrides Trench.

The seismic profiles approaching (Figure 3) and leaving (Figure 13) Site 286 show that much of the stratigraphic column, the bulk of which is the Eocene turbidite sequence, has been deformed along with the sea floor. The structure has been modified in places by piercement structures. The R/V *Kana Keoki* track, on which the site was selected, indicates that the same features continue to the north. The regional extent of the sediments is discussed further in Packham and Terrill, this volume. It is clear, however, that the middle to early late Eocene volcanogenic unit at least is involved in the

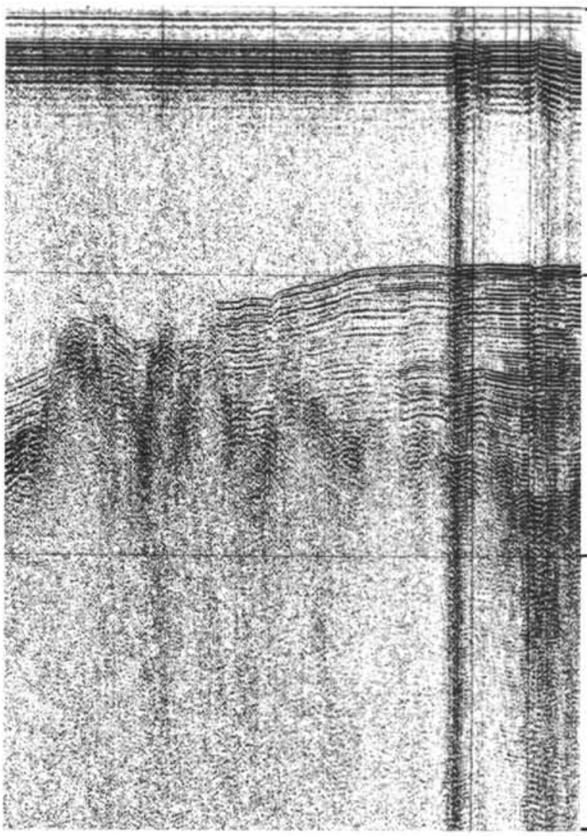

Figure 13. *Seismic profile taken on D/V* Glomar Challenger *on leaving Site 286.*

deformation. The early Pliocene to Quaternary sediments appear to flank a horizontal basin or channel fill immediately to the north of the site. Similar deposits are seen to the west on the profile leaving the site (Figure 14). These occur at lower levels to the west, giving the appearance of having been derived from an eastern source (?the New Hebrides).

The lithologic history of the site has been interpreted in the Lithologic Summary and the principal points are:

1) Rapid deposition of a submarine fan at the base of a volcanic ridge took place directly on basaltic flows (Unit 4) in middle Eocene time. Active andesitic volcanism continued until near the end of the Eocene. Deposition of the siltstone-sandstone sequences was probably by turbidity currents in relatively deep water, but above the foram solution depth during Subunit 3C time and near that depth during Subunit 3A time. The nonbedded conglomerates (Subunit 3B) were possibly formed by debris-flow. Sediments originated in shallow water (abundant shallow-water fossils are present).

2) Volcanic activity declined sharply during the late Eocene and Oligocene. Mainly biogenic sediments were deposited in late Eocene and Oligocene with small amounts of ash throughout Unit 2. The depositional surface was below the foram solution depth and above the nanno solution depth.

3) In the latest Oligocene to perhaps Miocene time, abyssal clay rich in glass shards (Subunit 1B) was deposited below both the foram and nanno solution depths. The subsidence indicated by microfossil dissolution follows the pattern expected during progressive cooling of the lithosphere after formation.

4) A period of nondeposition or erosion may have occurred before the early Pliocene sediments of Subunit 1A were deposited, or a highly condensed sequence of unfossiliferous Miocene strata may be present in the uncored interval. This is in contrast to the thick volcanic sections at Sites 205 and 285.

5) Volcanic activity was more or less continuous throughout the Pliocene and Pleistocene, but at some distance (glass shard ash through Subunit 1A). Reworked fossils, including shallow-water, benthonic neritic species of Miocene and Pliocene age in the upper part of Unit 1 (Core 286-2 of Pleistocene age), suggest erosion of older shelf deposits nearby (?New Hebrides or Loyalty Islands) during the Pleistocene. Clay in portions of Core 286-2 containing the reworked fossils also may have been derived from nearby land.

The turbidite-volcanogenic succession was deposited in a basin much simpler in structure than at present exists. This is necessitated by the evidence of deformation seen in the profiles and the depositional processes involved. This is in contrast to Site 285 where the evidence of the profiles indicated that the small depositional basins existed prior to the deposition of the volcanogenic turbidites. It also appears from the nature of the sedimentary succession at Site 286 that late Eocene to latest Oligocene time was one of progressive decrease of accumulation rates and probably increase of water depth. In view of the lack of contamination of the ooze sequence (Unit 2) with reworked clastic or biogenic sediment (apart from shallow-water displaced forams), it is likely that deformation of the sea floor mentioned previously occurred during, or more likely after, the deposition of Subunit 1B (latest Oligocene or earliest Miocene).

Three alternatives are available for the source area of the Eocene andesitic volcanic detritus; the Loyalty Islands to the south, the New Hebrides to the east, or one of the submarine ridges north of the site rather than from the New Hebrides. Seismic profiles presently available suggest that the strata sampled at Site 286 extend over much of the triangular area of sea floor bounded by these features and the New Hebrides Trench. The rocks of the New Hebrides Islands are dominated by lower to upper Miocene volcanic rocks and clastics (Mitchell and Warden, 1971), including abundant andesitic rocks (Colley and Warden, 1974). No trace of these are found at Site 286. Since a subduction zone exists between the site and the islands, it is reasonable to suppose that in the early Miocene the islands were located much further from the site. Even if a trench did exist between the site and the islands, had they been in their present location, accumulations of Miocene airborne ash would have been anticipated. Their presence in the vicinity cannot be inferred from our drilling result before the early Pliocene and the "collision" of the east-west ridges to the north of the site with the New Hebrides may have taken place in the Pleistocene. Shallow-water foraminifera are found in the Pleistocene part of Subunit 1A.

Emplacement of the ultramafic bodies on New Caledonia took place by obduction in the early Oligocene (Avias, 1966; Dubois, et al., 1973; Brothers and Blake, 1973). The implication of this finding is that a plate boundary passed through New Caledonia at that time and that Site 286 lay on an adjacent plate to the east. The absence from the site of detritus which was eroded from New Caledonia during the later part of the Oligocene and prior to the early Miocene transgression that occurred on the island is puzzling. This sediment may have been deposited in the Loyalty Basin (between the Loyalty Islands and New Caledonia) and the northern part of the New Caledonia Basin. Unfortunately, little is known of the geology of the Loyalty Islands. They appear to be composed of Miocene and later flat-lying limestones resting on a volcanic basement (exposed on Mare Island) (World Geological Map, Australia and Oceania, Sheet 8). The seismic profile taken on *Glomar Challenger* between Sites 285 and 286 shows the sequence drilled at Site 286 extending up the flanks of the Loyalty Island ridge suggesting that the elevation of the Loyalty Islands postdates the volcaniclastic sequence and may have taken place at the time of the emplacement of the New Caledonia ultramafics in the early Oligocene. If the Loyalty Islands formed some kind of a barrier in the Oligocene it might be suggested that they represent the eroded remnant of the Eocene volcanic arc and that the boundary between the Australia and Pacific plates (a subduction zone) lay to their south, between them and New Caledonia during the Eocene as well as the Oligocene. In its simplest form, this model would imply that the supposed Eocene crust at Site 286 was accreted onto the margin of the Pacific plate in the manner that the Fiji Plateau is thought to have been added to it. The evidence from the seismic profiles, however, does not support this view. The alternative model is that a ridge to the north or east of Site 286 was a volcanic arc and a subduction zone lay to the north of it. The shallow ridge to the north of the site could well have been part of the arc supplying the volcanic debris. A further possibility is that the arc may have moved away to the east or north as the sea floor developed. Relicts of such an arc may be represented by Fiji where Eocene volcaniclastic sediments are abundant (Rodda, 1967) or perhaps in the deeper part of the New Hebrides. Although no Eocene volcanics can be recognized, Coleman (1970) has recorded the presence of derived shallow-water Eocene fossils. A northerly or easterly arc would require development of the marginal basin on the edge of the India plate.

The evidence of overthrusting in New Caledonia in the Oligocene and possibly the decline in abundance of volcanic debris in the latest Eocene and the Oligocene suggest the cessation of subduction and the transfer of interplate motion to obduction. It appears that the deformation of the sea floor in the vicinity of Site 286 in the late Oligocene or the Miocene is an event which followed the cessation of overthrusting in New Caledonia and may have been associated with the formation of a new subduction zone to the north. The accumulation of volcanic products associated with this new zone could have been responsible for the formation of the New Hebrides as a volcanic arc. Since shallow-water forms are associated with volcanism in earliest Miocene, the deformation and the postulated development of a new subduction zone would have had to occur in Oligocene time. The polarity of such an arc is not evident from the results of drilling at Site 286. The influence of the New Hebrides is seen in the lower Pleistocene to Quaternary sediments.

It should be noted that the regional Eocene-Oligocene unconformity recorded by Kennett et al. (1972) and found on Leg 30 at Sites 287 and 289 (also inferred at Site 288) is absent at Site 286. The Norfolk Ridge and its extension through New Caledonia may have been an effective barrier at this time to the deep currents thought to be responsible for the break in sedimentation in the New Caledonia Basin, Coral Sea, and on the Lord Howe Rise.

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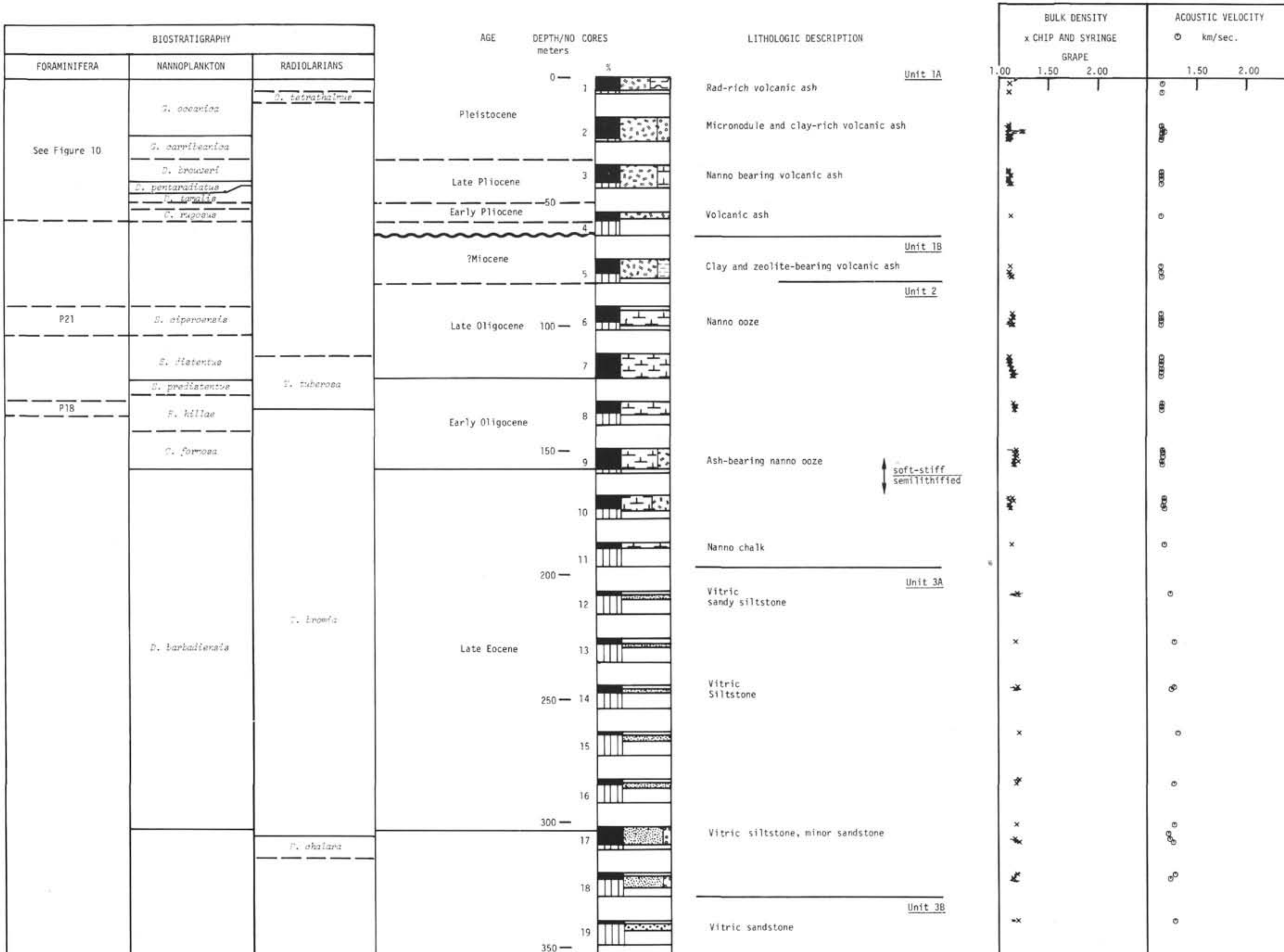


Figure 14. *Composite biostratigraphy, lithology, and physical properties, Site 286.*

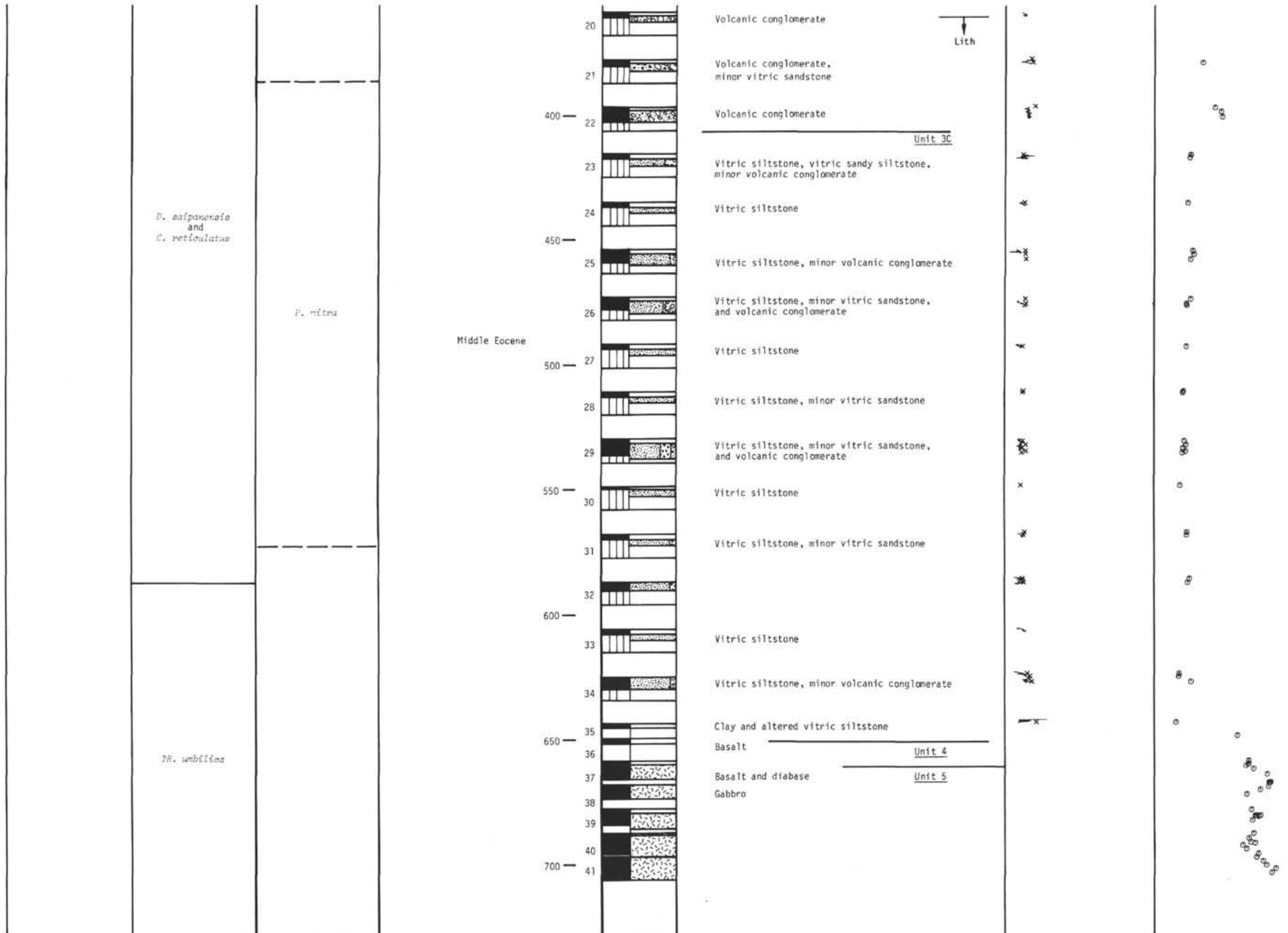


Figure 14. *(Continued).*

APPENDIX A
Smear-Slide Determination, Site 286 (values in percent)

Sample (Interval in cm)	Depth (m)	Grain Size: Sand	Silt	Clay	Quartz	Feldspar	Clay minerals	Heavy minerals	Mica	Rock fragments	Volc. glass	Pyrite + magnetite	Micronodules	Zeolite	Micarb	Calc. spicules	Forams	Nannos	Radiolaria	Sponge spicules	Diatoms + Silicoflag.	Plant debris	Lithologic Unit
1-1, 96	0.96	30	55	15	2	2		2			18		20		5			10	30	2	7	2	
1-1, 140	1.40	10	80	10	2	3		2			18		5	2	10		2	2	30	2	21	1	
1-2, 100	2.50	3	97		3	2			2		48		10		10			10	5	5	5		
1-4, 28	4.78	3	97			1					15						5	70	2	5	2		
1-4, 112	5.62	10	70	20			5	5			10		5	3	10		2	10	33	5	12		
1-4, 145	5.95	2	98		1	2					40		2	5				5	5	15	5		
1-5, 32	6.32		100		2	3			2		28		5	10	30			10		10			
1, CC	7.60				2	2		2			30		10		3		1	10	26	2	11	1	
1, CC	7.60	30	65	5	2	2					49	1			1		2	25	5	3	10		
1, CC	7.60	25	70	5	2	1			1	2	54				3		5	12	5	10	5		
2-1, 69	17.19	10	90		1	1			1		82							15					
2-1, 130	17.80	2	60	38			10	5			10	2	2	1	10			56		2		2	
2-2, 96	18.96		90	10							95		2					3					
2-2, 133	19.33	5	60	35	5	3	30				48		5	1				3				5	
2-3, 41	19.91				1			1	2	1	78		2	5				10					1A
2-3, 140	20.20	10	60	30	5	2	30	3			48			5						2		5	
2-4, 75	21.75	80	20		7	7			2		27						35	20		2			
2-4, 106	22.06	5	85	10							5				70		20	5					
2-4, 130	22.30	10	85	5	2	5			1		79	2	10					1					
2-5, 16	22.66	80	20		1										5		84	15					
2-5, 110	23.60	10	70	20	10	5	11	3			30		25	5	5			2		2		2	
2, CC	25.60	2	45	50	2	3	28				15		15	15	2			20			tr		
3-1, 145	36.95				2	1			3		64		15	10	5								
3-2, 8.5	37.09		50	50	3	2		tr			91		1	3									
3-4, 95	40.95		70	30			5				5	3	2	10	8			67					
3-5, 105	42.55	80	20								2		2				76	20					
3, CC	43.10	5	51	44	5	10	44	5			16		10		5			3				3	
4-1, 96	55.66		90	10	2	2			5		81		10										
4-2, 60	56.60		100								25				10		15	40		1			
4, CC	56.10		100			1		1	1		7				15			74		1			
5-2, 80	75.80		50	50	2	1	50	2			5	3	15	20								2	
5-2, 149	76.69		40	60	1	1			2		80		15										
5-4, 140	79.60		70	30	1		29				5		30	30								5	1B
5-5, 148	80.98		75	25	2	1			1		66			20				10					
5, CC	81.10				2	1			1		80		10	5				tr					
6-2, 100	95.00		80	20								2	1	20	5	5		65				2	
6-3, 105	96.55		95	5					1					2		2		95					
6-3, 20	95.70	1	99										1	3	94			2					
6-4, 140	98.40	10	80	10	1						10	3	20		2	2		52		10			
6-5, 57	99.07		100										3			2		95					
6-5, 80	99.30	10	80	10				2			5		10			5		53	10	15			
6, CC	98.60				1						5		3	1				90					
7-2, 150	114.97		100		1				1					3				90		5			
7-4, 40	116.87	80	20		30	25		25			5	10											
7-4, 140	116.87	15	70	15							5		15					45	15	20			
7-6, 42	119.89	3	97		3						15		5				1	74		2			
7, CC	121.07	10	80	10				2			5		5					63	10	15			
8-1, 70	131.20		100		1						2	tr						92		5			
8-2, 10	132.10	5	85	10		1		2			3	3	5				1	65	10	10			2
8, CC	135.10		100											3	30		5	62					
9-2, 129	152.29	85	15		20	15		11			4	10			16		20		2		2		
9-2, 131	152.31				1	1					5							90	1	2			
9-3, 145	153.95	80	20		10	5		45			15	5						20					
9-4, 140	155.40	20	70	10	5	4		5			30	2		2				42	5	5			
9. CC	157.10				2			1						5	15		3	62		2			
10-1, 105	169.55	10	80	10	5	5		2			45	2						21	10	10			
10-3, 145	172.95	5	95		2						25	2					5	53	3	10			
10-4, 94	173.94	90	10		15	40		2		11	30									2			
10-4, 140	174.40	5	95		3			2				2		3	25			60		5			
10, CC	174.60		100						2		5						3	85		5			
11, CC (top)	189.10		100		2				2		5		2	1	15			73					
11, CC (bottom)	189.10	35	65		25	15					48	1						10		1			

APPENDIX A – *Continued*

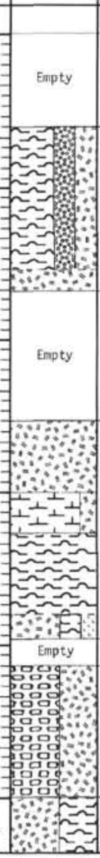
Sample (Interval in cm)	Depth (m)	Grain Size			Quartz	Feldspar	Clay minerals	Heavy minerals	Mica	Rock fragments	Volc. glass	Pyrite + magnetite	Micronodules	Zeolite	Micarb	Calc. spicules	Forams	Nannos	Radiolaria	Sponge spicules	Diatoms + Silicoflag.	Plant debris	Lithologic Unit
		Sand	Silt	Clay																			
12-2, 145	209.45	90	10		10	20		10			50	5		5									
12-2, 147	209.47	10	75	15	10	30	14	2		5	30	6						1	1	1			
12, CC	209.60		100		3	1		2	5		60	1	5					15	3	5			
13, CC	228.60		100		3	3					58		2				2	20	2	10			
14-1, 94	265.44	80	20			40		30			23							5	1	1			
14-2, 89	266.89	65	35		15	25		5			15		4	3	10		1	20			2		
14, CC	267.60	20	80		10	7			5		62	5	5	5						5			
15, CC	268.10				5	4					65	2						15	1	8			3A
15, CC	268.10		100		3	4					65		5	2				5	2	7	2		
16-1, 92	283.42	5	95		3	21		2	1		59	5		2	3			5					
16, CC	285.60		100		2	2					80		3					10		3			
17-1, 110	302.60	5	90	5	4	5		2			77	2			5			2	1	2			
17-4, 128	307.28	40	60			30		2			59	5						2		2			
17-5, 114	308.64	70	30		10	30		7			33	3		2				15					
18, CC	328.10		100								45		5				2	55	2	10			
19-1, 102	340.52	70	30		5	20		7			38	3		2	5			15		5			
19, CC	341.10	70	30		15	10		2			60	5		2	5			10		1			
20, CC	361.60	90	10		5	3		10	2	1	63	3		2				10		1			
21-1, 127	378.77					5					95												3B
21-2, 108	380.08	5	90	5		3		2			71	2			10			10	tr	2			
21, CC (fine)	380.60	30	70		5	3		5			40	3			17			25			2		
21, CC (coarse)	380.60	85	15		3	4		15			65	3		10									
22-2, 47	398.47	5	90	5		2		tr			91				3			3		1			
23-1, 133	416.83	10	85	5	2	5		2			51				20			20					
23, CC	418.60		80	20		7		2			80	2			5			3		1			
24, CC	437.60		100		1	5		8			62	5		3						1			
25-1, 141	454.91	5	90	5		5		2			86	2			3			2					
25-2, 130	456.30	5	95			3		1			77	1		2	5		1	10					
25-4, 13	458.13	70	20	10		30		10			45	10			2			2	1				
25-4, 146	459.66	5	95			7		1			77	3			5			7					
25, CC	459.60	20	70	10	2	5		3			40	2	2		5			5	33	3			
26-2, 145	475.65							3			62	2		1				30		2			
26-3, 110	476.60		80	10		2		2			40	3		3	25			25					
26-4, 28	477.28	5	95			3		3			67	2			15			10					
26-4, 70	477.70	35	65			20		5			53	2			5			15					
26, CC	478.60	5	85	10		2		2			82	2			5			5		2			
27-2, 147	494.47	15	85			2		5			69			5	10			10		2			
27, CC	496.60		100		1	3					81	5						10					
28-1, 106	511.56		95	5		2					80				10			5	2	1			
28-2, 64	512.66	90	10			15		12			57	5		1	5			5					
28-2, 98	512.98	2	98			5					76			2	5			10		2			
29-1, 146	530.96	1	99			3		1			88		1	3	1				2	1			
29-2, 140	532.40	10	85	5		30		2			60	3			3			2	tr	tr			
29-3, 132	533.82	7	93			12		2			81	2							2				3C
29-4, 74	536.76	2	93	5		33		2			35	2						tr	26	2			
29-5, 130	536.80	1	99			1		1			84				3			7	1	3			
29, CC	537.10		100		1	2		5			79	7		1				5					
30, CC	550.10	10	85	5		5		2			82				5			2	3	1			
30, CC	550.10	40	60		2	5					77	7	5	2						2			
31-2, 23	569.23	25	70	5		2					90	2			3			3	tr				
31-2, 80	569.80		100			2					73			1	7			15		2			
31, CC	570.60		100			5		1			87	2		2				3					
32-1, 92	587.62		100			3					79	2		1	5			10					
33-1, 140	606.90	3	92	5		2		2			84			2	5			5					
33, CC	608.60				1	7		3			79	5	2					3					
34-1, 145	625.95	5	95			5					93			2									
34-2, 98	626.98	40	50	10		40		1			59												
34-3, 18	627.68	40	60			2		1			95	2											
34, CC	629.10	5	95		1	6		2			82	1		1	2			5					
35-1, 80	644.30					2	50				46			2				tr					
35-1, 110	644.60		5	95		5					80		11						2	2			
35, CC (light)	645.10	5	95			2		2			70	2		2	15			5		2			
35, CC (dark)	645.10		70	30		5					55		40					tr					

Site 286 Hole Core 1 Cored Interval: 0.0-7.0 m

AGE: PLEISTOCENE
NANNOS: *Gephyrocapsa oceanica*
RADS: *Ommatartus tetrathalmus* Zone

FOSSIL	ABUND.	PRES.	SECTION
N	C	f	1
N	C	f	2
N	C	f	4
F	A	e	Core Catcher
R	C	g	Core Catcher
N	C	g	Core Catcher

SECTION: 0, 1, 2, 3, 4, 5, Core Catcher
METERS: 0.5, 1.0



DEFORMATION: 3

LITHOLOGIC DESCRIPTION

10YR 3/3 mottled with 10YR 3/1

10YR 4/3 no mottling

MICARB, DIATOM, AND NANNO-BEARING MICRO-NODULE AND GLASS SHARD ASH-RICH RAD OOZE, dark brown, mottled with very dark gray; soupy to soft.

SS 1-96

30% R	10% N	2% Q	2% S
20% Nod	5% D	2% F	2% SI
18% Gl	5% M	2% HM	2% Plant D.

SS 1-140 RAD OOZE

Grain Size 2-12 (5, 62, 33)

X-ray 2-16

67% Amor	3% Quar	18% Mont	25% Augi
33% Cryst	36% Plag Fsp	2% Clin	
11% Calc	3% Mica	2% Anal	

Water Content 2-82 (58)

DIATOM-SPONGE SPICULE-RADIOLARIAN-MICRONODULE-MICARB-NANNO-BEARING GLASS SHARD ASH, brown; soupy to soft, slightly mottled.

SS 2-100

48% Gl	10% N	5% SI	2% Mi
10% Nod	5% D	3% Q	
10% M	5% R	2% F	

10YR 5/2

10YR 4/3

10YR 5/2
2.5Y 3/2 mottled
2.5Y 3/2, 10YR 3/2

10YR 4/3

FORAM AND SPONGE SPICULE BEARING GLASS SHARD RICH NANNO OOZE, grayish brown; soupy, mottled to swirled.

SS 4-28

70% N	5% F	2% D	1% Fsp
15% Gl	5% S	2% R	

Grain Size 4-132 (58)

FELDSPAR, MICRONODULE, ZEOLITE, SPONGE SPICULE, NANNO BEARING GLASS SHARD MICARB OOZE, brown; soupy to soft, mottled to swirled.

SS 5-32

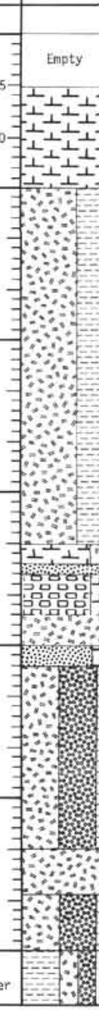
30% M	10% S	3% Fsp
28% Gl	5% Nod	2% Q
10% N	5% Z	2% Mi

Site 286 Hole Core 2 Cored Interval: 16.5-26.0 m

AGE: PLEISTOCENE
NANNOS: *Gephyrocapsa oceanica*; *Gephyrocapsa carribbeanica*
RADS: ?

FOSSIL	ABUND.	PRES.	SECTION
N	C	f	1
F	C	f	1
N	C	f	2
F	C	f	2
F	R	f	3
N	C	f	3
F	C	g	4
N	R	p	4
N	C	f	4
F	C	g	4
F	C	g	5
F	R	f	5
N	R	p	5
F	C	g	5
N	C	p	5
F	—	—	Core Catcher
R	—	—	Core Catcher
N	R	p	Core Catcher

SECTION: 0, 1, 2, 3, 4, 5, 6, Core Catcher
METERS: 0.5, 1.0



DEFORMATION: 3

LITHOLOGIC DESCRIPTION

10YR 5/4

10YR 5/4
7.5YR 4/4 streaked and mottled
10YR 4/3

HEAVY MINERALS, CLAY, GLASS SHARD, MICARB-BEARING NANNO OOZE, yellowish brown; soft.

SS 1-130

56% N	10% M	2% Nod	1% Z
10% Cl	5% HM	2% S	
10% Gl	2% Py	2% Plant D.	

$CaCO_3$ 2-68 (2.1)

Water Content 2-126 (59)

10YR 5/4

gradual color change

7.5YR 4/4

10YR 4/4

10YR 4/4 swirled with 10YR 5/4

10YR 3/3

FELDSPAR, NANNO, QUARTZ, AND MICRONODULE BEARING CLAY GLASS SHARD ASH, brown; soft.

SS 2-133

48% Gl	5% Q	5% Plant D.	3% N
30% Cl	5% Nod	3% Fsp	1% Z

Water Content 3-118 (57)

10YR 4/4 swirled with 10YR 5/4

10YR 3/3

GLASS SHARD AND NANNO BEARING FORAM RICH MICARB OOZE, light yellowish brown, mottled; soft.

SS 4-106

70% M	20% F	5% Gl	5% N

Water Content 4-110 (60)

mixed 2.5Y 3/2 and 10YR 7/3

7.5YR 4/4

10YR 5/4 mottled with 7.5YR 4/4

7.5YR 4/4 mottled with 10YR 5/4

10YR 4/4

7.5YR 4/4 mottled with 10YR 5/4

10YR 4/3

HEAVY MINERALS, FELDSPAR, ZEOLITE, MICARB, AND QUARTZ(?) BEARING CLAY MICRONODULE RICH GLASS SHARD ASH, brown, mottled; soft, with scattered pumice fragments up to 1/4" diameter.

SS 5-110

30% Gl	10% Q	5% M	2% S
25% Nod	5% Fsp	3% HM	2% Plant D.
11% Cl	5% Z	2% N	

X-ray 6-70

68% Amor	6% Quar	14% Mont	2% Amph
32% Cryst	42% Plag	2% Clin	12% Augi
5% Calc	7% Mica	10% Phil	

Water Content 6-80 (60)

Explanatory notes in Chapter 2
— denotes absence

Site 286 Hole Core 3 Cored Interval: 35.5-45.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LATE PLIOCENE	Discoaster tamalis	Barren; Discoaster brouweri; Discoaster pentaradiatus	?	F	—	—	0, 1	0.5, 1.0	Empty	3	* * *
				N	—	—	2				WC GZ
				F	R	f					*
				N	—	—	3				WC
				F	—	—					
				F	—	—	4				WC
				N	C	f					*
				N	R	p					
				F	R	f	5				
				F	A	e					* WC
				N	R	p					
				F	R	p	Core Catcher			3	*
				R	—	—					
				N	C	g					

LITHOLOGIC DESCRIPTION

X-ray 1-110

63% Amor	31% Plag	1% Clin	11% Augi
37% Cryst	8% Mica	25% Phil	
5% Quar	17% Mont	2% Amph	

10YR 4/4 — ZEOLITE, MICA, MICARB BEARING MICRONODULE RICH GLASS SHARD ASH, dark yellowish brown, unbedded; soft.

SS 1-145

64% Gl	10% Z	3% Mi	1% Fsp
15% Nod	5% M	2% Q	

10YR 5/4

Water Content 2-78 (60)

Grain Size 2-79 (0, 42, 58)

Water Content 3-77 (52)

Water Content 4-68 (61)

PYRITE, CLAY, GLASS SHARD, MICARB, ZEOLITE BEARING NANNO OOZE, yellowish brown; soft.

SS 4-95

67% N	8% M	5% Gl (altered)	2% Nod
10% Z	5% Cl	3% Py	

10YR 5/4

mottled 10YR 4/4 and 10YR 5/4

Water Content 5-112 (57)

Grain Size CC (5, 51, 44)

10YR 4/4

10YR 4/4 swirled with 10YR 5/3

PLANT DEBRIS, NANNO, QUARTZ(?), HEAVY MINERALS, MICARB, MICRONODULE, FELDSPAR BEARING, GLASS SHARD (altered) RICH CLAYEY SILT, brown; soft.

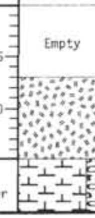
10YR 4/3

SS CC

44% Cl	10% Nod	5% M
15% Gl	5% Q	3% N
10% Fsp	5% HM	3% Py

Site 286 Hole Core 4 Cored Interval: 54.5-64.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
EARLY PLIOCENE		Ceratolithus tricorniculatus (C. rugosus Subzone)					0, 1	0.5, 1.0	Empty		
				F	C	f				3	* WC GZ
				N	R	p					
				F	R	f	Core Catcher			3	*
				R	—	—					
				N	C	p					



LITHOLOGIC DESCRIPTION

MICA AND MICRONODULE BEARING GLASS SHARD BEARING GLASS SHARD ASH, dark brown, mottled and streaked with yellow brown; soft, with thin (2mm) layers of foraminifer sand.

10YR 3/3

10YR 5/4

SS 1-96

81% Gl	5% Mi	2% Fsp
10% Nod	2% Q	

streaked 10YR 3/3 and 10YR 5/4

X-ray 1-100

76% Amor	38% Dolo	4% Mica	7% Phil
24% Cryst	12% Quar	2% Chlo	2% Anal
4% Calc	20% Plag	11% Mont	

Water Content 1-106 (53)

Grain Size 1-107 (5, 35, 60)

10Y 3/3 — GLASS SHARD-BEARING MICARB RICH NANNO OOZE, dark brown; soft.

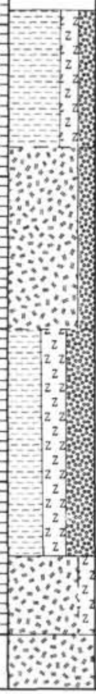
SS CC

74% N	7% Gl	1% Mi
15% M	1% Fsp	1% S

Explanatory notes in Chapter 2

Site 286 Hole Core 5 Cored Interval: 73.5-83.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
? MIDDLE MIOCENE – ? EARLY MIOCENE	Barren	N	—	--	0, 1	0.5, 1.0	Empty			
		N	—	--	2				* WC	
		F	—	--					*	
		N	—	--	3				*	
		N	R	P	4			3	GZ WC	
		F / N	— / R	-- / P	5				* WC	
? LATE OLIGOCENE	Barren ?	F / R / N	T / — / R	P / -- / P	5, Core Catcher			4, 3, 3	CC * *	



10YR 3/3

PYRITE AND GLASS SHARD BEARING MICRONODULE AND ZEOLITE-RICH CLAY, dark brow; soft to stiff.

SS 2-80

50% Cl	15% Nod	3% Py	2% HM
20% Z	5% Gl (altered	2% Q	1% Fsp

Water Content 2-90 (56)

MICRONODULE RICH-GLASS SHARD ASH, dark brown; soft to stiff.

SS 2-149

80% Gl	2% Mi	1% Fsp
15% Nod	1% Q	

X-ray 3-90

70% Amor	24% Quar	12% Mica	35% Mont
30% Cryst	25% Plag	4% Chlo	

7.5YR 3/2

Grain Size 4 20.5 (0, 12, 88)

Water Content 4-23 (58)

VOLCANIC GLASS AND PLANT DEBRIS BEARING CLAY MICRONODULE ZEOLITITE, dark brown; stiff; slightly mottled; limestone pebble 3 x 4 cm at Section 4-25 to 28, composed of foram and clam shell debris.

SS 4-140

30% Nod	29% Cl	5% Py
30% Z	5% Gl	1% Q

Water Content 5-65 (50)

$CaCO_3$ 5-100 (1)

10YR 3/3

ZEOLITE AND MICRONODULE BEARING GLASS SHARD ASH, dark brown; stiff.

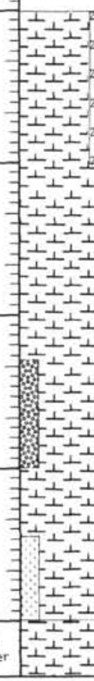
10YR 3/3

SS CC

80% Gl	5% Z	1% Fsp
10% Nod	2% Q	1% Mi

Site 286 Hole Core 6 Cored Interval: 92.5-102.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
LATE OLIGOCENE	P21 / *Sphenolithus ciperoensis*	N / N	C / C	p / p	0, 1	0.5, 1.0	Empty			
		F	T	f	2				* WC	
		F	R	f	3			3	*	
									* WC	
		N	C	f	4				WC CC *	
					5			2	* * WC GZ	
	?	F / R / N	T / T / C	p / — / f	Core Catcher			3	*	



MICARB AND CALCAREOUS SPONGE SPICULE BEARING ZEOLITE RICH NANNO OOZE, brown, mottled; stiff; pockets of white foram sand in interval Section 2-90 to 110.

SS 2-100

65% N	5% M	2% Py	1% Nod
20% Z	5% Calc S.	2% Plant D.	

Water Content 2-105 (50)

10YR 3/3

NANNO OOZE, brown, mottled with dark grayish brown; stiff; pocket of algal silt at Section 2-18 to 24.

10YR 5/3

SS 3-105

95% N	2% Z	2% Calc S.	1% Mi

Water Content 3-125 (45)

Water Content 4-76 (52)

$CaCO_3$ 4-110 (31)

10YR 4/3

PYRITE, GLASS SHARD, SPONGE SPICULE-BEARING MICRONODULE-RICH NANNO OOZE, mottled brown and grayish brown; stiff.

SS 4-140

52% N	10% Gl	3% Py	2% Calc S.
20% Nod	10% S	2% M	1% Q

MICRONODULE-BEARING NANNO OOZE, SS 5-57.

GLASS SHARD, CALCAREOUS SPONGE SPICULE, MICRONODULE, AND RAD-BEARING SPONGE SPICULE-RICH NANNO OOZE, yellowish brown, mottled; stiff.

streaked and mottled 10YR 6/3, 2.5Y 5/2, 10YR 4/3

SS 5-80

53% N	10% Nod	5% Gl	2% Hm
15% S	10% R	5% Calc S.	

Grain Size 5-99 (0, 41, 59)

Water Content 5-106 (51)

10YR 4/3

10YR 3/3

10YR 4/4

10YR 5/4, 10YR 4/4, 10YR 3/3, 2.5Y 5/2, 2.5Y 4/2 swirled, mottled, and streaked

MICRONODULE, ASH-BEARING NANNO OOZE, dark yellowish brown.

10YR 4/4

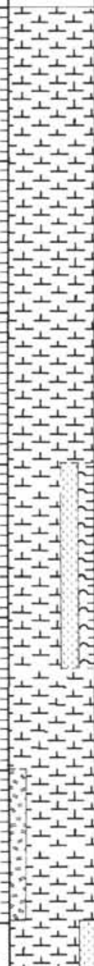
SS CC

90% N	3% Nod	1% Z
5% Gl	1% Q	

Explanatory notes in Chapter 2

Site 286 Hole Core 7 Cored Interval: 111.5-121.0 m

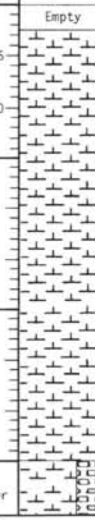
AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LATE OLIGOCENE		Sphenolithus distentus	Theocyrtis tuberosa Zone	N	C	f	0, 1	0.5, 1.0		3		10YR 4/3 mottled with 10YR 5/4; 10YR 5/4 mottled with 10YR 4/4. Water Content 1-55 (55)
				R	C	f	2				WC	10YR 4/4. Water Content 2-77 (52). ZEOLITE AND SPONGE SPICULE-BEARING NANNO OOZE, yellowish brown; stiff; slightly mottled. SS 2-150: 90% N, 5% S, 3% Z, 1% Q, 1% Mi
				F	R	p					*	
							3				WC *	10YR 5/4. Water Content 3-50 (52). X-ray 3-50: 41% Amor, 59% Cryst; 83% Calc, 3% Quar; 10% Plag, 4% Mont
				N	C	f	4				WC	10YR 5/4 mottled with 10YR 4/4. Water Content 4-75 (51). GLASS SHARD BEARING MICRONODULE, RAD, AND SPONGE SPICULE RICH NANNO OOZE, yellowish brown; stiff. SS 4-140: 45% N, 20% S, 15% Nod, 15% R, 5% Gl
				FB	R	p					*	Water Content 5-60 (45)
				R	R	f	5				WC	QUARTZ(?) MICRONODULE BEARING GLASS SHARD-RICH NANNO OOZE, dark yellowish-brown; stiff; small patches of heavy mineral bearing sand at Section 6-38 to 40.
		S. predistentus		N	C	f	6				* GZ WC	10YR 4/4. SS 6-42: 74% N, 15% Gl, 5% Nod, 3% (?) Q, 2% S, 1% F. Water Content 6-75 (48). Grain Size 6-76 (2, 50, 48)
EARLY OLIGOCENE				FB / R / N	T / R / C	p / f / f	Core Catcher				*	GLASS SHARD, MICRONODULE, AND RAD-BEARING SPONGE SPICULE RICH NANNO OOZE, brown; stiff. 10YR 5/3. SS CC: 63% N, 15% S, 10% R, 5% Gl, 5% Nod, 2% HM



FB indicates the occurrence of benthonic foraminifera only.

Site 286 Hole Core 8 Cored Interval: 130.5-140.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY OLIGOCENE	P18	Reticulofenestra hillae	Theocyrtis tuberosa Zone	N	C	f	0, 1	0.5, 1.0	Empty	4	* WC CC	10YR 6/3. SPONGE SPICULE BEARING NANNO OOZE, pale brown; stiff to semilithified minor dark gray streaks and mottles, volcanic granules present at Section 2-10, and volcanic pebble 1/4" diameter at Section 2-83. SS 1-70: 92% N, 5% S, 2% Gl, 1% Q. Water Content 1-71 (44). $CaCO_3$ 1-100 (44)
				F	T	p					*	NANNO OOZE, SS 2-10.
				R	R	f	2			3	WC	Water Content 2-50 (43)
				F	R	f						
		Reticulofenestra hillae Zone	Thyrsocyrtis bromia Zone	N	C	f	3				WC	Water Content 3-45 (42)
				R	R	f						ZEOLITE, FORAM BEARING MICARB NANNO OOZE, pale brown; stiff to very stiff.
				FB / R / N	T / R / C	p / f / f	Core Catcher				*	10YR 6/3. SS CC: 62% N, 30% M, 5% F, 3% Z



Explanatory notes in Chapter 2

Site 286 Hole Core 9 Cored Interval: 149.5-159.0 m

AGE: EARLY OLIGOCENE (Sections 0–4); LATE EOCENE (Sections 4–Core Catcher)

Zones: *Cyclococcolithina formosa*; *Discoaster barbadiensis*; *Thyrsocyrtis bromia* Zone

SECTION	FOSSIL	ABUND.	PRES.
0			
1	N	C	f
2	R	R	f
2	N	A	g
3	F	T	f
3	N	C	g
4	N	C	f
5	N	C	f
5	N	C	f
5	N	C	f
Core Catcher	F	R	f
Core Catcher	R	T	f
Core Catcher	N	A	g

Section 0–1: Empty (upper part); meters 0.5, 1.0

LITHOLOGIC DESCRIPTION

Water Content 1-63 (39)

10YR 6/3 mottled with 10YR 6/2

Water Content 2-4 (38)

GLASS SHARD AND OPAQUE MINERALS-BEARING HEAVY MINERAL FELDSPAR AND MICARB RICH FORAM QUARTZ SAND, dark gray; stiff; very fine to fine grained, X-micro laminated at base, 11 above lower contact erosional.

10YR 4/1

SS 2-129

20% Q(?)	15% Fsp	4% Gl
20% F	11% HM	2% D
16% M	10% Opaq	2% R

Water Content 3-17 (37)

10YR 7/2 mottled with 10YR 6/3

10YR 4/1

10YR 6/3

X-ray 4-38

52% Amor	38% Calc	51% Plag	4% Mont
48% Cryst	5% Quar	1% Mica	1% Amph

Water Content 4-66 (44)

Grain Size 4-66.5 (3, 61, 36)

10YR 6/4 mottled with 10YR 6/3

FELDSPAR, QUARTZ(?) HEAVIES, RAD, AND SPONGE SPICULE BEARING GLASS SHARD NANNO OOZE, light yellowish brown, mottled with pale brown; stiff.

10YR 6/3

SS 4-140

42% N	5% HM	4% Fsp
30% Gl	5% R	2% Py
5% Q(?)	5% S	2% Z

Water Content 5-40 (42)

10YR 5/4 mottled by 10YR 6/3

$CaCO_3$ 5-66.5 (22)

10YR 6/3

ZEOLITE BEARING MICARB-RICH NANNO OOZE, pale brown; stiff.

10YR 6/3

SS CC

62% N	5% Z	2% Q	1% HM
15% M	3% F	2% S	

Site 286 Hole Core 10 Cored Interval: 168.5-178.0 m

AGE: LATE EOCENE

Zones: *Discoaster barbadiensis*; *Thyrsocyrtis bromia*

SECTION	FOSSIL	ABUND.	PRES.
0			
1	FB	T	p
3	F	T	p
Core Catcher	F	T	p
Core Catcher	R	T	f
Core Catcher	N	C	g

Section 0–1: Empty (upper part); meters 0.5, 1.0

LITHOLOGIC DESCRIPTION

X-ray 1-91

56% Amor	3% Calc	89% Plag
44% Cryst	1% Quar	7% Mont

Water Content 1-101 (46)

10YR 3/3 mottled with 10YR 4/3, streaked with 10YR 4/2, 10YR 5/4 and 10YR 5/3

QUARTZ, FELDSPAR, RAD, SPONGE SPICULE BEARING NANNO RICH VITRIC TUFF, dark brown, mottled with grayish and yellowish brown; semilithified intense bioturbation, including "Chondrites" and "Zoophycos" Parallel microlamina common.

10YR 5/3

SS 1-105

45% Gl	10% R	5% Q(?)	2% HM
21% N	10% S	5% F	2% Py

10YR 4/4

10YR 5/4 — Chondrites at Section 2-6

Zoophycos at Section 2-105

10YR 5/3

10YR 6/3 mottled with 10YR 5/3

Water Content 2-67 (43)

Water Content 3-103 (54)

Water Content 4-67 (51)

10YR 4/3 mottled with 10YR 5/3

VOLCANIC ROCK FRAGMENTS AND QUARTZ(?) RICH ALTERED VOLCANIC GLASS FELDSPAR SANDSTONE, very dark gray; semilithified, very fine-grained.

10YR 5/3 mottled with 10YR 4/4

SS 4-94

40% Fsp	15% Q(?)	2% HM
30% Gl (altered)	11% Vol. R F	2% S

10YR 4/3, mixed with 10YR 3/3, 10YR 5/4, and 10YR 4/4

10YR 5/4 — fine sandstone bed 1/2 cm thick

10YR 4/4 — Zoophycos

QUARTZ, ZEOLITE, SPONGE SPICULE BEARING, MICARB RICH NANNO CHALK, light gray; semilithified.

10YR 7/2

SS 4-140

60% N	5% HM	3% Q
25% M	5% S	3% Z

7.5YR 6/4

FORAM, SPONGE SPICULE, GLASS SHARD-BEARING NANNO CHALK, light gray; semilithified.

SS CC

85% N	5% S	2% Mi
5% Gl	3% F	

Site 286 Hole Core 11 Cored Interval: 187.5-197.0 m

AGE: LATE EOCENE

Zones: *Discoaster barbadiensis*; *Thyrsocyrtis bromia*

SECTION	FOSSIL	ABUND.	PRES.
0			
1	F	T	p
1	F	T	p
1	F	T	f
Core Catcher	R	R	f
Core Catcher	N	C	p
Core Catcher	N	R	p

Section 0–1: Empty (upper part); meters 0.5, 1.0

LITHOLOGIC DESCRIPTION

ASH BEARING NANNO OOZE, intensely mottled.

10YR 6/4 with minor 10YR 5/2 and 10YR 5/3

Water Content 1-75 (47)

GLASS SHARD BEARING MICARB-RICH NANNO CHALK, light brownish gray; semilithified.

SS CC[1]

73% N	5% Gl	2% Mi	1% Z
15% M	2% Q	2% Nod	

10YR 6/2

NANNO BEARING FELDSPAR AND QUARTZ(?) RICH VITRIC TUFF, dark gray; semilithified.

10YR 4/1

SS CC[2]

48% Gl S.	15% Fsp	1% HM
25% Q(?)	10% N	1% S

Explanatory notes in Chapter 2

Site 286 Hole Core 12 Cored Interval: 206.5-216.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
LATE EOCENE		Discoaster barbadiensis	Thyrsocyrtis bromia	R	C	f	0, 1, 2	0.5, 1.0	Empty	4/2	WC, *, *, *	
				FB R N	T T R	p p p	Core Catcher				*	

Water Content 2-5 (36)

X-ray 2-54
31% Amor 1% Quar 5% Mont
69% Cryst 94% Plag

Olive gray siltstone, moderately to intensely bioturbated; minor fine grained sandstone in thin (1-2 cm) graded beds; minor X and parallel microlaminations.

5Y 4/1 and minor 5GY 6/1 — ZEOLITE, QUARTZ, BEARING HEAVY MINERAL, AND FELDSPAR RICH, GLASS SHARD SANDSTONE, greenish gray; semilithified, fine to medium grained.

SS 2-145
50% Gl 15% HM 5% Z
20% Fsp 10% Q(?)

OPAQUES, VOLCANIC ROCK FRAGMENTS, ALTERED GLASS SHARDS AND QUARTZ(?) BEARING CLAY AND GLASS RICH FELDSPAR SILTSTONE, greenish gray; semilithified.

SS 2-147
30% Fsp 10% Q(?) 2% HM 1% R
30% Gl 5% Opaq 1% G 1% S
14% Cl 5% Vol. R F 1% N

10YR 5/1 — QUARTZ, MICA, RAD, MICRONODULE, SPONGE SPICULE BEARING, NANNO RICH VITRIC TUFF, gray; semilithified.

SS CC
60% Gl 5% Nod 3% Mi
15% N 5% S 3% R
5% HM 3% Q 1% Fsp

Site 286 Hole Core 13 Cored Interval: 225.5-235.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
LATE EOCENE		Discoaster barbadiensis	Thyrsocyrtis bromia				0, 1, 2	0.5, 1.0	Empty	4, 2	GZ, WC, GZ	
				F R N	— T R	— p p	Core Catcher				*	

Grain Size 2-11 (6, 67, 27)

Volcanic siltstone, light to medium gray and light olive gray, mottled, with parallel microlamination; pumice fragments up to 3/4" diameter at Section 2-20 to 35; minor dark gray, fine gray sandstone in graded beds 1 cm thick, and small pockets of medium grained gray sandstone; semilithified.

N7, N6, 5GY 6/1

Water Content 2-55 (43)

Grain Size 2-98 (64, 31, 5)

QUARTZ, FELDSPAR, SPONGE SPICULE-BEARING NANNO RICH VOLCANIC GLASS (VITRIC) SILTSTONE, gray; semilithified.

5Y 5/1

SS CC
58% Gl 10% S 3% Fsp 2% F
20% N 3% Q 2% Nod 2% R

Site 286 Hole Core 14 Cored Interval: 244.5-254.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
LATE EOCENE		Discoaster barbadiensis	Thyrsocyrtis bromia	R	T	f	0, 1, 2	0.5, 1.0	Empty	c a b bx b c c d b/c b c	*, WC, WC, *, *	
				F R N	— R R	— p p	Core Catcher				*	

NANNO BEARING, GLASS SHARD RICH HEAVIES AND FELDSPAR SAND, gray; semilithified, fine-grained.

SS 1-94
40% Fsp 23% Gl 1% R
30% HM 5% N 1% S

N7-N6

Water Content 1-133 (36)

Water Content 2-66 (41)

ZEOLITE, MICRONODULE, PYROXENE BEARING GLASS SHARD, QUARTZ, NANNO, FELDSPAR RICH SAND, gray; semilithified, coarse-grained.

SS 2-89
25% Fsp 15% Gl 4% Nod 1% F
20% N 10% M 3% Z
15% Q(?) 5% HM 2% SI

X-ray 2-108
39% Amor 3% Q 12% Mont
61% Cryst 77% Plag
7% Calc 1% Chlo

This core, and the succeeding cores through 19 consist of gray siltstone and sandstone composed dominantly of volcanic ash. These rocks were originally deposited in rhythmic sedimentary cycles comprising a sandstone basal unit (usually graded) and overlying sequences of siltstone characterized by: 1) parallel microlamination; 2) cross bedded microlamination; 3) bioturbation; or 4) structureless siltstone. The order of these siltstone units is variable and they may repeat several times between basal units. Some of this repetion is probably due to drilling disturbance. Only a few short segments, generally no more than 1 to 2 feet long, are continuous, and only a few of these exhibit all the types of sedimentary structures found throughout the cores.

For convenience, the following categories are recognized and designated by letter symbol. Note that these symbols differ slightly from those defined for Site 285. Also note that 2 or more types may occur together; e.g. b & c.

Interval a - graded sandstone, with little or no parallel or cross bedded microlamination.

Interval b - well developed microlamination in either siltstone or sandstone; may be parallel or cross bedded, but parallel predominates. Non-parallel microlaminations are indicated by X.

Interval c - moderate to intensely bioturbated siltstone.

Interval d - massive, structureless, or only slightly mottled siltstone or sandstone.

10YR 5/1 — SPONGE SPICULE, ZEOLITE, PYRITE, MICA, FELDSPAR, QUARTZ(?) BEARING GLASS SHARD (VITRIC) SILTSTONE, gray; semilithified.

SS CC
62% Gl 7% Fsp 5% Py 5% Z
10% Q 5% Mi 5% Nod 5% S

Explanatory notes in Chapter 2

Site 286 Hole Core 15 Cored Interval: 263.5-273.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE
					0			
LATE EOCENE	Discoaster barbadiensis (nannos); Thyrsocyrtis bromia (rads)				1	Empty; 0.5; 1.0	c, b, c, b, c	GZ, WC, CC
		F / R / N	— / T / C	— / p / f	Core Catcher			*

Lithology:

LITHOLOGIC DESCRIPTION

Grain Size 1-68 (0, 61, 39)

Water Content 1-95 (33)

$CaCO_3$ 1-140 (16)

← pumice fragment 1/2" diameter at Section 1-148.

5Y 5/1 — FELDSPAR, QUARTZ, SPONGE SPICULE BEARING NANNO RICH GLASS SHARD SILTSTONE, gray; semilithified.

SS CC

65% Gl	5% Q	1% R
15% N	4% Fsp	
8% S	2% Py	

Site 286 Hole Core 16 Cored Interval: 282.5-292.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE
					0			
LATE EOCENE	Discoaster barbadiensis (nannos); Thyrsocyrtis bromia (rads)				1	Empty; 0.5; 1.0	bx, c, c	WC, *
					2	Empty	c	WC
		F / R / N	— / T / C	— / p / f	Core Catcher			*

Lithology:

LITHOLOGIC DESCRIPTION

N4

5GY 6/1

N4/N5

N5/N6

5Y 5/1

Water Content 1-86 (34)

QUARTZ, MICARB, NANNO, HEAVY MINERAL BEARING FELDSPAR RICH VITRIC SILTSTONE, medium dark gray; semilithified.

SS 1-92

21% Fsp	5% N	3% M	1% Mi
7% HM	3% Q	2% Z	

Water Content 2-95 (40)

SPONGE SPICULE, MICRONODULE, NANNO-BEARING VITRIC SILTSTONE, gray; semilithified.

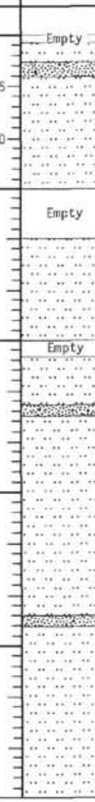
SS CC

80% Gl	3% Nod	2% Q
10% N	3% S	2% Fsp

Site 286 Hole Core 17 Cored Interval: 301.5-311.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE
					0			
MIDDLE EOCENE	Discoaster saipanensis – Cyclicargolithus reticulatus; Discoaster barbadiensis (nannos); ? Podocyrtis chalara or Thyrsocyrtis bromia; Thyrsocyrtis bromia (rads)	N	C	g	1	Empty; 0.5; 1.0	c, c, c, c	WC, *
		N / R / F	C / R / —	g / p / —	2	Empty	c, c, b, c, c	
		N / R	C / C	p / —	3	Empty	d, c, c, b, c	
		R / F / N	R / T / C	f / g / f	4		c, c	*, WC
		R / N	T / C	p / f	5		b,bx, b, c	GZ, CC, *, WC

Lithology:



LITHOLOGIC DESCRIPTION

N5 — Water Content 1-15 (39)

X-ray 1-15

52% Amor	16% Calc	70% Plag
48% Cryst	2% Quar	12% Mont

5GY 6/1 — QUARTZ(?), FELDSPAR, MICARB BEARING GLASS SHARD (VITRIC) SILTSTONE, gray; semilithified.

N4

N5

SS 1-110

77% Gl	5% Q	2% N
5% Fsp	2% HM	2% S
5% M	2% Py	1% R

5GY 6/1

Convolute microlaminae at Section 3-70.

N5

5GY 4/1

OPAQUE MINERAL BEARING FELDSPAR GLASS SHARD (VITRIC) SANDY SILTSTONE, greenish gray; semilithified; coarse sand grains scattered in siltstone matrix.

SS 4-128

59% Gl	5% Opaq	2% N
30% Fsp	2% HM	2% S

Water Content 4-141 (43)

Grain Size 5-61 (3, 67, 30)

$CaCO_3$ 5-63 (12)

HEAVY MINERALS, QUARTZ(?), BEARING NANNO RICH FELDSPAR-GLASS SHARD SANDSTONE, olive gray; semilithified, very fine grained, with parallel and cross microlaminations.

5Y 4/1

SS 5-114

30% Fsp	10% Q(?)	2% Z
15% N	10% HM	

Water Content 5-119 (33)

Explanatory notes in Chapter 2

Site 286 Hole Core 18 Cored Interval: 320.5-330.0 m

AGE: MIDDLE EOCENE
NANNOS zone: Discoaster saipanensis – Cyclicargolithus reticulatus

FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			0					
R	T	p	1	0.5, 1.0	Empty	c, c, c	WC	5GY 6/1; 5GY 4/1
			2		Empty	d, b, c	WC	5Y 4/1 and 5GY 6/1; 5GY 4/1
R	T	p	3		Empty	c, b		5GY 4/1 mottled with 5GY 6/1; 5Y 4/1
F, R, N	–, T, C	–, p, f	Core Catcher				*	5Y 4/1

VOLCANIC RICH SILTSTONE, greenish gray, mottled, moderate to intense; semilithified.
Water Content 1-121 (38)

Water Content 2-142 (45)

MICRONODULE, SPONGE SPICULE BEARING GLASS SHARD NANNO CHALK, olive gray; semilithified.

SS CC

55% N	10% S	2% F
45% Gl	5% Nod	2% R

Site 286 Hole Core 19 Cored Interval: 339.5-349.0 m

AGE: MIDDLE EOCENE
NANNOS zone: Discoaster saipanensis – Cyclicargolithus reticulatus

FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			0					
			1	0.5, 1.0	Empty	c, b, d	WC, *	5Y 4/1
F, N	R, R	p, f	Core Catcher				*	5Y 4/1

Water Content 1-95 (37)

medium coarse-grained sandstone, with minor mottled siltstone

SPONGE SPICULE, MICARB, QUARTZ(?) BEARING NANNO AND FELDSPAR-RICH VITRIC SANDSTONE, olive gray; semilithified; fine grained.

SS 1-102

38% Gl	15% N	5% Q(?)	5% S
20% Fsp	10% HM	5% M	2% Z

MICARB, HEAVIES, FELDSPAR, NANNO BEARING QUARTZ(?) RICH GLASS SHARD (VITRIC) SANDSTONE, olive gray; semilithified.

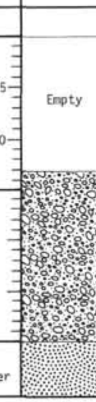
SS CC

15% Q(?)	10% N	5% M	1% S
10% Fsp	7% HM	2% Z	

Site 286 Hole Core 20 Cored Interval: 358.5-368.0 m

AGE: MIDDLE EOCENE
NANNOS zone: Discoaster saipanensis-Cyclicargolithus reticulatus

FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			0					
			1	0.5, 1.0	Empty			
			2			4		5Y 4/1
F, R, N	R, T, R	f, p, p	Core Catcher				*	5Y 3/1



Drilling breccia composed of broken bits of conglomerate with clasts ranging from granules to pebbles 1 cm in diameter; set in a coarse-grained sandstone matrix; minor fragments of greenish gray mottled siltstone also present. Most clasts in conglomerate are pumice and volcanic glass, and are subrounded.

FELDSPAR, QUARTZ(?), NANNO-BEARING, HEAVIES AND FELDSPAR RICH VITRIC SANDSTONE, very dark gray; semilithified.

SS CC

63% Gl	5% Q(?)	2% Z
13% HM	3% Fsp	1% Vol. R F
10% N	2% Mi	1% S

Site 286 Hole Core 21 Cored Interval: 377.5-387.0 m

AGE: MIDDLE EOCENE
NANNOS zone: Discoaster saipanensis-Cyclicargolithus reticulatus
RADS zone: Podocyrtis mitra

FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
			0					
			1	0.5, 1.0	Empty		WC	5GY 4/1 + pumice fragment - 2 cm in diameter
F	R	f	2			c, b	WC, *, *	
FB, R, N	R, T, R	p, p, p	Core Catcher				*[1], *[2]	2.5Y 6/1; 2.5Y 4/1

CONGLOMERATE, with clasts of pumice and volcanic glass up to 1 1/2 cm in diameter, set in coarse-grained sandstone matrix, also mainly of volcanic origin; no bedding visible, but a crude clast orientation is provided by flat fragments that lie mainly in the horizontal plane; lithified.

Water Content 1-91 (26)

Water Content 2-77 (24)

X-ray 2-92

49% Amor	11% Calc	8% Mont
51% Cryst	81% Plag	

FELDSPAR, NANNO, AND MICARB-BEARING VITRIC SILTSTONE, greenish gray; semilithified; interbedded with coarse-grained sandstone and thin beds of granule conglomerate; pumice fragments up to 1/4" diameter scattered through siltstone.

SS 2-108

71% Gl	10% N	2% HM	2% S
10% M	3% Fsp	2% Opaq	1% R

FELDSPAR, QUARTZ(?), HEAVIES, BEARING, MICARB, NANNO RICH VITRIC SANDY SILTSTONE, gray; semilithified.

SS CC[1]

40% Gl	17% M	5% Q(?)	2% S
25% N	8% HM	3% Fsp	

SS CC[2]
VITRIC SANDSTONE, dark gray.

Explanatory notes in Chapter 2

Site 286 Hole Core 22 Cored Interval: 396.5-406.0 m

AGE: MIDDLE EOCENE

NANNOS: Discoaster saipanensis Cyclicargolithus reticulatus

RADS: Podocyrtis mitra

Section	Meters	Fossil	Abund.	Pres.	Lithology	Deformation	Litho. Sample
0							
1	0.5, 1.0				Empty		WC
2		F / R	R / T	f / p		c	*
3							*
4							
Core Catcher		N	R	p			

LITHOLOGIC DESCRIPTION

5GY 4/1 Amphistegina

CONGLOMERATE, with pumice and volcanic glass fragments up to 2 cm in diameter; no grading or bedding visible. Shallow water fossils, including forams, shell fragments, and algal oncolites, are found in very small abundance scattered throughout core. These are designated "f"

Water Content 1-97 (20)

5GY 6/1 to 5GY 4/1

NANNO AND MICARB BEARING VITRIC SILTSTONE, greenish gray; semilithified, mottled, with scattered sand grains present and a thin layer of granule conglomerate.

5GY 4/1

SS 2-47

pumice fragment 3 cm long

f

f

f

f

clast of bioturbated dark greenish gray siltstone - 3 cm long

Chemical Analysis #2 at Section 3-100

f

f

f

Thin section CC:
Largest fragment in Section is 7 mm. Rock is a mixture of pebble size volcanic rock fragments (pumice, andesite and basalt), subangular to angular, in a matrix of sand to granule size rock fragments and crystals (fragments) and silt and clay size particles (nannos, micarb and ?clay minerals). No quartz detected. Phenocrysts and loose crystals are mainly feldspars and pyroxenes.

5GY 4/1

Explanatory notes in Chapter 1

Site 286 Hole Core 23 Cored Interval: 415.5-425.0 m

AGE: MIDDLE EOCENE

NANNOS: Discoaster saipanensis-Cyclicargolithus reticulatus

RADS: Podocyrtis mitra

Section	Meters	Fossil	Abund.	Pres.	Lithology	Deformation	Litho. Sample
0							
1	0.5, 1.0				Empty	c/b	* WC
2		FB	T	p		c, d, b,bx, d, bc, b, c	WC, CC, GZ, *
Core Catcher		F / R / N	T / R / C	p / p / f			*

LITHOLOGIC DESCRIPTION

FELDSPAR BEARING NANNO AND MICARB RICH VITRIC SILTSTONE, greenish gray; semilithified.

SS 1-133

51% Gl	20% N	2% Q(?)
20% M	5% Fsp	2% HM

Water Content 1-141 (40)

5GY 4/1 Water Content 2-95 (39)

$CaCO_3$ 2-95 (3)

5GY 6/1 Grain Size 2-95 (2, 61, 37)

+ Andesite pebble, 5 cm diameter (thin section)

X-ray 2-106

71% Amor	3% Calc	66% Plag	22% Mont
29% Cryst	8% Quar	1% Chlor	

+ flame structure at base of sandstone bed

5GY 4/1

NANNO, MICARB, AND FELDSPAR BEARING VITRIC SILTSTONE, dark greenish gray; lithified.

SS CC

80% Gl	5% M	2% HM	1% S
7% Fsp	2% N	2% Opaq	

Site 286 Hole Core 24 Cored Interval: 434.5-444.0 m

AGE: MIDDLE EOCENE

NANNOS: Discoaster saipanensis-Cyclicargolithus reticulatus

RADS: Podocyrtis mitra

Section	Meters	Fossil	Abund.	Pres.	Lithology	Deformation	Litho. Sample
0							
1	0.5, 1.0				Empty	d	
2						b, c, d, c	WC
Core Catcher		F / R / N	– / T / C	– / p / f			*

LITHOLOGIC DESCRIPTION

5Y 4/1

Siltstone, olive gray, lithified with minor grayish black (N2) fine grained sandstone.

Water Content 2-10 (36)

+ pumice fragments

ZEOLITE, AND FELDSPAR BEARING HEAVIES AND MICRONODULE RICH VITRIC SILTSTONE, dark gray; lithified.

7.5YR 3.5/0

SS CC

15% Nod	5% Fsp	1% Q
13% HM	3% Z	1% S

Explanatory notes in Chapter 2

Site 286 Hole Core 25 Cored Interval: 453.5-463.0 m

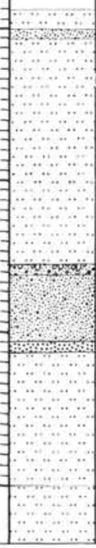
AGE: MIDDLE EOCENE

ZONE: FORAMS / NANNOS: Discoaster saipanensis - Cyclicargolithus reticulatus; RADS: Podocyrtis mitra

FOSSIL	ABUND.	PRES.	SECTION
F R N	R R	f- p-	Core Catcher

SECTION: 0, 1, 2, 3, 4, Core Catcher — METERS: 0.5, 1.0

LITHOLOGY: Empty (Section 1)



DEFORMATION: c, b, b,bx, d, b, c, b, bx, b c, c/b, bx, c, d, bx, b, c, bx, b, a, bx, a, d, c, b, c/b, b

LITHO.SAMPLE: *, WC, *, WC, GZ, CC, WC, *, *

LITHOLOGIC DESCRIPTION

MICARB AND FELDSPAR BEARING VITRIC SILTSTONE, olive gray; lithified.

SS 1-141
86% Gl 3% M 2% Opaq
5% Fsp 2% HM 2% N

convolute laminae and pumice fragment

5Y 4/1

Water Content 2-42 (36)

N5
5Y 4/1
5GY 6/1
5Y 4/1

Water Content 3-20 (33)

Grain Size 3-74 (29, 61, 10)

N7
pumice fragments

Channel filled with cross laminated medium grained dark gray sandstone.

Conglomerate composed of pumice fragments 1 1/2 cm diameter in coarse-grained sandstone matrix.

$CaCO_3$ 4-12.5 (1)

N2
5Y 4/1

OPAQUE AND HEAVIES BEARING FELDSPAR VITRIC SANDSTONE, grayish black; lithified.

SS 4-13
45% Gl 10% HM 2% M 1% R
30% Fsp 10% Opaq 2% N

Water Content 4-80 (34)

5GY 6/1

HEAVIES, MICARB, FELDSPAR, NANNO BEARING VITRIC SILTSTONE, greenish gray; lithified, contact with underlying siltstone contorted.

SS 4-146
77% Gl 7% N 4% HM
7% Fsp 5% M

2.5YR 3.5/0

HEAVIES, SPONGE SPICULE, MICARB, NANNO, AND FELDSPAR-BEARING RAD VITRIC SILTSTONE, very dark gray; lithified.

SS CC
40% Gl 5% M 3% S 2% Nod
33% R 5% N 2% Q(?)
5% Fsp 3% HM 2% Py

Site 286 Hole Core 26 Cored Interval: 472.5-482.0 m

AGE: MIDDLE EOCENE

ZONE: FORAMS / NANNOS: Discoaster saipanensis - Cyclicargolithus reticulatus; RADS: Podocyrtis mitra

FOSSIL	ABUND.	PRES.	SECTION
F	R	f-	3
F	R	f-	4
F R N	— T C	-- p- f-	Core Catcher

SECTION: 0, 1, 2, 3, 4, Core Catcher — METERS: 0.5, 1.0

LITHOLOGY: Empty (Section 1)

DEFORMATION: b c, bx, c, b, b,bx, c, b, b, bx, a-?, b, a, d, a, a, c, b, c, b, b, a, c

LITHO.SAMPLE: WC, *, *, WC, *, WC, *, *

LITHOLOGIC DESCRIPTION

5Y 4/1

olive gray siltstone

Water Content 2-72 (33)

Granule conglomerate and coarse-grained sandstone - grain size increases upward (reversed graded).

N3

HEAVY MINERAL BEARING NANNO VITRIC SILTSTONE, dark greenish gray; lithified.

5GY 4/1
N3

SS 2-145
62% Gl 3% HM 1% Z
30% N 2% Mag 1% S

5Y 4/1

OPAQUE AND ZEOLITE BEARING MICARB AND NANNO RICH VITRIC SILTSTONE, olive gray; lithified.

SS 3-110
40% Gl 25% N 3% Z 2% HM
25% M 3% Opaq 2% Fsp

Water Content 3-117 (34)

Water Content 4-31 (36)

MICARB AND HEAVIES BEARING NANNO AND FELDSPAR RICH VITRIC SILTSTONE, olive gray; lithified.

convolute laminated

SS 4-76
53% Gl 15% N 5% M
20% Fsp 7% HM

conglomerate clasts to 1.5 cm

5GY 4/1
5Y 4/1

MICARB AND NANNO BEARING VITRIC SILTSTONE, olive gray; lithified.

SS CC
82% Gl 5% N 2% HM 2% S
5% M 2% Fsp 2% Py

Explanatory notes in Chapter 2

Site 286 Hole Core 27 Cored Interval: 491.5-501.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE EOCENE	Discoaster saipanensis-Cyclicargolithus reticulatus; Podocyrtis mitra	F R N	— R C	-- p- f-	0, 1, 2, Core Catcher	0.5, 1.0	Empty	d bx c b c c b	WC * *	

N7
← flame structure at base of sandstone

N6 and 5GY 6/1 — Water Content 2-78 (36)

vertical streaks due to dewatering of sediment

HORNBLENDE, ZEOLITE, MICARB, NANNO BEARING VITRIC SILTSTONE, light gray; lithified.

SS 2-147
69% Gl 10% N 5% Z 2% S
10% M 5% HM 2% Fsp

5Y 5/1 — FELDSPAR AND NANNO BEARING VITRIC SILTSTONE, gray; lithified.

SS CC
81% Gl 5% HM 1% Q
10% N 3% Fsp

Site 286 Hole Core 28 Cored Interval: 510.5-520.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE EOCENE	Discoaster saipanensis-Cyclicargolithus reticulatus; Podocyrtis mitra	F R N	— R R	-- f- p-	0, 1, 2, Core Catcher	0.5, 1.0	Empty	c b d c b	* WC WC * GZ * GZ	

NANNO AND MICARB BEARING VITRIC SILTSTONE, light gray; lithified, mottled, and burrowed, with burrows filled with fine sandstone.

SS 1-106
80% Gl 5% N 2% R
10% M 2% Fsp 1% S

Water Content 1-117 (35)

N6

← pumice granules in siltstone

X-ray 2-22
80% Amor 11% Quar 4% Mica 20% Mont
20% Cryst 60% Plag 3% Chlo 2% Amph

Water Content 2-30 (37)

NANNO AND MICARB-BEARING FELDSPAR AND HEAVY MINERAL RICH VITRIC SANDSTONE, gray; lithified, reverse graded, fine grained.

SS 2-64
57% Gl 15% Fsp 5% N
17% HM 5% M 1% Z

← vertical dewatering marks

Grain Size 2-87 (13, 71, 16)

FELDSPAR, MICARB, NANNO BEARING VITRIC SILTSTONE.

SS 2-98

Grain Size 2-130 (0, 67, 33)

5Y 5/1 — VITRIC SILTSTONE

Explanatory notes in Chapter 1

Site 286 Hole Core 29 Cored Interval: 529.5-539.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE EOCENE	Discoaster saipanensis - Cyclicargolithus reticulatus; Podocyrtis mitra	F R N	— R R	f- p-	0, 1, 2, 3, 4, 5, Core Catcher	0.5, 1.0	Empty; Empty	b c b bx,c a d b b a d bx d a d bx b c d	* WC * WC * * CC WC * *	

ZEOLITE AND FELDSPAR BEARING VITRIC SILTSTONE, olive gray; lithified.

SS 1-146
88% Gl 3% Z 1% HM 1% M
3% Fsp 2% R 1% Nod 1% S

5Y 4/1 — Water Content 2-76 (31)

OPAQUE, MICARB BEARING FELDSPAR VITRIC SILTSTONE, greenish gray; lithified.

SS 2-140
60% Gl 3% Opaq 2% HM 1% R
30% Fsp 3% M 2% N 1% S

5GY 6/1 — Water Content 3-85 (40)

← swirled

Sandstone, gray, graded from medium at base to fine at top, flame structure at base.

Water Content 4-58 (41)

5Y 4/1 — RAD, FELDSPAR VITRIC SILTSTONE, dark greenish gray; lithified.

5G 4/1 — SS 4-74
35% Gl 26% R 2% Opaq 1% N
33% Fsp 2% HM 2% S

5Y 4/1 — $CaCO_3$ 5-99 (0)

Water Content 5-99 (38)

MICARB, SPONGE SPICULE, NANNO, BEARING VITRIC SILTSTONE, greenish gray; lithified.

SS 5-130
84% Gl 3% M 1% Fsp 1% R
7% N 3% S 1% HM

5GY 6/1 — Very fine grained, silty sandstone with granules of white pumice.

5Y 5/1 — NANNO BEARING HEAVY MINERAL RICH VITRIC SILTSTONE, gray; lithified.

SS CC
79% Gl 5% N 1% Q
12% HM 2% Fsp 1% Z

Explanatory notes in Chapter 2

Site 286 Hole Core 30 Cored Interval: 548.5-558.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE EOCENE		Discoaster saipanensis-Cyclicargolithus reticulatus	Podocyrtis mitra				0						
							1	0.5	Empty				Siltstone and minor sandstone greenish gray, dark greenish gray, and light gray.
								1.0		c d	WC	5GY 6/1, 5GY 4/1	Water Content 1-103 (40) FELDSPAR AND MICARB BEARING VITRIC SILTSTONE, dark greenish gray; lithified.
				F R N	T R R	f- f- p-	Core Catcher				*	5G 4/1	SS CC 82% Gl 5% M 2% HM 1% S 5% Fsp 3% R 2% N

Site 286 Hole Core 31 Cored Interval: 567.5-577.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE EOCENE		Discoaster saipanensis-Cyclicargolithus reticulatus	Podocyrtis mitra				0						
							1	0.5	Empty				Water Content 1-81 (31)
								1.0		b a bx c b c d	WC	N4 5Y 4/1	medium coarse grained sandstone with granules of pumice MICARB AND NANNO BEARING VITRIC SANDY SILTSTONE, light gray; lithified.
							2			– c – d c	* WC *	N7 5Y 4/1	SS 2-23 90% Gl 3% N 2% Opaq 3% M 2% Fsp 1% R Water Content 2-46 (36) X-ray 2-48 74% Amor 8% Calc 71% Plag 26% Cryst 2% Quar 19% Mont MICARB BEARING NANNO RICH VITRIC SILTSTONE, olive gray; lithified. SS 2-80 73% Gl 7% M 2% S 15% N 2% Fsp 1% Z
				F R N	– R R	– f- p-	Core Catcher				*	5GY 5/1	NANNO, FELDSPAR BEARING VITRIC SILTSTONE, medium greenish gray; lithified. SS CC 87% Gl 3% HM 2% Z 5% Fsp 3% N

Site 286 Hole Core 32 Cored Interval: 586.5-596.0 m

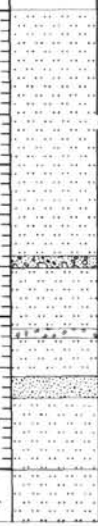
AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE EOCENE		▲ ? Reticulofenestra umbilica ?					0						
				F N	– R	– f-	1	0.5 1.0		d bx c b c d/b	WC *	5Y 6/1 5GY 4/1 5Y 6/1 5Y 4/1 Zoophycos 5GY 6/1 Zoophycos 5Y 4/1	Water Content 1-49 (35) FELDSPAR, MICARB, NANNO BEARING VITRIC SILTSTONE, olive gray; lithified. SS 1-92 79% Gl 5% M 2% HM 10% N 3% Fsp 1% Z Water Content 2-52 (35)
				N	R	p-	2			c b c b b	WC		+ sandstone, dark gray, medium to coarse grained ▲ Discoaster saipanensis – Cyclicargolithus reticulatus

Site 286 Hole Core 33 Cored Interval: 605.5-615.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE		LITHOLOGIC DESCRIPTION
MIDDLE EOCENE		? Reticulofenestra umbilica ?					0						
							1	0.5 1.0	Empty	c c b	*	5G 4/1	MICARB AND NANNO BEARING VITRIC SILTSTONE, dark greenish gray; lithified. SS 1-140 84% Gl 5% N 2% HM 5% M 2% Fsp 2% Z X-ray 2-60 77% Amor 4% Calc 72% Plag 23% Cryst 5% Quar 19% Mont
				F	–	–	2			4	*		Drilling breccia comprised of fragments of olive green siltstone and minor medium gray - fine grained sandstone.
				R N	T R	p- p-	Core Catcher				*	5G 3/1	NANNO, FELDSPAR AND HEAVY MINERAL BEARING VITRIC SILTSTONE, very dark greenish gray; lithified. SS CC 79% Gl 7% Fsp 2% Nod 8% HM 3% N 1% Q

Explanatory notes in Chapter 2

Site 286 Hole Core 34 Cored Interval: 624.5-634.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
					0				
	Barren ?				1	0.5, 1.0		d c, d c, bx c,bx, c c	WC, *
					2			c, c, c, bx c	WC, *, *
	?	F	—	—	3			c, c, c	*, *, WC
		N	—	—	Core Catcher				*

LITHOLOGIC DESCRIPTION

5G 6/1 mixed with 5G 4/1

Water Content 1-56 (31)

FELDSPAR BEARING ALTERED GLASS VITRIC SILTSTONE, greenish gray; lithified.

5G 6/1 with 5Y 4/1 and 5G 4/1; 3 mm thick sandstone bed

SS 1-145

93% Gl	5% Fsp	2% Z

Water Content 2-14 (28)

X-ray 2-77

48% Amor	1% Quar	29% Mont
52% Cryst	71% Plag	

5G 6/1; 5G 4/1 mottled; 5G 6/1

FELDSPAR, AND ALTERED GLASS VITRIC SANDY SILTSTONE, greenish gray; lithified.

5Y 4/1; 5G 6/1

SS 2-98

59% Gl	40% Fsp	1% HM

VITRIC TUFF, light gray; lithified.

5G 6/1 mottled with 5G 4/1

SS 3-18

95% Gl	2% Fsp	2% Opaq	1% HM

5GY 6/1; N7

X-ray 3-26

64% Amor	6% Quar	22% Mont	19% Phil
36% Cryst	47% Plag	6% Clin	Tr% Goet

Water Content 3-85 (22)

5Y 4/1 mottled with 5G 4/1

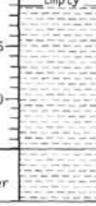
NANNO-FELDSPAR BEARING VITRIC SILTSTONE, dark greenish gray; lithified.

5G 4/1

SS CC

82% Gl	3% HM	1% Z
6% Fsp	2% M	
5% N	1% Q	

Site 286 Hole Core 35 Cored Interval: 643.5-649.0 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
MIDDLE EOCENE	Barren ?				0		Empty		
		N	—	—	1	0.5, 1.0			*, *, WC, *, CC, *
		F / R / N	— / T / R	— / p / p	Core Catcher				*[1], *[2]

LITHOLOGIC DESCRIPTION

X-ray 1-12

55% Amor	2% Calc	66% Plag
45% Cryst	3% Quar	29% Mont

5GY 6/1; 5Y 7/2; 5Y 6/1; 5YR 8/4 with streaks of 5YR 2/1

ALTERED GLASS CLAY, moderate orange pink, with sandy layers brownish black; stiff to semilithified.

SS 1-80

50% Cl (altered glass)	2% Fsp	1% N (-)
46% Gl	2% Z	

5YR 8/1 very soft

ALTERED GLASS SHARD SILTSTONE, moderate to orange pink, stiff to semilithified.

SS 1-110

80% Gl (altered)	5% Fsp	2% S
11% Iron O.	2% R	

(glass may be altered to clay and zeolite)

$CaCO_3$ 1-111 (0)

Water Content 1-111 (17)

X-ray 1-146

41% Amor	4% Quar	54% Mont
59% Cryst	41% Plag	1% Clin

7.5-5.5/6 (medium brown); 10YR 3/1 (dark gray)

NANNO BEARING MICARB RICH ALTERED GLASS VITRIC SILTSTONE, medium brown; lithified to soft.

SS CC[1]

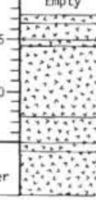
70% Gl	5% N	2% Mag	2% Z
15% M	2% Fsp	2% horn.	2% S

FELDSPAR BEARING FERRIC OXIDE ALTERED GLASS SHARD CLAYEY SILTSTONE, dark gray; soft to semilithified.

SS CC[2]

55% Gl (altered)	5% Fsp
40% Fer O.	1% N (-)

Site 286 Hole Core 36 Cored Interval: 649.0-658.5 m

AGE	FORAMS / NANNOS / RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
					0				
					1	0.5, 1.0	Empty 		*, *
					Core Catcher				

LITHOLOGIC DESCRIPTION

Basalt

Chemical analyses - #3 and #4 at Section 1-128

Chemical analysis - #5 and #6 at Section 1-135

Most of the basalt core pieces can be subdivided into two intercalated types which are most readily distinguished by their color:

(1) "black glassy" basalt, dry grayish-black (N2), wet black (N1); dense, very fine-grained; ~5% olivine phenocrysts, <1 mm long; no amygdules; no obvious structures.

(2) "brown devitrified" basalt, color ranges from dry olive-gray (5Y 4/1) mottled with 'rusty' areas, dry medium brown to dark yellowish brown (5YR 4/4-10YR 4/2); characteristicly these pieces have variolitic structures up to 2 cm in diameter, and sparse vesicles or calcite amygdules, <2 mm.

In addition jet-black glass occurs as fragments in a dolomite vein at Section 1-40 to 44 cm, in a composite vein with dolomite and opal (?) at Section 1-72 to 75 cm, and as a glass seam 1 cm wide at Section 1-124 to 126 cm. In thin section this tachylyte is a clear deep red-brown with sparse olivine phenocrysts. In places the tachylyte is green due to chloritization.

Sparse calcite and/or chlorite veins, 0.1-1.0 cm occur throughout.

Explanatory notes in Chapter 2

Site 286 Hole Core 37 Cored Interval: 658.5-668.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
							0		Empty			
							1	0.5 1.0			*	Chemical analysis - #7 and #8 at Section 1-75
							2					
							3					
							4					
							5					
							Core Catcher					

Basalt

As described for Core 36 Section 1. All of the type (2) brown variety.

Gabbro

Diabasic chill zone: dry medium dark to medium light gray (N4-N6) getting lighter down core, wet ~greenish-black (5GY 2/1).

The contact between the basalt and gabbro chill zone was not preserved but occurs between two pieces of core. The top of the chill zone is marked by a 1.5 mm green chloritized tachylyte, which has flow structures indicating a derivation from the gabbro (thin section). In the 5-7 cm below the glass the rock grades downwards through a chloritized glassy quench zone (~1 cm), a variolitic zone (~4 cm), and a fine-grained diabase. The grain-size of the diabase increases rapidly downwards, and at the bottom of Section 1 the average grain-size is ~1.5 mm. Below Section 1 the grain-size increases very slowly.

Calcite amygdules, <3 mm, ~1-2% volume.

Sparse calcite-chlorite-disseminated pyrite veins, <2 mm.

Gabbro: dry ~greenish-gray (5G 6/1, wet greensih-black (5G 2/1). Two pyroxene gabbro: diabasic texture with calcium-rich clinopyroxene and pigeonite forming the groundmass around the plagioclase laths (>AN60). Euhedral magnetite up to 1 mm. Visual estimate: 50-60% plagioclase, 35-45% pyroxene and 5% magnetite. The average grain size gradually changes downwards from approximately 1.5 mm to 2.5 mm.

Chloritization of the gabbro appears to extend throughout, with approximately 25% of the primary minerals being replaced. The calcium-rich pyroxene being the most subject to replacement by chlorite.

'Amygdules' are common throughout (although these are probably filled vugs); filled with an unidentified light blue (5B 7/6) or light blue-green soft mineral; <7 mm rarely >4 mm; tend to be concentrated in bands 5-10 cm wide; 1-15% volcanic.

Rare serpentine(?) or calcite veins, <2.5 mm wide; often with fine disseminated pyrite (continued on Core 38)

Site 286 Hole Core 38 Cored Interval: 668.0-677.5 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
							0					diseminated fine pyrite
							1	0.5 1.0	Empty			
							2					calcite veins, <.5 mm
							3					← dry dark greenish gray (5G 4/1), wet greenish black (5GY 2/1) definite increase in 'greeness' of the rock, probably increased chloritization
							4					
							Core Catcher					

Gabbro

like sections Core 37 Sections 2 to 5. Plagioclase crystal habit appears to gradually change from elongate to more tabular. (a vein ~3 mm). Pyroxene average grain size <1.5 mm.

Rock wet ~greenish black (5GY 2/1, very difficult to estimate color because of coarse grain size.

Sudden change in color to dry dusty green (5G 3/2). On sawed slab amount of interstitial dark green material noticeably increased relative to Core 37 and Core 38 Sections 1, 2 and 3. Thin section study indicates >50% rock chlorite.

Explanatory notes in Chapter 2

Site 286 Hole Core 39 Cored Interval: 677.5-687.0 m

AGE | FORAMS | NANNOS | RADS | FOSSIL CHARACTER: FOSSIL, ABUND., PRES. | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION

Section 0

Section 1 (0.5, 1.0) — Lithology: Empty

Sections 2–5, Core Catcher

Gabbro

Similar to Core 38 Section 4.

Vugs continue as in Cores 37 and 38, partially to completely filled with very pale blue (5B 8/2, wet) soft unidentified mineral; <1 cm diameter, usually <5 mm; ~2-5% volume of rock.

Average grain size of gabbro 2.5-3 mm.

Few vugs in Section 4.

No vugs in Section 5.

Site 286 Hole Core 40 Cored Interval: 687.0-696.5 m

AGE | FORAMS | NANNOS | RADS | FOSSIL CHARACTER: FOSSIL, ABUND., PRES. | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION

Section 0

Section 1 (0.5, 1.0) — Lithology: Empty

Sections 2–6, Core Catcher

Gabbro

Like Cores 38 and 39, average grain size ~3-3.5 mm.

← chlorite or serpentine or fracture

← .7 mm

← 3 mm $CaCO_3$ veins aragonite(?)

10 cm wide oxidized zone with limonite or goethite spots yellowish orange (10YR 6/6)

← 1 mm $CaCO_3$ vein

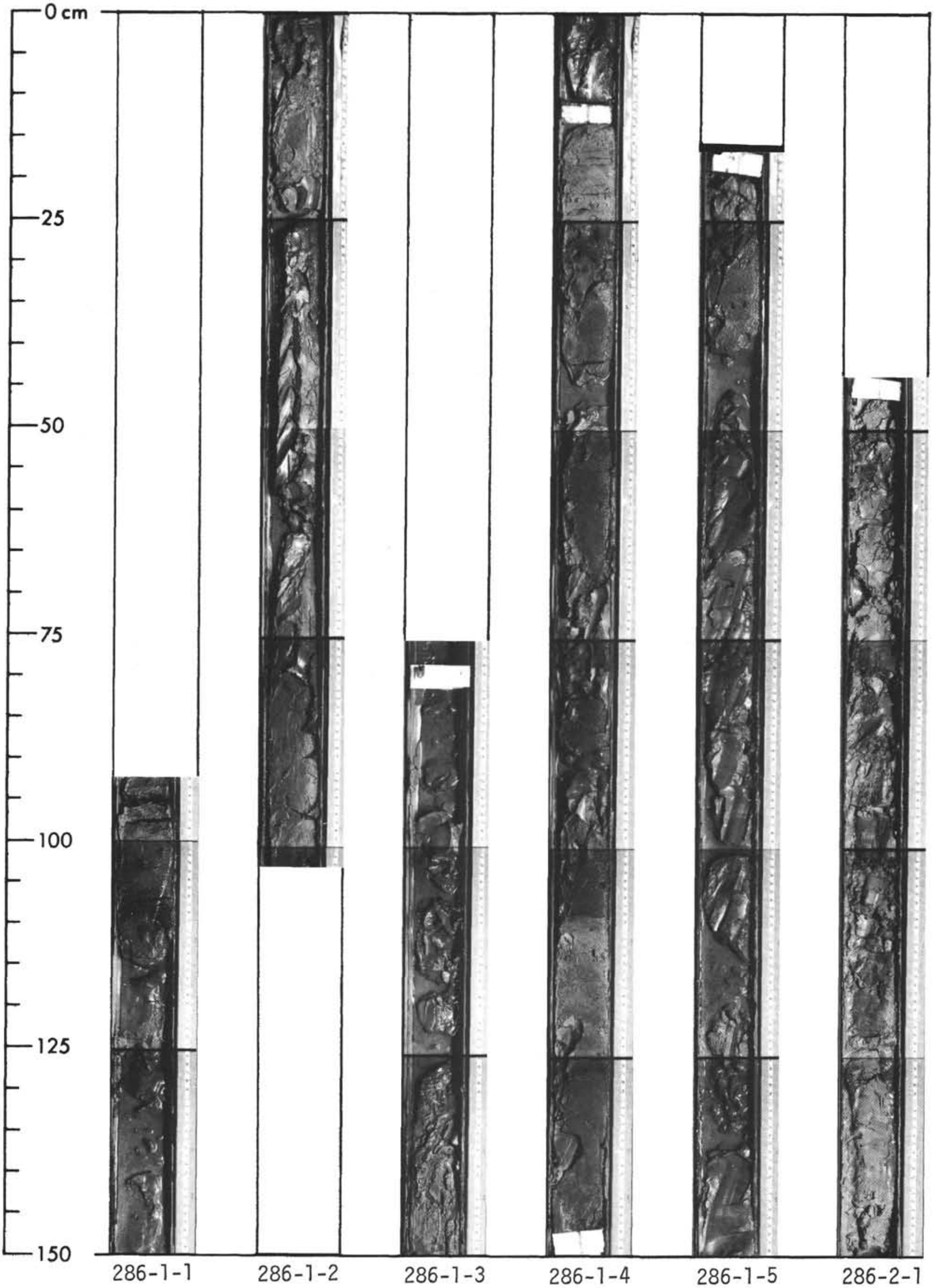
← .3 mm $CaCO_3$ vein

Explanatory notes in Chapter 2

Site 286 Hole Core 41 Cored Interval: 696.5-706.0 m

AGE	FORAMS	NANNOS	RADS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
							0		Empty			Gabbro Wet, greenish-black (5G 2/1). Dry, greenish-gray (5GY 6/1) with spots of greenish-black (5GY 2/1) (chlorite). Sudden drop in grain size, between Core 40 Section 6 and Core 41 Section 1, from ~3.5 to 1.5 (average). Thin section study shows aleration has decreased to approximately 25% of the rock. Grain size increases downwards; averaging approximately 3 mm at the bottom of Core 41 Section 6.
							1	0.5 1.0				
							2					← .5 to 1 cm wide oxidized zone similar to Core 4 Section 4
							3		Void			← 2.5 cm wide oxidized zone ← oxidized zone 1-4 cm wide, with 2 mm goethite(?) vein
							4					← Below Core 41 Section 4 80 cm vugs filled with soft light green material (like all cores above); <1 cm diameter, 3-8%.
							5					1 cm wide ozidized zone and chlorite on seam 1 mm $CaCO_3$ vein
							6					
							Core Catcher					

Explanatory notes in Chapter 2.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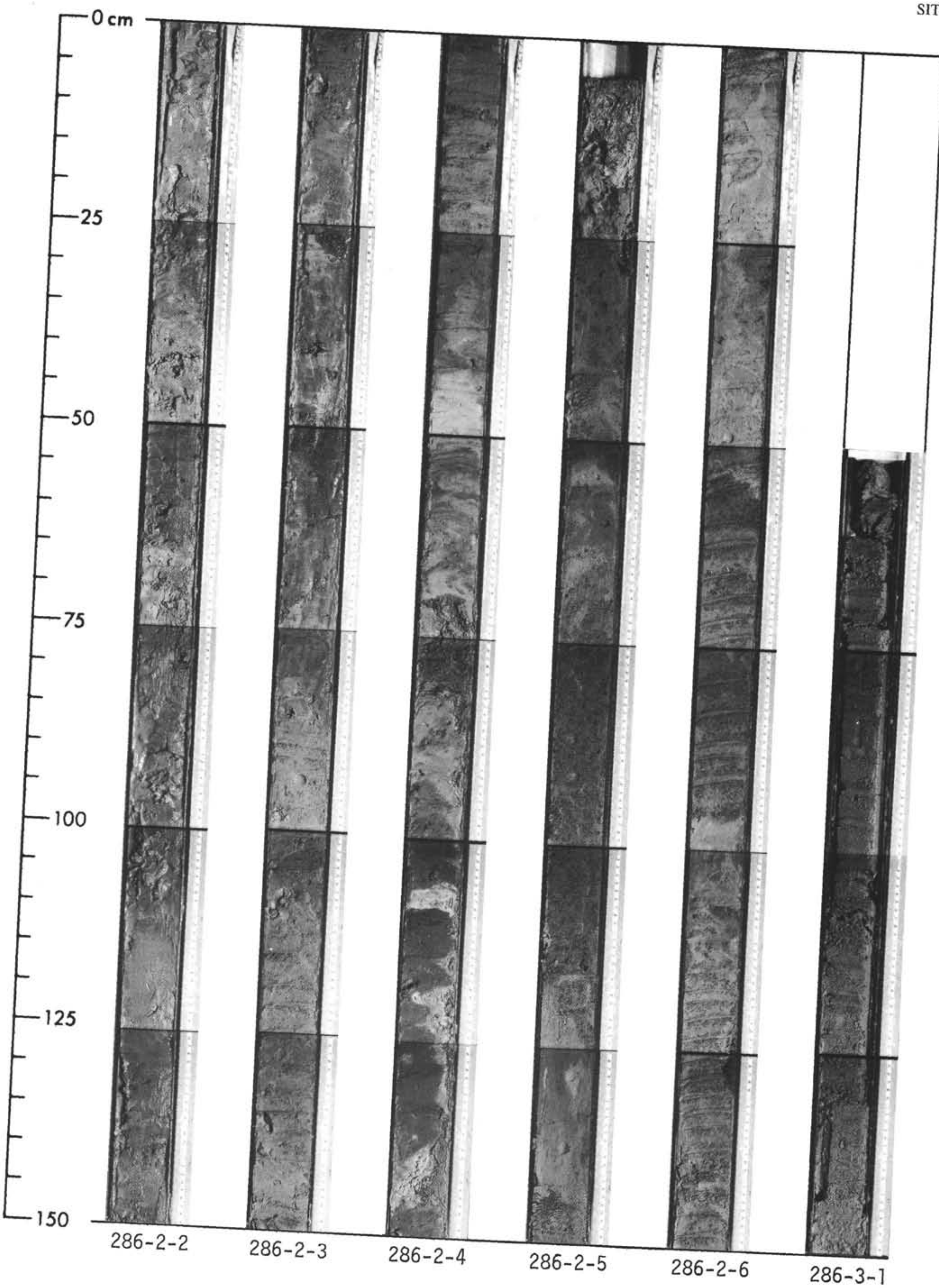
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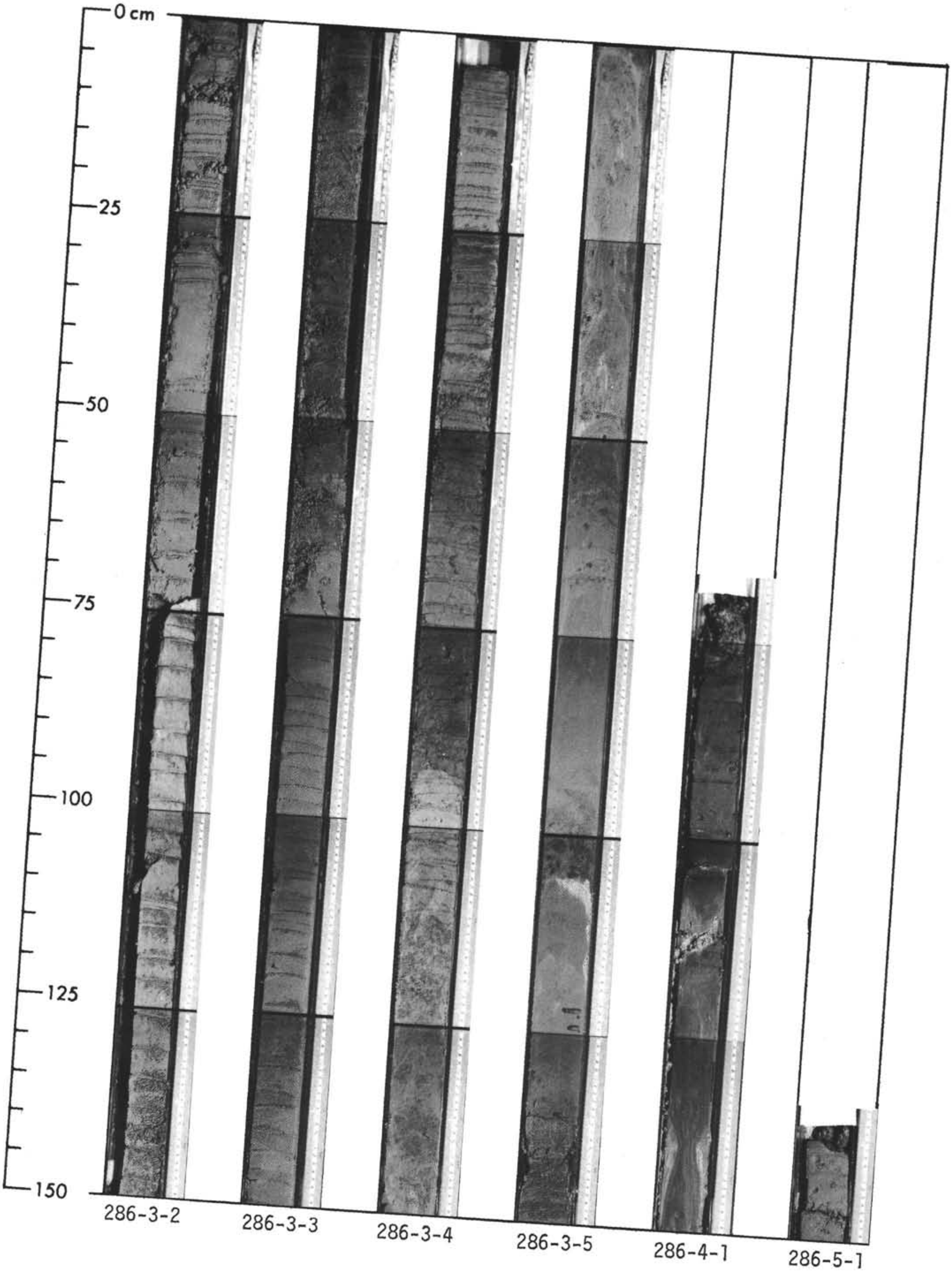
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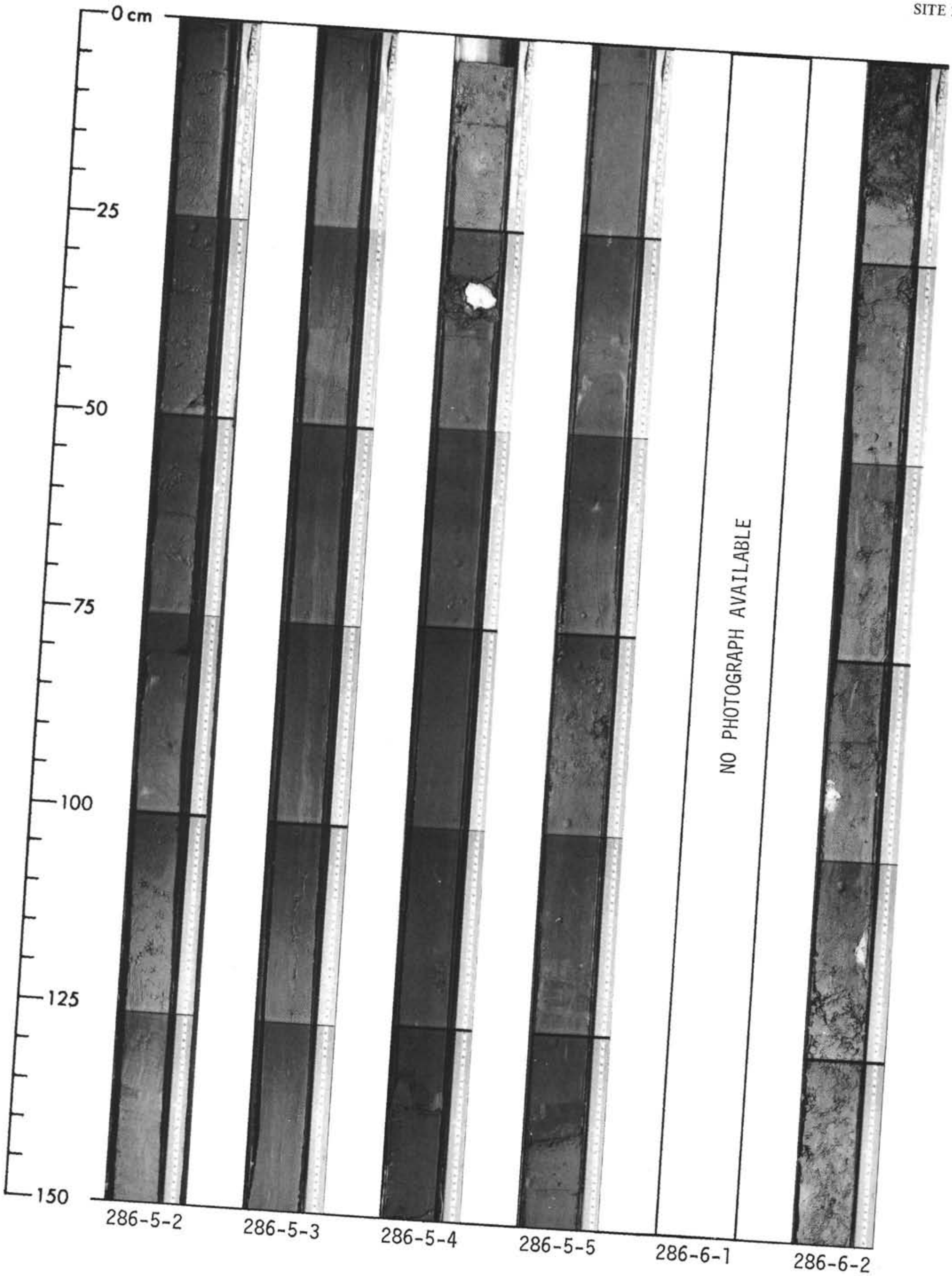
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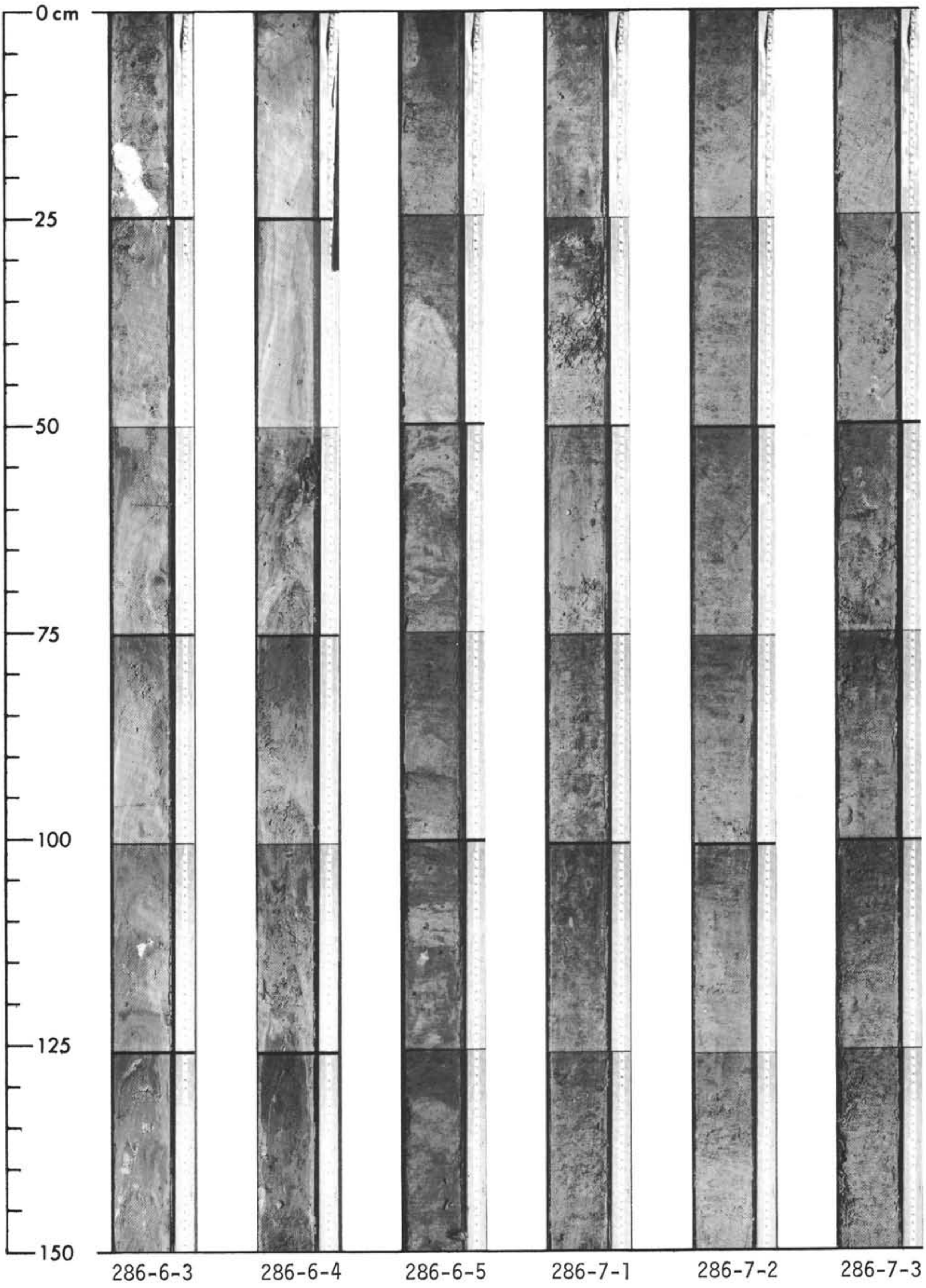
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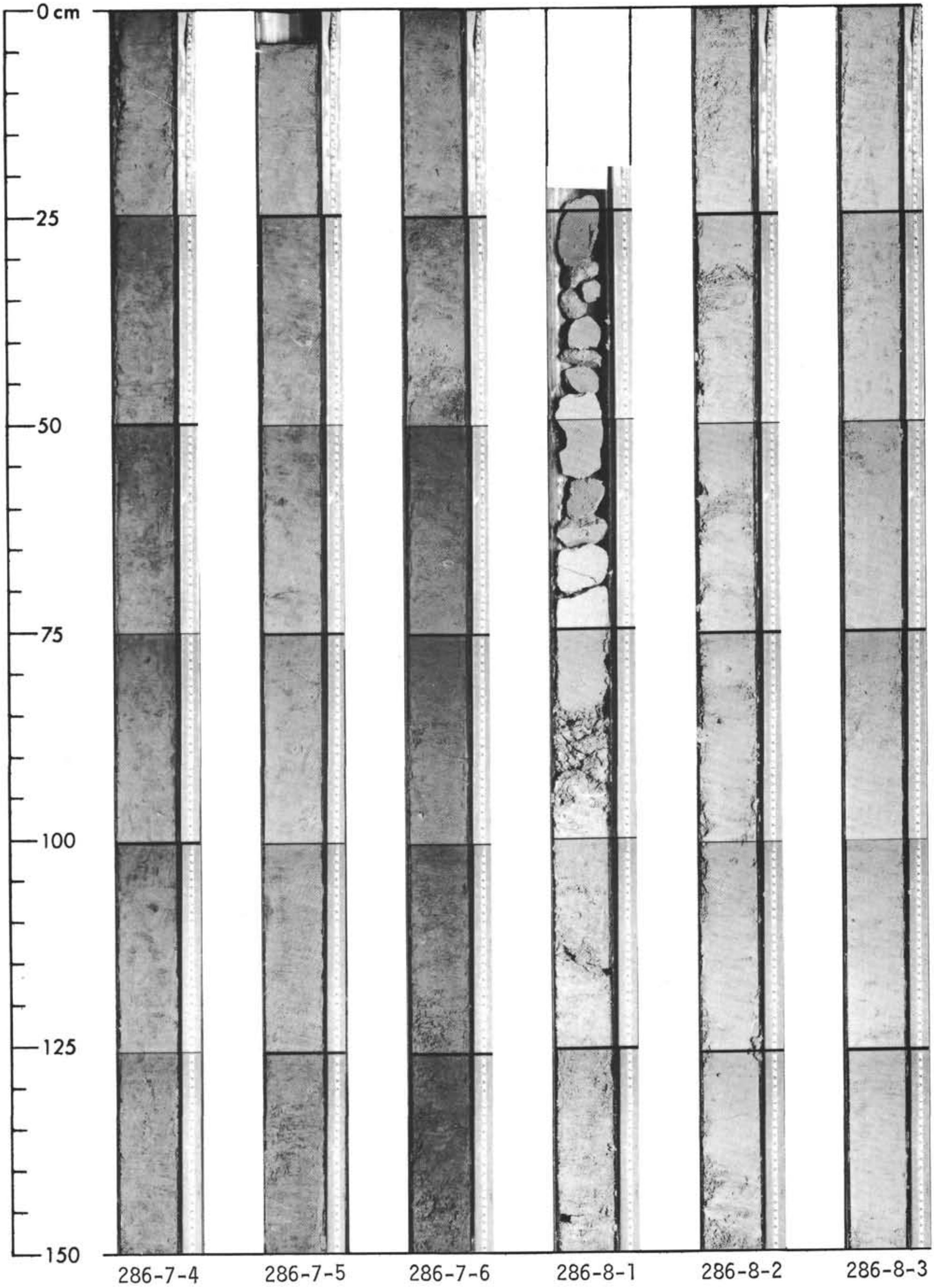
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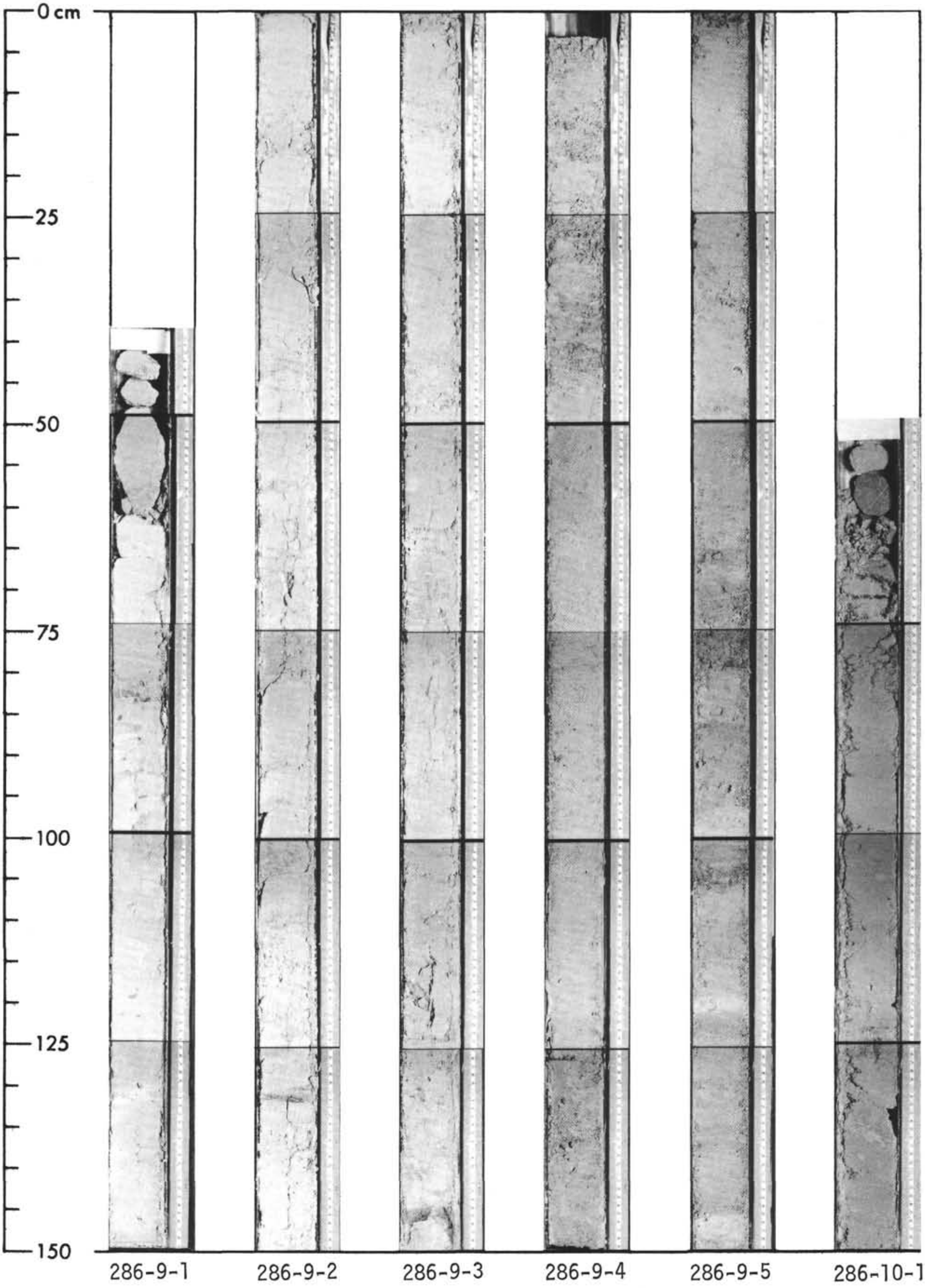
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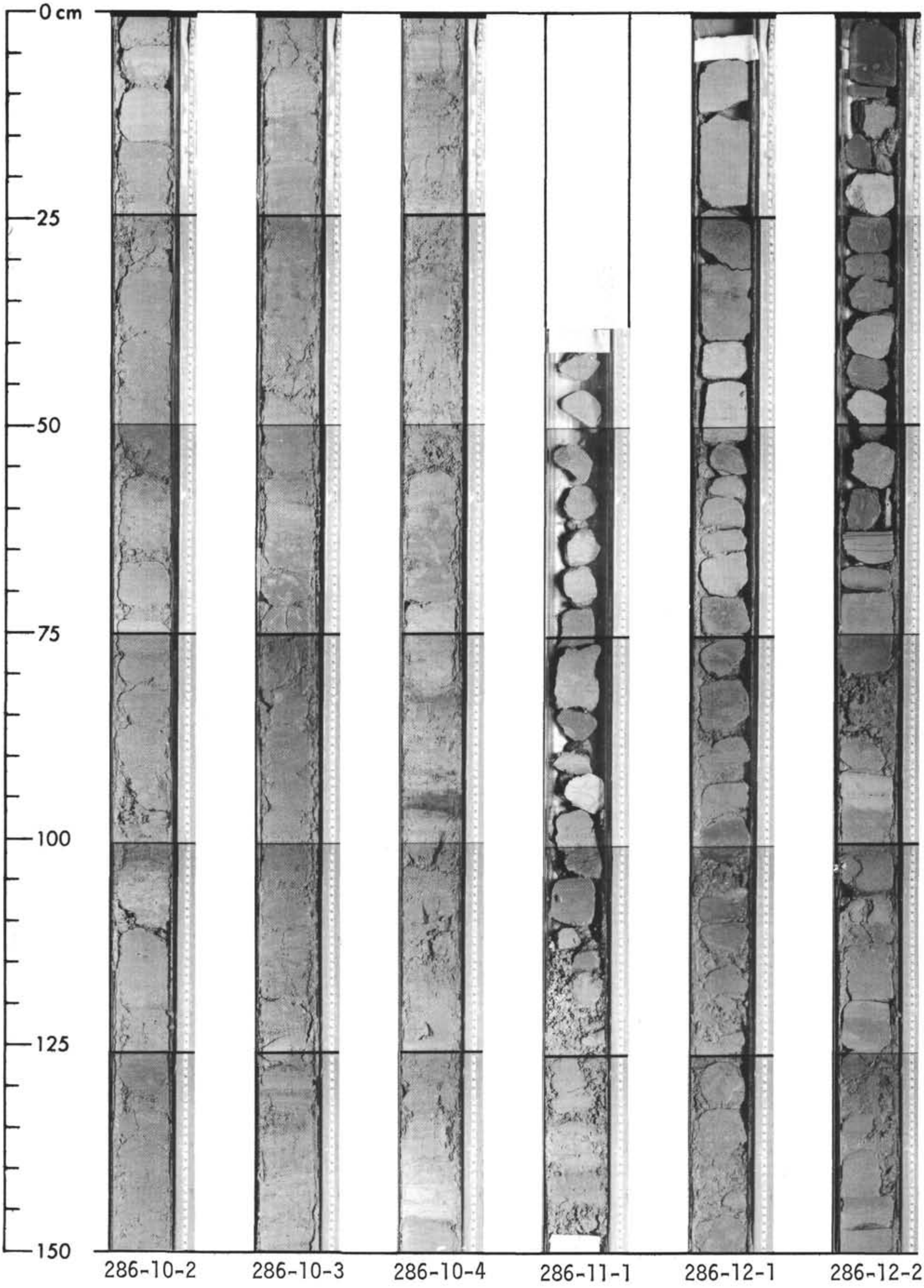
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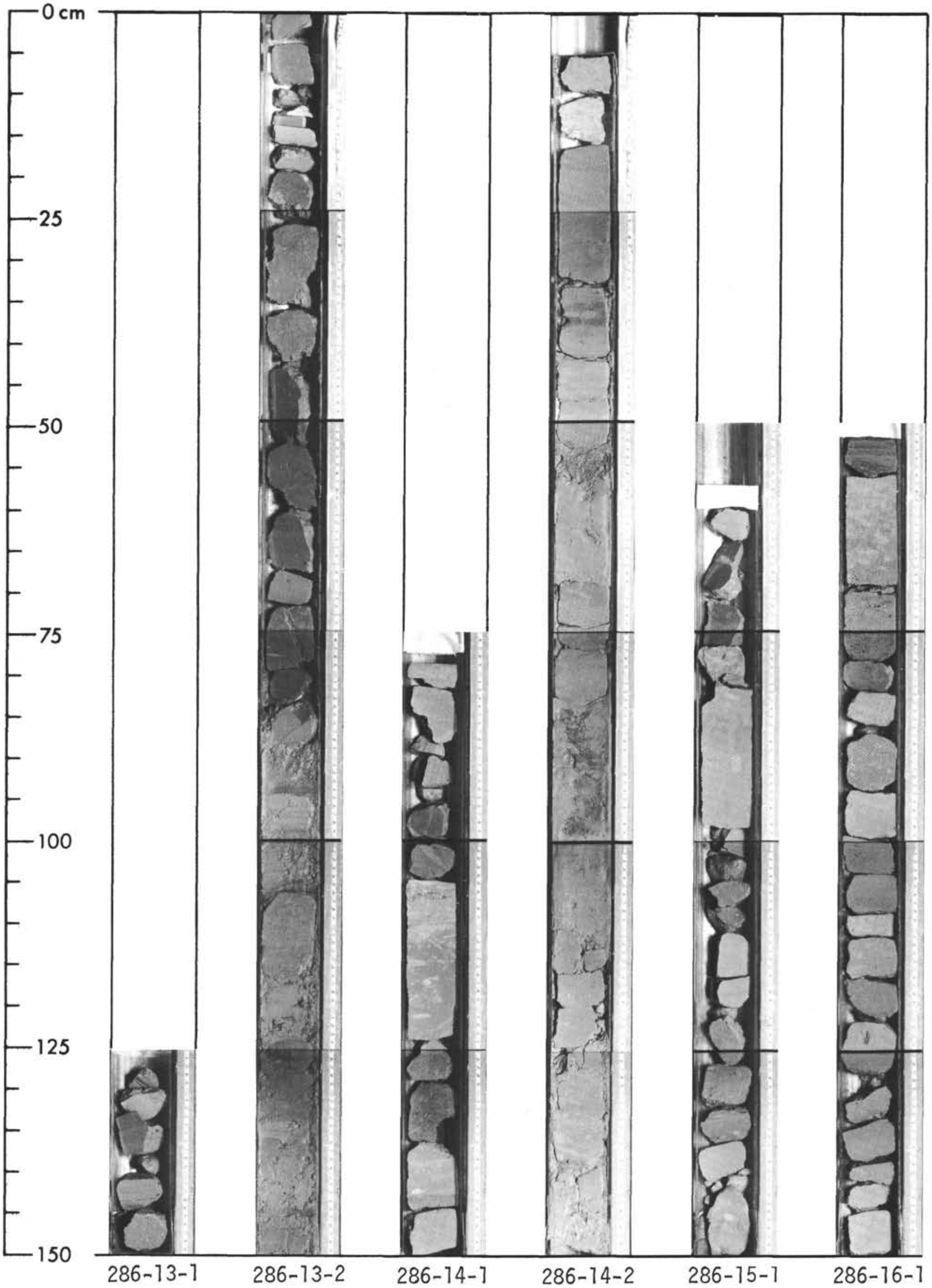
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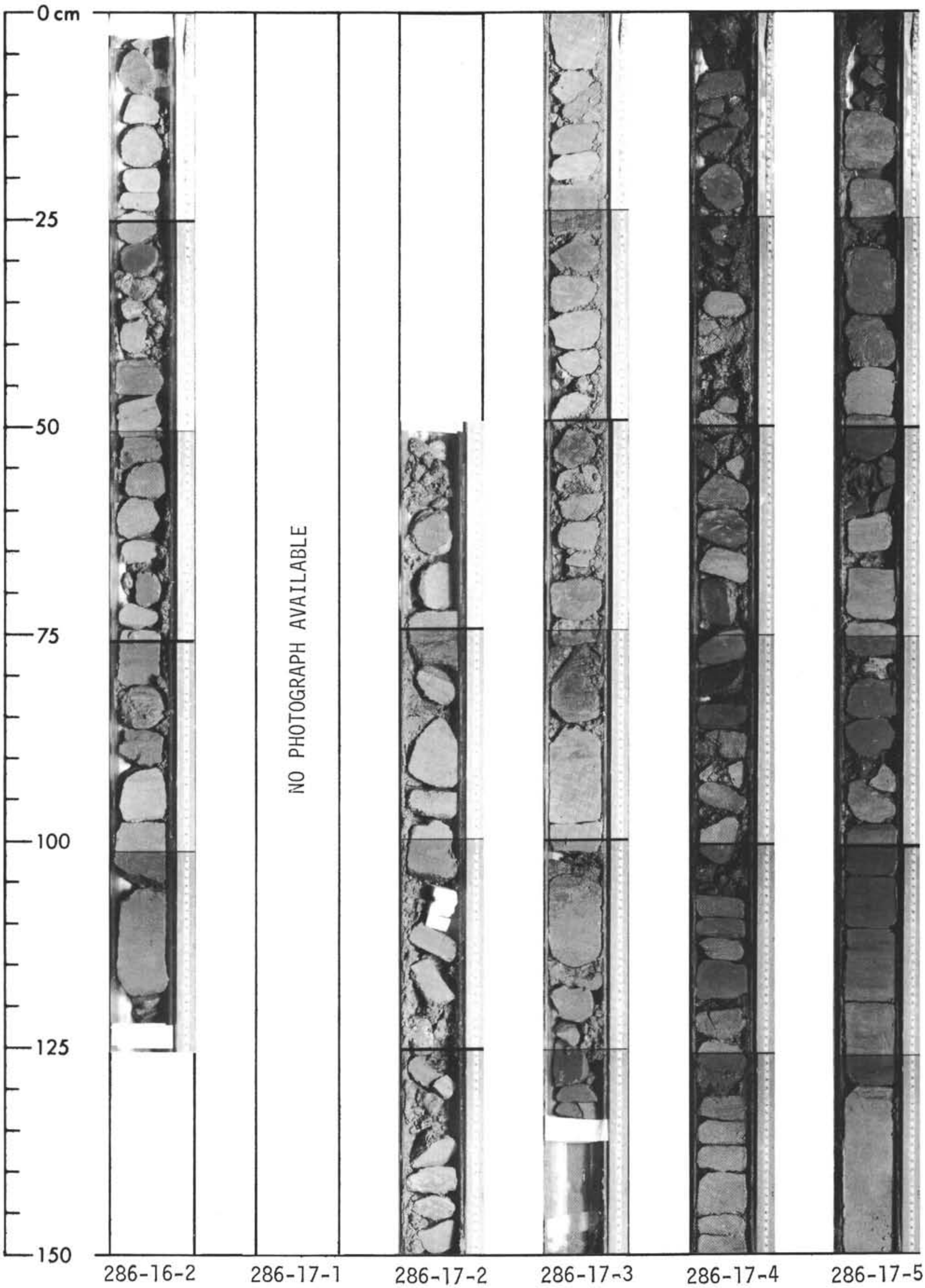
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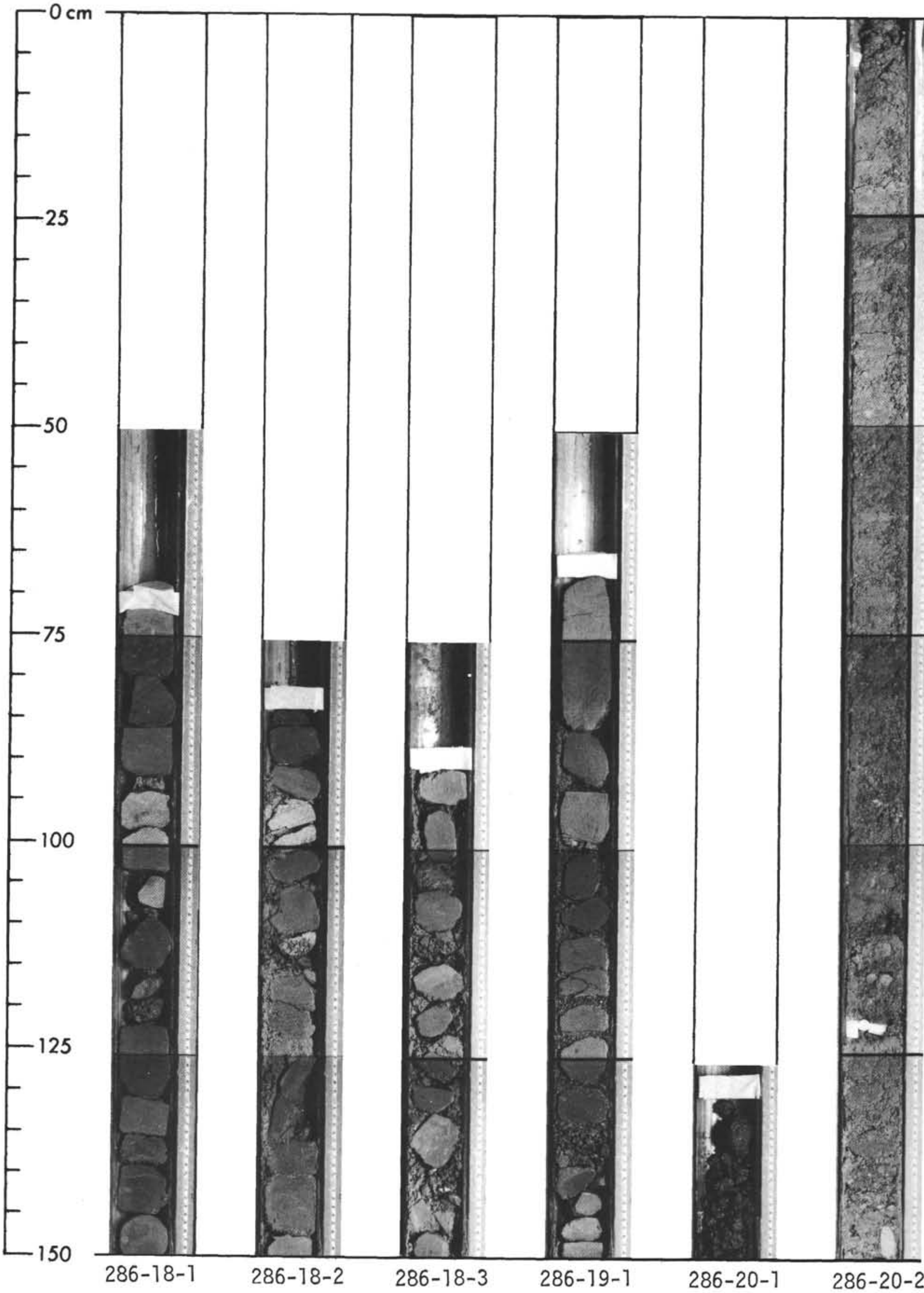
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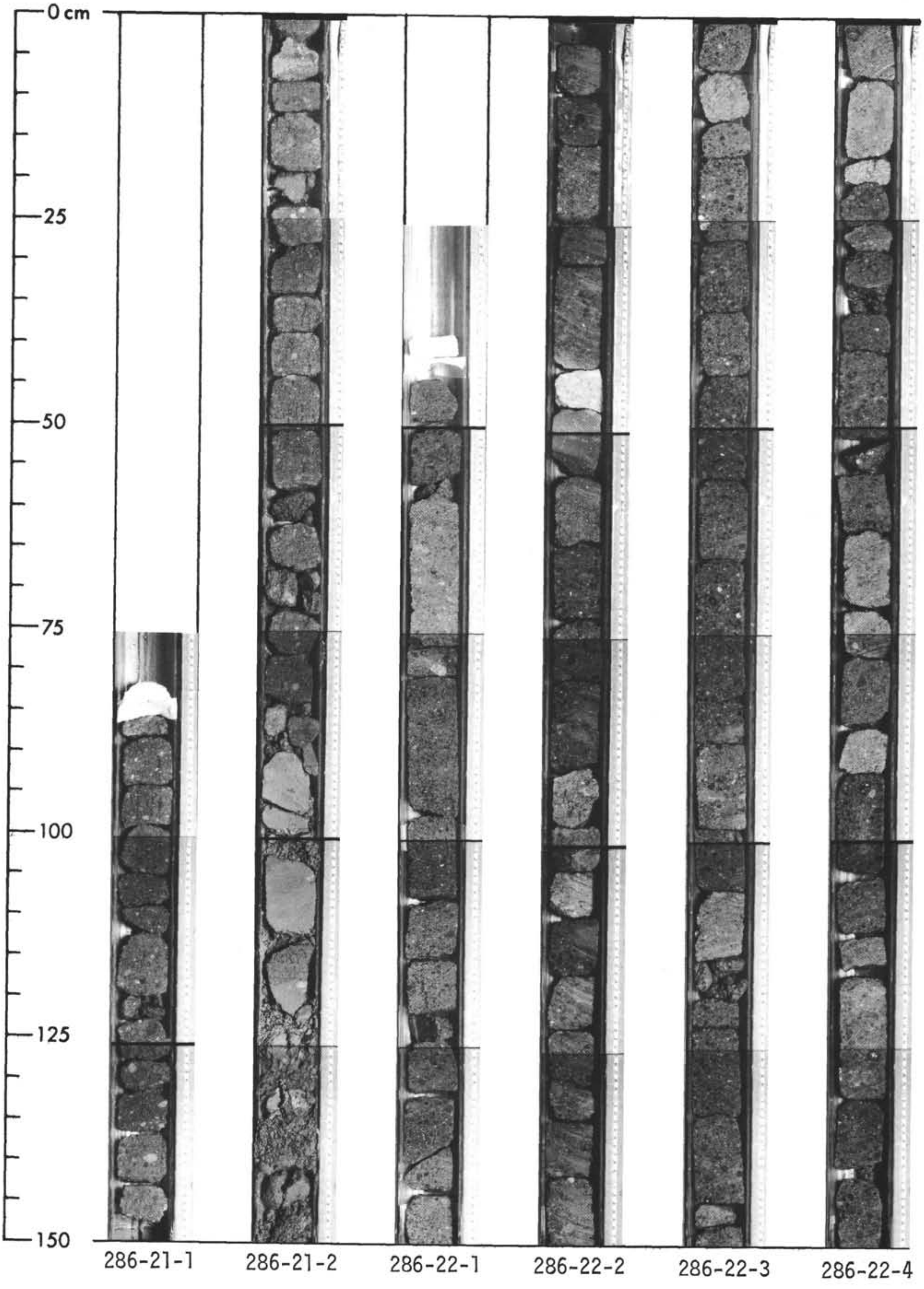
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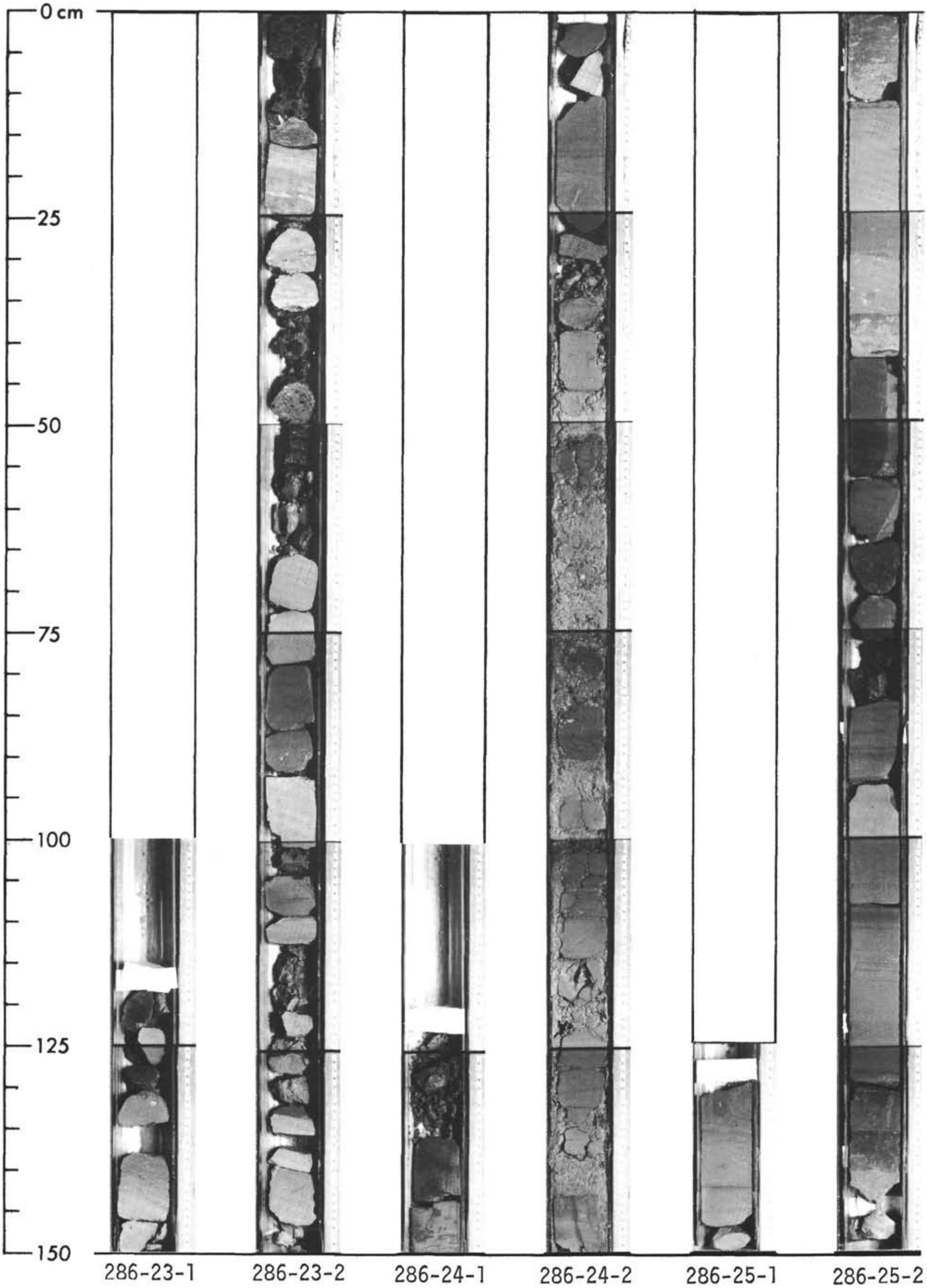
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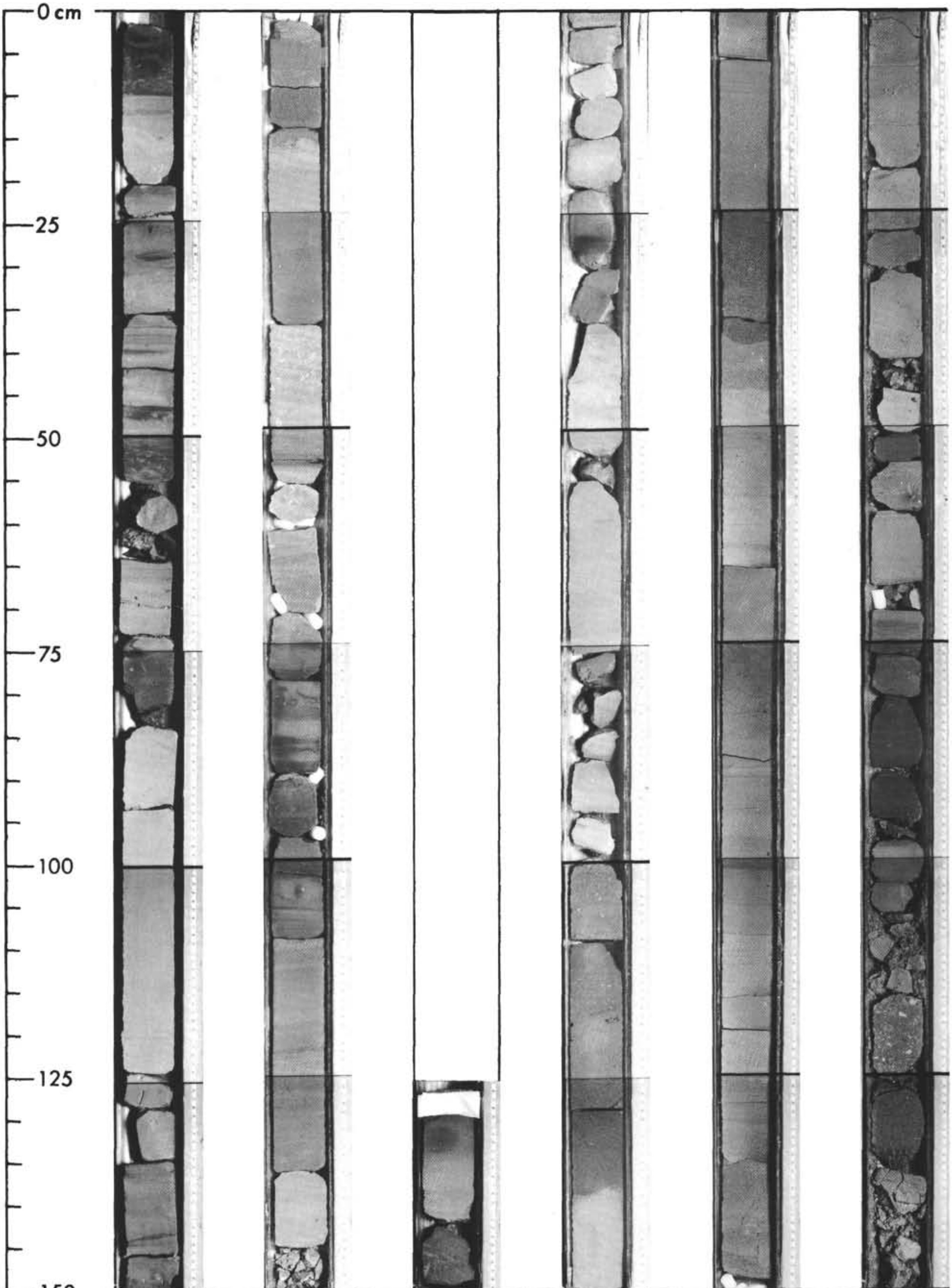
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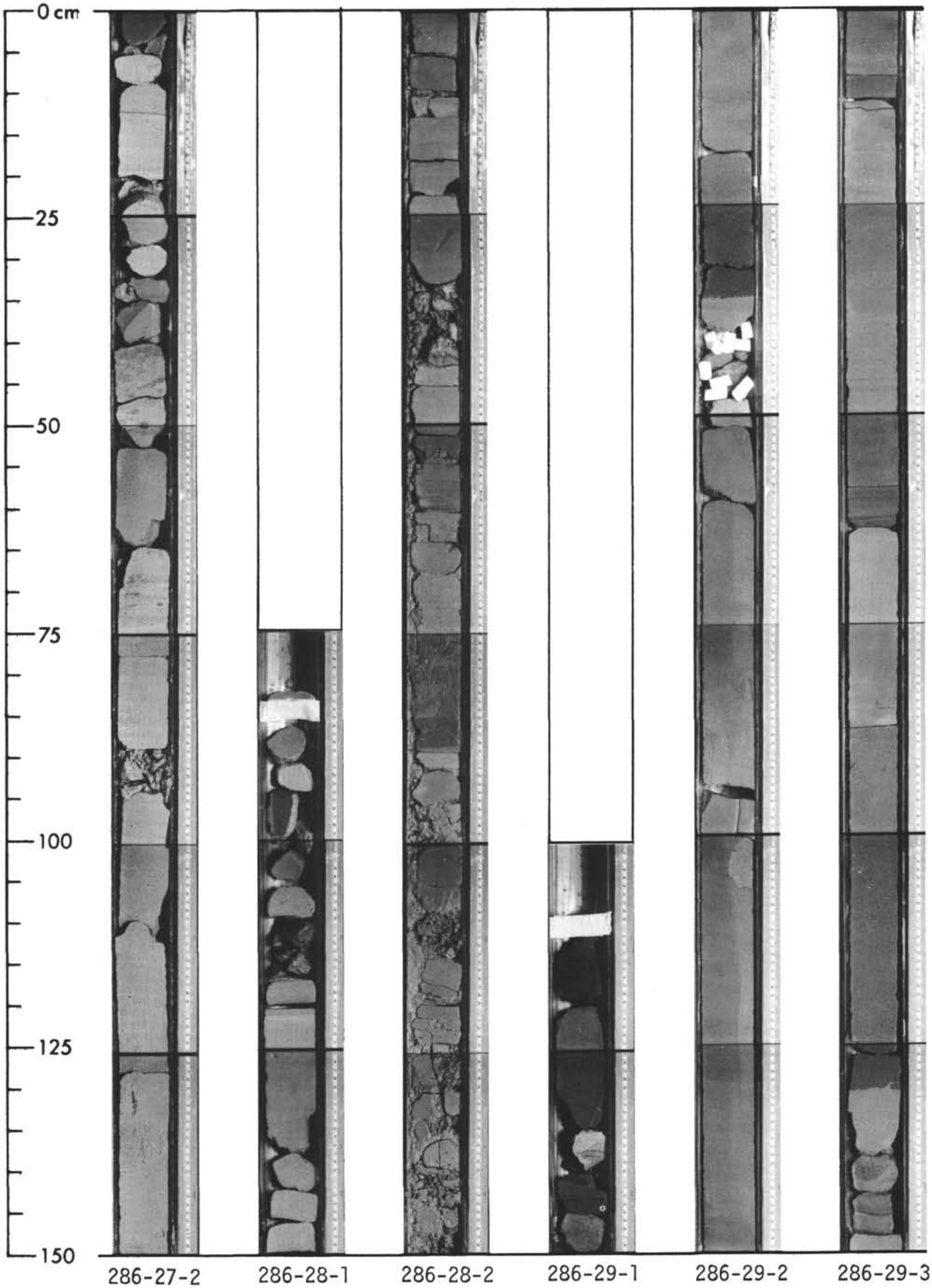
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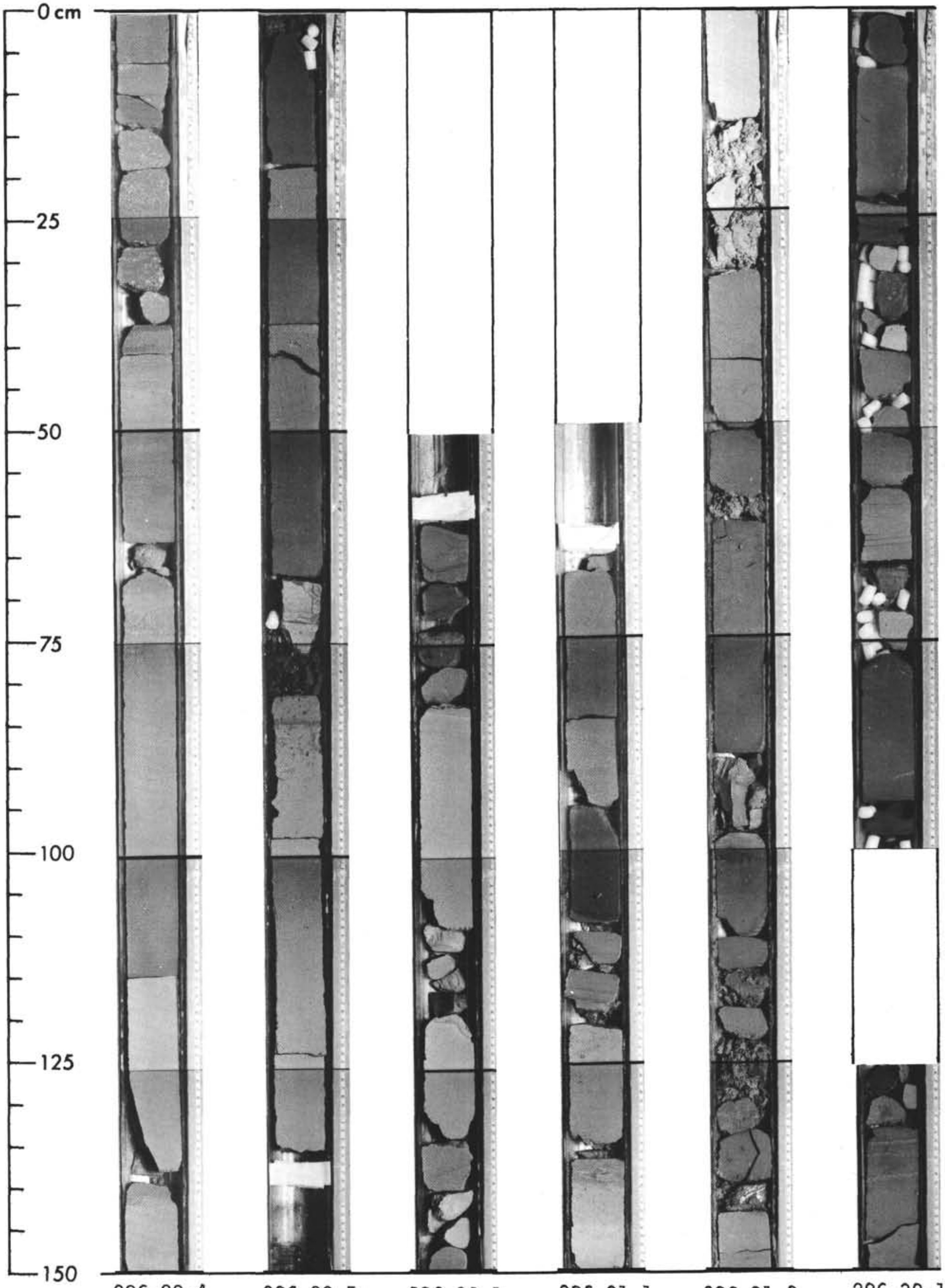
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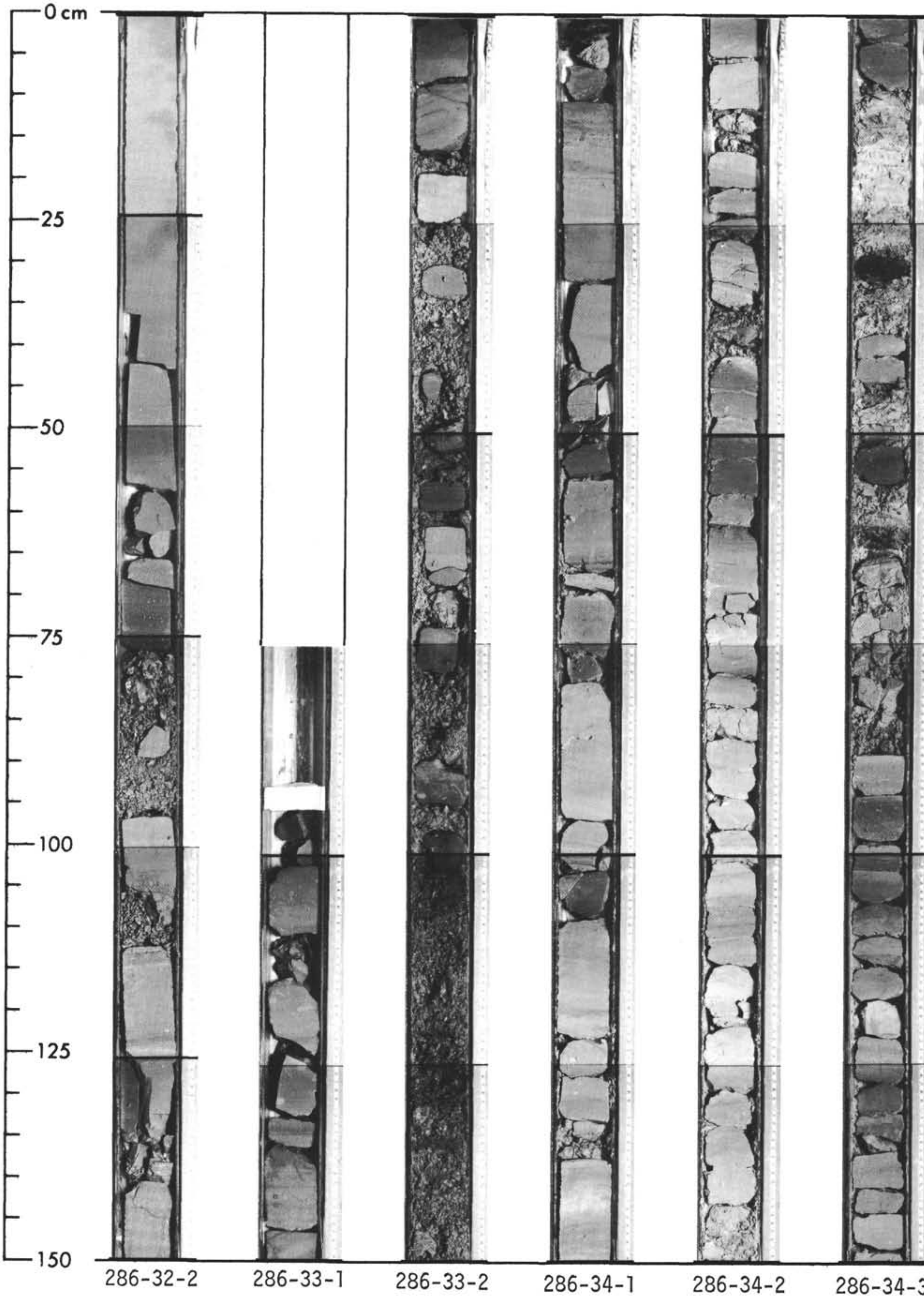
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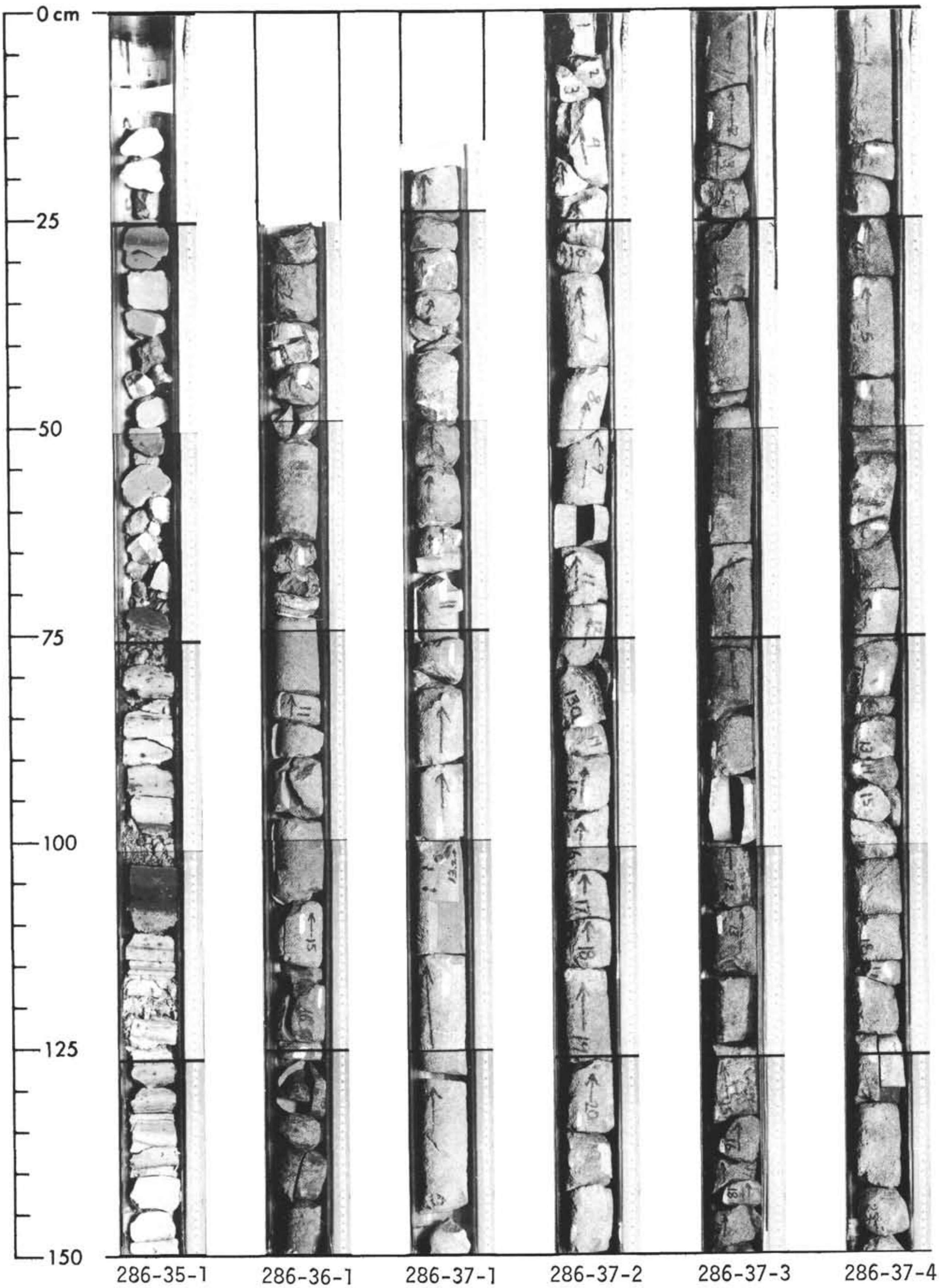
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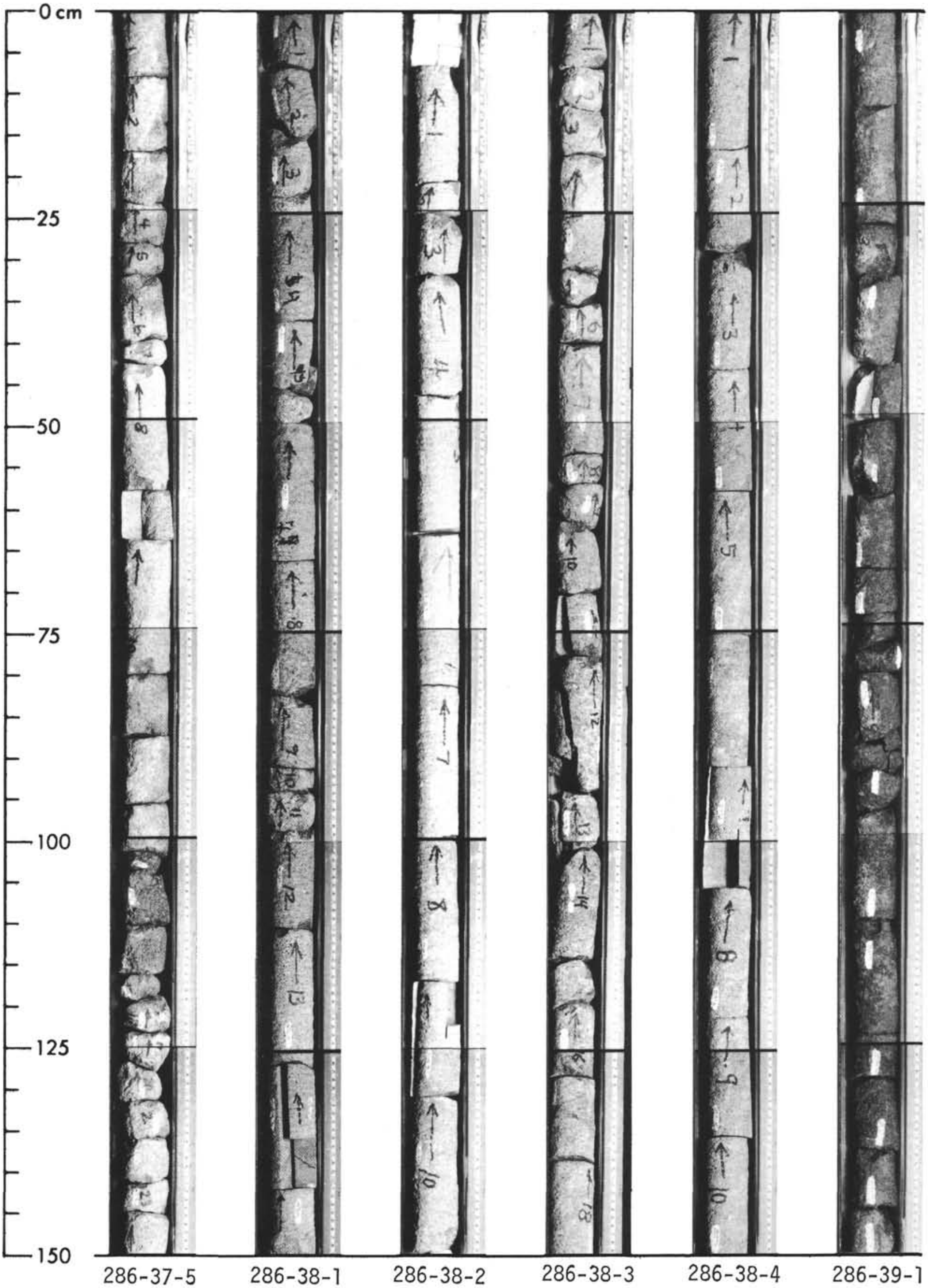
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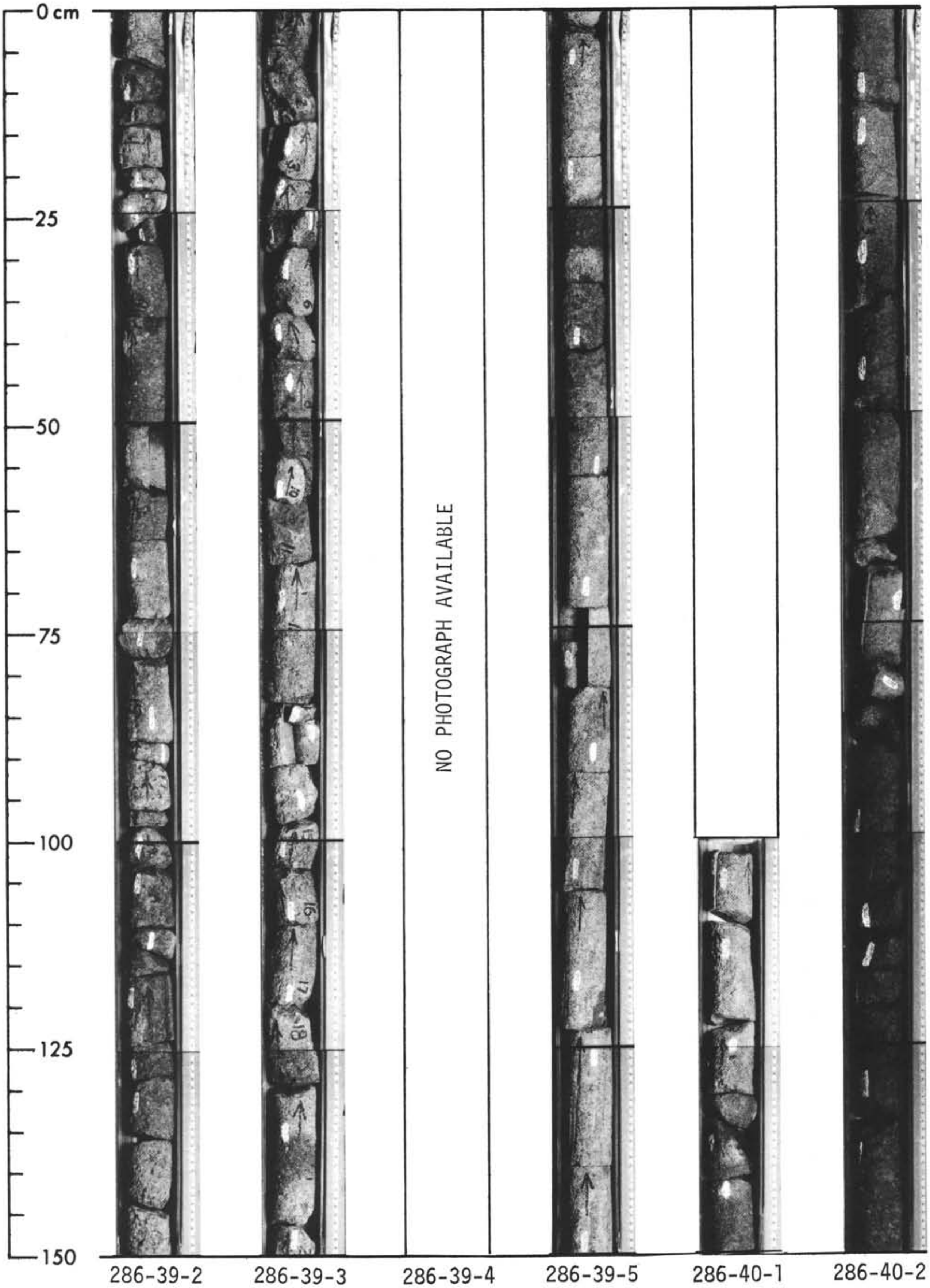
50
75
100
125
150
286-37-5
286-38-1
286-38-2
286-38-3
286-38-4
286-39-1


0 cm
25
50
75
100
125
150
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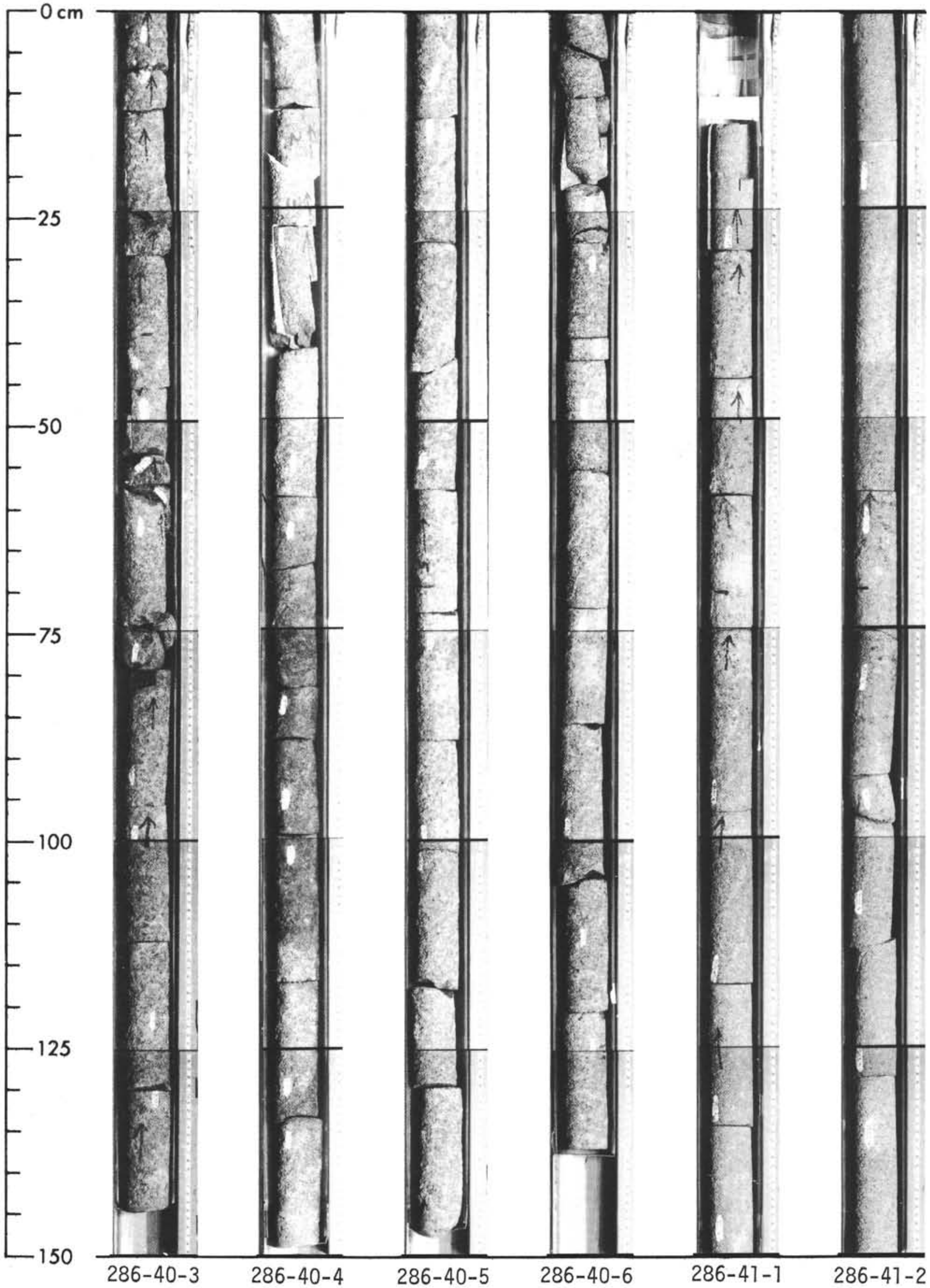
286-39-2
286-39-3
286-39-4
286-39-5
286-40-1
286-40-2


0 cm
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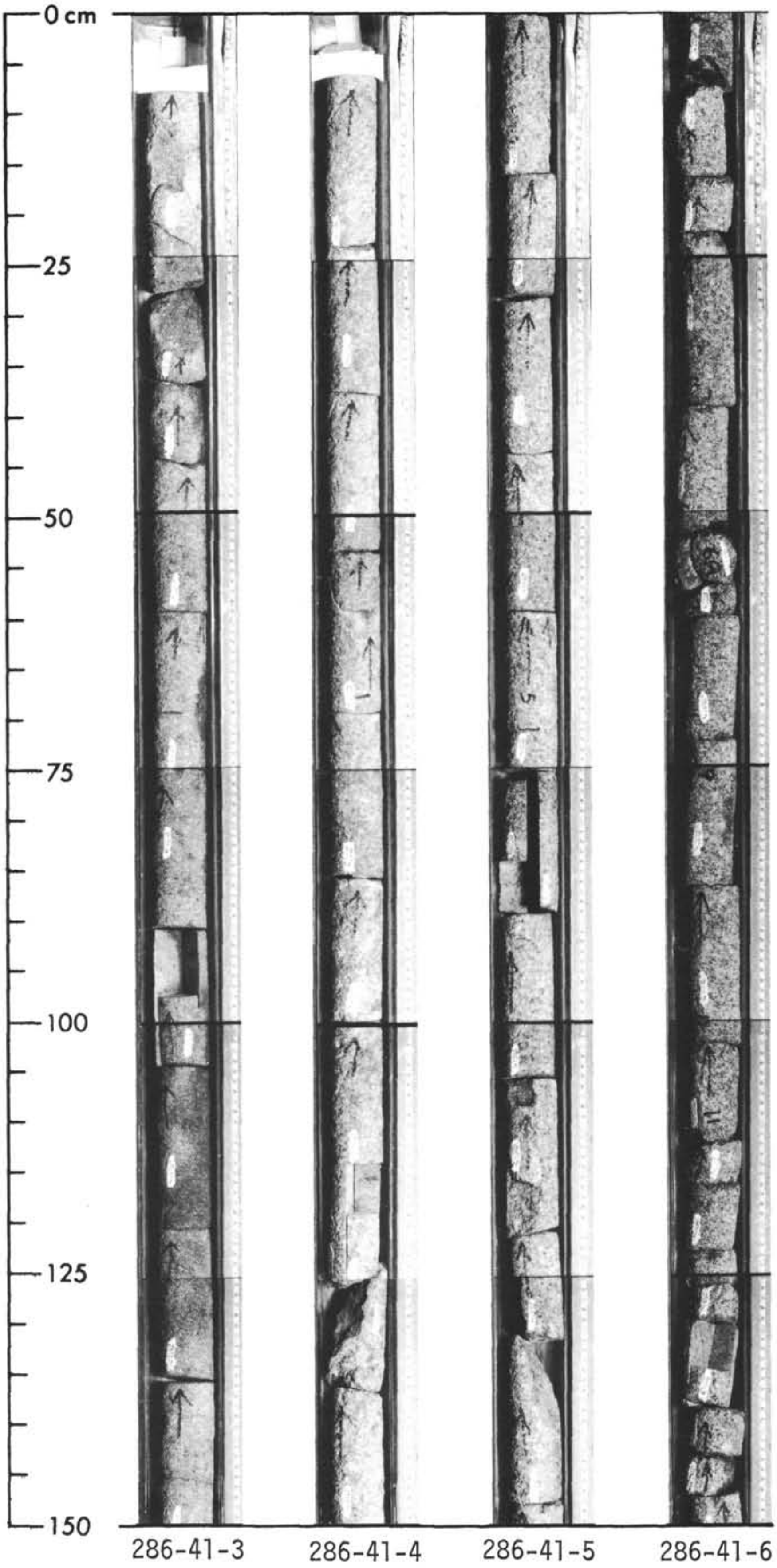
50
75
100
125
150
286-40-3
286-40-4
286-40-5
286-40-6
286-41-1
286-41-2


0 cm
25
50
75
100
125
150
286-41-3
286-41-4
286-41-5
286-41-6