9. SITE 256

The Shipboard Scientific Party[1]

SITE DATA

Locality: South Wharton Basin west of Wallaby Plateaus

Position:
lat 23°27.35'S
long 100°46.46'E

Dates Occupied: 15-17 October 1972

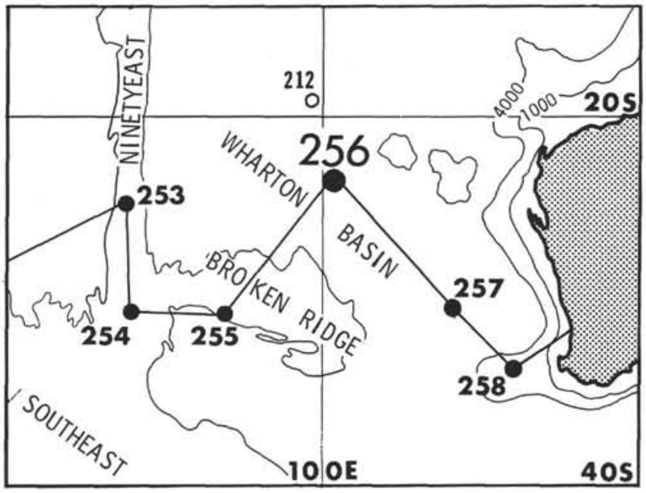
Water Depth: 5361 meters

Penetration: 270 meters

Number of Cores: 11

Oldest Datable Sediment Cored:
Depth (subbottom): 251.0 meters (Core 9)
Nature: Detrital clay
Age: Vraconnian (late Albian)

Basement:
Depth encountered (subbottom): 251 meters
Nature: Olivine poor, glassy basalt
Penetration: 19 meters



Principal Results: The basalt is overlain by 251 meters of upper Albian to Recent brown detrital clay. There is probably a disconformity between the Cretaceous and Neogene sediments, but due to the unfossiliferous nature of the clays this cannot be proven.

BACKGROUND AND OBJECTIVES

Site 256 is located in the southern Wharton Basin west of the Wallaby Plateaus in 5361 meters of water (Figure 1). The Wharton Basin contains the greatest depths in the Indian Ocean reaching over 6000 meters in the north central part and having an average depth of 5000 meters to the south. These great depths have led to the suggestion that the basin is Cretaceous or older (McKenzie and Sclater, 1971). Some reconstructions of Gondwanaland, for instance Du Toit (1937), show the Wharton Basin as a gap between proto-India and proto-Australia, which led Dietz and Holden (1971) to suggest that the basin was older than the breakup of Gondwanaland, or at least Paleozoic. Falvey (1972) and Sclater and Fisher (in press) have recently suggested that the Wharton Basin was formed by north-south spreading since the Early Cretaceous and that the gap between India and Australia never existed. The drilling results from DSDP Leg 22, show that the northern Wharton Basin is at least as old as Late Cretaceous (Site 212, fig. 1) and gets younger to the north, substantiating the idea of post-Jurassic north-south spreading and rejecting Dietz and Holden's (1971) hypothesis.

Some authors have also suggested that India was once joined to Western Australia and that the southern Wharton Basin was formed by post-Jurassic east-west spreading (Veevers et al., 1971; Crawford, 1969). This idea may or may not be in conflict with the observation of north-south spreading in the northern Wharton Basin. Unfortunately, magnetic anomalies have not been mapped in the southern basin to substantiate the hypothesis of east-west spreading. Site 256 was designed to establish whether the Wharton Basin becomes steadily older to the south and to establish the age gradient in conjunction with other holes in the Wharton Basin. Presumably an east-west gradient would verify the idea that India was joined to Australia, while a north-south gradient would indicate that it was joined to Antarctica.

The seismic data in the vicinity of the site show rough deep-sea topography with a variable sediment cover

[1]Thomas A. Davies, Scripps Institution of Oceanography, La Jolla, California; Bruce P. Luyendyk, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts (now at University of California at Santa Barbara); Kelvin S. Rodolfo, University of Illinois at Chicago Circle, Chicago, Illinois; D. R. C. Kempe, British Museum (Natural History), London, United Kingdom; Barrie C. McKelvey, The University of New England, Armidale, N. S. W., Australia; Rosanne D. Leidy, Harvard University, Cambridge, Massachusetts; George J. Horvath, The Florida State University, Tallahassee, Florida (now at State of Florida Department of Pollution Control, Tallahassee, Florida); Roy D. Hyndman, Dalhousie University, Halifax, Nova Scotia, Canada; Hans R. Thierstein, Geologisches Institut, Zurich, Switzerland (now at Lamont-Doherty Geological Observatory, Palisades, New York); Esteban Boltovskoy, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; Patricia Doyle, Scripps Institution of Oceanography, La Jolla, California.

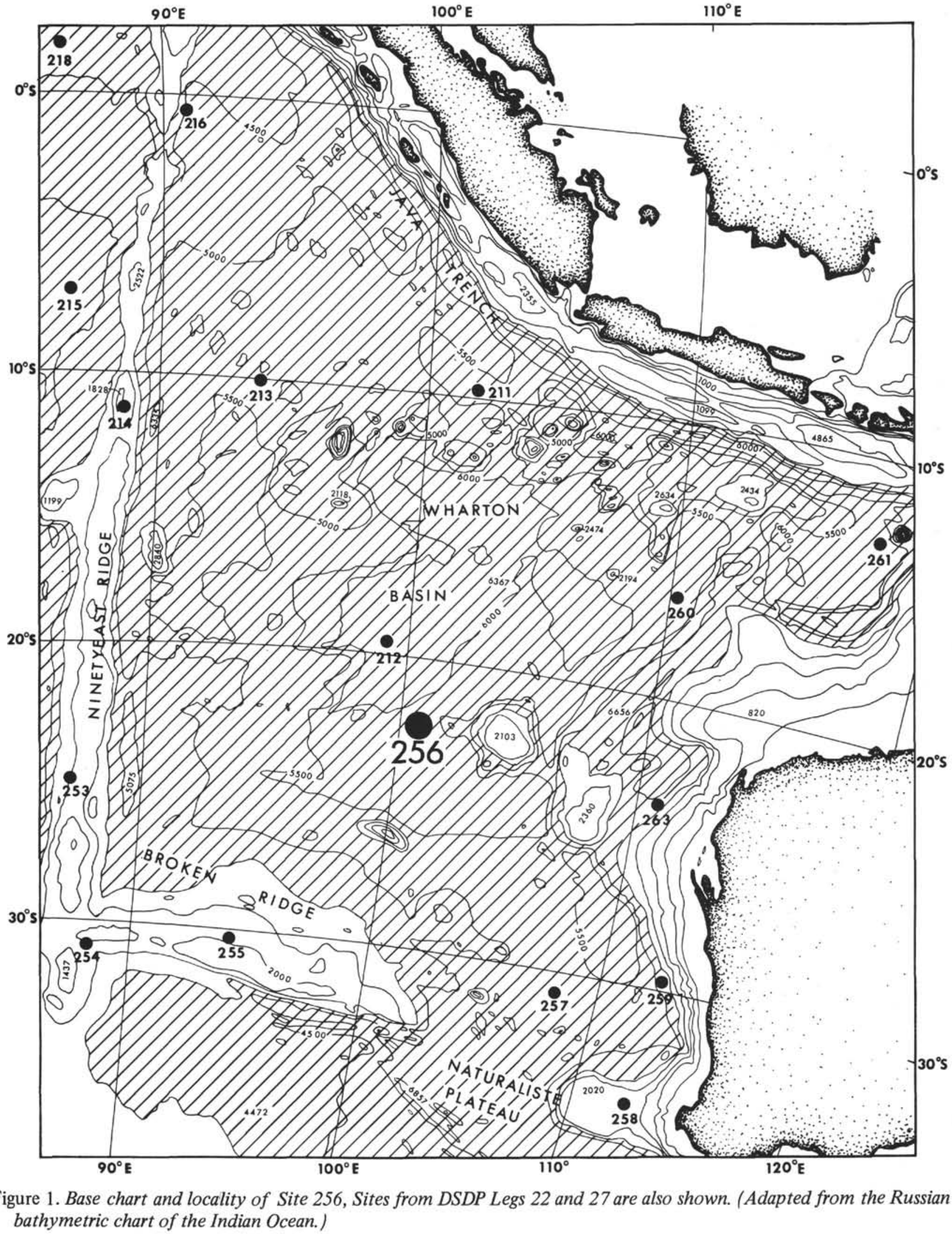


Figure 1. *Base chart and locality of Site 256, Sites from DSDP Legs 22 and 27 are also shown. (Adapted from the Russian bathymetric chart of the Indian Ocean.)*

(Figure 2). The area appears as typical buried abyssal hill topography. The site is located on a gentle hill slope (Figures 2 and 3). Just south of the site a 6000-meter-deep trough contains up to 0.5 sec DT of sediment. Near the site there is about 0.305 sec DT of sediment, devoid of internal reflectors, above an unusually flat acoustic basement. This degree of flatness suggests at first that the acoustic basement may be a sedimentary horizon rather than basalt (Figure 3).

OPERATIONS

Glomar Challenger approached Site 256 from the south along a track running at an angle to the original *Conrad*-9 track, on the basis of which the site had been selected. The principal features of the bathymetry were immediately recognizable; however, some course adjustment was necessary before the chosen site was located. The beacon was dropped while underway at 5 knots, at 1032, 15 October. The water depth was 5361 meters. After retrieving the underway survey gear we returned and, taking up position over the beacon, began lowering the drill pipe. Weather and sea conditions were good although large swells from the southwest and a strong current from the north gave us some trouble throughout operations at this site.

Bottom was reached about 2300, and an attempt was made to cut a core. While retrieving the core barrel, at 0020, 16 October, a flag on the sand line was missed and the core barrel jammed in the Bowen unit above the tool joint where the pipe is normally broken to retrieve the core. While this problem was being investigated, matters were further complicated by a power failure which occurred at 0032. Power for draw works blowers, gyros, and dynamic positioning was lost for about 2 min. However, since the bottom hole assembly was above the mudline at the time, the resulting loss of positioning control did not have serious consequences. The positioning computer was reprogrammed and the core barrel worked free of the Bowen unit so that operations were back to normal by 0300, 16 October. To add insult to injury, the core barrel, when finally retrieved from the top joint of pipe, proved to be completely empty so apparently the bottom hole assembly had not up to that time made contact with the sea bed at all.

The first core was finally brought onboard at 0450, and intermittent drilling and coring then proceeded uneventfully and with good recoveries until, following Core 5, we attempted a downhole temperature measurement. The downhole instrument was retrieved and an apparently good measurement had been made, but the "stinger" probe had sheared off immediately below the electronics package. There was some concern that the probe would give problems if it became wedged in the bit. However, operations proceeded unimpeded until a second downhole temperature measurement was

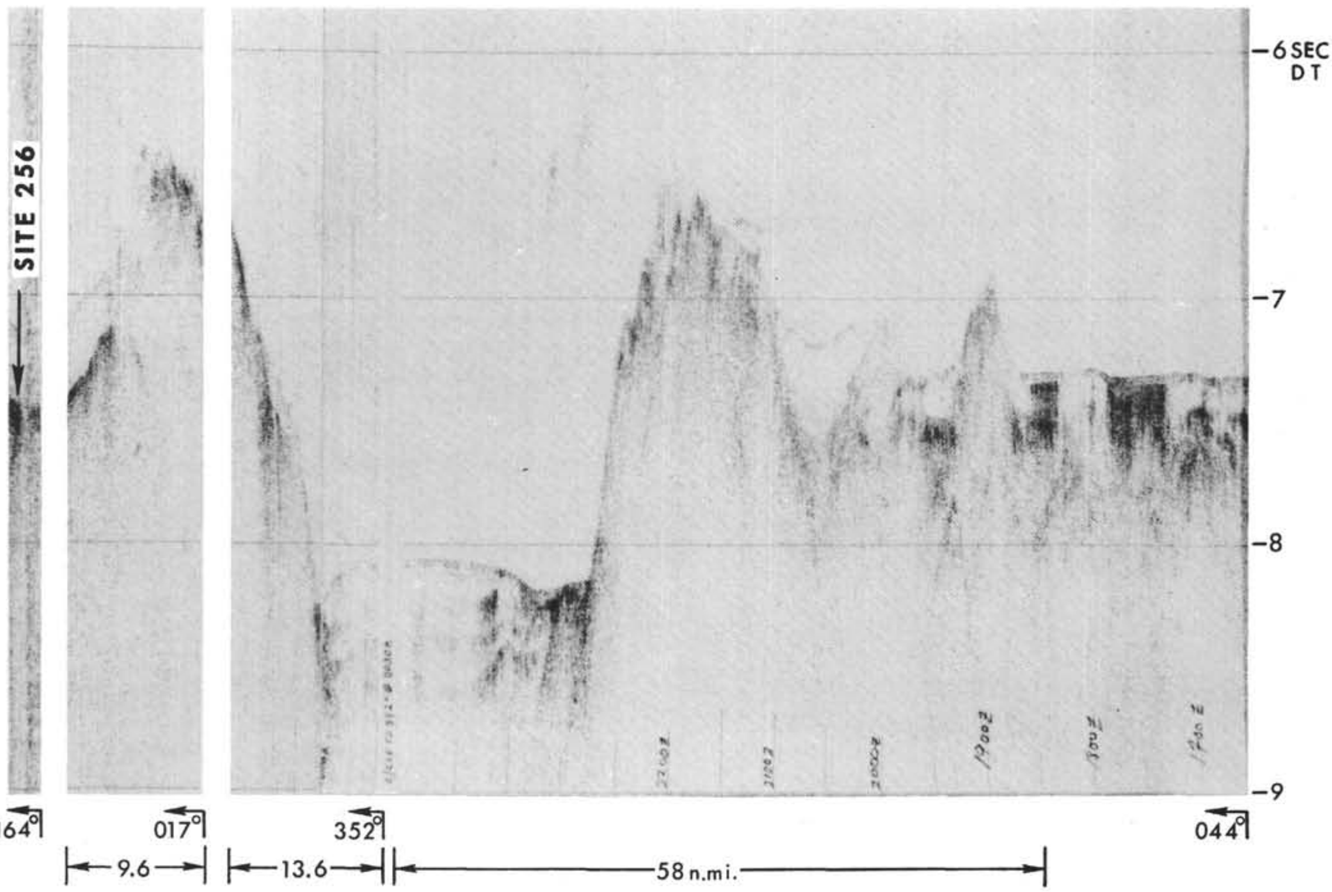


Figure 2. *Seismic reflection profile approaching Site 256, taken from D/V* Glomar Challenger.

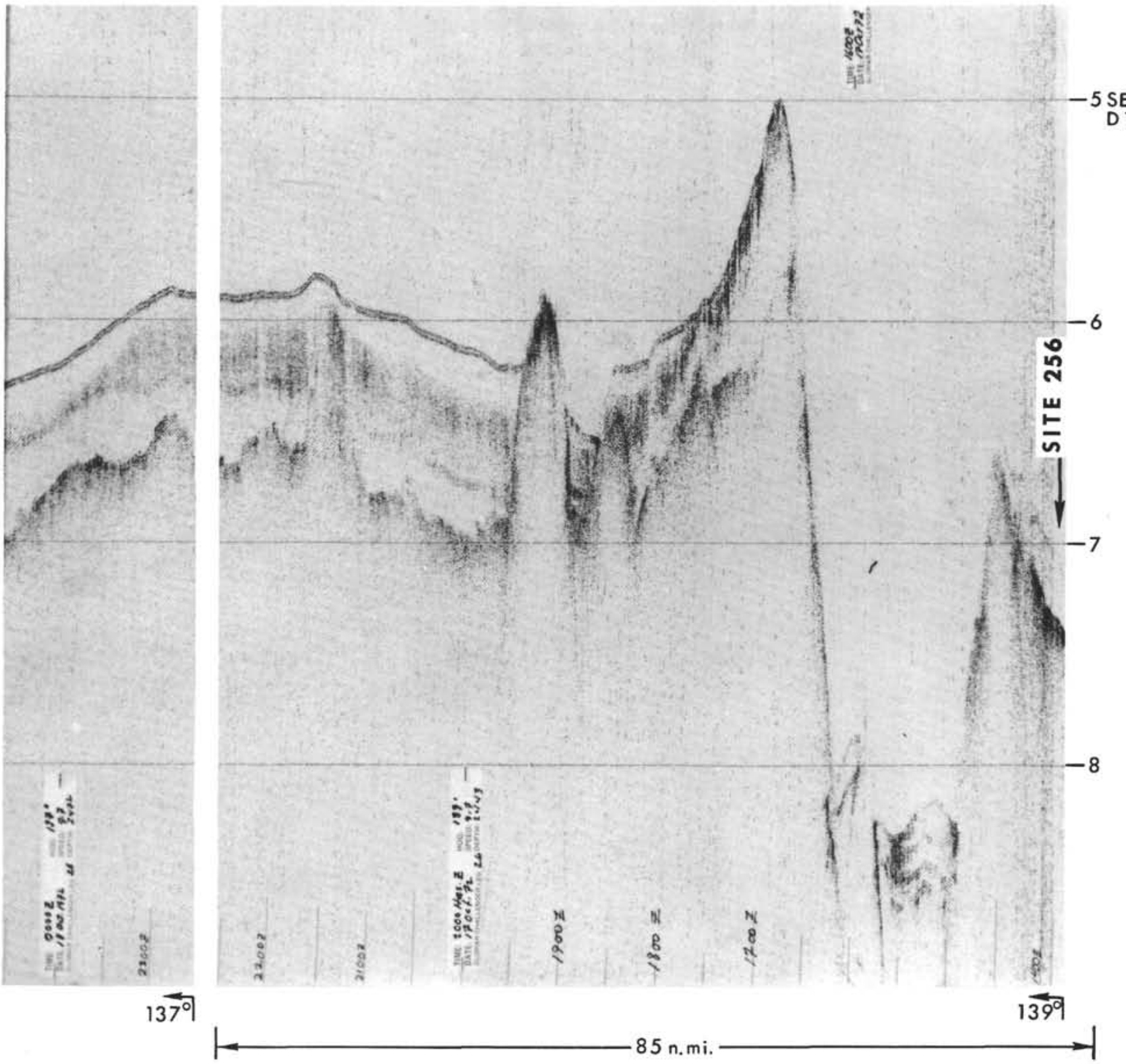


Figure 3. *Seismic reflection profile leaving Site 256, taken from D/V* Glomar Challenger.

attempted following Core 7. This time the core barrel was obviously wedged securely in place since it was necessary to overpull on the sand line by some 6000 lb before the barrel was released and could be retrieved. On recovery the entire downhole instrument package was missing, and from the state of the core catchers it was readily apparent that the instrument had been ripped out bodily through the mouth of the core barrel. In both these instances the downhole instrument had been operated in the latched mode, which in principle permits a core to be cut at the same time as the temperature measurement is made. It is believed that, in the stiff clays found at this site, as soon as the bottom hole assembly was lowered and/or rotated to cut a core the stinger, extending beyond the bit, was bent out of alignment. In the first instance this resulted in the stinger breaking off. In the second, presumably the stinger was bent around the bit in such a way that it could not be drawn back through the throat of the bit with the resulting loss of the entire package.

There was now real anxiety about the junk in the hole, and attempts were made to clear it by flushing the hole and drilling ahead before coring again. This was apparently successful and one more core was cut before basement was encountered while cutting Core 9, at a subbottom depth of 251 meters. Two further cores were cut into basement before operations were curtailed in the hope of making time to fit a ninth site on Leg 26. On pulling the last core, the hole felt very tight and on recovery of the string it was found that the bit had lost all three cones. One of these fell off during recovery but the other two were left in the hole. It is suspected that a piece of the heat-flow equipment had become wedged between two of the cones, preventing them from turning. We had then drilled with the bit locked until the two cones finally sheared off, this presumably happening during or at the end of cutting the last core. See Table 1 for coring summary.

Tools were laid down and we got underway for Site 257 at 2035, 17 October. No time was spent in pre- or postsite survey.

LITHOLOGY

This site, drilled in 5361 meters of water, penetrated 251 meters of predominantly detrital clay (Unit 1) overlying 19 meters of fine- to coarse-grained olivine basalt (Unit 2). Recovery was limited to 65.5 meters of sediment and 12.5 meters of basalt. The sediments are soft, largely barren deep-sea detrital clay, ranging in color from moderate brown to grayish-brown, grading into coccolith detrital clay at the base. Minor grayish-green layers and common biscuits of drilling breccia are found below 128 meters (Core 5). Drilling breccia is present continuously downward from Core 6 (180.5 m) to the sediment/basalt contact; stiffer discrete greenish-gray, reddish-brown, grayish-brown, and dark brown clay chunks mixed randomly in the grayish-brown drilling breccia matrix in Cores 8 and 9 differ from the matrix in having lower abundances of coccoliths.

Unit 1

Typically the entire clay sequence is composed of 78%-98% detrital clay. Sand contents range from 0.0% to 0.5%, and silt comprises 2.3%-24% of the sediment, increasing down the hole. The following components are ubiquitous: fish debris in trace amounts to 4%; quartz in trace amounts to 1%; mica typically in trace amounts to 2%, rarely 5%; very rare traces of heavy minerals and glauconite. At the top of Unit 1 (Cores 1-5) the clay comprises approximately one-half montmorillonite and one-half equal kaolinite and mica/illite, with traces of chlorite and palygorskite. Quartz and feldspar (predominantly potassic) are present (total ca, 22%), with traces of glauconite, clinoptilolite, gibbsite, and calcite. Below this (Cores 7 and 8) lies a presumably incipient chert horizon, in which mica/illite predominates over montmorillonite, quartz and feldspar are common, and more than half the total consists of cristobalite, clinoptilolite (Figures 4 and 5) and tridymite, similar to the association already observed at Site 250, except that palygorskite is absent and clinoptilolite reaches 26%. As at Site 250, the high proportion of montmorillonite in a detrital sediment argues strongly for a largely volcanic provenance; the parameters controlling the palygorskite-cristobalite (-tridymite)-clinoptilolite (-phillipsite-analcite) balance, while largely chemical, are clearly complicated.

At the base (Core 9) the calcareous clay contains montmorillonite and mica/illite (in the ratio 3:1), quartz, potassium feldspar, and clinoptilolite, with traces of analcite and hematite.

Ferromanganese micronodules surrounded by black-gray halos are present throughout Core 4 and absent elsewhere. These micronodules have a chemical affinity with black mottles in Core 3 which do not contain micronodules at their centers. These have been identified by X-ray powder photograph as lithiophorite (Figure 6) a platy, monoclinic mineral with resemblances to some clay minerals. This Li-Mn mineral (Al, Li) (MnO_2 $[OH]_2$), previously known as lithian wad, has become fairly widely known in ore bodies and soils, forming a major constituent mineral in nodular manganese in Australian soils (Wilson et al., 1970). It is not thought to be known from DSDP cores although it is

TABLE 1
Cores Cut at Site 256

Core	Date (Oct. 1972)	Time	Depth from Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	16	0450	5371.0-5380.5	0-9.5	9.5	9.6	101
2	16	0620	5380.5-5390.0	9.5-19.0	9.5	9.4	99
Drilled			5390.0-5418.5				
3	16	0802	5418.5-5428.0	47.5-57.0	9.5	9.1	96
Drilled			5428.0-5456.5				
4	16	0936	5456.5-5466.0	85.5-95.0	9.5	9.5	100
Drilled			5466.0-5494.5				
5	16	1109	5494.5-5504.0	123.5-133.0	9.5	5.75	61
Drilled			5504.0-5532.5				
Drilled			5532.5-5551.5				
6	16	1510	5551.5-5561.0	180.5-190.0	9.5	9.6	101
Drilled			5561.0-5580.0				
7	16	1720	5580.0-5589.5	209.0-218.5	9.5	2.8	29
Drilled			5589.5[a]-5608.5				
8	16	2140	5608.5-5618.0	237.5-247.0	9.5	9.0	95
9	17	0201	5618.0-5627.5	247.0-256.5	9.5	3.4	36
10	17	0628	5627.5-5634.0	256.5-263.0	6.5	6.0	92
11	17	1014	5634.0-5641.0	263.0-270.0	7.0	4.2	60
Total					99.0	78.35	79

[a]Heat-flow measurement.

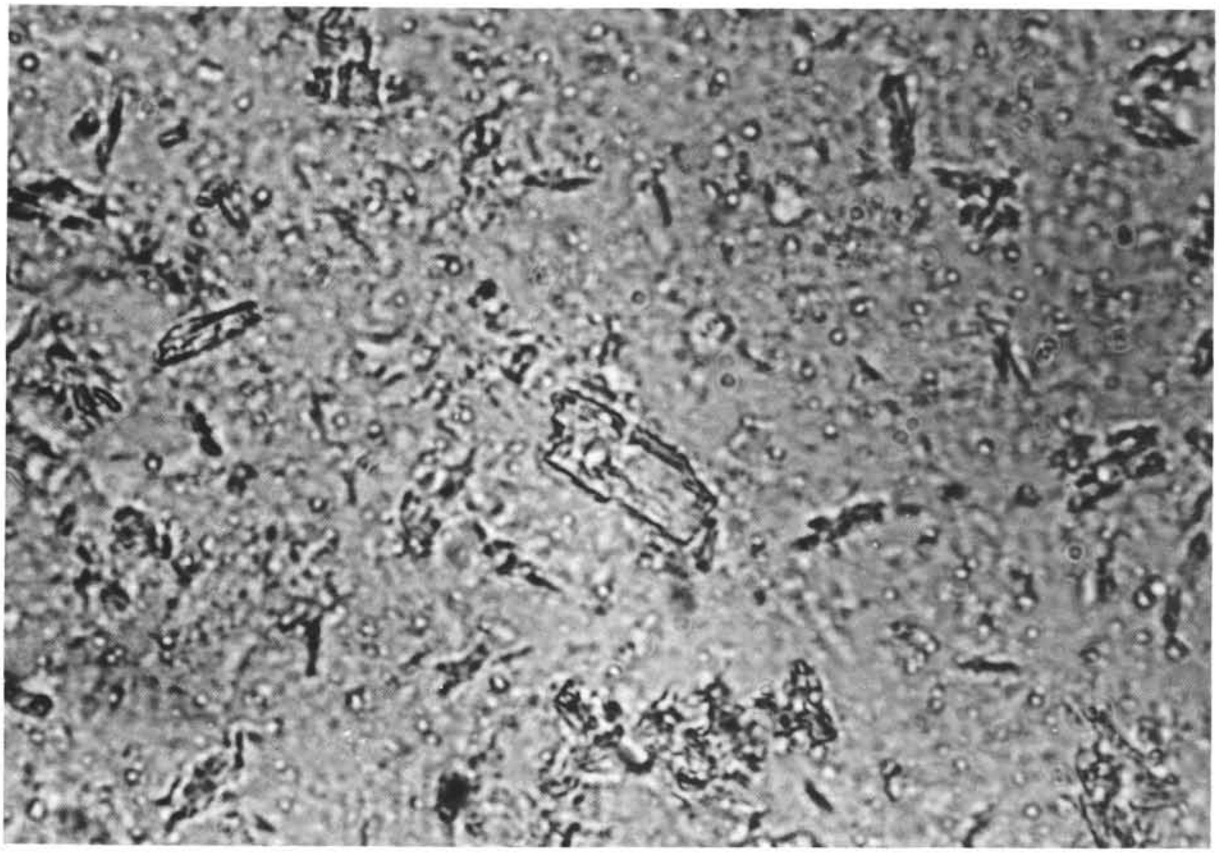


Figure 4. *Photomicrograph of clinoptilolite grains from Unit 1, Site 256 (X900).*

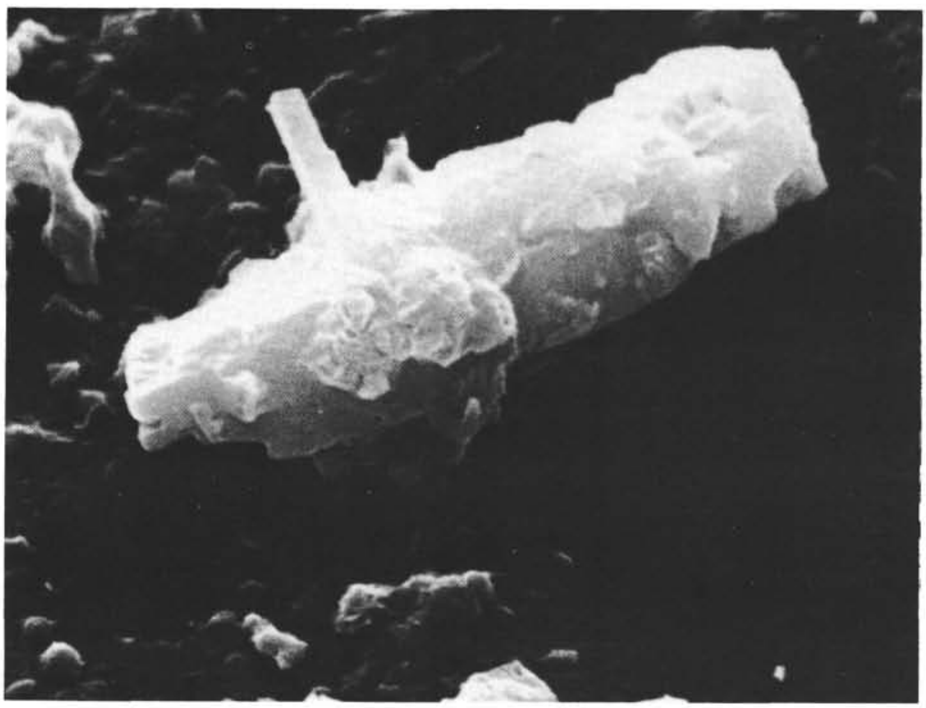


Figure 5. *SEM photograph of clinoptilolite from Site 256 (X5000).*

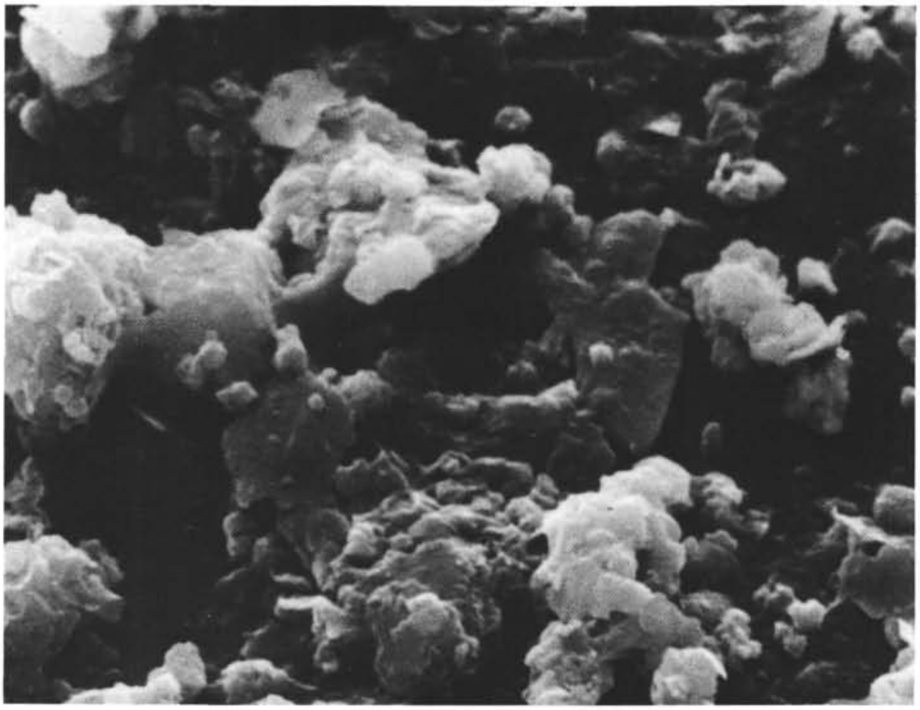


Figure 6. *SEM photograph of lithiophorite from Site 256 (X10,000).*

almost certainly present in some manganese nodules. The incidence of a lithium-rich (up to 1% Li_2O) manganese mineral in a deep-sea core is best explained by the strong "scavenging" or "collecting" powers of manganese.

Core 5 contains small euhedral crystals of authigenic rhodochrosite (Figure 7); Core 7 contains traces of barite (Figure 8). Both the rhodochrosite and barite are approximately 1 mm in size.

The following components have been observed in smear slides to display trends within the record at Site 256:

1) Decrease downwards through the upper part of the record in percentage of microscopic translucent and opaque iron aggregates, from 20% to 25% in Core 1, to between trace amounts and 8% in Core 4, to between trace amounts and 1% below Core 4.

2) Zeolites increase in abundance downward (trace amount to 1% in Cores 1-5, 5%-25% from Core 6 downward). Authigenic rims on clays are frequent from Core 5 downward.

3) As mentioned above, coccoliths are present in trace amounts in Core 7, increasing in abundance downward to the sediment/basalt contact in Core 9. There is no necessity for postulating sediment transport to explain the occurrence of calcareous fossils or the irregular-shaped clay pebbles, which may have been produced by drilling disturbances, in this part of the record (cf. Site 212, Leg 22, in the deepest portion of the Wharton Basin). This point is discussed further in the Paleontology Section, this chapter.

The sedimentary record at Site 256 represents undisturbed deep-sea deposition proceeding at a slow rate, as indicated by presence of zeolites, fish debris, authigenic rims on clays, and the scarcity of silt- and sand-size detrital material. Due to the lack of fossils in most of the sediments, presence of depositional hiatuses cannot be documented at present. Cores 8 and 9 are the only portions which would have been deposited in the vicinity of lysoclinal depths. These sediments containing foraminifera and coccoliths may be a reflection of a deeper lysoclinal level or of shallower depths of the sea floor at this time. In either case, deeper than lysoclinal conditions prevailed throughout deposition of all sediments above Core 7. The presence of trace amounts of coccoliths in Core 7 indicates a gradual transition to deeper water conditions.

The nature of the contact between the coccolith-bearing detrital clay and the underlying basalt cannot be established.

Unit 2

The second unit consists of fine- to coarse-grained, olivine-poor, glassy basalt, encountered at a depth of 251 meters and continuing, with many voids, through three cores down to 270 meters. At the upper contact, highly altered, fine-grained basalt occurs, locally brecciated, the fractures being filled with spherulitic calcite. The fine-grained rock grades downward into fresh medium-grained basalt, and the same alternation is repeated three or more times. Thus, there are at least four flows, grading upward from fine to medium or coarse grained; in view of the voids there may well be more. The rocks are gray in color and are generally very fresh, but they are commonly fractured, with calcite veins filling the fractures.

The contact with the overlying brown clay is normal, and the basalt represents the ocean floor. Olivine is

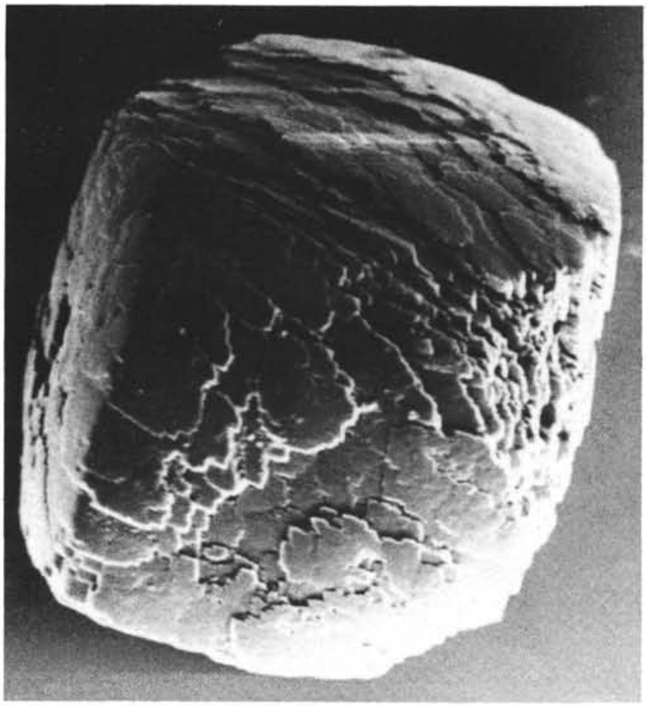


Figure 7. *SEM photograph of rhodochrosite from Site 256 (X100).*

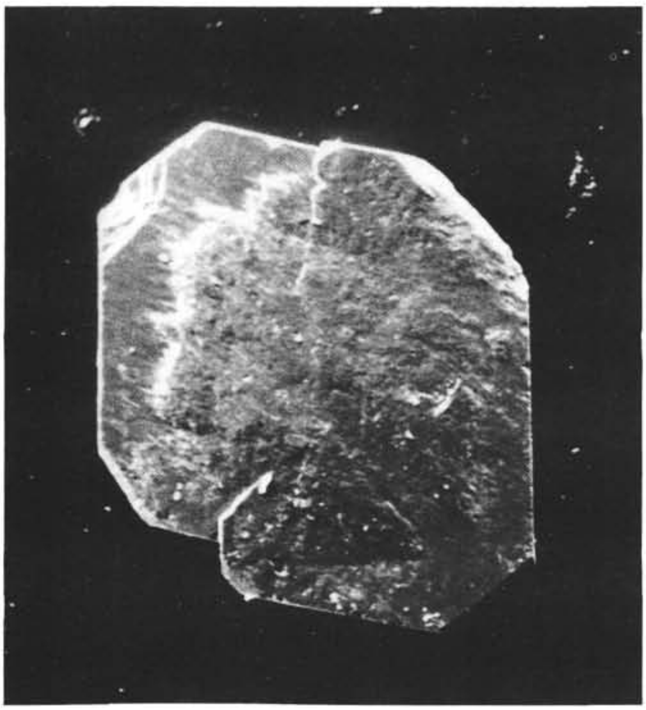


Figure 8. *SEM photograph of barite from Site 256 (X50).*

TABLE 2
Modes of the Basalts, Site 256

	Coarse-Grained Basalt (11-3, 110 cm)	Coarse-Grained Basalt (10-2, 102 cm)	Medium-Grained Olivine Basalt (10-4, 133 cm)	Medium-Grained Olivine Basalt (9-3, 128 cm)	Medium-Grained Olivine Basalt (9-3, 45 cm)	Fine-Grained Olivine Basalt (11-2, 64 cm)	Fine-Grained Olivine Basalt (10-4, 87 cm)	Fine-Grained Altered Olivine Basalt (9-2, 51 cm)
Olivine	–	–	2	2	1	2	tr	1
Plagioclase	34	34	35	35	36	30	20	32
Pyroxene	36	36	30	30	30	15	8	7
Iron oxide	10	10	10	10	12	13	10	10
Glass	20	20	23	23	23	40	62	30
Celadonite	–	–	–	–	–	–	–	20

present but apparently in the smallest quantities yet encountered on Leg 26. Eight thin sections were cut and are described below under three headings.

1) Coarse basalt forms the lower portions of two of the lower flows drilled. They are subophitic to hyalo-ophitic in texture, the noncrystalline groundmasses consisting of dark brown to black mesostatic pools containing many devitrified feathery iron-rich microlites. No olivine is present. Plagioclase laths reach 0.9 mm (1.1 mm in the lowest rock) and are accompanied by occasional zoned prismatic crystals some half that size in length. They are partially enclosed in clusters of pyroxene ($2V\gamma$ca 45°) grains reaching 0.5 mm. Iron ore, probably ilmenite, mainly occurs as chunky bars, up to 0.5 mm, and grains. There are occasional black glassy veins traversing the rocks.

2) Medium olivine basalt is the most common at Site 256, especially in the upper and lower parts of the basalt sequence, where it forms the slowly cooled parts of two or three flows. In thin section the basalt is similar to the coarse basalt, but contains a few percent of olivine crystals, euhedral in outline (up to 0.5 mm) but completely altered to a dark olive bowlingite. Plagioclase forms acicular laths reaching 1.3 mm, i.e., longer than in the coarse basalt. Again, squarish zoned prismatic crystals are also present and are practically phenocrystic in nature. Locally, the latter occur in clusters with largish pyroxene crystals, the glomerophyric groups measuring some 1.5 mm in each direction. In the middle of the upper flow, slight brecciation has occurred so that fragments of the uppermost fine-grained basalt are enclosed in the medium-grained rock.

3) Fine-grained glassy olivine basalt forms the upper part of each of the flows encountered. Slightly feathery subvariolitic glass, reddish gray in color, with olive patches, forms approximately half the rocks. Olivine crystals are sparsely present, reaching 0.3 mm and totally altered. Plagioclase laths normally reach 0.8 mm in length but in one rock reach 1.5 mm; these very acicular laths are accompanied by occasional square prisms having the same measurement and thus are truly phenocrystic. Pyroxene grains do not exceed 0.2 mm in one rock and 0.4 mm in another and are neutral colored as in the coarser rocks, with some zoning. Ilmenitic iron oxide, in long acicular bars (up to 0.2 mm) and grains, completes the fine-grained rocks. The fine-grained basalt has clusters of feldspar and pyroxene grains, some 0.8 mm each way, and in this respect, and in the presence of olivine, resemble the medium- but not the coarse-grained rocks.

The brecciated basalt, near the contact with the overlying clay, occurs within a sequence of altered greenish-gray, with pink and mottled areas, fine-grained basalt. A large fracture zone, some 6 cm across, including brecciated fragments of basalt, has been filled in with calcite. The carbonate forms a fibrous vein along the contact with the basalt, penetrating some of the feldspar laths and other minerals, and is bordered on the inner side with a rim of spherulitic green palagonite. On the inner side of the rim, the fracture space is completely occupied by spherulitic calcite. The basalt itself is similar in most respects to the other fine-grained rocks. The few olivine crystals are pseudomorphed mainly by carbonate, and the glomerophyric clusters of feldspar and pyroxene reach 1.5 mm in either direction; the overall grain size of the rock is slightly greater than in the others. Green palagonitic or chlorite-serpentine aggregate forms small pools within the dark glass, but the rock is unusual in that it contains abundant celadonite. This mineral, vividly pleochroic from blue to green, forms birefringent, obliquely extinguishing prisms up to 0.3 mm in length, as well as patches, throughout the rock; it is especially concentrated near the fractured area.

SHIPBOARD GEOCHEMICAL MEASUREMENTS

Routine analyses for salinity, *p*H, and alkalinity were conducted on interstitial water samples squeezed from five sediment samples taken at depths in the hole from 7.5 to 245 meters below the sea floor. In addition, *p*H was measured on each of the unsqueezed samples by the punch-in method. The sampling and analytical techniques are described in the report on Site 250, and the results for Site 256 are summarized in Table 3 and presented in graphical form in Figure 9.

Results

The parameters of *p*H, salinity, and alkalinity do not appear to vary meaningfully. Flow-through and punch-in *p*H values differ by 0.07-0.18 *p*H unit, the punch-in values being consistently higher. This discrepancy is somewhat larger than average for the previous Leg 26 sites, although not as great as at Site 250. Again, the hypothesis that sediments with a high clay content require greater extraction pressures and extraction times, resulting in losses of dissolved carbon dioxide and

TABLE 3
Summary of Shipboard Geochemical Measurements, Site 256

Sample (Interval in cm)	Depth Below Sea Floor (m)	Lab Temp (°C)	*p*H Punch-in/ Flow-through	Alkalinity (meq/kg)	Salinity (°/oo)
(Reference seawater)	–	–	8.52/8.19	2.37	35.5
1-5, 140-150	7.40-7.50	24.0	6.99/6.87	2.38	35.2
3-5, 144-150	54.44-54.50	24.0	7.03/6.96	2.15	35.2
5-4, 140-150	129.40-129.50	24.0	7.06/6.98	2.35	34.1
6-5, 144-150	187.94-188.00	23.3	7.24/7.06	2.47	34.6
8-5, 140-150	244.90-245.00	24.0	7.41/7.31	2.10	35.2

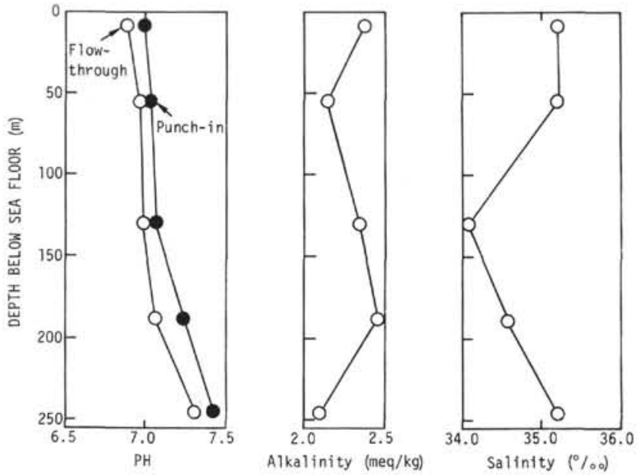


Figure 9. *Graphic summary of geochemical measurements taken at Site 256.*

a consequently lower flow-through *p*H, appears borne out.

Punch-in *p*H in the uppermost sample was measured as 6.99, well below the range of 7.8-8.2 normal for seawater. With depth, the punch-in *p*H increased to a maximum of 7.41 in the sample from the greatest depth.

Alkalinity in the uppermost sample was 2.38 meq/kg. With depth the values fluctuated within the narrow range of 2.10-2.47 meq/kg.

Salinity in the uppermost two samples (from 7.5 and 54.5 m below the sea floor) was 35.2°/oo, or 0.5°/oo higher than the site's regional near-bottom salinity of 34.7°/oo given by Wyrtki (1971). At a depth of 129.5 meters below the sea floor the salinity was only 34.1°/oo. From this depth downward, salinity increased to 35.2°/oo at 245 meters, the greatest depth sampled.

PHYSICAL PROPERTIES

At Site 256 bulk density, porosity, acoustic velocity, and thermal conductivity were measured. The methods are described in the Explanatory Notes (Chapter 2). The results are shown in the hole summary diagram.

Density, Porosity, and Water Content

Densities are low and increase uniformly with depth in the sedimentary section, from 1.25 g/cc near the surface to 1.56 g/cc near basement. The densities from the GRAPE are slightly higher than those from the syringe and section weight. The average water content in the sediments is 58% and porosity 76%; both decrease uniformly and rapidly with depth.

Acoustic Velocity and Acoustic Impedance

The acoustic velocity is very uniform in the upper 150 meters of the section with an average of 1.50 km/sec. Velocities increase in the lower part of the section to 1.62 km/sec just above basalt basement. There is a negligible difference in velocities parallel and perpendicular to the bedding. The Hamilton Frame velocity for five samples of basalt ranged from 4.75 km/sec for an altered section to 6.29 km/sec for a very fresh section. The mean was 5.69 km/sec.

The only significant acoustic impedance contrast was between the sediments and basalt, where the contrast was a factor of 4.

CORRELATION OF SEISMIC REFLECTION PROFILE WITH DRILLING RESULTS

An on-site reflection profile was run to better estimate the depth to basement using a 30-in.[3] airgun and an SSQ41 sonobuoy (Figure 10). The basement return is clearly visible at 0.305 sec DT subbottom with no apparent reflector below it. A very hazy reflector is seen near 0.25 sec DT, but it is very weak and inconsistent. Basement was reached at 251 meters which yields an apparent velocity for the section of 1.65 km/sec compared to a measured velocity of very close to 1.5 km/sec. No visible lithologic change was seen between 200 and 250 meters that might indicate the origin of the very weak intermediate reflector.

PALEONTOLOGY

Biostratigraphic Summary

At Site 256, drilled in 5361 meters of water, only very few poorly preserved calcareous microfossils were found in the 251 meters of variously colored clays.

Some Pliocene planktonic foraminifera were found between 3.5 and 125.5 meters. The Quaternary is therefore less than 3.5 meters thick. The presence of Tertiary sediments older than Pliocene could not be determined by faunal evidence so far. Cores 1 to 5 contain well-preserved fish debris. Cretaceous Radiolaria were found in Cores 6 and 7. Core 7 yielded arenaceous foraminifera and rare, strongly etched calcareous nannofossils of Cretaceous age. In Cores 8 and 9 arenaceous and calcareous foraminifera and common, moderately etched nannofossils of upper Albian age were found.

The Cretaceous micro- and nannofossils at Site 256 are considered to be in situ for the following reasons: (1) there is a continuous increase in number and state of fossil preservation downwards through Cores 7 to 9; (2) the nannofloras are homogeneous; (3) the sediments show no evidence of transportation and redeposition (see Lithology Section).

Sediments of Cores 1 to 7 were deposited in water depths below the carbonate compensation depth, Cores 8 and 9 within the lysocline. The low diversity of foraminiferal species as well as the composition of the calcareous nannoplankton assemblages indicate a cool paleoenvironment in the Cretaceous.

Foraminifera

Because of the great water depth, the fauna were found in a poor state of preservation; many samples were completely barren and several had only a few arenaceous foraminifera which could not be used for age determination or contained only rare calcareous benthonic or very small-sized, unidentifiable planktonic species.

In Sample 1-3, 40-42 cm, taken at a drilling depth of 3.5 meters, *Globigerina nepenthes* (one specimen) and a probable *Globorotalia miozea conoidea* (also one

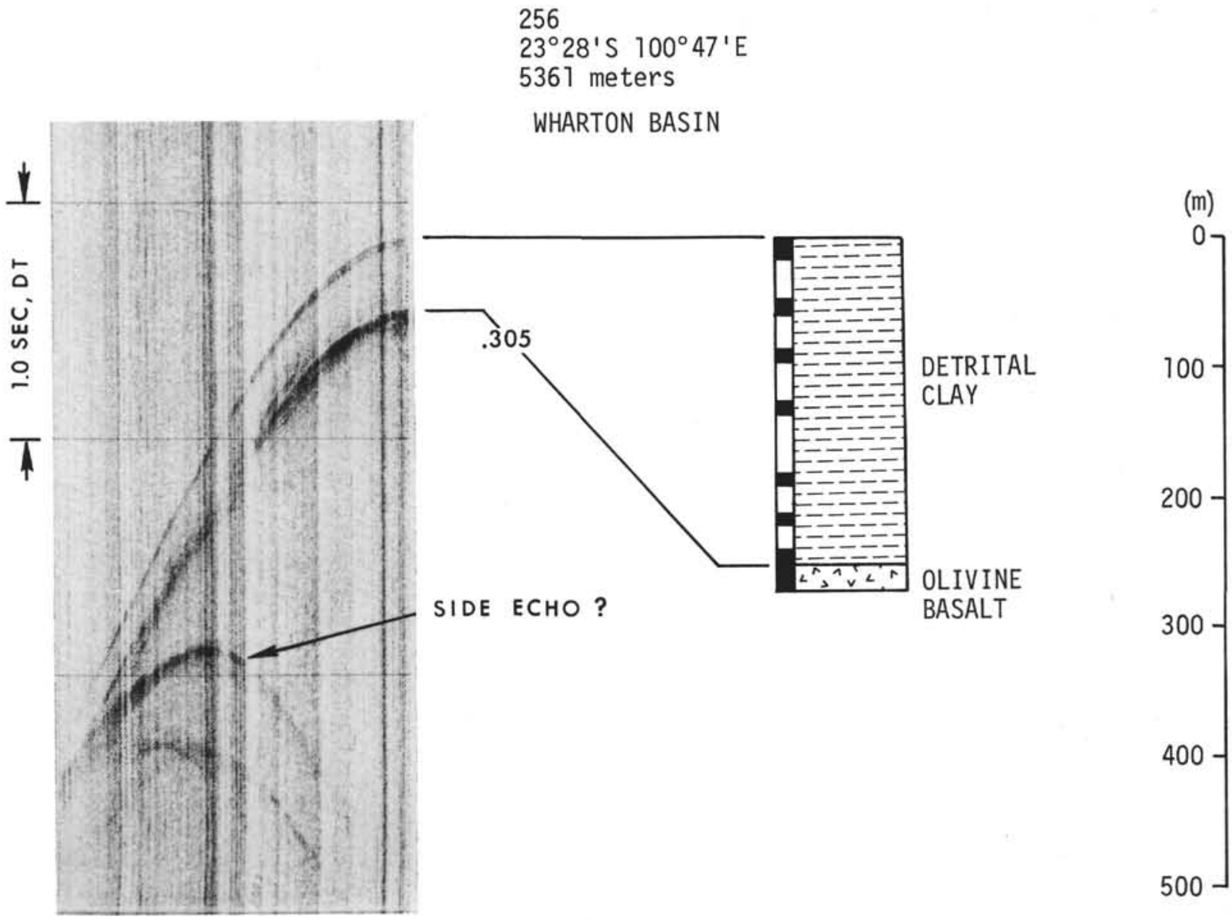


Figure 10. *Correlation of seismic reflection profile and drilling results at Site 256.*

specimen) were found. Both species cannot be younger than early Pliocene in age. The core catcher from Core 1 (depth 9.5 m) contains *Globigerinoides trilobus s.l.*, *Globorotalia inflata s.l.*, and probable *G. tosaensis* which are also Pliocene in age. Thus, the Quaternary section is certainly less than 3.5 meters thick.

The best-preserved fauna was encountered in Sample 5-2, 35-39 cm at a subbottom depth of 125.5 meters. It contains *Globorotalia miozea conoidea, G. margaritae, G. inflata s.l., Globigerina decoraperta, G. nepenthes, G. quinqueloba, Globigerinita glutinata,* and many minute, unidentifiable, planktonic foraminifera. Specimens are small sized, rather rare, but well preserved. They do not appear to be reworked. This assemblage can be either uppermost late Miocene or, more likely, early Pliocene in age. Thus, at least the upper 125.5 meters belong to the Pliocene to Recent interval, although with the available material, the Pliocene/Pleistocene boundary cannot be located precisely.

The lower part of Core 5 and Cores 6 and 7 contain only sparse assemblages of primitive arenaceous foraminifera. Many of them are poorly preserved and no age assignment can be made for this portion of the section. In Sample 7, CC, however, a more diverse arenaceous assemblage occurs, with representatives of the genera *Turritellella, Cribrostomoides,* and *Dorothia filiformis* (Berthelin). The same assemblage is found in the uppermost part of Core 8 (Section 1 and upper part of Section 2). Below this level some calcareous benthonic forms can be observed. They are moderately preserved and strongly etched. In Section 6 of this core they become more numerous and are accompanied by strongly etched planktonic foraminifera (*Hedbergella planispira* with transitional forms to *Hedbergella infracretacea*). The benthonic species of this Lower Cretaceous assemblage include *Pelosina caudata* (Montanaro Gallitelli), *Ammodiscus cretaceus* Reuss, *Glomospira gordialis* (Parker and Jones), *Clavulina gabonica* Le Calvez, de Klasz, and Brun, *Dorothia filiformis* (Berthelin), and *Gavelinella intermedia* Berthelin. The same assemblage occurs in Core 9, immediately above the basalt.

The distribution of calcareous benthonic and planktonic foraminifera in the lowermost part of this site show a gradual transition from deposition in water depths within the lysocline, immediately above the basalt, to depths below the lysocline above a drilling depth of 239 meters.

A striking feature of the foraminiferal assemblages at the base of this site is the restriction to virtually a single species of planktonic foraminifera. Based on the occurrence of *Hedbergella planispira* alone, no precise age determination can be given. Its presence does not, however, contradict the upper Albian age given by the nannoplankton and the radiometric age determination.

The low diversity of the faunas, combined with a great water depth, could be interpreted as a consequence of either selective dissolution or the existence of a cold-water environment during the Albian. Since similar observations were made at Site 258, where we are dealing with a shallower environment, the second of these alternatives is favored.

Calcareous Nannoplankton

Stratigraphy: The 18 samples prepared from Cores 1 through 6 were barren of nannofossils. Sample 256-7-3, 111 cm shows very rare, strongly etched Cretaceous species. Several samples from Cores 8 and 9 contain abundant, moderately etched nannoplankton assemblages of the *Eiffellithus turriseiffeli* Zone (upper Albian, 100-103 m.y.B.P.). The lowermost fossiliferous sample, still belonging to this zone, has been found in Sample 256-9-1, 130 cm, a few centimeters above the basalt, for which an absolute age of 92 ±4 m.y. has been determined (see Rundle et al., Chapter 17, this volume).

Preservation: All nannofossils at this site show moderate to strong signs of dissolution.

Paleoecology: The upper Albian assemblages indicate a transitional (non-Tethyan) paleoenvironment.

SEDIMENTATION RATES

Because of very poor paleontological data obtained at this site, no sedimentation rates can be calculated. The rates within the sequences, 0-125.5 meters (Pliocene or younger) and 237.5-248.5 meters (Albian), however, must have been higher than the average rate within the sequence, 125.5-237.5 meters subbottom depth.

SUMMARY AND CONCLUSIONS

Summary of Results

Site 256 is located in 5361 meters of water in the southern Wharton Basin, on the flank of a basement high which forms the northern lip of a deep trough, probably a fracture zone. About 0.3 sec DT of transparent sediment occurs at this location. At Site 256 one hole was drilled 270 meters through 251 meters of sediments and 19 meters of basalt. The oldest sediment is uppermost Albian at the sediment-basalt contact.

The sediments at the site are predominantly pelagic detrital clay, moderate brown to grayish brown, and grading into coccolith detrital clay below about 238 meters. Drilling breccia is continuous downwards from 180.5 meters. Grayish-green layers are found below 128 meters. The concentration of zeolites increases downwards in the section to 25%. Translucent iron aggregates make up 25% of the clay near the top of the section above the appearance of the grayish-green layers. The basalt recovered is coarse grained, olivine poor, and glassy. These rocks are gray and fresh but highly fractured, with calcite veins filling the fractures. From variations in grain size, at least four flows were sampled, each flow being about 3-4 meters thick as estimated from our recovery.

The section is largely barren of microfossils thus prohibiting the identification of series boundaries. The upper 125.5 meters are Pliocene and younger based on a few foraminifera and radiolarians. Cretaceous radiolarians were found at 190 and 218.5 meters. Etched Cretaceous nannofossils were also found at 218.5 meters. Below 238 meters arenaceous and calcareous foraminifera and etched nannofossils of uppermost Albian age are common. The minimum basement age is then 101 ±1 m.y. The foraminiferal assemblages of the lower section lack diversity. This and the general nature of the nannofossil assemblages suggest a cold-water regime was present in the Cretaceous.

A lack of identifiable series boundaries precludes calculations of sedimentation rates. However, the rates for the Pliocene to Recent and for the Cretaceous intervals must be relatively higher than for the barren interval (125.5-190.0 m.

Preliminary Conclusions

The relatively minor calcareous component in the section, and the etching of those forms present, suggest that this site has been within the lysocline during the Albian and below the carbonate compensation depth (CCD) since then. As with Site 251, this probably means that the lysocline and the CCD were higher than today during at least the late Cretaceous. The lack of faunal diversity suggests colder water at the site and therefore a more southerly latitude in the Cretaceous which is consistent with paleoreconstructions for this period.

The age of 101 m.y. determined for this site is in good agreement with a north-south age gradient (older to south) determined for the northern Wharton Basin on Leg 22, DSDP. However, Site 212 (DSDP Leg 22) is probably not as old as the authors believe (von der Borch, Sclater, et al., 1974). They give an age of Mid Cretaceous based on extrapolation of the sedimentation rate down through a barren clay section. If the Wharton Basin models of Falvey (1972) or Sclater and Fisher (in press) hold, Site 212 cannot be older than Site 256 (101 m.y., assuming that a disconformity does not exist at the sediment-basalt contact at Site 256). The oldest sediment dated at Site 212 is Maestrichtian (65-71 m.y.) 34 meters above the contact. However, magnetic lineations mapped by Sclater and Fisher (in press) show that Site 212 must be older than anomaly 33b, or at least Coniacian (81-86 m.y.). Therefore, Site 212 is somewhere between about 85 and 100 m.y. old.

REFERENCES

Crawford, A. R., 1969. India, Ceylon and Pakistan: New age data and comparisons with Australia: Nature, v. 223, p. 380-383.

Dietz, R. S. and Holden, J. C., 1971. Pre-Mesozoic oceanic crust in the eastern Indian Ocean (Wharton Basin)?: Nature, v. 229, p. 309-312.

Du Toit, A. L., 1937. Our wandering continents: Edinburgh (Oliver and Boyd).

Falvey, D. A., 1972. Sea floor spreading in the Wharton Basin (northeast Indian Ocean) and the breakup of eastern Gondwanaland: Australian Petrol. Explor. Assoc. J., v. 12, p. 86-88.

McKenzie, D.P. and Sclater, J. G., 1971. The evolution of the Indian Ocean since the Late Cretaceous: Roy. Astron. Soc. Geophys. J., V. 25, p. 437-528

Sclater, J. G. and Fisher, R. L., in press. The evolution of the east central Indian Ocean, with emphasis on the tectonic setting of the Ninetyeast Ridge: Geol. Soc. Am. Bull.

Veevers, J. J., Jones, J. G., and Talent, J. A., 1971. Indo-Australian stratigraphy and the configuration and dispersal of Gondwanaland: Nature, v. 229, p. 383-388.

von der Borch, C. C., Sclater, J. G., et al., 1974. Initial Reports of the Deep Sea Drilling Project: Volume 22. Washington (U.S. Government Printing Office).

Wilson, M. J., Berrow, M. L., and McHardy, W. J., 1970. Lithiophorite from the Lecht mines, Tomintoul, Banffshire: Min. Mag., v. 37, p. 618.

Wyrtki, K., 1971. Oceanographic Atlas of the International Indian Ocean Expedition: Washington (U.S. Government Printing Office).

APPENDIX A
Grain-Size Determinations for Site 256

Core, Section Top of Interval (cm)	Subbottom Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
1-1, 90	0.9	0.1	17.0	82.9	Clay
1-3, 90	3.9	0.1	18.0	81.8	Clay
1-6, 89	8.4	0.1	10.1	89.8	Clay
2-1, 90	10.4	0.2	5.3	94.5	Clay
2-3, 91	13.4	0.1	6.2	93.8	Clay
2-6, 90	17.9	0.1	5.5	94.4	Clay
3-2, 90	49.9	0.0	3.5	96.5	Clay
3-4, 90	52.9	0.0	3.6	96.4	Clay
4-2, 90	87.9	0.0	3.2	96.8	Clay
4-4, 90	90.9	0.1	3.8	96.2	Clay
4-6, 90	93.9	0.0	2.3	97.7	Clay
5-2, 90	125.9	0.2	6.8	92.9	Clay
5-4, 90	128.9	0.5	8.4	91.2	Clay
6-2, 90	182.9	0.1	18.0	81.9	Clay
6-4, 95	185.9	0.3	21.4	78.3	Clay
6-6, 81	188.8	0.1	19.7	80.1	Clay
7-3, 113	213.1	0.0	16.8	83.2	Clay
8-5, 80	244.3	0.0	23.9	76.0	Clay

APPENDIX B
Carbon-Carbonate Determinations for Site 256

Core, Section Top of Interval (cm)	Subbottom Depth (m)	Total Carbon (%)	Organic Carbon (%)	$CaCO_3$ (%)
1-1, 88.8	0.88	0.2	0.2	0
1-6, 88.0	8.38	0.2	0.2	0
2-1, 88.0	10.38	0.1	0.1	0
2-3, 88.0	13.38	0.2	0.1	0
2-6, 88.0	17.88	0.1	0.1	0
3-2, 88.0	49.88	0.1	0.1	0
3-4, 88.0	52.88	0.1	0.1	0
4-2, 88.0	87.88	0.1	0.1	0
4-4, 88.0	90.88	0.1	0.1	0
4-6, 88.0	93.88	0.1	0.1	0
5-2, 88.0	125.88	0.1	0.1	0
5-4, 88.0	128.88	0.1	0.1	0
6-2, 88.0	182.88	0.1	0.1	0
6-4, 90.0	185.90	0.1	0.1	0
6-6, 80.0	188.80	0.1	0.1	0
7-3, 112.0	213.12	0.1	0.1	0
8-5, 84.0	244.34	0.1	0.1	0

APPENDIX C
X-Ray Analyses for Site 256

Core	Cored Interval Below Sea Floor (m)	Sample Depth Below Sea Floor (m)	Diff.	Amor.	Calc.	Quar.	Cris.	K-Fe.	Plag.	Kaol.	Mica	Chlo.	Mont.	Paly.	Trid.	Clin.	Anal.	Hema.	Gibb.	Hali.	U–4[a]
Bulk Sample																					
1	0.0-9.5	6.9	87.5	80.4	–	19.0	–	11.0	4.9	19.5	19.3	–	24.1	–	–	2.3	–	–	–	–	–
3	47.5-57.0	54.0	84.8	76.2	–	5.5	–	3.5	2.0	21.8	18.5	4.8	42.5	–	–	–	–	–	1.3	–	–
4	85.5-95.0	94.2	85.5	77.3	1.0	7.4	–	2.3	–	26.7	14.1	–	47.3	–	–	–	–	–	–	1.0	P
5	123.5-133.0	128.9	88.4	81.8	–	14.5	–	12.7	1.9	15.2	29.6	2.0	24.0	–	–	–	–	–	–	–	–
7	209.0-218.5	213.3	87.8	81.0	–	9.2	38.2	5.6	–	–	15.1	–	6.8	–	7.8	17.1	–	–	–	–	–
8	237.5-247.0	244.6	85.2	76.8	–	7.5	25.9	4.8	–	–	17.4	–	6.7	–	1.6	36.0	–	–	–	–	–
9	247.0-256.5	248.3	81.1	70.4	46.4	14.0	–	4.9	–	–	7.3	–	21.4	–	–	5.9	–	–	–	–	–
2-20μ Fraction																					
1	0.0-9.5	6.9	73.5	58.6	–	38.3	–	12.3	10.5	15.1	17.7	–	–	–	–	6.1	–	–	–	–	–
3	47.5-57.0	54.0	77.8	65.4	–	18.0	–	12.3	4.9	15.6	23.9	5.1	17.1	–	–	–	–	–	3.2	–	–
4	85.5-95.0	94.2	80.5	69.5	–	18.8	–	13.1	2.0	18.2	25.4	2.8	19.7	–	–	–	–	–	–	–	P
5	123.5-133.0	128.9	75.7	62.0	–	32.2	–	24.2	9.4	5.5	25.9	2.9	–	–	–	–	–	–	–	–	–
7	209.0-218.5	213.3	72.3	56.7	–	15.3	39.8	7.6	–	–	5.0	–	–	–	6.3	26.1	–	–	–	–	–
8	237.5-247.0	244.6	60.1	37.7	–	15.6	–	8.1	–	–	5.2	–	–	–	–	69.8	1.3	–	–	–	–
9	247.0-256.5	248.3	77.3	64.5	–	36.2	–	17.2	–	–	12.8	–	20.5	–	–	10.2	–	3.1	–	–	–
<2μ Fraction																					
1	0.0-9.5	6.9	88.7	82.4	–	20.0	–	0.6	2.2	14.2	9.6	–	29.4	13.8	–	1.6	–	–	–	8.7	–
3	47.5-57.0	54.0	86.3	78.6	–	11.0	–	5.4	3.8	27.2	9.4	2.8	27.4	–	–	–	–	–	2.2	10.8	–
4	85.5-95.0	94.2	85.8	77.8	–	8.6	–	4.8	–	16.4	16.4	–	40.5	–	–	–	–	–	–	13.2	P
5	123.5-133.0	128.9	85.9	78.0	–	19.1	–	10.0	–	8.8	28.1	–	23.4	–	–	–	–	–	–	10.7	–
7	209.0-218.5	213.3	82.6	72.9	–	10.6	50.5	6.5	–	–	6.3	–	9.2	–	4.5	8.6	–	–	–	3.8	–
8	237.5-247.0	244.6	86.7	79.2	–	4.3	37.8	6.5	–	–	11.9	–	24.8	–	5.5	3.6	–	–	–	5.6	–
9	247.0-256.5	248.3	86.5	78.9	–	27.4	–	8.7	–	–	4.2	–	35.1	–	–	1.6	–	–	–	23.0	–

[a]Narrow peaks at 4.63Å and 9.33Å. P = present.

Site 256 Hole Core 1 Cored Interval: 0.0-9.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	LITHO. SAMPLE	
QUATERNARY			RP	4	B		1	*, CC GZ	5YR 3/4
			RP	4		FG	2	*HO	
			RP	4	B	FG	3	*, CC GZ	
			RP	4			4	*	very faint, slight mottling
			RP	4			5	KE, *XM	5YR 3/2
			RP	4			6	*, CC GZ	
			RP	4	B	RG	Core Catcher	*	5YR 3/4

LITHOLOGIC DESCRIPTION

Moderate brown ferruginous DETRITAL CLAY, grading to grayish brown in Sec. 6.

TEXTURE: Sand 0.1%
Silt 10-18%
Clay 82-90%

MAJOR CONSTITUENTS:

73-78% detrital clay
20-25% opaque and amorphous translucent microscopic ferruginous grains and aggregates

MINOR CONSTITUENTS:

Tr- 3% quartz
Tr- 3% mica
Tr(rare) amphibole
Tr- 1% rare occurrences of glauconite
Tr- 1% zeolite; more from Sec. 4 down

BIOGENIC CONSTITUENTS:

1- 4% fish debris (collophanous)
In Sec. 6: trace coccoliths.

Total Carbon: 0.2%
Organic Carbon: 0.2%
Calcium Carbonate: 0%

CONSOLIDATION: Very soft.

Explanatory notes in chapter 2

Site 256 Hole Core 2 Cored Interval: 9.5-19.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	LITHO. SAMPLE	
PLIOCENE-QUATERNARY			RP	4	B		1	*, CC GZ	5YR 3/2
			RP	4			2	KE *, *	1 cm 10YR 6/6 smear
			RP	4	B		3	*, CC GZ	1 cm 10YR 6/6 patch
			RP	4			4	*	
			RP	4			5	*, HO	
			RP	4			6	*CC GZ KE	
			RP	4	B	B	Core Catcher	*	5YR 3/2

LITHOLOGIC DESCRIPTION

Grayish brown ferruginous DETRITAL CLAY, with very minor dark yellowish orange patches.

TEXTURE: Sand 0.1-0.2%
Silt 5-6%
Clay 94%

MAJOR CONSTITUENTS:

78-84% detrital clay
10-20% ferruginous material as in Core 1, including 1-2% silt-sized spherules.

MINOR CONSTITUENTS:

Tr- 1% quartz
Tr- 1% mica
Tr- 1% zeolite
Rare traces of glauconite and zircon

BIOGENIC CONSTITUENTS:

Tr- 2% collophanous fish debris
Rare traces of coccoliths

Total Carbon: 0.1-0.2%
Organic Carbon: 0.1%
Calcium Carbonate: 0%

CONSOLIDATION: Very soft.

Explanatory notes in chapter 2

Site 256 Hole Core 3 Cored Interval: 47.5-57.0 m

AGE	FORAMS	ZONE	NANNOS	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
PLIOCENE-QUATERNARY				RP	4	B		1	0.5, 1.0			* *
				RP	4			2				CC GZ KE * *
				RP	4	B		3				* * *
				RP	4			4				CC GZ *
				RP	4			5		VOID		HO KE XM *
				RP	4			6		VOID	▼▲	*
				RP	4	B	B	Core Catcher				*

7.5YR 4/3 with 0.5-1 cm N1 mottles

1 x 2 cm 7.5YR 6/8 mottle

7.5YR 4/3 w/ 1 cm mottles as above becoming more abund.

10YR 4/4

7.5YR 4/3

10YR 4/4

LITHOLOGIC DESCRIPTION

Dark orange brown ferruginous or iron-bearing DETRITAL CLAY, with 0.5-1 cm black mottles throughout and fewer reddish-yellow streaked mottles. The black mottles are composed of 25-30% amorphous translucent or opaque microscopic ferruginous aggregates and colloidal-sized clay with relatively high birefringence. The yellow mottles are poorer (1%) in ferruginous material than the matrix.

TEXTURE: Sand 0%
Silt 4%
Clay 96%

MAJOR CONSTITUENTS:

90-94% clay
2- 5% amorphous ferruginous aggregates

MINOR CONSTITUENTS:

Tr- 1% quartz
Tr- 3% mica
One rare trace occurrence of zeolite

BIOGENIC CONSTITUENTS:

1- 4% collophanous fish debris
One rare trace occurrence of coccoliths

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 256 Hole Core 4 Cored Interval: 85.5-95.0 m

AGE	FORAMS	ZONE	NANNOS	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
?				RP	4	B		1	0.5, 1.0			* *
				RP	4			2				CC GZ KE *
				RP	4	B		3				* * KE
				RP	4			4				* CC GZ
				RP	4			5				*
				RP	4			6				CC GZ * XM HO, KE
				RP	4	B	B	Core Catcher				*

10YR 4/4

7.5YR 4/4 w/ abund. N1 1-5 mm micro-nodules

Same, in 5 cm patch

10YR 5/4

10YR 6/6 band

2.5Y 4/2

10YR 6/6 patch

Arrows indicate stretched mottles, 1 x 5-10 cm, 10YR 6/6

2.5Y 4/4

2.5Y 3/2

2.5Y 4/4

LITHOLOGIC DESCRIPTION

Mostly dark yellowish brown and dark grayish brown DETRITAL CLAY with a basal 30 cm interval of olive brown FERROMANGANESE RICH DETRITAL CLAY. Approximately 2-3% of the core consists of dark gray patches approximately 1 cm in diameter, many with 1-5 mm micro-nodular centers. Smear slides of the micronodules assay 50% black opaque (ferromanganese) clay-sized grains and aggregates, and 50% very fine clay with relatively high birefringence.

TEXTURE: Sand 0.0-0.1%
Silt 2-4%
Clay 96-98%

MAJOR CONSTITUENTS:

91-96% clay
Tr- 8% ferromanganese material as above

MINOR CONSTITUENTS:

Tr- 1% quartz (all but 1 smear = Tr)
Tr- 5% mica

BIOGENIC CONSTITUENTS:

Tr- 2% collophanous fish debris

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 256 Hole Core 5 Cored Interval: 123.5-133.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: DISSOL. EFFECTS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
PLIOCENE					B B		1	0.5 1.0			KE KE * HO	5YR 4/4 1 x 2 cm 5Y 6/2 patch
			RP	4			2				CC GZ	10% 1-3 cm 10YR 4/3 patches 10YR 4/3 patch Same
?			RP	4			3				* * MY	Same Same 1-2 cm 10YR 4/3 layers
			RP	4			4		VOID		KE XM CC GZ HO *	5G 6/1 patch 5YR 4/6 5G 6/1 patch
			FP	4	B	B	Core Catcher				*	5YR 5/4 w/ 5G 6/1 patches

DETRITAL CLAY, moderate brown except for yellowish-red bottom 1 m. The clay particles exhibit authigenic growth or replacement rims that become extinct under crossed nichols at angles which differ from extinction angles of the particle cores. Two 3-4 cm patches or layers of greenish-gray detrital clay occur in Sec. 4 and the core-catcher; these differ from the rest of the core in having only traces of ferruginous material.

TEXTURE: Sand 0.2-0.5%
Silt 7-8%
Clay 91-93%

MAJOR CONSTITUENTS:

97-100% clay

MINOR CONSTITUENTS:

Tr quartz
Tr- 2% mica
Tr- 1% ferruginous aggregates
Tr- 2% collophanous fish debris
Rare traces of glauconite, zeolite, and coccoliths

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

CONSOLIDATION: Soft.

Explanatory notes in chapter 2

Site 256 Hole Core 6 Cored Interval: 180.5-190.0 m

AGE	ZONE: FORAMS	ZONE: NANNOS	FOSSIL CHARACTER: FORAMS	FOSSIL CHARACTER: DISSOL. EFFECTS	FOSSIL CHARACTER: NANNOS	FOSSIL CHARACTER: SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER CRETACEOUS	?				B		1	0.5 1.0	VOID		*	
						CG	2				CC GZ *	
					B	CG	3				*	
							4				CC GZ *	
			B			CG	5				*	
							6		VOID		CC GZ * KE HO	
			RP	4	B	CG	Core Catcher				* * *	5YR 5/3 with 5G 6/1 patches and streaks of 10YR 3/2

Drilling breccia of zeolite-bearing and zeolite-rich DETRITAL CLAY.

Generally, a predominant softened matrix of reddish-brown DETRITAL CLAY with a few greenish-gray and very dark gray chunks, some stiff or even semilithified.

TEXTURE OF MATRIX: Sand 0.1-0.3%
Silt 18-21%
Clay 78-82%

MAJOR CONSTITUENTS:

74-94% clay particles with authigenic rims
5-25% zeolite

MINOR CONSTITUENTS:

Ferruginous aggregates in traces to 1% (in matrix); up to 10% in the grayish chunks.

Tr- 2% mica
Tr- 2% collophanous fish debris
Rare traces of quartz, glauconite and heavy minerals

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

Explanatory notes in chapter 2

Site 256 Hole Core 7 Cored Interval: 209.0-218.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER CRETACEOUS	?		RM	4	B	CM	1	0.5, 1.0	VOID			5Y 5/4 with minor 5G 6/1
						FM	2					5G 5/4 w/ minor 5G 6/1
						CG						
			RG	4	RPE	RP	3				KE, HO, *CC, *GZ, XM	5G 5/4 [5 cm 5G 6/1] [7 cm 5G 6/1] [4 cm 5G 6/1]
			RG	4	B	FM	Core Catcher				*	5Y 5/4

Sections 1 and 2 are severely brecciated and washed jumbles of reddish brown and (minor) greenish gray DETRITAL CLAY. The top of Sec. 3 is less washed, but extremely brecciated.

Below 70 cm, Sec. 3 is reddish brown zeolite-rich DETRITAL CLAY with 3 layers of greenish gray DETRITAL CLAY 3 to 7 cm thick.

TEXTURE: Sand 0%
Silt 17%
Clay 83%

COMPOSITION:

82% clay
15% zeolite
1% ferruginous aggregates
Tr mica
1% collophanous fish debris
Tr coccoliths

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

CONSOLIDATION: Semi-lithified or stiff where undeformed.

Explanatory notes in chapter 2

Site 256 Hole Core 8 Cored Interval: 237.5-247.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS. ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER ALBIAN		Eiffellithus turriseiffeli				RP	1	0.5, 1.0	VOID		*	Predominantly 10YR 5/2
			RM	4	APE						*	[5YR 4/6 chunk] [10YR 4/1 chunk]
			RM	4		FP	2				*	
			RM	3							*	10YR 5/2 chunk
			RM	4			3				*	-do-
			RM	3	AME						*, KE	5YR 4/6 chunk
			RM	3		RP	4					
			RM	3	AME						*	10YR 5/2 chunk
			RM	3		FM	5				*, GZ, *CC, XM	5G 6/1 chunk; 5YR 4/6 chunk
			FM	3	AME				VOID			
			FM	3		RP	6				KE	
			FM	2	AME						*, HO	5 & 7 cm chunks w/ graded transitions 5G 6/1 & 10YR 5/2
ALBIAN			CM	2	AME		Core Catcher					* 5G 6/1 & 10YR 5/2

Drilling breccia. Predominantly grayish brown DETRITAL CLAY and COCCOLITH DETRITAL CLAY, both zeolite-rich in part. Core-catcher is COCCOLITH DETRITAL CLAY and zeolite-rich DETRITAL CLAY.

Lesser chunks of greenish gray COCCOLITH DETRITAL CLAY and yellowish-red and gray zeolite-rich DETRITAL CLAY, the larger chunks as indicated.

TEXTURE: Sand 0%
Silt 24%
Clay 76%

COMPOSITION:

47-96% clay
Tr-25% zeolite
Tr- 3% ferruginous aggregates
Tr-40% coccoliths
Tr- 1% collophanous fish debris
Tr- 2% mica
Tr of zircon uncommon
Tr of quartz (one occurrence)

Total Carbon: .1%
Organic Carbon: .1%
Calcium Carbonate: 0%

CONSOLIDATION: Semi-lithified where less disturbed.

Explanatory notes in chapter 2

Site 256 Hole Core 9 Cored Interval: 247.0-256.5 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
UPPER ALBIAN	ALBIAN	Eiffellithus turriseiffeli	CM	2	AME AME	B	1	0.5, 1.0	VOID	▲▲	KE, *KE, *	5G 6/1 & 10YR 5/2 [5YR 4/6 patch] 5GY 4/1 & 5GY 6/1
							2				*TS KE, *	← 2 cm fracture filled with carbonate-cemented basalt breccia
							3				*TS KE, *TS	N5 medium-grained; Fine grained; Medium grained

LITHOLOGIC DESCRIPTION

Top 20 cm: drilling breccia of greenish gray and grayish brown DETRITAL CLAY as in previous core, followed by basal 5 cm of FERRUGINOUS COCCOLITH DETRITAL CLAY, brown in color.

Below this sediment is dark greenish-gray, highly altered fine-grained BASALT, with carbonate and minor serpentine or chlorite fill in fractures. Downward, the grain size of the basalt varies as indicated.

N.B.: The nature of the contact is not known; it is most probably disturbed and deformed beyond recognition.

COMPOSITION OF BASAL CLAY:

45% clay
25-30% translucent and opaque ferruginous material
30% coccoliths
Trace amounts of mica and fish debris.

N.B.: Drilling records indicate that the sediment/basalt contact was reached at 251 m depth.

Explanatory notes in chapter 2

Site 256 Hole Core 10 Cored Interval: 256.5-263.0 m

AGE	FORAMS ZONE	NANNOS ZONE	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	
							1	0.5, 1.0	VOID			N5
							2		VOID		KE *TS	N5
							3		VOID			N5
							4		VOID		*TS, KE	N5; Fining downward; ← Minimum size; N4; pyrite lining fractures
							5		VOID		*TS	← 1 mm calcite-lined fracture

LITHOLOGIC DESCRIPTION

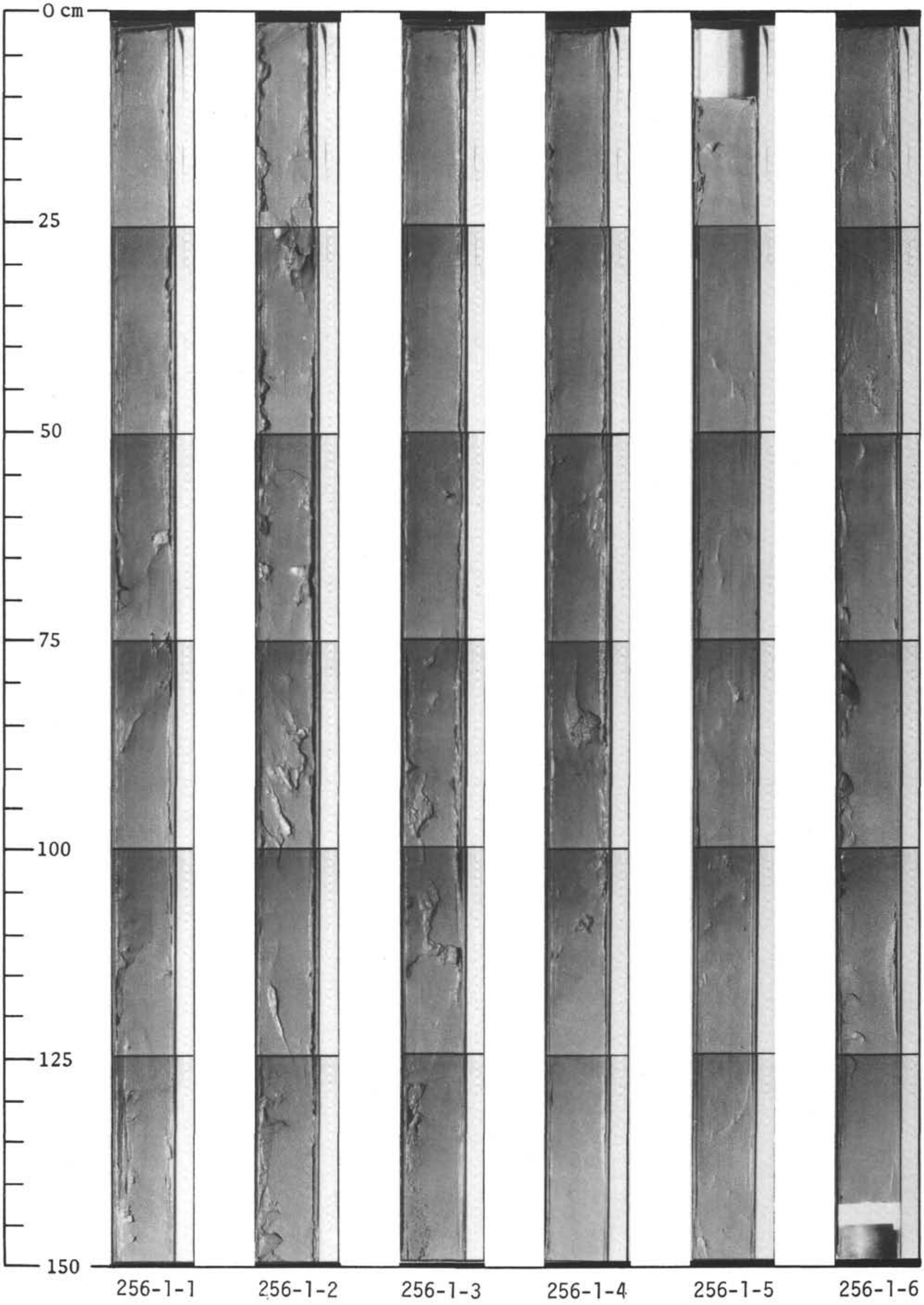
Fresh medium-grained BASALT with 40-cm finer-grained interval in Sec. 6.

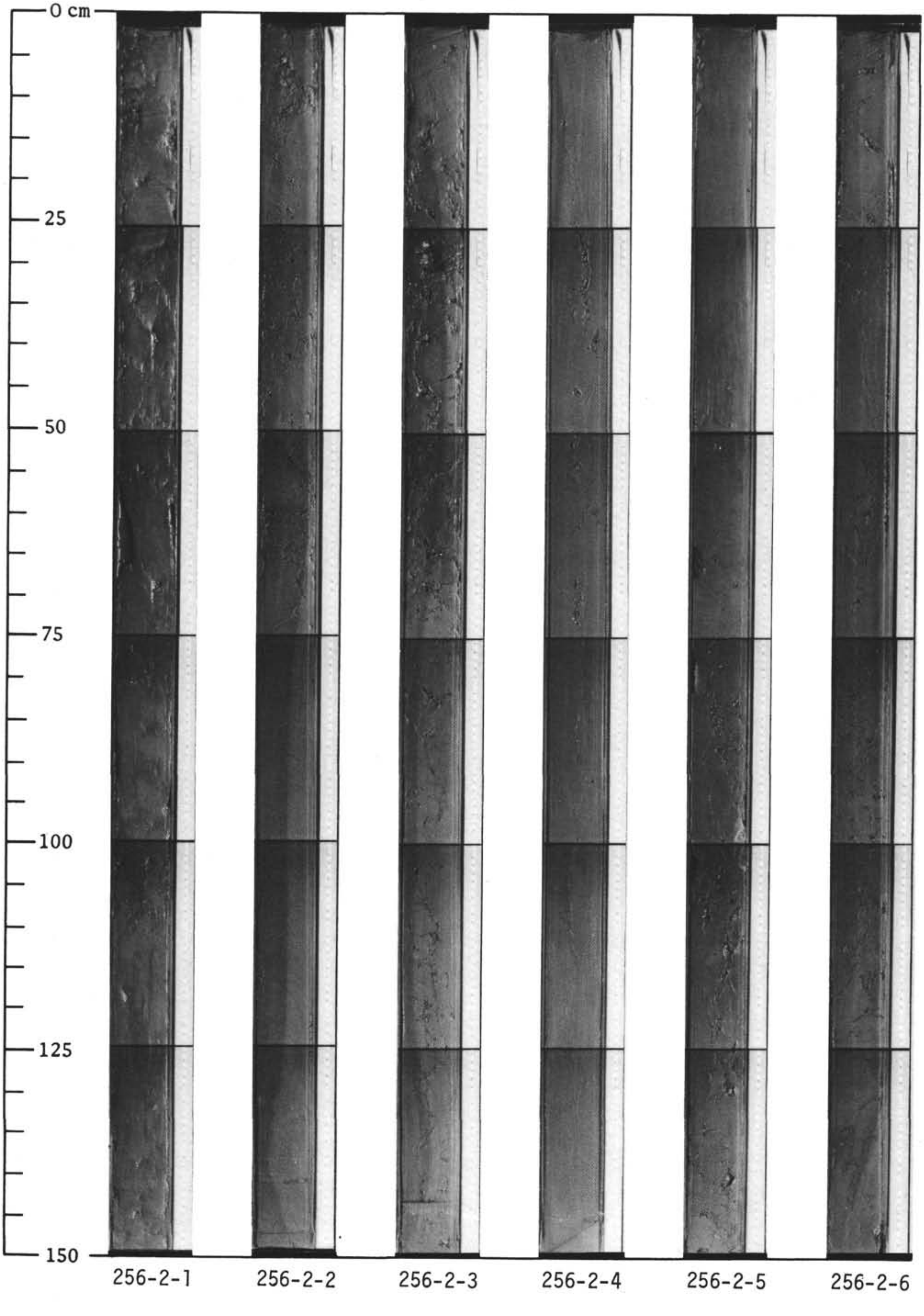
Explanatory notes in chapter 2

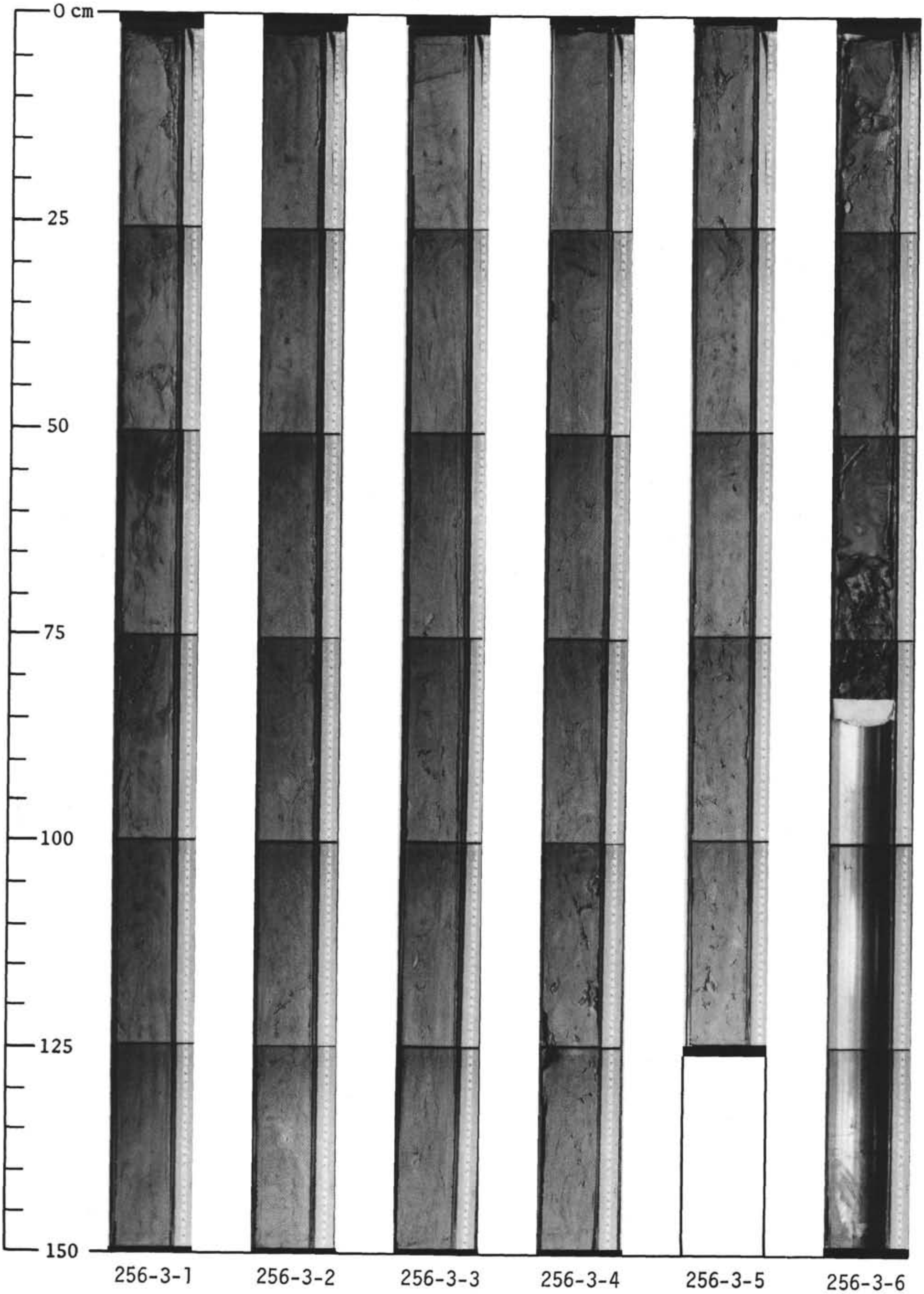
Site 256 Hole Core 11 Cored Interval: 263.0-270.0 m

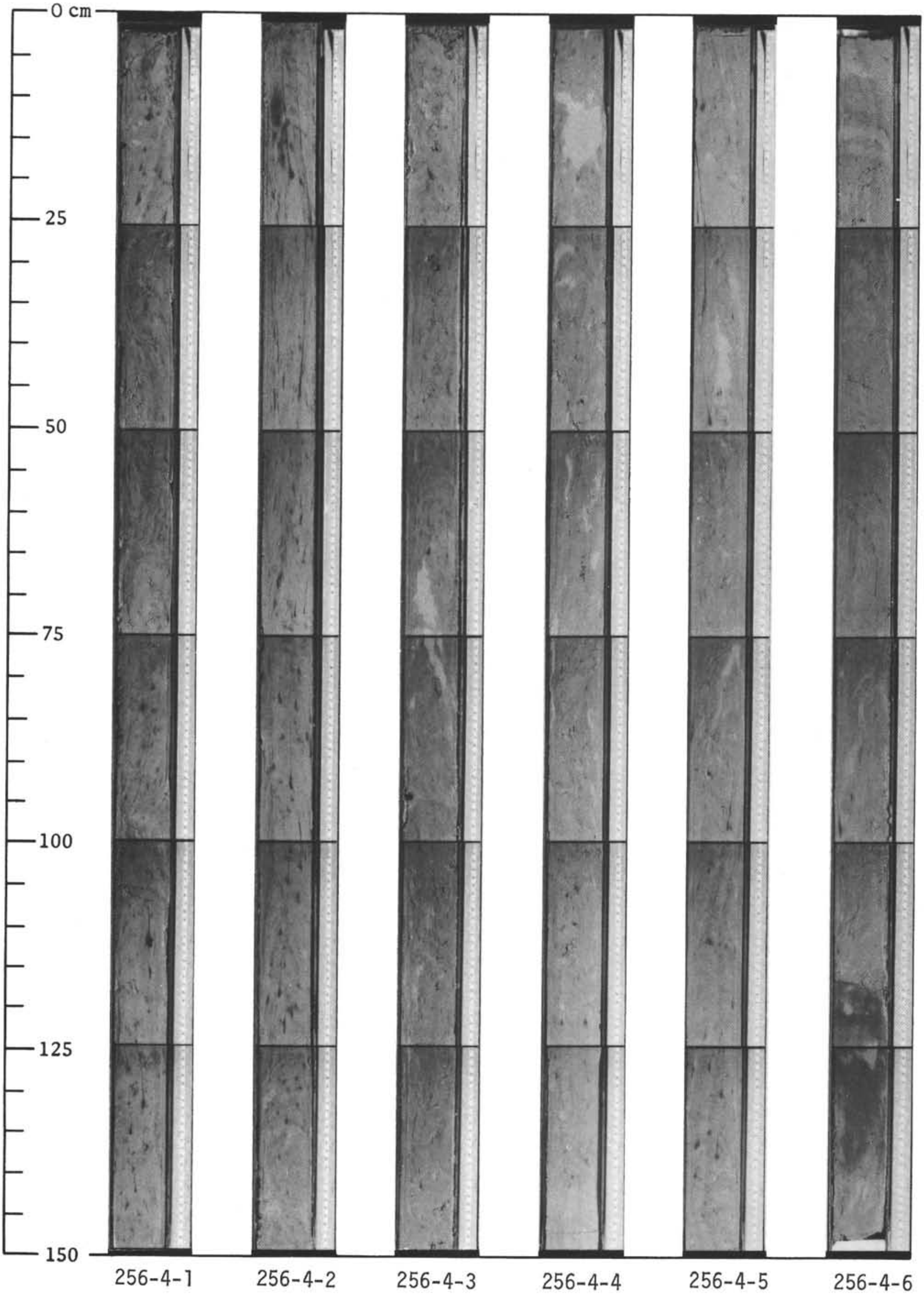
AGE	FORAMS	NANNOS	FOSSIL CHARACTER: FORAMS	DISSOL. EFFECTS	NANNOS	SILICEOUS FOSS., ETC.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
									VOID			
							1	0.5 1.0			N5 ←1 mm calcite vein	Gray medium-grained fresh BASALT with a 15-cm finer-grained interval in Sec. 2. Occasional calcite or fracture fillings.
							2				*TS --- fine-grained	
									VOID			
							3				←calcite vein *TS KE	

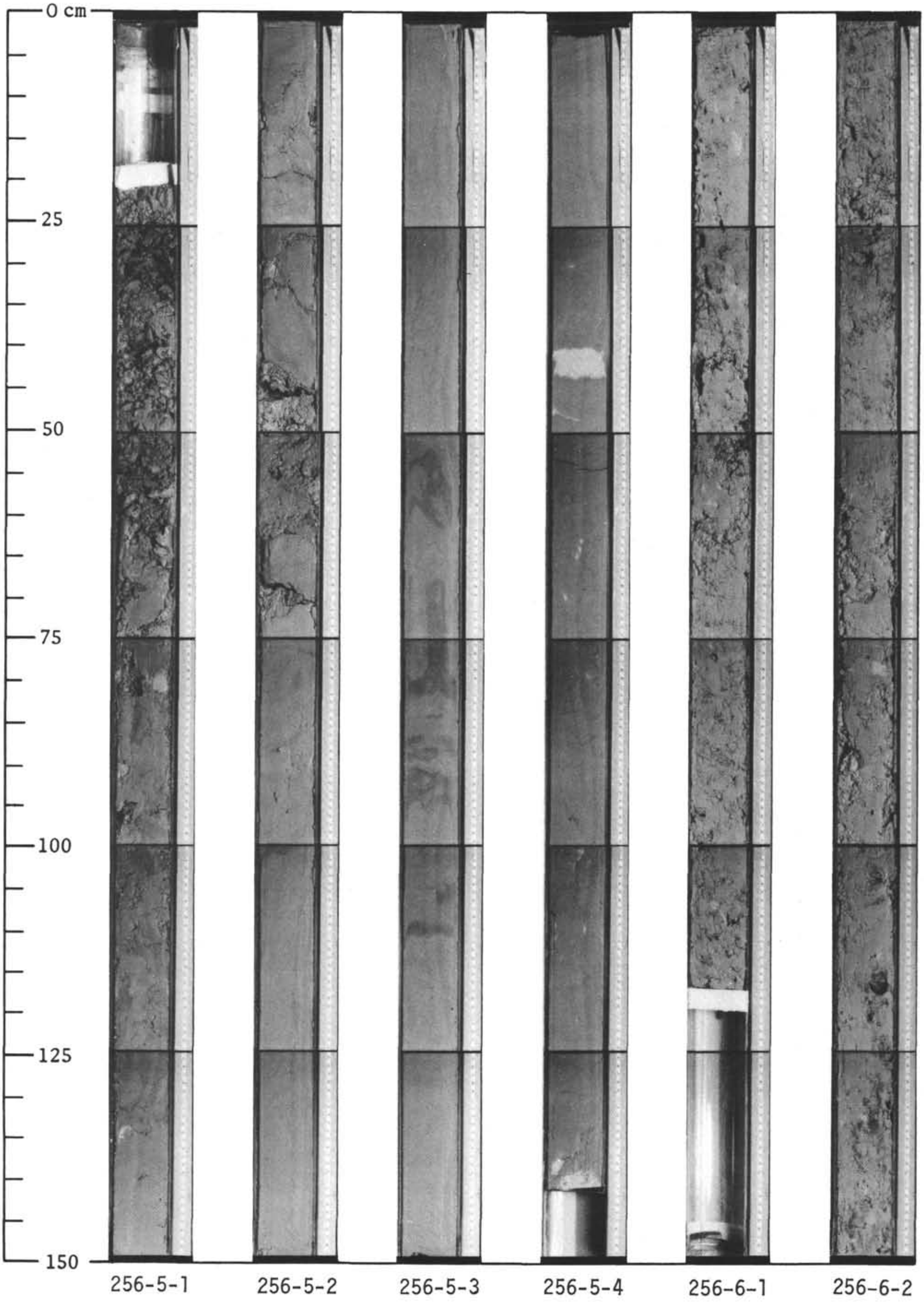
Explanatory notes in chapter 2

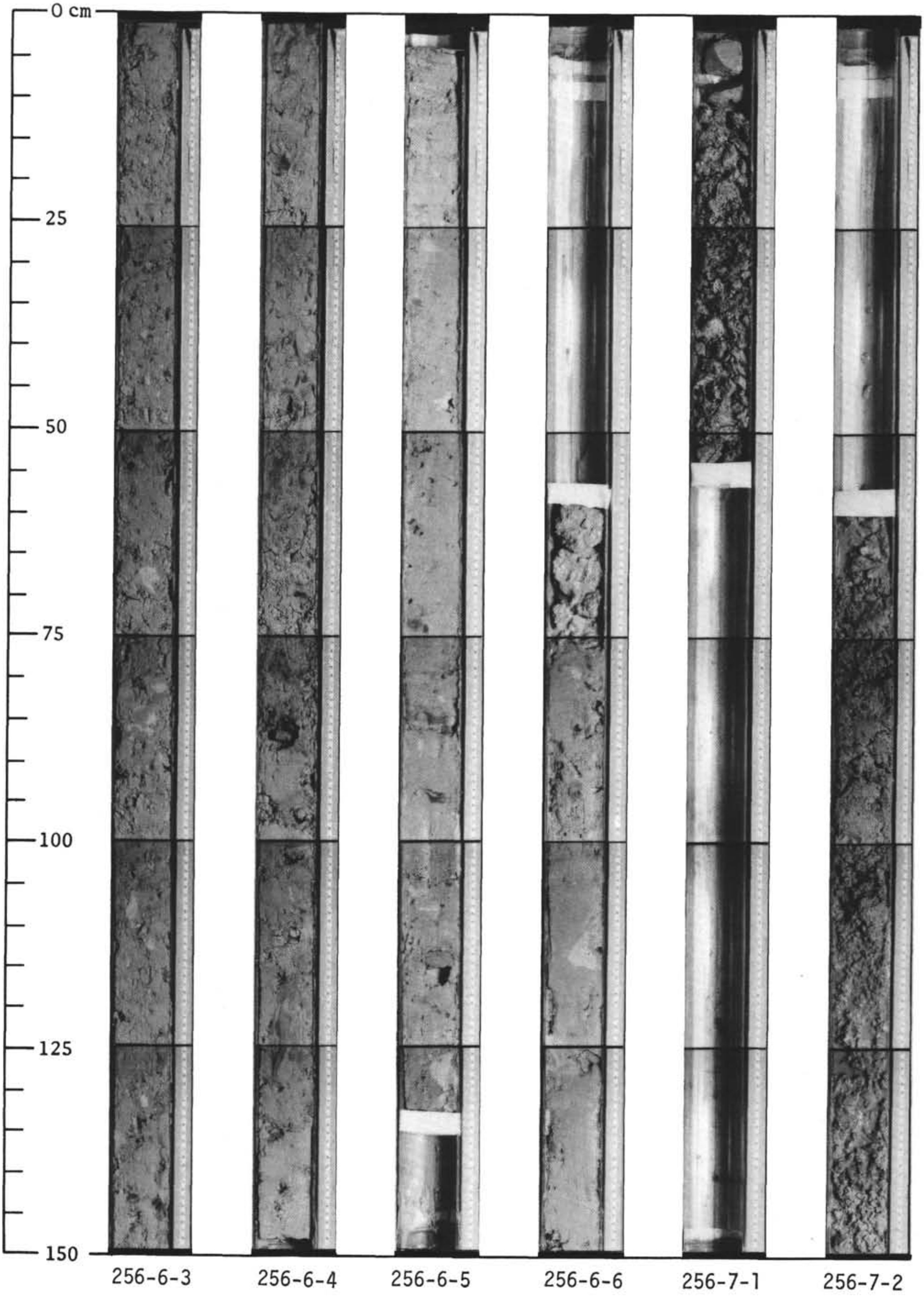

0 cm
25
50
75
100
125
150
256-1-1
256-1-2
256-1-3
256-1-4
256-1-5
256-1-6

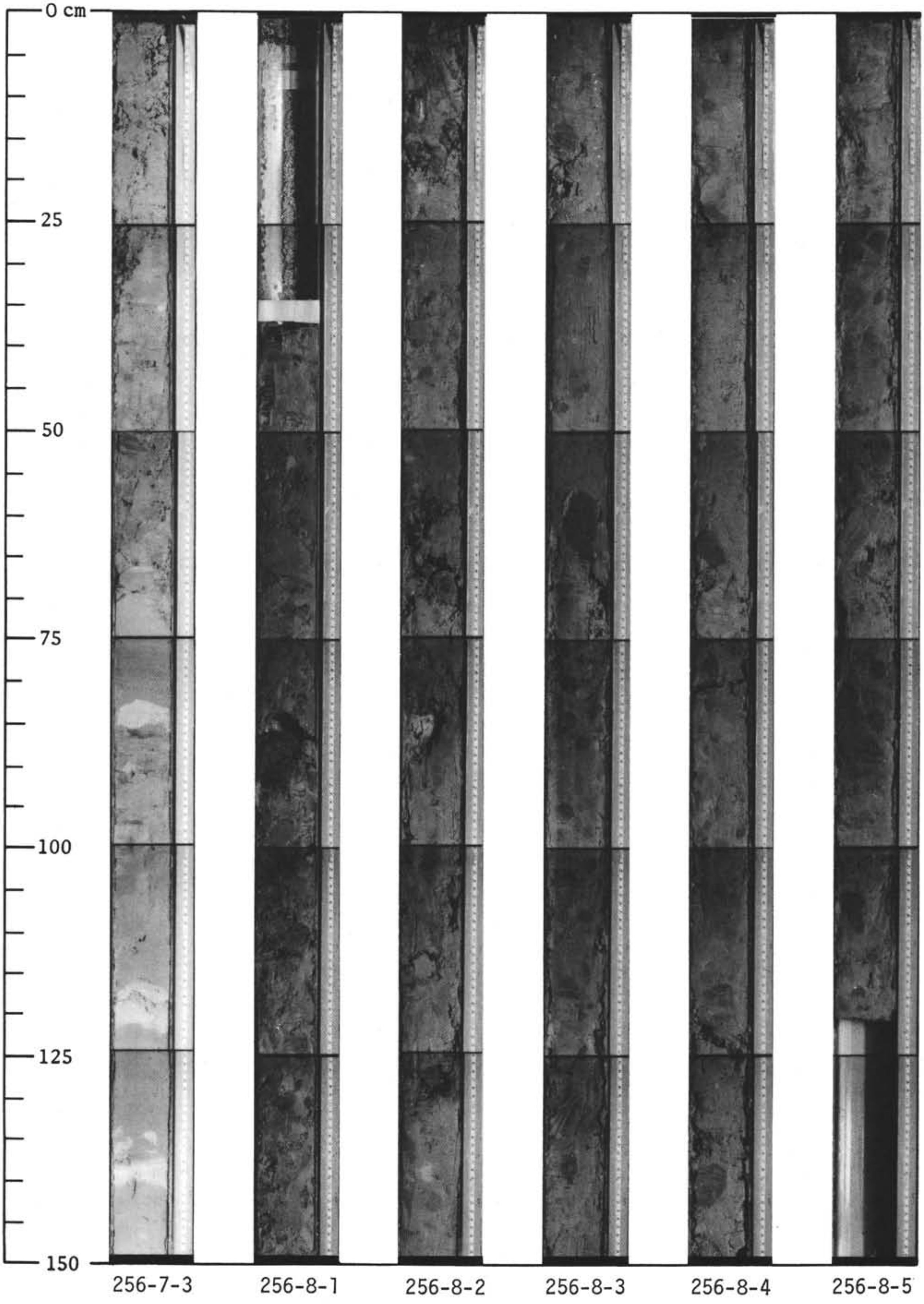

0 cm
25
50
75
100
125
150
256-2-1
256-2-2
256-2-3
256-2-4
256-2-5
256-2-6

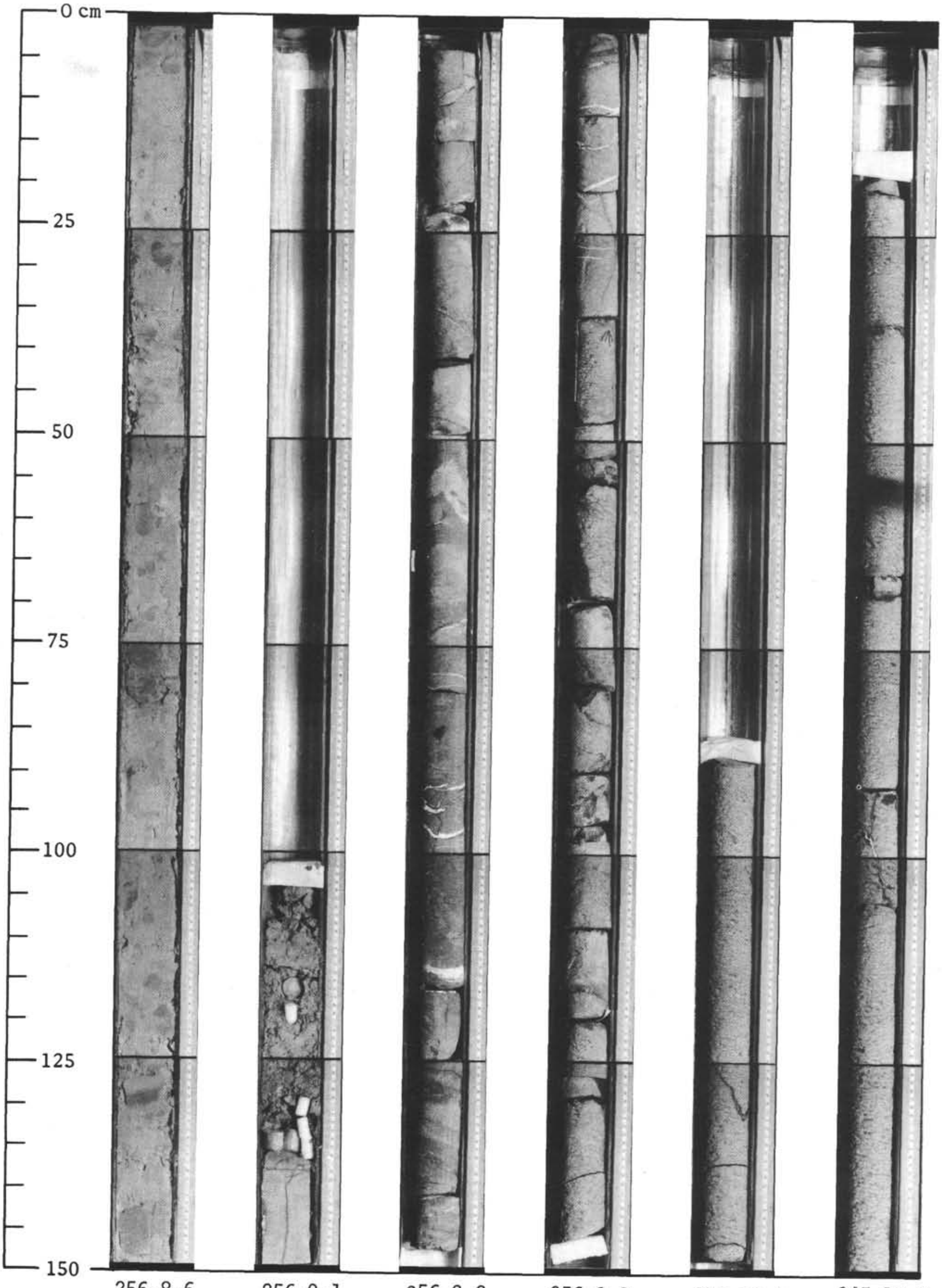

0 cm
25
50
75
100
125
150
256-3-1
256-3-2
256-3-3
256-3-4
256-3-5
256-3-6

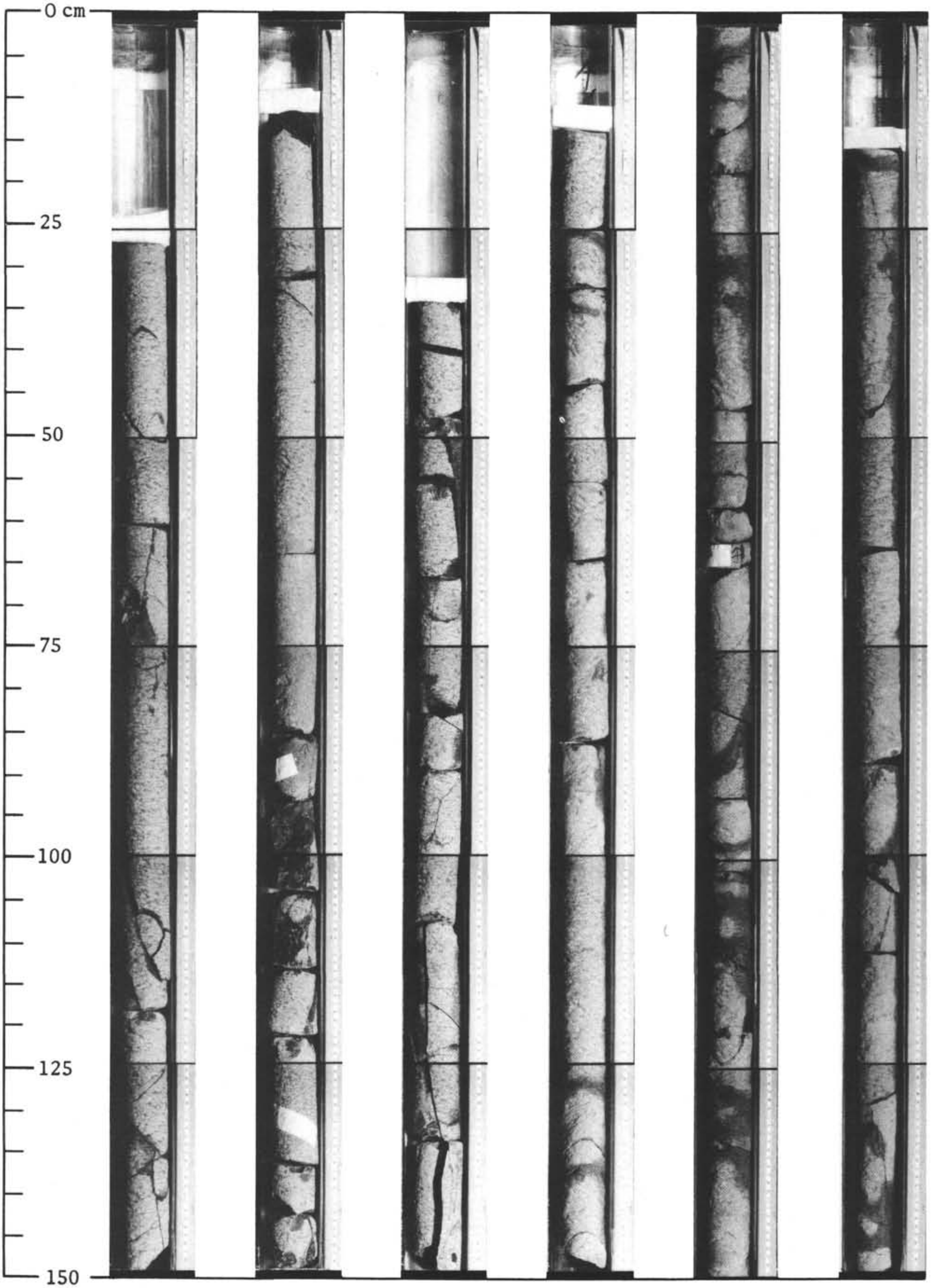

0 cm
25
50
75
100
125
150
256-4-1
256-4-2
256-4-3
256-4-4
256-4-5
256-4-6


0 cm
25
50
75
100
125
150
256-5-1
256-5-2
256-5-3
256-5-4
256-6-1
256-6-2


0 cm
25
50
75
100
125
150
256-6-3
256-6-4
256-6-5
256-6-6
256-7-1
256-7-2


0 cm
25
50
75
100
125
150
256-7-3
256-8-1
256-8-2
256-8-3
256-8-4
256-8-5


0 cm
25
50
75
100
125
150
256-8-6
256-9-1
256-9-2
256-9-3
256-10-1
245-10-2


0 cm
25
50
75
100
125
150
256-10-3
256-10-4
256-10-5
256-11-1
256-11-2
256-11-3

SUMMARY OF DRILLING RESULTS: SITE 256/0 - 200 m

BIOSTRATIGRAPHY				AGE	CORES NO/DEPTH	LITHOLOGIC DESCRIPTION	⊡ GRAPE × SYRINGE BULK DENSITY (1.00 – 2.50)	ACOUST. VEL. KM/SEC (1.0 – 6.0)
FORAMINIFERA	NANNOPLANKTON	RADIOLARIANS	MACRO-FOSSILS					
Remnants of planktonic foraminifera	Barren			Quat	0; 1; 2	Moderate brown, grayish brown, and reddish brown DETRITAL CLAY with minor greenish gray, orange brown, grayish, and dark brown intervals below 128 meters. Black ferromanganese micronodules between 85.5 m and 95.0 m (Core 4).		
				Pliocene	50; 3			
Few planktonic foraminifera				?	4 (Mn)			
Poor arenaceous foraminifera				Lower Pliocene	100; 5			
				Indet. Cretaceous	150; 6			

SUMMARY OF DRILLING RESULTS: SITE 256/200 - 400 m

BIOSTRATIGRAPHY: FORAMINIFERA	NANNOPLANKTON	RADIOLARIANS	MACRO-FOSSILS	AGE	CORES NO/DEPTH	LITHOLOGIC DESCRIPTION
Cretaceous arenaceous foraminifera	Barren			Indeterminate Cretaceous	200; 7	
Benthonics only	Eiffellithus turriseiffeli Zone			Late Albian	8	
Benthonic and plankt.foram.					250; 9; 10; 11	OLIVINE BASALT, fine-grained and weathered beneath contact, fresh and predominantly medium-grained with minor gradational fine-grained intervals at depth.
					300	
					350