6. SITE 330

The Shipboard Scientific Party[1]
With Additional Reports From
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SITE DATA

Date Occupied: 6-8 May 1974

Time on Site: 50 hours 03 minutes

Position (Satellite): 50°55.19'S, 46°53.00'W

Number of Holes: 2

Water Depth: 2626 meters (echo sounding)

Bottom Felt at: 2636 meters (drill pipe)

Penetration:
Hole 330: 575.5 meters
Hole 330A: 47.5 meters

Number of Cores:
Hole 330: 17
Hole 330A: 5

Total Core Recovered:
Hole 330: 85.5 meters (53%)
Hole 330A: 4.0 meters (8%)

Age of Oldest Sediment: Middle(?) to Upper Jurassic

Acoustic Basement: Precambrian to lower Paleozoic metasedimentary gneiss intruded by granite pegmatite, at 550.3 meters

Summary: Site 330, in 2626 meters of water at the western end of the elongate rise forming the eastern end of the Falkland Plateau, the Maurice Ewing Bank, was selected to elucidate the pre-Aptian history of the Falkland Plateau and to obtain a biostratigraphic section older than that cored at Sites 327 and 329. Two holes were drilled, the deepest penetrating gneissose and granitic continental basement at 550 meters subbottom.

Silty clay and ooze containing Eocene to Oligocene and Recent diatoms were recovered above 34 meters. At this level 166 meters of Albian-Cenomanian zeolite-rich nanno clay were penetrated. The clay overlies 225 meters of sapropelic claystone which extends to 425 meters subbottom. This claystone contains Oxfordian and Aptian fossils. A drastic reduction in sedimentation rate, nondeposition, or even erosion must have taken place even allowing for a 19-meter coring gap. Beneath the sapropelic claystone is 115 meters of Oxfordian interbedded silty clay and clayey silt with layers of sandstone and limestone. A terrigenous source is apparent for these sediments which overlie a subarkosic sandstone at least 20 cm thick thought to be a beach sand reflecting a basal marine transgression. The underlying siltstone and sandstone contain lignite interbeds and indicate fluviatile deposits. These sediments are 3 meters thick, extending from 547 to 550 meters subbottom. At 550 meters they unconformably overlie the gneissose and granitic basement of which 19.5 meters was cored. The top of the basement has been calcretized.

The basement rocks were clearly part of an extensive continental igneous and metamorphic complex of Precambrian age affected by thermal events at various times during the Paleozoic. This is in keeping with their regional setting prior to the opening of the South Atlantic Ocean. The calcrete formation suggests alteration of the basement under Mediterranean-type climatic conditions prior to the deposition of the overlying nonmarine Jurassic sediments. The sedimentary succession indicates a subsequent history of Mid-Late Jurassic (probably Oxfordian) marine transgression, a period of restricted circulation until the end of the Aptian, establishment of open marine conditions by the early Albian, and subsidence to the present depth of the site during the Late Cretaceous and Paleogene.

BACKGROUND AND OBJECTIVES

Site 330 is located 10 km southwest of, and downslope from, Site 327, in 2626 meters of water on the western nose of the elevated eastern part of the Falkland Plateau (see Figure 1). Like Site 329 it was proposed during Leg 36 by the shipboard party to augment the information obtained by drilling at Site 327, as a preferred alternative to other sites in the vicinity of the Rio Grande Rise proposed by DSDP. The total sediment thickness at the site was estimated, before drilling, to be about 750 meters and the original RC 16-06 reflection profile (Figure 2), showed the upper sedimentary layers to be thinner than at Site 327, so that the earlier history of the Falkland Plateau was more accessible. In view of the estimated sediment thickness and the likely time limitation, penetration to presumed continental acoustic basement was considered an unrealistic objective, but even limited penetration below the Aptian claystones at the base of Hole 327A would provide valuable information on the early history of the breakup of Gondwanaland.

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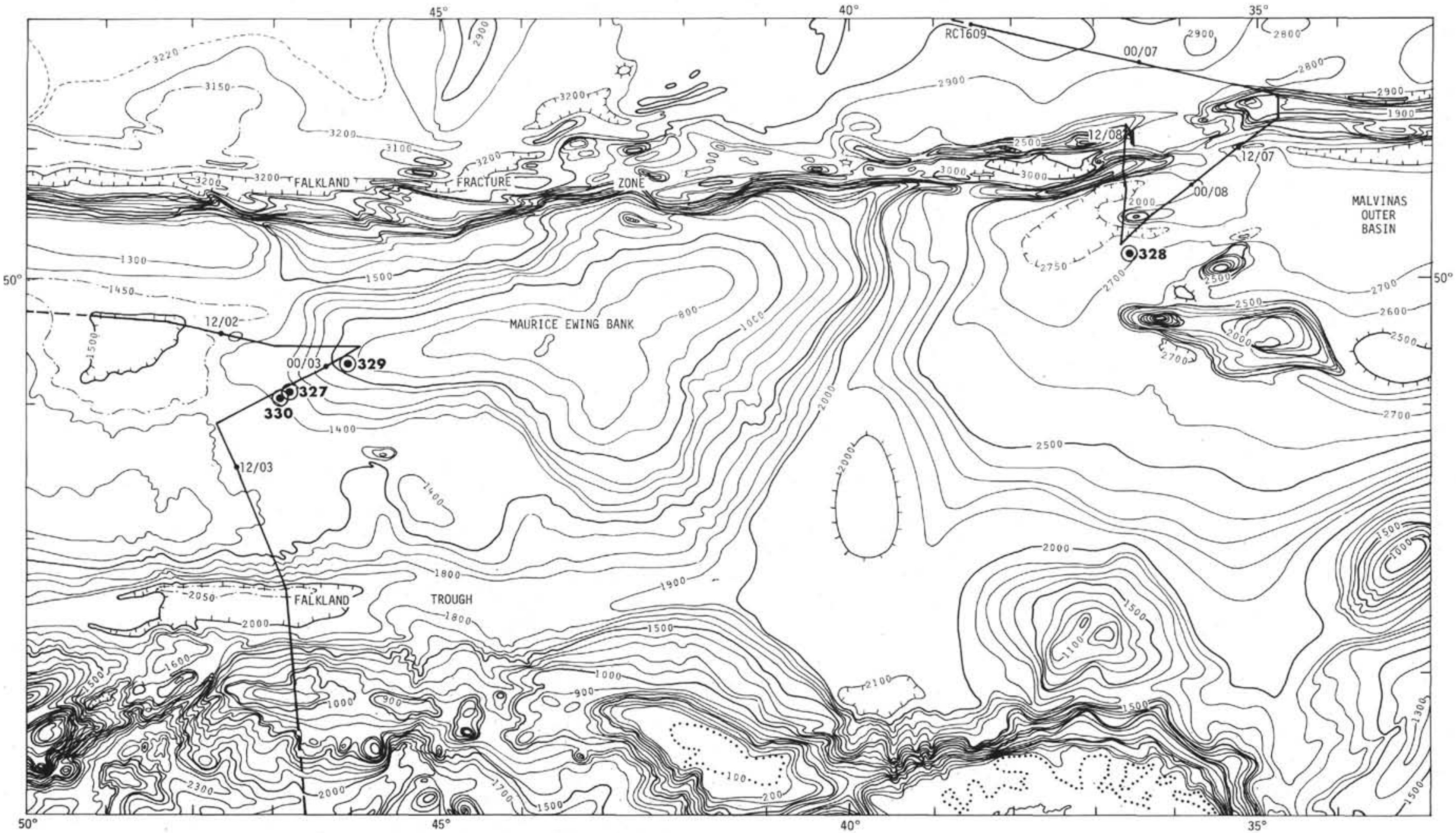


Figure 1. *Bathymetry of the Maurice Ewing Bank in the vicinity of Sites 327, 329, and 330 (after Lonardi and Ewing, 1971) with* Robert D. Conrad *1606 track chart.*

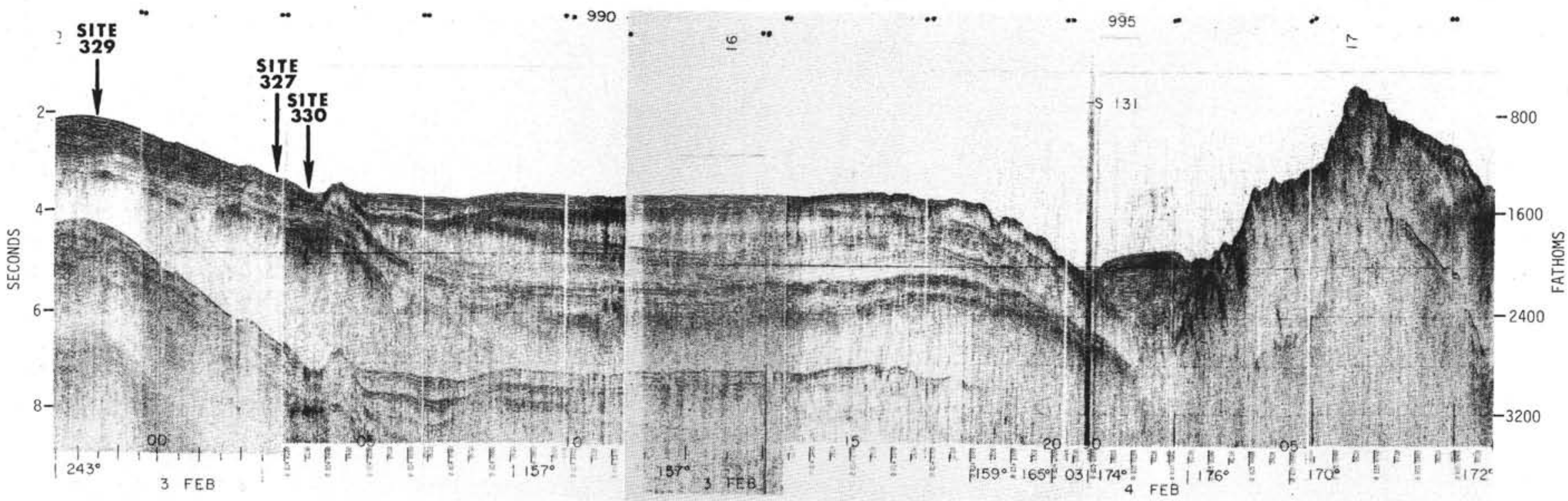


Figure 2. Robert D. Conrad *16-06 reflection profile in the vicinity of Site 330 (see Figure 1 for track).*

SURVEY AND OPERATIONS

Site 330, lying about 10 km southwest of Site 327, was chosen to provide easier access to the deeper part of the section displayed on the RC 16-06 reflection profile but not reached in the earlier hole because of bad weather. The approach was made along 240°T at 8 knots, directly from Site 329 and passing close to Site 327 (see Figure 3). It became obvious (Figure 4) that a near-exact duplicate of the shallow part of the RC 16-06 reflection profile was being obtained, making it easy to locate the site on the basis of the profile alone. The beacon was therefore dropped on the first approach and further site survey dispensed with to save time. The ship slowed to 5 knots at 0430Z on 6 May and the beacon was dropped at 0542Z, at 50°55.19'S 46°53.00'W in 2626 meters of water. The pipe started down soon afterwards and was spudded in at 1400Z. To save time, the bottom-hole assembly was washed in and the first core not taken until 129 meters subbottom, arriving on deck at 1840Z (Table 1). Intermittent coring (1 in 5) continued to 300 meters, where three successive cores were taken to sample a prominent reflector not reached with certainty at Site 327. It was not obvious that the reflector had been sampled, but since it was more likely to have lain shallower than deeper than the cored sequence, intermittent coring (1 in 3) was resumed. At 550 meters a second reflector was expected; the first core yielded a much more sandy lithology than had been seen hitherto, but the following two sampled gneissose basement, which the reflection profile had led us to expect about 200 meters deeper down. Coring was therefore terminated, at 575 meters subbottom at 0515Z on 8 May. Recovery on the 17 cores was 85.5 meters (53%).

There appeared still to be several hours before the expected bad weather would arrive, so a second hole was initiated to sample the upper part of the section, for comparison with the Site 327 Paleogene section. However, of the five cores cut, only one gave nonzero

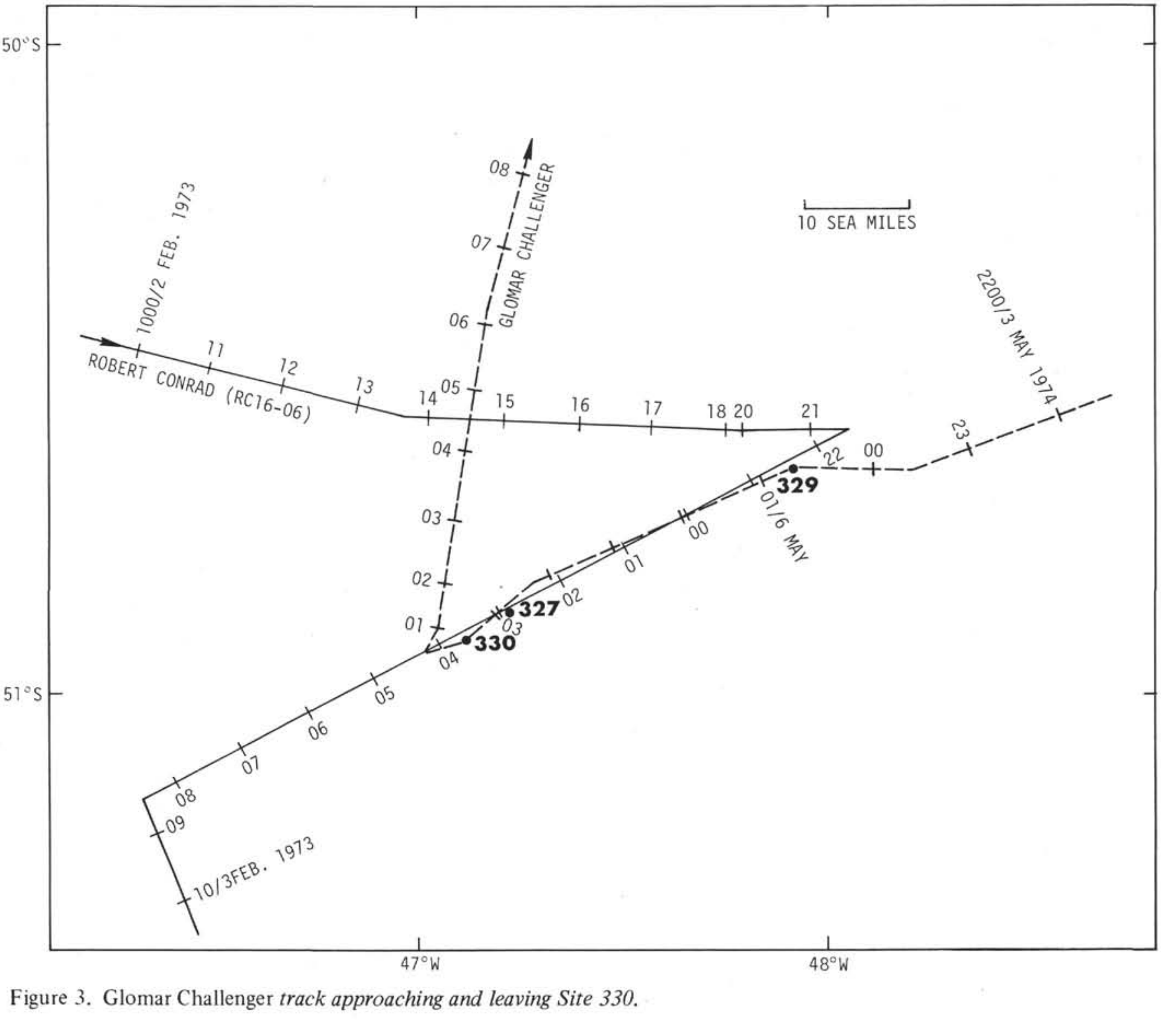


Figure 3. Glomar Challenger *track approaching and leaving Site 330.*

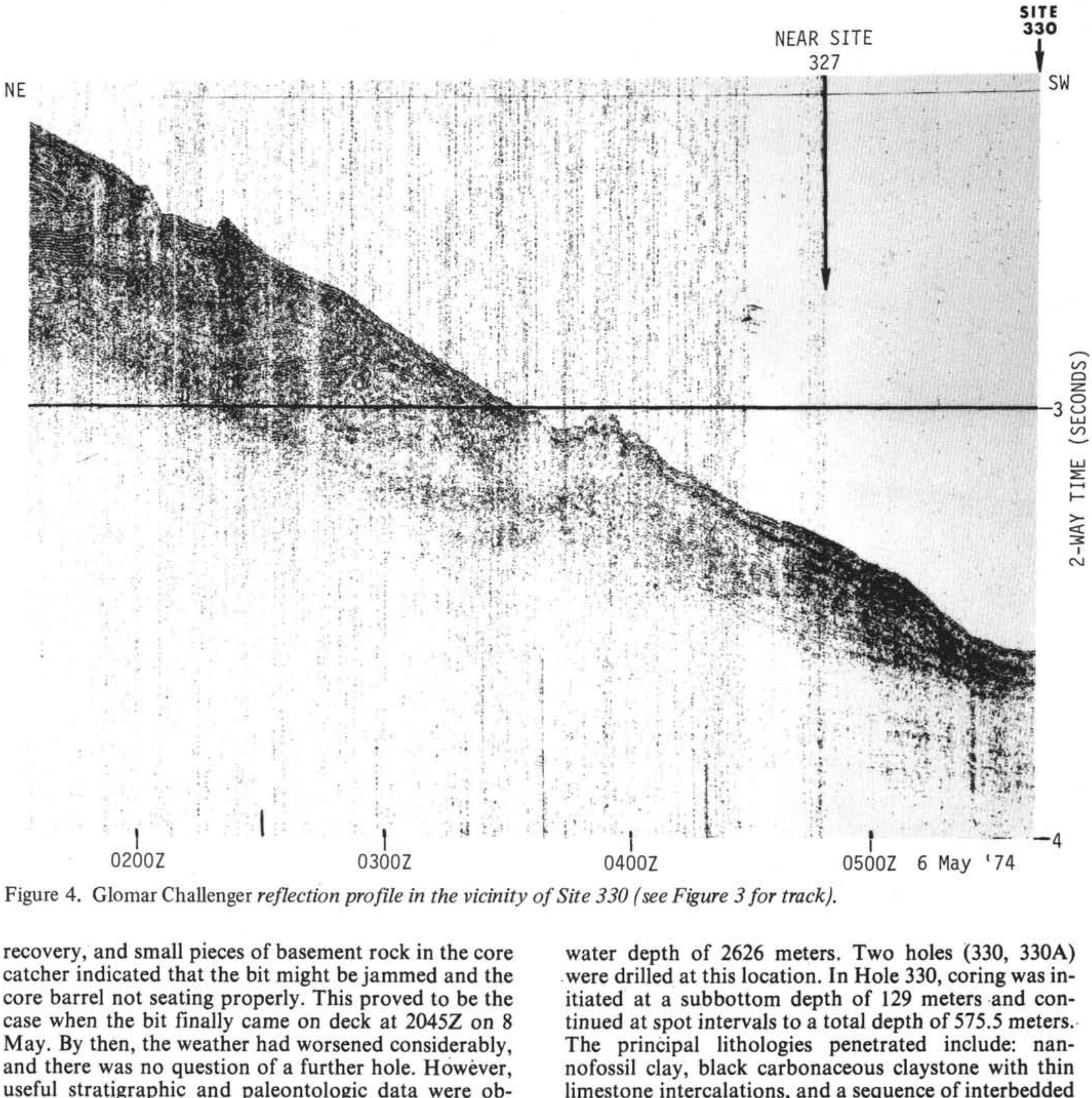


Figure 4. Glomar Challenger *reflection profile in the vicinity of Site 330 (see Figure 3 for track).*

recovery, and small pieces of basement rock in the core catcher indicated that the bit might be jammed and the core barrel not seating properly. This proved to be the case when the bit finally came on deck at 2045Z on 8 May. By then, the weather had worsened considerably, and there was no question of a further hole. However, useful stratigraphic and paleontologic data were obtained from sediment recovered in the core liner and adhering to the drill bit.

The ship passed over the beacon with underway gear operating at 2214Z, headed along 255° at 5 knots. After 2 hr spent steaming in this direction, to examine the way in which the upper sedimentary layers behaved over a small bathymetric high southwest of the site, the ship increased speed and headed north for the Argentine Basin and Site 331.

LITHOLOGIC SUMMARY

General Statement

Site 330 is situated on the Falkland Plateau slightly downslope and southwest of Sites 327 and 329 at a water depth of 2626 meters. Two holes (330, 330A) were drilled at this location. In Hole 330, coring was initiated at a subbottom depth of 129 meters and continued at spot intervals to a total depth of 575.5 meters. The principal lithologies penetrated include: nannofossil clay, black carbonaceous claystone with thin limestone intercalations, and a sequence of interbedded terrigenous silt and sandstones which contain thin lignite layers near the base. These sediments range from Albian to Oxfordian (and possibly middle Jurassic) in age. Basement rocks of probable Precambrian calcitized acidic gneiss and Paleozoic granite were encountered at 550 meters subbottom depth and were cored for a total of 20 meters.

Site 330A was drilled to a total depth of 53 meters. Five cores were attempted, only one of which (Core 1A, 5.5-15 m) was successful. This contained principally clay diatom ooze of late Eocene age. Muddy water with Cenomanian to late Albian foraminifera and coccoliths was obtained from Cores 4A and 5A (34-53 m).

The seven litho-stratigraphic units penetrated in these two holes are described below (Figure 5). Bound-

TABLE 1
Coring Summary, Site 330

Core	Date (May 1974)	Time (GMT Z)	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
Hole 330							
1	6	1840	2765.0-2774.5	129.0-138.5	9.5	9.5	100
2	6	2115	2812.5-2822.0	176.5-186.0	9.5	1.6	17
3	7	0005	2860.0-2869.5	224.0-233.5	9.5	2.1	22
4	7	0215	2907.5-2917.0	271.5-281.0	9.5	2.4	25
5	7	0420	2936.0-2945.5	300.0-309.5	9.5	3.4	36
6	7	0530	2945.5-2955.0	309.5-319.0	9.5	9.0	95
7	7	0655	2955.0-2964.5	319.0-328.5	9.5	8.6	91
8	7	0900	2983.5-2993.0	347.5-357.0	9.5	5.2	55
9	7	1040	3012.0-3021.5	376.0-385.5	9.5	2.5	26
10	7	1250	3040.5-3050.0	404.5-414.0	9.5	2.4	25
11	7	1520	3069.0-3078.5	433.0-442.5	9.5	8.6	91
12	7	1755	3097.5-3107.0	461.5-471.0	9.5	9.5	100
13	7	1940	3126.0-3135.5	490.0-499.5	9.5	5.3	56
14	7	2140	3154.5-3164.0	518.5-528.0	9.5	5.3	56
15	8	0010	3183.0-3192.5	547.0-556.5	9.5	3.1	33
16	8	0210	3192.5-3202.0	556.5-566.0	9.5	3.0	32
17	8	0515	3202.0-3211.5	566.0-575.5	9.5	4.0	42
Total					161.5	85.5	53
Hole 330A							
1	8	1025	2641.5-2651.0	5.5-15.0	9.5	4.0	42
2	8	1115	2651.0-2660.5	15.0-24.5	9.5	0	0
3	8	1215	2660.5-2670.0	24.5-34.0	9.5	0	0
4	8	1440	2670.0-2679.5	34.0-43.5	9.5	0	0
5	8	1540	2679.5-2689.0	43.5-53.0	9.5	0	0
Total					47.5	4.0	8

aries between Units 1 to 5 are arbitrarily placed in uncored intervals across which lithologic changes occurred.

Unit 1 (0-34 m, Core 1A)

The only sample definitely from Unit 1 was Core 1A from 5.5 to 15 meters below the surface. The diatom ooze retained on the bit after Hole 330A was terminated probably also derives from this unit, but from what part is unknown. The upper 70 cm of Core 1A consists of moderate brown diatom-rich silty clay. This contains about 50%-60% clay and 30% of siliceous remains, mainly diatoms but including Radiolaria, sponge spicules, and silicoflagellates. The terrigenous component (about 15%) comprises mostly silt-sized quartz and feldspar and a trace of fine to coarse sand-sized manganese micronodules, glauconite, and rock fragments. Downward in the unit the sediment becomes a very pale orange clayey diatom ooze containing about 50%-60% diatoms, 25%-30% clay, and 5% terrigenous silt. Other siliceous biogenic remains comprise 5%-10%. Small manganese nodules (up to 1 cm diameter) occur sporadically throughout and calcareous nannofossils become significant (up to 3%) near the bottom of the core. The entire core shows evidence of intense disturbance by coring.

Unit 2 (34-200 m, Cores 330-4A and 5A, 330-1 and 2)

Two cores (330-1 and 2) between the depths of 129 and 186 meters were obtained in this unit. The upper boundary is placed at 34 meters on the basis of muddy water and bit samples from Cores 330-4A and 5A. The unit consists principally of alternating light brown and pinkish-gray bands of zeolite-rich nanno clay. Clay content generally varies between 45% and 55%, nannos between 20% and 30%, and zeolite (mostly clinoptilolite) constitutes up to 15%. Micrite makes up the order of 5%-15% and appears to consist of broken-down and recrystallized nannofossils as well as comminuted *Inoceramus* and other pelecypod fragments which occur throughout the unit. A probable altered volcanic ash layer (79% montmorillonite) occurs in Core 1, Section 4. Moderate to intense bioturbation, including occasional *Zoophycos* trails, is evident through much of the unit. In the lower part (Core 2, Section 2), the sediment color changes to predominantly greenish-gray with occasional light brown bands. Slight compositional changes which accompany this color change include: (1) increase in clay and zeolite content; (2) disappearance of siliceous biogenic remains; (3) appearance of finely disseminated and occasional large nodules of pyrite; (4) appearance of porcellanite (up to 80% cristobalite) and micritic limestones containing silicified remains of foraminifera and Radiolaria. These changes reflect a transition to more restricted, euxinic conditions which characterized accumulation of Unit 3.

Unit 3 (200-425 m, Cores 330-3 to 10)

Olive-black carbonaceous (sapropelic) claystone constitutes the dominant lithology of Unit 3. These are

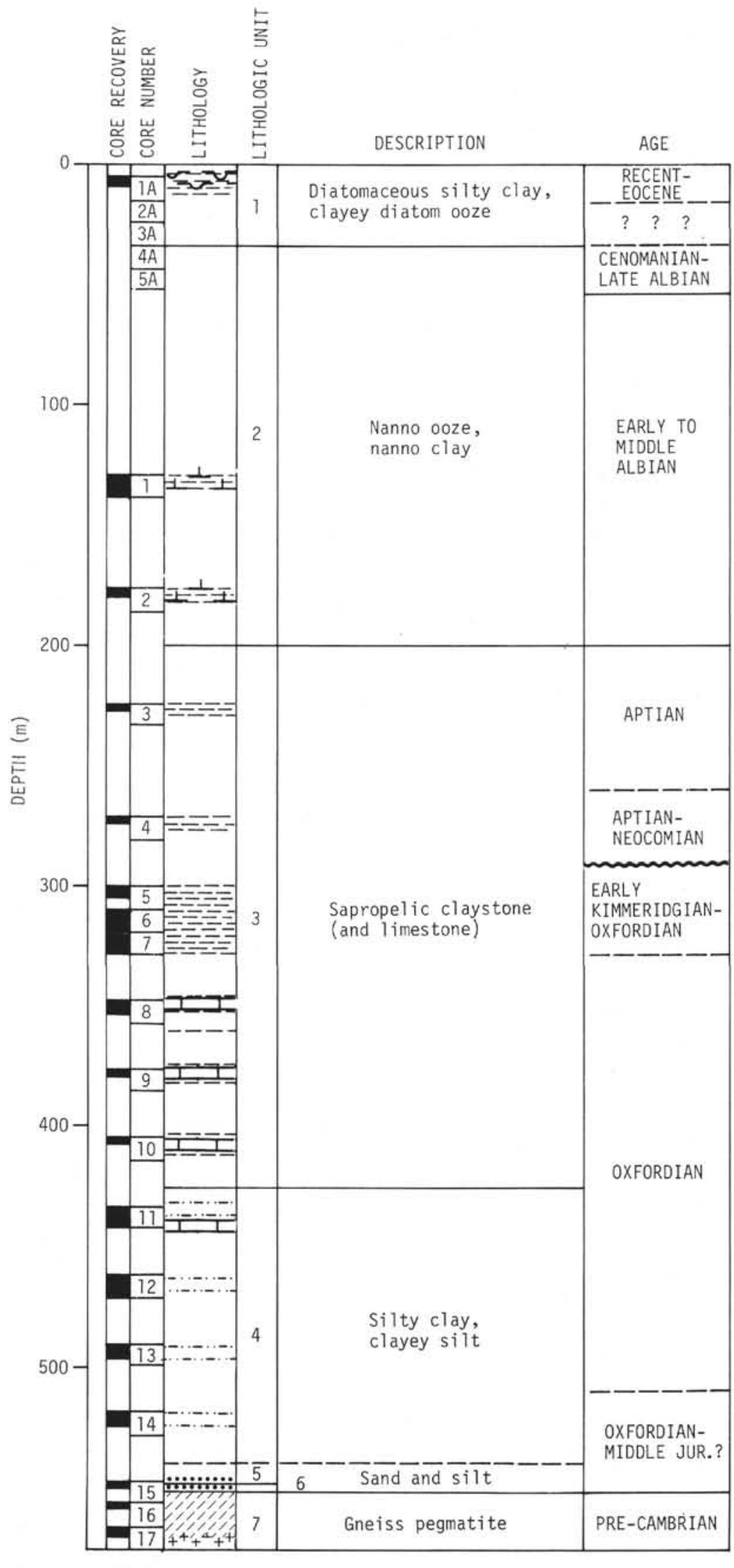


Figure 5. *Columnar section of Site 330 showing basic lithology recovered.*

fetid sediments which exude a strong petroliferous odor, and they reflect the existence of euxinic conditions on the Falkland Plateau from Late Jurassic through Aptian time. Interspersed with the claystone are thin (5-20 cm) olive-gray porcellanites and micritic limestones including one (Core 3, Section 2) which consists almost exclusively of braarudosphaerid remains. Also interspersed in the section, from Core 6 downward, are thin (<5 cm) layers of bluish-gray clay. X-ray analysis shows these layers to consist principally of montmorillonite whereas the associated black claystones consist mainly of illite and quartz; accordingly, the layers are thought to represent altered volcanic ash beds (bentonites).

As estimated from smear slides, the main constituents of the black claystones include clay (55%-85%), zeolite (10%-15%, mainly clinoptilolite), carbonaceous material (10%-12%), and pyrite (2%-3%). Nannofossils comprise up to 20% of the sediment in Cores 7 and 8, but are rare near the top (Core 3, Section 1) and base (Cores 9 and 10) of the section. Shore-lab data fail to confirm more than 1%-2% of zeolite, and show organic carbon to average about 3%, but to range as high as 6%. In the upper section, the organic material is almost exclusively amorphous (sapropelic), however structured kerogen (probably land-derived plant detritus) constitutes as much as 15% of the organic fraction below Core 7. A variety of megafaunal remains including *Inoceramus, Belemnites rostra*, Onychites, and several species of thin-walled mytilacean pelecypods occur in the claystones. These are particularly common in the section between 300 and 360 meters (Cores 5-8). A vague lamination, visible largely due to oriented bits of organic matter, is characteristic of most of the claystone section. An exception to this is Core 7 where well-developed lamination on a 1-3 cm scale is expressed by slight color variations. Smear-slide examination indicates this layering relates to slight variations in nannofossil concentration.

Relatively light colored (olive-gray), well-indurated beds the order of 5-20 cm thick occur interspersed throughout the sapropelic claystone unit. Near the top of the section (Cores 3 and 4), these beds include porcellanite, siliceous micritic limestone, and one layer of glauconitic claystone. All of these rock types contain remains of Radiolaria and foraminifera (?) which have been replaced and filled by either sparry calcite, silica, or glauconite. These coarser elements comprise from 30% to over 50% of the rock and are set in a mixed matrix of clay and micrite. Deeper in the section (Cores 4-10), the light colored beds consist mainly of vaguely laminated micritic to microspar limestone with a few spar-filled allochems. Persistent minor constituents of these limestones include clay (trace-30%), pyrite (1%-10%), and carbonaceous material (trace-10%). In Core 10, Section 1, what appears to have been a clay-rich micrite has been about half recrystallized to coarse sand-sized siderite rhombs.

Unit 4 (425-540 m, Cores 11-14)

The sediments comprising Unit 4 are much more variable lithologically than in any of the overlying units. Much of the section in Unit 4 consists of silty clay, clayey silt, and sand-silt-clay with occasional interbeds of limestone and sandstone. Specific sedimentologic changes which serve to distinguish these deposits from the overlying claystones include: (1) increase in the grain size and abundance of terrigenous components; (2) slight but distinct color change from olive-black to dusky yellowish-brown and olive-gray; (3) a change in the character of the incorporated carbonaceous matter from sapropelic (amorphous) to plant detritus (charcoal and wood fragments) in which internal structure is visible; (4) loss of the strong, petroliferous odor; (5) common development of bedding and lamination which reflect textural variations; (6) more frequent and obvious evidence of bioturbation.

The principal sediment types in Unit 4 are silty clay and clayey silt. These dominate the section in all cores taken, however, they are particularly pervasive in the upper section (Cores 11, 12). Interbeds of silt and sand-silt-clay increase in frequency downhole, while limestone decreases. Quartz and K-feldspar dominate the silt and sand fraction of these sediments with typical quartz/feldspar ratios the order of 3 or 4 to 1. Other ubiquitous constituents in this fraction are pyrite (1%-7%), plant detritus (1%-15%), traces of glauconite, and heavy minerals including garnet, zircon, tourmaline, apatite, and siderite. Illite is the principal clay mineral through the section. Kaolinite and montmorillonite constitute minor admixtures in the upper section; however, kaolinite shows a steady increase in abundance downward. Megafossil remains, specifically fragments and valves of several pelecypod species, are rare in the upper half of the unit, but become common near the base of Core 13 and continue through Core 14 where they are concentrated in layers of 3-5 cm thickness. None appear to be in growth position.

Primary sedimentary structures noted in this unit are of three main types:

1) A fairly regular alternation (interbedding) of relatively coarse (sand-silt-clay), intermediate (slightly clayey silt), and fine (silty clay) textured sediments in layers the order of 10-50 cm thick. This is most obvious and regular in Core 12 but obtains to some extent throughout the unit;

2) Lamination on a scale of 1-3 mm which particularly typifies the finer textured beds. For the most part the lamination is rather subtle; however, in two parts of the section (Core 12, Section 5; Core 14, Sections 2, 3), the lamination is very distinct and reflects alternation of slightly clayey silts (1-2 cm thick) separated by silty clays (1-3 mm thick).

3) Bioturbation which varies from moderate to intense and is particularly characteristic of the intermediate to coarse textured beds cited in (1) above.

The limestones found interbedded in Unit 4 bear many similarities to those of Unit 3. They are thin (10-20 cm), olive-gray in color, and extensively recrystallized. Sparry to microsparry calcite comprises anywhere from 50% to about 95% of these rocks and a persistent admixture of pyrite (1%-3%) and plant debris (1%-3%) is present. On the other hand, these limestones generally contain less micrite, lack any evidence of planktonic microfossils, and commonly contain a significant component of terrigenous silt and sand. All gradations between sandy limestone and calcareous sandstone occur in the section. One bed from the base of Core 13 contains roughly equal proportions of fine to medium terrigenous sand and allochems (including pelecypod fragments, echinoid spines, bryozoa, and [?]coral), set in a matrix of microspar. This was probably a sandy calcarenite at the time of deposition.

Unit 5 (540-547.2 m, Core 15, 0-20 cm)

Unit 5 consists of olive-gray to medium gray subarkosic sandstone of unknown thickness. Only 20 cm of this were sampled in the top of Core 15; however, the overlying interval was not cored, hence the unit may be considerably thicker. The sandstone is medium grained, well sorted, and friable. Subangular to subrounded quartz constitutes about 90% of the sandstone; the remainder consists of subhedral K-feldspar, rock fragments, and a trace of heavy minerals which include garnet, tourmaline, and zircon. The high textural maturity of this unit and its stratigraphic position between definite marine strata above and probable terrestrial fluvial sediments below (Unit 6) suggest a beach origin.

Unit 6 (567.2-550.3 m, Core 15)

A complex sequence of terrigenous, silty sandstone and sandy siltstone beds comprises most of Unit 6. For the most part, these sediments are moderate to dark yellowish-brown in color and contain an abundance of fragmental plant remains and lignite. One greenish-gray claystone (30 cm thick) and a thin (3 cm) lignite bed complete this sedimentary unit which directly overlies the basement rocks of Precambrian-lower Paleozoic metasedimentary gneiss. Immediately above the contact is a thin layer of bluish-white clayey sand in which the chief clay mineral is kaolinite. This may represent part of an old soil profile.

The coarse textured beds of this unit range from 40 to 80 cm in thickness, and each shows a rough gradation from predominantly silty sandstone (or very sandy siltstone) at the base to siltstone at the top. The sandstones are dominantly fine medium but very poorly sorted. Sand size ranges from very fine to very coarse and in several beds, angular granules of quartz and feldspar appear to be floating in a silt-sand matrix along with clasts of carbonized wood and lignite. Trending upward into the siltstone part of each bed, the large angular clasts disappear, the color changes to more drab (olive-gray), and complex sedimentary structures appear. The thin lignite and overlying greenish-gray claystone in Core 15, Section 2 appear to cap one of the graded beds.

Unit 7 (550.3-570.8 m, Cores 15-17)

Continental basement was encountered at 550 meters subbottom depth in Hole 330. Altogether 19.5 meters of basement were cored, with total recovery of about 7.3 meters. The last few centimeters (3 pieces) were recovered from the bit following the abandonment of Hole 330A. These latter samples are labeled 17, CC. The low recovery might be accounted for in part by the fragmentation of the more friable pelitic rock types during drilling.

The rock types recovered may be grouped into five different lithologies which will be described in turn.

Metasedimentary Gneisses

Rocks in this group include those with a dominant metamorphic fabric. Although few of the rocks are coarse grained and most are micaceous to a variable extent (including almost pure biotite), the term gneiss is used in preference to schist because in general quartz and feldspar rather than mica dominate the fabric.

Quartz is the dominant mineral, forming 50% or more of the mode in most rocks. Other major minerals are K-feldspar, plagioclase, biotite (reddish-brown and green), garnet, chlorite, and a variety of secondary products such as calcite, siderite, pyrite, topaz, and sericite, pyrophyllite, or other fine-grained indeterminate microcrystalline material related to the later hydrothermal activity or the formation of calcrete. Accessories included zircon, apatite, magnetite, and (a major mineral in some rocks) tourmaline. Tourmaline and pyrite are notable components of the unconsolidated sand overlying the basement.

The range of rock types represented corresponds to quartz-rich semipelite through to biotite-rich pelite. Some bands richer in K-feldspar approximate to arkose. Other bands rich in K-feldspar and quartz, but poor in plagioclase and biotite, and bearing garnet, appear from their textures to represent early deformed pegmatites. These are designated π_1 on the barrel logs. A foliation and lithological banding is obvious in hand specimen, but this is variably developed: in some parts of the core there is no obvious lithological banding over distances as great as 20 cm. Splitting of the core revealed that much of the lithological banding is discontinuous and lensoid. The foliation is inclined at about 30° relative to the core. In thin section, the gneisses have a granular to subgranular texture, with average grain size about 1 mm. The biotites are aligned parallel to the foliation, but in detail the biotites form aggregates whose overall shape is more equant, and not so obviously related to the foliation. The biotite fabric is, however, better defined in the more pelitic rocks, where the quartzes and feldspars are also more elongated in the plane of the foliation.

The metamorphic grade of the gneisses is relatively high, as judged by (a) the abundance of garnet in the assemblages, (b) the presence of a rather calcic plagioclase (An_{35-40}) and the absence of epidote, and (c) the absence of primary muscovite and the presence of stable K-feldspar. The strong reddish-brown coloration of the biotite also indicates high-grade conditions. These factors would concur with a grade of metamorphism equivalent to the upper amphibolite facies.

Secondary retrogressive features are abundant, however, red biotite being replaced by green biotite and chlorite, garnet being replaced by chlorite, plagioclase being clouded and replaced by carbonates.

Granite Pegmatite

Almost 1.4 meters of coarse-grained granite-pegmatite was cored in the lower section of Core 17 before the hole was terminated. The pegmatite is variable in texture and distribution of minerals. The upper contact with the gneisses has a grain size of less than 0.5 cm and is distinctly richer in plagioclase and quartz relative to the center. The central part of the pegmatite has a grain size of ca. 1 cm, but this zone is flanked on either side by zones with potash feldspars several centimeters in diameter, intergrown with quartz and biotite.

The K-feldspar is microperthitic and partially and variably inverted to microcline. Vermicular intergrowths with quartz are common. Plagioclase (An_{20}) is rather clouded and sericitized. The original biotite has been almost completely replaced by very pale green chlorite.

Large purple-red garnets occur in the pegmatite within 10 cm of the upper contact. These garnets are intergrown with quartz in vermicular fashion and are surrounded by quartz. They also occur in the gneisses for about 2 meters above the contact, and are easily distinguished from the small granular garnets which occur throughout the gneisses.

Thin veins of K-feldspar-rich pegmatite are seen within the gneisses at intervals up the core section. They are probably closely related to the main mass of pegmatite since they have a similar mineralogy and are undeformed. On the barrel logs these are labeled π_2 to distinguish them from the earlier deformed pegmatite veins, designated π_1.

Thin Basic Veins

Thin intrusive basic veins cross-cut the foliation of the gneisses in Core 16-1, 40-70 cm. Thin quartz-pegmatite bands are also cut by the veins. The veins are dark green in color and have been altered to a fine dark green smectite clay (which dried out and cracked apart within a few hours of opening the core). There is no indication that the veins were or are deformed. They would appear to have been intruded later than the granite pegmatite.

Microsyenite Intrusion

The lowermost sample retrieved in the drill bit (17, CC, #3) consisted of dark gray fine-grained igneous rock containing xenoliths of granite and quartz. The sample immediately above it (17, CC, #2) carried the chilled margin of this intrusion against the coarse-grained granite. Most of the xenoliths are irregular in shape and rather corroded. The groundmass is of almost indeterminate mineralogy, consisting of granular feldspars in a matrix of radiating fibers of sericite. The mafic minerals in the groundmass are badly clouded.

The chilled margin is welded rather firmly to the granite in an irregular contact. In this way it differs from the soft altered thin basic veins. The two phases of intrusion are probably unrelated.

Basement Calcrete

The upper part of Core 16, Section 1 is characterized by calcite-impregnated gneisses superficially similar to calcareous sandstones. The carbonate may form up to 40% of the rock, but the biotites and quartzes retain their original fabric. The original mineral grains have essentially been pulled apart and the intervening spaces infilled with calcite.

The calcite-rich zone extends for barely more than 40 cm below the top of the basement, and by about 70 cm depth the amount of calcite is not much more than 2% or 3%, decreasing further with depth in the core. Plagioclase is the only mineral in the gneisses which shows extensive replacement by calcite: it is barely recognizable in the calcite-rich zone. Calcite-filled veins extend, in decreasing abundance, most of the way down the core.

The most likely explanation of this carbonate-rich zone is that it represents a paleobasement calcrete (caliche) which formed at or very near the old land surface before it was buried beneath Upper Jurassic sediments. The source of the carbonate is unlikely to be the sediments themselves since the unconsolidated sand overlying the basement has no calcite cement.

PHYSICAL PROPERTIES

Sonic velocities and other physical properties (wet bulk density, porosity, and water content) were determined in all 17 cores recovered from Hole 330, using the Hamilton frame system for the former and gravimetric and GRAPE laboratory methods for the latter. These values are shown in the site summary graphic logs and core summaries. Acoustic impedances were calculated from these measurements. A second hole (330A) was drilled in the same location to a depth of 53 meters, but only the top 4 meters were recovered, and no physical properties were determined due to the high degree of disturbance.

A variety of sediments was measured at this location, including nanno oozes, nanno clays, sapropelic claystones, limestones, sandstones, and samples from the acoustic basement, which consisted of calcitized gneiss and granite of continental origin.

In addition to the above-mentioned typical lithology, frequent thin layers of micritic limestones, ranging in thickness between 5 and 60 cm, occur at depths greater than 200 meters downhole and exhibit very different physical properties. In particular, sonic velocities of micritic nanno limestones and micritic limestones increase consistently as a function of depth (minimum 2.57 km/sec, maximum 5.20 km/sec) and are about 20% to 200% higher than those measured in the sediments with which they are interbedded.

The first core was drilled at a depth of 129 meters below sea floor, penetrating a sequence of Cenomanian to mid-Aptian nanno oozes and nanno clays (Lithologic Unit 2), and the basement was reached at a depth of about 550 meters. Average sediment porosities are relatively low downhole (61% to 32%), wet bulk densities high (1.66 g/cm^3 to 2.12 g/cm^3), and water content low (39% to 16%). Within the same depth interval, average sonic velocities for each core measured in typical lithological samples range from 1.61 km/sec to 2.05 km/sec. Higher values are apparently more a result of composition and relative compaction with depth rather than a consequence of great age (sediments of Jurassic age exhibit velocities ranging on the average between 1.80 km/sec and 2.05 km/sec). The average variation of acoustic impedance with depth is rather uniform (2.70×10^5 g/cm² sec to 4.0×10^5 g/cm² sec).

Across the boundary between nanno clay (Unit 2) and sapropelic claystones (Unit 3), at about 200 meters depth, there is a moderate increase of average sonic velocities (1.73 km/sec to 2.02 km/sec). The top of Unit 3 correlates in age and composition with a similar formation of Aptian age or older, found at Site 327 at 330 meters depth.

At Site 330, a velocity inversion is also found downhole within sapropelic claystones at 270 meters, where average velocity decreases to 1.61 km/sec. Beyond 270 meters, velocities as well as other properties change with depth. However, from 400 meters down to 530 meters, average velocities measured across silty clays and clayey silts (Unit 4) are remarkably constant (1.79 km/sec). Basal sediments consisting of sandstone, siltstone, and lignite (540 to 556 m) exhibit similar physical properties as the upper Lithologic Unit 4. Measurement of sonic velocities in these sediments proved, however, to be extremely difficult, as sonic waves were greatly attenuated across the samples, due to its composition (high proportion of plant debris), coarse grain size, and low water content. Only two measurements could be obtained which averaged 2.05 km/sec (siltstone and sandy siltstone).

Repeated measurements of sonic velocities and bulk densities were taken on 16 selected samples from the basement rock. Some of the measurements were performed in dried out conditions and repeated on the same samples after they had been soaked in water for 18 hr. Velocities measured on wet samples were 1% higher. Calcitized acid gneiss ranges in velocity from 3.67 km/sec to 5.31 km/sec, macrofoliated gneiss from 2.45 km/sec to 3.14 km/sec, and granite from 5.29 km/sec to 5.72 km/sec. Bulk densities for all 16 samples range from 2.47 g/cm² to 2.65 g/cm².

The plotted values are estimated to be accurate to ±7% syringe porosity, ±6% GRAPE porosity, ±0.1 g/cm³ syringe bulk density, and ±1% velocity.

PALEONTOLOGY

Biostratigraphic Summary

The lower portion of the sedimentary sequence at Site 330 consists primarily of an Upper Jurassic transgressive paralic sequence grading upwards from basal sands into fine clastics with open marine fauna and flora (see Lithologic Summary). Following an apparent Upper Jurassic-Lower Cretaceous hiatus, fine clastic deposition continued but graded into open marine, nannofossil-rich clays deposited in progressively deeper waters which approached the carbonate compensation depth by late Albian/Cenomanian time. The sequence is capped disconformably by Eocene and Quaternary diatomaceous ooze.

The sequence was sampled in two drill holes. Hole 330 was cored discontinuously from 129 meters to basement (575.5 m). The drill string was then raised to the sediment surface and Hole 330A was begun in order to sample the top of the section. This effort was largely unsuccessful because pieces of basement rock from Hole 330 lodged in the bottom-hole assembly prevented proper functioning of the coring apparatus. Core 1 of Hole 330A contained a badly disturbed section of diatom ooze, whereas Cores 4, 5, and the drill bit yielded traces of nanno-rich clay. The hole was then abandoned due to coring difficulties.

All siliceous microfossil groups are well represented in the mixed upper Eocene/Quaternary diatom ooze with a few coccoliths present. Only coccoliths, Radiolaria, foraminifera, and palynomorphs are present in the remainder of the section at this site. The calcareous and siliceous microfossils become sparse below the nanno clay of Lithologic Unit 2, whereas palynomorphs are found only below that level. Planktonic foraminifera are only found in Unit 2, although benthonics are present intermittently down to Core 14. These are mostly agglutinated forms, with calcareous benthonics only in Cores 11 and 13. Interestingly, the fauna of Core Catcher 13 is exclusively calcareous. As noted at Site 327A, planktonic foraminifera here are of extremely low generic and specific diversity, a function of their high latitudinal, cool water site of deposition. Calcareous nannofossils appear not to be as restricted ecologically.

Coccoliths are abundant down to Core 330-3 and occur intermittently thereafter. In Core 4, they are limited in diversity and rather poorly preserved, but are well preserved and reasonably diverse in the Oxfordian clays of Cores 5 to 7. They decrease in numbers below that level, and are absent in most samples from Cores 11 to 13. They show a slight rise in abundance in Core 13, Section 1. Well-preserved Cretaceous Radiolaria are found in Cores 3, in Cores 330-2 and -3, whereas pyritized Jurassic forms are found in Cores 330-10 and 12. Palynomorphs in Cores 3 to 15 are quite rich and well preserved. Assemblages include: spores, pollen, dinoglagellate cysts, acritarchs, and tasmanitids. The last is a cool water form which occurs in the lower portion of the section (below Core 7).

A wide range of invertebrate fossils is present in the Mesozoic units, particularly in the Jurassic. Belemnites, scolecodonts, cephalopod arm hooks, and bivalves (*Inoceramus* and mytilaceans) are common in the Jurassic section, with *Inoceramus* extending into the Cretaceous. Badly recrystallized corals were encountered in a hard limestone lamina in Core Catcher 13 near the bottom of the hole.

Core 1 of Hole 330A is dated late Eocene on the basis of all fossil groups present. A water Sample 330A-4 and the drill bit sample from Hole 330A contain, respectively, Cenomanian and Albian assemblages of nannofossils and foraminifera.

Samples 330-1, CC and 330-2, CC contain coccoliths referable to the lower to middle Albian *Prediscosphaera cretacea* Zone, an assignment corroborated by foraminiferal determinations, and one in general agreement with the occurrence of the late Albian to early

Cenomanian Radiolaria taxa *Cyrtocapsa grutterinki* and *Excentrophylomma cenomana* in 330-2, CC.

Core 330-3 is dated Aptian on the basis of coccoliths, foraminifera, and pollen. It probably belongs to the coccolith *Chiastozygus litterarius* Zone. Core 4 contains few diagnostic microfossils but is considered Aptian or Neocomian in age on the basis of palynomorphs and coccoliths.

Cores 5 to 7 contain an Upper Jurassic coccolith assemblage referable to the *Vekshinella stradneri* Zone of Barnard and Hay (1974). The assemblage contains *Stephanolithion bigoti*, and is considered Oxfordian to possibly early Kimmeridgian in age. An onychite from Core 6 is identified as *Paraglycerites necans*, an Upper Jurassic form of the family Glyceridae. Coccoliths in Cores 8 to 13 are sparse and cannot be dated precisely. Pollen suggest a probable Upper Jurassic (Oxfordian) age for most of the remainder of the sedimentary section.

Foraminifera

Samples 4, CC, 5, CC and the bit sample from Hole 330A contain a moderately well preserved foraminiferal fauna that includes the planktonic species *Hedbergella delrioensis, H. amabilis, H. planispira, Schackonia cenomana*, and *Praeglobotruncana delrioensis* suggesting a Cenomanian age. Benthonic species suggest lower bathyal water depths of 1000 to 2000 meters.

Planktonic foraminiferal assemblages from Cores 1 to 2 of Hole 330 include *Hedbergella delrioensis, H. amagilis, H. planispira*, and *H. sigali* and the benthonic species *Dorothia trochus, Osangularia utaturensis, Planularia bradyana, Tritaxia gabonica, Uvigerinammina jankoi*, and *Vaginulina recta*. These indicate an early to possibly middle Albian age. Shelf break (100-400 m) water depths are suggested by this moderately well preserved fauna.

Dark sapropelic claystones, zeolite-rich, and interbedded with micritic limestones, were recovered from Cores 3 to 14. The cores with the highest organic content (Cores 5 to 7) are devoid of foraminifera. Species-poor assemblages of mostly primitive agglutinated benthonics are found in Cores 4, 10 to 12, and 14. Calcareous faunas consisting of a few lagenid species occur in Cores 11 and 13.

Calcareous Nannofossils and Silicoflagellates

Site 330 was drilled primarily in order to sample Mesozoic strata between basement and the deepest level penetrated by Hole 327A, and to attempt to date a prominent acoustic reflector near the top of that interval. This was done in Hole 330. Hole 330A was an attempt to sample the top part of the section at Site 330, however, Mesozoic sediment was recovered only from muddy water in the core after coring attempts 4 and 5, and from the end of the drill bit after the pipe was pulled from the hole.

Core 1 of Hole 330A contains a diatom ooze with silicoflagellates and a few etched nannofossils including *Reticulofenestra bisecta, R. umbilica, Isthmolithus recurvus*, and *Discoaster saipanensis*. These indicate a late Eocene age for most of the core.

Water from Cores 4 and 5 as well as a pinkish mud which adhered to the bit after the drilling tools were retrieved from the hole yielded a mixed Albian to Cenomanian assemblage which includes forms such as *Eiffellithus turriseiffeli* and *Seribiscutum primitivum.*

Cores 1 and 2 of Hole 330 were taken over 100 meters below the top of the section, and contain a Lower Cretaceous nannoflora similar to that near the top of the section except that *Eiffellithus turriseiffeli* is absent. Nannoconids are quite diverse. The assemblage is assigned to the *Prediscosphaera cretacea* Zone which is considered early Albian in age. The diversity of the assemblages in this part of the section compares favorably with that reported in equatorial regions by Roth and Thierstein (1972).

Core 3 is basically a micrite composed of braarudosphaerid particles. *Braarudosphaera* is common along continental margins where salinities are slightly less than in open marine areas (Bukry, 1974). *Prediscosphaera cretacea, Lithostrinus floralis*, and *Parhabdolithus angustus* are apparently absent, but *Vagalapilla matalosus* is common. This indicates an Aptian age for the sample.

Core 4 contains a few *Watznauria* but little in the way of diagnostic coccoliths. No diagnostic lowermost Cretaceous (Berriasian to Barremian) fossils were observed in this core, but pollen studies indicate an Aptian to Neocomian age. Thus a sharp biostratigraphic discontinuity separates Core 4 from Core 5 which is Late Jurassic in age. Cores 5 to 7 contain a rather sparse, but a well-preserved Oxfordian assemblage dominated by *Watznaueria communis, Cyclogellosphaera margereli*, and *Zeugrhabdotus erectus* with rare to common *Ethmorhabdus gallicus, Axopodorhabdus cylindricus, Polypodorhabdus escaigi, Vekshinella stradneri, Stephanolithion bigoti*, and *Hexapodorhabdus cuvillieri*. According to Meed (1971) and Rood and Barnard (1972), *S. bigoti* is probably confined to Callovian and Oxfordian strata of England and northern France. The above assemblage is assigned to the *Vekshinella stradneri* Zone of Barnard and Hay (1974). Lack of coccoliths in the lowermost Kimmeridgian of northern Europe, however, leaves open the possibility that this zone may extend as high as lower Kimmeridgian in other areas.

Cores 8 and 13 contain fewer and less diagnostic forms than Cores 5 to 7; no Liassic assemblages were obtained.

In general, the Jurassic assemblages seem about as diverse as those of England. The English Jurassic assemblages are less diverse than those of France (Meed, 1971) and are considered boreal in nature.

Diatoms

No diatoms were observed in the recovered core material from Hole 330.

Samples 330A-1-1, 25-27 cm and 330A-1-1, 77-78 cm contain a mixed assemblage of diatoms ranging in age from Eocene to Recent. Included in this assemblage are: *Thalassiothrix* spp., *Thalassionema nitzschioides, Nitzschia kerguelensis, Coscinodiscus lentiginosus, Actinocyclus ingens, Coscinodiscus elliptopora, Denticula lauta, Denticula antarctica, Charcotia actinochilus,* *Hemidiscus karstenii, Coscinodiscus endoi, Pyxilla prolongata, Hemiaulus polymorphus, Stephanopyxis superba*, and *Rocella gemma*.

Samples 330A-1-1, 126-128 cm through 330A-1-2, 140-142 cm contain Eocene diatoms with no admixture of Neogene forms. Among the diatoms observed in this interval are: *Pyxilla prolongata, Hemialus polymorphus, Pterotheca carinifera, Pterotheca aculeifera, Stephanopyxis superba, Cyclostella hannae, Triceratium unguiculatum, Brightwellia pulchra*, and *Goniothecium odontella*.

Admixture of Eocene-Recent diatoms in the first 80 cm of Section 1 may be due to the slurring of sediment in the core upon recovery. If this is the case, the distinct possibility exists of a hiatus at about the 80-cm level in this core. This hiatus would then correspond to a lithology change at about the 80-cm level from diatom-rich silty clay to clay diatom ooze. Diatoms are common to abundant and moderately to well preserved through the core.

Radiolaria

Few Radiolaria were found in the sediments recovered at this site. Their preservation is in general poor and diversity is low. Only in Cores 1 and 2 of Hole 330 and in Core 1 in Hole 330A were well-preserved Radiolaria found. The assemblage from 330-2, CC is well preserved and has a considerable diversity. About 10 genera could be recognized, and the presence of *Cyrtocapsa grutterinki* and *Excentrophylomma cenomana* indicates a late Albian to early Cenomanian age for this sample. A very similar assemblage was observed in a sample from Core 3, Section 1 in the same hole. Below this level the sediment is barren of Radiolaria until Core 10. The core-catcher sample from this core contains a large number of pyritized Radiolaria. Because the pyrite crystals have obliterated most of the diagnostic features, no species identification could be made and even determination of genera became difficult. Below this level the Radiolaria gradually disappear again. The last two specimens were found in Core 12, Section 4.

The core catcher from Core 330A-1 yielded a mixed fauna of late Eocene to Pleistocene in age. The contamination is undoubtedly caused by the very disturbed nature of this core. Other samples from this core also contain mixed assemblages with faunas representative of the late Paleocene to Pleistocene.

Two pyritized specimens of Radiolaria were found in the sediments from the Jurassic interval. Unfortunately their poor preservation does not allow species identification.

Palynomorphs

Rich and very well preserved assemblages of spores, pollen, dinoflagellate cysts, acritarchs, and tasmanitids (Prasinophyceae, algae) are present from Core 3 through to Core 15.

Cores 4 and 5 are of early Aptian or Neocomian age. Core 3 contains *Belodinium* sp. aff. *B. dysculum, Muderongia simplex, Gonyaulacysta* spp., and abundant *Tsugaepollenites* spp. and *Classopollis* sp. The presence of *Nannoceratopsis* cf. *N. pellucida* and *Endoscrinium luridum* in Core 4 indicates reworking of Oxfordian-Kimmeridgian sediments. Assemblages in Cores 5 to 15 are dominated by spores and pollen and the frequency of marine components progressively decreases downhole. Dinoflagellate cysts in Cores 5 to 7 suggest an early Kimmeridgian or Oxfordian age.

Sapropelic sediments of Cores 8 to 10 contain abundant large tasmanitids and very few dinoflagellate cysts. In the remaining cores *Tsugaepollenites* spp. (particularly *T. trilobatus*) dominates the assemblages. These sediments are difficult to date precisely but there is no evidence that they are older than Oxfordian.

Miscellaneous Fossils

Several miscellaneous groups of fossil organisms were encountered in the sediments recovered at Site 330. These fossils have proved valuable in corroborating age determinations based on calcareous nannofossils and in the reconstruction of paleoenvironments.

Scolecodonts

No annelid worm jaw elements (scolecodonts) were encountered in Hole 330.

Cephalopod Arm Hooks (Onychites)

Microscopic structures identified as cephalopod arm hooks were extracted in samples prepared for scolecodonts. One species has been identified as *Paraglycerites necans*, an Upper Jurassic marine form of the family Glyceridae.

Belemnoids

Abundant belemnoides (dibranchiate cephalopods) were encountered throughout the Jurassic portion of the hole. Several near-perfect specimens were recovered as well as many broken fragments. The genus *Hibolites* has been tentatively identified; this genus is characteristic of the Upper Jurassic.

Amminoids

Several fragments of an ammonite were recovered from Core 11. Preservation was good with nacre and intact siphuncle preserved.

Bivalves

Several well-preserved mytilacean bivalves were encountered in Core Catcher 6 as well as many broken fragments of shells scattered throughout the cores. Pelecypods of this suborder are known to inhabit marine environments ranging from the high-water mark to a few hundred fathoms.

As at Site 327, *Inoceramus* fragments and prisms were common in many portions of the Mesozoic section.

Corals

Several poorly preserved objects believed to be corals were cored in a limestone lamina recovered in Core Catcher 13. These animals are known to live today generally in warm waters of depths to 100 fathoms.

CORRELATION BETWEEN REFLECTION PROFILES AND LITHOLOGY

As in the cases of the other sites occupied during Leg 36, no independent check was obtained on the validity of the compressional wave velocities measured on samples cored at Site 330. Likely weather-controlled time limitations prevented any preliminary survey over and above a straightforward approach to the site, and the weather itself was too bad when the site was abandoned to make a sonobuoy station worth attempting. Acoustic basement was cored, in contrast with other sites, but was obviously so rough as to preclude the use of an exact identification on the reflection profiles as a velocity check. Thus, measured velocities are again plotted unmodified in Figure 6, and no allowance for systematic errors is made in fitting an approximate model velocity-depth function. Velocities higher than 2.4 km/sec are plotted down the depth axis in Figure 6, to conserve space.

Since the intention was to core the deeper part of the Falkland Plateau section, where it was more accessible than at Site 327, the first core was not taken until 129 meters, and the uppermost velocity measurement was made on a sample from 130 meters. Although an "A" hole, drilled to sample this upper section, yielded no measurable sample because of a chunk of basement rock lodged beneath the core barrel, microfossil ages on such samples as were obtained are used here by analogy with Site 327 stratigraphy to infer the upper part of the velocity-depth model. We assume an upper 5 meters of gravel and glacial dropstones (Site 327) above 15 meters of late Eocene silty clay (330A-1). The Albian to Cenomanian clay found at 34 meters is assumed to continue down from 20 meters to the depth at which measurements become available; a velocity gradient similar to that obtained at Site 327 is introduced, to represent compaction and, at the base of the unit, an admixture of thin beds of micrite, porcellanite, pyrite, etc. Velocities within this Unit (Unit 2 of Site 330, Cores 1 and 2) are less than they are within the stratigraphic equivalent (Unit 7) at Site 327. The underlying 120 meters contains only two cores, so that the velocity-depth model must again be constructed with the aid of that at Site 327. An abrupt increase in velocity in the upper part of Unit 8 (Site 327) is caused both by a greater degree of induration of the major lithology (shale to claystone) and a significant (up to 7%) admixture of thin limestones and cherts of much higher velocity. The velocity inversion below this high-velocity layer results from both the virtual disappearance of the thin high-velocity beds, and a change in the major lithology to a semi-indurated sapropelic shale. At Site 330, Cores 3 and 4 are of the same age as the upper and lower parts of Unit 8 of Site 327, and lithologically are roughly similar (a thin limestone does occur in Core 4). A high-velocity layer similar to that of Unit 8 of 327 has therefore been introduced; its confinement between Cores 2 and 4 requires it to be thinner here than at Site 327, and it has been given a slightly lower velocity in accord with the comparison made above of the upper parts of both holes.

Below Core 4, sampling is more frequent. The velocities of the major lithologies of both Unit 3 (sapropelic claystone) and Unit 4 (interbedded sands, silts, and clays) are low and the proportion of thin high-velocity limestones is again never more than 7% of a particular cored interval. The velocity model is biased high to take account of the limestones, and makes some allowance for induration down the hole. The basal sandstones and siltstones of Units 5 and 6 are thin at Site 330, but appear to have a significantly higher velocity than those above. Granitic gneiss at 550 meters forms the acoustic basement.

The *Glomar Challenger* profile in Figure 4 passes close to Site 327 and reflectors are found at the point of closest approach which are probably identical with those detected on the RC 16-06 profile considered in the account of that site. This is a particularly valuable property in view of the uncertainties in the velocity-depth model at Site 330. In particular, reflectors occupying the upper 0.23 sec TW at Site 327 are confined here to the uppermost 0.11 sec, the lowest reflector within this sequence again occurring in the thick Albian and younger clays of Unit 2 (Unit 7 at Site 327) but, as there, impossible to identify with any lithologic change. Reflectors coincident at Site 327 with the top and base of the high-velocity Aptian claystone occur here at 0.22 sec and 0.31 sec TW, respectively, equivalent to 176 and 270 meters. The upper reflector thus lies directly above Core 330-2, whereas the top of the equivalent Unit 3 is considered to lie below Core 330-2. This discrepancy of at least 5 meters (3%) could result from uncertainties in the upper part of the velocity-depth model at Site 330 or could indicate that, at Site 327 also, the upper part of Unit 8 lies above the Aptian-Albian boundary. Either possibility can be accommodated within the uncertainties of the method. The upper boundary of the high-velocity layer is here taken as 184 meters and the lower as 270 meters. As expected, the apparent Oxfordian to Aptian hiatus, at 0.325 to 0.35 sec TW does not give rise to a reflector on the *Glomar Challenger* profile. Since this could be a result of a lack of profiler output power, and since the base of the record lies at only 0.45 sec TW, above the base of the hole, a section of the RC 16-06 profile has been added in Figure 7 to complete the comparison. This profile also shows the reflector at 0.11 sec TW, despite interference from the sea-bed reflection. The record is obscured at 0.22 sec TW, but a strong primary reflection at 0.31 sec TW can be seen. This last partly obscures the record between 0.325 and 0.35 sec TW, but no very strong reflector is present. The next major reflection occurs at about 0.60 sec TW, the depth (540 m) of the basal sands. A distinctive basement reflection is not seen on the record until about 0.2 sec later, but the presence of basement at lesser depth can (with hindsight!) be inferred from the downward curvature in places of the reflections from the (presumed planar) basal sandstone. The reflection profile suggests therefore that the site was located at an isolated basement high.

SUMMARY AND CONCLUSIONS

Site 330 is located at the western end of the elongate rise which forms the eastern extremity of the Falkland Plateau. The site lies downslope from Sites 329 and 327, in 2626 meters of water at 50°55.19'S, 46°53.00'W. It was occupied from 0542Z 6 May 1974 to 2214Z 8 May 1974 while two holes were drilled.

The first hole penetrated 575.5 meters of which 161.5 meters were cored and 85 meters (53%) recovered. It bottomed in gneissose and granitic basement. The second hole (330A) penetrated only 53 meters, of which 47.5 meters were cored with a recovery of only 4 meters (8%). This hole was abandoned because the coring process was inhibited by the presence of granitic basement rock from Hole 330 in or just above the drill bit. Microfossils in the muddy water contained in the core, and in mud adhering to the drill bit, indicate that sediments of Cenomanian-late Albian age were penetrated.

In the first hole, the bottom-hole assembly was buried before coring commenced at 129 meters. Thereafter, intermittent coring (1 in 5) was undertaken to 300 meters, where three consecutive cores were recovered. Intermittent coring (1 in 3) was continued from 328.5 meters to 547 meters where continuous coring was resumed through the basement contact. Coring in Hole 330A was continuous.

The objectives at the site were to elucidate the pre-Aptian history of the Falkland Plateau and to obtain a biostratigraphic section older than that recovered at Sites 327 and 329 nearby. As in the case of these earlier sites, the objectives bear directly on the separation of Africa, South America, and Antarctica and on paleocirculation within the Southern Ocean.

Seven lithologic units are distinguished in the section recovered from Holes 330 and 330A. The uppermost unit consists of diatomaceous silty clay and diatom ooze. Only 4 meters were cored within this unit between 5.5 and 15 meters subbottom, but it is taken arbitrarily to continue to 34 meters where calcareous sediment of Unit 2 was obtained. Unit 1 contains Eocene and Recent diatoms and ranges in composition from 50% to 60% clay and 30% silt (quartz and feldspar) to 50% to 60% diatoms and 25% to 30% clay. It is underlain by approximately 166 meters of Albian-Cenomanian zeolite-rich nanno clay, the upper part of which was recovered only as a suspension in the core barrel liner and in traces on the drill bit from Hole 330A. Unit 3 is approximately 225 meters thick, extending from 200 to 425 meters subbottom, and consists of sapropelic claystone with thin subordinate limestone and porcellanite layers. The claystone, which has a fetid smell, contains 55%-85% clay, sapropel, pyrite, and traces of zeolite. The limestone layers are micritic. Nannofossils are present in both clay and limestone down to approximately 350 meters subbottom (Core 8). *Inoceramus* fragments, onychites, belemnites, and thin-walled pelecypods are also present. The claystone is very finely laminated and signs of bioturbation are generally absent. The sediments of Unit 3 recovered are predominantly Oxfordian and Aptian. Intermediate ages could be represented in a coring gap of between 281 meters and 300 meters (Cores 4, 5), but a drastic reduction in sedimentation rate, possibly nondeposition, or even erosion, must be invoked to explain the biostratigraphic evidence. However, there was very little change in the conditions of sedimentation before and after the possible hiatus, and the strong acoustic reflector originally considered to coincide with it is now thought to represent the velocity inversion occurring higher in Unit 3 between Cores 3 and 4.

Unit 4, the section beneath the sapropelic claystone, is made up of approximately 115 meters of interbedded silty clay and clayey silt with layers of sandstone and limestone. It extends from 425 meters to 540 meters subbottom and appears to have been deposited entirely during the Oxfordian. Compared with the overlying claystone, Unit 4 contains more terrigenous detritus and terrestrial palynomorphs, and carbonized wood rather than sapropel. The fetid smell of Unit 3 is absent. Thin bedding reflecting textural variations is common in Unit 4, as are signs of bioturbation. Unit 5 is a subarkosic sandstone layer of which only 20 cm was recovered, but which could be much thicker. It contains no distinctive microfauna or microflora, is well-sorted and friable, consisting of 90% quartz along with K-feldspar, rock fragments, garnet, tourmaline, and zircon. The unit is thought to be a beach sand reflecting a basal marine transgression, because the underlying Unit 6 is composed of terrestrial deposits. Most of Unit 6, which is 3 meters thick and extends from 547 to 550 meters subbottom, consists of sandy siltstone and silty sandstone. These sediments are formed primarily of poorly sorted, angular to subangular quartz and feldspar, and are arranged in a sequence of crudely graded beds. The occurrence of lignite interbeds and the oxidized nature of these sediments indicate fluvial deposits, perhaps deposited in a paralic environment.

At 550 meters subbottom Unit 6 unconformably overlies a gneissose and granitic continental basement of which 19.5 meters was cored. The basement consists of quartz-rich metasedimentary gneiss of semipelitic composition, concordant pegmatites, coarse-grained unfoliated K-feldspar-rich granite pegmatite, thin mafic veins, and a microdiorite intrusion chilled against the granite pegmatite. The gneissose foliation dips at up to 30°. The top of the basement has been altered to form calcrete and this is overlain by a thin "soil" profile as indicated particularly by the texture and clay mineralogy. It is uncertain whether the calcrete represents the base of the soil profile, or whether it formed by a different process at an earlier time.

The nature of the basement rocks clearly indicates that they once formed part of an extensive igneous and metamorphic complex. Regional considerations indicate that the gneissose rocks are likely Precambrian because the Paleozoic sedimentary rocks of the Falkland Islands and of southern Africa, although deformed during the early Mesozoic Gondwanian orogeny, are mostly unmetamorphosed. These general considerations are supported by the isotope geochemistry of the gneisses which indicate that they are indeed Precambrian but that they underwent thermal metamorphism on at least two occasions during the Paleozoic (Beckinsale et al., this volume).

The following history is inferred for the basement rocks:

1) Deposition of original sediments ranging in composition from shale to arkosic sandstone. This probably took place during the Precambrian but subsequent to the Archaean.

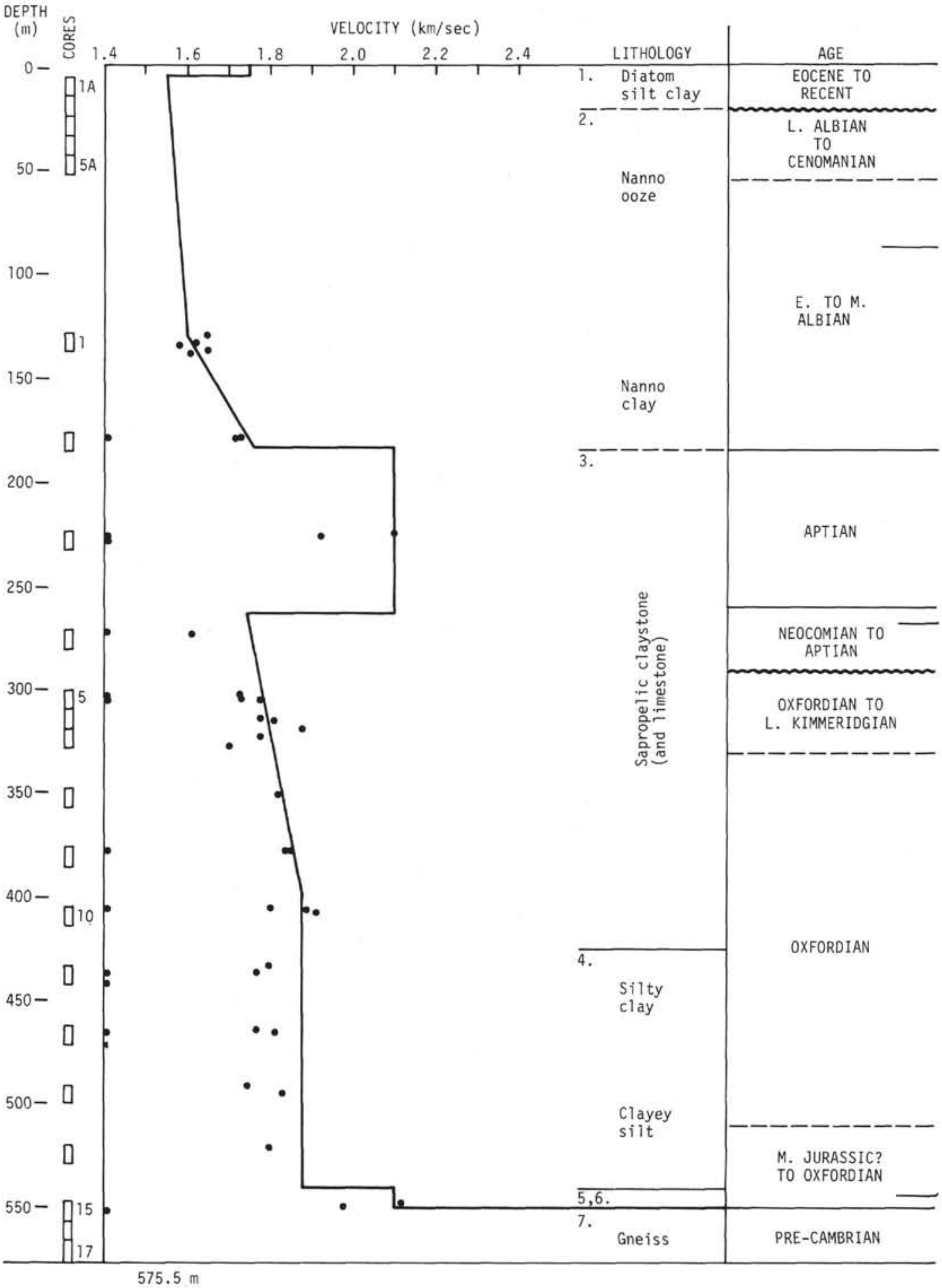


Figure 6. *Correlation between* Robert D. Conrad *1606 reflection profile and lithology recovered at Site 330.*

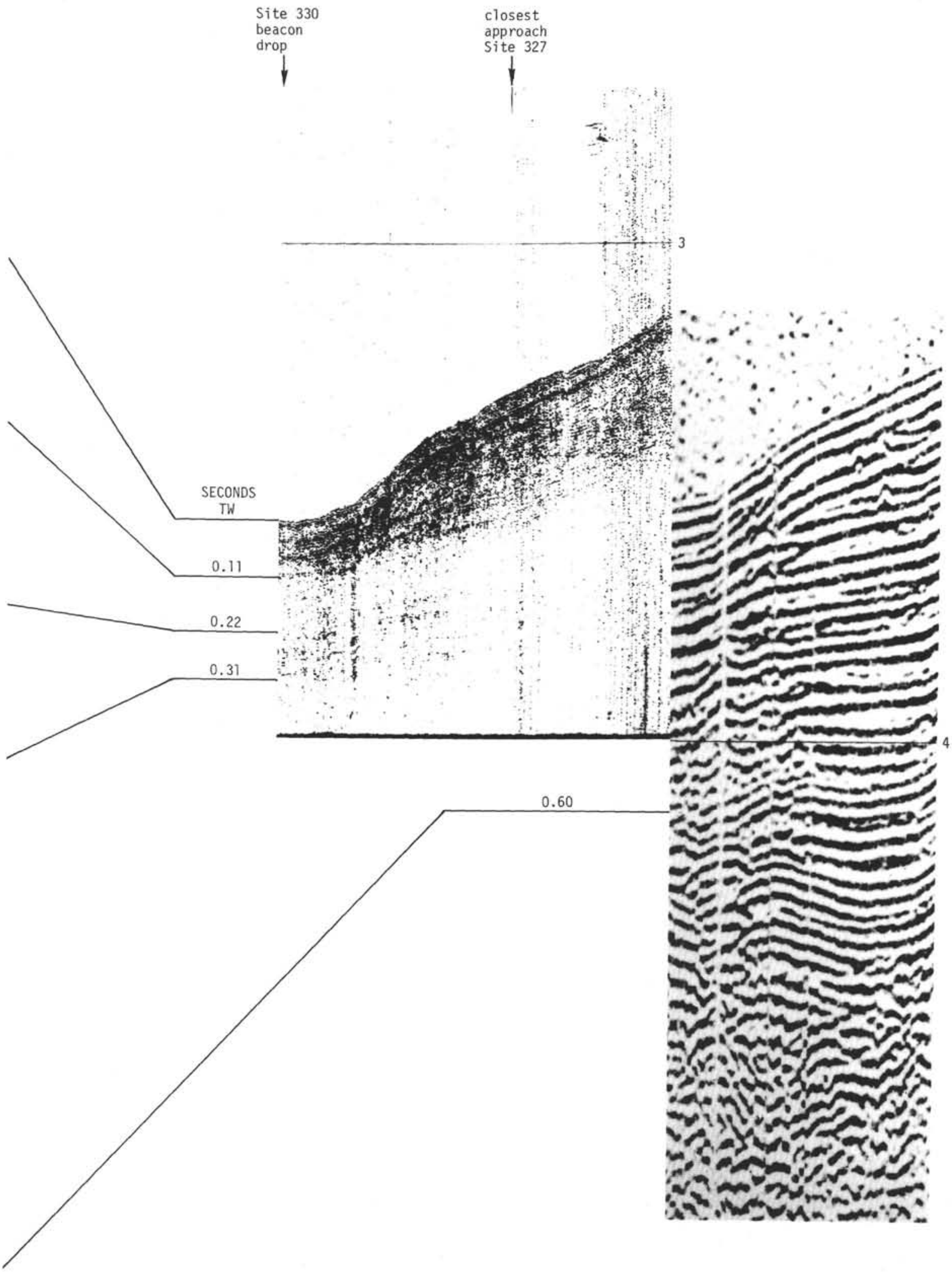


Figure 6. *(Continued).*

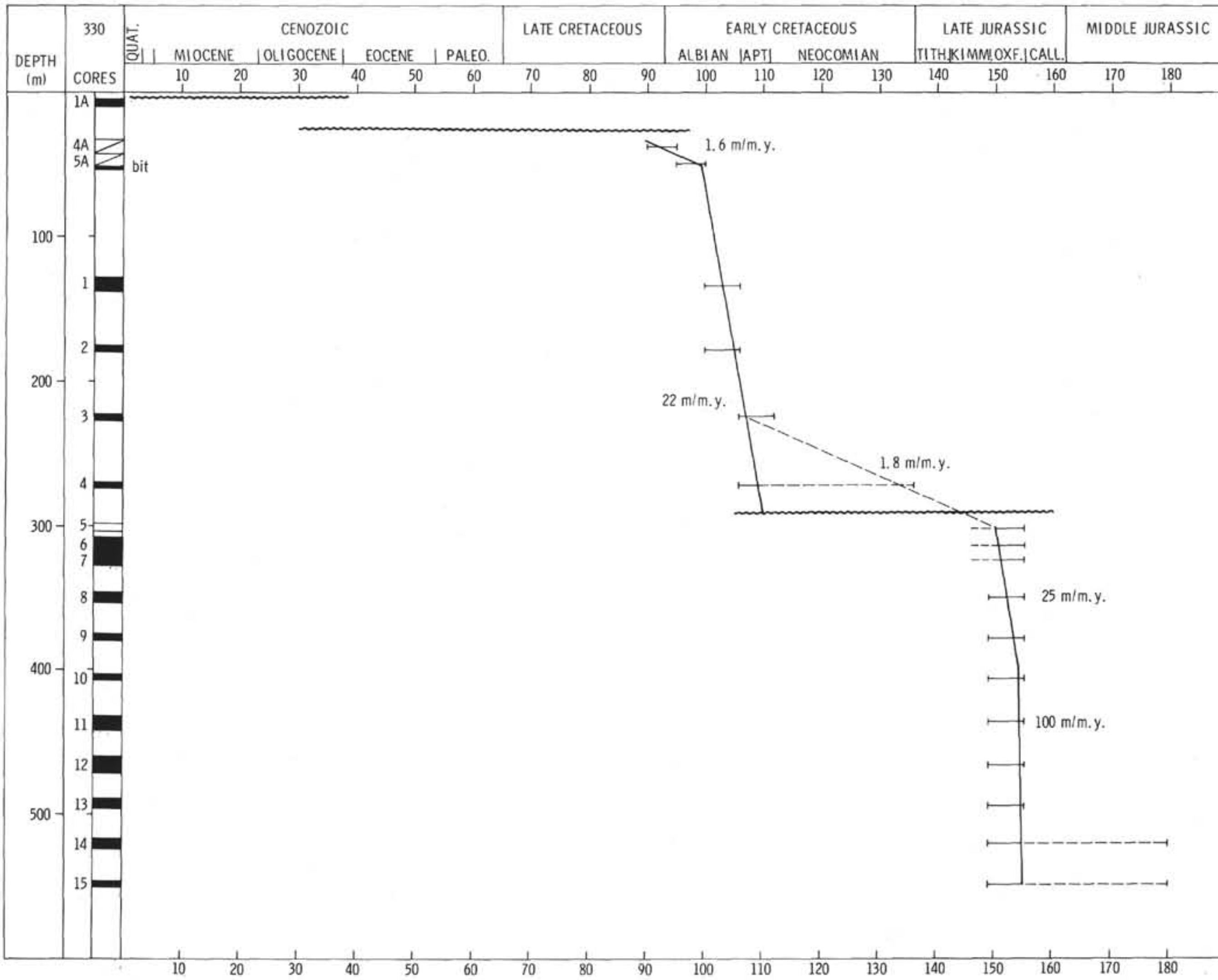


Figure 7. *Sedimentation rates at Site 330.*

2) Upper amphibolite facies metamorphism and formation of early pegmatites; broadly coeval deformation including development of main gneissose foliation. These events were probably Precambrian also.

3) Retrogressive metamorphism including replacement of red biotite by green biotite and chlorite, and replacement of garnet by chlorite. This event may be recorded by the Rb-Sr isochron of 535 ±66 m.y.

4) Emplacement of undeformed coarse-grained granite-pegmatite. This may be recorded by the K-Ar age of 399 ±10 m.y. obtained from the gneiss itself.

5) Intrusion of thin mafic veins.

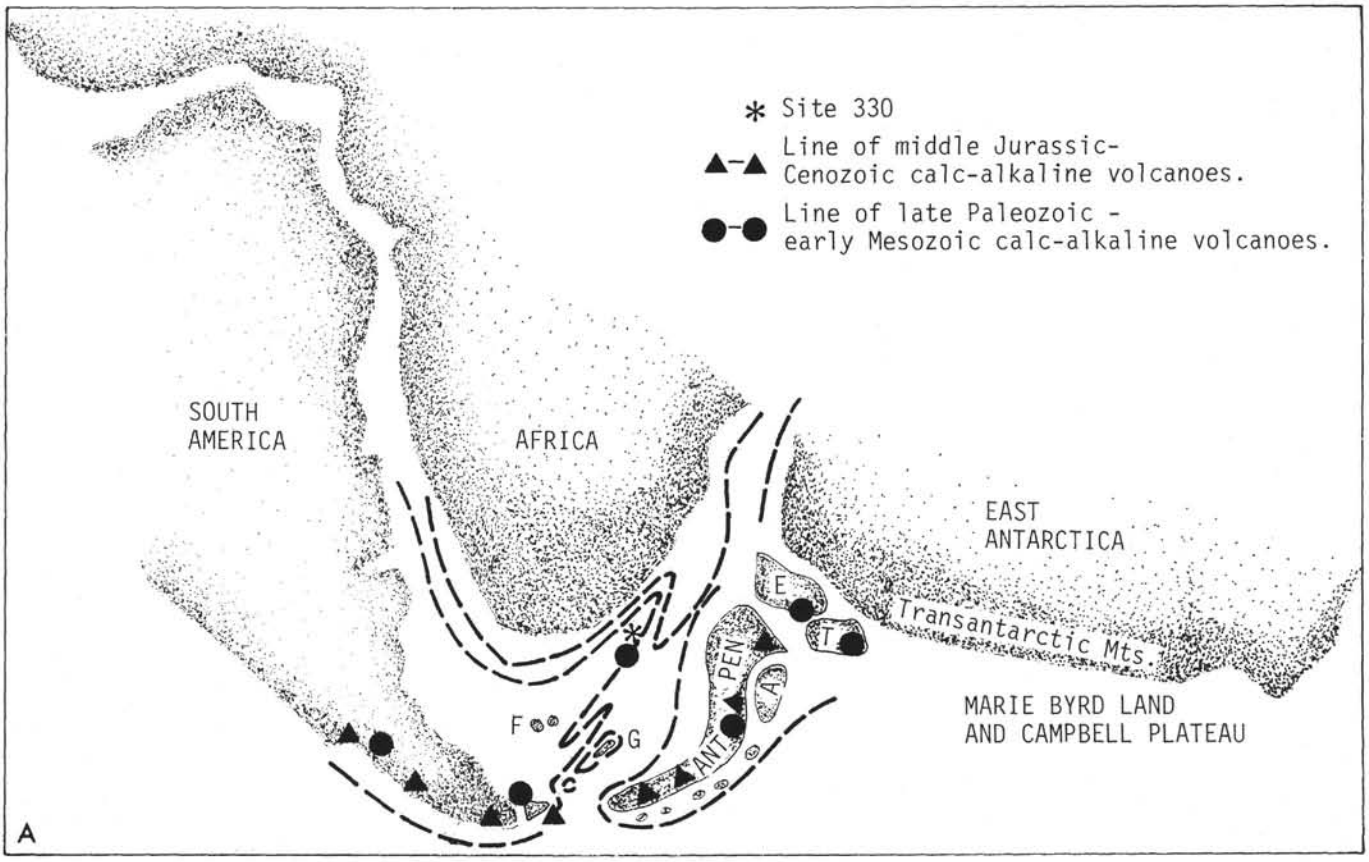
6) Intrusion of fine-grained microsyenite. It is believed that the K-Ar age of approximately 290 m.y. obtained from the granite-pegmatite could reflect this event.

7) Uplift and erosion.

8) Calcrete formation.

Penetration of metasedimentary gneiss of Precambrian age, and of granitic rocks, beneath the Mesozoic sedimentary cover of the Falkland Plateau at Site 330 proves conclusively the continental nature of the eastern extremity of the plateau. This is an important result because it allows a more precise reconstruction of the Africa-South America portion of Gondwanaland in the vicinity of the Falkland Plateau, the Agulhas Bank, and the Mozambique Plateau (Figure 8). The entire Falkland Plateau was widely presumed to be continental prior to the drilling of this site, on the basis of its bathymetric relation to South America, the continental rocks forming the Falkland Islands, and seismic refraction data. However, the depth of the eastern part of the plateau had precluded its being included in reconstructions such as that of Bullard et al. (1965).

Pre-Mesozoic rocks comparable to those recovered at Site 330 occur at Cape Meredith on West Falkland, near the Cape of Good Hope, and along the southeastern coast of Africa (Figure 8). Published ages are not available for the rocks of the Cape Meredith complex. However, K-Ar data indicate that it is in excess of 1000 m.y. old. The basement rocks near Durban, South Africa, have comparable ages and hence the



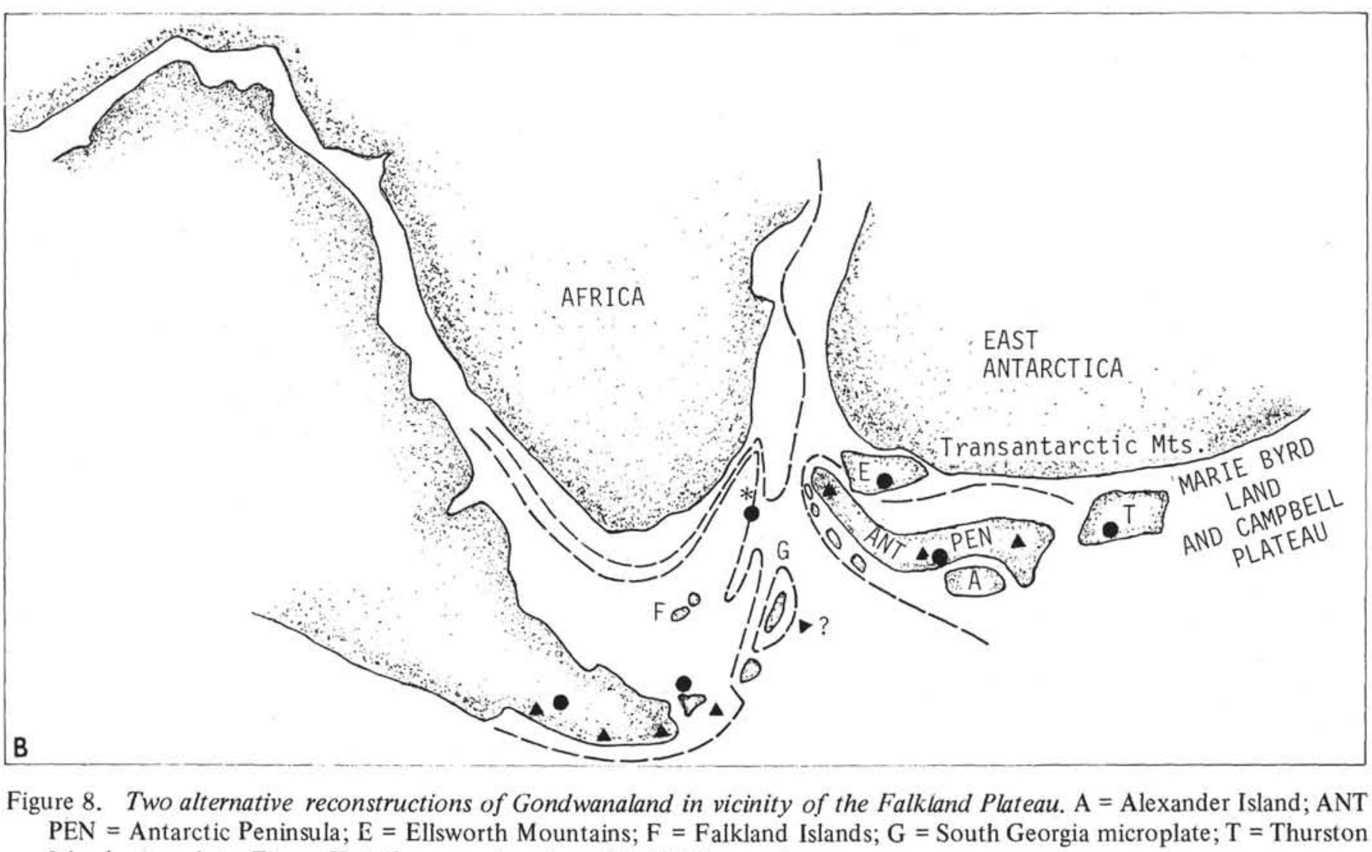


Figure 8. *Two alternative reconstructions of Gondwanaland in vicinity of the Falkland Plateau.* A = Alexander Island; ANT PEN = Antarctic Peninsula; E = Ellsworth Mountains; F = Falkland Islands; G = South Georgia microplate; T = Thurston Island microplate; *Figure 8b is the reconstruction of de Wit (in press).*

Precambrian age of the basement of the eastern Falkland Plateau indicated by the geochemical data is in keeping with its predrift geologic setting. The 535 m.y. date of the Rb-Sr isochron on the basement gneiss is close to ages obtained from the granitic intrusions near the Cape of Good Hope and suggests reheating of the gneiss at this time. The youngest K-Ar age obtained, 290 m.y., is close to the time when calc-alkaline detritus started to be deposited in the Cape and Karroo sequences of southern Africa (Elliot and Watts, 1974). Further reheating of the basement gneiss by intrusion may have occurred at this time. Deformation of the Cape Basin sediments occurred in the late Paleozoic-early Mesozoic. The resultant fold belt extends into South America and Antarctica (Figure 8) and was called the Gondwanide fold belt by Du Toit (1937). The general trend of the Gondwanide fold axes and axial planes in South Africa is south of east. Hence the intermontane basins that resulted from the folding extend onto the African continental margin, and from the predrift reconstruction of Africa and South America would be expected to have their continuation on the Falkland Plateau.

The top 30-40 cm of the basement rock has the appearance of a calcareous sandstone with angular quartz grains. It is separated from the overlying sedimentary deposits by a thin interval of clayey sand with no obvious sedimentary structure. The gneissose foliation of aligned biotite flakes continues up to the sand and the "calcareous sandstone" is clearly weathered basement gneiss. The weight percentage of $CaCO_3$ rises to 40% immediately below the basement surface and falls off gradually to about 10% and less 30-40 cm downward. Calcite veins are ubiquitous, plagioclase and much of the K-feldspar are replaced by calcite which has also grown along grain boundaries. The basement gneiss therefore weathered to a calcrete before deposition of the overlying Jurassic sediments. While calcrete formation occurs under widely varying environmental conditions, it appears to be favored by a Mediterranean-type climate, i.e., hot without excessive precipitation.

However, the presence of kaolinite as the dominant clay in the overlying sediments implies fairly thorough leaching, which is characteristic of more substantial rainfall than calcrete formation. One possible explanation of this apparent anomaly is that a time gap separates calcrete formation and the development of a kaolinite-bearing soil profile. As the early Mesozoic Gondwanian orogeny resulted in significant basement uplift and subsequent erosion, it is conceivable that development of the soil profile is related to the environmental conditions prevailing during the Jurassic marine transgression.

The subsequent history of the eastern end of the Falkland Plateau is one of mid-Late Jurassic (probably Oxfordian) marine transgression, a period of restricted circulation extending to the end of the Aptian, establishment of open marine conditions by the early Albian, and subsidence of Site 330 to its present depth during the Late Cretaceous and Paleogene.

The probable Upper Jurassic sandstone, sandy siltstone, and lignite (Unit 6) that overlie the calcreted basement surface represent the products of paralic fluviatile deposition in a swampy coastal plain environment. The mineralogy and textural immaturity of the clastic sediments imply derivation from local basement highs, in this case possibly the elevated eastern end of the Falkland Plateau. The east-southeast-trending basins of southern Africa, which extend onto the continental margin and hence probably onto the Falkland Plateau, developed during the early Mesozoic Gondwanide deformation and have a comparable history of basin infilling (Dingle, 1973).

The overlying clean and well-sorted sandstone (90% quartz) is the product of the first marine incursion across the coastal plain and resulted in reworking in a high energy, and gradually deepening, environment to form a strand. The clayey silt, limestone, and clayey sandstone beds on top of the pure sandstone reflect shelf conditions with significant terrigenous sediment supply and local shoals, possibly with coral reefs. Reflection profiles (Figure 2) show the site to be situated on the northern margin of a marine basin 1.5 km deep at the time of the marine transgression. Clearly the site was on a subsiding portion of the margin of the South American-African part of Gondwanaland and was becoming more remote from sediment supplies.

A gradual restriction of circulation in the Late Jurassic followed the marine incursion. This situation lasted from at least the Oxfordian until the end of the Aptian with sediments apparently being derived from an Africa-South American land mass. No single accurate estimate of sedimentation rate is possible for the Upper Jurassic. A minimum average rate for the Oxfordian is 50 m/m.y. However, the absence of any positively dated sediment younger than Oxfordian-earliest Kimmeridgian and older than Aptian-Neocomian? indicates at least very slow deposition. Coring was not continuous, but the lack of an obvious lithologic change in this interval (Cores 4, 5) suggests that the absence of sediment of intervening age does result from slow deposition rather than an erosional hiatus. Although sedimentation rate curves indicate rather rapid average sedimentation rates for the Oxfordian, it seems likely that Unit 4 was deposited more rapidly than the average and the Oxfordian sapropelic clay of the lower part of Unit 3 more slowly. At any rate the occurrence of restricted circulation conditions on the southern side of the eastern Falkland Plateau in the Oxfordian-Aptian interval following the initial marine transgression signifies that the basin to the south of Site 330 was not exposed to an open ocean environment. Probably, parts of the Andean-West Antarctic Cordillera intervened between the plateau and the ancestral Pacific Ocean, and the other new intra-Gondwanaland ocean basins developed no earlier than did the South Atlantic.

A marked change in the environment of the eastern Falkland Plateau occurred after the Aptian. There is an increase in the proportion of planktonic microfossils, particularly nannofossils, with respect to clay (which became predominantly montmorillonite). The sapropelic material is no longer present, and the remains of *Inoceramus* and other pelecypods are common, as are signs of bioturbation. Hence open ocean conditions seem to have become established in the early Albian. This is approximately the time at which a seaway of oceanic depth could have developed in the South Atlantic between the Falkland Plateau and Africa according to magnetic anomaly data (Francheteau and Le Pichon, 1973; Larson and Ladd, 1973). Shelf communication between southern Africa and South America until about this time is indicated by similarity of Neocomian marine pelecypods in the succession exposed near Port Elizabeth in South Africa with forms of equivalent age in southern South America (Uhlig, 1911; Rayment and Tait, 1972).

Moderately resistant coccoliths were mostly etched during the Cenomanian. A similar event seen at Site 327 is thought to result from CCD movement rather than exceptionally rapid tectonic subsidence of the Falkland Plateau. There is no other evidence for tectonic subsidence of this type, and it seems unlikely (see Site 327). Reflection profiles suggest that an erosion surface truncates these sediments and that the overlying deposits containing Eocene siliceous microfossils may possibly represent redeposition of sediments of that age eroded from upslope by strong Neogene current action.

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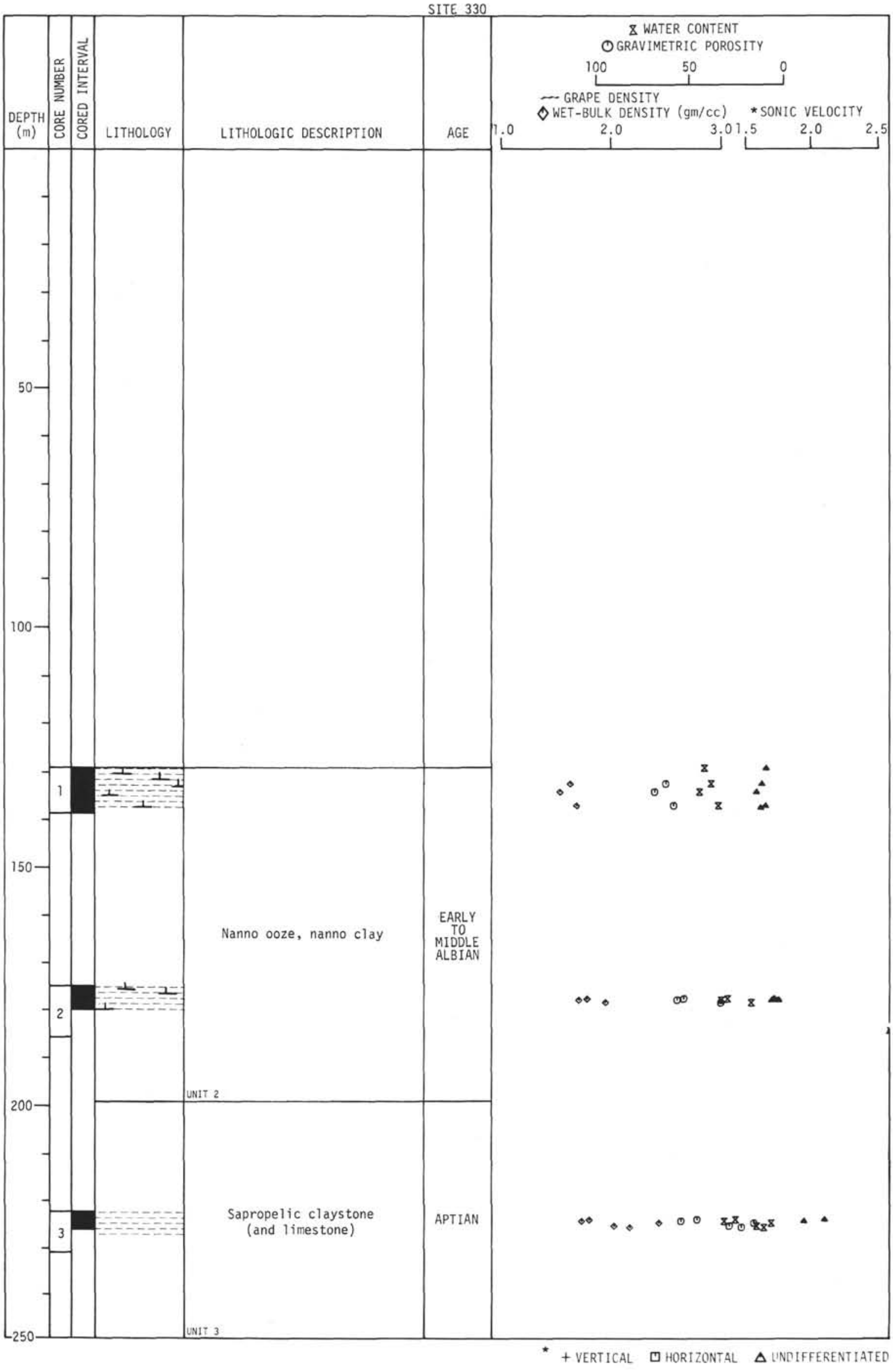
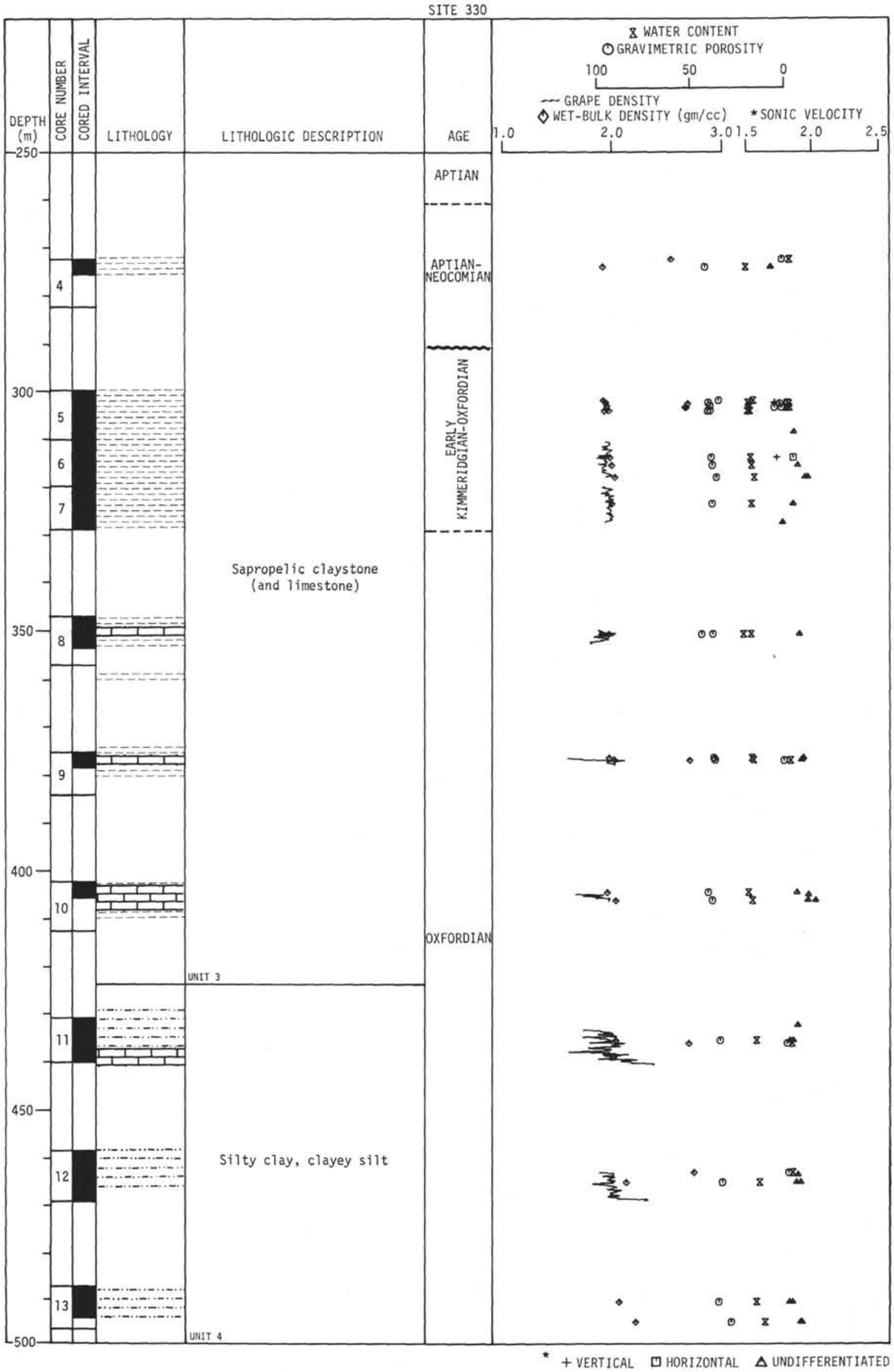
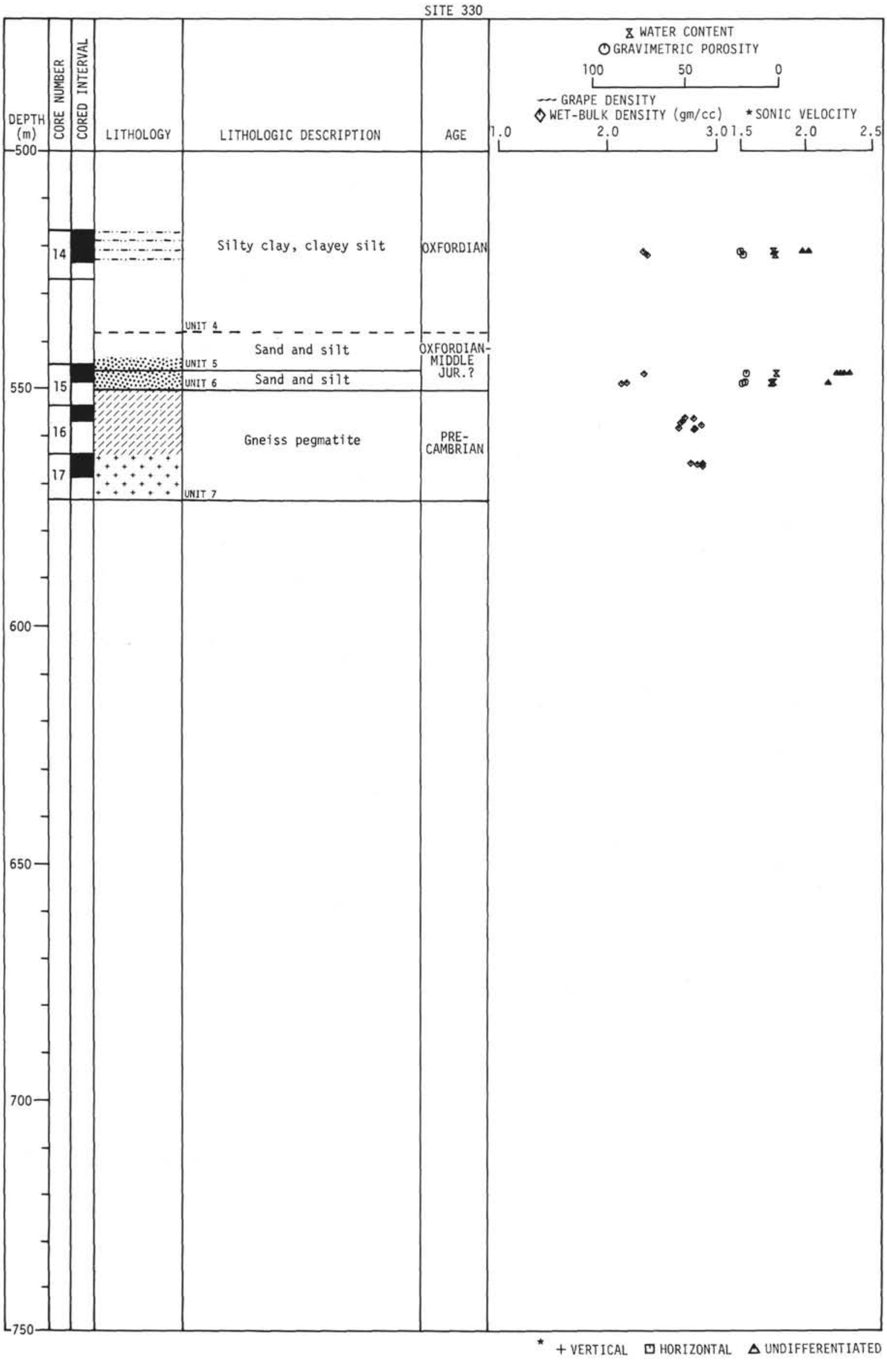
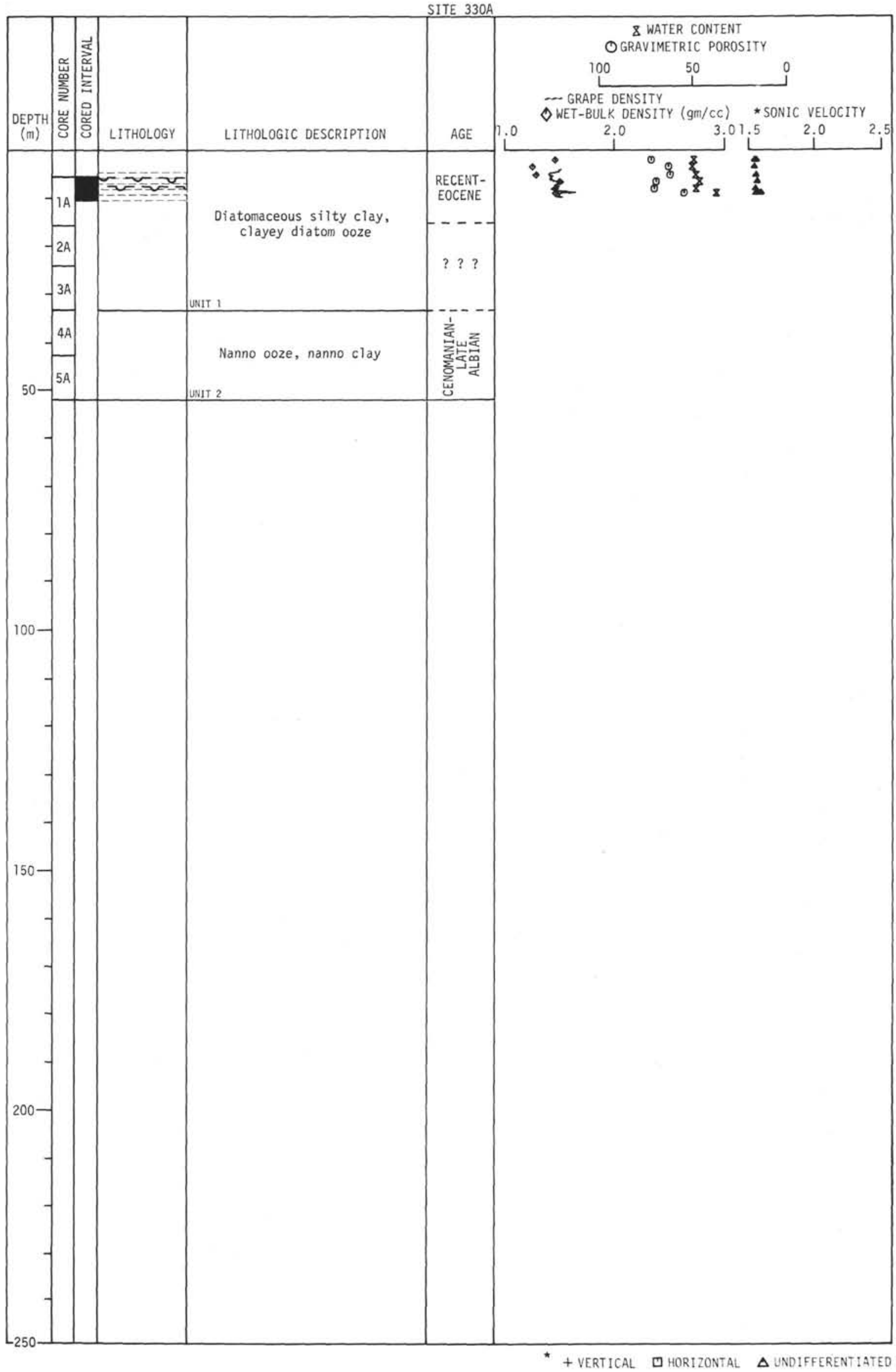

SITE 330
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
WATER CONTENT
GRAVIMETRIC POROSITY
100 50 0
GRAPE DENSITY
WET-BULK DENSITY (gm/cc)
1.0 2.0 3.0
SONIC VELOCITY
1.5 2.0 2.5
50
100
150
200
250
1
2
3
Nanno ooze, nanno clay
EARLY TO MIDDLE ALBIAN
UNIT 2
Sapropelic claystone (and limestone)
APTIAN
UNIT 3
+ VERTICAL
HORIZONTAL
UNDIFFERENTIATED

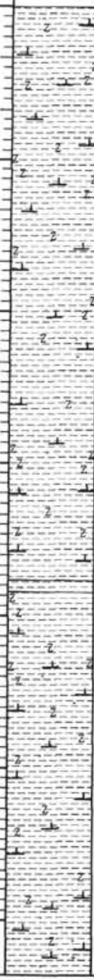

SITE 330
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
WATER CONTENT
GRAVIMETRIC POROSITY
100 50 0
GRAPE DENSITY
WET-BULK DENSITY (gm/cc)
1.0 2.0 3.0
*SONIC VELOCITY
1.5 2.0 2.5
250
300
350
400
450
500
APTIAN
APTIAN-NEOCOMIAN
EARLY KIMMERIDGIAN-OXFORDIAN
OXFORDIAN
Sapropelic claystone (and limestone)
UNIT 3
Silty clay, clayey silt
UNIT 4
4
5
6
7
8
9
10
11
12
13
* + VERTICAL
HORIZONTAL
UNDIFFERENTIATED


SITE 330
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
WATER CONTENT
GRAVIMETRIC POROSITY
100
50
0
GRAPE DENSITY
WET-BULK DENSITY (gm/cc)
SONIC VELOCITY
1.0
2.0
3.0
1.5
2.0
2.5
500
550
600
650
700
750
14
15
16
17
Silty clay, clayey silt
OXFORDIAN
UNIT 4
Sand and silt
UNIT 5
OXFORDIAN-MIDDLE JUR.?
UNIT 6
Sand and silt
Gneiss pegmatite
PRE-CAMBRIAN
UNIT 7
+ VERTICAL
HORIZONTAL
UNDIFFERENTIATED


SITE 330A
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
WATER CONTENT
GRAVIMETRIC POROSITY
100
50
0
GRAPE DENSITY
WET-BULK DENSITY (gm/cc)
SONIC VELOCITY
1.0
2.0
3.0
1.5
2.0
2.5
1A
2A
3A
4A
5A
Diatomaceous silty clay, clayey diatom ooze
UNIT 1
Nanno ooze, nanno clay
UNIT 2
RECENT-EOCENE
? ? ?
CENOMANIAN-LATE ALBIAN
50
100
150
200
250
* + VERTICAL
HORIZONTAL
UNDIFFERENTIATED

Site 330 Hole Core 1 Cored Interval: 129.0-138.5 m

AGE	ZONE: NANNOS	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
EARLY-MIDDLE ALBIAN	Prediscosphaera cretacea				0				
					1	0.5, 1.0			90
					2				
					3				90
					4				122
					5				22, 35
					6				
		F N	C A	G M	Core Catcher				



LITHOLOGIC DESCRIPTION

banded:
5YR 6/4
5YR 8/1

shells

variegated:
5YR 5/6
5YR 6/4
5YR 8/1

shells

banded:
5YR 6/4
5YR 8/1
5B 9/1
5GY 6/1

shells

ZEOLITE RICH NANNO CLAY
Mainly light brown and pinkish gray in bands of 10-20 cm; parts are variegated. Contains minor amounts of micrite, forams and diatoms. Fragments of thin shelled pelecypod and Inoceramus occur throughout. Moderate to intense bioturbation in Sections 3, 4, and 5.

Characteristic smear slide

	1-90	4-122	CC
clay	54	98	50
nannos	20	TR	25
zeol.	15	TR	15
micrite	10	-	10
qtz.	-	2	TR
opaque	1	-	TR
forams	TR	-	-
diatoms	TR	TR	-

Carbon-carbonate

	4-60	4-120
t. carb	5.5	2.3
o. carb	0.1	0.1
$CaCO_3$	45.0	19.0

Bulk X-ray

	4-125
amor.	31.0
calc.	2.6
quar.	1.6
K-Fe.	9.3
plag.	4.4
mica	2.0
mont.	78.8
clin.	1.2

Site 330 Hole Core 2 Cored Interval: 176.5-186.0 m

AGE	ZONE: NANNOS RADS	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
EARLY-MIDDLE ALBIAN	Prediscosphaera cretacea RK5-RK5				0				
					1	0.5, 1.0	VOID		144
					2		VOID		41, 115
		R N	F A	M M	Core Catcher				

LITHOLOGIC DESCRIPTION

banded:
10YR 7/4
5YR 6/4
N7

pyrite nodule

5GY 6/1

NANNO CLAY
Greenish gray wiht occasional bands of grayish orange and light brown. Inoceramus and other pelecypod fragments occur throughout. Forams and pyrite (occasionally in large nodules) occur in trace quantities. Entire core shows moderate bioturbation including Zoophygus at 2-90. Very firm.

Core catcher includes fragments of:
1) NANNO CLAYSTONE (as above)
2) LIMESTONE (olive gray [5Y 4/1])
3) PORCELLANITE (olive gray [5Y 4/1])

Characteristic smear slide

	2-115
clay	55
nannos	30
zeol.	15
pyrite	TR
forams	TR
micrite	TR
qtz.	TR

Carbon-carbonate

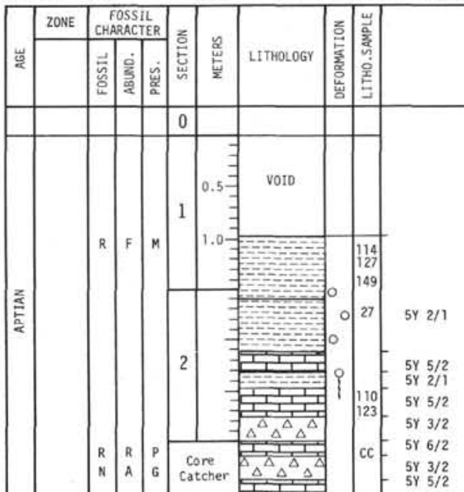
	2-108
t. carb	5.0
o. carb	0.1
$CaCO_3$	41.0

Bulk X-ray

	2-105	CC
amor.	36.7	12.5
calc.	65.6	-
quar.	5.4	2.3
cris.	-	80.3
K-Fe.	-	2.1
plag.	-	1.4
mica	5.2	1.6
mont.	6.9	1.4
trid.	-	10.4
clin.	16.9	0.3
pyri.	-	0.2

Explanatory notes in Chapter 1

Site 330 Hole Core 3 Cored Interval: 224.0-233.5 m



SAPROPELIC CLAY (CLAYSTONE)
PORCELLANITE (minor lith)
MICRITIC LIMESTONE (minor lith)
Clay is mainly olive black; contains zeolite, nannos and pyrite and yields fetid odor when cut. Porcellanite and limestone occur interbedded in 10-20 cm intervals. Limestones are light olive gray and contain varying amounts of zeolite, sapropel and nannos.
Section 1 (130 to 150) glauconitic porcellanite
Section 2 (95 to 110) Braarudosphaera limestone

Smear slide

	1-149	2-27
clay	88	64
zeol.	2	15
sapropel	TR	10
nannos	-	5
auth. si.	5	5
pyrite	TR	1
glauc.	5	1

Thin section

	2-115	2-145	CC
spar.	30	-	-
micrite	62	32	5
auth. si.	-	60	83
sapropel	7	5	10
pyrite	1	3	2
nannos	-	TR	TR

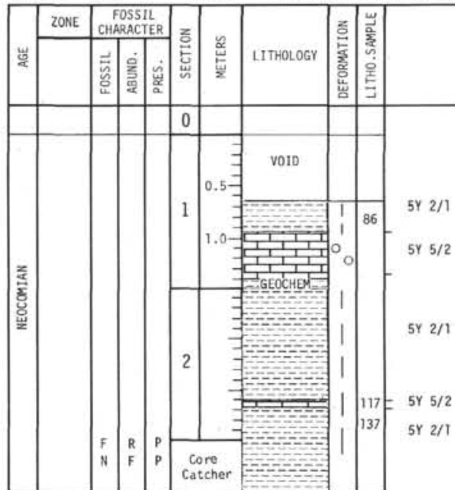
Carbon-carbonate

	2-40
t. carb	5.8
o. carb	5.8
$CaCO_3$	-

Bulk X-ray

	1-148	2-68	2-135	2-141	CC
amor.	29.9	15.2	-	-	18.0
calc.	-	99.4	17.5	-	91.0
quar.	5.8	0.6	7.8	27.5	1.1
cris.	74.4	-	59.5	56.1	-
mica	6.9	-	1.4	1.8	-
mont.	2.4	-	1.3	-	3.1
trid.	9.4	-	11.4	14.0	-
clin.	0.6	-	-	-	2.1
pyri.	0.4	-	1.1	0.7	2.6

Site 330 Hole Core 4 Cored Interval: 271.5-281.0 m



SAPROPELIC CLAY (CLAYSTONE)
Olive gray to olive black with thin interbeds of light olive gray Limestone. Clays contain nannos, zeolite (clinoptilolite?) and pyrite; vague very fine lamination. Limestone dominantly micrite-microspar; about 15% allochems (probably rads) now replaced by sparry calcite. Both lithologies yield petroliferous odor when cut. Section 2-115 belemnite rostrum.

Characteristic smear slide

	1-86	2-137
clay	60	68
sapropel	10	5
zeol.	5	20
nannos	10	1
qtz.	8	-
pyrite	7	5

Carbon-carbonate

	1-82
t. carb	5.3
o. carb	5.3
$CaCO_3$	TR

Thin section

	2-115
micrite	45
microspar	40
spar	10
sapropel	5
pyrite	TR
qtz.	TR
feld.	TR

Bulk X-ray

	1-113
amor.	16.9
calc.	93.9
quar.	2.9
mont.	3.2

Explanatory notes in Chapter 1

Site 330 Hole Core 5 Cored Interval: 300.0-308.5 m

AGE	ZONE (NANNOS)	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
OXFORDIAN-KIMMERIDGIAN	Stephanolithion bigotti	N	F	G	0, 1, 2, 3, Core Catcher	0.5, 1.0	VOID; GEOCHEM		137, 26, 106, 138, 84, 93

LITHOLOGIC DESCRIPTION

5Y 4/1

5Y 2/1

5Y 4/1

Scolecodonts in CC

SAPROPELIC CLAY (CLAYSTONE)
Olive black with thin interbeds of olive gray sparry Limestone. Clay beds show vague lamination, belemnite rostra and partially pyritized pelecypod shells. Limestones are laminated and at Section 1, 120 to 130 show internal "load(?)" deformation.

Smear slide

	2-26
clay	84
sapropel	5
pyrite	8
nannos	3
plant remains	TR

Thin section

	1-120	3-85
spar.	90	60
clay	8	30
sapropel	2	8
pyrite	TR	2
nannos	TR	TR

Carbon-carbonate

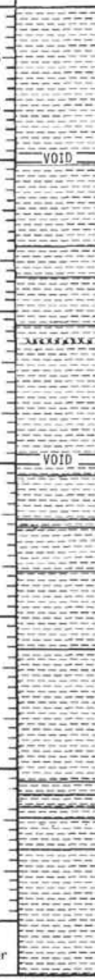
	2-109	3-109
t. carb	3.5	4.9
o. carb	2.9	2.8
$CaCO_3$	5.0	17.0

Bulk X-ray

	2-80
amor.	48.2
calc.	4.1
quar.	26.4
K-Fe.	10.7
plag.	5.3
kaol.	1.6
mica	28.1
chlo.	1.9
mont.	12.5
pyri.	8.4
amph.	1.0

Site 330 Hole Core 6 Cored Interval: 309.5-319.0 m

AGE	ZONE (NANNOS)	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
OXFORDIAN-KIMMERIDGIAN	Stephanolithion bigotti				0, 1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0	VOID; VOID		100, 115, 64, 100



LITHOLOGIC DESCRIPTION

5B 5/1

pyrite

5Y 2/1 with laminations of 5B 5/1

5B 5/1

Scolecodonts (Paraglycentes) in CC

SAPROPELIC CLAY (CLAYSTONE)
Olive black with thin (1-5 cm) layers of bluish gray clay. Black clays contain thin shelled pelecypod, Inoceramus, and belemnite rostra throughout, but especially in Sections 1-3. Occasional carbonized wood fragments. Vague lamination throughout. Bluish-gray clay layers consist principally of montmorillonite. Commonly these have sharp bases and moderately bioturbated tops.

Characteristic smear slide

	1-100	6-100
clay	72	83
zeol.	16	10
sapropel	4	2
nannos	3	2
qtz. & feld.	4	2
pyrite	1	1

Carbon-carbonate

	1-80	2-80	3-80
t. carb	3.6	3.4	4.6
o. carb	2.9	2.8	3.1
$CaCO_3$	6.0	5.0	12.0

	4-80	5-80	6-80
t. carb	4.2	4.5	4.6
o. carb	3.5	3.7	4.4
$CaCO_3$	6.0	6.0	2.0

Bulk X-ray

	4-61 (blue gray)	4-66 (black)
amor.	25.3	55.0
calc.	-	4.4
quar.	3.6	31.4
K-Fe.	3.9	8.0
plag.	2.7	6.4
kaol.	-	0.9
mica	9.2	29.6
chlo.	-	2.3
mont.	79.4	16.9
pyri.	1.1	-

Explanatory notes in Chapter 1

Site 330 Hole Core 7 Cored Interval: 319.0-328.5 m

AGE	ZONE: NANNOS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
OXFORDIAN-KIMMENIDGIAN	Stephanolithion bigotti				0					
					1	0.5, 1.0	VOID		101	
					2					5B 5/1 lamination
					3				40, 41	shell rich; 5Y 2/1
					4				37, 39	shell rich
					5					shell rich
					6					
		N	A	G	Core Catcher					Scolecodonts in CC

SAPROPELIC CLAY (CLAYSTONE)
Olive black with occasional thin laminations of bluish gray clay. Thin shelled pelecypod remains, *Inoceramus* prisms and belemnite rostra occur throughout but are especially common in zones indicated as shell rich.

Sections 1 and 2 - vague lamination on mm scale.

Sections 3 to 6 - regular lamination at 1 to 3 cm scale which reflect variations in nanno content. Slight bioturbation in shelly layers.

large pelecypod casts.

Characteristic smear slide

	1-101	3-40	3-41
clay	55	72	73
zeol.	15	20	20
nannos	15	1	TR
sapropel	10	5	5
pyrite	5	2	2
auth. Si.	-	TR	-

Grain size

	3-100	6-20
sand	0.6	4.6
silt	30.0	28.8
clay	69.4	66.5

Carbon-carbonate

	1-100	3-100	4-100	5-100	6-100
t. carb	4.0	3.9	4.0	4.2	4.1
o. carb	3.6	3.3	3.2	3.0	2.8
$CaCO_3$	4.0	5.0	7.0	10.0	11.0

pelecypod shell rich zones

Site 330 Hole Core 8 Cored Interval: 347.5-357 m

AGE	ZONE: NANNOS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
OXFORDIAN-KIMMENIDGIAN	Stephanolithion bigotti				0					
					1	0.5, 1.0	VOID		101	5Y 2/1
					2				68, 140	5Y 4/1; 5Y 2/1; 5Y 4/1
					3		GEOCHEM			5Y 2/1; 5Y 4/1; vein calcite
LATE JURASSIC					4				103	5Y 2/1; laminae of 5B 5/1
		N	C	G	Core Catcher					

SAPROPELIC CLAY (CLAYSTONE)
MICROSPAR LIMESTONE (minor lith)
Olive black nanno-rich claystone with interspersed 5-10 cm beds of microspar limestone. Occasional laminae of bluish gray clay. Claystones contain fragments of pelecypods (including *Inoceramus*) and belemnite rostra. Vague lamination throughout.

Limestones dominantly microspar with sparry allochems probably representing replaced radiolaria. Parts laminated. parts burrow mottled.

Smear slide

	1-101 (black)	2-68 (blue gray)
clay	62	99
nannos	20	-
zeol.	10	-
sapropel	5	-
pyrite	3	TR
auth. Si.	-	1

Thin section

	2-50	2-59	2-140
spar.	10	20	5
microspar	40	57	50
micrite	40	15	39
sapropel	7	7	1
pyrite	3	1	5

Grain size

	1-122
sand	0.2
silt	33.9
clay	65.9

Carbon-carbonate

	1-101	2-101	3-75
t. carb	4.3	3.9	5.5
o. carb	2.9	3.0	3.6
$CaCO_3$	11.0	7.0	15.0

Site 330 Hole Core 9 Cored Interval: 376.0-385.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LATE JURASSIC					0					
					1	0.5, 1.0	VOID		97, 127	5Y 2/1; 5Y 4/1
					2				114	5Y 2/1; 5Y 4/1; 5Y 2/1; nodules of 10YR 5/4
		N	R	M	Core Catcher					

SAPROPELIC CLAY (CLAYSTONE)
MICROSPAR LIMESTONE (minor lith)
Principally olive black claystone with interbeds (5-10 cm) of olive gray micrite-microspar limestone. Contains thin shelled pelecypod fragments, sapropel and carbonized plant remains. Bluish gray clay laminae at 1-101 and 2-145. Yellowish brown siliceous "clay" nodules at 2-110 to 120. Scolecodonts in core catcher.

Smear slide

	1-97	CC
clay	87	78
zeol.	10	15
siderite	2	-
nannos	1	TR
pyrite	-	4
sapropel	TR	2
plant frags.	TR	1

Carbon-carbonate

	1-114	2-80
t. carb	3.4	2.8
o. carb	3.0	2.8
$CaCO_3$	4.0	0.0

Explanatory notes in Chapter 1

Site 330 Hole Core 10 Cored Interval: 404.5-414.0 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE		LITHOLOGIC DESCRIPTION
LATE JURASSIC		R F N	R A R	P P M	0, 1, 2, Core Catcher	0.5, 1.0	VOID		75, 127	5Y 4/1, 5Y 2/1	

SAPROPELIC CLAY (CLAYSTONE)
SIDERITIC LIMESTONE (minor lith)
Claystone is olive black.
Contains rare thin pelecypod shells and carbonized plant remains. Vague lamination throughout. Thin bluish gray clay lamina at 2-140.

Limestone is olive gray to dark yellowish brown and consists principally of sand-sized siderite rhombs and clay. Vague lamination and "load" deformation structure visible.

Smear slide

	2-127
clay	75
zeol.	15
qtz.	3
sapropel	1
pyrite	1

Thin section

	1-75
siderite	50
clay	45
sapropel	3
plant frags.	1
pyrite	1
nannos	TR

Grain size

	1-138
sand	0.3
silt	21.8
clay	77.9

Carbon-carbonate

	1-99	2-66
t. carb	2.9	1.9
o. carb	3.9	1.9
$CaCO_3$	0.0	0.0

Site 330 Hole Core 11 Cored Interval: 433.0-442.5 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE		LITHOLOGIC DESCRIPTION
LATE JURASSIC		R F N	R R B	P P –	0, 1, 2, 3, 4, 5, 6, Core Catcher	0.5, 1.0	VOID		TS 140, 65, 92, 79, 141, 94, 116, TS 148, TS CC	10YR 2/2, N7 to N8, 5Y 3/2, 5G 4/1 mottled with 10YR 4/2, 5Y 3/2, 5Y 4/1, 5Y 3/2, 5Y 4/1, 5Y 3/2	

SILTY CLAY-CLAYEY SILT
SPARRY LIMESTONE (minor lith)
SILTY SANDSTONE (minor lith)
Core is dominantly dusky yellowish brown to olive gray silty clay and clayey silt with interbedded olive gray limestone and dark greenish gray silty sandstone. The silt consists principally of quartz and feldspar with fine to coarse carbonized plant remains, a few thin-shelled pelecypod fragments and traces of glauconite. Generally well laminated on a 1-2 mm scale.

Limestone principally recrystallized to sparry calcite or siderite and contains abundant terrigenous fraction.

Sandstone is very fine, calcareous and contains abundant carbonized plant fragments and pyrite.

Characteristic smear slide

	2-65	3-92	4-79	5-94	6-116
qtz. & feld.	65	70	70	58	78
rock frags.	-	-	-	10	-
clay	33	25	29	10	20
calcite	-	-	-	15	-
pyrite	3	2	1	4	1
plant remains	TR	1	TR	1	1
glauc.	-	TR	-	2	-

Thin section

	1-140	5-88	CC
siderite	45	-	-
spar	-	38	73
micrite	10	-	-
clay	43	10	-
detrital sand & silt	TR	50	20
pyrite	TR	1	5
plant remains	2	1	2

Grain size

	2-19	4-60	5-100
sand	TR	18.9	7.8
silt	36.0	24.3	49.9
clay	64.0	56.7	42.3

Carbon-carbonate

	2-100	4-100
t. carb	1.9	1.6
o. carb	1.9	1.6
$CaCO_3$	0.0	0.0

Explanatory notes in Chapter 1

Site 330 Hole Core 12 Cored Interval: 461.7-471.0 m

AGE | ZONE | FOSSIL CHARACTER (FOSSIL, ABUND., PRES.) | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION

AGE: LATE JURASSIC

FOSSIL	ABUND.	PRES.	SECTION
			0
			1
			2
			3
F	R	P	4
R	R	P	
			5
			6
N	B	—	Core Catcher

METERS: 0.5, 1.0

LITHO.SAMPLE: 53, 120, 29, 18, 80, 100, 145, TS

10YR 2/2 to 5Y 2/1

5Y 4/1

alternating 5Y 3/2 5Y 4/1

interlaminated N4 5Y 3/2

alternating 5Y 3/2 5Y 4/1

5Y 4/1 with veins of 10R 2/2

SILTY CLAY
SAND-SILT-CLAY (minor lith)
LIMESTONE (minor lith)
Principally olive gray silty clay with occasional interbeds of sand-silt-clay and olive gray microspar limestone. Silt is predominantly quartz and K-feldspar. Carbonized plant remains common throughout; belemnite rostra and thin pelecypod fragments occur sporadically. Textural variations (sand:silt:clay) yield bedding at 10-30 cm scale; lamination (mm scale) is superimposed in finer beds. Bioturbation common in coarse silt and sand-silt-clay beds.

Grain size

	2-54	3-99	4-99	5-119	6-98
sand	0.4	21.3	2.4	1.8	10.8
silt	33.7	43.4	42.0	46.0	43.7
clay	65.8	35.3	55.5	52.2	45.5

Carbon-carbonate

	2-10	4-10	6-10
t. carb	1.2	1.2	1.3
o. carb	1.2	1.2	1.2
$CaCO_3$	0.0	0.0	1.0

Bulk X-ray

	5-18	6-15
amor.	57.9	50.3
quar.	30.7	38.2
K-Fe.	11.1	11.5
plag.	2.7	5.4
kaol.	-	11.2
mica	31.3	17.6
chlo.	13.3	3.5
mont.	9.3	8.9
pyri.	1.6	3.7

Thin section

	6-145
microspar	50
micrite	20
detrital sand & silt	15
spar	11
plant frags.	3
pyrite	1

Site 330 Hole Core 13 Cored Interval: 490.0-499.5 m

AGE | ZONE | FOSSIL CHARACTER (FOSSIL, ABUND., PRES.) | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO.SAMPLE | LITHOLOGIC DESCRIPTION

AGE: LATE JURASSIC

FOSSIL	ABUND.	PRES.	SECTION
			0
N	R	M	1
N	R	M	2
			3
			4
F	F	P	Core Catcher
N	B	—	

METERS: 0.5, 1.0

LITHO.SAMPLE: 79, 110, 36, 103, TS, CC

5Y 4/1 to 5Y 2/1

5Y 4/1 to N4

5Y 4/1

CLAYEY SILT
SAND-SILT-CLAY (minor lith)
SANDY LIMESTONE (minor lith)
Predominantly olive black clayey silt with interbeds of olive gray sand-silt-clay and occasional beds of sandy microspar limestone. Silt is predominantly quartz and feldspar with common carbonized plant remains and pyrite. A few pelecypod shells near base. Textural variations (sand:silt:clay) yield bedding at 10-60 cm scale with superimposed lamination at mm scale.

Smear slide

	1-99	2-116	4-36	4-103
qtz. & feld.	59	70	42	46
clay	30	10	30	52
rock frags.	2	10	20	1
pyrite	3	2	3	3
plant frags.	3	2	4	3
nannos	-	1	-	-

Grain size

	1-90	2-120	3-90	4-73
sand	4.0	14.8	22.5	33.6
silt	51.1	44.5	38.3	40.6
clay	44.8	40.7	39.2	25.8

Carbon-carbonate

	1-80	1-86	3-80	3-86	4-70
t. carb	1.3	1.3	0.9	0.9	1.0
o. carb	1.3	1.2	0.8	0.8	0.8
$CaCO_3$	1.0	1.0	0.0	1.0	1.0

Bulk X-ray

	4-135
amor.	36.7
qtz.	39.5
K-Fe.	19.6
plag.	6.7
kaol.	16.0
mica	12.8
chlo.	3.5
pyri.	1.9

sandy limestone (microsparite)
allochems include:
echinoid spines
coral(?)
pelecypod

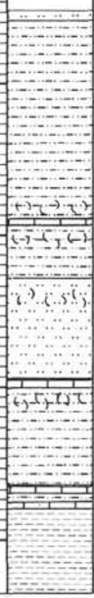
Thin section

	CC
microspar	55
allochems	25
detrital sand	20
pyrite	TR
plant frags.	TR

Explanatory notes in Chapter 1

Site 330 Hole Core 14 Cored Interval: 518.5-528.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
MIDDLE-LATE JURASSIC					0				
					1	0.5, 1.0	VOID		112
					2				95, 136 TS
					3				148
					4				73, 117, 118 TS
		F	C	P	Core Catcher				



LITHOLOGIC DESCRIPTION

CLAYEY SILT
SILT (minor lith)
LIMESTONE (minor lith)
CLAY (minor lith)

Predominantly olive gray clayey silt with thin (5-10 cm) interbeds of light olive gray limestone and yellowish brown silt. One bed of yellowish brown 'lignitic' claystone at base. Silts are predominantly quartz and feldspar; pyrite and carbonized plant remains occur throughout shell rich layers at 2-110, 3-60, 4-10. Clayey silts vary from well laminated (1-2 cm scale) to highly bioturbated.

5Y 4/1 to 5Y 3/2

10YR 2/2

5Y 4/1 occasional layers 5YR 2/2

10YR 2/2

Characteristic smear slide

	1-112	2-95	4-73	CC
qtz. & feld.	45	50	38	15
clay	25	19	56	65
plant frags.	27	30	3	14
pyrite	3	1	2	5

Thin section

	4-118
spar	87
clay	10
pyrite	2
plant	1
detrital sand & silt	TR

Grain size

	1-92	2-1
sand	4.0	6.1
silt	82.0	69.9
clay	14.0	23.9

Carbon-carbonate

	2-81	4-118	4-130
t. carb	1.2	8.2	1.6
o. carb	1.0	0.4	1.7
$CaCO_3$	2.0	65.0	0.0

Bulk X-ray

	4-120
amor.	48.8
quar.	31.5
K-Fe.	8.1
plag.	3.7
kaol.	20.7
mica	21.2
chlo.	4.1
mont.	3.8
pyri.	7.1

() shell rich

Site 330 Hole Core 15 Cored Interval: 547.0-556.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE
MIDDLE-LATE JURASSIC					0				
					1	0.5, 1.0			10, 60
					2				44, 64, 94
		N	B	—	Core Catcher				

LITHOLOGIC DESCRIPTION

5Y 4/1 — Sandstone, olive gray, medium, well sorted, friable.

5YR 3/4, 5Y 4/1 — Sandstone, moderate brown, silty, fine-medium (range to granule) poorly sorted. Fragments of lignite and wood.

gradational contact

10YR 4/2 — Siltstone, olive gray, sl. sandy, very fine. Clasts of wood, lignite, and terrigenous granules, very angular.

irregular contact — Sandstone, yellowish brown, silty, fine-med. (range to granule), poorly sorted, angular, with lignite clasts and pyrite. Rip-up structure in Section 2 (10-20).

5GY 6/1, 5YR 2/2 — Claystone, greenish gray, with chalcedonic quartz, pyrite, fine plant remains.

10YR 4/2 — Lignite, dusky brown.

Clayey siltstone, dark yellowish brown, with abundant plant frags., lignite and pyrite.

5Y 4/1 to 5B 9/1 — Sand-silt-clay to clayey silt, yellowish brown to olive gray, lignite fragments.

calcitized granular acid gneiss — Clayey sand olive gray to bluish white, fine-med. (range v. fine→granule) poorly sorted, angular; soft

lignite fragments

Smear slide

	2-94
qtz. & feld.	53
clay	35
plant frags.	20
heavies	1

Grain size

	1-30	1-53	1-97	2-126
sand	62.7	24.9	42.1	48.3
silt	19.8	56.1	40.3	29.3
clay	17.5	19.1	17.6	22.4

Bulk X-ray

	2-44	2-91	2-147
amor.	25.1	49.3	19.1
quar.	2.1	43.3	68.4
K-Fe.	10.2	10.9	-
plag.	0.3	4.9	-
kaol.	22.8	24.1	23.0
mica	4.7	14.3	8.6
chlo.	1.3	-	-
mont.	56.7	2.5	-
pyri.	1.8	-	-

Explanatory notes in Chapter 1

Site 330 Hole Core 16 Cored Interval: 556.5-566.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
					0					
?PRECAMBRIAN-?					1	0.5, 1.0	VOID		G G G G G G	
					2				G G G G G	

N7
5GY 6/1
5GY 4/1 (basic vein)
10R 6/6 (granite vein) "2
5BG 5/2 (basic vein)
5GY 6/1
10YR 7/4 (granite vein) "1
5GY 6/1
10YR 7/4 (granite veins) "1
5GY 5/1 (biotitite)
5Y 4/1
10YR 7/4 (granite vein)
5YR 7/2 (foliat. granite vein) "1
N8 (quartz vein)
10YR 7/4 (granite vein) "2
10YR 7/4 (granite vein) "2
N7
10YR 7/4 (granite vein) "2
5G 6/1

Top 50 cm of gneiss highly calcitized, with up to 40% $CaCO_3$ interstitial matrix. Associated pyrite.
Granular textured quartz-rich gneisses. Only weak foliation and banding. Quartz ~50% remainder green and brown biotite ~10%. Badly clouded plagioclase, orthoclase; garnet part repl. by chlorite; siderite.
Granite veins: (pegm.) K-feld., quartz, plag., biot.
Basic veins: replaced by fine-grained chlorite/smectite cross-cut foliation.
Gneiss: mineralogically similar to above, but more biotite-rich. Alternation of biotite-rich and biotite poor bands produces more well-defined foliation. Garnet more prominent; repl. by chlorite.
Foliated granite vein: ("1) K-feldsp., qtz., garnet, biotite.
Granite veins: ("2) K-feld., quartz, plag., biot.
GNEISS ORNAMENT
Short dashes - granular texture, poor foliation.
Longer dashes - good foliation.
(Dip of foliation relative to core barrel is ~30°.)

Site 330 Hole Core 17 Cored Interval: 566.0-575.5 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
					0					
PRECAMBRIAN?					1	0.5, 1.0	VOID		G G G G G	
					2				G G G	
					3				G G G	
					Core Catcher				G G	

N7
5YR 8/4 (granite vein) "2
5G 6/1
5G 6/1
5GY 6/1
5YR 8/1 (granite vein) "1
5G 6/1
5G 5/1
10YR 7/4 (granite vein) "2
5G 5/1
fault breccia
5GY 6/1
pale red purple garnet clusters at margin of granite peg & gneiss

Gneiss. Texture varies from granular with little foliation, to quite well foliated and banded more biotite-rich gneiss...as indicated. Composition mainly quartz-rich (~50%) but varying proportions of deep red-brown to green biotite, plagioclase, K-feldspar, garnet, etc. from band-to-band. The plagioclase, and K-feldspar tend to be clouded. Centers of plagioclase may show replacement by calcite.
Garnet - 2 generations, an early variety variably replaced by chlorite and a red purple garnet forming larger grains and clear and fresh.
Accessories - tourmaline, apatite, zircon, pyrite.
Much secondary veining by fine-grained sericite (prophyllite?). Also calcite veins, especially near ?fault breccia.

5YR 8/4 GRANITE PEGMATITE ("2)
Coarser grained patches as shown
~20% qtz., 65% K-feldsp., 10% plag., 5% biot.

5YR 8/4 Fine-grained microsyenite with chilled margin against granite and containing small xenoliths of granite.

Site 330 Hole A Core 1 Cored Interval: 5.5-15.0 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
					0					
EOCENE TO RECENT					1	0.5, 1.0	VOID		75, 125	
EOCENE					2					
					3		VOID		50	
					Core Catcher					

DIATOM-RICH SILTY CLAY
Moderate brown.

5YR 3/4

Characteristic smear slide

	1-75
qtz. & feld.	15
clay	55
diatoms	25
rads	3
spic.	2
lignin	7
glauc.	TR
pyrite	TR
silico.	TR

10YR 8/2 and 5YR 3/4

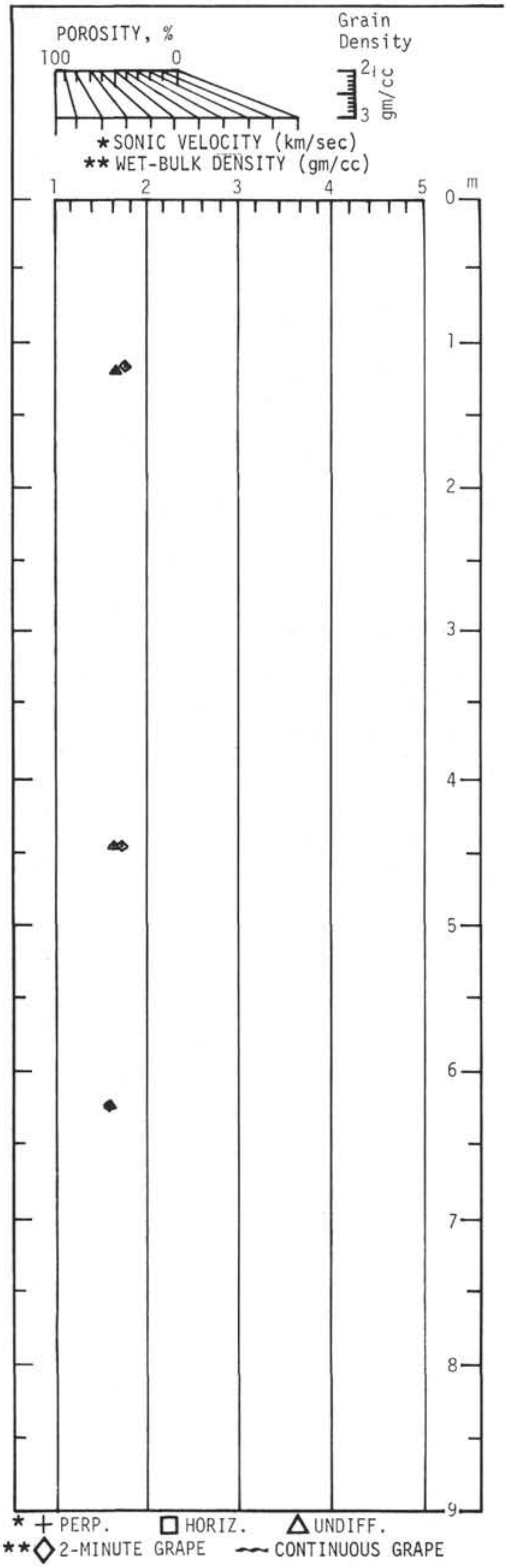
CLAY DIATOM OOZE
Very pale orange, marbled by coring with moderate brown. Scattered 1 cm manganese nodules.

Characteristic smear slide

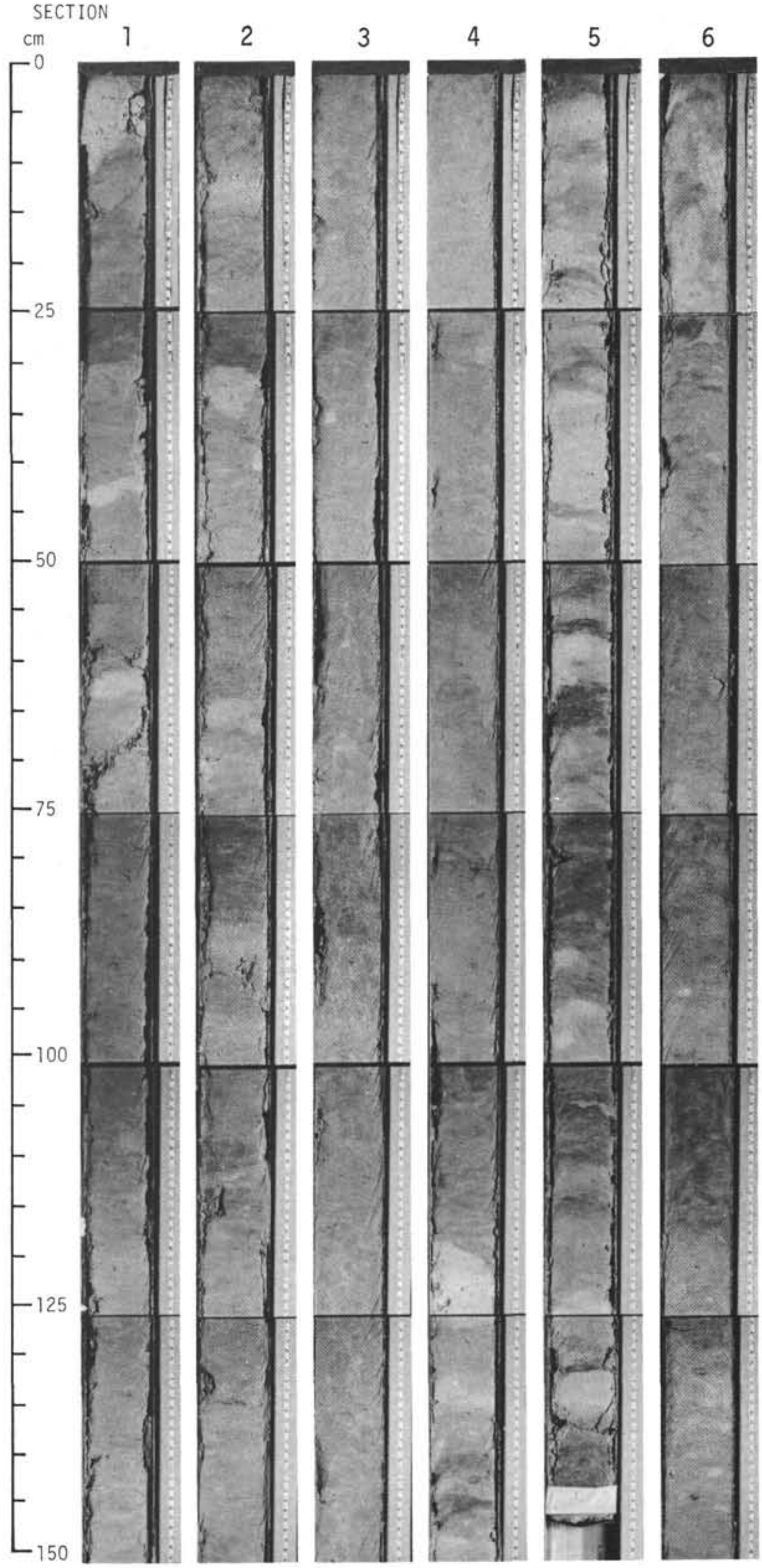
	3-50
clay	30
diatoms	55
qtz. & feld.	4
nannos	3
mica	TR
heavies	TR
glauc.	TR

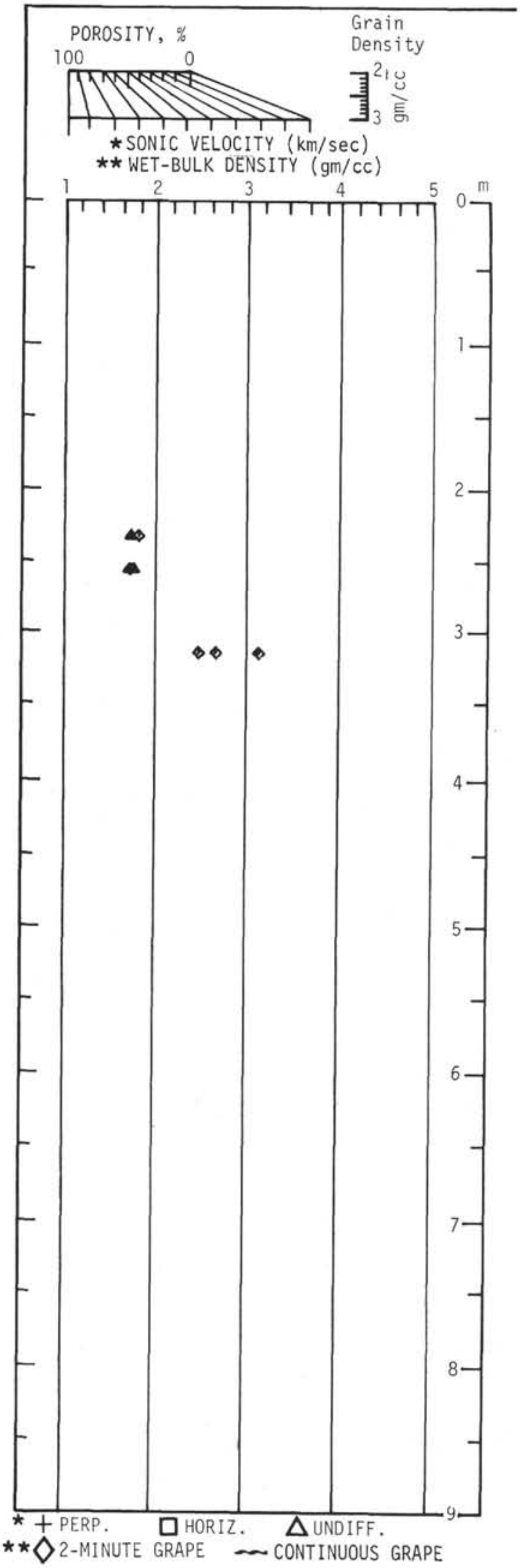
GRANITE FRAGMENT
Contamination from basement of Hole 330.

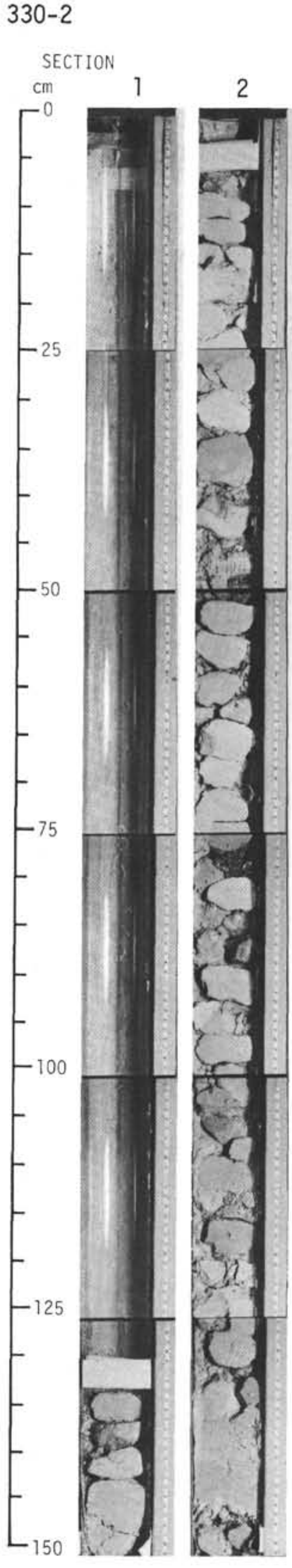
Explanatory notes in Chapter 1

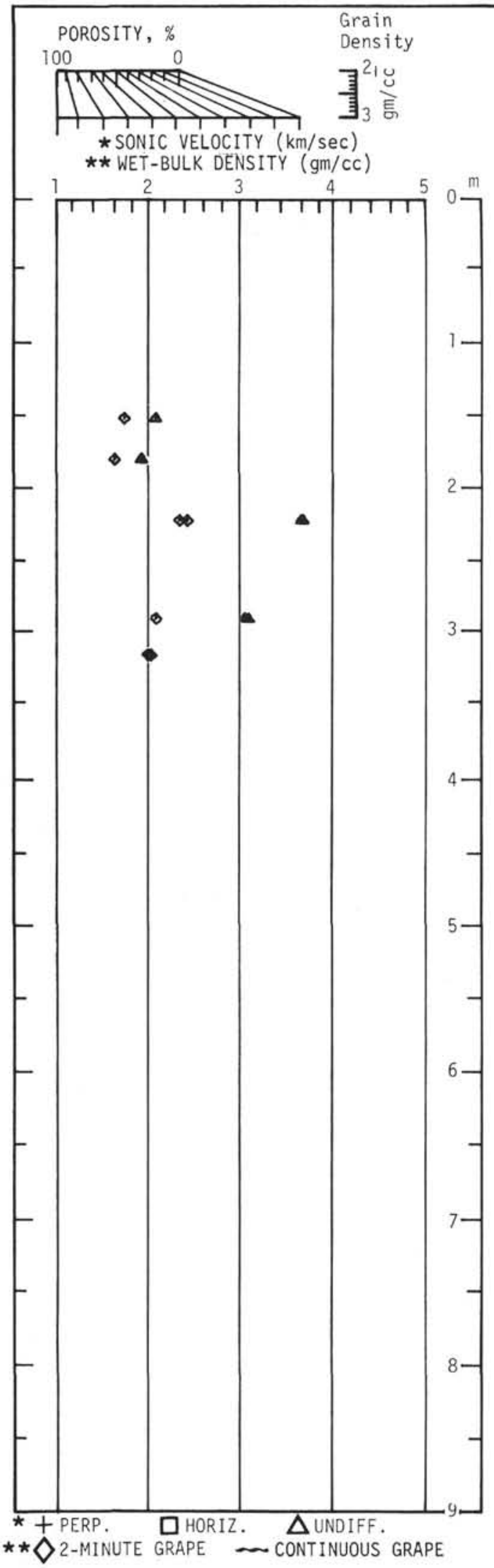

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
0 m
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

330-1

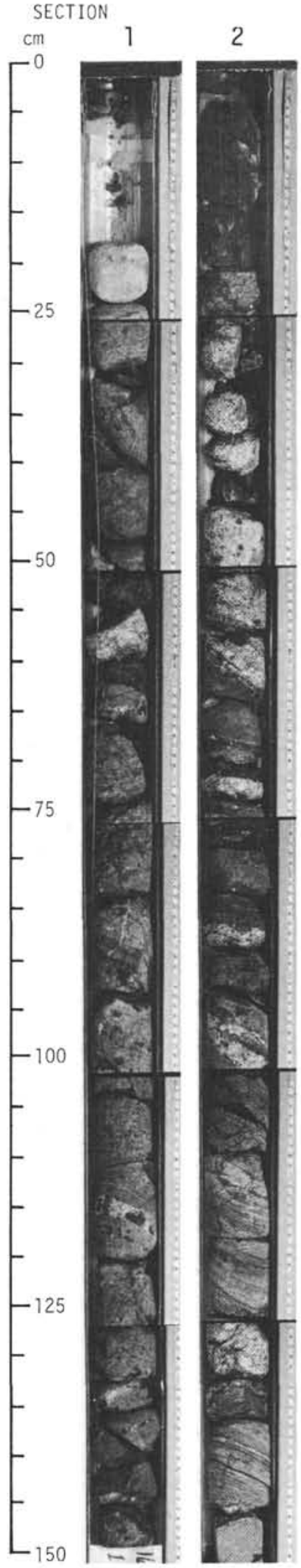

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

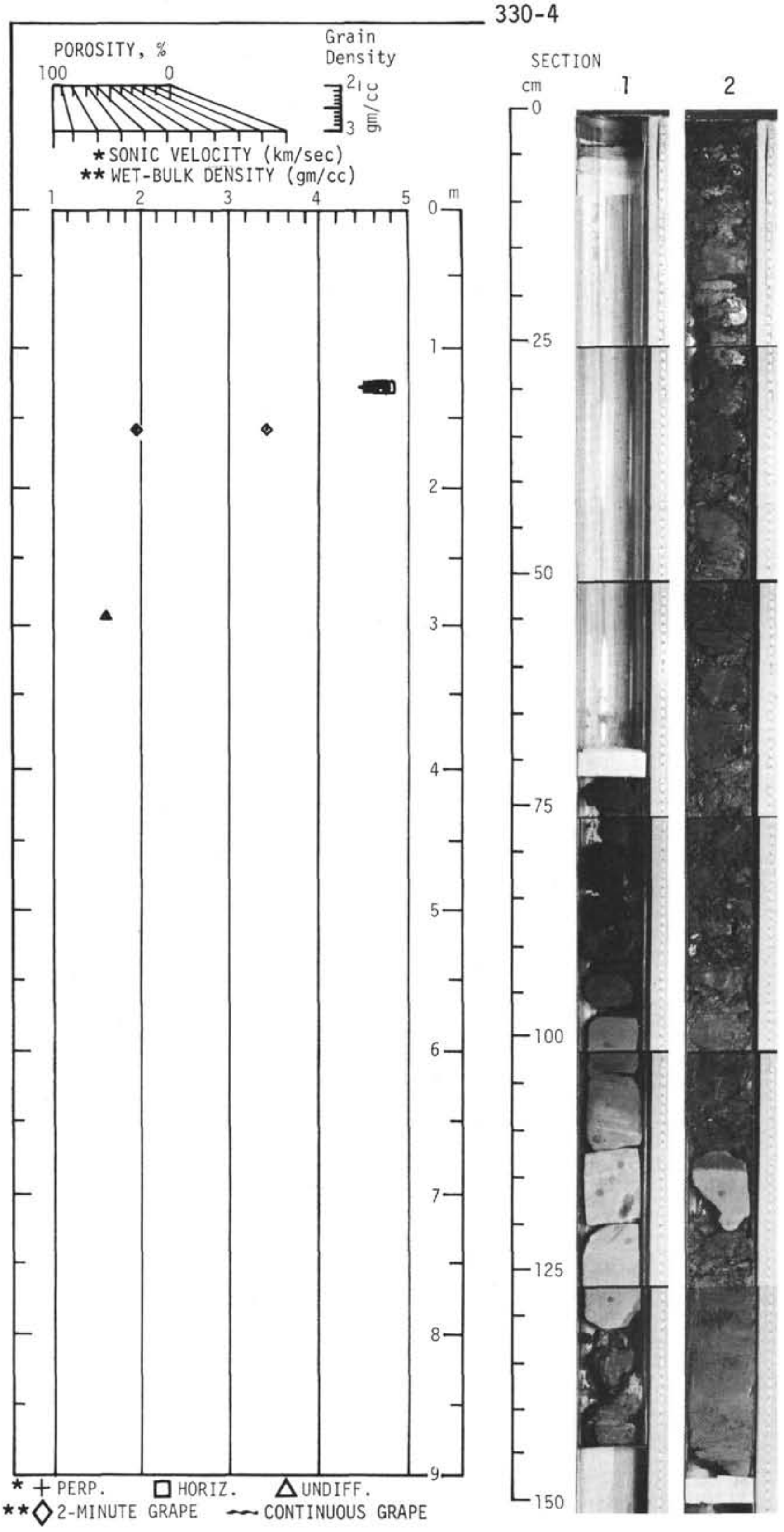

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
0
m
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE


330-2
SECTION
cm
1
2
0
25
50
75
100
125
150

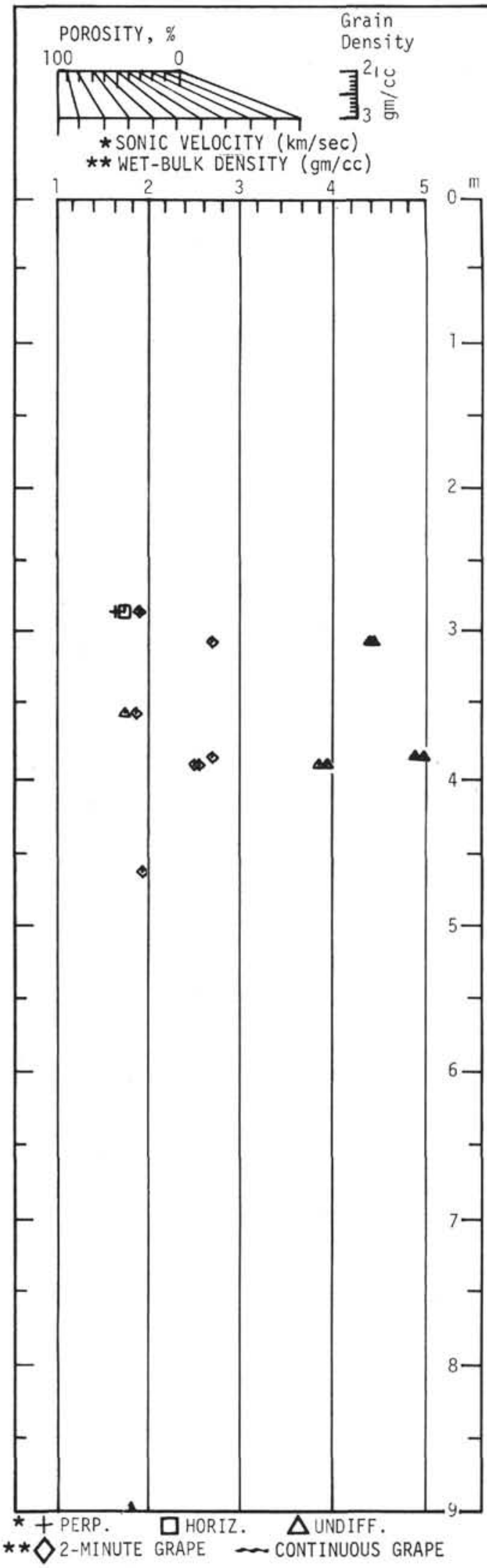

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP. □ HORIZ. △ UNDIFF.
** ◇ 2-MINUTE GRAPE ~ CONTINUOUS GRAPE

330-3

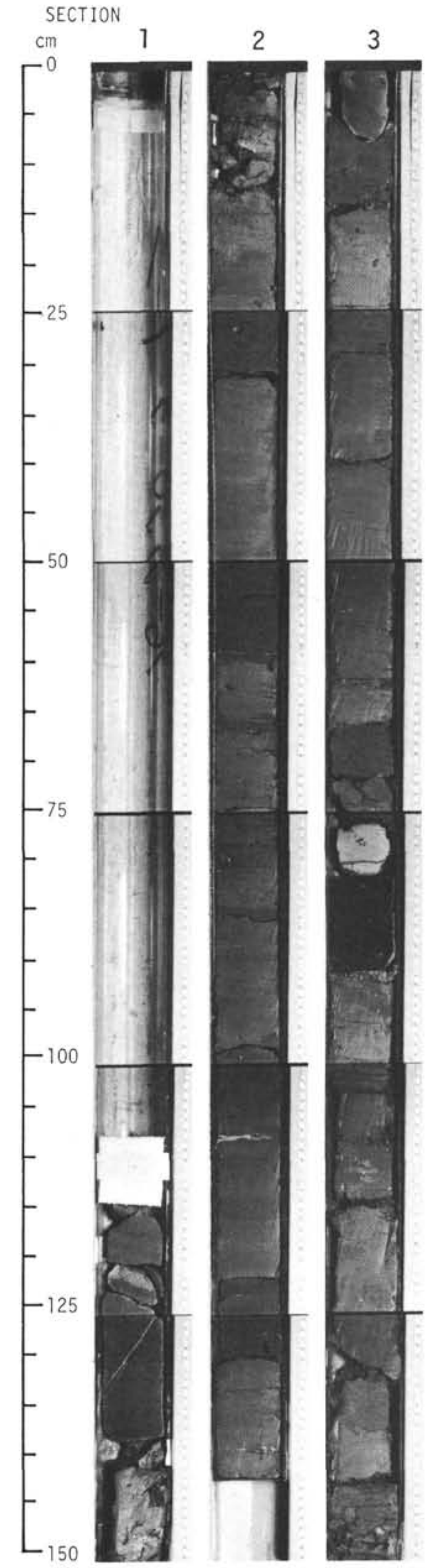

SECTION
cm
1
2
0
25
50
75
100
125
150

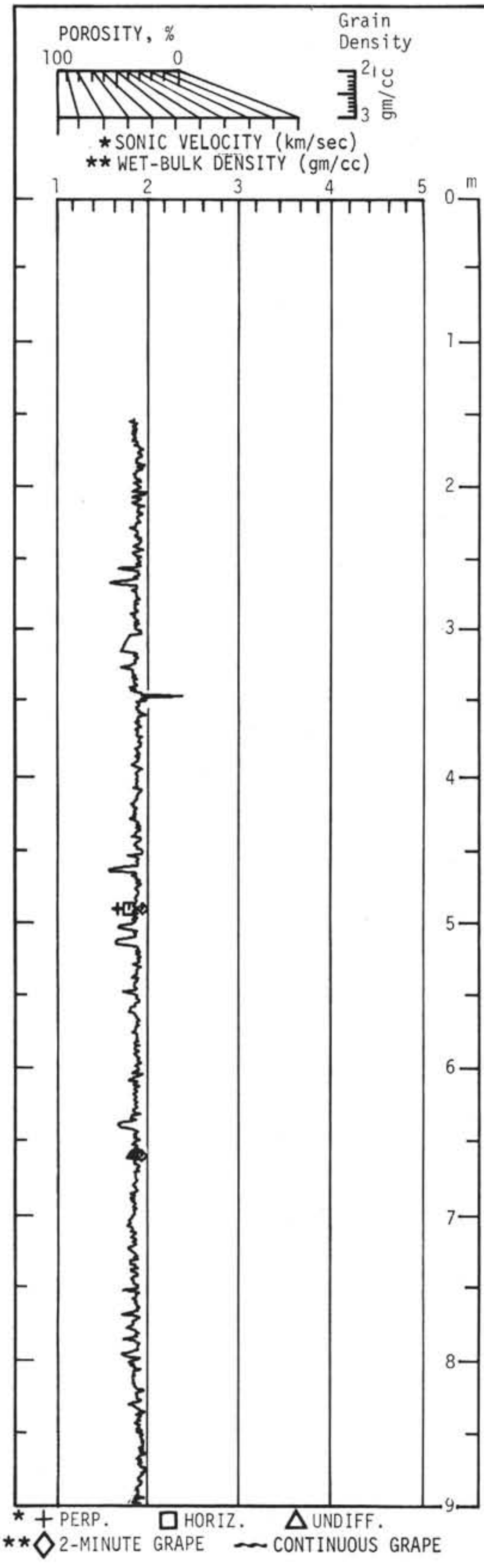


330-4
POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE
SECTION
cm
1
2
0
25
50
75
100
125
150

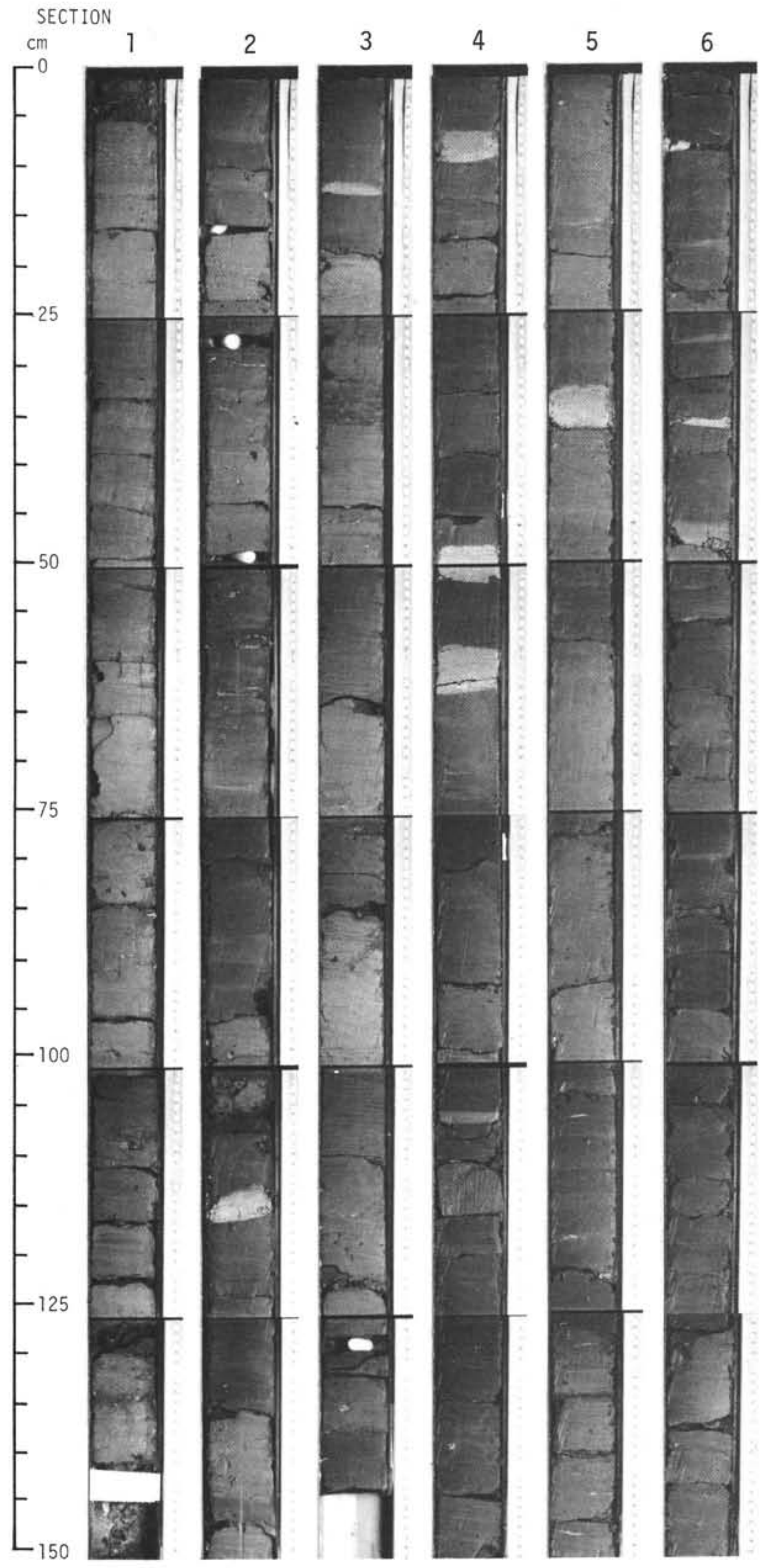

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

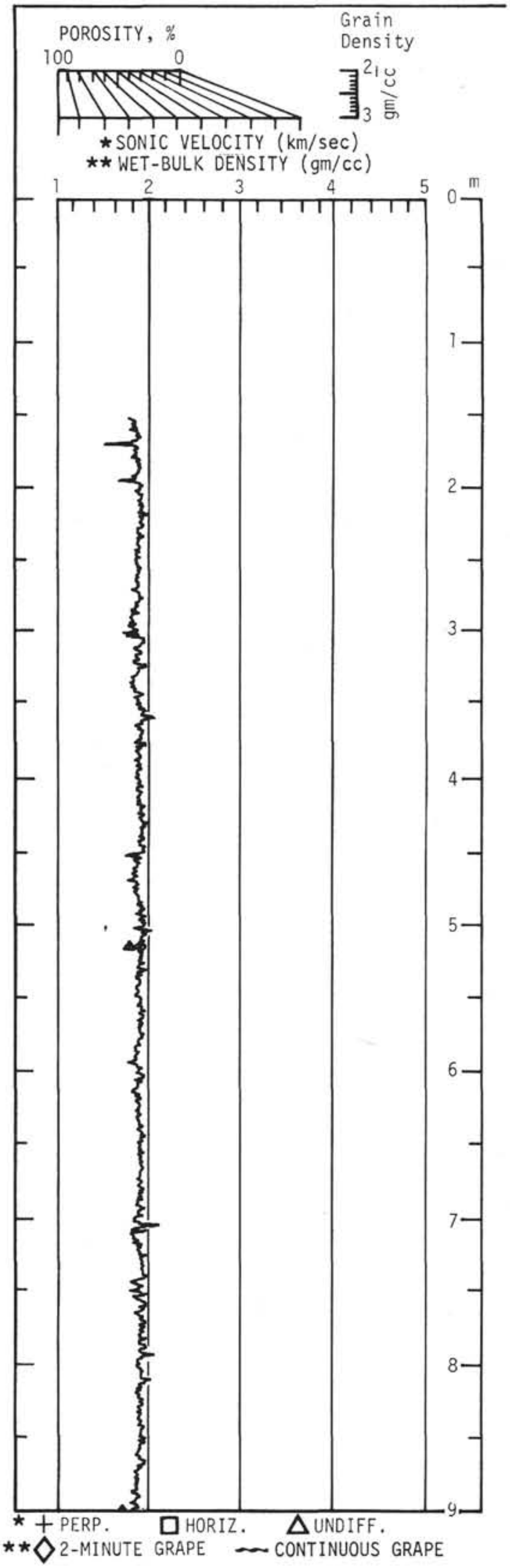
330-5


SECTION
cm
1
2
3
0
25
50
75
100
125
150

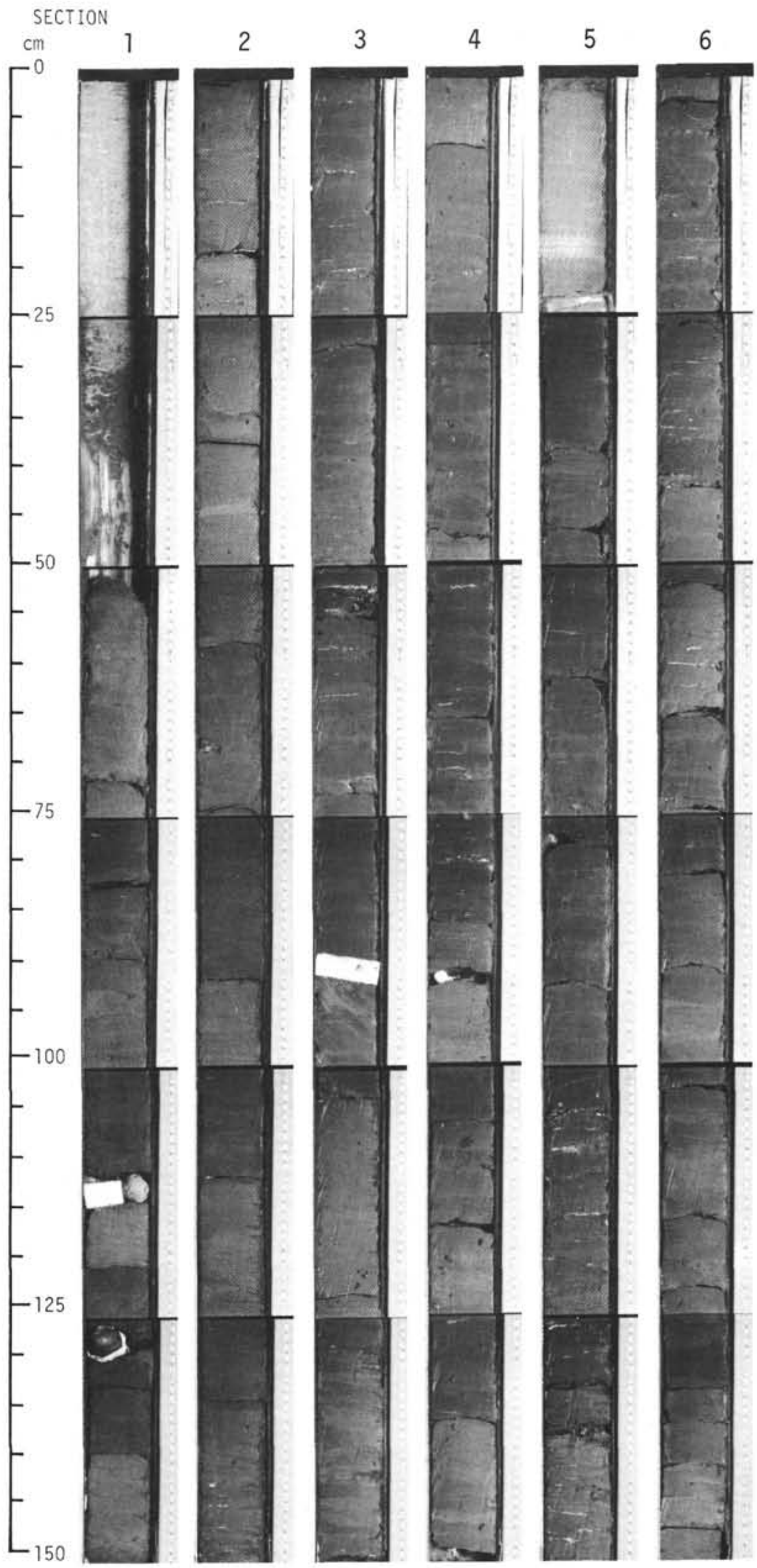

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

330-6

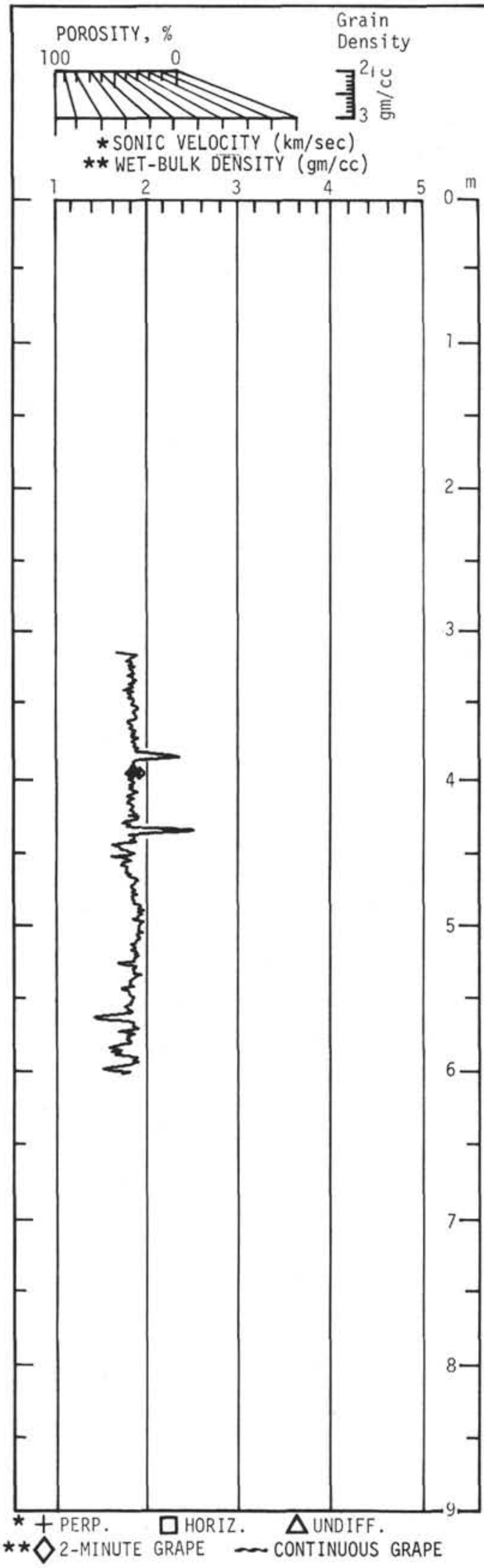

SECTION
cm
0
25
50
75
100
125
150
1
2
3
4
5
6

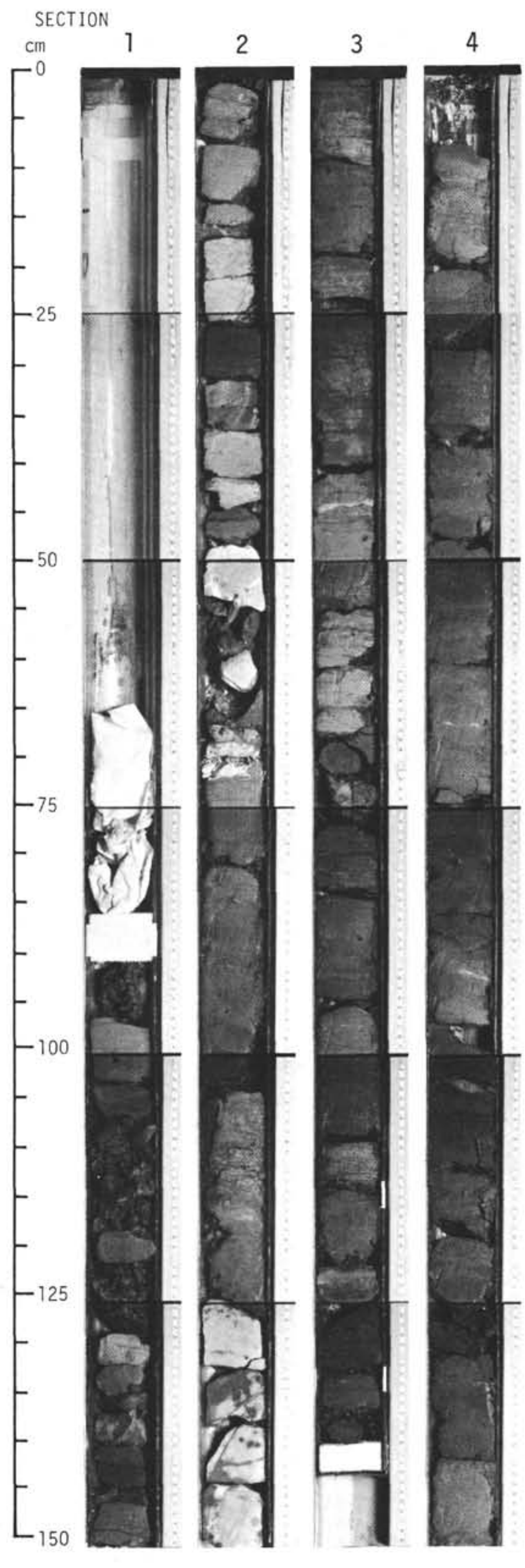

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

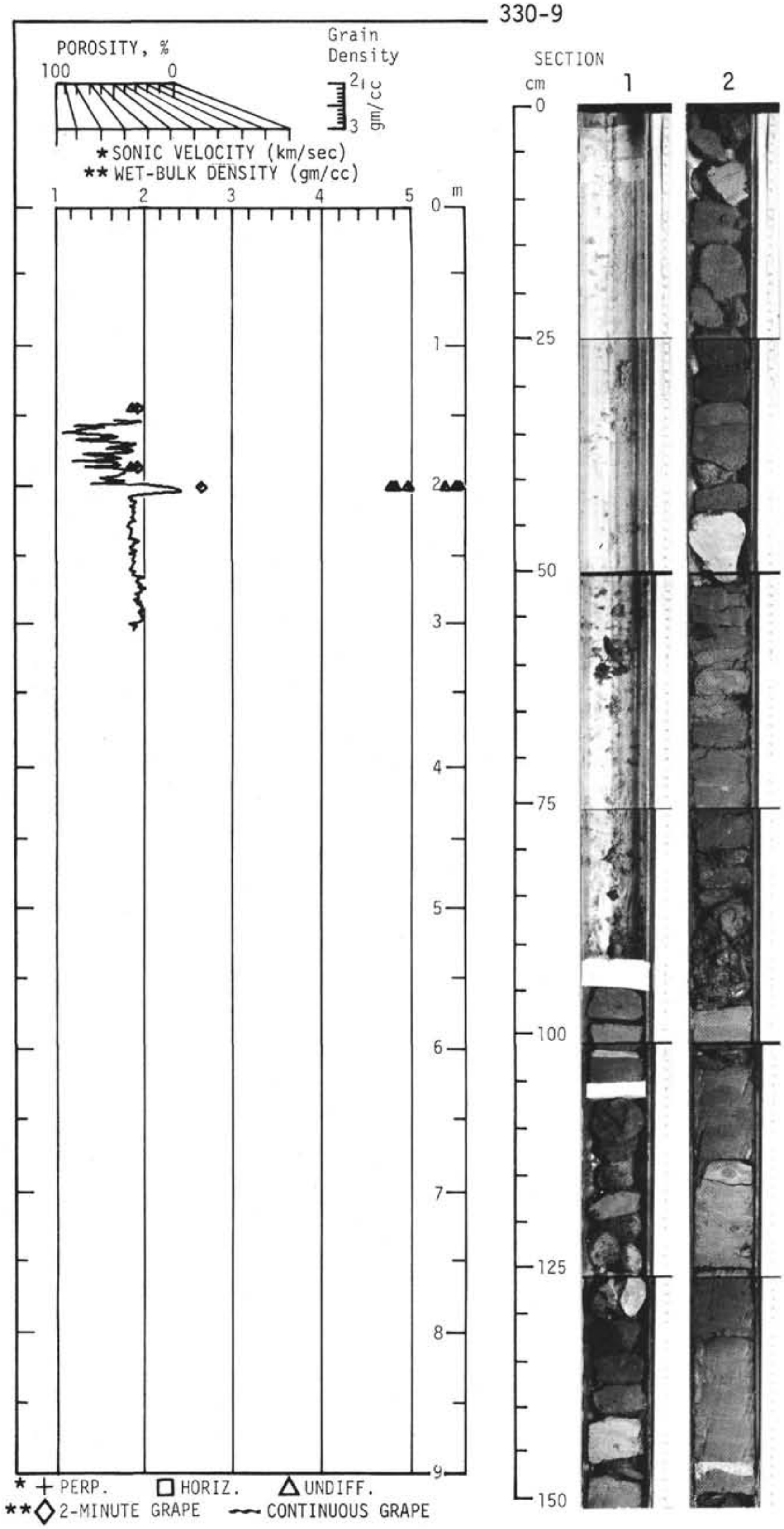
330-7


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

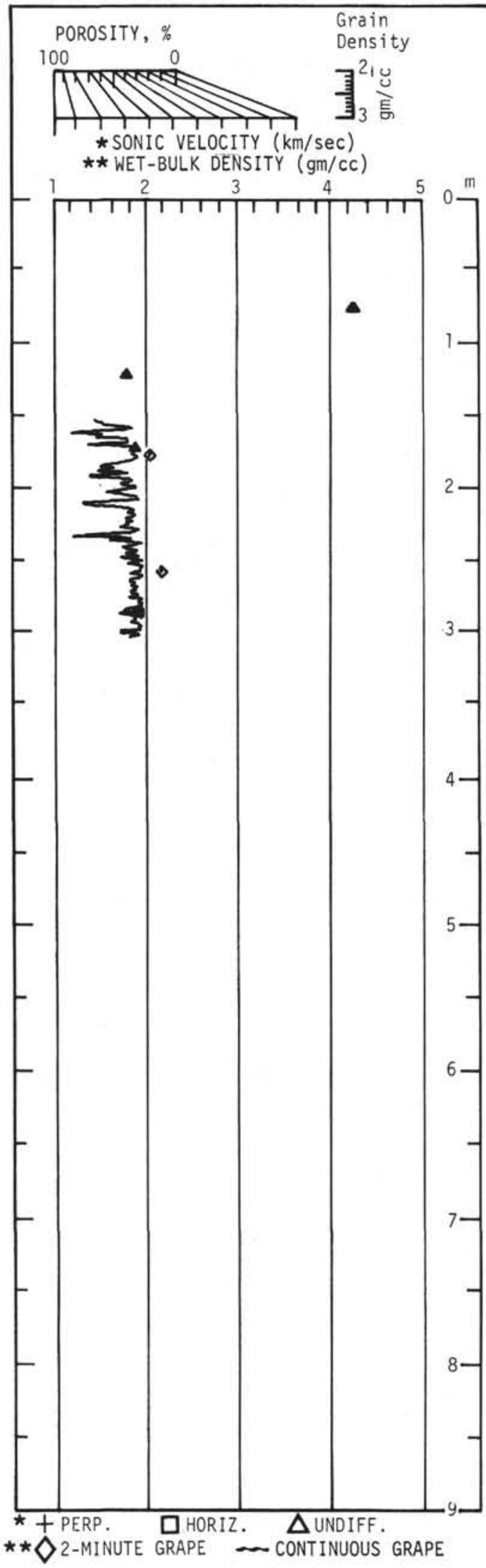
330-8


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

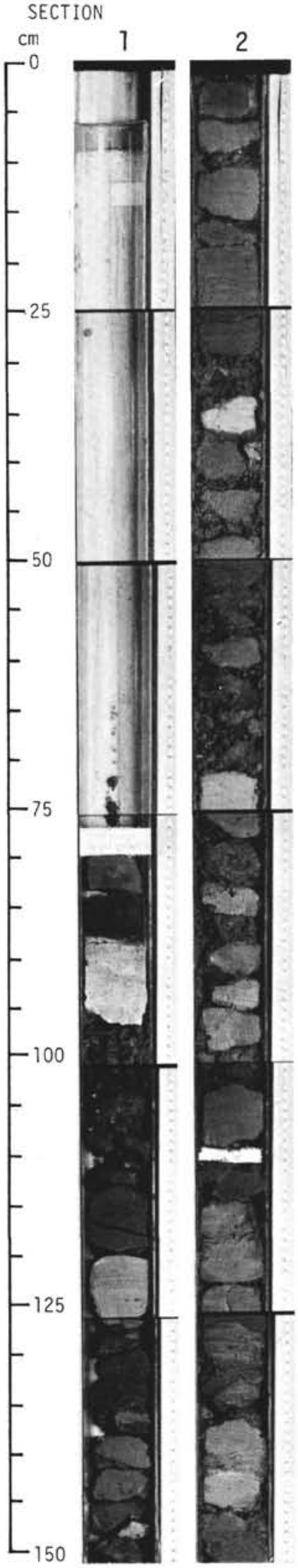

SECTION
cm
1
2
3
4
0
25
50
75
100
125
150



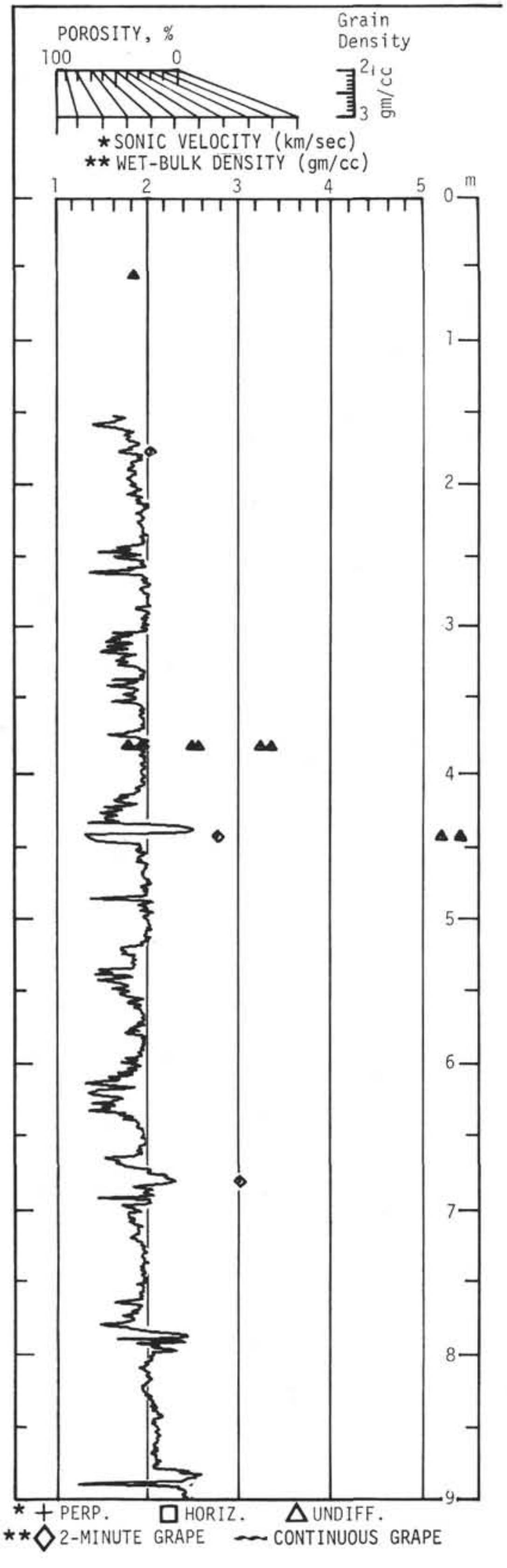
330-9
POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE
SECTION
cm
1
2
0
25
50
75
100
125
150

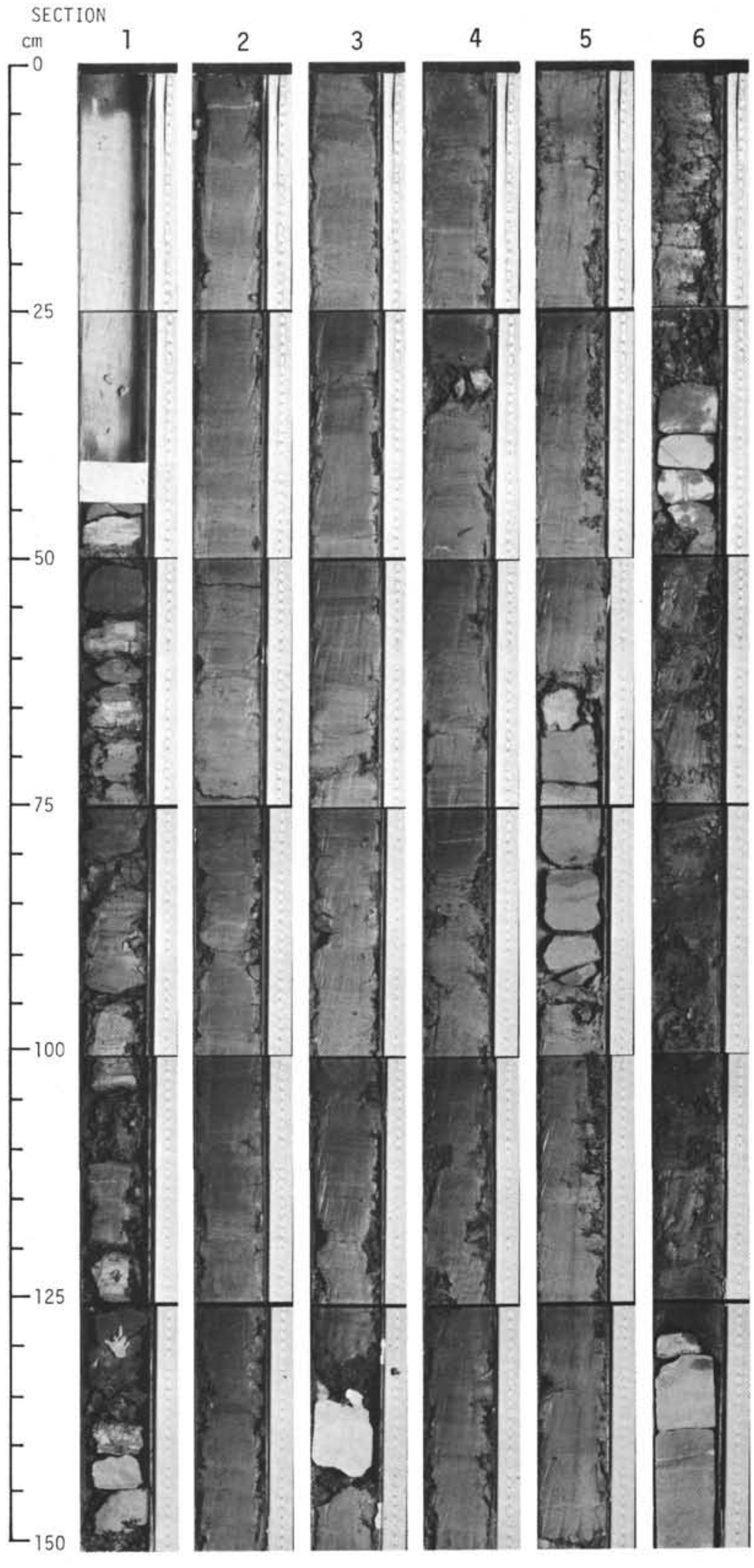

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE

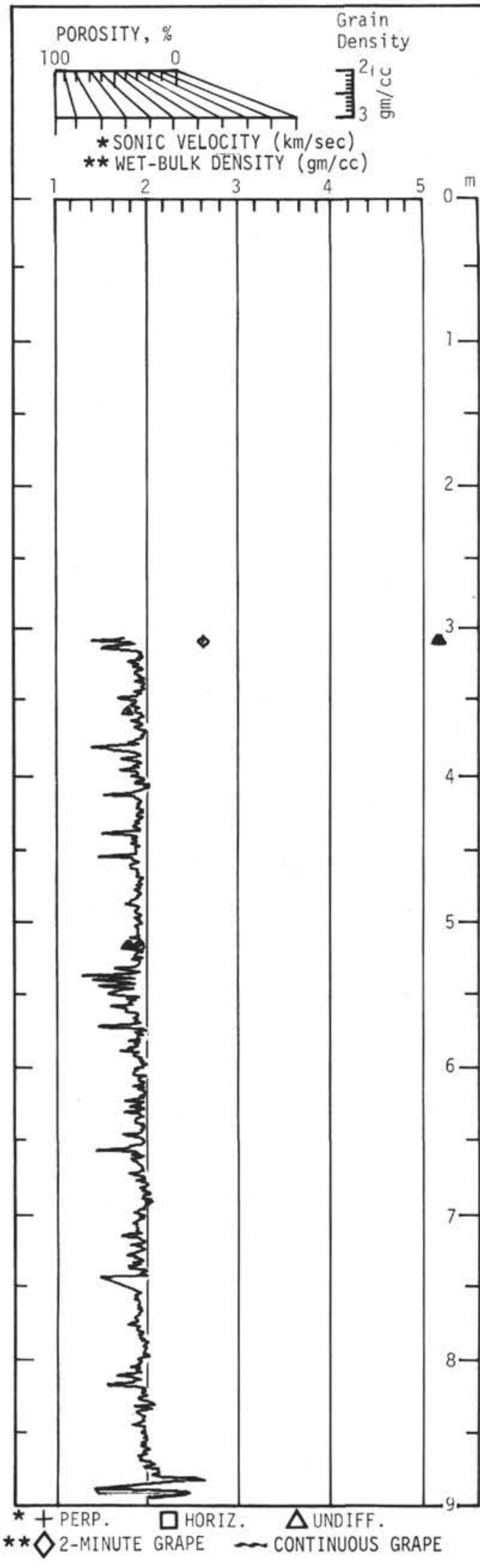
330-10

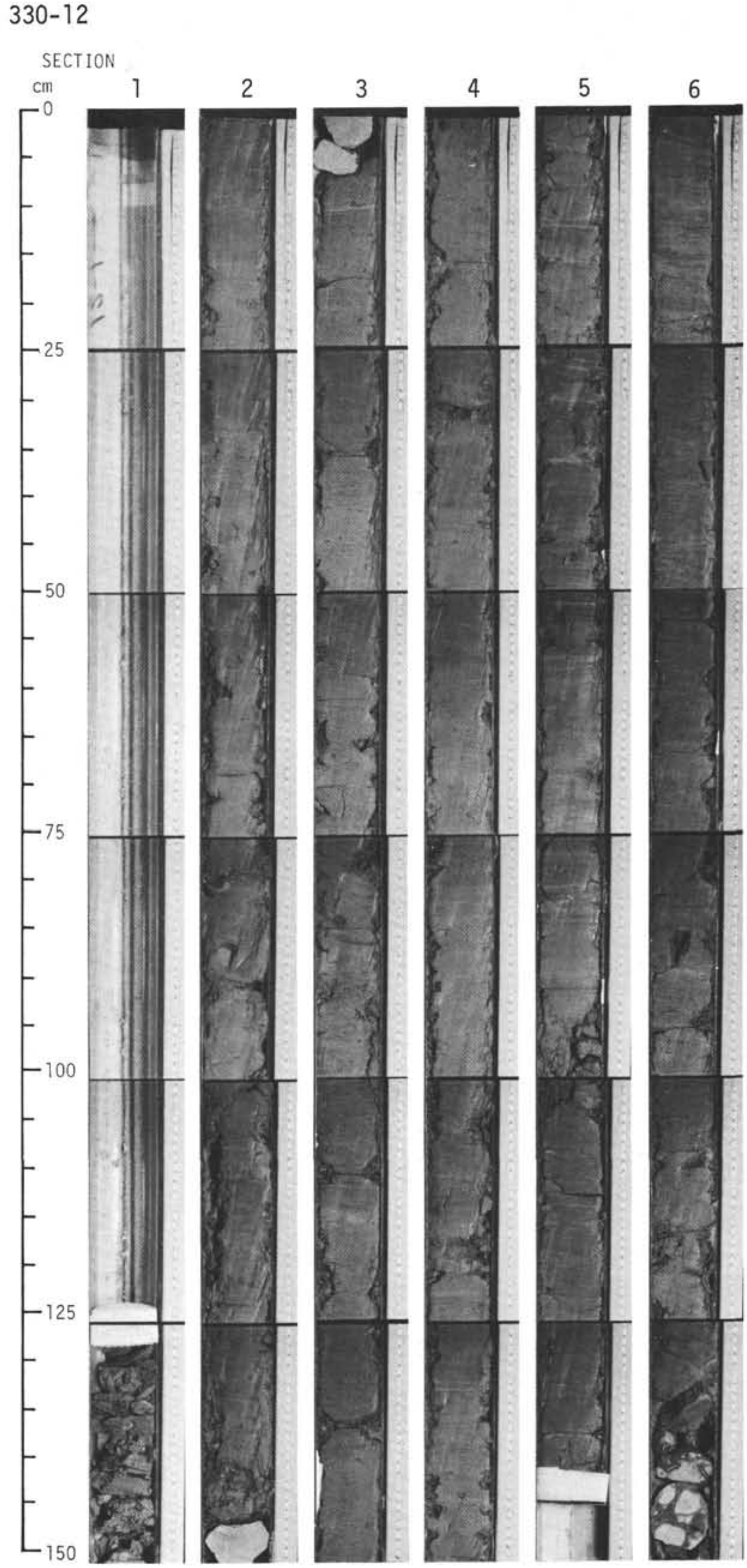

SECTION
cm
1
2
0
25
50
75
100
125
150

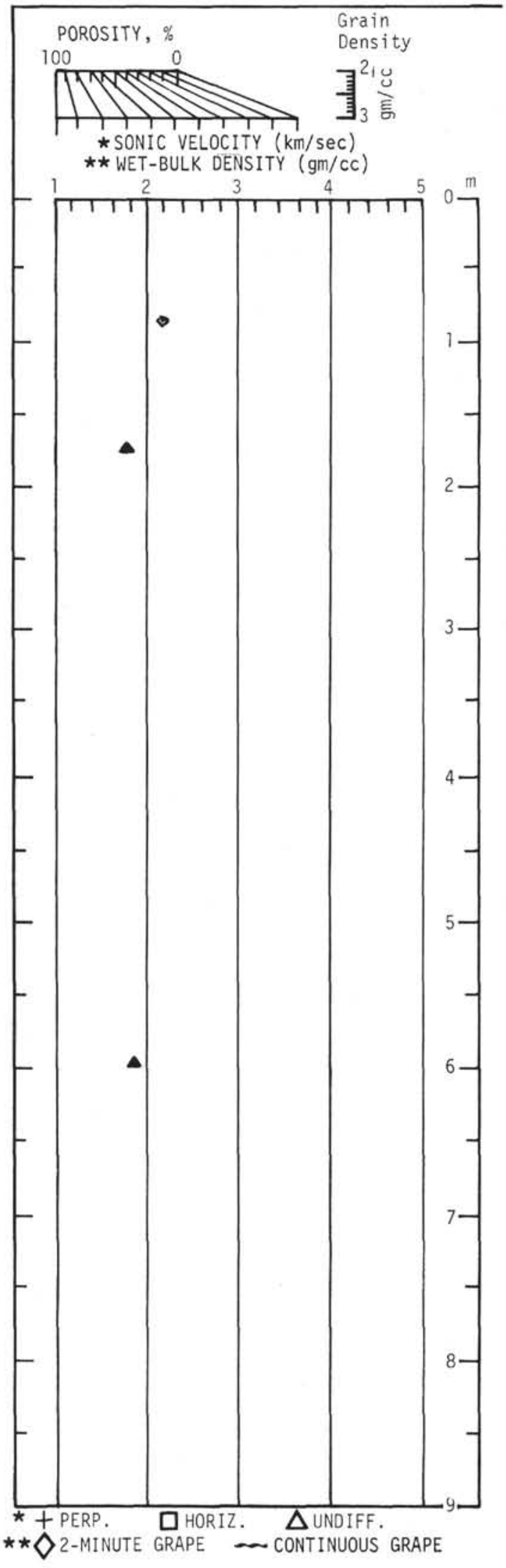
330-11

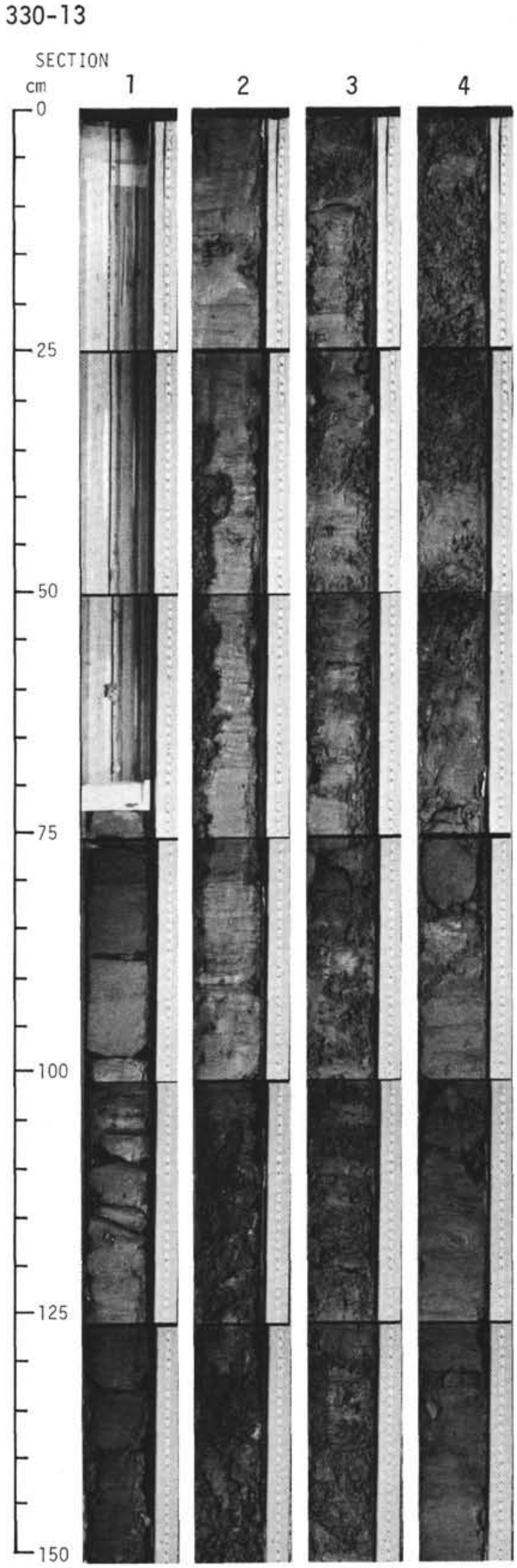

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE

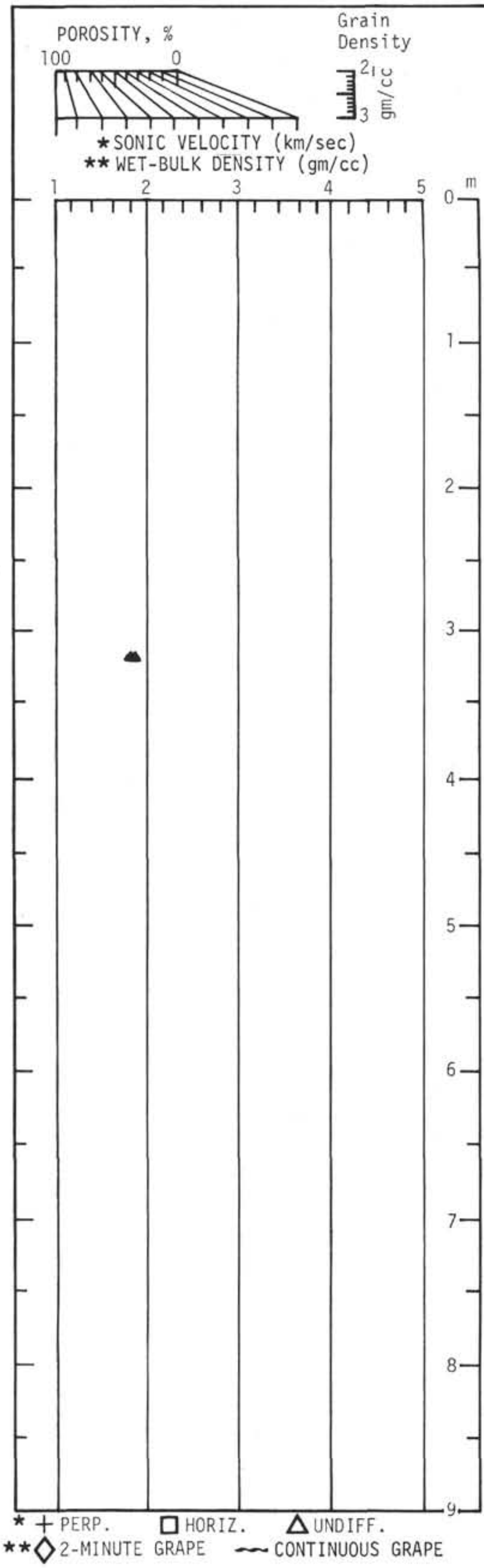

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE


330-12
SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

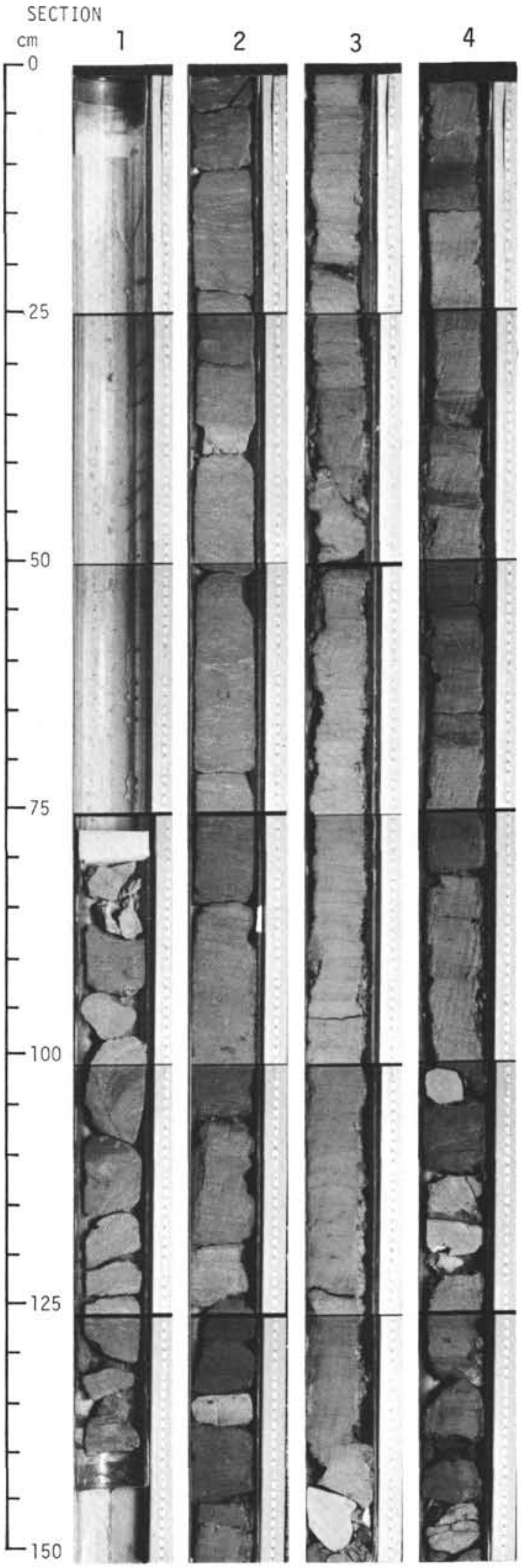

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE


330-13
SECTION
cm
1
2
3
4
0
25
50
75
100
125
150

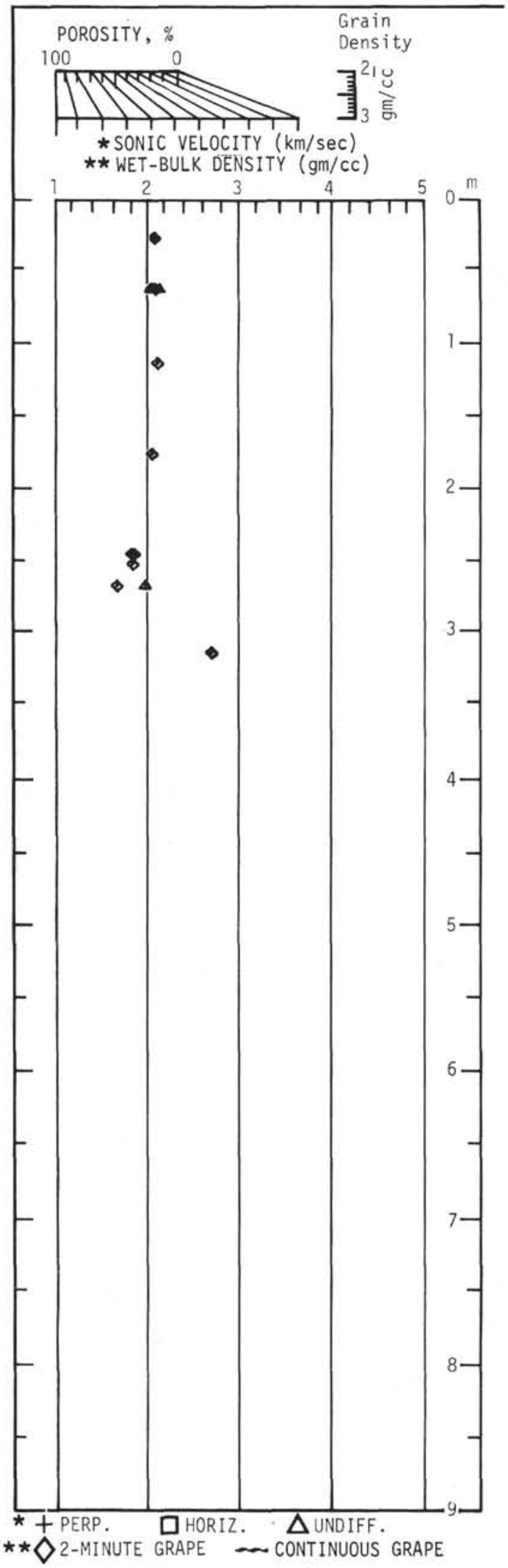


POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE

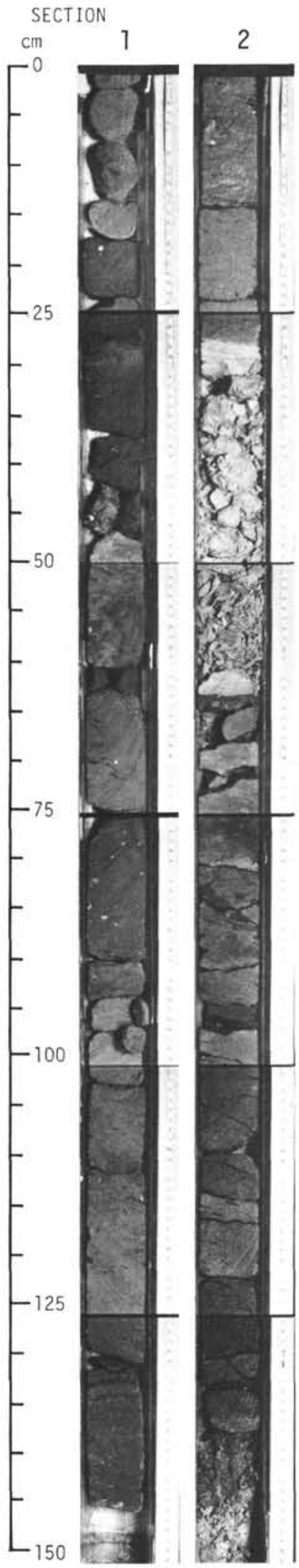
330-14

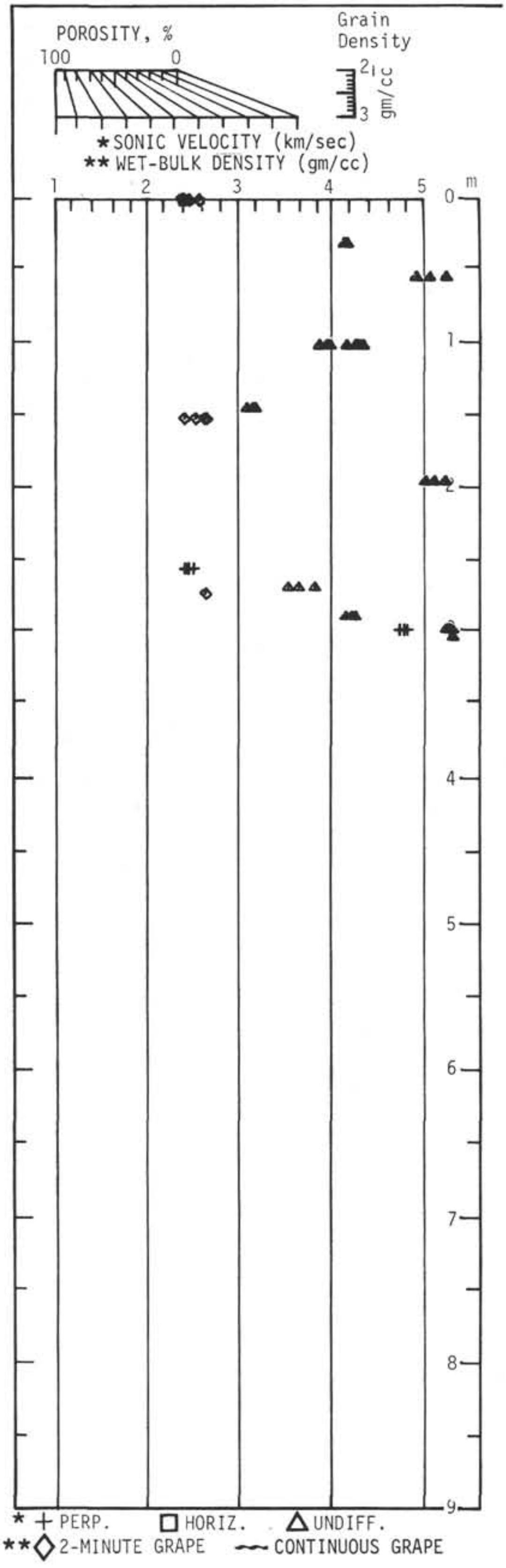


SECTION
cm
1
2
3
4
0
25
50
75
100
125
150

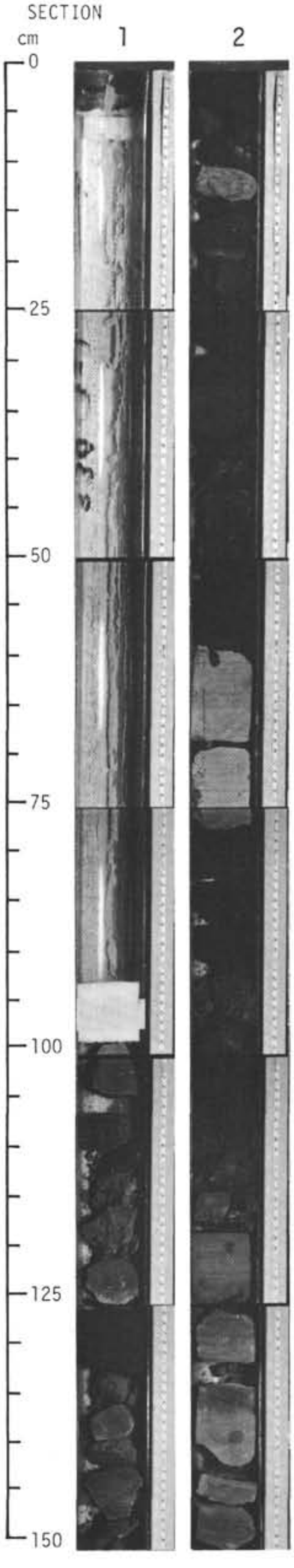

POROSITY, %
100
0
Grain
Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

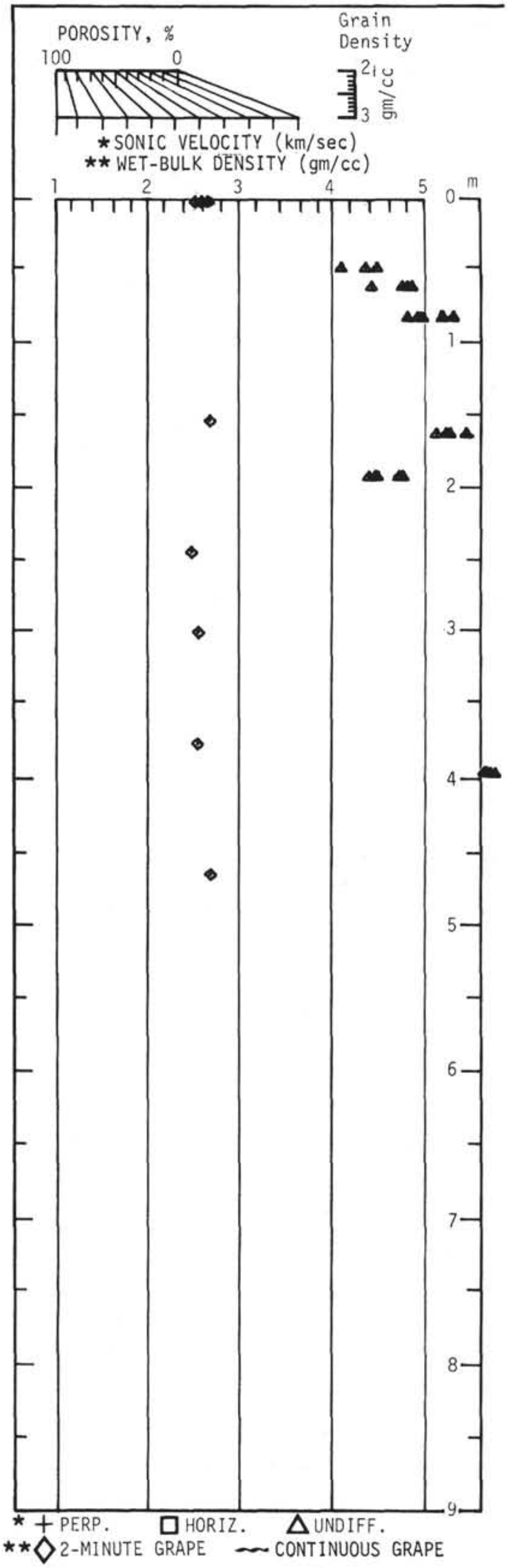
330-15

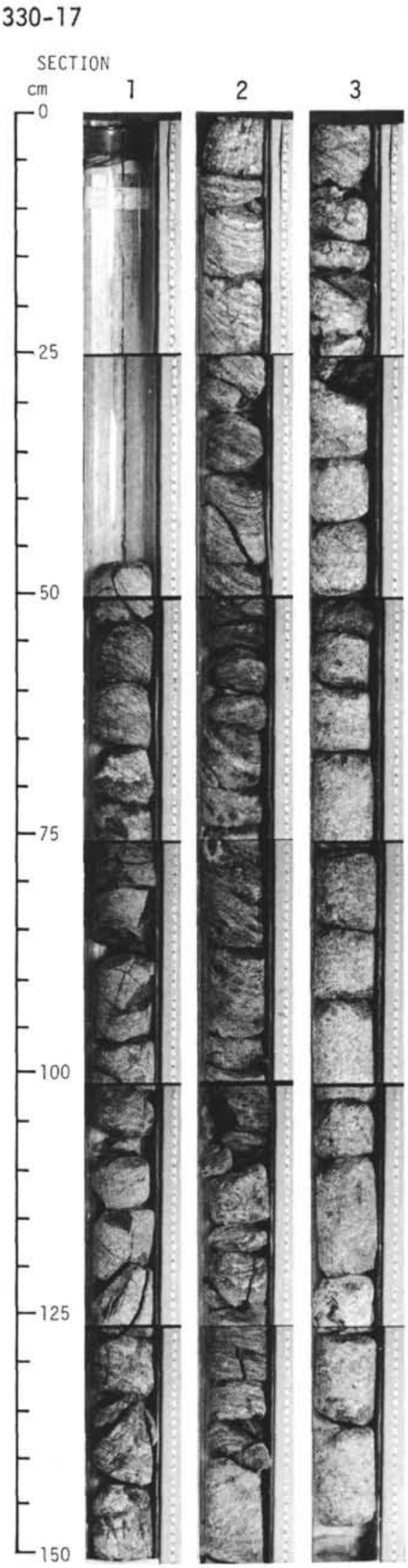

SECTION
cm
1
2
0
25
50
75
100
125
150

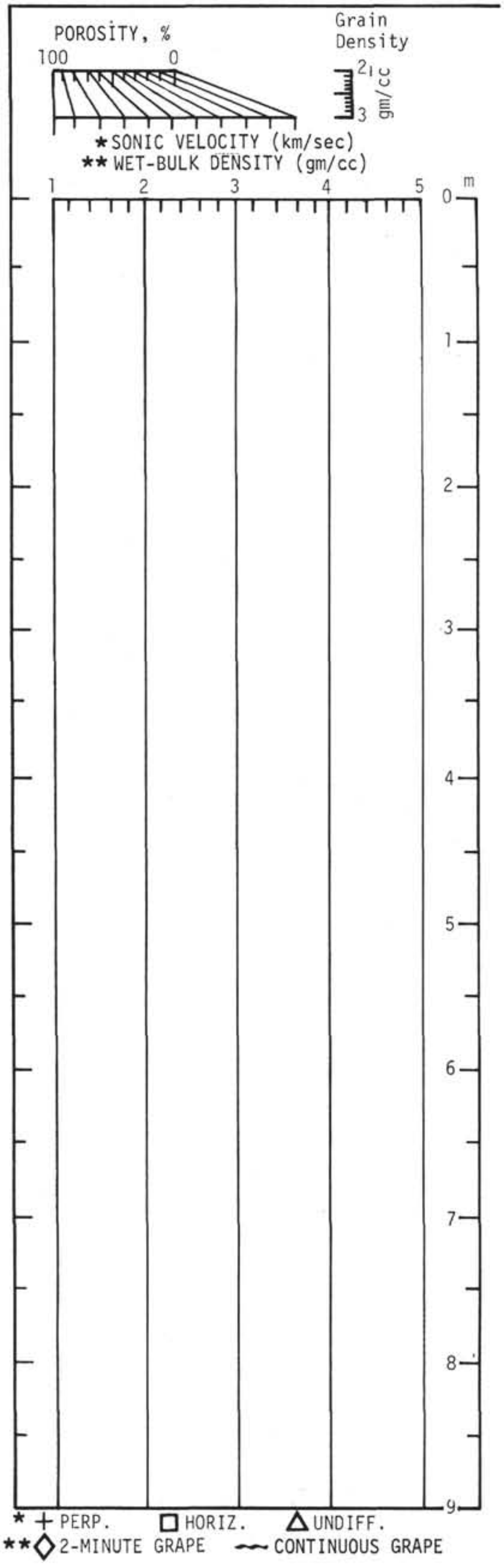

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE

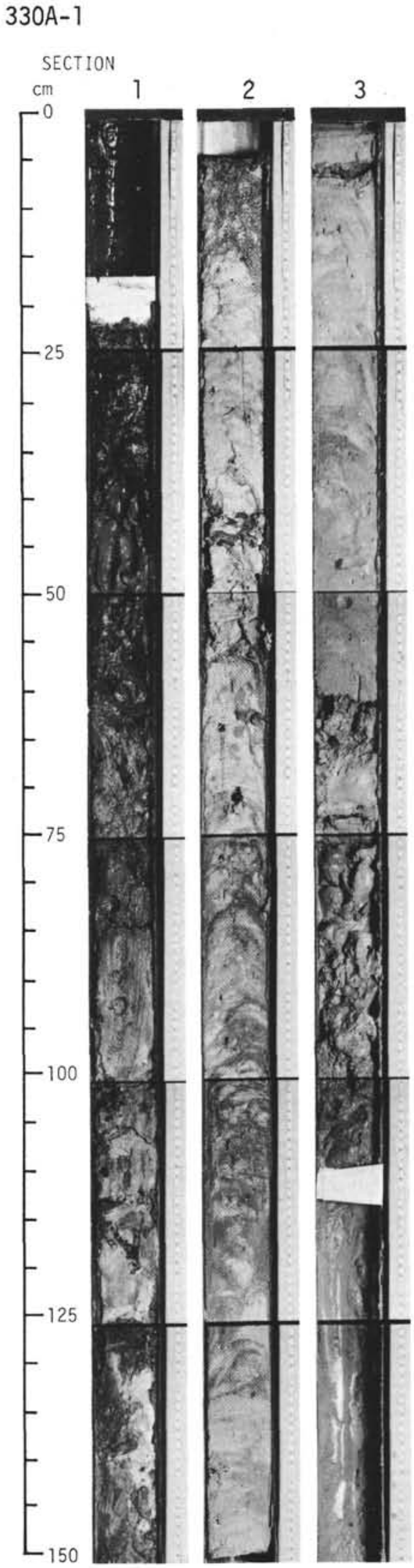
330-16


SECTION
cm
1
2
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain
Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
0
m
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE


330-17
SECTION
cm
1
2
3
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
HORIZ.
UNDIFF.
** 2-MINUTE GRAPE
CONTINUOUS GRAPE


330A-1
SECTION
cm
0
25
50
75
100
125
150
1
2
3