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A SUMMARY OF SELECTED DATA: DSDP LEGS 20-44,(U)
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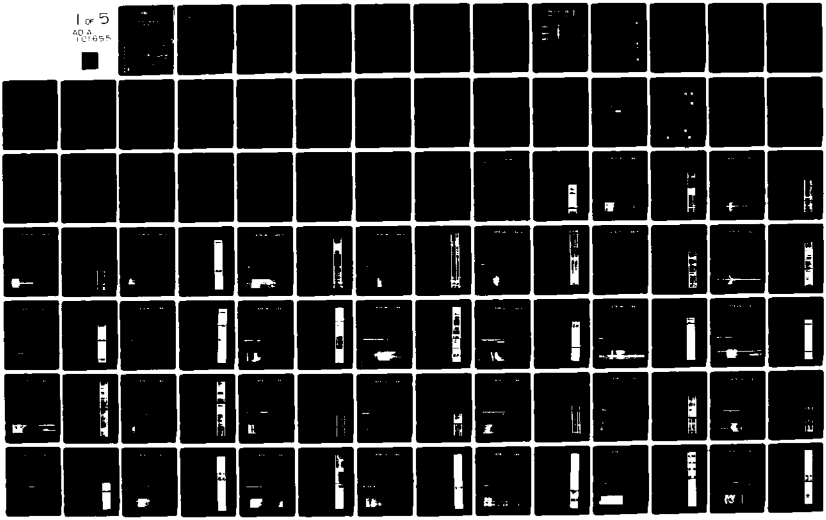

LEVEL II

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NORDA Report 25

A Summary of Selected Data: DSDP Legs 20-44

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Foreword

This report is a presentation of data from the first 44 legs of the D/V GLOMAR CHALLENGER, a deep-ocean drill ship operating under the direction of the Deep Sea Drilling Project. The selection of parameters presented and the graphic format were designed to convey a summary view of the interrelationship between the seismic, lithologic, and physical property data as a first step in the synthesis of this information in support of geoacoustic modeling.

C. G. Darrell, Captain, USN
COMMANDING OFFICER
NORDA

Executive Summary

Deep ocean sediment cores recovered by the drill ship D/V GLOMAR CHALLENGER have provided invaluable "boundary conditions" for the interpretation of marine seismic reflection and refraction data. In combination, these data provide much of the basis for constructing geoacoustic models in support of low-frequency acoustic propagation in the deep ocean. This report provides a concise, graphic correlation between vertical reflection seismic records across the drill holes, and lithologic-physical property data measured from the drilled cores. This correlation and condensation in a standardized format is the first step in producing a synthesis of the data, which will provide insight into the correlation between lithologic and acoustic properties of marine sediments. As stated, this data presentation is only the first step of a synthesis, and interpretation has been minimized. The material is being published at this time in the belief that the condensed data presentation is of immediate value to many people independent of the author's ultimate objective. A detailed discussion of terminology and measurement technique is provided for users from outside the geoscience discipline.

Acknowledgements

It is readily apparent that a major portion of this publication is the graphic representation of data. Foremost in making this project possible was Renee Edman, NORDA Scientific Illustrator. Her continued advice and suggestions throughout the entire process, in addition to her illustrations, were indispensable. The authors are greatly indebted to her for these contributions.

We are grateful to the Deep Sea Drilling Project (DSDP) A-031, University of California, Scripps Institution of Oceanography, for making the data available. The project was further aided by the following people at DSDP. Barbra Long assisted in preliminary planning and provided information on data availability. Peter Woodbury developed the methods of presentation and use of computer programs for the physical properties and lithologic plots. Tom Birtley and Nancy Freelander accomplished the organization and plotting of those data.

Chris Brown of the NSTL Photographic Laboratory printed the photographs. The text was typed by Iris DeSpain and edited by Linda McRaney, both of NORDA. Peter Fleischer critically reviewed the manuscript. This project was funded by Naval Electronics Systems Command (NAVELEX) Code 320.

Contents

A Summary of Selected Data: DSDP Legs 20-44

I. Introduction

Project Mohole demonstrated that the drilling techniques so highly developed by the petroleum industry could be extended to deep ocean water depths. It also demonstrated that an exploratory program of ocean sediment and upper basaltic layer drilling would require a different type of platform from that required to penetrate to the upper mantle. As a result, the National Science Foundation (NSF) proposed to the United States Congress in 1963 that an "Ocean Sediment Coring Program" be initiated separately from the Mohole Project. To pursue this endeavor, four oceanographic institutions joined to form the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), with initial funding by NSF in fiscal year 1965. These efforts resulted in the construction of the drill ship D/V GLOMAR CHALLENGER by Global Marine Inc., with design capabilities of drilling a 2500 ft hole in 20,000 ft of water.

On 16 August 1968, a 2528 ft hole was completed in 9275 ft of water at 25° 51.5'N and 92°11.0'W in the Gulf of Mexico. This was the initial drill hole of the NSF-Funded Deep Sea Drilling Project (DSDP). GLOMAR CHALLENGER proceeded to complete 44 drilling legs (a total of 394 holes) under the direction of DSDP. After Leg 44, NSF funding was augmented by funds from other nations and GLOMAR CHALLENGER continued to drill, but under the direction of the International Program of Ocean Drilling (IPOD). This phase of the program added Legs 45-69, and was continued until October 1979. Current plans are to extend the exploratory drilling program to August 1981 with Legs 70-82. With eleven years of drilling completed, and all ocean drilled (with the exception of the Arctic Ocean), there is now a growing trend toward drill data syntheses on both regional and global scales.

The compilation of data presented in this publication was to provide a foundation for a synthesis directed toward deep-sea geoacoustic modeling. To produce such a synthesis, however, the vast amount of data available from DSDP had to be sorted, condensed, and formated to allow data relevant to one specific purpose to be assimilated. A further consideration was that a synthesis of data from a continuing project must have a data "cut-off" point. This investigation, therefore, is limited to data from only the DSDP phase of the drilling program (Legs 1-44), a point chosen because it was an organizational break in the program, and because the detailed data of the first half of the drilling program is now published and readily available in the Initial Reports of the Deep Sea Drilling Project (hereafter referred to as Initial Reports).

The data presented were obtained directly from DSDP in the form of digital magnetic tapes, computer plots and 35 mm microfilm, while the descriptive paragraphs were summarized from discussions in the Initial Reports. The selection of data to present and the presentation format were designed to convey a summary view of the interrelationship between seismic, lithologic, and physical properties. The data presentation and discussion follow the form of the Initial Reports wherever possible, and are discussed in the section entitled Explanatory Notes. Portions of the Explanatory Notes quoted directly from the Initial Reports are indicated by a different type style and referenced.

II. Explanatory Notes

A. Key to Illustrations

The majority of this publication consists of a graphic presentation of data collected by the D/V GLOMAR CHALLENGER. Figure 1 is a sample drill hole illustration from Section V. The numbers are keyed to the descriptions which follow. Figure 2 defines the patterns used for presenting induration, lithology and cored interval of columns 7-10 of Figure 1.

1 Seismic record of region showing location of drill site.

2 Scale of two-way travel time, in seconds.

3 Seismic record with right-hand edge cropped at drill site location.

4 Two-way travel time picks, in seconds, of prominent reflecting horizons. Some that are not readily apparent on the photo copy of the seismic record are taken from the Initial Reports.

5 Interval velocity of correlated seismic travel time to drilled lithogic-depth. Velocity values are taken from the Initial Reports and are computed directly from the interval (time and depth). Velocities are not given where correlations or values were questionable.

6 Interface picks, in meters, at discontinuities in lithology taken from the Initial Reports or determined from the core data directly.

7 8 9 10 Lithologic data are presented in four columns (Fig. 2). Column 7 indicates the degree of sediment induration. The scale is divided into soft, firm, and hard, and represents a qualitative assessment of penetrometer data. Column 8 indicates the composition as calcareous, siliceous, detrital, and igneous. Column 9 indicates the mode of deposition and includes pelagic, transitional, and terrigenous. Column 10 shows the cored intervals.

11 Geologic age, series or stage boundaries are indicated by tick marks (see Time Stratigraphic Framework, Section II.B.2.e.).

12 Drill depth, scale in meters.

13 Sand content is plotted with percentage increasing to the right, while clay is plotted with percentage increasing to the left. Silt content is represented by the remaining area between the curves (see Grain Size Analyses Section II.B.2.a.).

14 Calcium carbonate content is plotted with percentage increasing to the right, while silica content is plotted with percentage increasing to the left. The remaining area is material other than calcium carbonate or silica. Since these two factors were measured by different means, they have been normalized not to exceed 100% (see Carbonate and Silica Analyses, Section II.B.2.b. and c.).

15 Sound velocity measurements taken in core samples are plotted increasing to the right. The scale ranges from 1.5 km/sec to 4.0 km/sec, with values outside this range plotted on the boundaries.

16 Measured porosity values are plotted increasing to the left, with the scale ranging from 40% to 90%. Values below 40% are truncated.

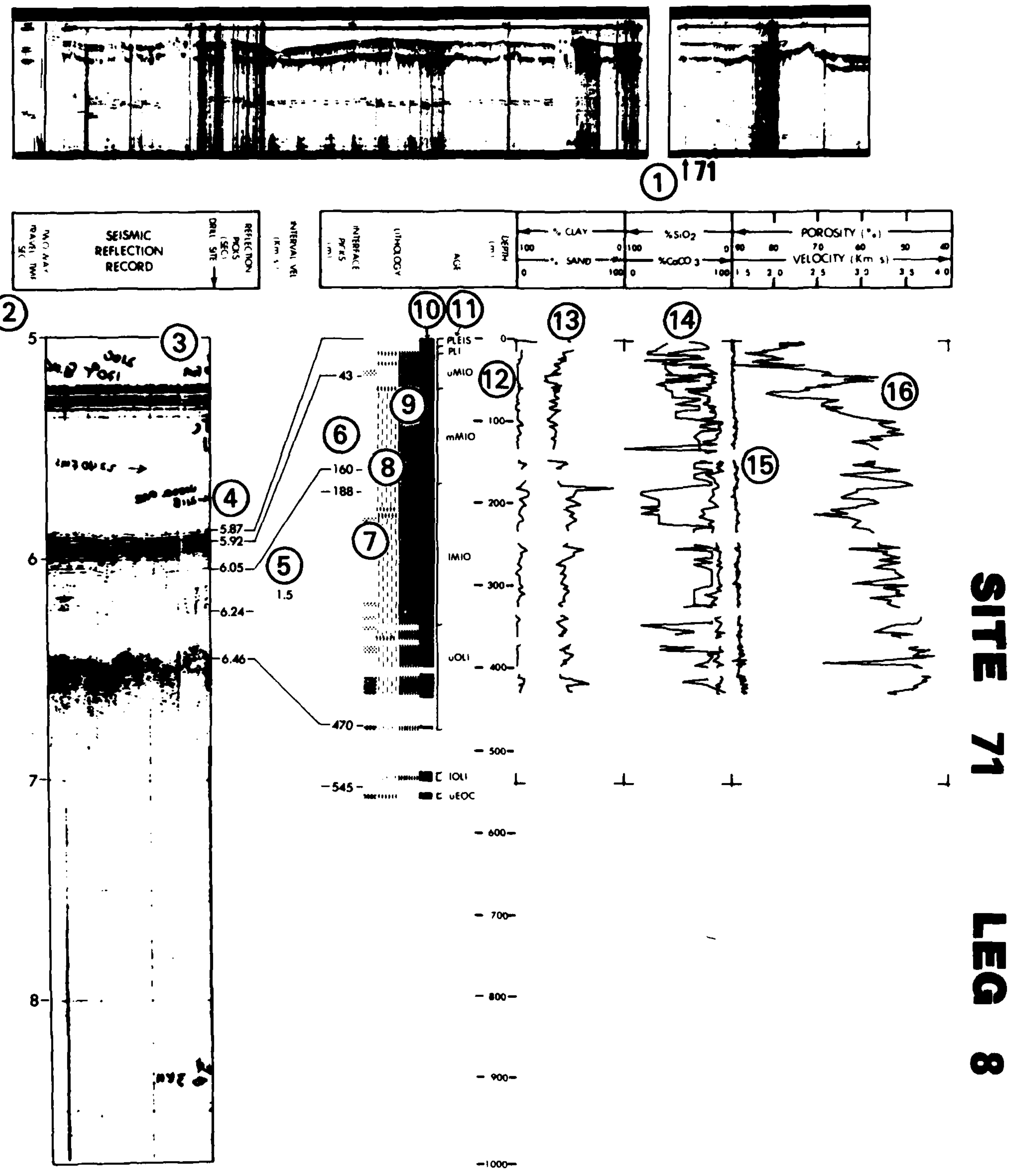


Figure 1. Key to data summaries

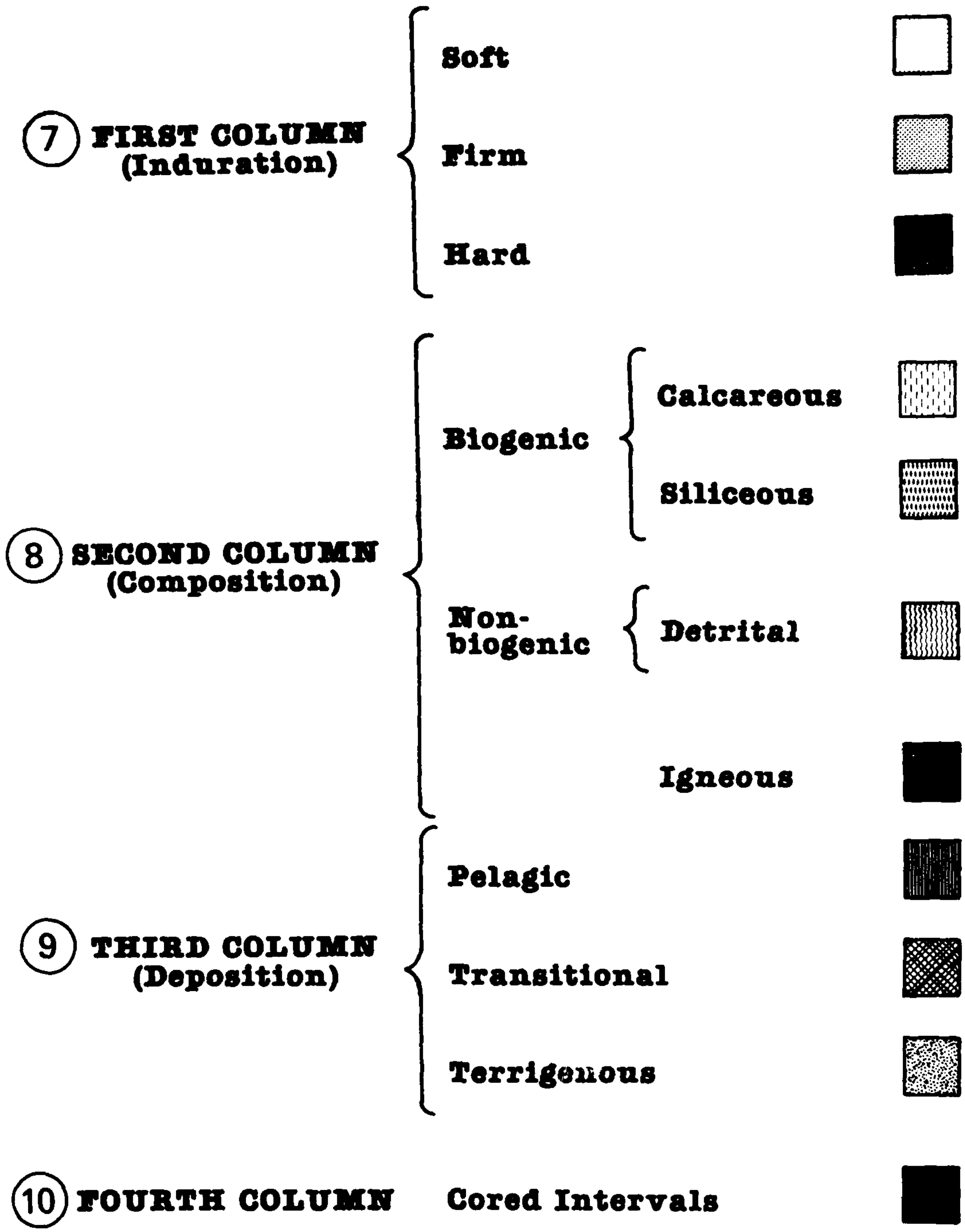


Figure 2. Legend of lithologic data

B. Measurements

The core analysis is divided into two parts: the initial On-Board Studies (Sect. II, B.1) and the subsequent Shore-Based Studies (Sect. II, B.2). The discussion in these sections is predominantly in the form of excerpts quoted from the Initial Reports, and provides the details of measurement relevant to the data plotted in Section V (7, 13-16 of Fig. 1). The Time Stratigraphic scale used is that presented in JOIDES (1974). The abbreviations shown in the Time Stratigraphic Framework Chart in Section II, B.2 are those used in the Data Summary Section.

1. On-Board Studies

a. Porosity, Wet-bulk Density, Water Content*

Aboard the GLOMAR CHALLENGER wet-bulk density and porosity were measured by two methods. One utilized small individual sediment samples, which were collected from the relatively "undisturbed" center portion of the cores. The volumes of these wet samples combined with their wet and dry weights were used to calculate their wet-bulk density and porosity. The second method required measurements of gamma-ray attenuation through the sediments and rocks, which relates to their wet-bulk density. This was done by a system called Gamma Ray Attenuation Porosity Evaluator, which will hereafter be referred to by its acronym GRAPE.

Weight And Volume Density Measurements

Wet-bulk density in this report is defined as the weight in grams of the wet-saturated sediment (or rock) per cubic centimeter of the wet-saturated sediment. Porosity is defined as the volume of pore space divided by the volume of the wet-saturated sample and is expressed as a percentage. Water content is defined as the weight of water in the sediment divided by the weight of the saturated wet-sediment and is also expressed as a percentage. Salt corrections were not made.

Individual soft sediment samples were taken with a one cubic centimeter syringe with the end cut off, squared, and sharpened, so that the leading sharp edge was flush with the inside diameter of the syringe. The sampling technique is similar to that of piston coring. The syringe cylinder and the end of the plunger are placed flush with the surface of the sediment to be sampled, and then the plunger is held stationary while the cylinder is slowly pushed into the sediment. Volume measurements of hard sediments are not possible with this technique.

Volume of the soft sample is measured with the same syringe before the sample is weighed. The sample is then weighed while wet and after drying at 110°C for 24 hours and then cooling in a desicator for at least two hours. The greatest limitation on these measurements is the size of the sample which can be weighed accurately at sea (less than one gram). Therefore, a single weighing, if the sea state permits, has an error of about ± 1 percent, and a single volume measurement on this small sample is subject to a high error of about ± 4 percent. Weight-weight water content measurements, which do not involve volume measurements, have a precision of about ± 2 percent (absolute error).

Calculations of water content, wet-bulk density, and porosity are as follows (without salt correction):

$$\text{Water Content (\%)} = 100 \times \frac{(\text{weight wet sediment}) - (\text{weight dry sediment + salts})}{(\text{weight wet sediment})} \quad (1)$$

*This section, Porosity, Wet-bulk, Density and Water Content, is quoted from Boyce (1970).

Wet bulk density (g/cc) = (2)

$$\frac{\text{(Weight wet sediment)}}{\text{(Volume wet sediment)}}$$

Porosity (%) = (100/1.00 g/cc)

$$\left[\frac{\text{(weight wet sediment)} - \text{(weight dry sediment + salts)}}{\text{(Volume wet sediment)}}\right] \quad (3)$$

Averaged, or estimated, grain densities are used when calculating porosity with the shore-based laboratory GRAPE computer program. Some average grain density values are approximated using the porosity, wet-bulk density, and water content measurements done on individual samples by Equation 4. This equation is not precise and has a large scatter of grain densities, especially when the sample has a high porosity, and therefore is used only to get an average value.

Porosity =

$$\frac{\left(\dfrac{\text{wt. water}}{\text{density water}}\right) \times 100}{\left(\dfrac{\text{wt. water}}{\text{density water}}\right) + \left(\dfrac{\text{wt. dry sed. + salt}}{\text{density dry sed. + salt}}\right)}$$

Density Dry Sed. + Salt

$$= \frac{\text{(wt. dry sediment + salt)}}{\left[\dfrac{\text{wt. evaporated (100) water}}{\text{density water (porosity)}}\right] - \left[\dfrac{\text{wt. evaporated water}}{\text{density water}}\right]} \quad (4)$$

$$= \frac{\text{wt. dry sediment + salt}}{\left[\left(\text{volume evaporated water}\right)\left(\dfrac{100}{\text{porosity}}\right)\right] - \left(\text{volume evaporated water}\right)}$$

Salt correction may be made if desired.

Grape System

Basically, the GRAPE device consists of a drive system to move geologic material between a shielded gamma ray source (Ba^{133}) and a shielded scintillation detector. The system also includes an analog computer which immediately calculates apparent wet-bulk density from the measured parameters. Evans (1965), Harms and Choquette (1965), Evans and Cotteral (1970), Brier et al. (1969), and Whitmarsh (1971) contain discussions of the principle; Evans (1965) and Evans and Cotteral (1970) also give a detailed equipment description.

The GRAPE works on the principle that gamma rays of a specified energy interval (0.3 to 0.359 Mev) are absorbed or scattered when they travel through a sediment or rock sample, and that this attenuation is related to the density of that material. These gamma rays are absorbed or scattered by the electrons in the minerals, and it is assumed that the ratio of the number of electrons in any given mineral to its density can be considered a constant; however, this is not true for all minerals. The variation of this "constant" is seen as a variation of the attenuation coefficient for those "anomalous" minerals. Corrections for these "anomalous" minerals may be applied in the future when the mineralogy and attenuation coefficients become accurately known. At the present, only a correction for the "anomalous" water density, or attenuation coefficient, is applied as it comprises up to 80 percent of the sample..

Theory

The GRAPE system provides continuous apparent wet-bulk density measurements on the basis of gamma ray attenuation in an ideal slab absorber (Evans, 1965):

$$I = I_0 e^{-\mu \rho_B} \quad (5)$$

$$\rho_B = \frac{1}{\mu d} \ln \left(I_0/I\right) \quad (6)$$

"I is the intensity of the gamma-ray beam which penetrates the absorber with on loss in energy,
I_0 is source intensity,
ρ_B is the bulk density in g/cm^3

is the mass attenuation coefficient in cm^2/g, and

μd is the thickness or diameter of the sample in cm."

In some sediments, it may be necessary to make corrections for minerals whose attenuation coefficients differ significantly ($\pm$ 3%) from that of quartz. Corrections for "anomalous" attenuation coefficients of minerals, other than seawater, were not made, but corrections may be applied in the future when the exact quantitative mineralogy and attenuation coefficient become known.

The above equation with an assumed μ of 0.100 or 0.102 cm^2/g is accurate for minerals which have a similar attenuation coefficient to that of quartz or calcite, respectively, or, in other words, the equation is accurate for minerals that have a ratio of the mineral electron density (ρ_e) to its bulk density (ρ_B) which approximates that of quartz or calcite. According to Evans (1965) "Corrections must be provided when the electron factor (Θ) varies significantly ($\pm$ 3% or greater):"

$$\Theta = {}_e / {}_B \qquad (7)$$

"A convenient unit for Θ is the number of electrons per cubic angstrom (ρ_e) per unit density (ρ_B) ...This ratio is 0.303 for many common rocks and minerals, such as calcite, quartz, dolomite and some clays."

Evans (1965) suggests (and the method followed by Deep Sea Drilling) "In evaluating equation (... Equation 6 above) the most convenient computational procedure is to consider μ a constant, 0.100 cm^2/g, and use corrected grain densities for any sample components having electron factors in the range of 0.294 Θ = 0.312 The corrected grain densities (ρ_{GC}) are calculated from the following relationship:

$$_{GC} = \frac{\Theta_1 \rho_{GL}}{\Theta} \qquad (8)$$

Where Θ_1 is the electron factor of the 'abnormal' component, θ is the normal electron factor 0.303, and ρ_{GL} is the measured grain density of the component which requires correction." An example is aluminum which has an electron factor of 0.291 (Evans, 1965).

$$\rho_{GC} = \frac{0.291}{0.303} \times 2.71 \text{ g/cc} = 2.60 \text{ g/cc}$$

Electron density factors and corrected densities of some common minerals are listed in Harms and Choquette (1965), Table 1, P24C-25C) and Evans and Cotteral (1970).

Density values for seawater (1.025 g/cc) and aluminum (2.71 g/cc) are calculated by the GRAPE as approximately 1.125 g/cc and 2.60 g/cc, respectively, when calculations are based on an attenuation coefficient near that of quartz and calcite (0.100 and 0.102 cm^2/g, respectively) (Schlumberger, 1966; Evans, 1965). For an approximation of "true sediment wet-bulk density, similar density corrections for other minerals may be ignored and the GRAPE data thought of as two phases consisting of seawater and solid mineral grains of quartz. Since seawater is a major constituent, a correction factor must be applied. This is accomplished by processing the apparent density data through one of the computer programs described below.

Errors

Whitmarsh (1971) shows a comparison of GRAPE density averages per 1.5 meter core lengths (referred to as sections) to wet-bulk densities determined by weight and volume measurements of the entire 1.5 meter core section. These section-density averages agreed within $\pm$0.03 g/cc, which is very good when considering the variables. The GRAPE samples a pencil size area across the diameter of the core including a disturbed portion of the sides of the liner, which is about 12 percent of the sample. However, that same disturbed sediment around the outer perimeter is a large volume of the core and is about

25 percent of the entire volume of the core section used in the weight-volume density calculations. In addition, minerals may be present which have a different attenuation coefficient than that of calcite.

In general, wet-bulk density data of small weighed samples agree with the GRAPE data within ±5 percent. This is fairly good when considering that the actual samples of the two methods are different. The individual porosity and wet-bulk density weighed samples are small (less than 1 cc) and from the center portion of the cores, while the GRAPE samples are of pencil size volume and extend across the entire diameter of the core. This includes the outer peripheries of the cores which are usually disturbed as a soup or heavy paste. In addition, the single GRAPE sample is a moving average of about 1 cm which is measured in a time of 2 seconds (actual movement is 2.95 mm). This short 2 second gamma ray counting period by itself has an error of ±6 percent.

b. Sound Velocity*

Sound velocity measurements were taken in each major lithology on undisturbed samples. From some high quality hand-sized samples it is possible to detect anisotrophy. Samples of stiff sediment or isolated chunks of hard rocks are lifted from the core and cleaned of disturbed material. The surfaces of the sample that have contact with the transducers are carefully (so as not to disturb the sample) squared off with a knife or saw and smoothed. The acoustical contact with the transducers is made with a few drops of seawater.

In a few instances, the velocities of weak sediments were measured through the core liner when the sediments were too soft to be handled without destroying their integrity. In these measurements, the typical liner travel time and liner thickness, as measured with the transducers, were subtracted in the calculation. These measurements were used to get a "ball park" answer for a particular sediment type, or for drilling predictions; these data are discussed as generalities in the text and labeled in the tables as approximate data.

When samples contained abundant gas it was not possible to measure velocities because of sound pulse attenuation. Even if the pulse were not completely attenuated, the data would not be representative of in situ conditions, despite pressure and temperature corrections because of gas expansion and loss factors.

Sound Velocity Method and Equipment for the Hamilton Frame System

Sound velocity is essentially the distance that sound waves travel at a given temperature and pressure. To effectively assess the sound velocity of rocks or sediments we must measure the distance the sound wave travels, the time required to travel this distance, and the temperature and pressure at which this occurs. In this case, it is the compressional velocity at 400 kHz.

In the Hamilton-Frame system, the travel distance is measured simply by attaching a Dial Micrometer to a transducer that moves a vertical distance equal to the sample thickness. When the sending and receiving transducers are touching each other, there is zero distance between them. A distance reading D_1 is recorded from the Dial Micrometer. When a sample is placed between the transducers, a second Dial Micrometer reading D_2 is recorded, and the travel distance is calculated as D_1-D_2.

The travel time across the sample is measured in a similar manner as the distance and is made simultaneously with the distance measurements. The lower transducer sends the sound wave

*Sound Velocity section quoted from Boyce (1970) and the upper one receives it. When the two transducers are together, the received wave is observed in an oscilloscope and a relative time reading, t_1, is recorded. There is some relative time across the transducers at zero separation. A sample is placed between the transducers and a second reading, t_2, of the received wave is recorded. This is essentially the relative time the sound takes to cross the transducers plus the sample. Thus, the time that the sound traveled through the sample is t_2-t_1. Velocity is calculated by $Vp = (D_1-D_2/t_2-t_1) =$ km/sec. The temperature of the sample is recorded at the time of measurement.

Temperature

The velocity measurements were done after the samples were brought to room temperature. This allows for a good comparison of data and eliminated samples with a temperature gradient. The temperatures of the soft sediments could be obtained by simply inserting a thermometer into, or near the sample. Where the rocks were without a soft matrix in which to insert a thermometer, the room temperature was recorded after sufficient time was allowed for the rock to come to room temperature.

Sound Velocity Test And Comparisons

1) Distilled water at a known temperature:

Measured	Theoretical	Percent Error
1.503	1.489	+0.93
1.490	1.489	+0.07
1.486	1.490	-0.27

2) Semistandard lucite, brass and aluminum blocks:

	LUCITE	BRASS	ALUMINUM
Boyce	2.741 km/sec	4.506 km/sec	6.293 km/sec
Leg 15	(±0.84%)	(±0.45%)	(±1.29%)
Schrieber[3]	2.745 km/sec	4.529 km/sec	6.295 km/sec
	(±0.006 km/sec	(±0.004 km/sec	(±0.008 km/sec

c. Penetrometer*

The purpose of the penetration measurements is to indicate relative differences of the sediment stiffness for purposes of lithologic description. Penetrometer values are in units of millimeters that a standard needle will penetrate under a fixed load of 50 g ± .1 g. The standard needle is about 5 cm in length and 1.00 to 1.02 mm in diameter. This equipment is described in detail in American Society of Testing and Materials (1965). These measurements are not designed to be a calculated specific unit of strength such as shear strength. Because the surface sediments are normally disturbed during coring operations, these values are not necessarily representative of in situ conditions.

d. Seismic Profiles

All the photographs in this report are of seismic reflection data collected on the R/V GLOMAR CHALLENGER. The seismic reflection profiler system was generally the same on all legs, consisting of:

1. Bolt PAR 600A airgun of variable size, 30-300 cubic inches.
2. A 20-element EVP23 towed array.
3. Bolt FA-7 band pass filter, set for a 30-150 Hz band.
4. Two EDO Western Model PBR 333 recorders.

Sites with seismic record photographs missing indicate no adequate data are available on microfilm from the GLOMAR CHALLENGER. Other research vessels gathered seismic data on the preliminary site surveys and generally, have data available. To find other sources for seismic data, refer to the Initial Reports of the Deep Sea Drilling Project.

*Penetrometer explanation comes from Boyce, (1970).

2. Shore-based Studies

a. Grain-Size Analyses

Grain-Size distribution was determined by standard sieving and pipette analysis. The sediment sample was dried and then dispersed in a Calgon solution. If the sediment failed to disaggregate in Calgon, it was dispersed in hydrogen peroxide. The sand-sized fraction was separated by a 62.5 μm sieve, with the fines being processed by standard pipette analysis following Stokes settling velocity equation, which is discussed in detail in Volume IX of the Initial Reports of the Deep Sea Drilling Project. Step-by-step procedures are covered in Volume IV. In general, the sand-, silt-, and clay-sized fractions are reproducible within $\pm$2.5% (absolute) with multiple operators over a long period of time. A discussion of this precision is in Volume IX. Sediment classification is after Shepard (1954) or JOIDES (1974) with the sand, silt, and clay size boundaries based on the Wentworth (1922) scale (Figs. 3a & 3b Lithologic Data, this paper).

b. Carbon and Carbonate Analyses*

The carbon-carbonate data were determined by a Leco induction furnace combined with a Leco acid-base semi-automatic carbon determinator. Normally, the more precise seventy-second analyzer is used in place of the semi-automatic carbon determinator.

The sample was burned at 1600°C, and the liberated gas of carbon dioxide and oxygen was volumetrically measured in a solution of dilute sulfuric acid and methyl red. This gas was then passed through a potassium hydroxide solution, which preferentially absorbs carbon dioxide, and the volume of the gas was measured a second time. The volume of carbon dioxide gas is the difference of the two volumetric measurements. Corrections were made to standard temperature and pressure. Step-by-step procedures are in Volume IV of the Initial Reports of the Deep Sea Drilling Project and a discussion of the method, calibration, and precision are in Volume IX.

Total carbon and organic carbon (carbon remaining after treatment with hydrochloric acid) are determined in terms of percent by weight and the theoretical percentage of calcium carbonate is calculated from the following relationship:

Percent calcium carbonate ($CaCO_3$) = (%total C −%C after acidification) X 8.33

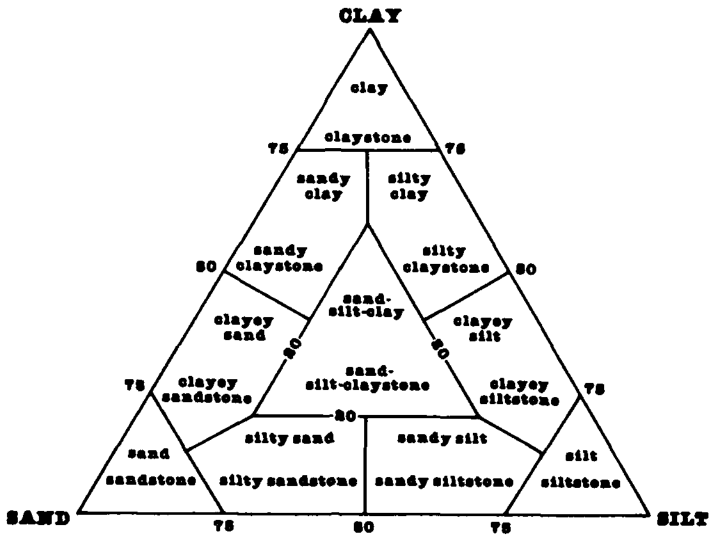
However, carbonate sediments may also include magnesium, iron, or other carbonate; this may result in "calcium" carbonate values greater than the actual content of calcium carbonate. In our determinations, all carbonate is assumed to be calcium carbonate. Precision of the determination is as follows:

Total carbon (within 1.2%–12%	=	$\pm$0.3% absolute
Total carbon (within 0%–1.2%	=	$\pm$0.06% absolute
Organic carbon	=	$\pm$0.06% absolute
Calcium carbonate (within 10% −100%)	=	$\pm$3% absolute
(within 0% − 10%)	=	$\pm$1% absolute

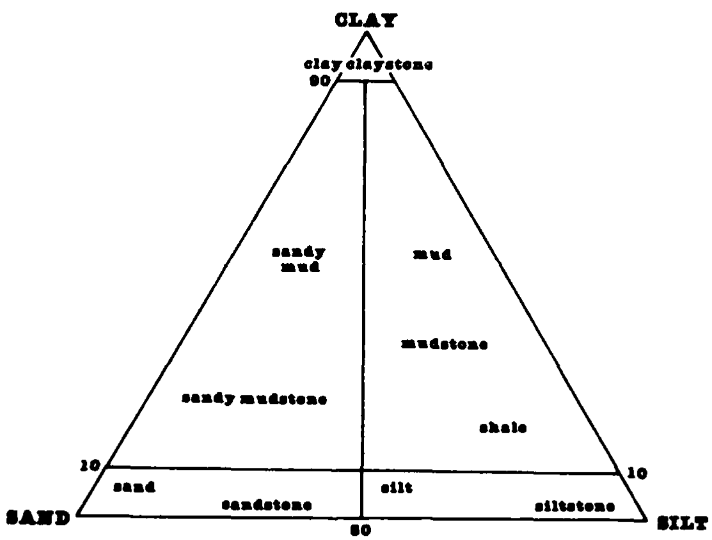
c. Silica Analysis

The silica percentage was taken from a smear slide description of a portion of the sediment or rock. A thin layer of material is applied with water onto a glass slide. It is first dried, then covered with a material of known refractive index. The material is then observed with a transmitted-light microscope. The optical behavior of a mineral allows its composition to be determined and its relative abundance is estimated. It is assumed that,

*Carbon and Carbonate Analyses sections summarized and quoted from Boyce and Bode (1972).



(after Sheppard 1954)



(JOIDES 1974)

Figure 3. Sediment textural classifications

within a reasonable error range, the scientists are consistent in determining what minerals are on a slide and what their relative abundances are.

d. X-ray Methods

Samples of sediment were examined using X-ray diffraction methods at the University of California under the supervision of H. E. Cook

Treatment of the raw samples included washing to remove seawater salts, grinding to less than 10 μm under butanol, and expansion of montmorillonite with trihexylamine acetate. The sediments were X-rayed as randomized powders. A more complete account of the methods used at Riverside is found in Appendix III of Volume IV and Appendix III of Volume XXVIII of the Initial Reports.

e. Time Stratigraphic Framework

Abbreviations of geologic time units used are shown in Figure 4, along with the classification scheme recommended by the JOIDES Advisory Panel on Paleontology and Biostratigraphy in Appendix I, Vol. 3, pp. 609, Initial Reports of the Deep Sea Drilling Project.

C. Lithologic Classification

Two lithologic classifications are discussed in this section. The first classification scheme (Sect. II, C.1) was devised for use with digital computers (Davies et al., 1977). This automated scheme was used to generate the lithologic presentations in the Data Summary Section of this report, and is used by the DSDP with their automated data files. The second classification (Sect. II, C.2) is a more complete and formal scheme which is used in the Initial Reports, JOIDES (1974). Both schemes are discussed here to enable the reader to discern their similarities and dissimilarities, and to compare the condensed data presentation of this report to be more complete lithologic classifications of the Initial Reports.

1. Automated Lithologic Classification Scheme

The lithologic classification scheme used in this study is taken from a computer program developed by Davies, Mushich, and Woodbury (1977) for the automated classification of deep-sea sediments. They utilized a modification of a deep-sea sediment classification scheme developed by a working group from the JOIDES Advisory Panel on Sedimentary Petrology and Physical Properties (see Section I. A.2.), which has been used by DSDP since Leg 38.

The modified scheme is a dichotomous key (Fig. 5) with which sediments are initially separated into those that are dominantly biogenetic in composition and those that are not. Biogenetic sediments are defined as those in which either the siliceous or calcareous fossil content exceeds 30% or in which the total biogenetic components exceed 50%. Biogenetic sediments in which the total biogenetic component exeeds 70% are considered pure biogenetic sediments; those with less than 70% are considered transitional biogenetic sediments. The classification divides the biogenetic sediments into those which are primarily calcareous and those which are siliceous. Both pure and transitional biogenetic sediments are then further subdivided into monogenetic and heterogeneous groups, and are finally classified on the basis of the major biogenetic component. Monogenetic calcareous sediments have more than 60% carbonate, and monogenetic siliceous sediments more than 50% siliceous fossils. Dolomites (greater than 70% dolomites) and shallow-water carbonates (greater than 30% shallow-water indicators) are separated as special groups.

The nonbiogenetic (detrital) sediments are divided, on the basis of the presence or absence of more than 10% "slow-sediment indicators," into pelagic and nonpelagic (terrigenous) groups. Slow sediment indicators include authigenic components (zeolites, iron manganese micronodules,

APPROX. TIME (10^6 YEARS)			SERIES	STAGE	
	CENOZOIC CEN	QUAT. QUAT	Holocene HOLO		
1.5	CENOZOIC CEN	QUAT. QUAT	Pleistocene PLEIS		
	CENOZOIC CEN	TERTIARY TERT	Pliocene PLI	upper	uPLI
7	CENOZOIC CEN	TERTIARY TERT	Pliocene PLI	lower	lPLI
	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	upper	uMIO
	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	middle	mMIO
26	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	lower	lMIO
	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	upper	uOLI
	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	middle	mOLI
37-38	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	lower	lOLI
	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	upper	uEOC
	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	middle	mEOC
53-54	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	lower	lEOC
	CENOZOIC CEN	TERTIARY TERT	Paleocene PAL	upper	uPAL
64-65	CENOZOIC CEN	TERTIARY TERT	Paleocene PAL	lower	lPAL
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Meastrichtian	MAES
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Campian	CAMP
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Santonian	SANT
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Coniacian	CONI
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Turonian	TURO
100	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Cenomanian	CENO
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Albian	ALBI
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Aptian	APTI
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Barremian	BARR
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Hauterivian	HAUT
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Valangianian	VALA
136	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Berriasian	BERR
	MESOZOIC MES	JURASSIC JURA	upper uJURA	Tithonian	TITH
	MESOZOIC MES	JURASSIC JURA	upper uJURA	Kimmeridgian	KIMM
154	MESOZOIC MES	JURASSIC JURA	upper uJURA	Oxfordian	OXFO

Figure 4. Time stratigraphic framework

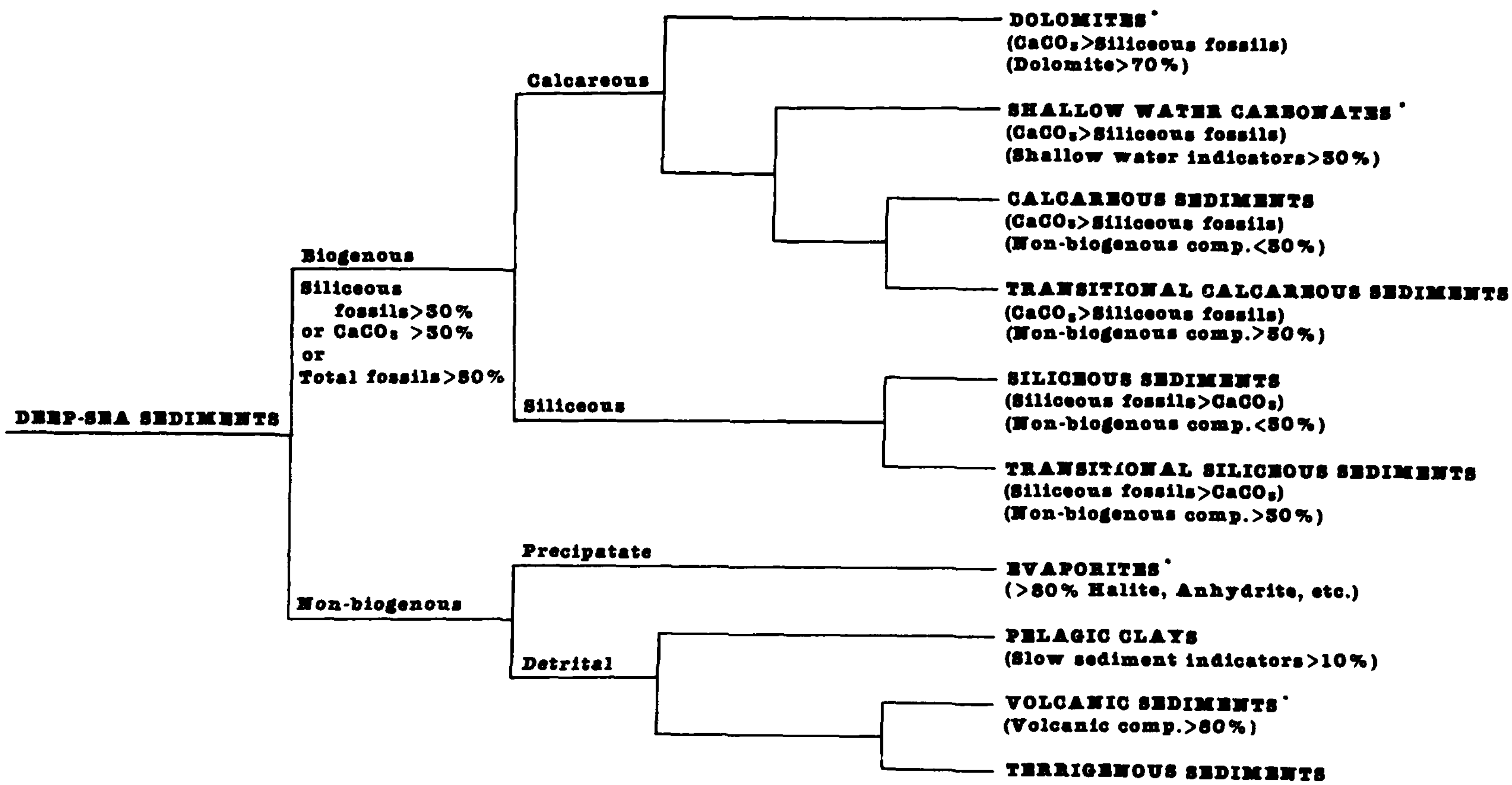


Figure 5. Scheme used for automated classification of deep-sea sediments

etc.), fish debris, and other indicators of very slow accumulation rates. Non-slow indicator sediments are divided into terrigeneous and volcanogenic (greater than 80% volcanogenic material) sediments classified on the basis of texture using schemes proposed by Wentworth (1922) and Wentworth and Williams (1932), as shown in Figures 3a and 3b. All sediment groups are classified according to the degree of induration.

2. JOIDES Lithologic Classification Scheme*

PRINCIPLES USED IN CLASSIFICATION

1. This is a lithologic summary classification designed to generalize core descriptive material of greater detail into a form suitable for standard core and hole logs. Its systematic use will facilitate core to core and leg to leg comparisons.

2. The classification covers most of the lithologic types encountered so far but does not attempt to be comprehensive. A category "special Rock Types" allows additional definitions and terminology at the discretion of the shipboard staff for rock types not covered.

3. Sediment names are those in common usage and have been defined within the limits of existing definitions.

4. Categories are based on sediment parameters measured on board ship. Refinement by shore laboratory data is possible but not necessary.

5. The classification is descriptive and genetic implications are not intended.

6. The degree of detail of the classification is scaled to the space limitations of printed graphic hole and core summaries.

*Explanation of JOIDES Lithologic Classification Scheme quoted from JOIDES (1974)

SHIPBOARD PARAMETERS MEASURED

Sediment and rock names are defined solely on the basis of compositional and textural parameters. The compositional factors are most important for description of those deposits more characteristic of open marine conditions, with textural factors becoming more important for the classification of hemipelagic and near-shore facies. Sediment names are thus based solely upon these parameters as determined in smear slides aided by compositional and textural properties apparent to the naked eye or under the hand lens. Other descriptive parameters include: induration, sediment disturbance, sedimentary structures, and color. The determination of these parameters is as follows:

1) Composition - biogenic and mineral components are estimated in percent from smear slides. $CaCO_3$ content is estimated by using the carbonate bomb available on the ship. Even with rapid use, a value of $\pm 5\%$ is achievable.

2) Texture - visual estimates from smear slide examination.

3) Induration - The determination of induration is highly subjective, but field geologists have successfully made similar distinctions for many years. The categories suggested here are thought to be practical and significant. The criteria of Moberly and Heath (1971) are used for calcareous deposits; subjective estimate or behavior in core cutting for others. There are three classes for calcareous sediments: two for all others.

a) Calcareous sediments

(i) Soft: Oozes have little strength and are readily deformed under the finger or the broad blade of a spatula.

(ii) Firm: Chalks are partly indurated oozes; they are friable limestones that are readily deformed under the fingernail or the edge of a spatula blade. More indurated chalks are termed limestones (see below).

(iii) Hard: Limestones as a term should be restricted to cemented rocks.

b) The following criteria are recommended for all but calcareous sediments:

(i) If the material is low state of induration as to allow the core to be split with a wire cutter, the sediment name only is used (e.g., silty clay; mud).

(ii) If the core must be cut on the band saw or diamond saw, the suffix 'stone' is used (e.g., silty claystone; mudstone; or shale, if fissile).

4) Sediment Disturbance - Deformation structures are generally of the type found in piston cores, and are usually simple to visualize and interpret.

a) Soft to firm sediment: The following categories are recommended.

(i) Slightly deformed-bedding contacts are slightly bent.

(ii) Moderately deformed-bedding contacts have undergone extreme bowing.

(iii) Very deformed-bedding is completely disturbed, sometimes showing symmetrical diapir-like structure.

(iv) Soupy-water saturated intervals which have lost all aspects of original bedding.

b) Hard sediments: There is also the need to indicate the degree of fracturing in hard sediments/rock. This is best accomplished with a written description in the Lithologic Description portion of the Core Form (Fig. 6).

5) Sedimentary structures - In many cores it is extremely difficult to differentiate between natural and coring-induced structures. Consequently, the description of sedimentary structures is optional. The following approach is suggested as a guideline, but the specialist is encouraged to use his own preferred system and set of symbols.

a) Median grain size profile: For the sections of terrigenous sediments, with interbeds of varying textural characteristics, the construction of median grain size profile based on hand lens observations provides a rapid method for illustrating graded and non-graded beds, bed thicknesses, and size distribution.

b) Sedimentary structures: A set of suggested symbols is provided for categories shown on (Fig. 7).

6) Color - According to standard Munsell and GSA color charts.

USE OF THE CORE FORM

1) Mandatory Graphic Lithology Column - This graphic column is based on the above classification scheme. Completion of the column using the appropriate symbols (Fig. 8) must be done for each site, and will be included in the Initial Core Description (ICD) and Initial Report Volume. The "Special Rock Type" category should be used for sediment types not in the classification.

a) Optional graphic column: If circumstances or the special skills and interests of the shipboard staff indicate an additional modified or different classification, another graphic column may be added to the right of the Mandatory Column using definitions, terminology and symbols that, in the opinion of the shipboard staff, will increase the information yield. This Optional Column must not substitute for the Mandatory Column.

2) Sediment disturbance column - Completion of the sediment disturbance column using symbols and distinctions given below is mandatory.

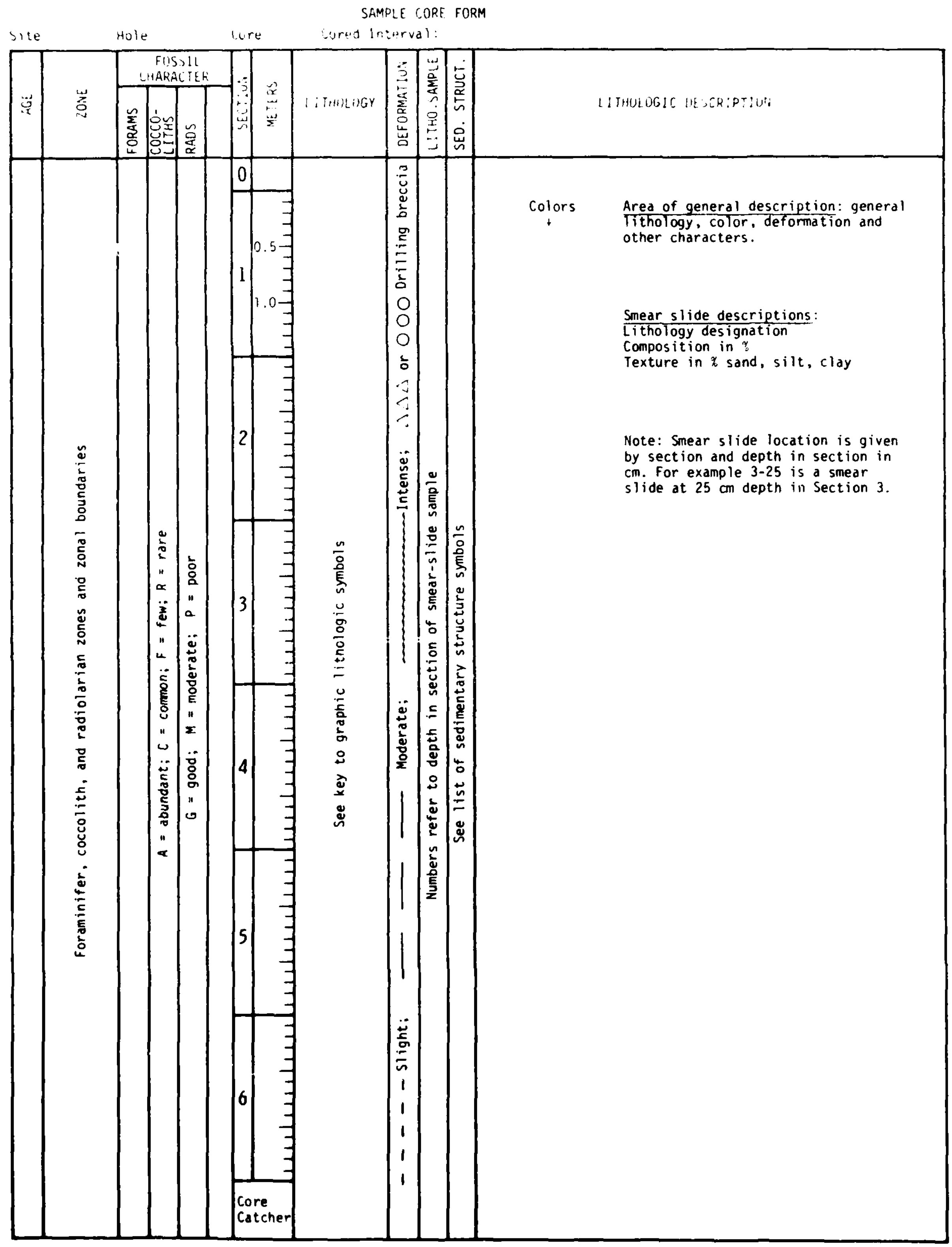


Figure 6. Sample core form (from DSDP, Vol. 39)

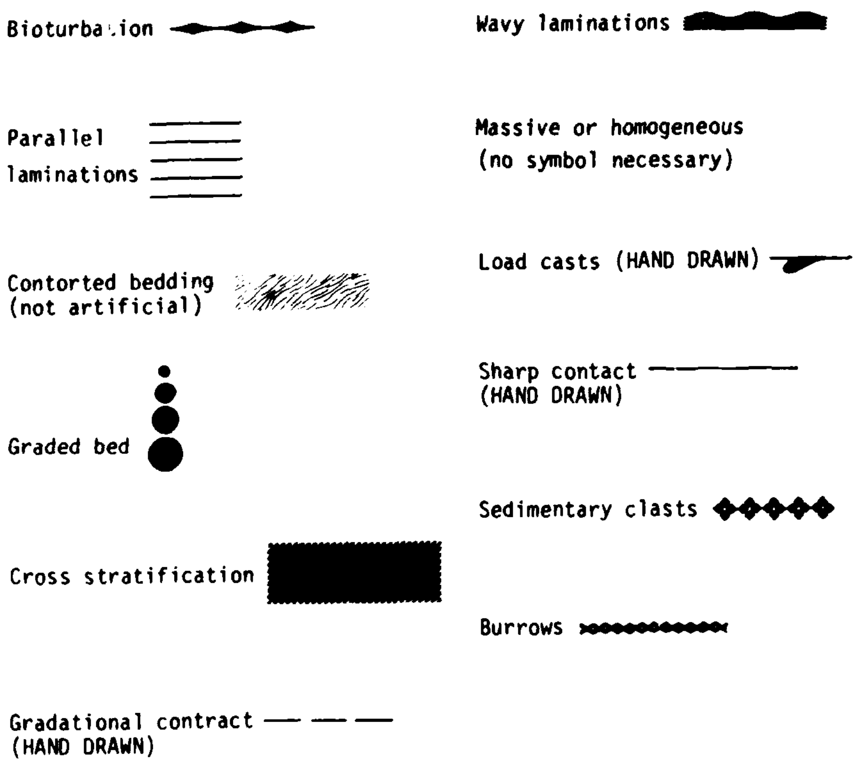


Figure 7. Sedimentary structure symbols (from DSDP, Vol. 39)

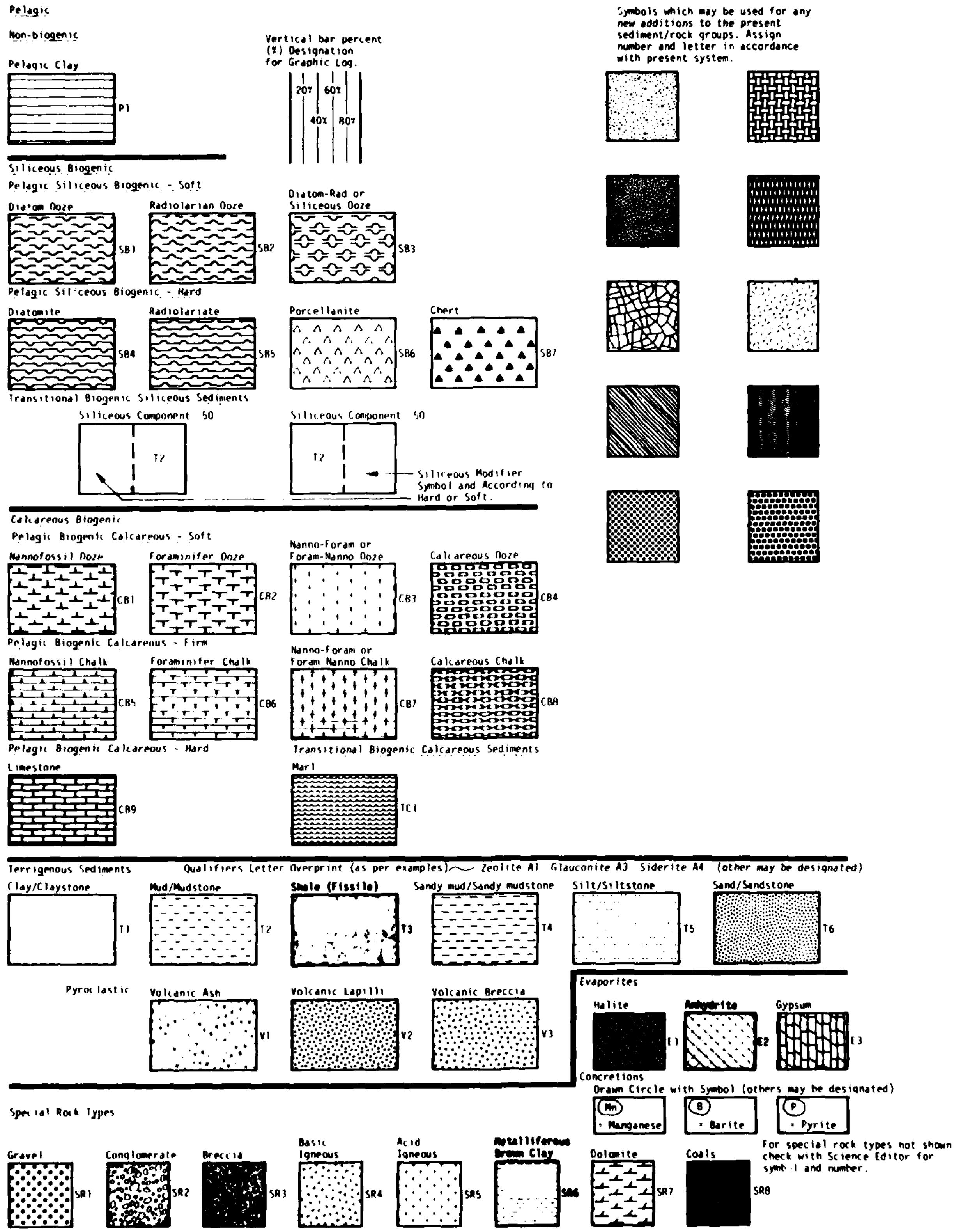


Figure 8. Lithologic symbols (from DSDP, Vol. 39)

3) <u>Sedimentary structure columns</u> - Structures may be designated on the core form in the sedimentary structure column parallel to the sediment disturbance column, and/or on the median grain size profile (for the sections of terrigenous sediments, with interbeds of varying textural characteristics). The median grain size profile is located in the lithologic description portion of the core form. A set of suggested symbols for a few more common structures has been prepared by DSDP (Fig. 6), but the shipboard geologist is free to use whatever additional symbols he may wish. These optional columns may not substitute for the mandatory sediment disturbance column and must be distinct from it.

4. <u>Lithologic description column</u> - Format, style, and terminology of the descriptive portion of the core sheets are not controlled by the mandatory column scheme, beyond the minimal name assignment which should be derived from this classification. However, colors and additional information on structure and textures should normally be included in the textural section of the core description.

LITHOLOGIC CLASSIFICATION SCHEME

The following define compositional class boundaries and use of qualifiers in the lithologic classification scheme:

1) <u>Compositional Class Boundaries</u>

a) $CaCO_3$ content (determined by $CaCO_3$ bomb): 30% and 60%. With a 5% precision and given the natural frequency distribution of $CaCO_3$ contents in oceanic sediments, these boundaries can be reasonably ascertained.

b) Biogenic opal abundance (expressed as percent siliceous skeletal remains in smear slides): 10%, 30%, and 50%. Smear-slide estimates of identifiable siliceous skeletal material generally imply a significantly higher total opal abundance. The boundaries have been set to take this into account.

c) Abundance of authigenic components (zeolites, Fe, and Mn microndules etc), fish bones, and other indicators of very slow sedimentation (estimated in smear slides); semi-quantitative boundary: common 10%. These components are quite conspicuous and a semi-quantitative estimate is adequate. Even a minor influx of calcareous, siliceous, or terrigenous material will, because of the large difference in sedimentation rate, dilute them to insignificance.

d) Abundance of terrigenous detrital material (estimated from smear slides): 30%.

e) Qualifiers: Numerous qualifiers are suggested; the options should be used freely. However, components of less than 5% (in smear slide) should not be used as a qualifier except in special cases. The most important component should be the last qualifier. No more than two qualifiers should be used.

Description of Sediment Types

1) Pelagic clay - Principally authigenic pelagic deposits that accumulate at very slow rates. The class is often termed brown clay, or red clay, but since these terms are confusing, they are not recommended.

a) Boundary with terrigenous sediments: Where authigenic components (Fe/Mn micronodules, zeolites), fish debris, etc., become common in smear slides. NOTE: Because of large discrepancy in accumulation rates, transitional deposits are exceptional.

b) Boundary with siliceous biogenic sediments: <30% indentifiable siliceous remains.

c) Boundary with calcareous biogenous sediments: Generally the sequence is one passing from pelagic clay through siliceous ooze to calcareous ooze, with one important exception: at the base of many oceanic sections, black, brown or red clays occur directly on basalt, overlain by or grading up into calcareous sediments. Most of the basal clayey sediments are rich in iron, manganese and metallic trace elements. For proper identification they require more elaborate geochemical work than is available on board. These sediments are placed in the "Special Rock" category, but care should be taken to distinguish them from ordinary pelagic clays.

2) Pelagic siliceous biogenic sediments - These are distinguished from the previous category because they have more than 30% identifiable siliceous microfossils. They are distinguished from the following category by a $CaCO_3$ content of less than 30%. There are two classes: Pelagic biogenic siliceous sediments (containing less than 30% silt and clay); and transitional biogenic siliceous sediments (containing more than 30% silt and clay and more than 10% diatoms).

a) Pelagic biogenic siliceous sediments:

soft: siliceous ooze (radiolarian ooze, diatom ooze, depending on dominant component).

hard:	radiolarite	porcellanite
	diatomite	chert

(i) Qualifiers:

Radiolarians dominant: radiolarian ooze or radiolarite.

Diatoms dominant: diatom ooze or diatomite. Where uncertain: siliceous (biogenic) ooze, or chert or porcellanite, when containing >10% $CaCO_3$, qualifiers are as follows:

indeterminate carbonate:	calcareous --
nannofossils only:	nannofossil --
foraminifers only:	foraminifer --

or

nannofossil-foraminifer -- depending on dominant component
foraminiferal-nannofossil --

b) Transitional biogenic siliceous sediments:

Diatoms <50%	diatomaceous mud:	soft
	diatomaceous mudstone:	hard
Diatoms >50%	muddy diatom ooze:	soft
	muddy diatomite:	hard

Radiolarian equivalents in this category are rare and can be specifically described.

3) Pelagic biogenous calcareous sediments - These are distinguished from the previous categories by a $CaCO_3$ content in excess of 30%. There are two classes: Pelagic biogenic calcareous sediments (containing less than 30% silt and clay); and transitional biogenic calcareous sediments (containing more than 30% silt and clay).

a) Pelagic biogenic calcareous sediments:
soft: calcareous ooze
firm: chalk
hard: indurated chalk.

The term limestone should preferably be restricted to cemented rocks.

(i) Compositional Qualifiers - Principal components are: nannofossils and foraminifers. One or two qualifiers may be used, for example:

Foram %	Name
<10	Nannofossil ooze, chalk, limestone.
10-25	Foraminiferal-nannofossil ooze
25-50	Nannofossil-foraminifer ooze
>50 for:	Foraminifer ooze

Calcareous sediment containing more than 10%-20% identifiable siliceous fossils carry qualifier radiolarian, diatomaceous, or siliceous depending on the quality of the identification. For example, radiolarian-foraminifer ooze.

b) Transitional biogenic calcareous sediments

(i) $CaCO_3$ = 30%-60%: marly calcareous pelagic sediments.
soft: marly calcareous (or nannofossil, foraminifer, etc.), ooze (see below)
firm: marly chalk
hard: marly limestone

(ii) $CaCO_3$ >60%: Calcareous pelagic sediments.

soft: calcareous (or nannofossil, foraminifer, etc.), ooze (see below)
firm: chalk
hard: limestome

NOTE: Sediments containing 10%-30% $CaCO_3$ fall in other classes where they are denoted with the adjective "calcareous." Less than 10% $CaCO_3$ is ignored.

4) Terrigenous sediments

a) Sediments falling in this portion of the classification scheme are subdivided into textural groups on the basis of the relative proportions of three grain size constituents, i.e., clay, silt, and sand. Rocks coarser than sand size are treated as "Special Rock Types." The size limits for these constituents are those defined by Wentworth (1922) (Fig. 9).

Five major textural groups are recognized on the accompanying triangular diagram (Fig. 3). These groups are defined according to the abundance of clay (>90%, 90-10%, <10%) and the ratio of sand to silt (>1 or <1). The terms clay, mud, sandy mud, silt, and sand are used for the soft or unconsolidated sediments which are cut with a wire in the shipboard core splitting process. The hard or unconsolidated equivalents for the same textural groups are claystone, mudstone (or shale, if fissile), sandy mudstone, siltstone, and sandstone. Sedimentary rocks falling into the consolidated category include those which must generally be cut with the band saw or diamond saw. Sands and sandstones may be subdivided further into very fine-, fine-, medium-, coarse-, or very coarse-grained sands and sandstones according to their median grain size.

(i) Qualifiers - In this group numerous qualifiers are possible, usually based on minor constituents, for example: glauconitic, pyritic, feldspathic. In the sand and sandstone category, conventional divisions such as arkose, graywacke, etc., are of course, acceptable, providing the scheme is properly identified. Clays, muds, silts, and sands containing 10%-30% $CaCO_3$ shall be called calcareous.

b) Volcanogenic sediments

Pyroclastic rocks are described according to the textural and compositional scheme of Wentworth and Williams (1932). The textural groups are:

Volcanic breccia >32 mm
Volcanic lapilli <32 mm
Volcanic ash (tuff, if indurated) <4 mm
Compositionally, these pyroclastic rocks are described as vitric (glass), crystal or lithic.

c) Clastic sediments of volcanic provenance are described in the same fashion as the terrigenous sediments, noting the dominant composition of the volcanic grains where possible.

5) Special rock types - The definition and nomenclature of sediment and rock types not included in the system described above are left to the discretion of shipboard scientists with the recommendation that they adhere as closely as practical to conventional terminology.

In this category fall such rocks as:
Intrusive and extrusive igneous rocks;
Evaporites, halite, anhydrite, gypsum (as a rock), etc.;
Shallow water limestone (biostromal, biohermal, coquina, oolite, etc.);

	Millimeters		Phi (ϕ) units	Wentworth size class
	2.00	2	1.0	Granule
SAND	1.68		0.75	Very coarse sand
	1.41		0.5	
	1.19		0.25	
	1.00	1	0.0	
	0.84		0.25	Coarse sand
	0.71		0.5	
	0.59		0.75	
	0.50	1/2	1.0	
	0.42		1.25	Medium sand
	0.35		1.5	
	0.30		1.75	
	0.25	1/4	2.0	
	0.210		2.25	Fine sand
	0.177		2.5	
	0.149		2.75	
	0.125	1/8	3.0	
	0.105		3.25	Very fine sand
	0.088		3.5	
	0.074		3.75	
	0.0625	1/16	4.0	
SILT	0.053		4.25	Coarse silt
	0.044		4.5	
	0.037		4.75	
	0.031	1/32	5.0	
	0.0156	1/64	6.0	Medium silt
	0.0078	1/128	7.0	Fine silt
	0.0039	1/256	8.0	Very fine silt
MUD	0.0020		9.0	Clay
	0.00098		10.0	
	0.00049		11.0	
	0.00024		12.0	
	0.00012		13.0	
	0.00006		14.0	

Grade scales for terrigenous sediment.

Figure 9. Sediment grain size scale

Dolomite;
Gravels, conglomerates, breccias;
Metalliferous brown clays;
Concretions, barite, iron-manganese, phosphite, pyrite, etc.;
Coal, asphalt, etc.;
and many others.

The mandatory graphic lithology column should be completed by shipboard staff with appropriate symbols for intervals containing special rock types. It is imperative that symbols and rock nomenclature be properly defined and described by shipboard staff.

III. Selected Bibliography of Special Studies

Included in the Initial Reports, along with the site discussions, are a number of "Special Studies". These studies are generally directed toward selected sites or synthesize the drill sites of a single leg; however, they often have regional or global significance. This section is comprised of a list of papers which appear in the Special Studies section of the Initial Reports, Volumes 1-44, which deal with geophysical, engineering, and physical properties of the sea floor.

Comparison of Three Methods of Measuring or Estimating Sonic Velocity in Sediments, Dean A. McManus, Vol. V, Chap. 27, p. 545, 1969.

Saturated Bulk Density, Grain Density and Porosity of Sediment Cores from the Western Equatorial Pacific: Leg 7, GLOMAR CHALLENGER, E. L. Gealy, Vol. VII, pt. 2, Chap. 24, p. 1081, 1969.

Sound Velocity, Elastic Constants, and Related Properties of Marine Sediments in the Western Equatorial Pacific: Leg 7, GLOMAR CHALLENGER, E. L. Gealy, Vol. VII, pt. 2, Chap. 25, p. 1105, 1969.

Physical Properties Synthesis, F. M. Cook and H. E. Cook, Vol. IX, pt. 3, Chap. 23, p. 945, 1969.

Leg XI Measurements of Physical Properties in Sediments of the Western North Atlantic and their Relationship to Sediment Consolidation, Fred J. Paulus, Vol. XI, pt. 3, Chap. 24, p. 667, 1970.

Compressional Sound Velocities in Semi-Indurated Sediments and Basalts from DSDP Leg XI, Edward Schreiber, P. J. Fox, and J. Peterson, Vol. XI, pt. 3, Chap. 25, p. 723, 1970.

Discussion and Interpretation of Some Physical Properties, R. B. Whitmarsh, Vol. XII, pt. 2, Chap. 12, p. 935, 1970.

Underway Geophysical Measurements Obtained on the GlOMAR CHALLENGER in the Eastern North Atlantic and Mediterranean Sea, W. B. F. Ryan and T. B. Gustafson, Vol. XIII, pt. 2, Chap. 15, p. 517, 1970.

Geophysical Surveys at Sites 120, 121, and 132 of the Deep Sea Drilling Projects, E. Christofferson and M. R. Fisk, Vol. XIII, pt. 2, Chap. 16, p. 581, 1970.

Correlation of a Trans-Tyrrhenian Reflection Profile with Site 132, E. F. K. Zarudzki, C. Morelli, I. Finetti, H. K. Wong, Vol. XIII, pt. 2, Chap. 17, p. 587, 1970.

Compressional Wave Velocity in Selected Samples of Gabbro, Schist, Limestone, Anhydrite, Gypsum and Halite, E. Schreiber, P. J. Fox and J. J. Peterson, Vol. XIII, pt. 2, Chap. 18, p. 595, 1970.

Evaluation of Physical Properties Measurements, J. M. Lort, Vol. XIII, pt. 2, Chap. 39, p. 1401, 1970.

Bathymetric, Magnetics, and Seismic Reflection Data: CHALLENGER Leg XIV, Dennis E. Hayes and Anthony C. Pimm, Vol. XIV, pt. 2, Chap. II, p. 341, 1970.

Physical Properties, Anthony C. Pimm, Vol. XIV, pt. 2, Chap. 18, p. 655, 1970.

Compressional Wave Velocities in Basalt and Altered Basalt Recovered During Leg XIV, Paul J. Fox and Edward Schreiber, Vol. XV, Chap. 31, p. 1013, 1970.

Physical Properties Summary, Robert C. Boyce, Vol. XV pt. 2, Chap. 38, p. 1067, 1970.

Physical Properties Evaluation, Richard H. Bennett and George H. Kellar, Vol. XVI, pt. 2, Chap. 13, p. 513, 1971.

Compressional and Shear Wave Velocities in Basaltic Rocks, Deep Sea Drilling Project, Leg 16, Nikolas I. Christensen, Vol. XVI, pt. 2, Chap. 24, p. 647, 1971.

Measurements of Porosity in Sediments of the Lower Continental Margin, Deep Sea Fans, the Aleutian Trench, and the Alaskan Abyssal Plain, Ronald von Huene, David J. W. Piper and John R. Duncan, Vol. XVII, pt. 2, Chap. 26, p. 889, 1971.

Physical Properties of Deformed Sediment from Site 181, Homa J. Lee, Harold W. Olsen, and Ronald von Huene, Vol. XVIII, pt. 2, Chap. 27, p. 897, 1971.

Preliminary Site Surveys in the Bering Sea for the Deep Sea Drilling Project, Leg 19, Daniel J. Fornari, Robert J. Iuliucci, and George G. Shor, Jr., Vol. XIX, pt. 3, Chap. 13, p. 569, 1971.

Compressional Shear Wave Velocities and Elastic Moduli of Basalts, Deep Sea Drilling Project, Leg 19, Nikolas I. Christensen, Vol. XIX, pt. 3, Chap. 17, p. 657, 1971.

Measurements and Estimates of Engineering and Other Physical Properties, Leg 19, Homa J. Lee, Vol. XX, pt. 3, Chap. 15, p. 319, 1971.

Physical Properties Synthesis, Leg 20, Deep Sea Drilling Project, George Z. Forristall, Vol. XX, pt. 2, Chap. 21, p. 319, 1971.

Triaxial Compression Tests, Leg 20, Deep Sea Drilling Project, Michael B. Smith, George Z. Forristall, Vol. XX, pt. 2, Chap. 21, p. 417, 1971.

R/V THOMAS WASHINGTON CRUISE ARIES V: Reconnaissance Seismic Reflection Profiles of Prospective DSDP Sites in the Northwest Pacific, Bruce C. Heezen and Marie Tharp, Vol. XX, pt. 2, Chap. 24, p. 429, 1971.

Site Survey Report: KANA KEOKI Sites 3 and 4 Honolulu to Ponape, 1971, R. G. Zachariadis, Vol. XX, pt. 2, Chap. 25, p. 487, 1971.

A Seismic Profile Between the Bonin Trench and 160°E, Thomas A. Davis, Vol. XX, pt. 1, Chap. 26, p. 505, 1971

Seismic Reflection Profiles Between Fiji, Guam, and Japan, Bruce C. Heezen and John W. Jones, Vol. XX, pt. 2, Chap. 28, p. 547, 1971.

Determination of Sedimentary Velocities Using Expendable Sonobuoys at DSDP, Leg 20 Drilling Sites, Northwest Pacific, E. John and W. Jones, Vol. XX, pt. 2, Chap. 30, p. 625, 1971.

Correlation of Seismic Reflectors, James E. Andrews, Vol. XXI, pt. 3, Chap. 12, p. 459, 1971.

Seismic Profiles Made Underway on Leg 22, John J. Veevers, Vol. XXII, pt. 2, Chap. 10, p. 351, 1972.

Correlation of Reflectors with Lithology for Site 212, George Carpenter, Vol. XXII, pt. 2, Chap. 15, p. 397, 1972.

Stratigraphic Seismic Section Correlations and Implications to Bengal Fan History, David G. Moore, Joseph R. Curray, Russell W. Raitt, and Frans J. Emmel, Vol. XXII, pt. 2, Chap. 16, p. 403, 1972.

Porosity, Density, Grain Density, and Related Physical Properties of Sediments from the Red Sea Drill Cores, Frank T. Manheim, Linda Dwight, and Rebecca A. Belastock, Vol. XXIII, pt. 4, Chap. 26, p. 887, 1972.

Appendix IV: Geophysical Appendix, Robert B. Whitmarsh, Vol. XXIII, pt. 5, p. 1159, 1972.

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V. Data Summary

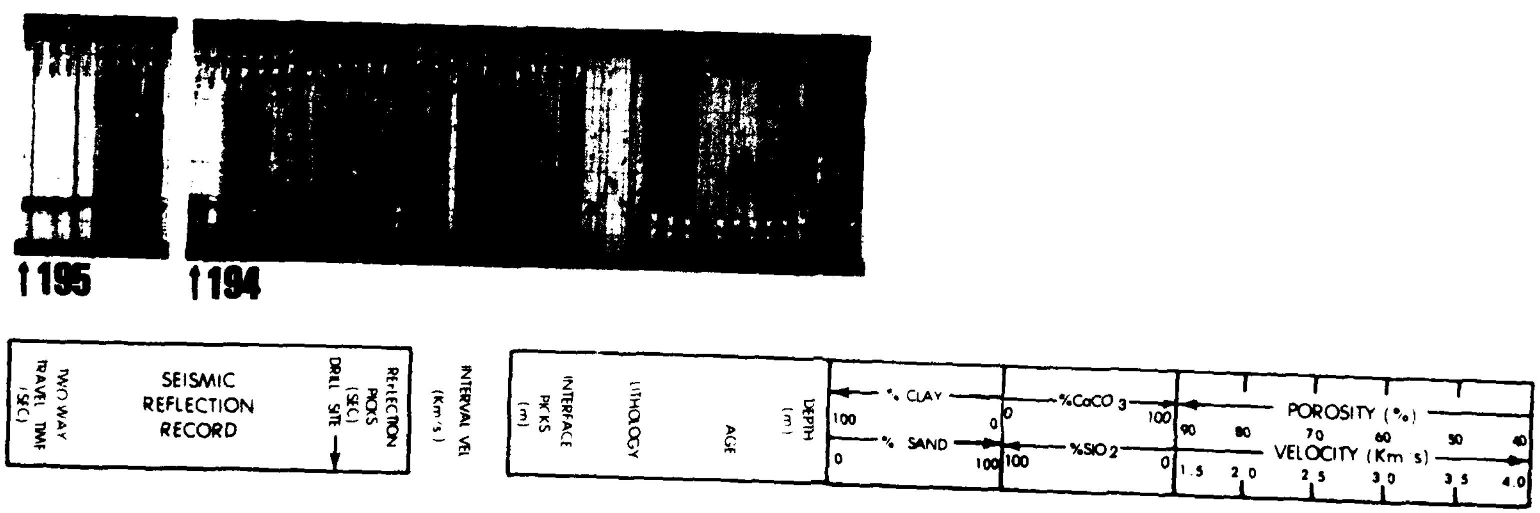
SITE DATA

Position:
  Latitude $33°58.7'$ N
  Longitude $146°48.6'$ E
Date: 09/19/71
Time: 0700Z
Water depth: 5754 meters
Location: Abyssal floor east of Japan

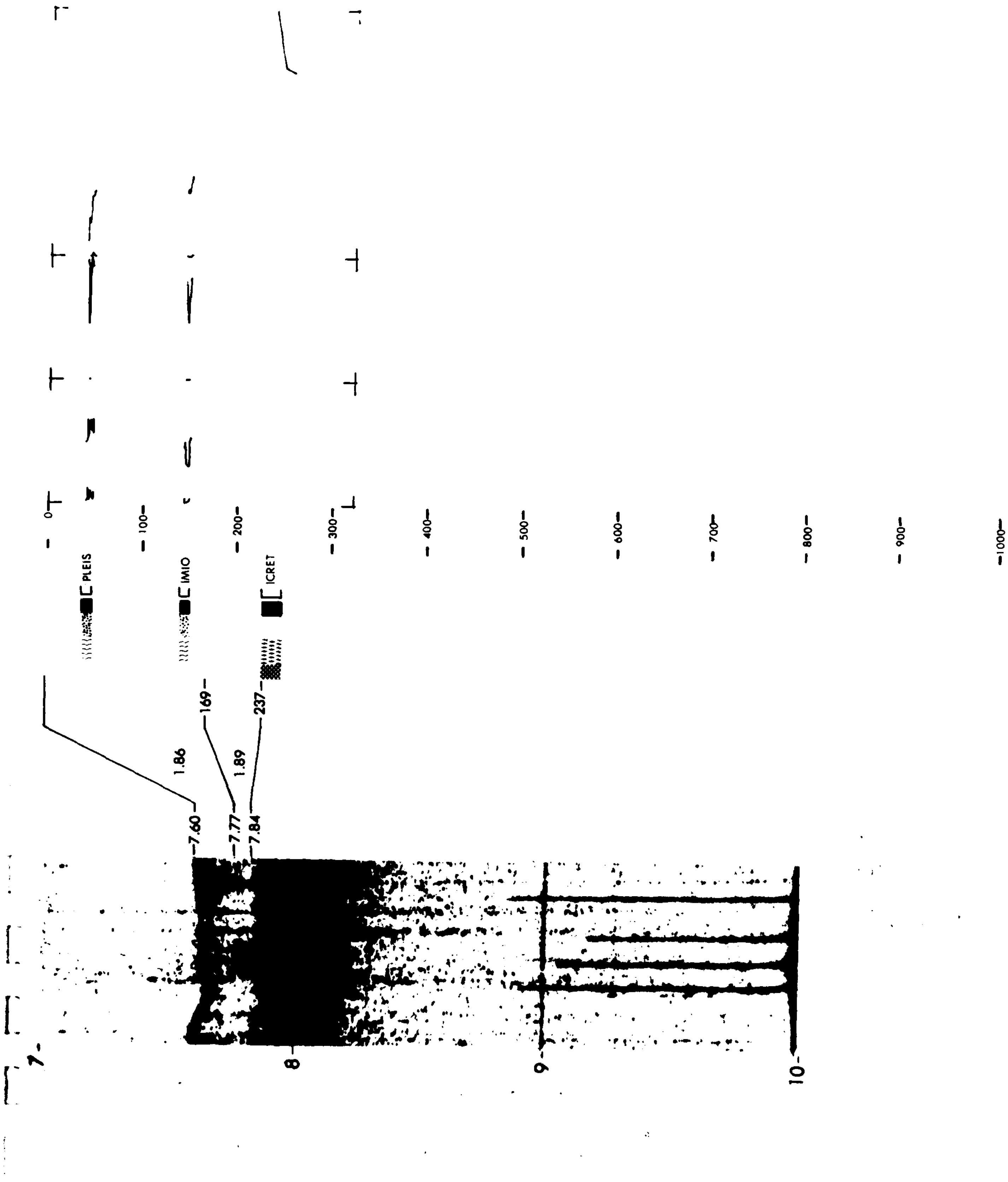
CORE DATA

Penetration:
  Drilled-- 216 meters
  Cored---- 40 meters
  Total---- 256 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 5 cores
  15 meters

The thickening of the upper transparent acoustic layer observed on seismic reflection records is principally the result of a wedge of late Miocene to Quaternary ashy clays which are nearly 1 km thick on the east side of the Japan Trench off Tokyo, and which progressively thin eastward for 1000 to 1500 km. This wedge of sediments, which was supplied from the island arcs and lands which border the Pacific Basin on the west, overlies a thinner, slowly deposited sequence of early Tertiary and Late Cretaceous abyssal clays which were apparently deposited without the influence of adjacent terrestrial and volcanic sources.



SITE 194 LEG 20



SITE DATA

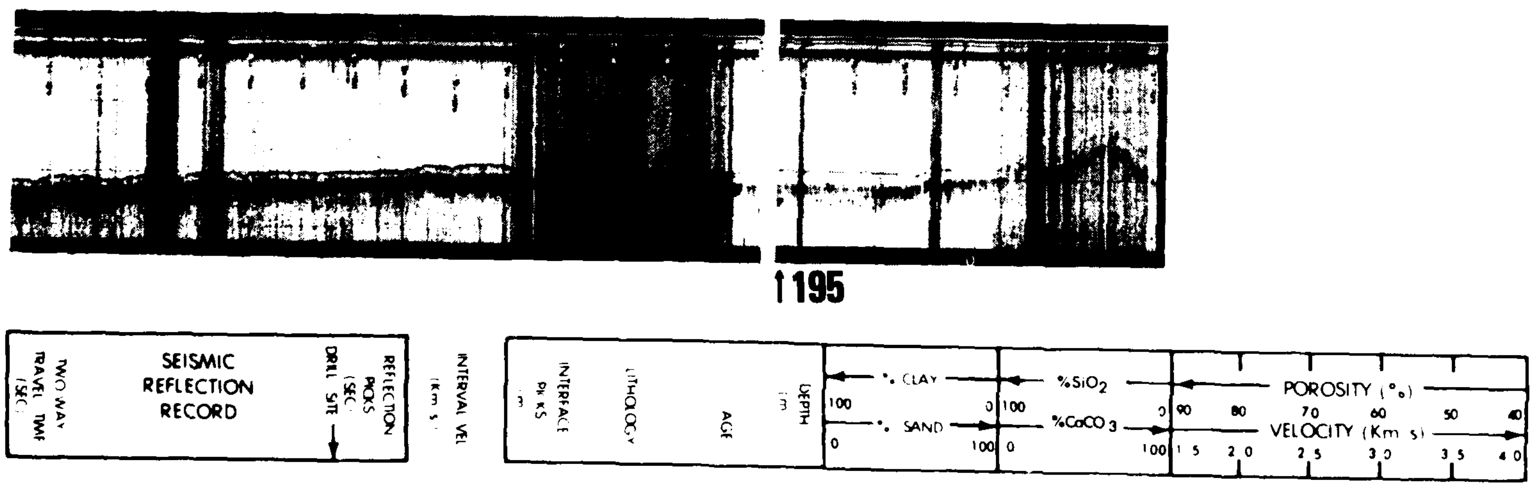
Position:
Latitude 32°46.4' N
Longitude 146°58.7' E
Date: 09/22/71
Time: 1535Z
Water Depth: 5968 meters
Location: Abyssal floor of Izu-Bonin Trench

CORE DATA

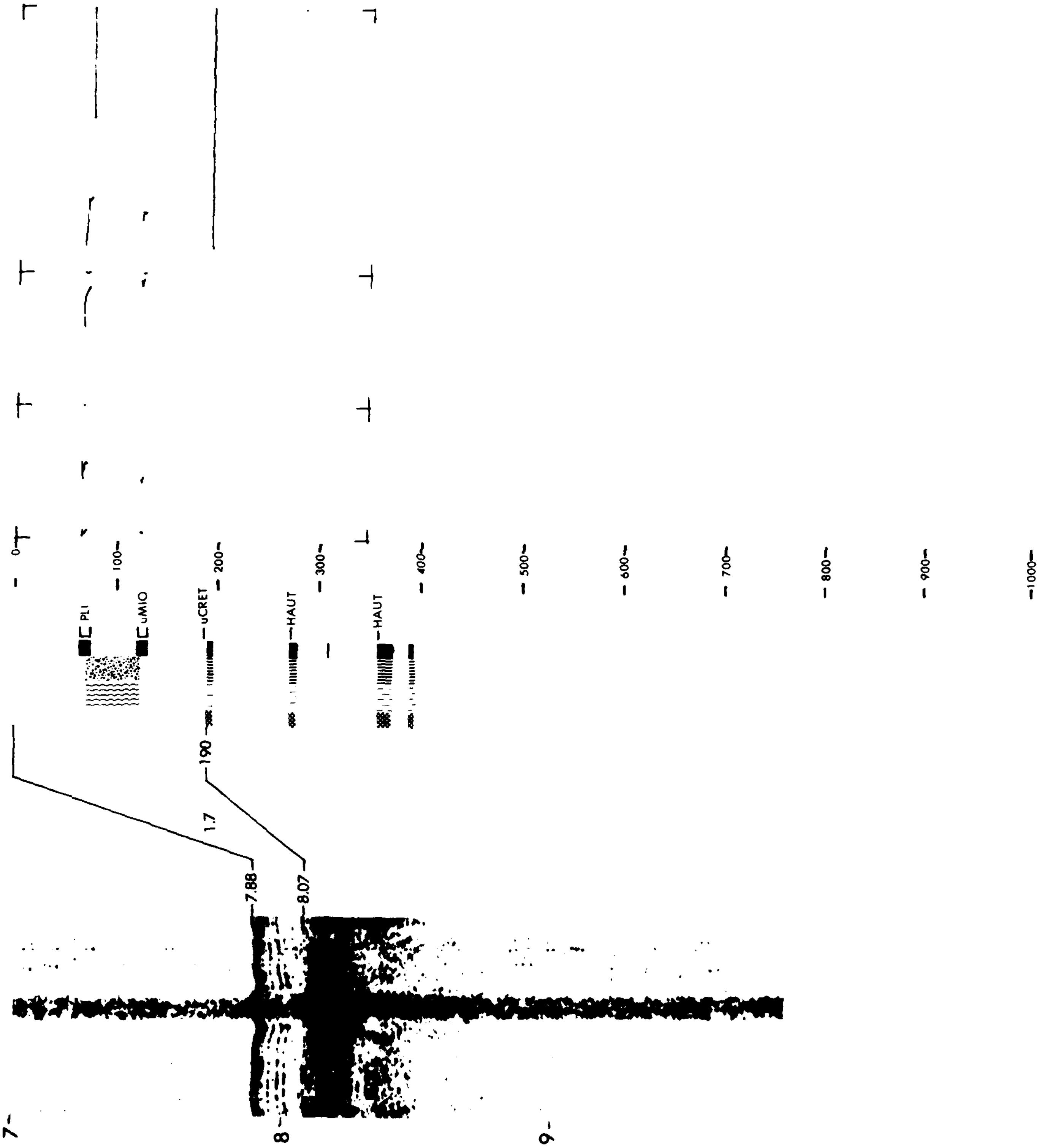
Penetration:	195	195A	195B	
Drilled--	261	283	376	meters
Cored----	31	0	16	meters
Total----	292	283	392	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	5	0	3	cores
	14	0	1	meters

The late Miocene to Quaternary wedge of ash clays reaches a thickness of approximately 150 meters at this site, which now lies over 800 km from probable sources in the Japan-Bonin Arc. The clays of this modern blanket can be distinguished from the underlying more slowly deposited early Tertiary clays by the virtual absence of zeolites. The chert barrier corresponds to the top of the acoustic opaque layer and is found in Mid-Cretaceous sediments. The opaque layer and the lower transparent layer cannot be distinguished at this location on the basis of the lithology of core samples or the drilling rates. Acoustic basement was not reached. If it is volcanogenic oceanic crust, the age of crust in this area could not be much older than Late Jurassic, since the chalk sequence in which the hole bottomed can be assumed to have been deposited at a normal rate of approximately 10 m/m.y. and thus could not be more than about 10 m.y. younger than the age at total depth. However, there is no evidence that the rather smooth "acoustic basement" in this area is igneous other than the fact that similar-looking reflections have been found to be basement in areas of younger crust.

One sample in Hauterivian time was tested; calcareous, pelagic, hard and nannofossil rich.



SITE 195 LEG 20



SITE DATA

Position:
- Latitude 30°07.0' N
- Longitude 148°34.5' E

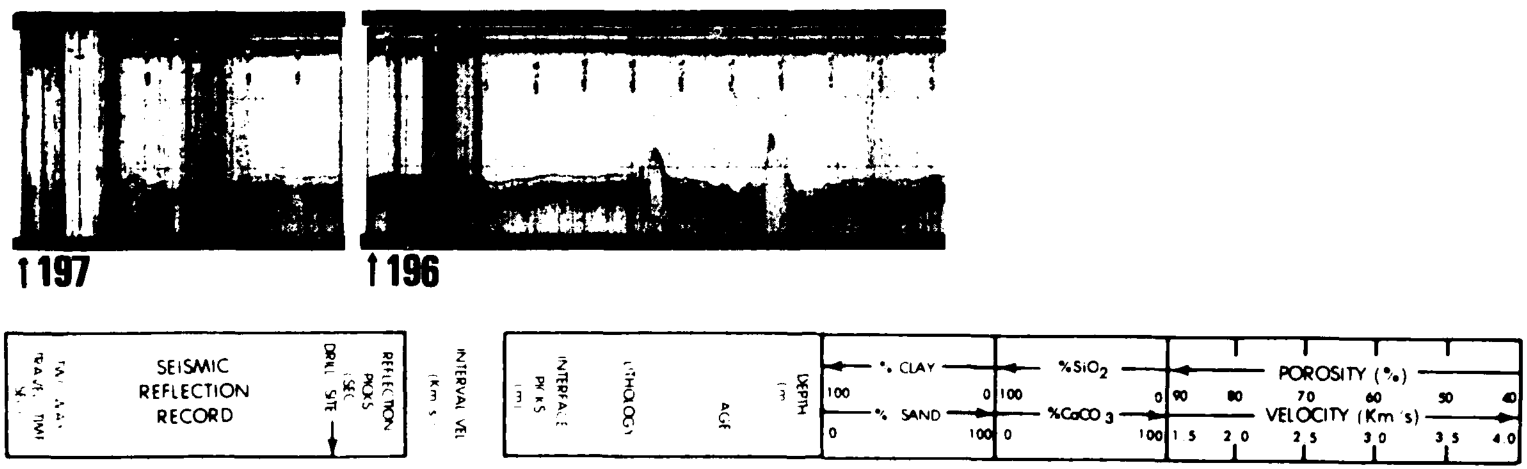
Date: 09/29/71
Time: 2121Z
Water depth: 6194 meters
Location: Abyssal floor east of Izu-Bonin Trench

CORE DATA

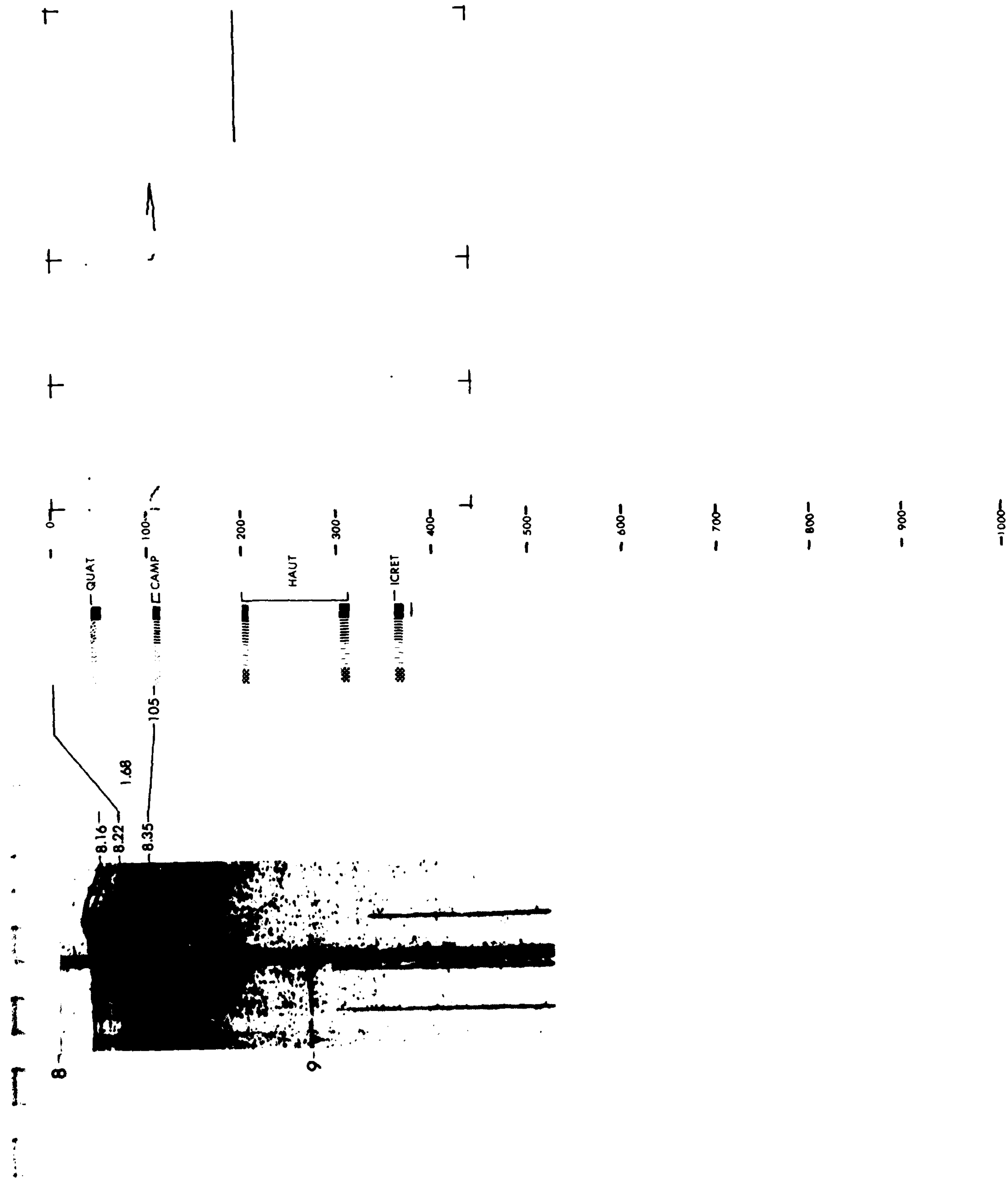
Penetration:
- Drilled-- 337 meters
- Cored---- 40 meters
- Total---- 377 meters

Recovery:
- Basement- 0 cores, 0 meters
- Total---- 6 cores, 8.5 meters

Site 196 lies southeast of Site 195 and about 200 km further from the arcs of the western Pacific. This increase in distance of 200 km is accompanied by a marked decrease in thickness of the wedge of nonzeolitic clays. It is difficult to distinguish between a plate tectonic convergence of the volcanic sources and the sites of deposition on the one hand and a late Tertiary episode of volcanism on the other. When the probable younger age of the base of the ashy layer at Site 196 is considered, the plate convergence model becomes more attractive. If the crust under Site 196 formerly lay more than 1500 km from the source under the exceedingly slow deposition regime of the abyssal midoceănic midlatitude desert region and then was transported westward toward the volcanic sources, only arriving at the proximity of their influence in the Pliocene, the transgressive age at the base of the upper ashy layer could be adequately explained. However, this need not be the only explanation, for a progressive shift in active volcanism from north to south along the Japan-Bonin Arc could produce a similar result.



SITE 196 LEG 20



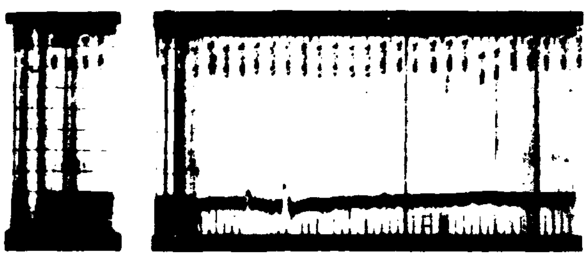
SITE DATA

Position:
Latitude $30^{\circ}17.4'$ N
Longitude $147^{\circ}40.5'$ E
Date: 10/03/71
Time: 0620Z
Water depth: 6153 meters
Location: Abyssal floor east of the Izu-Bonin Trench

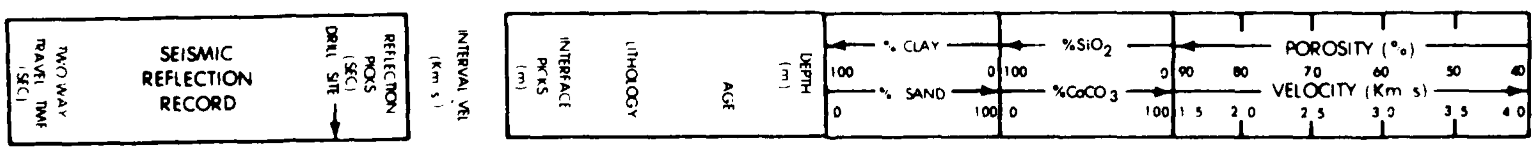
CORE DATA

Penetration:
Drilled-- 268 meters
Cored---- 10 meters
Total---- 278 meters
Recovery:
Basement- 1 cores
1 meters
Total---- 1 cores
1 meters

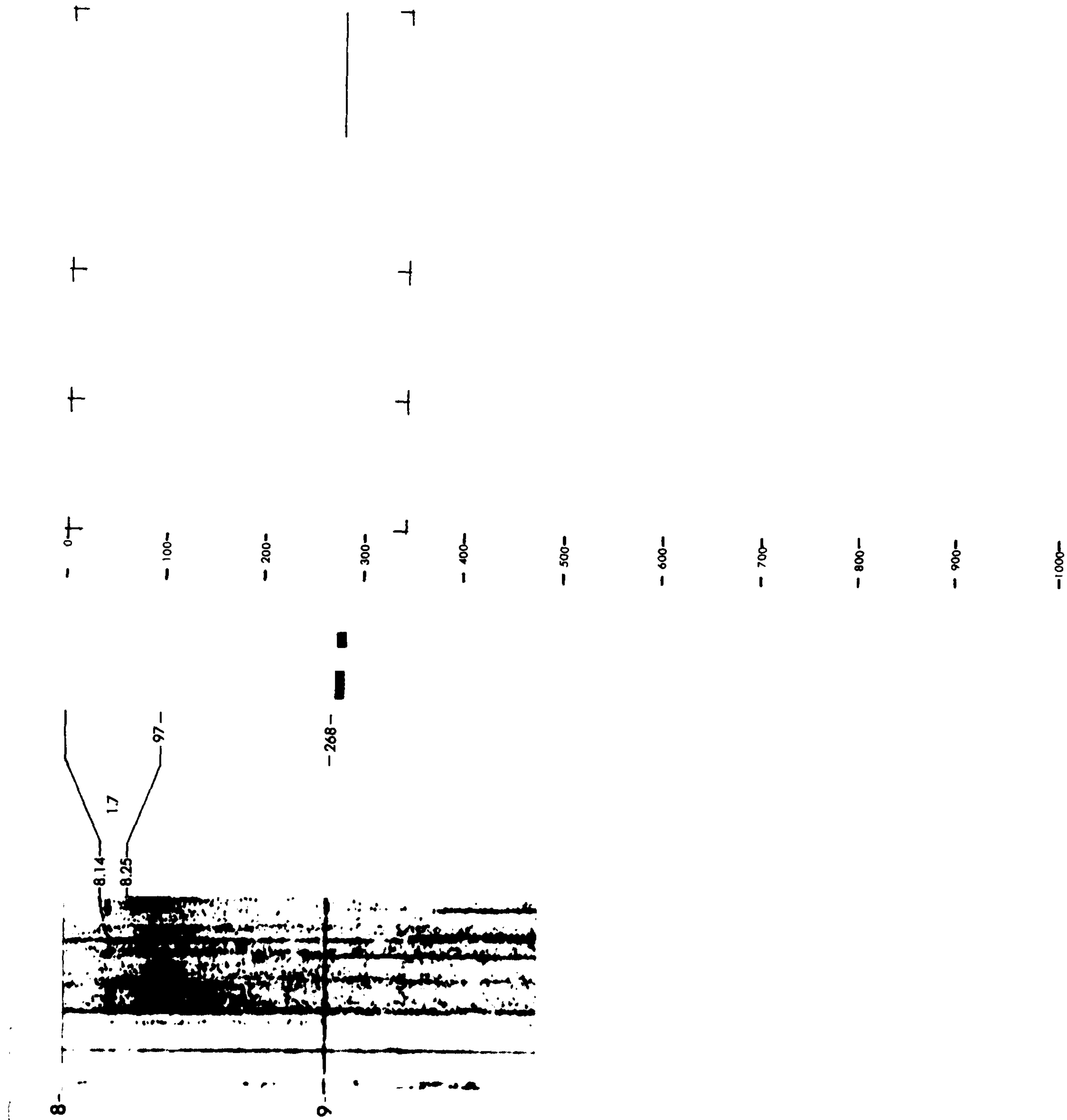
Sites 196 and 197 are only about 100 km apart; the depths of water differ by less than 50 meters, and the drilling rates in the upper 200 meters of each hole are virtually identical. It can be thus inferred that the age of the basalt recovered from the 283 meters subbottom at Site 197 is at least as old as the Late Jurassic-Early Cretaceous limestones sampled at Site 196. It seems probable that the basalt represents basement and is original oceanic crust. The recovered sample is composed of a fragmented core of a fine-grained tholeiitic basalt which is made up of plagioclase, augitic pyroxene, opaque iron oxides, and a serpentine-like alteration product. The basalt is cut by many veinlets (up to 0.5 cm) of calcite bordered by a thin margin of a greenish mineral. In one section (20 to 22 cm) intense veining results in complete alteration of the enclosed basalt, although in general the vein boundaries are sharp, and little or no alteration extends into the basalt.



↑197 ↑196



SITE 197 LEG 20



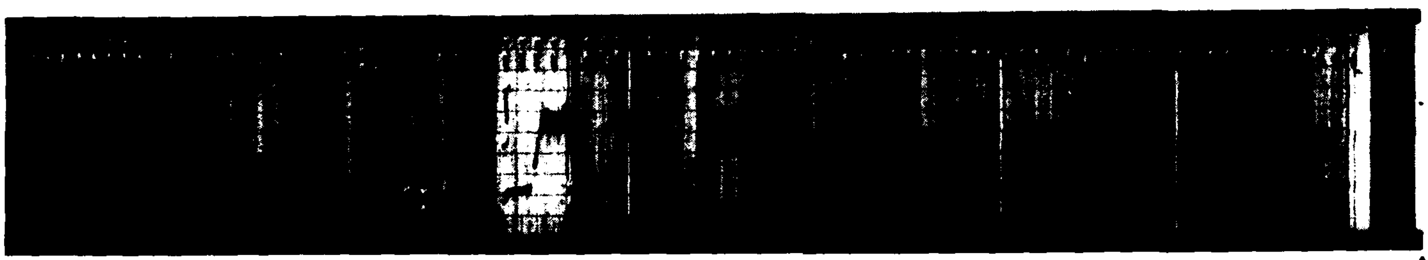
SITE DATA

Position:
Latitude 25°49.5' N
Longitude 154°35.0' E
Date: 10/14/71
Time: 2015Z
Water depth: 5958 meters
Location: Abyssal basin north of Marcus Island

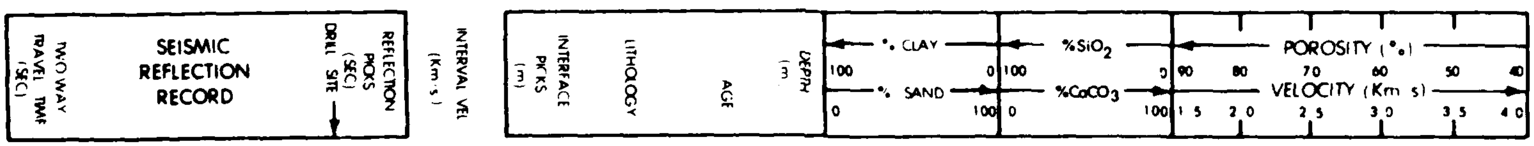
CORE DATA

Penetration:
Drilled-- 207 meters
Cored---- 51 meters
Total---- 258 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 6 cores
26 meters

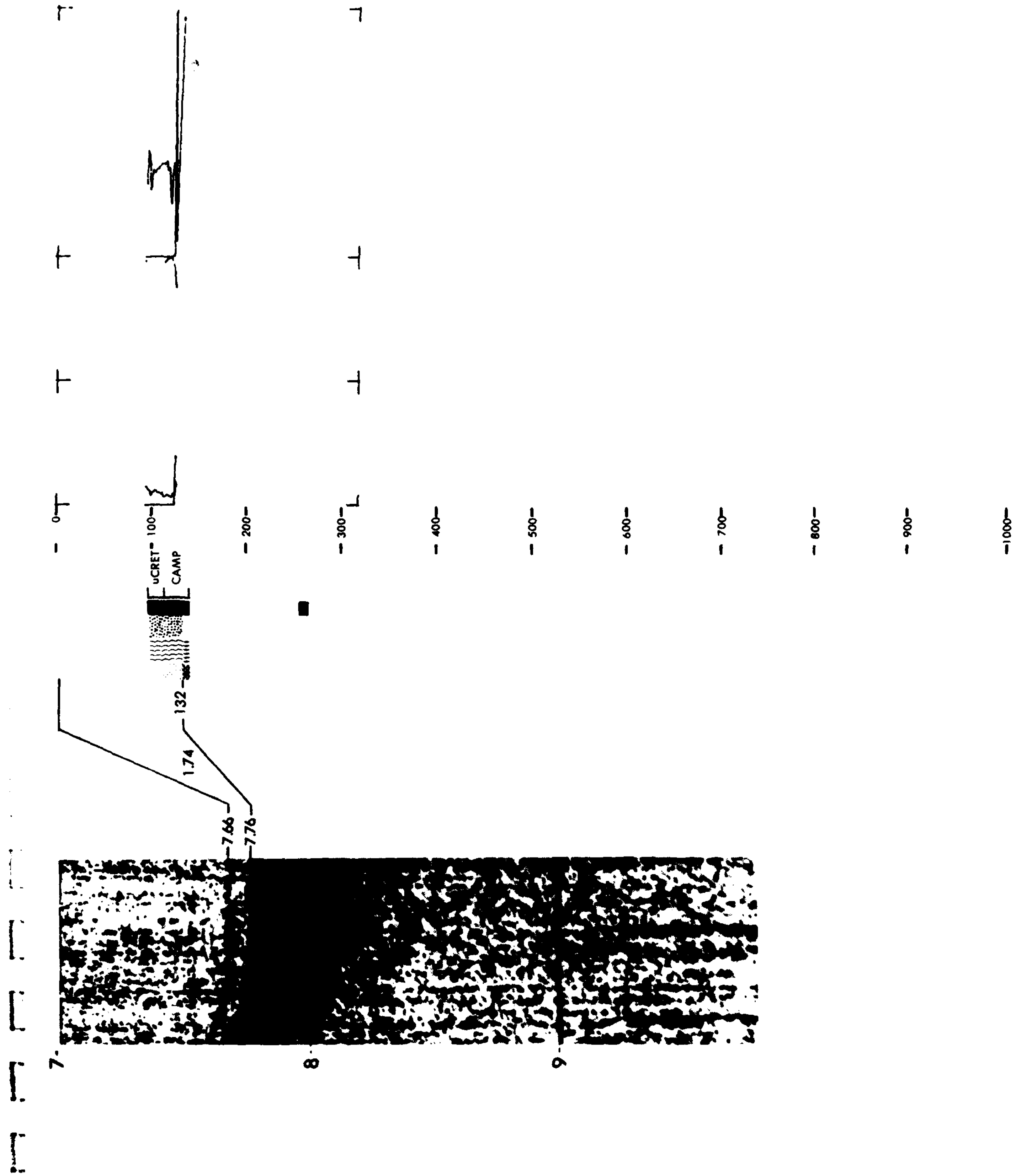
The crust in the abyssal basin north of Marcus Island was formed prior to the Late Cretaceous, probably in the Jurassic. The basement was not reached, but the calcareous nature of the basal sediments suggests definitely high sedimentation rates. In the cored sequence above the opaque layer, a downward transition is observed from very stiff, dark brown, limonitic zeolitic clays and salts with abundant ash components, to less dark radiolarian-rich zeolitic silts with increasing proportions of light volcanic ash and intercalated chert. Severe disturbance by drilling operations makes the cores almost useless for any further detailed study of the sedimentary structures, particularly the burrowing structures of organisms and the fine laminations in nonburrowed portions. The presence of sedimentary structures can only be inferred from the rarely-found less disturbed portions of the sediment and from chert pieces where they have been preserved.



198



SITE 198 LEG 20



SITE DATA

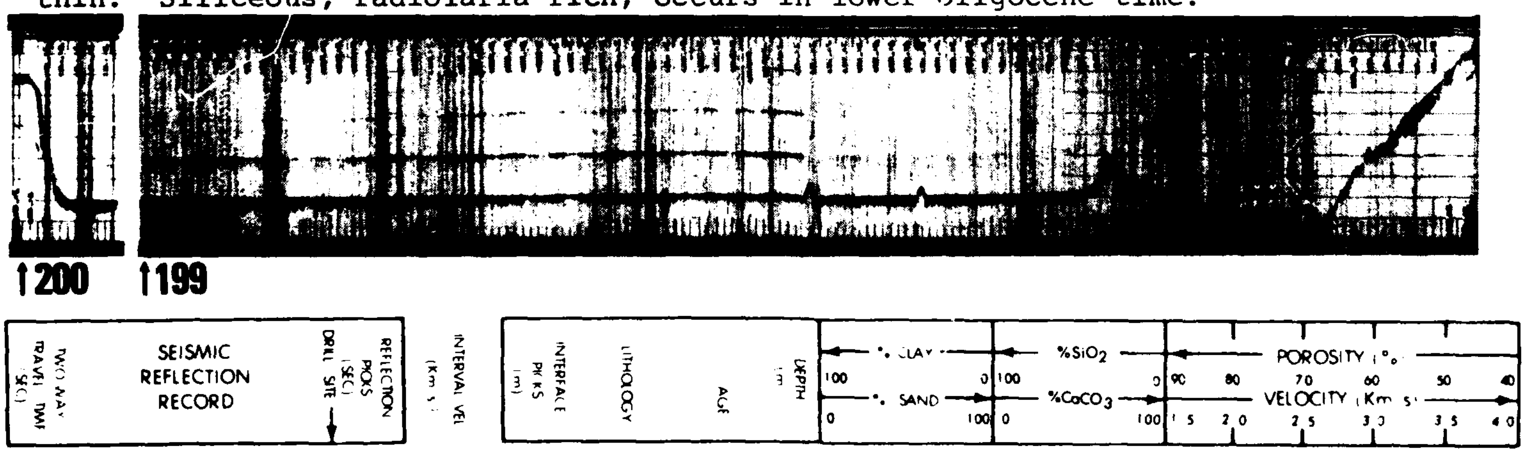
Position:
Latitude 13° 30.8' N
Longitude 156° 10.3' E
Date: 10/23/71
Time: 0200Z
Water depth: 6100 meters
Location: Caroline Abyssal Plain

CORE DATA

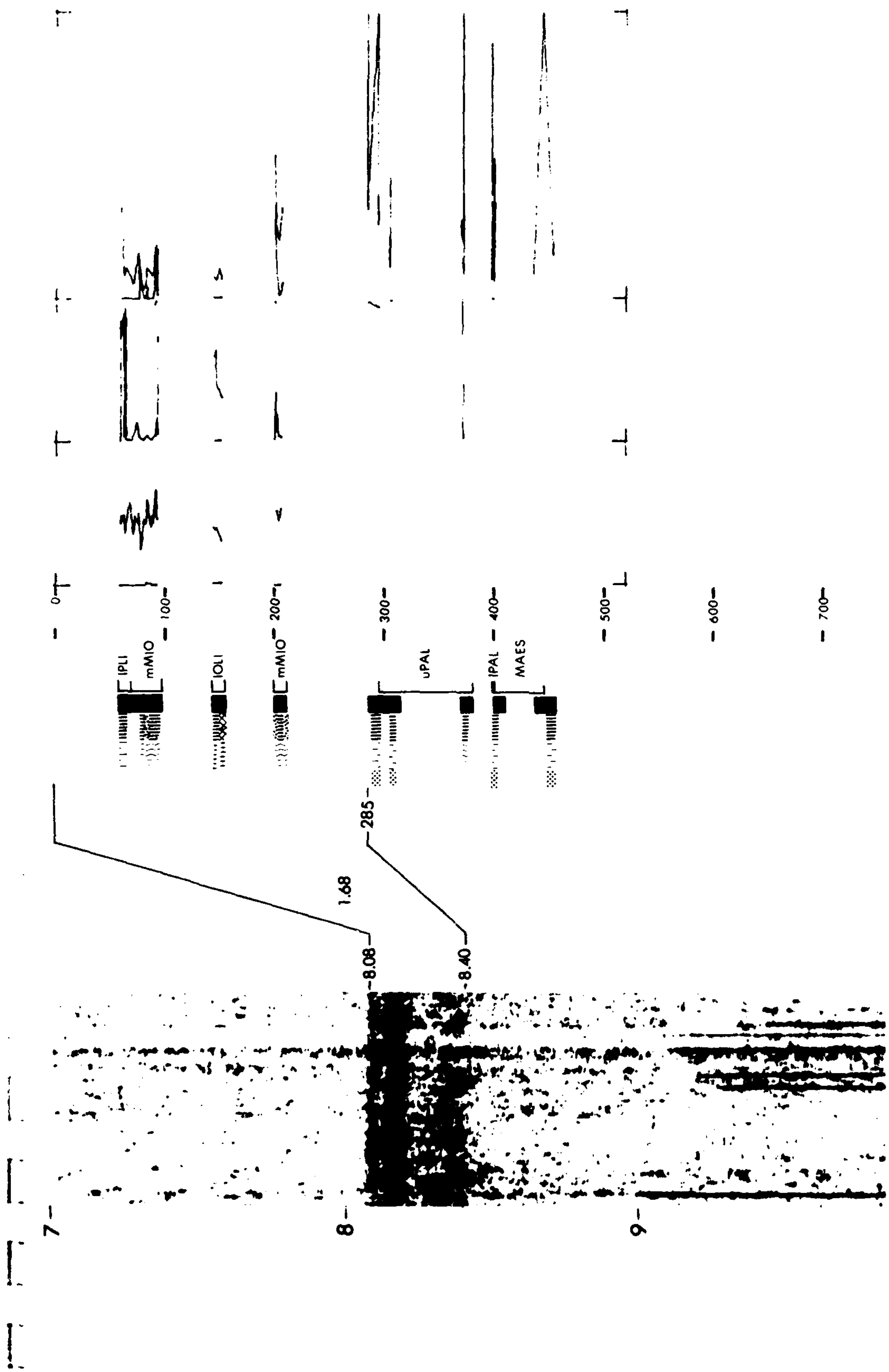
Penetration:
Drilled-- 142 meters
Cored---- 124 meters
Total---- 266 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 13 cores
59 meters

The Caroline Abyssal Plain has existed since the mid Miocene. However, since Site 199 is located near the margin of the plain, it is conceivable that the plain is somewhat older and was only built out to this location by the mid Miocene. The turbidites which contain fossils of Eocene through Miocene age could have been derived from the paroxysm which created the Caroline Ridge. The pelagic limestones of Upper Cretaceous to Paleogene age that underlie the turbidites represent mid-oceanic deposition at a considerably shallower depth with respect to the compensation depth as compared to the present abyssal depth. In the Maastrichtian, tuffs appear interbedded in the nannofossil limestones and the hole ended in tuff which is early Campanian or older. These tuffs apparently reflect nearby volcanism which might be assumed to be the volcanic episode which created the line of guyots and seamounts which lies north-northwest and south-southeast of the site. The seismic profiler record obtained after departing the site indicates at least 200 meters of sediment below the bottom of the hole. If carbonate rates of deposition of 10 m/m.y. are assumed, the basement age would be 120 million years.

Calcareous, occasionally nannofossil rich, interbedded with detrital layers some thin. Siliceous, radiolaria rich, occurs in lower Oligocene time.



SITE 199 LEG 20



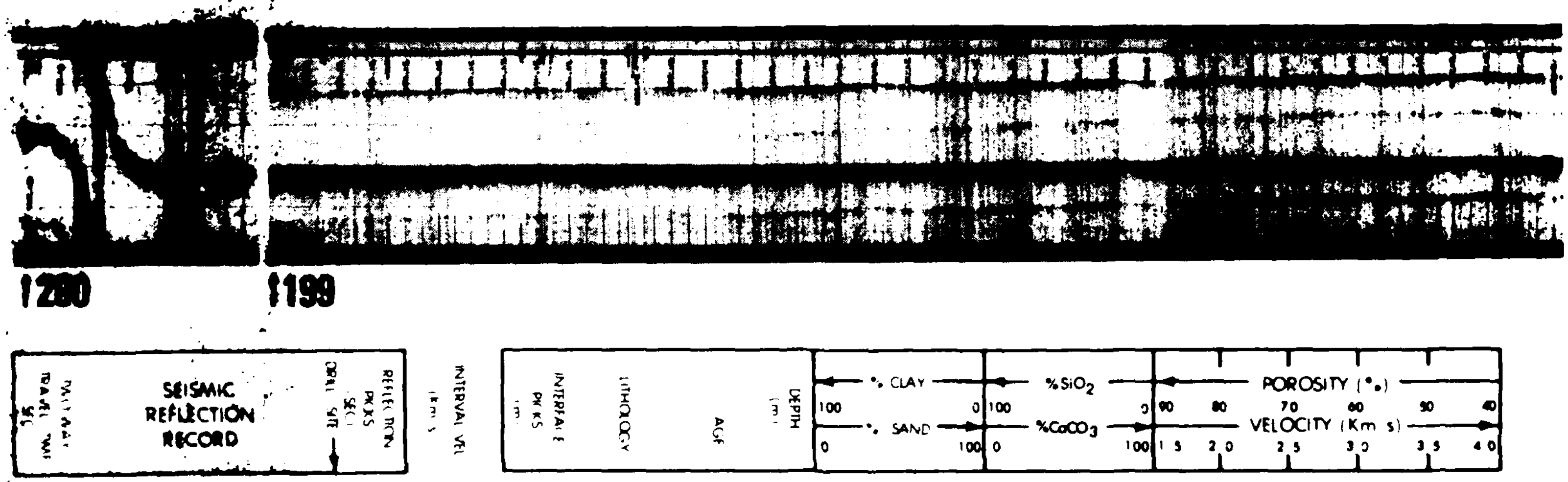
SITE DATA

Position:
Latitude 12°50.2' N
Longitude 156°47.0' E
Date: 10/26/71
Time: 2204Z
Water depth: 1479 meters
Location: Ita Mai Tai Guyot

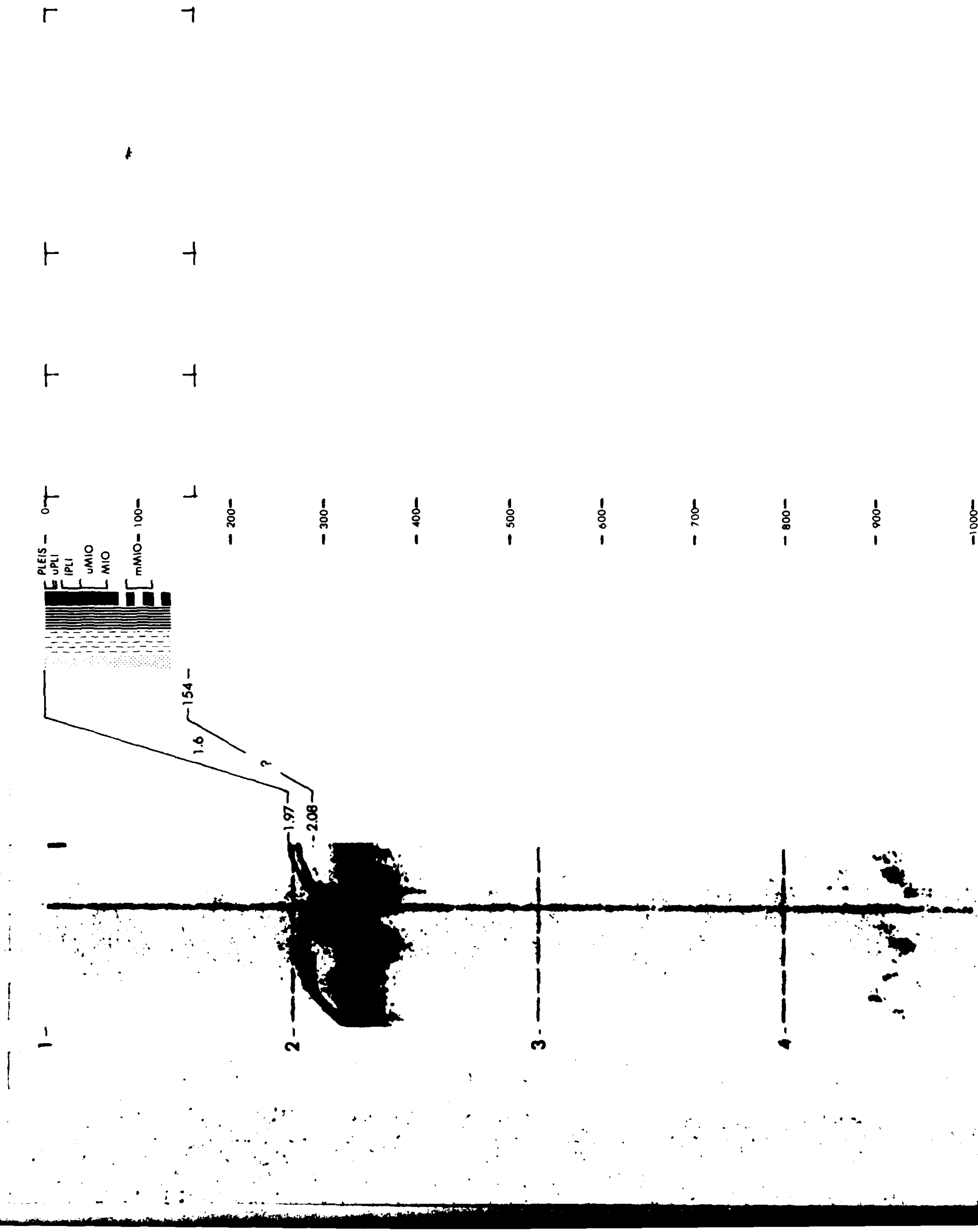
CORE DATA

Penetration:	200	200A	
Drilled--	19	113	meters
Cored----	95	19	meters
Total----	114	132	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	10	2	cores
	36	0	meters

The succession above the major reflector appears to be uniform in composition, consisting of a nannofossil-bearing foraminiferal ooze which is pale orange, white, or pinkish gray in color. The content of acid-insoluble material is less than 1 percent and consists of small grains of plagioclase feldspar and fish teeth. The winnowed foraminiferal ooze (or perhaps more properly foraminiferal sand) indicates a delicate balance between deposition and erosion throughout post-Paleocene time. It is not surprising to find winnowed foraminiferal ooze on the crest of seamounts, but Ita Mai Tai Guyot possesses a thicker section than one might expect to find. Certainly, the seismic profiler shows an exceptionally transparent and relatively thick acoustic layer. Many of the mid-Pacific mountains have thin sediment caps, but several which have been investigated near Wake Island do not, and the guyots off Japan which have been investigated have little or no sediment capping. Thus, the exceptionally thick cap on Ita Mai Tai may relate to exceptional conditions which may prevail or may have prevailed here.



SITE 200 LEG 20



SITE DATA	CORE DATA

SITE DATA

Position:
- Latitude 12° 49.9' N
- Longitude 156° 44.6' E

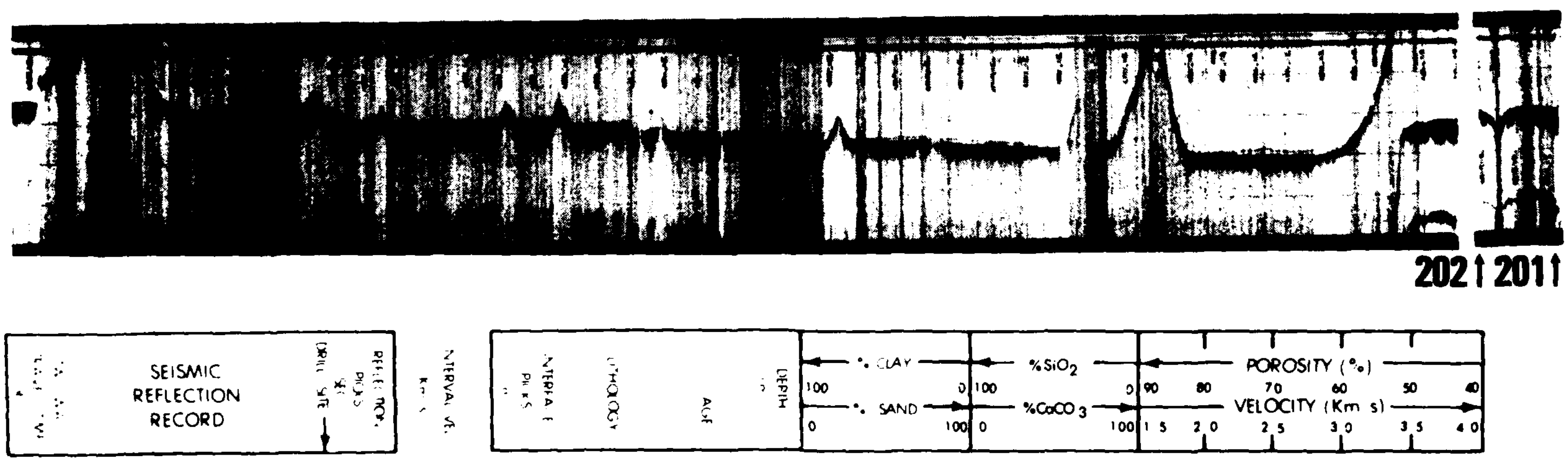
Date: 10/28/71
Time: 0115Z
Water depth: 1564 meters
Location: Ita Mai Tai Guyot

CORE DATA

Penetration:
- Drilled-- 96 meters
- Cored---- 0 meters
- Total---- 96 meters

Recovery:
- Basement- 0 cores, 0 meters
- Total---- 0 cores, 0 meters

Discussion with Site 200.



SITE 201 LEG 20

0 100 200 300 400 500 600 700 800 900 1000

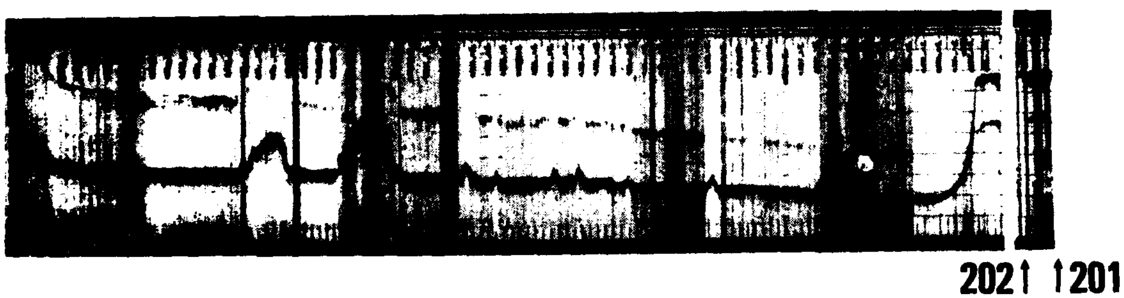
SITE DATA

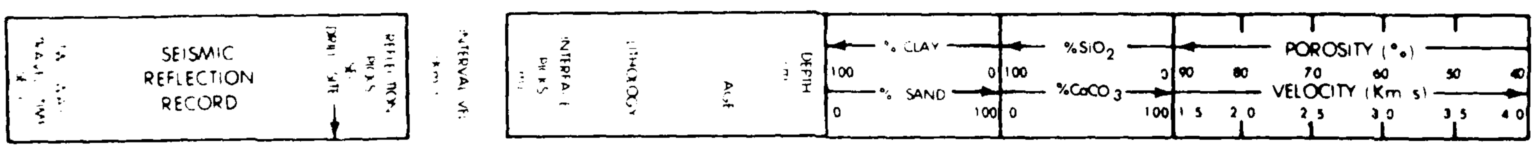
Position:
    Latitude 12° 48.9' N
    Longitude 156° 57.1' E
Date: 10/28/71
Time: 0959Z
Water depth: 1515 meters
Location: Ita Mai Tai Guyot

CORE DATA

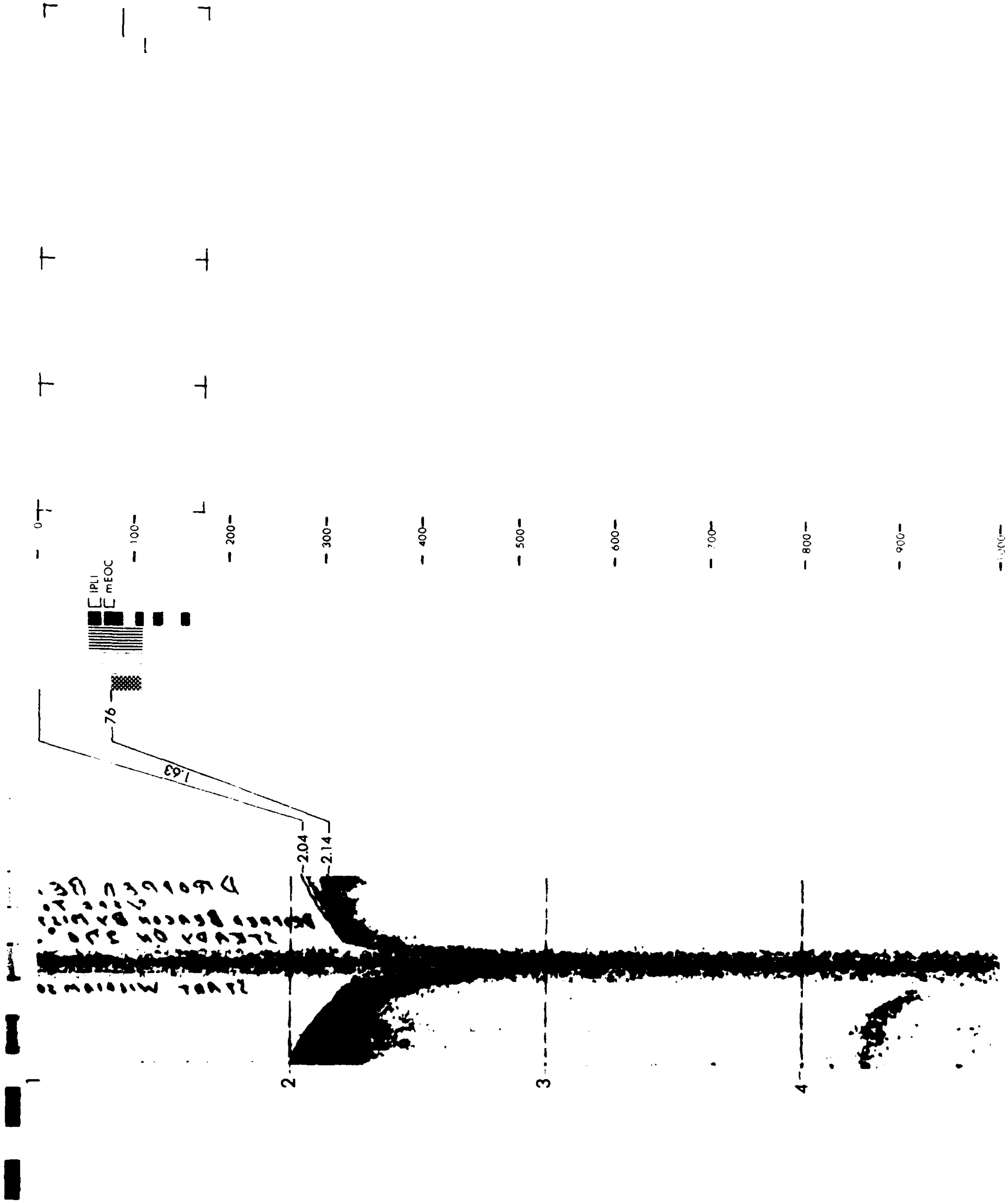
Penetration:
    Drilled-- 97 meters
    Cored---- 56 meters
    Total---- 154 meters
Recovery:
    Basement- 0 cores
        0 meters
    Total---- 6 cores
        2.5 meters

The early Eocene to Recent foraminiferal ooze capping the guyot, although thinner at Site 202 than at Sites 200 and 201, has nearly the same mechanical properties. The strong acoustic reflector which underlies the winnowed ooze is a 30- to 40-meter-thick oolitic limestone. Oolites are assumed to be characteristic of shallow, lime-saturated water near coral reefs in which continuous, rather vigorous agitation winnows out the fines and constantly rotates the oolites as they grow. The lime mud contains no foraminifera and (most remarkedly) no nannofossils. The mud does contain fine coral fragments and can be interpreted as a near-reef facies. probably lagoonal, rather than an offshore facies, where planktonic fossils should be present. Thus, one can envisage a history of volcanism culminating perhaps in the Campanian or Maastrichtian, as suggested by Hole 199, followed by the growth of fringing reefs on the subsiding foundation. However, subsidence rates relative to growth conditions were apparently too high for the coral to grow up indefinitely, and after a brief existence, the volcanic island became a coral bank and finally a subsiding guyot, collecting winnowed pelagic ooze. If we are not permitted to accept the tuff in Hole 199 as evidence of the growth of the pedestal of Ita Mai Tai Guyot, then we have no constraint on its age.





SITE 202 LEG 20



SITE DATA

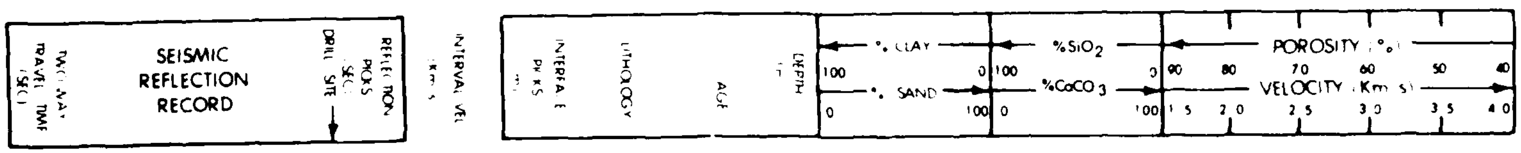
Position:
Latitude 22°09.2' S
Longitude 177°32.8' W
Date: 11/19/71
Time: 0051Z
Water depth: 2720 meters
Location: Lau Basin

CORE DATA

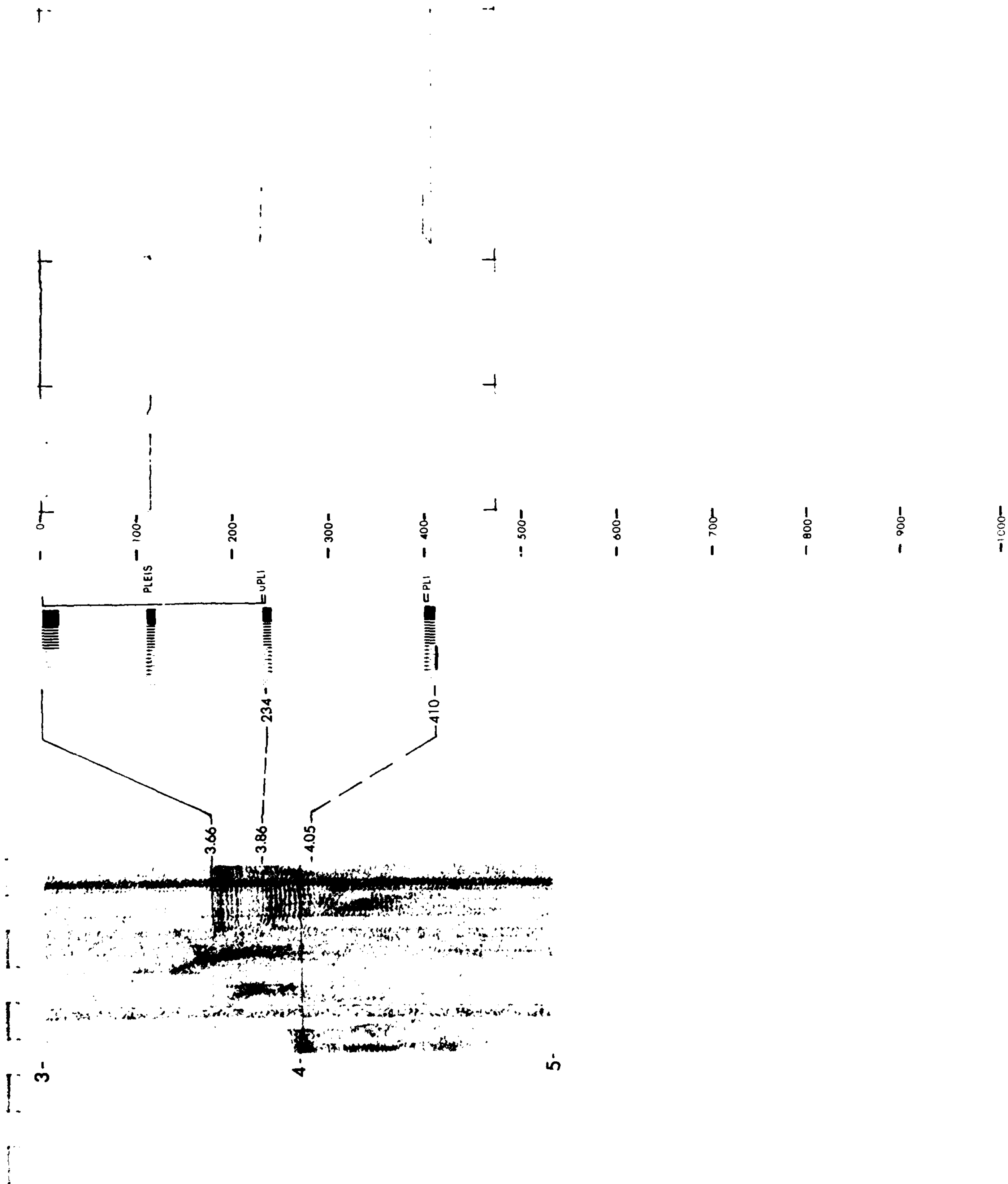
Penetration:
Drilled-- 367 meters
Cored---- 42 meters
Total---- 409 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 5 cores
20.3 meters

The cored sand layers contain volcanic glass with fresh surfaces and a high degree of sorting which suggests transport from a nearby source with little or no reworking, but which may be the result of drilling activity. The bottom of Core 5 contained a 5-cm fragment of highly vesicular olivine basalt with olivine phenocrysts. Volcanic debris at the site is generally more acidic higher in the section and may well be derived from the Tonga Ridge, while the basalt at the base of the hole suggests possible foramation of new sea floor in the extension of the basin. Unfortunately, it is not possible to derive definitive conclusions from the data available. The lack of sediment disturbance throughout the upper three quarters of the section suggests that extension has not been important in this local basin since early in its history. Nannofossil data suggest that basin depths have remained similar to those at present. An adjacent sediment pond shows considerable folding and marginal faulting which would indicate that the basin has been undergoing at least some extension to the present time. The rugged structure of the Lau Basin floor and the different structural patterns of adjacent sedimentary basins within it point to continuing extension and opening of the Lau Basin, at least since the Miocene, but also show that this has not been uniform or symmetrical.

1203



SITE 203 LEG 21



SITE DATA

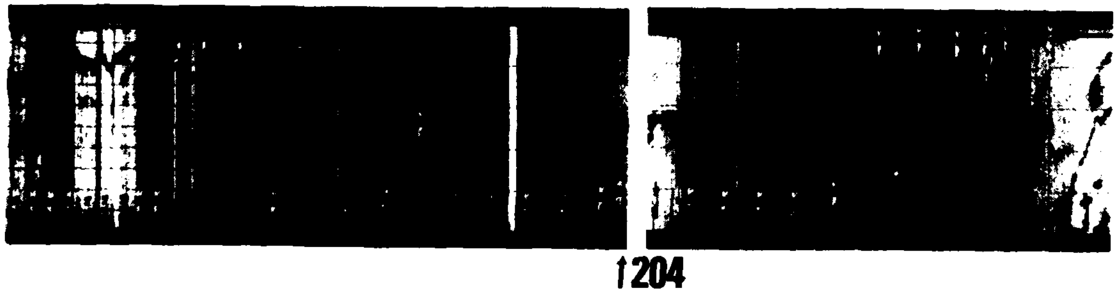
Position:
Latitude 24°57.3' S
Longitude 174°06.7' W
Date: 11/22/71
Time: 0725Z
Water depth: 5354 meters
Location: Pacific plate east of Tonga Trench

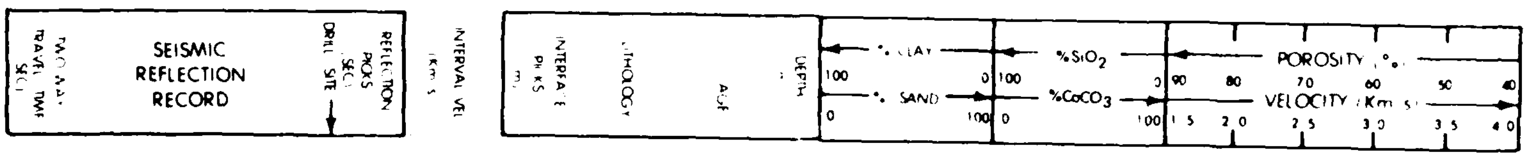
CORE DATA

Penetration:
Drilled-- 81 meters
Cored---- 79 meters
Total---- 160 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
49.4 meters

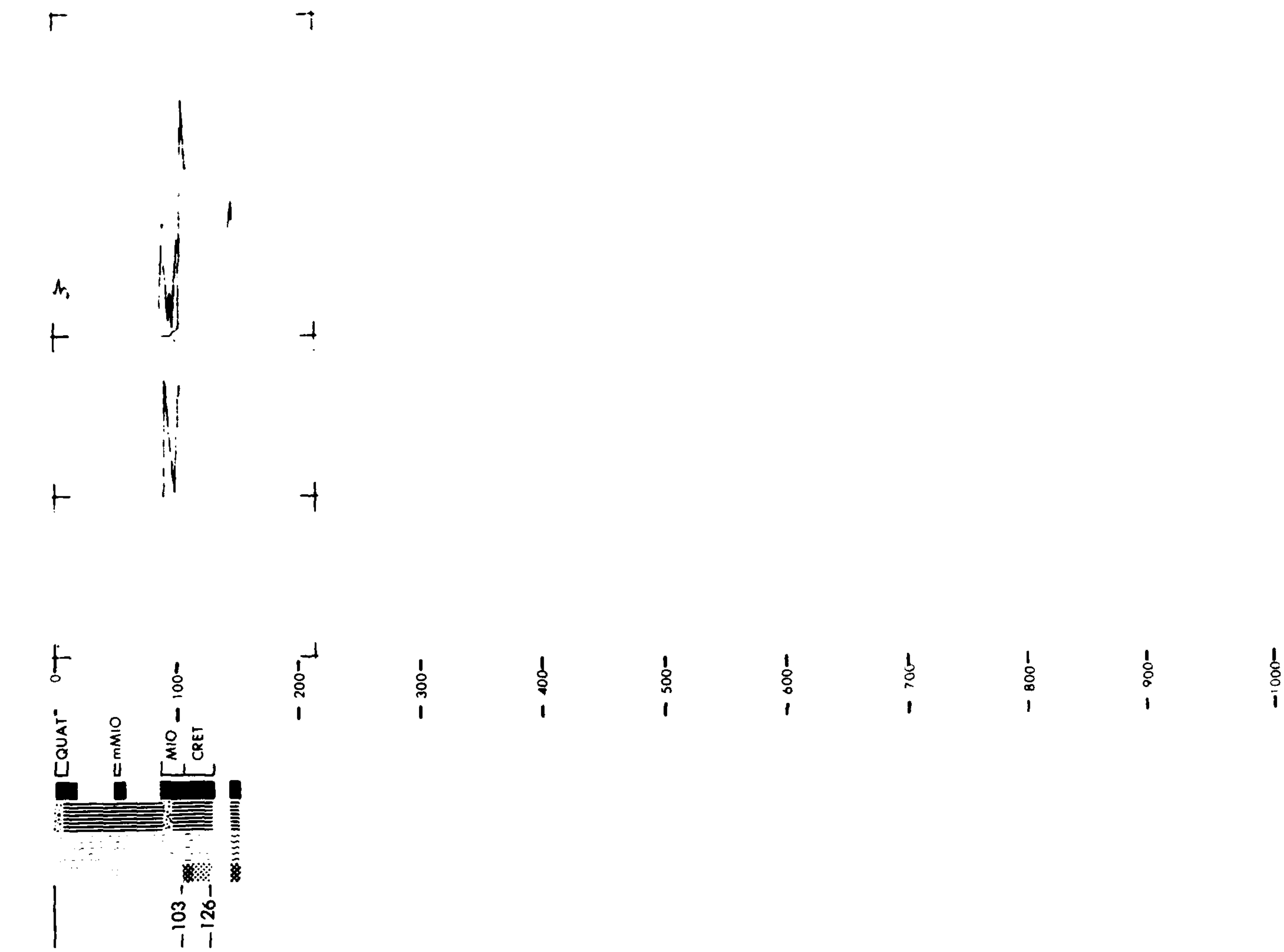
The lowest unit sampled is the vitric tuff with grain size similar to some of the ashes found in the higher unlithified sequence. (This material may have undergone submarine or subaerial transport.) The lithified tuffaceous sandstones and conglomerates which overlie the tuff are barren of fossils except for Inoceramus (?) fragments. The coarse grain size, granules, and abundant pebbles in this unit suggest nearby volcanic activity. The sedimentary structures, rounding, and sorting point to submarine transport after initial extrusion and deposition. The base of the abyssal clay and ash sequence appears to be an unconformity. The reworked assemblages in the lower portion of the sequence may represent a decreasing effect of current activity due to circulation changes and subsidence of the Louisville Ridge. Of possible greater significance is the indication of extensive volcanism throughout the cored sequence. This site is located in an area tectonically similar to Sites 52, 59, and 61. Lithologically, these four sites are similar. This similarity suggests widespread Cretaceous volcanism throughout the western Pacific with at least some portion of it from volcanic sources not directly associated with the present Pacific plate boundaries.

Two thin beds of calcareous sediment, occur in Miocene time.





SITE 204 LEG 21



SITE DATA

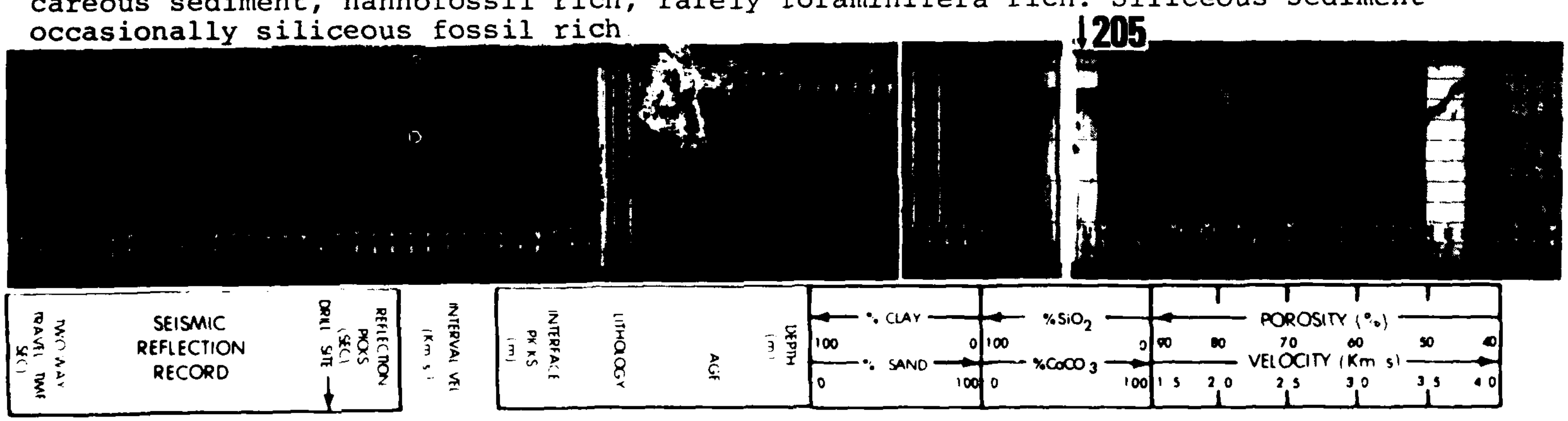
Position:
Latitude 25°31.0' S
Longitude 177°53.9' E
Date: 11/24/71
Time: 0445Z
Water depth: 4320 meters
Location: South Fiji Basin

CORE DATA

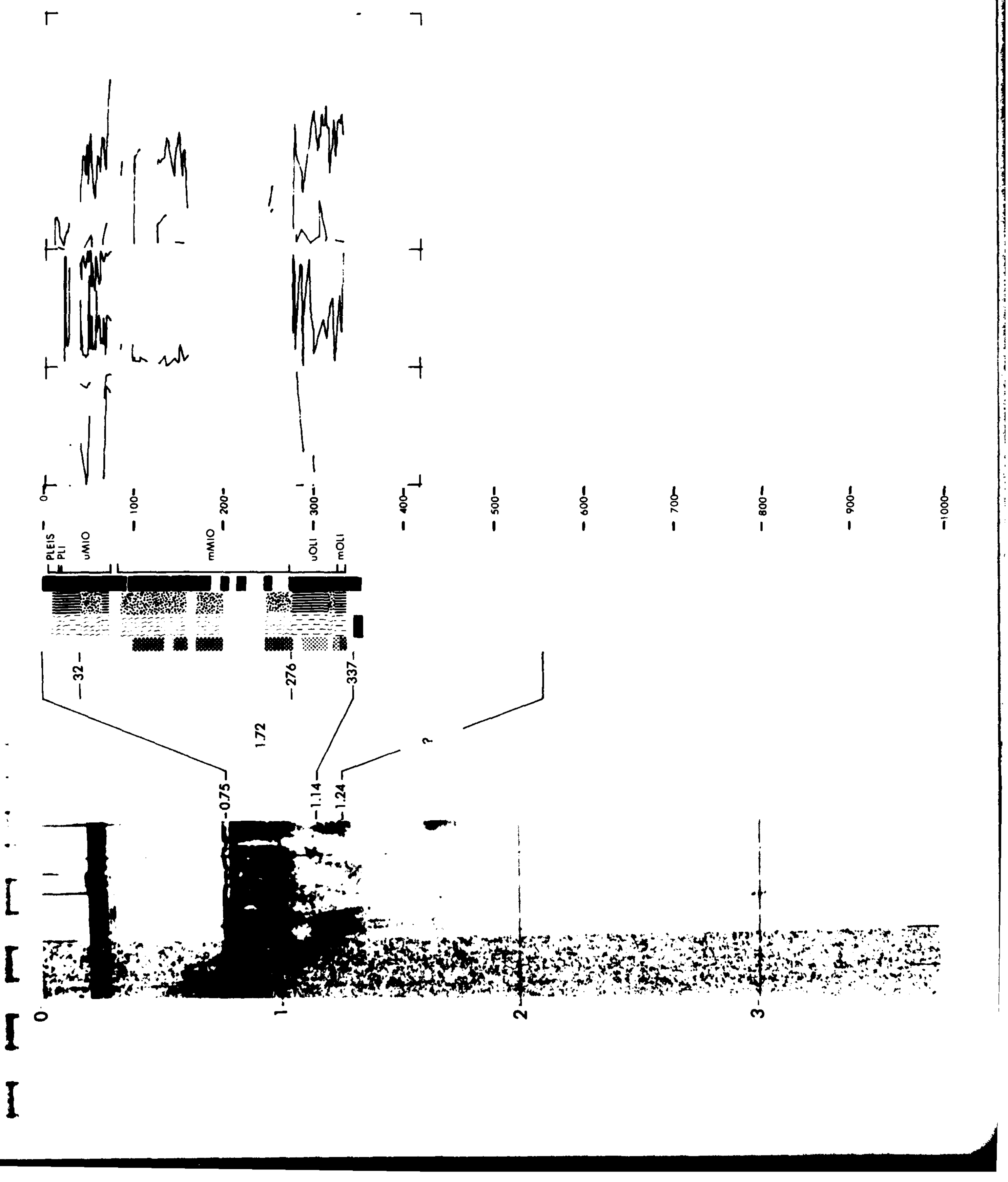
Penetration:
Drilled-- 67 meters
Cored---- 288 meters
Total---- 355 meters
Recovery:
Basement- 2 cores
5 meters
Total---- 32 cores
134.7 meters

Although there is no evidence for any degree of tectonism locally, a possible trend of deepening of the basin relative to the calcium carbonate compensation depth may be inferred. The Oligocene was a period of deep-water accumulation of nannofossil ooze with intermittent showers of intermediate and acidic volcanic ash. During this accumulation, the basalt was extruded as a pillow flow at or near the sea floor. A depositional hiatus in the early Miocene is represented by a disconformity. During middle Miocene, the accumulation increased. Although the sediment from this interval is predominantly volcanic detritus, calcareous sediments are common. The presence of shallow-water foraminifera, battered calcareous nannofossils, and rounded volcanic ash fragments indicates additional accumulation of transported sediment. By late Miocene a change in sedimentary patterns is marked by a decrease in volcanic debris, and the supply of shallow-water foraminifera ceased. These changes may have been brought about by the development of north-south barrier ridges on the western flank of the Lau Ridge. From late Miocene to Recent, abyssal brown clays with minor amounts of nannofossil ooze have accumulated near the carbonate compensation depth with occasional showers of volcanic ash of intermediate composition.

Calcareous and detrital sediments interbedded in thin layers. Much of the calcareous sediment, nannofossil rich, rarely foraminifera rich. Siliceous sediment occasionally siliceous fossil rich



SITE 205 LEG 21



SITE DATA

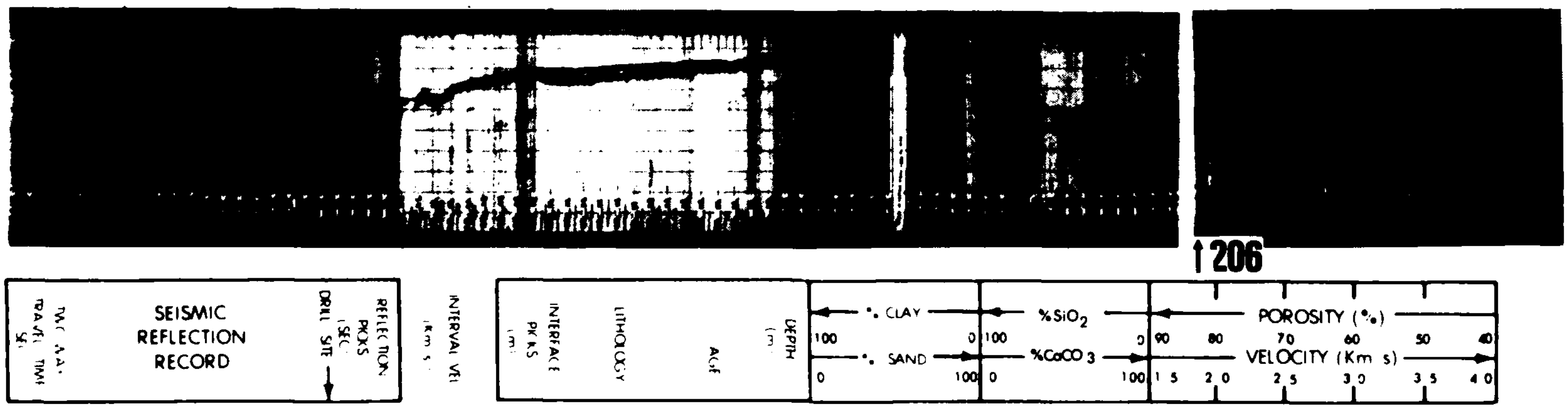
Position:
Latitude 32°00.7' S
Longitude 165°27.1' E
Date: 11/30/71
Time: 1610Z
Water depth: 3196 meters
Location: New Caledonia Basin

CORE DATA

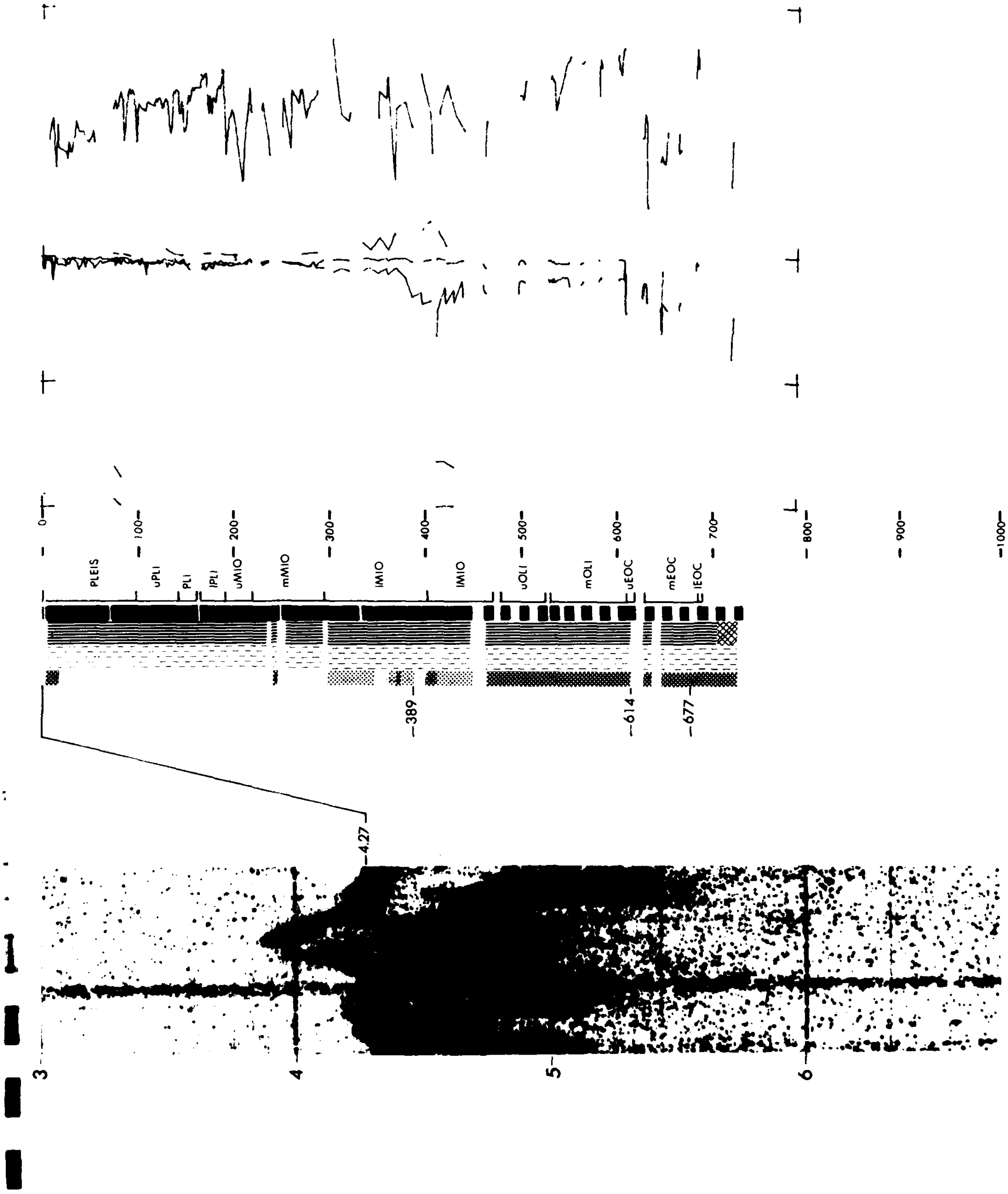
Penetration:	206	206A	206B	206C	
Drilled--	16	100	211	545	meters
Cored----	400	0	9	189	meters
Total----	416	100	220	734	meters
Recovery:					
Basement-	0	0	0	0	cores
	0	0	0	0	meters
Total----	45	0	1	21	cores
	243.6	0	.7	88.7	meters

Lithologically, the sediments are relatively uniform calcareous oozes. All were deposited in an oceanic environment above the calcium carbonate compensation depth. This section contains the most complete biostratigraphic record of planktonic foraminifera and calcareous nannofossils known for the middle Oligocene to the Recent in transitional Southern Hemisphere latitudes. This is the first site at which the regional unconformity was noted. The interval of late Eocene and early Oligocene is missing. A Paleocene-Eocene unconformity also occurs here encompassing middle Paleocene, late Paleocene, and most of the early Eocene. An age inversion of middle Paleocene underlying early Paleocene at the base of the hole is the result of slumping following deposition. The reflections recorded do not correlate well with lithologic breaks, although the "transparent" section may be related to disturbances noted in the lower units. The presence of clay in Unit 4 and Unit 2 may be related to local tectonic events. Aside from the presumed development of the hill near the site during early basin history, conditions, as reflected by the sediments, have been quite uniform. The area has undergone a small amount of subsidence, but has always been in the bathyal zone above the calcium carbonate compensation depth.

Pleistocene, Pliocene, Miocene, Oligocene and Upper Eocene sediments, nannofossil rich. One thin bed of siliceous sediment occurs in middle Eocene time.



SITE 206 LEG 21



SITE DATA

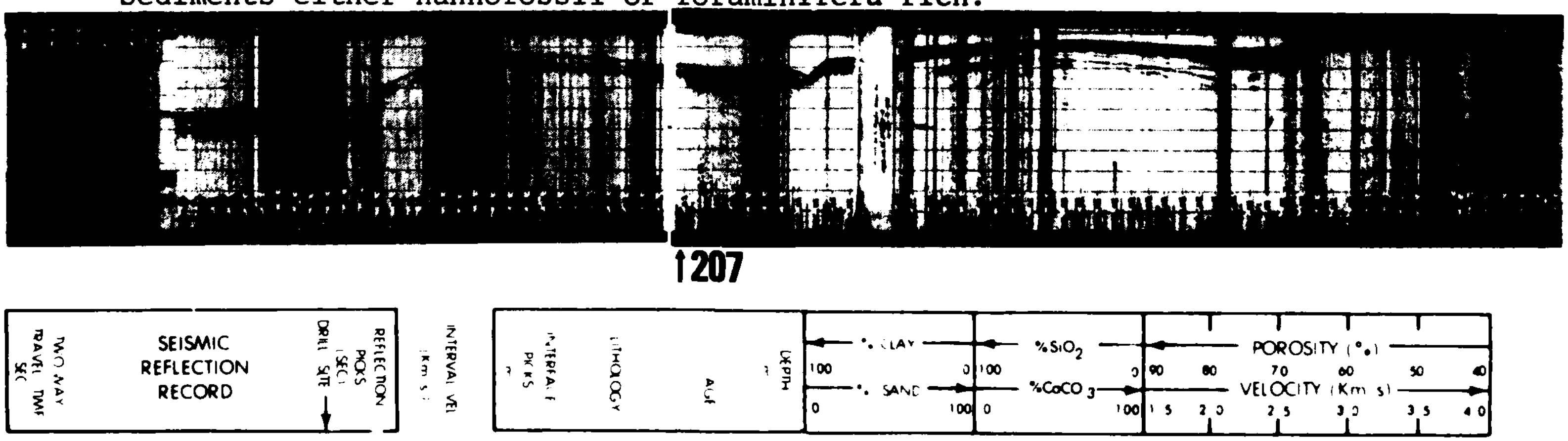
Position:
Latitude $36^{\circ} 57.7'$ S
Longitude $165^{\circ} 26.1'$ E
Date: 12/12/71
Time: 0026Z
Water depth: 1389 meters
Location: South Lord Howe Rise

CORE DATA

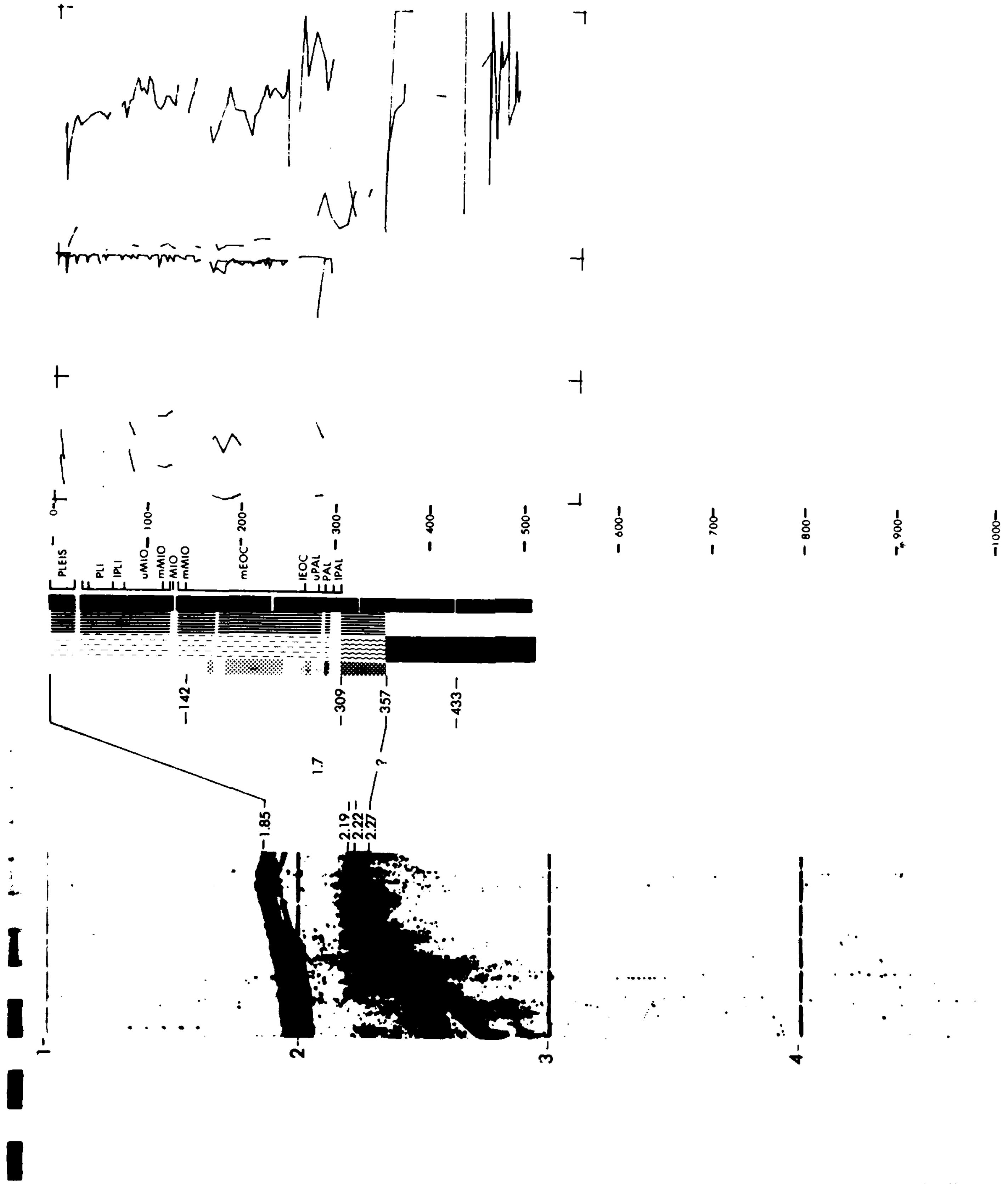
Penetration:	207	207A	
Drilled--	5	63	meters
Cored----	42	450	meters
Total----	47	513	meters
Recovery:			
Basement-	0	2	cores
	0	44.5	meters
Total----	5	50	cores
	38	212.3	meters

At the base of the cored sequence are the Upper Cretaceous rhyolites (flows, breccias, and pumiceous lapilli tuffs) of Units 4 and 5. The overlying silty claystone (Unit 3), was probably deposited in a shallow marine environment with restricted (nonoceanic) circulation. The author suggests that the source area must have been either of rather low relief or at some distance. At the base of Unit 3 there is a larger sand-sized fraction in the form of material derived from the underlying rhyolite as well as from a granitic or metamorphic source. Oceanic conditions began in middle Paleocene. Units 1 and 2 are basically composed of carbonate oozes of Paleocene to Recent age which were deposited well above carbonate compensation depth. The regional unconformity at this site is between Units 1 and 2 and separates late middle Eocene from early middle Miocene sediments. A second unconformity is present between Paleocene and Eocene sediments deeper in the section (latest Paleocene and earliest Eocene) which also occurs at Sites 206 and 208. Benthonic foraminifera indicate rapid increase in depth of sedimentation from the relatively shallow depths in the Maestrichtian to depths approximately equivalent to those of the present day (1400 m) during the early Eocene.

Sediments either nannofossil or foraminifera rich.



SITE 207 LEG 21



SITE DATA

Position:
Latitude 26°06.6' S
Longitude 161°13.3' E
Date: 12/12/71
Time: 2353Z
Water depth: 1545 meters
Location: North Lord Howe Rise

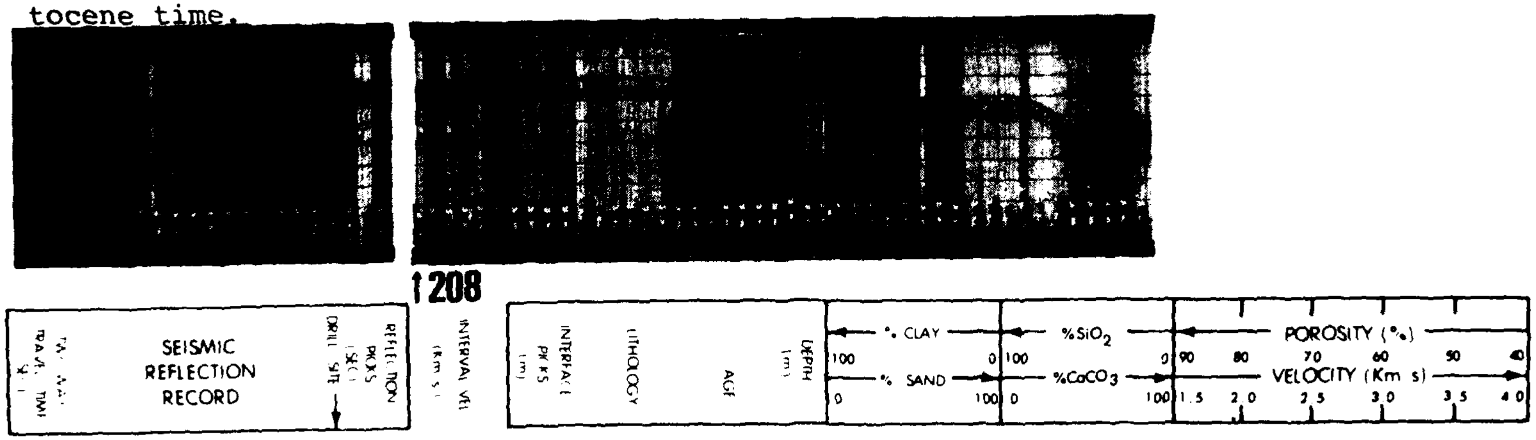
CORE DATA

Penetration:
Drilled-- 288 meters
Cored---- 306 meters
Total---- 594 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 34 cores
255.4 meters

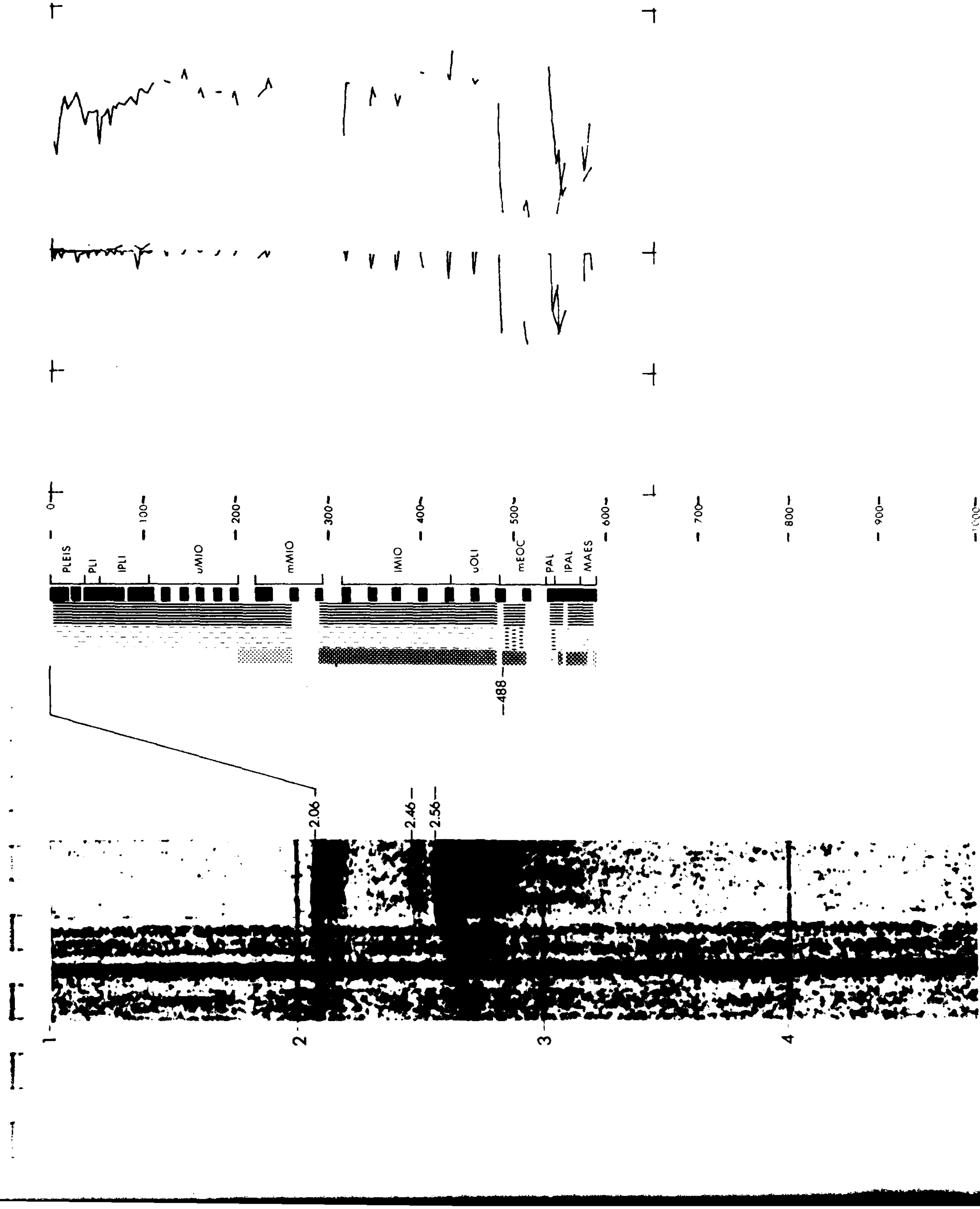
Eolian quartz, found in trace amounts in the late middle Miocene to late Pleistocene oozes, is assumed to be related to a period of aridity in Australia. The relative continuity of mid bathyal deposition and the paucity or absence of clastic detritus suggest that the Lord Howe Rise has existed as a feature isolated from Australia since at least the Maastrichtian. Normal oceanic conditions have prevailed at the site throughout the sequence samples. A small amount of subsidence is suggested from Late Cretaceous fauna. Late Eocene to mid Oligocene sediments are absent in the regional unconfirmity at this site as they are at Sites 206, 207, 209, and 210. Late Paleocene and early Eocene sediments are also missing as at Sites 206 and 207.

This site reinforces the picture developed by the coring at Site 207. The site was already oceanic and apparently separated from Australia by latest Cretaceous as was the southern rise. A small amount of subsidence continued, but this portion of the rise had reached upper bathyal depths much earlier than the southern rise. This pattern of later deepending to the southeast can be traced across the Challenger Plateau to New Zealand's South Island. The rise appears to have been stable at about its present depth along its length since middle Eocene.

Calcareous sediments; nannofossil rich, occasionally foraminifera rich in Pleistocene time.



SITE 208 LEG 21



SITE DATA

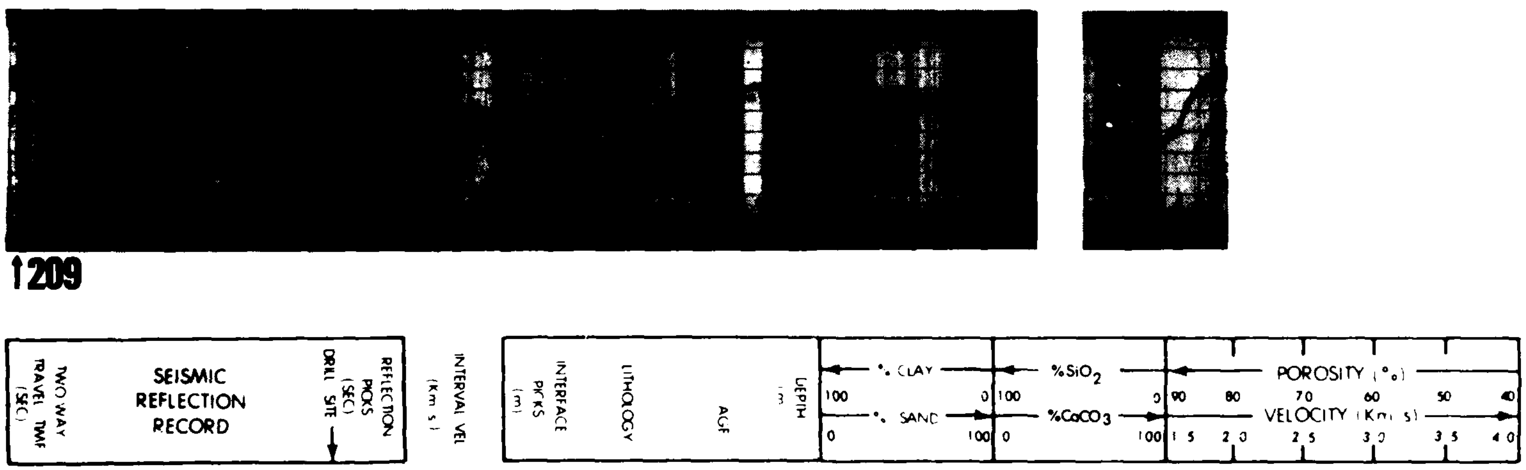
Position:
Latitude 15°56.2' S
Longitude 152°11.3' E
Date: 12/22/71
Time: 0430Z
Water depth: 1428 meters
Location: Queensland Plateau

CORE DATA

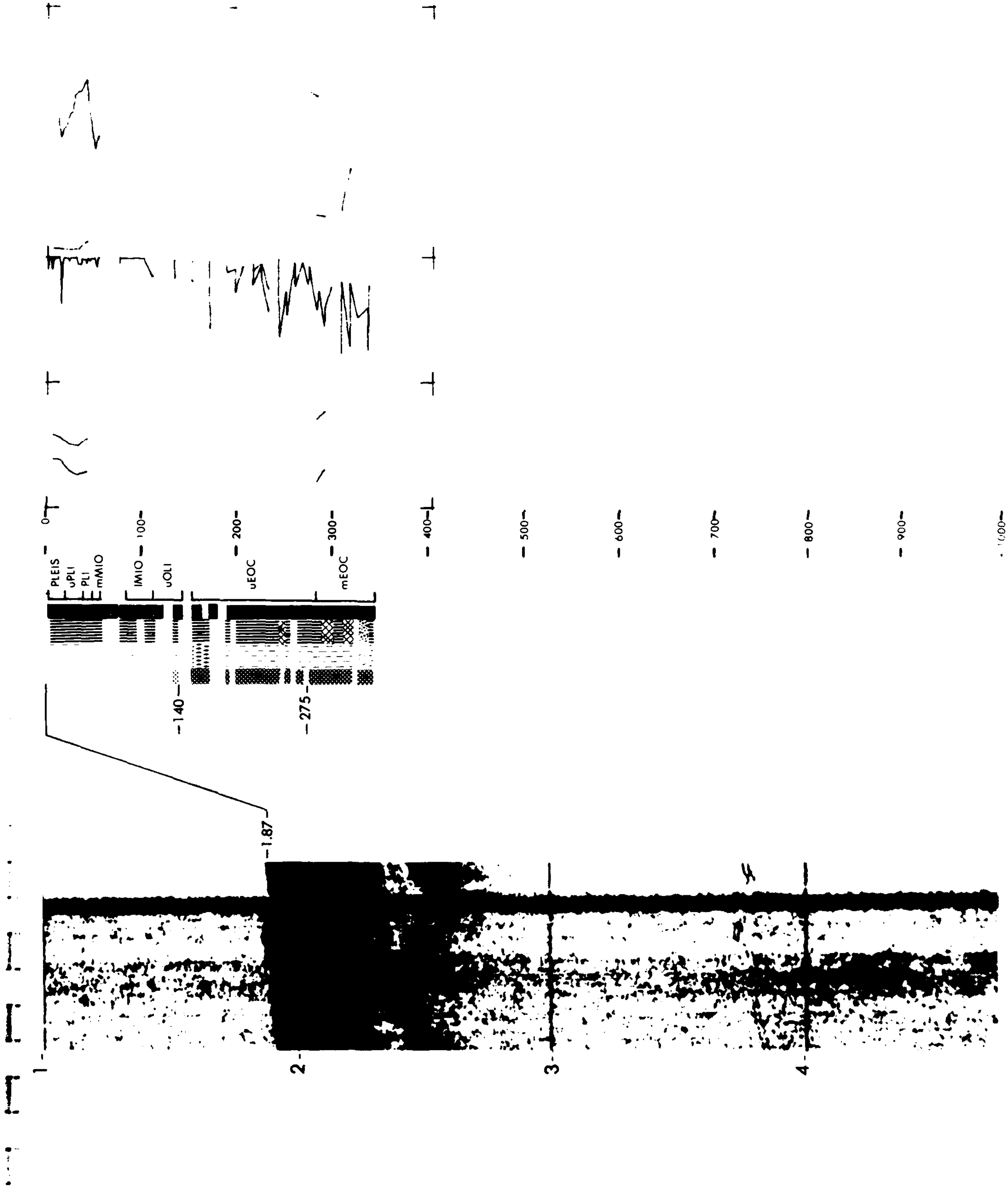
Penetration:	209	209A	
Drilled--	43	0	meters
Cored----	301	9	meters
Total----	344	9	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	34	1	cores
	76.7	2.2	meters

The regional unconformity occurs at Site 209 between Units 1 and 2 and extends from late Eocene to late Oligocene. The unconformity is not closely approximated by reflector in the seismic profiles. The sedimentary record indicates that the Queensland Plateau has undergone net subsidence from upper bathyal to neritic depths in the middle Eocene to mid-bathyal depths (near 1500 m) at the present time. During late Eocene, as deepending progressed and oceanic circulation established itself over the shelf, oceanic pelagic sediments began to predominate. Terrigenous detrital input decreased, and to a major extent ceased, by late Eocene. Unit 1 has less than 5% terrigenous component compared with 10% to 30% in Unit 2 and over 50% in Unit 3. Development of reefs and cays on the central Plateau during middle Eocene may have blocked bottom transport and impeded current distribution of the land-derived sediments at that time. Alternatively, development of the Queensland and Townsville Troughs, narrow deeps isolating the plateau from the Australian mainland, may have resulted in terrigenous debris failing to reach the Plateau.

Calcareous sediments either, nannofossil or foraminifera rich. Two thin siliceous beds in upper Eocene time. Two thin beds of detrital sediment in middle Eocene time.



SITE 209 LEG 21



SITE DATA

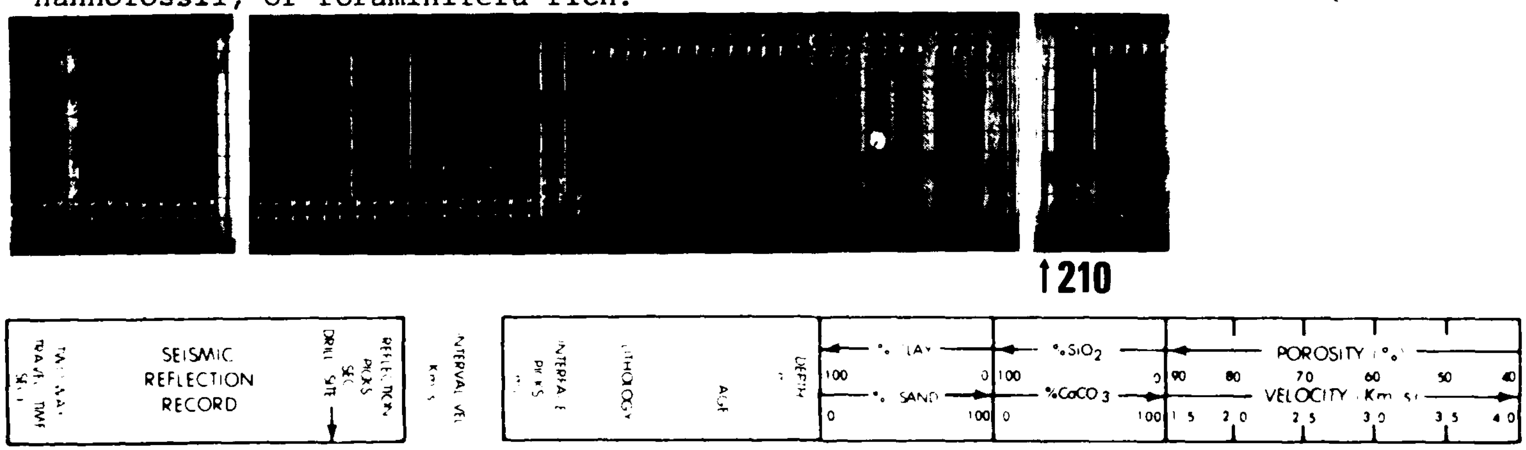
Position:
Latitude 13°46.0' S
Longitude 152°53.8' E
Date: 12/30/71
Time: 1400Z
Water depth: 4643 meters
Location: Coral Sea Basin

CORE DATA

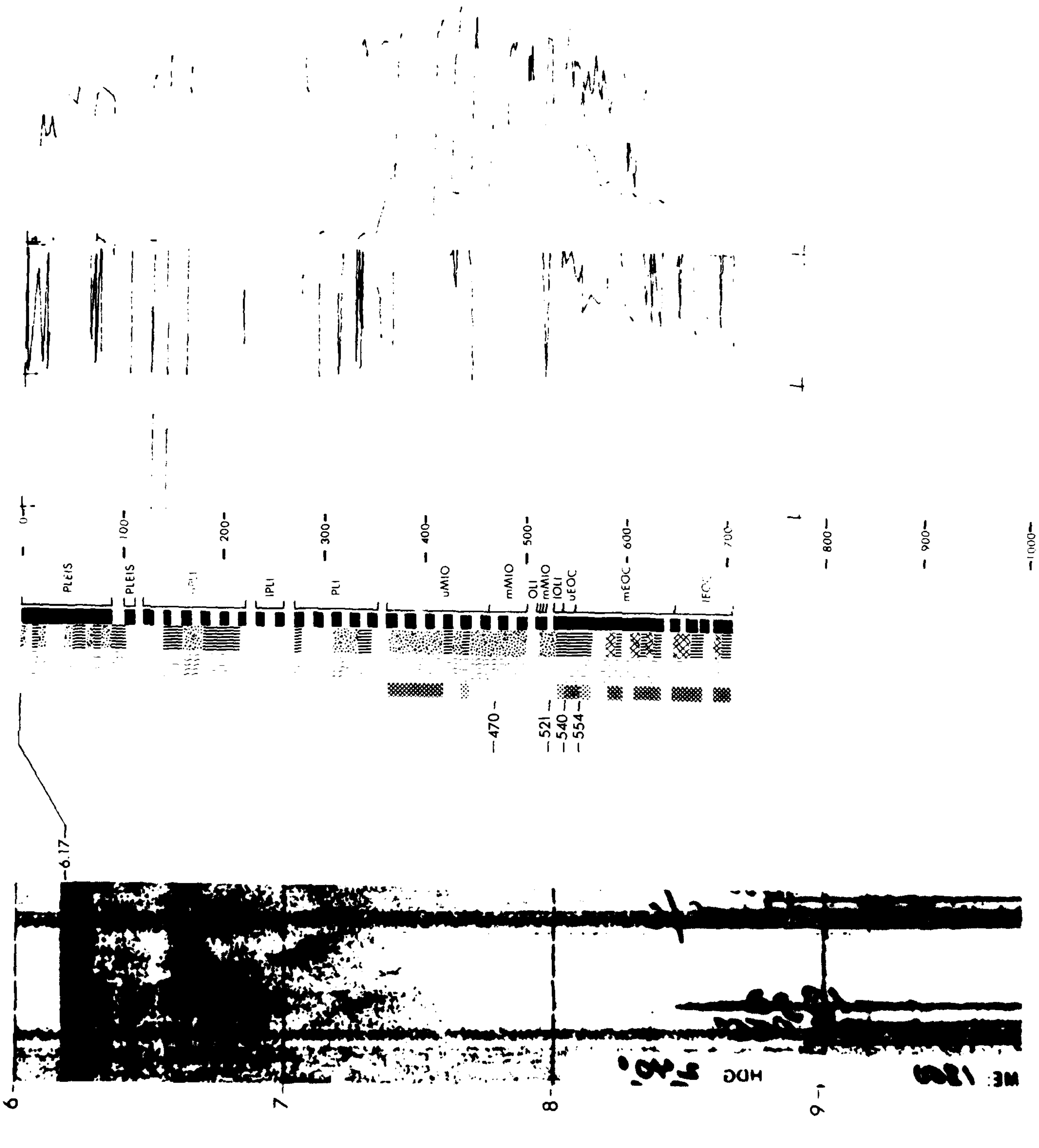
Penetration:
Drilled-- 261 meters
Cored---- 450 meters
Total---- 711 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 50 cores
263.3 meters

During early to late Eocene time clay, foraminifera, and nannofossils accumulated as a pelagic blanket at depths generally above the lysocline. Chert nodules appear in the later portion of this time interval and may be related to events producing a Eocene/Oligocene unconformity. At Site 210 the regional unconformity represents most of late Eocene and early Oligocene time. Dips in the beds of Units 4 and 5, the rough surface of Reflector 4, and the draped appearance of Reflector 3 suggest that disturbance of the basin floor, possibly in the form of folding, took place during this time gap. In late early to middle Oligocene time sediments were deposited below the lysocline and near the carbonate compensation depth. The abyssal clays of Unit 2 indicate either deepening of the basin below the compensation depth and/or raising of the carbonate compensation depth itself during early and middle Miocene time. During early late Miocene to Pleistocene time, deposition of Unit 1 took place. Basin morphology and the mineralogy of the detrital sediment in the turbidite sequences of silt and clay (Unit 1) indicate New Guinea as the major source of this detrital sediment. Detrital material in Units 4 and 5 may have been derived from Queensland.

Interbedded calcareous and detrital sediments. Calcareous sediments either, nannofossil, or foraminifera rich.



SITE 210 LEG 21



SITE DATA

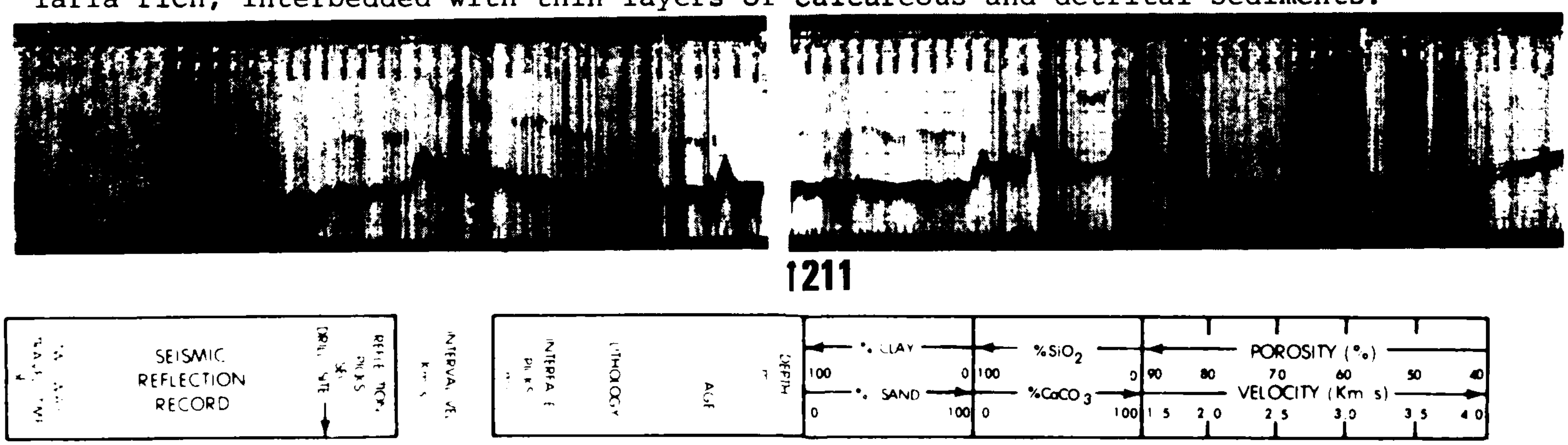
Position:
Latitude 9°46.5'S
Longitude 102°41.9'E
Date: 01/21/72
Time: 0055Z
Water depth: 5518 meters
Location: South of Java Trench

CORE DATA

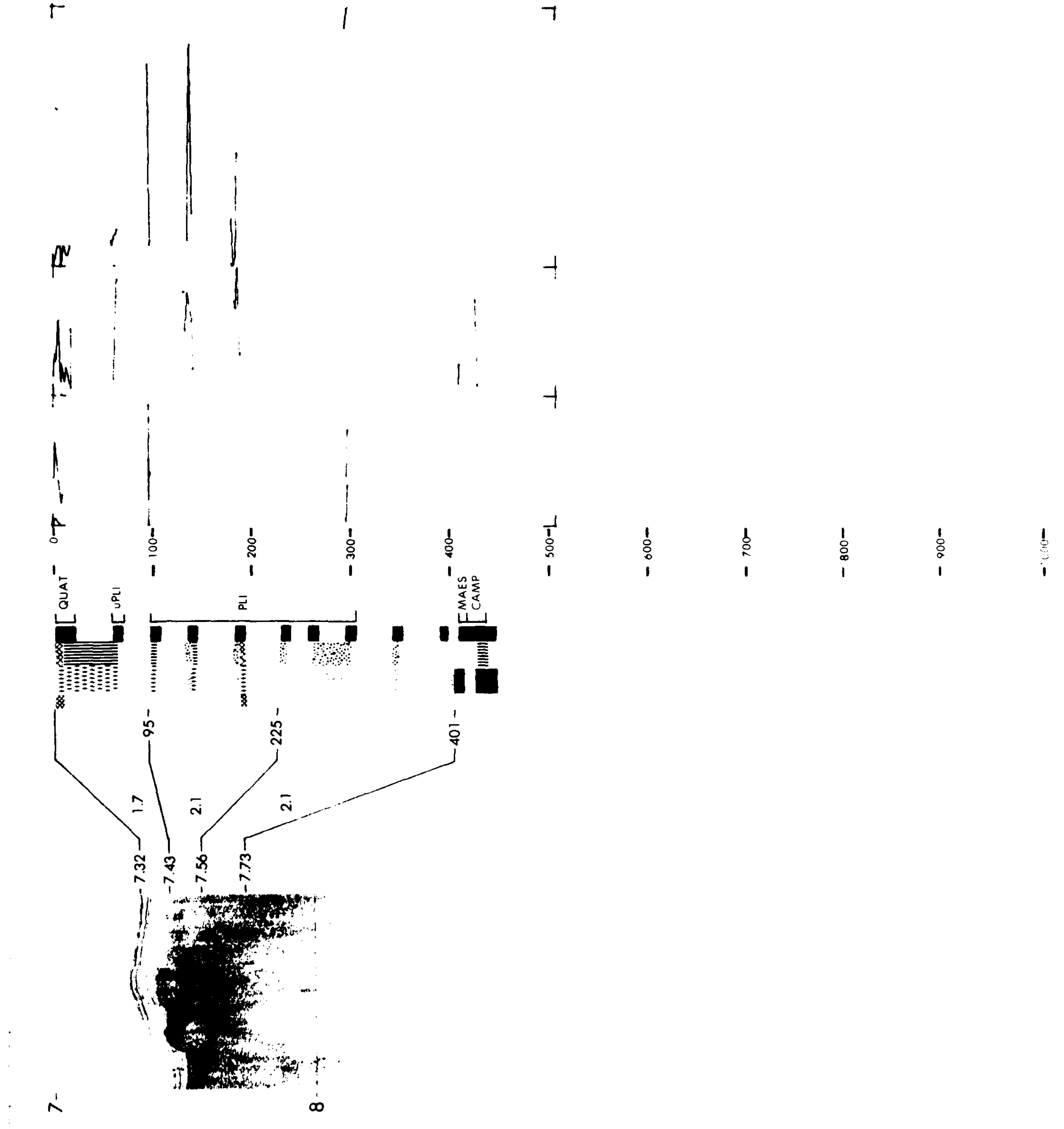
Penetration:
Drilled-- 305 meters
Cored----142.5 meters
Total---- 447 meters
Recovery:
Basement- 2 cores
8.5 meters
Total---- 15 cores
67.2 meters

The weathered amphibole-bearing basalts are considered to be extrusives, possibly pillow lavas which have been altered by the subsequent amphibolite intrusives as well as by submarine weathering processes. The basal sediments have an irregular laminated structure and contain an impoverished assemblage of calcareous nannofossils and benthonic foraminifera. A fresh diabase sill, 10 meters in thickness, has intruded the sediments 18 meters above basalt. Overlying the brown clay unit, at a sediment depth of about 300 meters, a series of micaceous silts and sands appears. The mineralogy is suggestive of a continental provenance with a variety of rock types including granites, metamorphics, and volcanics. It is consistent with the sediments having been part of the Nicobar Fan during Pliocene times, as is the presence of reworked foraminifera of shallow-water origin. The uppermost 100 meters of Site 211 consists of upper Pliocene to Quaternary radiolarian and diatom ooze with ash beds. This pelagic sediment represents oceanic deposition below the carbonate compensation depth. The ash deposits are of rhyolitic composition and most probably have come from the volcanically active Indonesian arc system to the north.

Quaternary siliceous sediments; diatom rich. Pliocene siliceous sediments; radiolaria rich, interbedded with thin layers of calcareous and detrital sediments.



SITE 211 LEG 22



SITE DATA

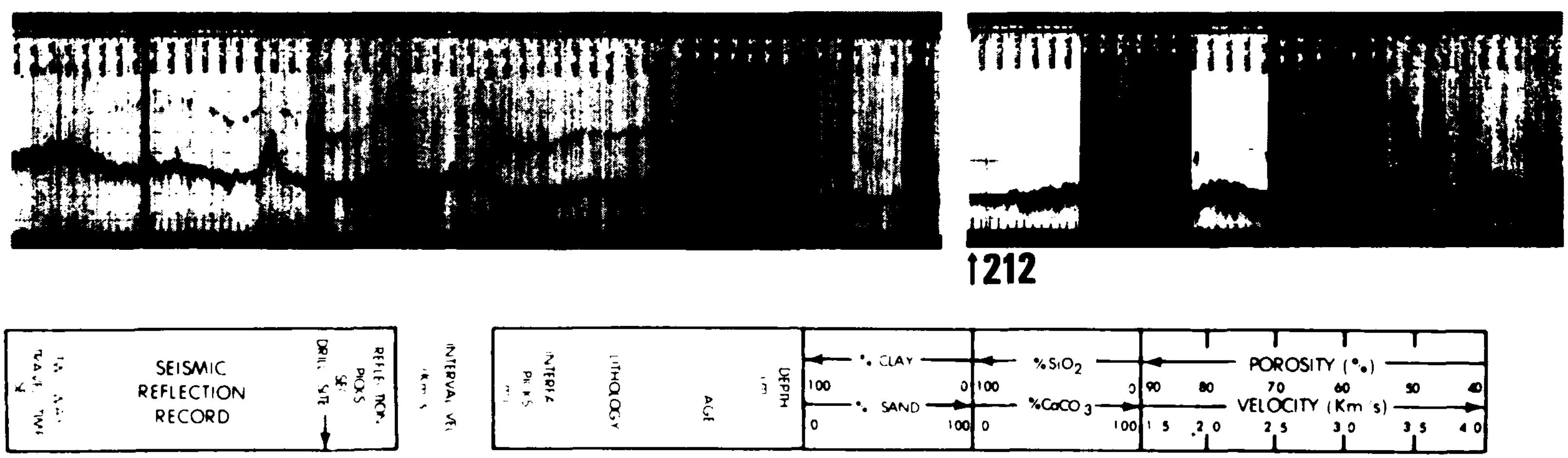
Position:
Latitude 19°11.3'S
Longitude 99°17.8'E
Date: 01/27/72
Time: 0530 Z
Water depth: 6233 meters
Location: Wharton Basin

CORE DATA

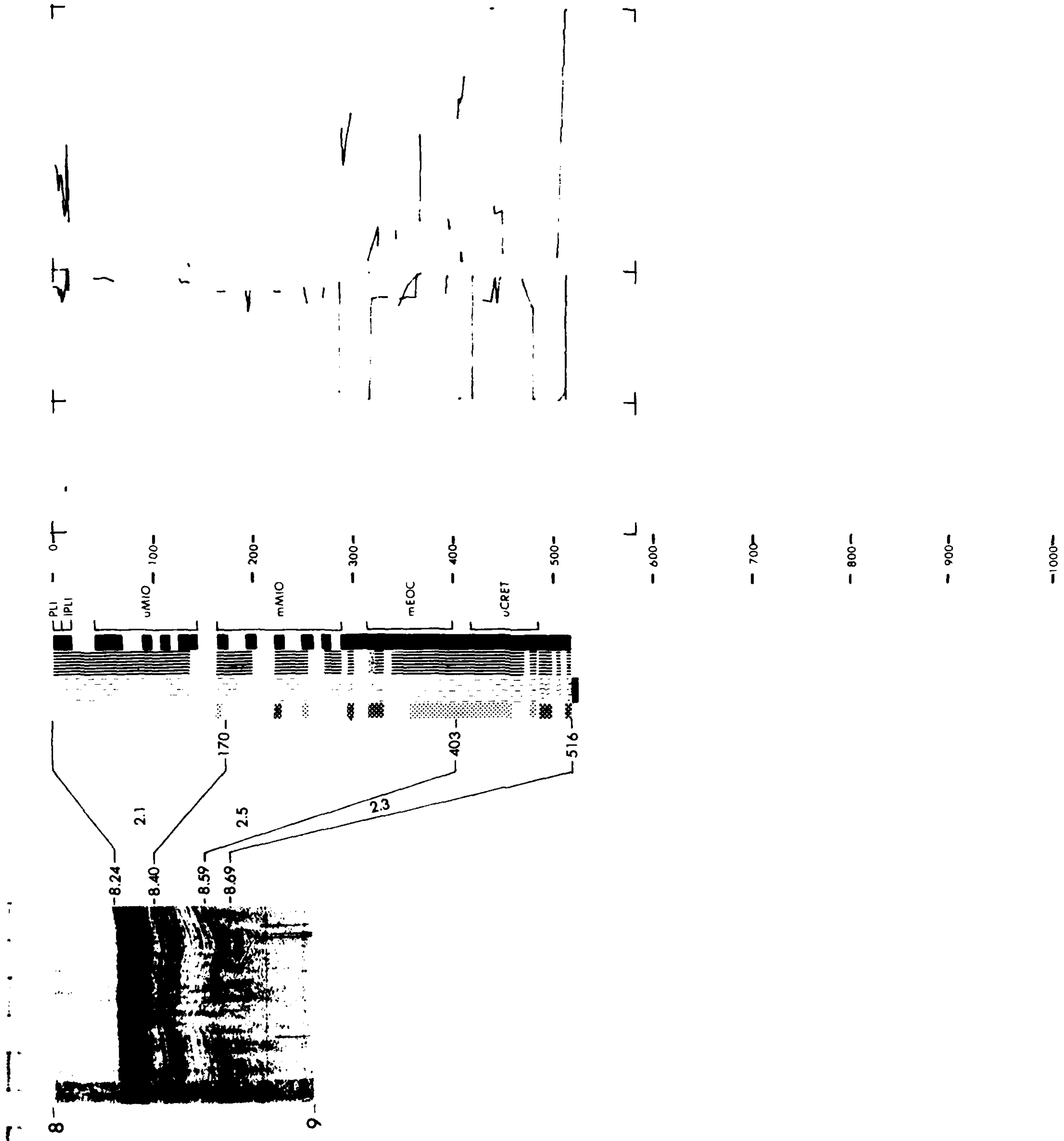
Penetration:
Drilled-- 155 meters
Cored---- 366 meters
Total---- 521 meters
Recovery:
Basement- 2 cores
4.05 meters
Total---- 39 cores
174.3 meters

The deepest lithologic unit cored, which may represent oceanic basement, consists of a succession of altered and weathered pillow lavas termed metabasalts. These have apparently suffered hydrothermal alteration, possibly due to the proximity of the Investigator Fracture Zone. Minor intercalcations of recrystallized carbonate between pillows represent older sediments trapped during the emplacement of the basalts. These rocks have all the characteristics of weathered mid-Indian Ocean Ridge basalts. Sedimentological and biostratigraphic evidence implies an exotic source for the calcareous units and suggest the sediments were emplaced by a combination of turbidite and nepheloid layer transport. Historic periods of significant carbonate accumulation which were related to concomitant and episodic lowering of the carbonate compensation depth are documented in the oceans. Each lowering was associated with carbonate accumulation on highs. The exotic chalk units at Site 212, which are postulated to have been transported to the locality are tentatively correlated with these episodes.

Calcareous sediment mostly nannofossil rich, interbedded with thin layers of detrital sediment, siliceous fossil rich.



SITE 212 LEG 22



SITE DATA

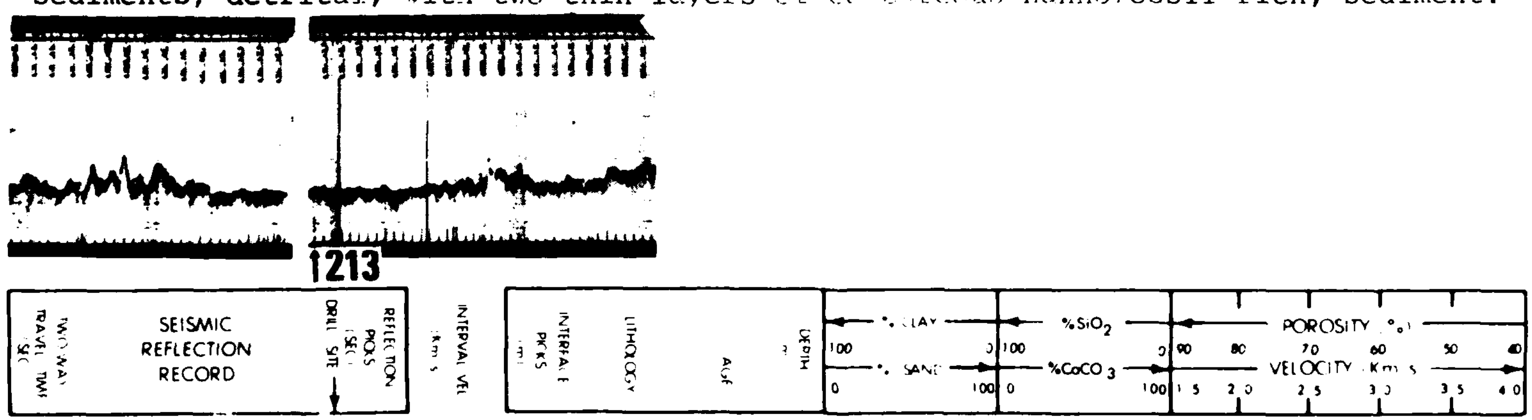
Position:
Latitude $10^{\circ}12.7'$S
Longitude $93^{\circ}53.8'$E
Date: 02/04/72
Time: 1200Z
Water depth: meters
Location: East of Ninetyeast Ridge

CORE DATA

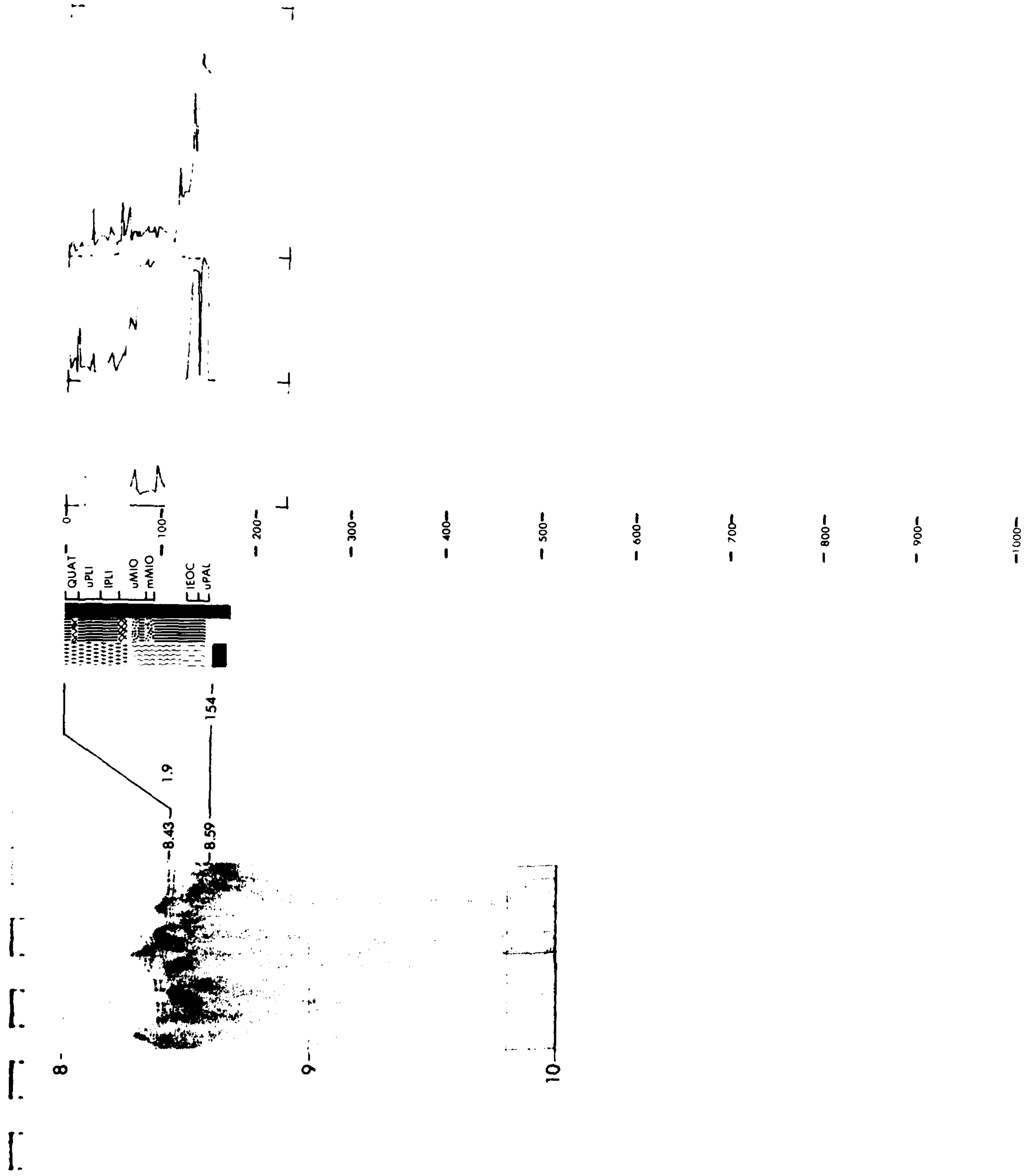
Penetration:	213	213A	
Drilled--	0	106	meters
Cored----	172.5	24.5	meters
Total----	172.5	130.5	meters
Recovery:			
Basement-	3	0	cores
	8.6	0	meters
Total----	19	3	cores
	145.5	24.5	meters

The basal unit is a weathered pillow-basalt with distinct mid-Indian Ocean ridge affinities. Foraminiferal and nannofossil assemblages in the calcareous section near the bottom of the hole have a low latitude oceanic aspect. Towards the top of the calcareous unit where it grades into overlying red clay, a residual flora and fauna composed only of the most resistant forms is present, indicating the onset of dissolution. At the time of the formation of oceanic crust at Site 213, the area was situated above the regional carbonate compensation depth as a sea-floor spreading center and remained so until early Eocene as evidenced by accumulation of biogenic carbonates. The ridge then slowly subsided below the carbonate compensation level during spreading, resulting in a gradual diminution of the carbonate supply to the sea floor. The resulting lack of diluting biogenous material would then favor the accumulation of nonfossiliferous zeolitic brown clay facies. During late Miocene, the plate moved northwards into equatorial high productivity regions so that brown clay sediments became swamped with biogenous material. Because the plate has subsided below the carbonate compensation depth, noncalcareous radiolarian diatom ooze began to accumulate and has persisted to the present.

Quaternary, Pliocene, and upper Miocene siliceous sediments; diatom rich. Younger sediments; detrital, with two thin layers of calcareous nannofossil rich, sediment.



SITE 213 LEG 22



SITE DATA

Position:
Latitude 11°20.2' S
Longitude 88°43.1' E
Date: 02/08/72
Time: 1659Z
Water depth: 1655 meters
Location: Crest of Ninetyeast Ridge

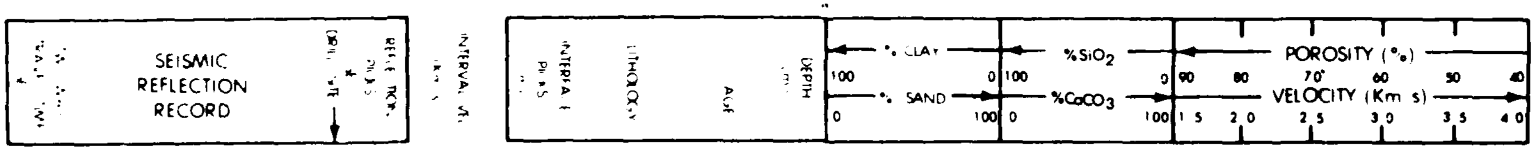
CORE DATA

Penetration:
Drilled-- 5.5meters
Cored----495.5meters
Total---- 500meters
Recovery:
Basement- 2 cores
4 meters
Total---- 54 cores
346 meters

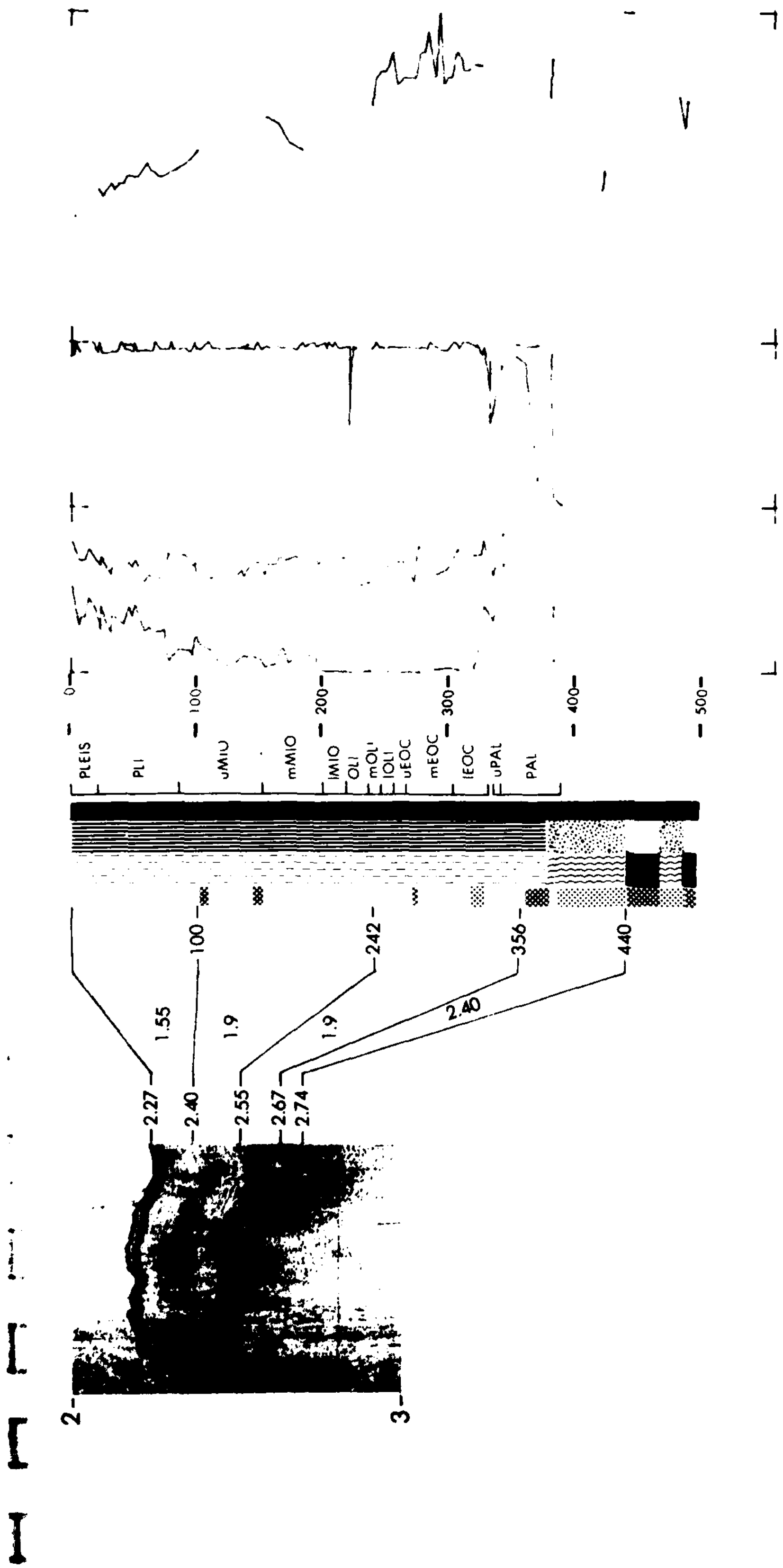
The igneous, sedimentary and paleontological evidence indicates that Ninetyeast Ridge was once an emergent chain of volcanic islands which sank below sea level in Paleocene times at Site 214. A short history of shallow-shelf and open-shelf conditions was followed in the early Eocene by a deepening to oceanic depths as suggested by the upward disappearance of glauconite and transition of the sediment to a pelagic calcareous ooze. Oceanic pelagic sedimentation has persisted in the area to the present. Biostratigraphic and lithologic observations place possible constrictions on the paleolatitude of Site 214 during the Paleocene. The site at present is located at 11° south of the equator and lies well within the zone of reef-building coral. No fragments of reef coral were found in the cored shelf sediments, suggesting that during Paleocene times the area was at a higher latitude than at present. Palynological evidence (Chapter 24) is in accord with this suggestion. The evidence presented for slow sinking of the Ninetyeast Ridge since the Paleocene would argue strongly against the McKenzie and Sclater (1971) compressional hypothesis for the origin of the ridge. In this hypothesis, the ridge would have been elevated in the middle Eocene and not the Paleocene as observed in the earliest sediment record.

Calcareous sediment; occasionally nannofossil rich. In Paleocene epoch, one thin layer-detrital.

214



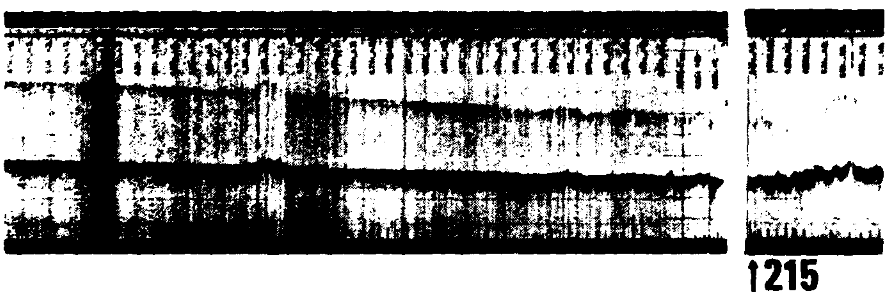
SITE 214 LEG 22

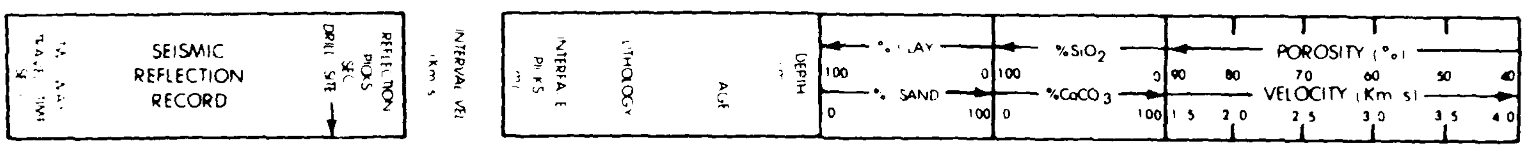


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	8°07.3' S	Drilled--	0 meters
Longitude	86°47.5' E	Cored----	175 meters
Date: 02/12/71		Total----	175 meters
Time: 2059Z		Recovery:	
Water depth: 5309 meters		Basement-	4 cores
Location: Central Indian Ocean Basin			13.3 meters
		Total----	20 cores
			113.3 meters

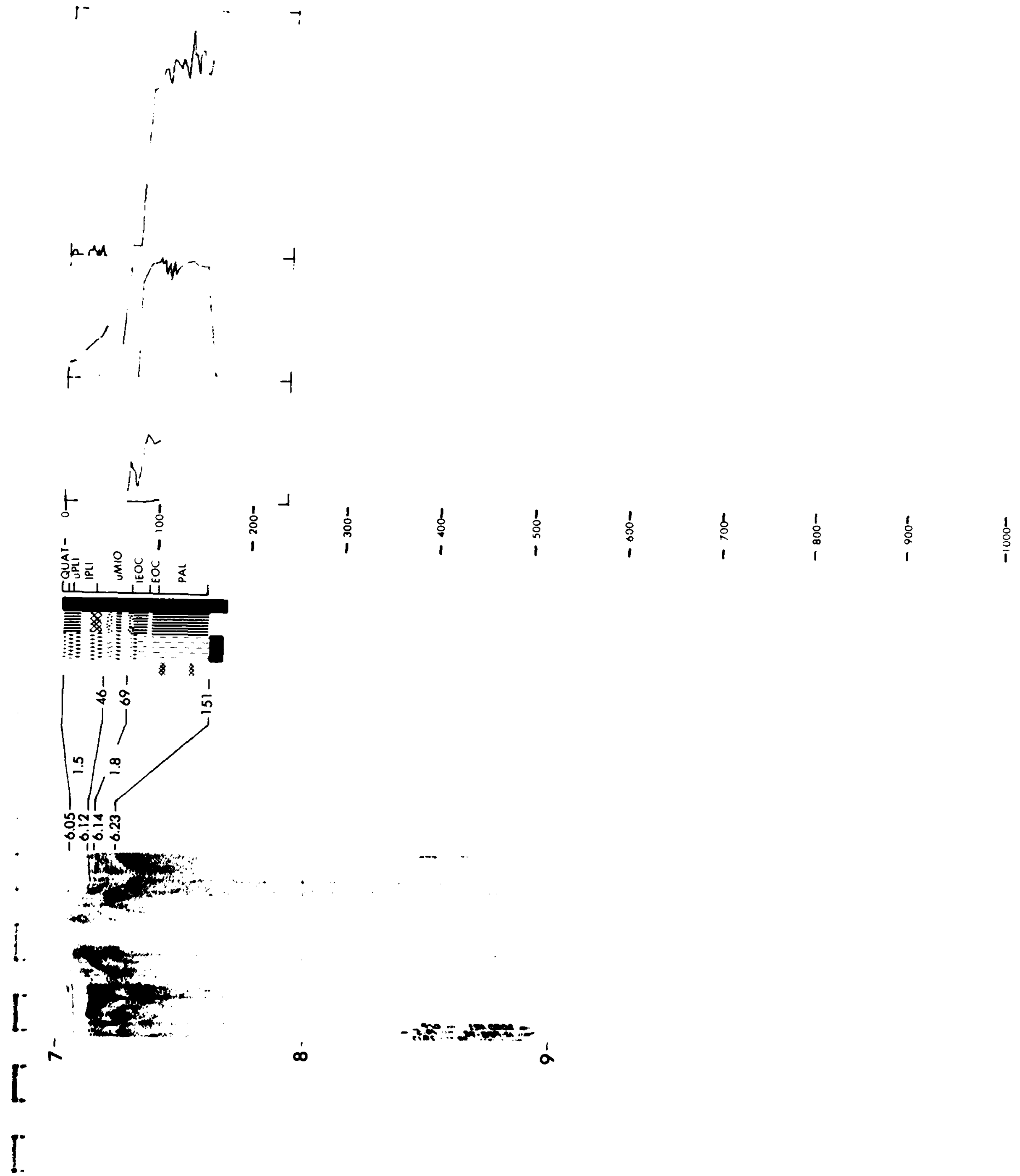
The hole was drilled in what appears on one crossing to be an 18-km-long basin of ponded and draped sediments up to 0.25 sec thick. The basin is separated by basement highs from the distal portion of the Bengal Fan to the north. The lowermost unit consists of a succession of pillow basalts with mid-Indian Ocean Ridge affinities. This typical sea-floor basalt is overlain by 1 meter of mid-Paleocene iron-oxide-rich nannofossil ooze which is in turn overlain by a 70-meter unit of nannofossil ooze and thin cherts of mid-Paleocene to early Eocene age. Seven meters of barren zeolitic brown clay, corresponding to a 4 - [illegible]. time interval, lies above the nannofossil ooze and is succeeded by upper Miocene terrigenous silts and clays. The uppermost unit at Site 215 is a 70-meter-thick radiolarian-diatom ooze of upper Miocene to Quaternary age. The stratigraphy and biostratigraphy of Site 215 imply subsidence accompanying sea-floor spreading in a fashion very similar to Site 213 which is situated on the opposite side of the Ninetyeast Ridge. The major difference between these two sites is the occurrence of upper Miocene terrigenous silts and clays at Site 215 which probably represent distal turbidites of the Bengal Fan.

Siliceous sediment diatom rich. Calcareous sediment nannofossil rich.





SITE 215 LEG 22



SITE DATA

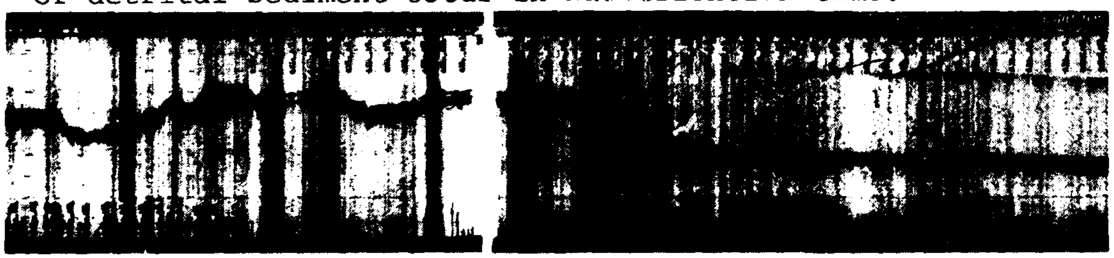
Position:
Latitude $1^{\circ}27.7'$ N
Longitude $90^{\circ}12.5'$ E
Date: 02/18/72
Time: 1642Z
Water depth: 2237 meters
Location: Crest of Ninetyeast Ridge

CORE DATA

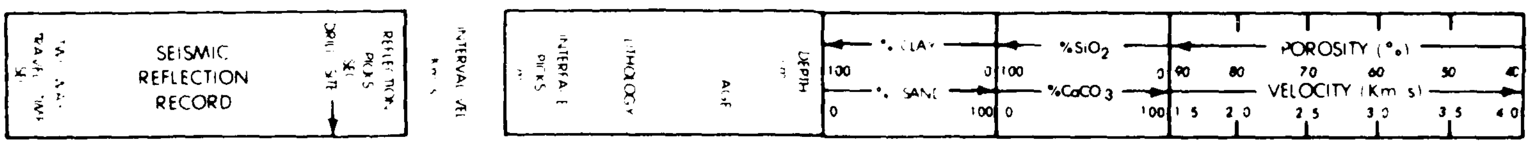
Penetration:	216	216A	
Drilled--	124.5	101.5	meters
Cored----	35.3	5.7	meters
Total----	477.5	158.5	meters
Recovery:			
Basement-	3	0	cores
	13.2	0	meters
Total----	38	6	cores
	170.8	53.7	meters

The stratigraphic column at Site 216 comprises three units, the lowermost of which is a tholeiitic basaltic rock with a composition similar to suites from St. Paul and New Amsterdam islands and significantly different from midocean ridge basalts. Lack of pillow structures and the amygdalar and vesicular nature of the rock suggest aerial or near-surface lava extrusion. The oldest sedimentary unit, immediately overlying the basalt, consists of late Maestrichtian ash beds, chalks and volcanogenic clays. Microfossil evidence, the presence of a molluscan fauna, and the occurrence of glauconite attest to a shallow water environment. By Paleocene time, paleontological evidence as well as the upward disappearance of glauconite suggest deepening of the area. The uppermost lithologic unit, of late Maestrichtian to Pleistocene or Recent age, is mainly composed of foraminifera-bearing nannofossil ooze and chalk. Sediments of this unit typify pelagic calcareous sedimentation above the $CaCO_3$ compensation depth and document further subsidence of the Ninetyeast Ridge to oceanic depths. This subsidence occurs earlier at this site than at Site 214.

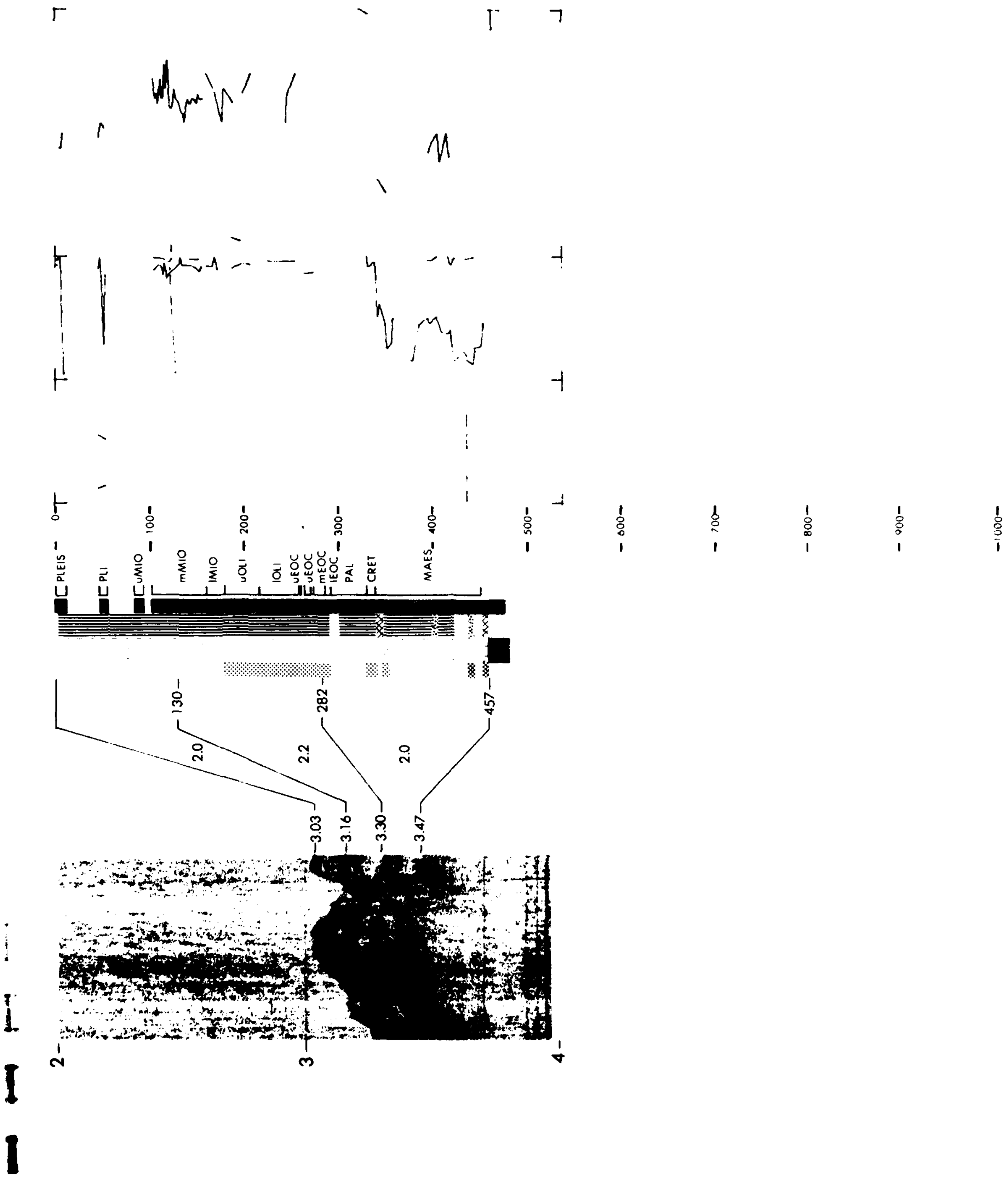
Pleistocene sediment foraminifera rich. Tertiary; nannofossil rich. Two thin layers of detrital sediment occur in Maestrichtian time.



↑216



SITE 216 LEG 22



SITE DATA

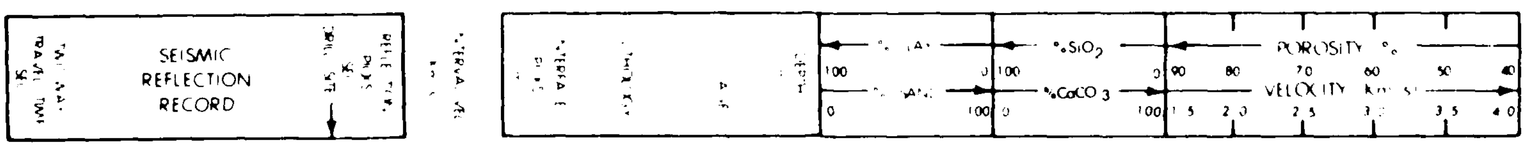
Position:
Latitude $8^{\circ}55.6'$N
Longitude $90^{\circ}32.3'$E
Date: 02/23/72
Time: 2133Z
Water depth: 3010 meters
Location: Northern Ninetyeast Ridge

CORE DATA

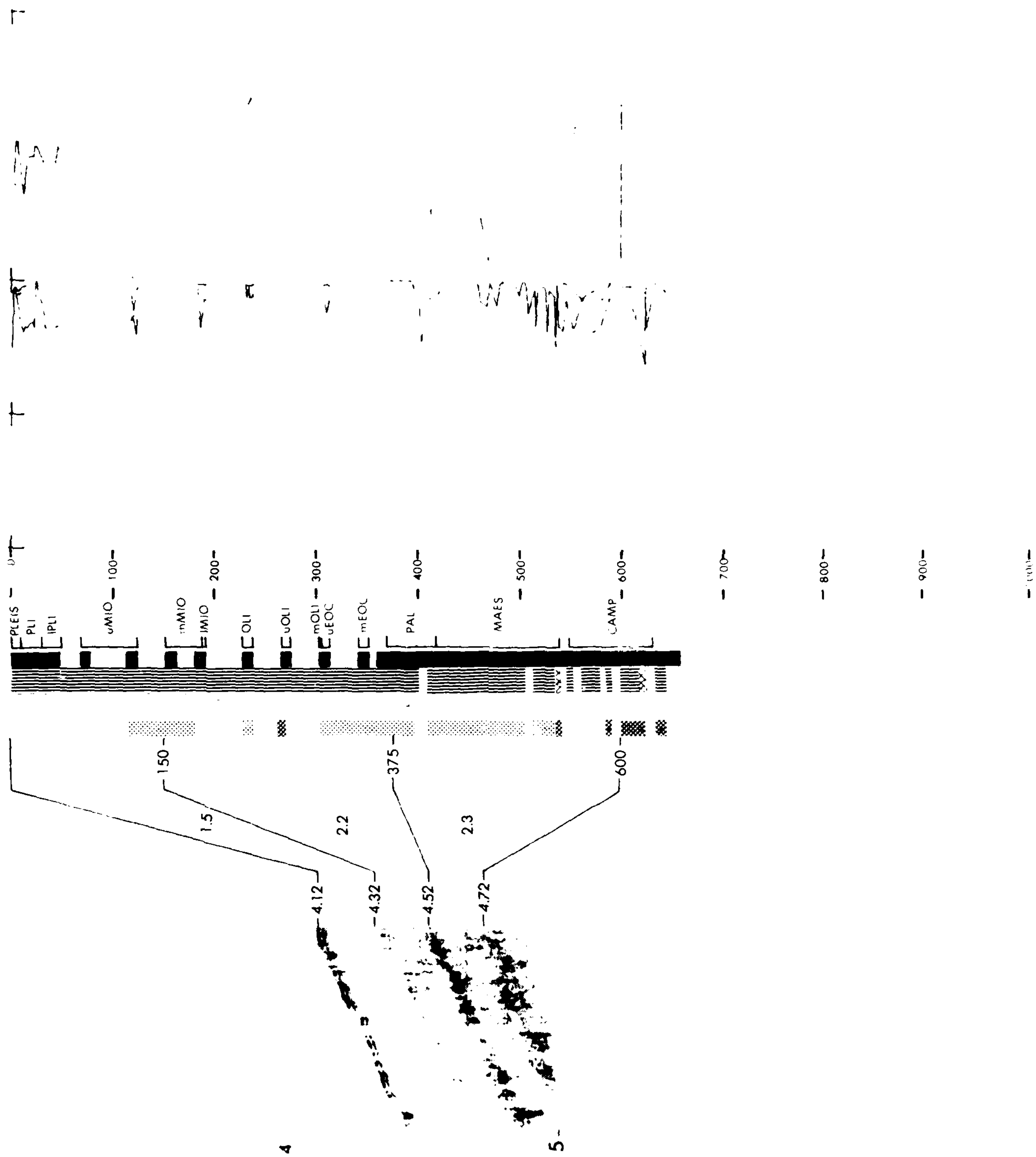
Penetration:	217	217A	
Drilled--	269	502	meters
Cored----	345.5	161.5	meters
Total----	614.5	663.5	meters
Recovery:			
Basement-	3	7	cores
	1.5	7.7	meters
Total----	37	17	cores
	183.4	41.6	meters

Igneous rock was not reached, and the oldest lithologic unit samples is a Campanian dolarenite-chert complex in which the dolomite is clearly of secondary origin. Sugary rhombs of this mineral have replaced shallow-water bioclastic material of possible lagoonal or shelf origin, and at least two repeated phases of dolomitization are indicated by zoned dolomitic overgrowths on sparry calcite nuclei. Progressive sinking of the Ninetyeast Ridge is reflected in the overlying lithologic unit which is composed of late Campanian to mid-late Miocene foraminifera- and clay-rich nannofossil ooze, chalk, and chert. Basal portions of this unit contain definite evidence for a shallow water environment. Paleontologic evidence indicates an oceanic environment for the carbonate ooze and chalk section above 500 meters. The uppermost lithologic unit is dominantly an oceanic calcareous nannofossil ooze of mid-late Miocene to Recent age. Oozes in this unit contain a significant admixture of terrigenous clay particularly in the upper part, which may be due to greater turbidite activity in the Bay of Bengal fan in late Miocene times. The two unconformities recognized by Curray and Moore (1971) were found to be uppermost Miocene and Paleocene-Eocene respectively.

Most calcareous sediment nannofossil rich. In Campanian age one layer oolite rich.



SITE 217 LEG 22



SITE DATA

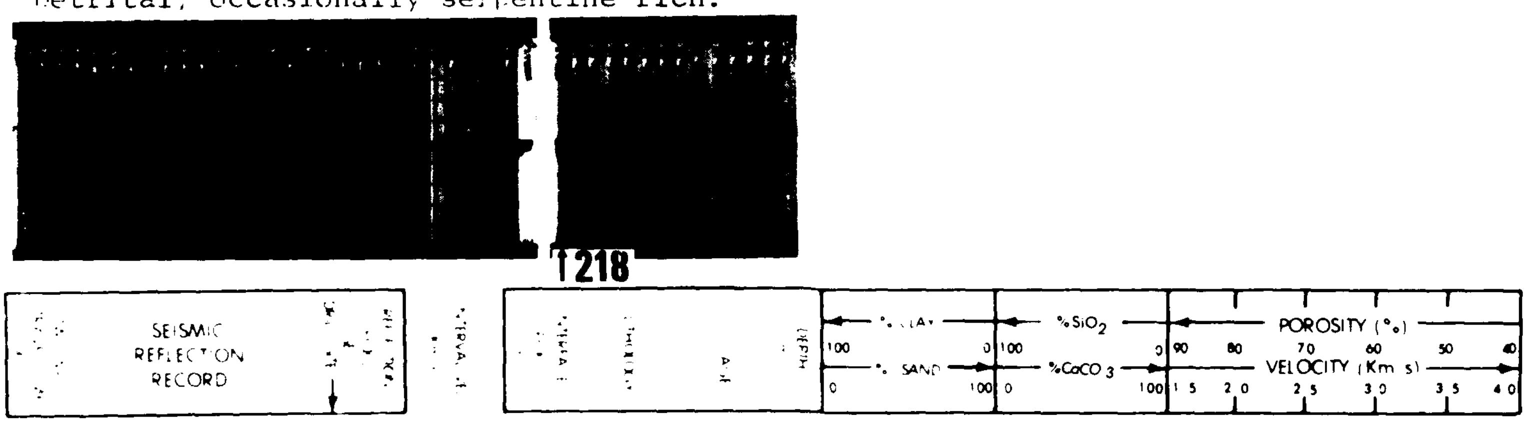
Position:
Latitude 8°00.4' N
Longitude 86°17.0' E
Date: 03/01/72
Time: 0400Z
Water depth: 3749 meters
Location: Central Bengal Abyssal Fan

CORE DATA

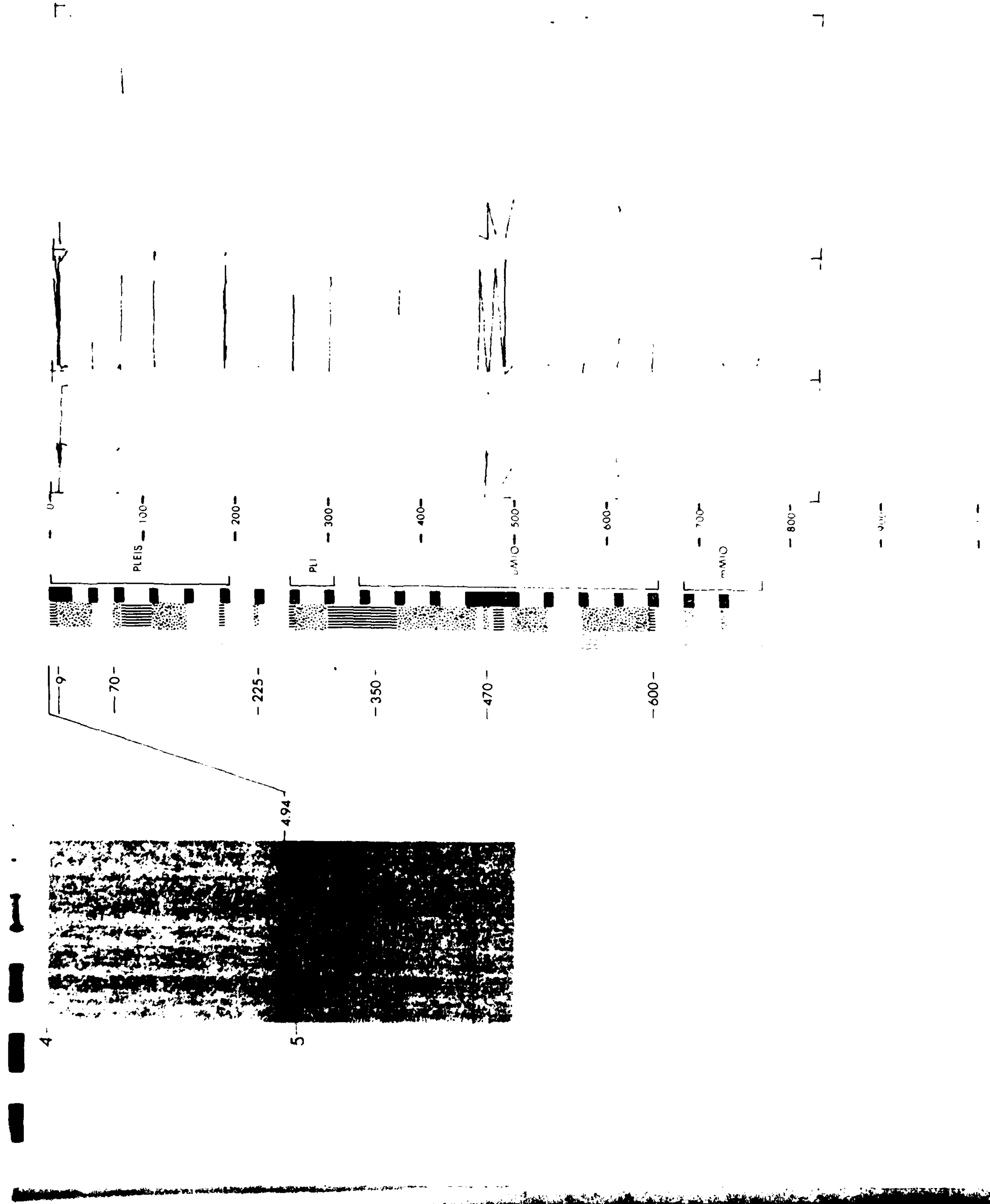
Penetration:
Drilled-- 522 meters
Cored---- 251 meters
Total---- 773 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 27 cores
59.4 meters

The entire sequence is composed of interbedded clean silts, sandy silts, clayey silts, and silty clays of turbidite origin with occasional layers of clay-rich nannofossil ooze. This rules out the possibility that the section at this site could be pelagic as was encountered at Site 217. These zones indicate pulsating turbidite deposition at the site. Four time intervals, one in the middle Miocene, two in the upper Miocene-lower Pliocene, and one in the Pleistocene, are characterized by relative abundance of coarse sediment and reflect periods of more intense turbidity current activity. Evidence of intense burrowing activity by bottom organisms is common in and near the pelagic segments of the cores, supporting the contention of lower depositional rates. Variations in the frequency and intensity of turbidity currents to any one site such as this could be effected by at least three obvious mechanisms: (1) shifting of the main current action to channel systems at varying distances from the site; (2) climatic variations and associated sea-level changes which affect the rate of sediment input to submarine valleys feeding the fan; (3) tectonic activity in the Himalayas and attendant erosive output of the Ganges-Brahmaputra River system which feeds sediment to the fan from the north.

Interbedded calcareous and detrital sediment. Calcareous; nannofossil rich. Detrital; occasionally serpentine rich.



SITE 218 LEG 22



SITE DATA

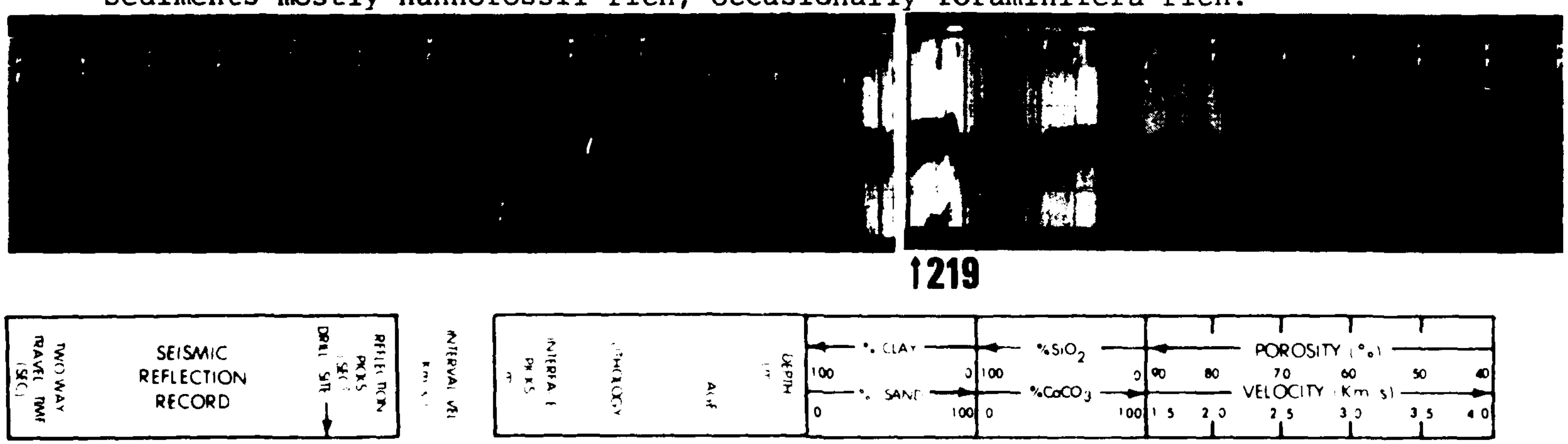
Position:
Latitude 9° 01.7' N
Longitude 72° 52.7' E
Date: 03/10/72
Time: 1330Z
Water depth: 1764 meters
Location: Crest of Laccadive-Chagos Ridge

CORE DATA

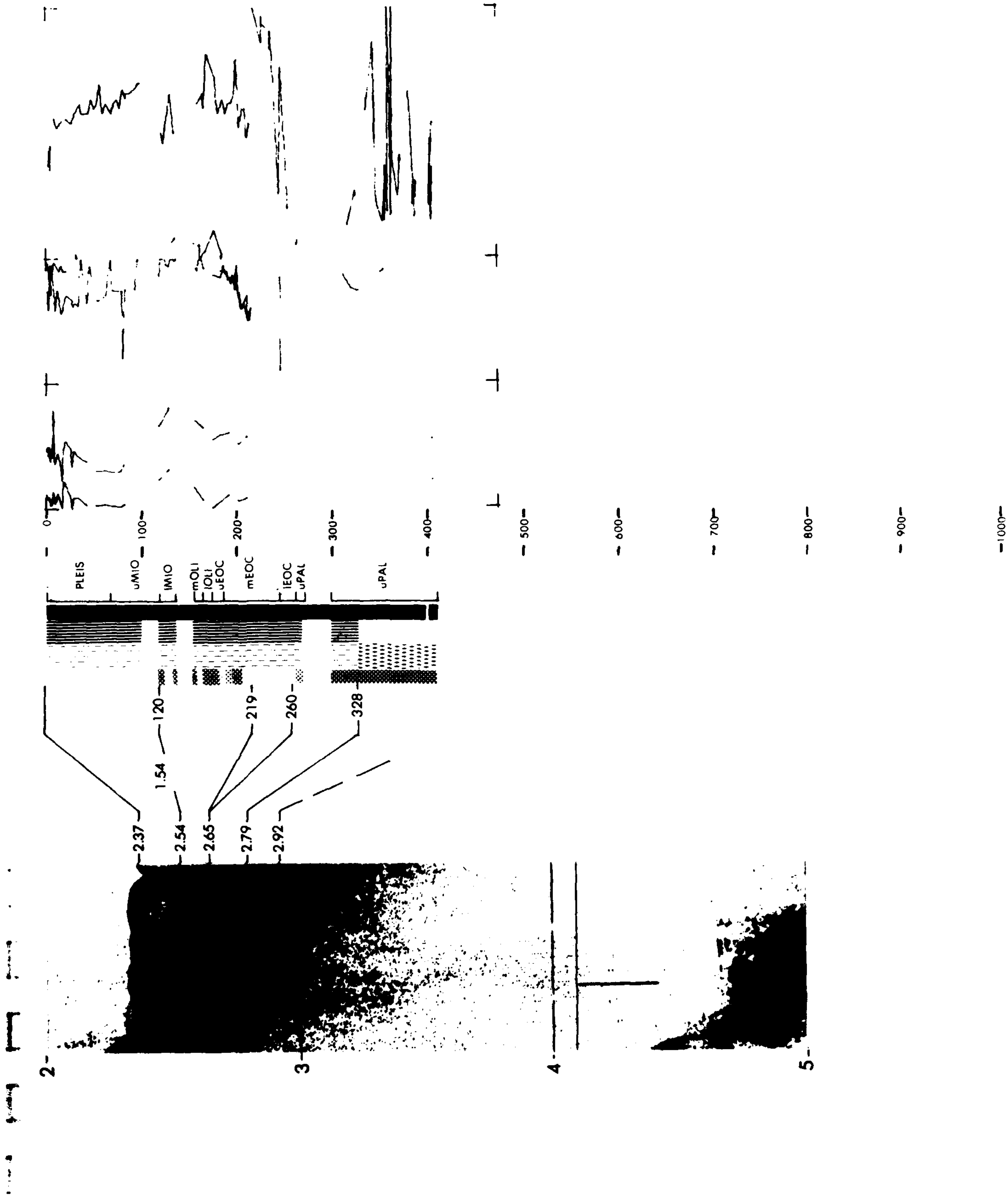
Penetration:	219	219A	
Drilled--	38	296	meters
Cored----	235	115	meters
Total----	273	411	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	28	14	cores
	1725	50.6	meters

In Late Paleocene time, shallow-water limestones, sandstones, and siltstones were deposited (at least 70 m/m.y.) on a subsiding foundation in water depths of less than 100 meters. The sediments suggest a volcanic provenance, perhaps the Deccan Traps. Then in Early Eocene time, the sea bed began to sink concurrently with other tectonic events in India and mainly chalk and ooze were deposited at a slower rate (18 m/m.y.). Biogenic silica, later to become chert, began to accumulate. Fairly constant conditions seem to have been maintained, except for an ever decreasing sedimentation rate, until Early Oligocene time when biogenic silica became scarce in the sediments. From Early Oligocene to Early Miocene time, sedimentation was minimal (about 1 m/m.y.) and probably reflects a time when the site was subject to strong bottom currents. In post-Early Miocene time, a nanno ooze, supplemented by a 20 to 35 percent detrital component, was deposited at a mean rate of around 15 m/m.y. At first the ooze contained abundant foraminifera but with the onset of upwelling they became rarer. Upwelling, which appears to have begun in Middle Miocene time, continues to the present day. Fresh volcanic glass is found throughout the Pleistocene sediments as has been reported to be of eolian origin probably from the southeast.

Sediments mostly nannofossil rich, occasionally foraminifera rich.



SITE 219 LEG 23



SITE DATA

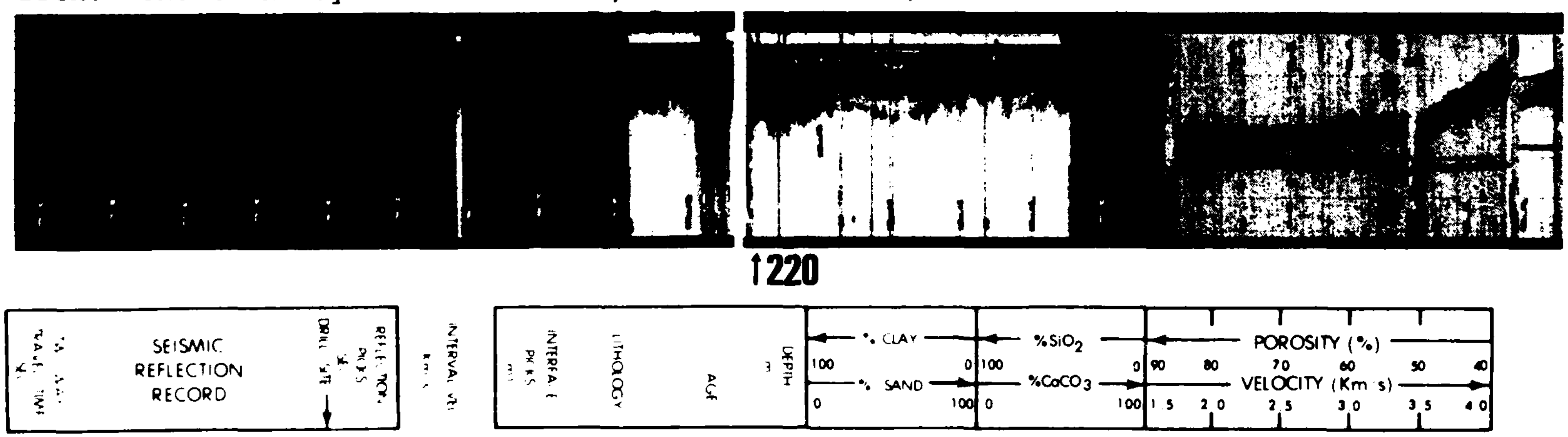
Position:
Latitude $6°31.0'$ N
Longitude $70°59.0'$ E
Date: 03/14/72
Time: 1952Z
Water depth: 4036 meters
Location: West of the Luccadive-Chagos Ridge

CORE DATA

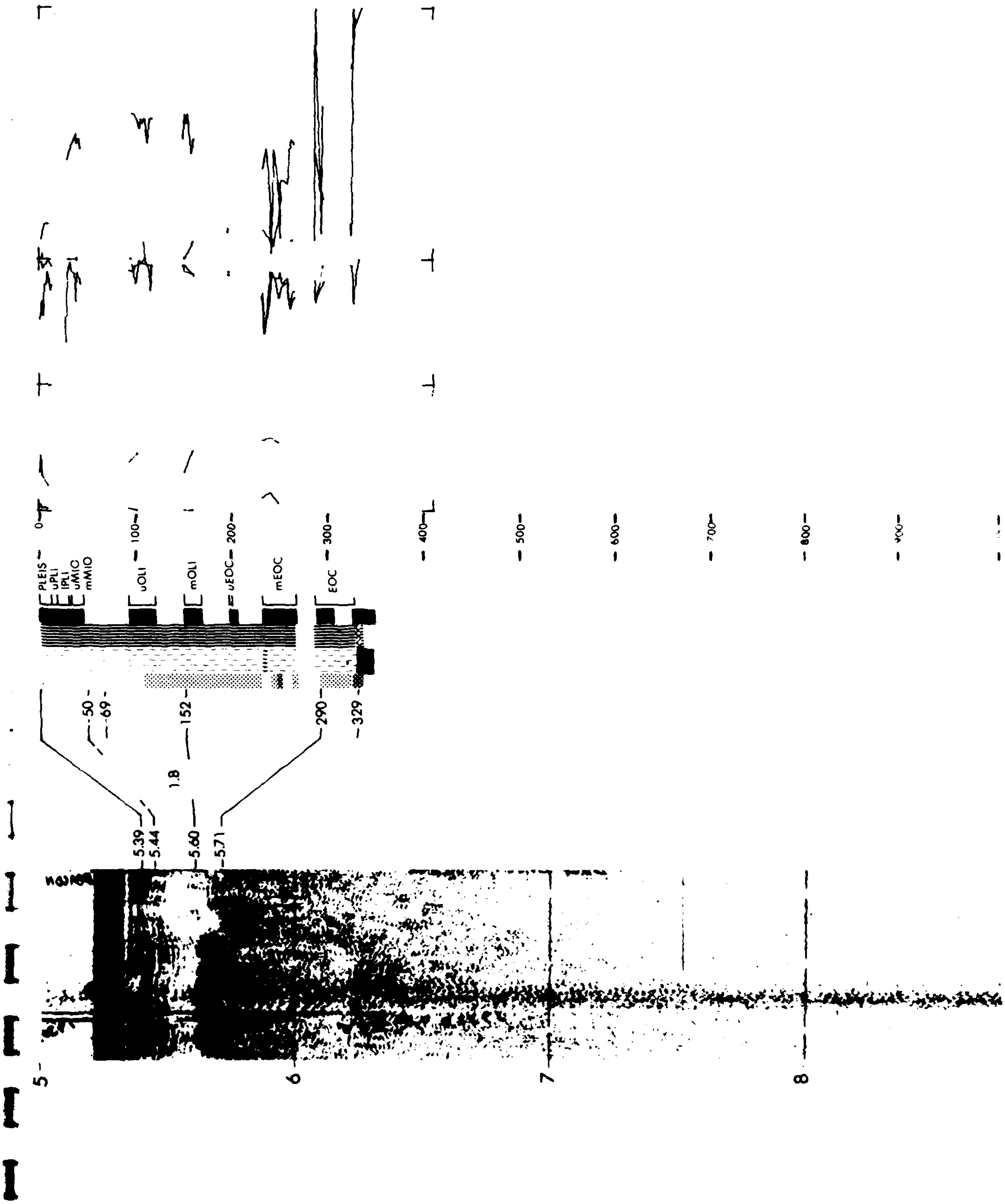
Penetration:
Drilled-- 173 meters
Cored---- 177 meters
Total---- 350 meters
Recovery:
Basement- 4 cores
7.5 meters
Total---- 21 cores
100.9 meters

The presence of two thin sediment layers between basalt flows suggests that short periods of sediment accumulation were interspersed during the last phase of basalt extrusion. The presence of the siliceous tests suggests that the site was either in an equatorial belt of high productivity or it was in a coastal upwelling area. By Late Eocene time, the high surface productivity at Site 220 had apparently ceased. The rate which dwindled to 6 m/m.y. suddenly increased in Late Oligocene time. This increase may reflect structural elevation of the site, possibly due to renewed sea floor spreading from the Carlsberg Ridge in the Oligocene after the hiatus postulated by McKenzie and Sclater (1971). Much of the subsequent depositional history, although hidden in an uncored interval, may largely have been one of the pelagic brown clay deposition. Deposition of this type is more logical than continuing nanno ooze sedimentation. Subsequently, continuous sediment accumulation included some turbidite deposition. Interbedded in this interval are thin foram sands containing redeposited shallow-water benthic forms, probably derived from the Chagos-Laccadive Ridge. A decrease upward of the solution levels of the foraminifera suggests a deepening CCD.

Sediments mostly nannofossil rich. One thin layer in Pleistocene epoch foraminifera rich. One thin layer of siliceous, radiolaria rich, sediment occurs in middle Eocene time.



SITE 220 LEG 23



SITE DATA

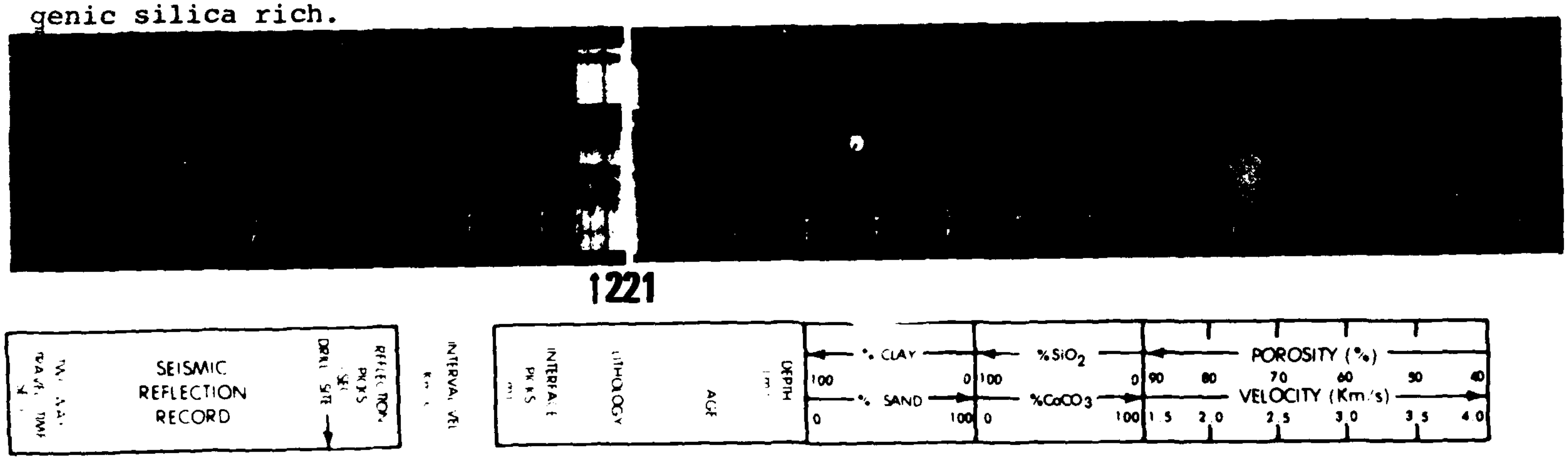
Position:
Latitude $7°58.2'$ N
Longitude $68°24.4'$ E
Date: 03/20/72
Time: 1320Z
Water depth: 4650 meters
Location: Arabian Abyssal Plain

CORE DATA

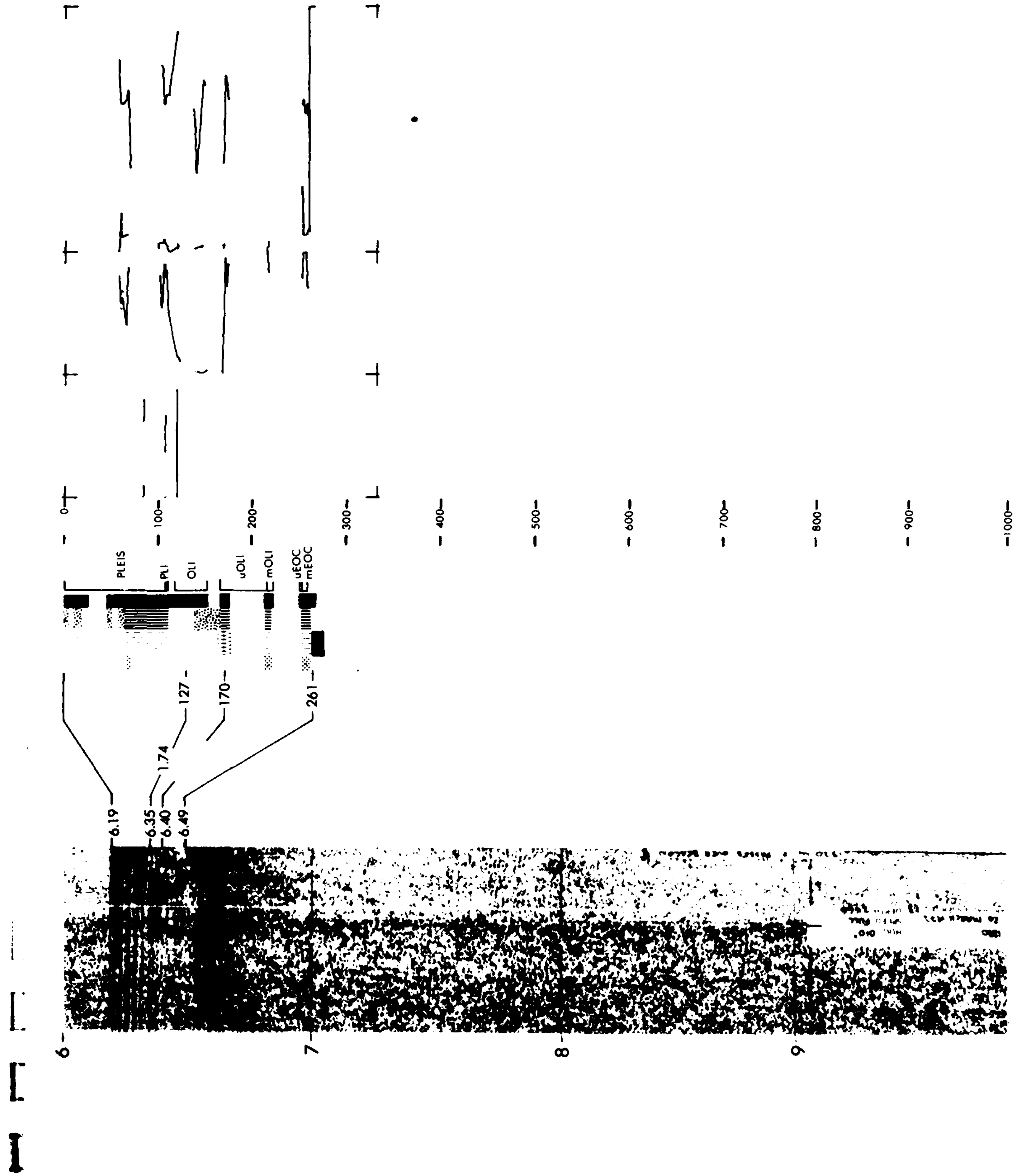
Penetration:
Drilled-- 100 meters
Cored---- 170 meters
Total---- 270 meters
Recovery:
Basement- 2 cores
5 meters
Total---- 19 cores
76.6 meters

The oldest rocks recovered at this site consist of 20- to 100-cm-thick tholeiitic basalt flows which contain a thin limestone bed. Overlying the basalt is a thin ash layer which, in turn, has a thin chert bed rich in radiolarians above it. A Middle Eocene age was assigned to the lowermost nannofossil chalks which lie above the chert. The deposition of such chalks and ooze continued until Late Oligocene time. An absence of all but the most solution resistant forms of foraminifera plus a slow rate of sedimentation indicates deposition was always in fairly deep water. During Late Oligocene time, the pelagic regime changed from one of nanno ooze to brown clay deposition, which persisted into an undifferentiated portion of Pliocene-Miocene time. At an undetermined point in Neogene time, onlapping turbidites from the Indus Cone reached the southern portion of the Arabian Sea at this site, initially mixing with the pelagic deposits. Finally, in Late Pliocene time, the onlapping turbidity current deposits, many derived from areas of carbonate sedimentation along the shelf of western India, dominated the sedimentary regime. A mix of multisource turbidites and pelagic deposits has apparently persisted to the present day.

Calcareous sediments nannofossil rich. Detrital sediment in Pliocene epoch; authigenic silica rich.



SITE 221 LEG 23



SITE DATA

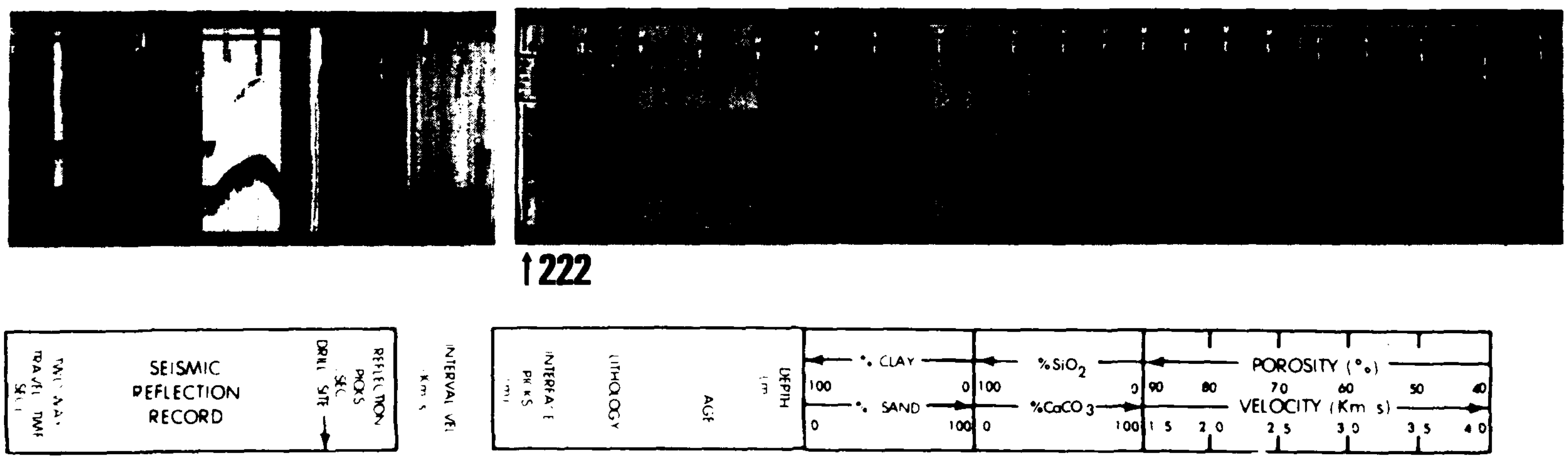
Position:
Latitude 20°05.5' N
Longitude 61°30.6' E
Date: 03/24/72
Time: 1400Z
Water depth: 3546 meters
Location: Owen Fracture Zone

CORE DATA

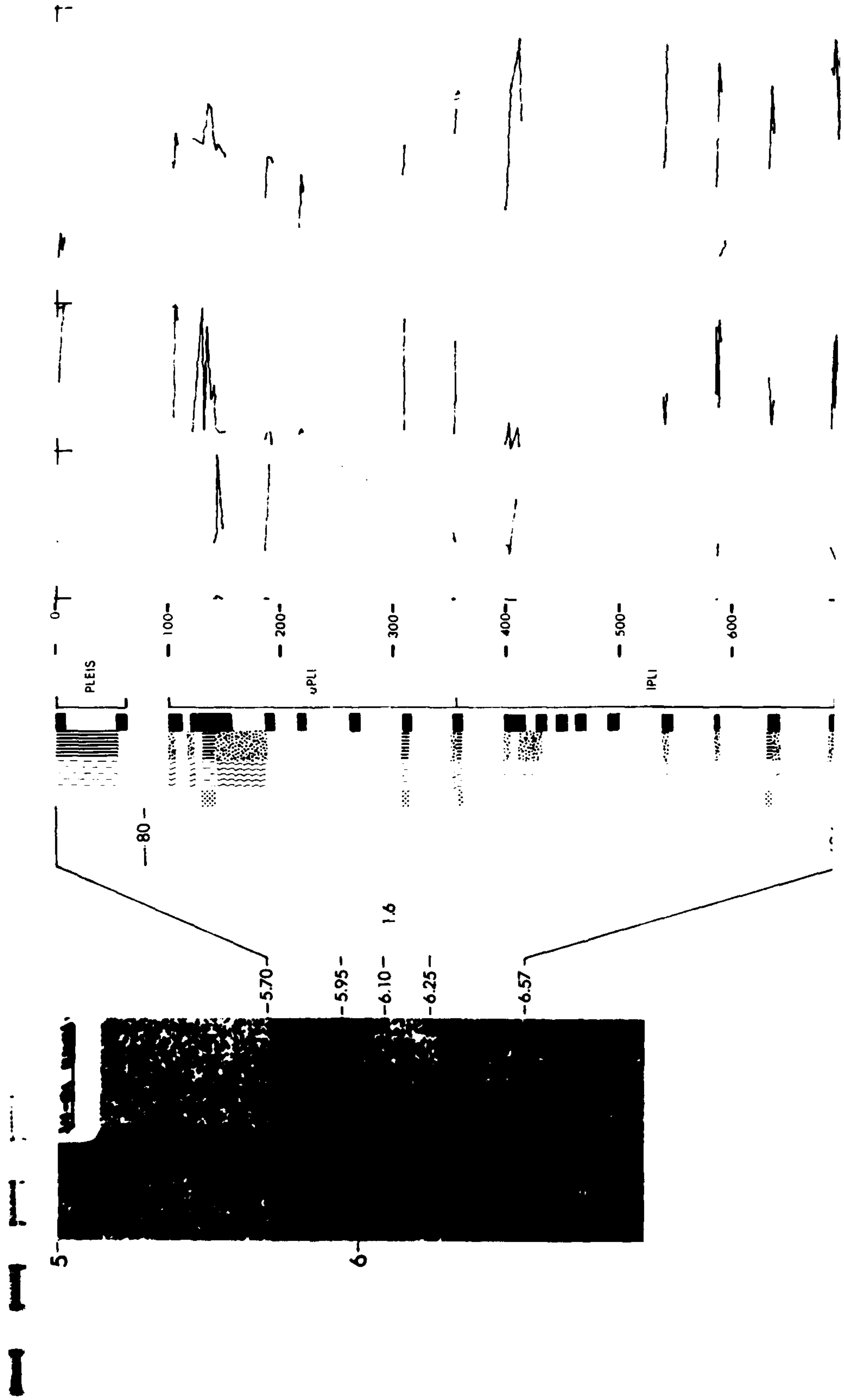
Penetration:
Drilled-- 987 meters
Cored---- 313 meters
Total----1300 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 36 cores
175.6 meters

The oldest stratigraphically recognizable interval encompasses the last million years of Late Miocene time. Almost the entire lower half of the 1300 meters of sediment penetrated at Site 222 were deposited during this period. Although consisting largely of gray silty clays plus associated silt and sand beds, there are many intervals of green silty clay as well. These contain burrow structures which, when taken with their higher content of nannofossils, suggests that they represent periods of slower deposition. Most likely they represent shifts in the loci of Indus Fan deposition. There is some question as to whether turbidity current deposition was an important factor in the deposition of any except the coarse-grained beds. This mode of deposition continued into the Pliocene although at a reduced rate. A pronounced change in rate and type of deposition took place at about the beginning of Pleistocene time. Coarse turbidites are completely absent and even the finer-grained clastics accumulated at a much slower rate. It appears that nonturbiditic processes dominated the depositional regime during Pleistocene time.

Calcareous and detrital sediments interbedded Calcareous; mostly nannofossil rich.



SITE 222



0
100
200
300
400
500
600
PLEIS
uPLI
lPLI
80
1.6
5.70
5.95
6.10
6.25
6.57
5
6

SITE DATA

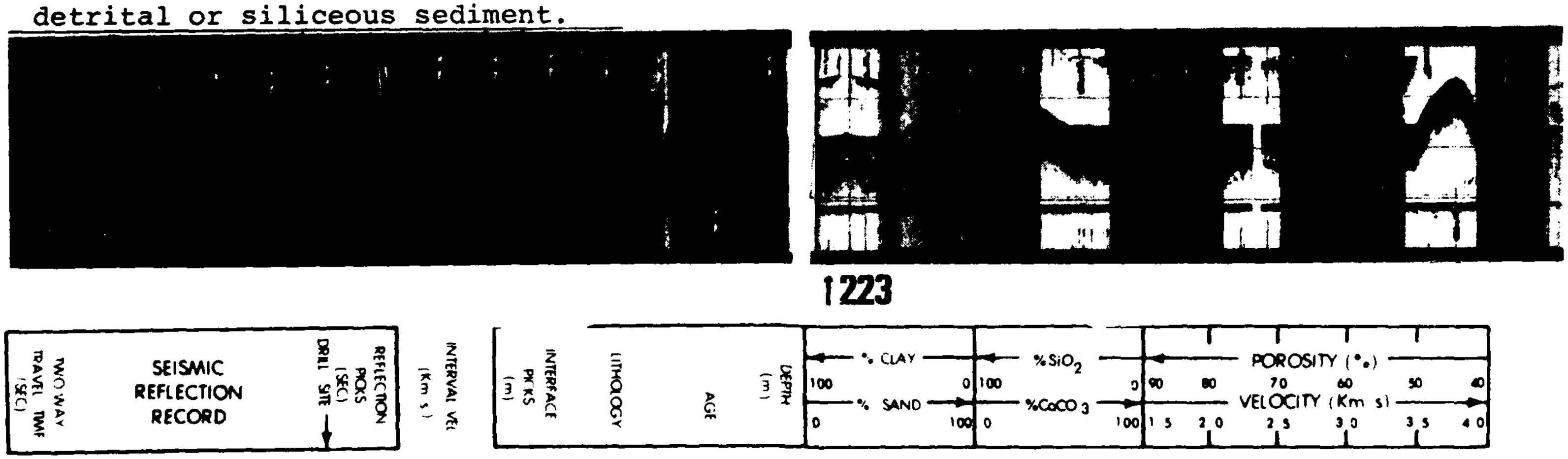
Position:
Latitude 18°45.0' N
Longitude 60°07.8' E
Date: 03/31/72
Time: 0945Z
Water depth: 3633 meters
Location: Owen Ridge

CORE DATA

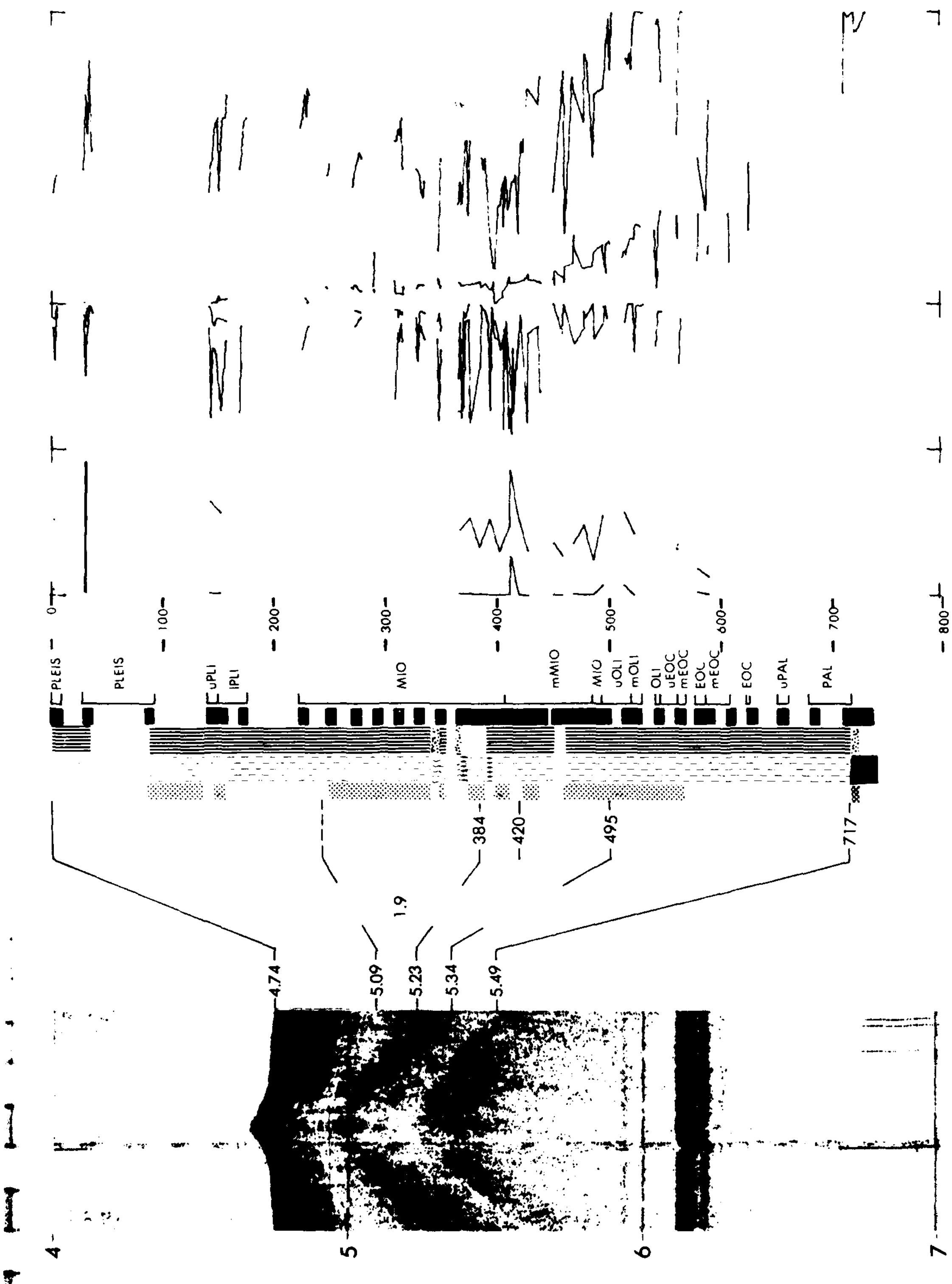
Penetration:
Drilled-- 371 meters
Cored---- 369 meters
Total---- 740 meters
Recovery:
Basement- 3 cores
8 meters
Total---- 42 cores
203.7 meters

At some unknown pre-Late Paleocene date, a subaqueous trachybasalt level was extruded. At about the same time a hyaloclastic breccia was formed. Then in the Late Paleocene, some 60 meters of brown claystone were laid down. The Upper Paleocene tuff was followed by a Lower Eocene detrital carbonate zeolitic claystone. During the remainder of the Eocene, the carbonate (nannofossil) content steadily increased, planktonic foraminifera reappeared, and eventually by Middle Eocene time, a nanno chalk was being formed. In the earliest Miocene a slight tilting to the west and uplift caused slumping and the deposition of a chalk breccia which is associated with a 6 m.y. gap in the sedimentary column. Deposition of nanno ooze recommenced at this site about 16 m.y. ago. In the later part of the Middle Miocene, about 12 m.y. ago, a series of features appeared in the sediments which recorded the onset of upwelling in the region. It is possible that this initiation of upwelling can be attributed to a major Middle Miocene phase of Himalayan uplift. The terrigenous aspect of the sediments increased in the Pliocene and latest Miocene to the extent that the sediment can be described as a nanno clayey siltstone.

Calcareous sediments; nannofossil rich. Miocene; calcareous with thin beds of detrital or siliceous sediment.



SITE 223 LEG 23



SITE DATA

Position:
Latitude 16°32.5' N
Longitude 59°42.1' E
Date: 04/05/72
Time: 0748Z
Water depth: 2500 meters
Location: Owen Ridge

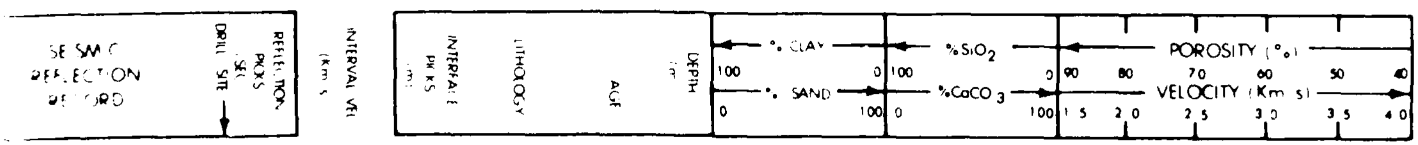
CORE DATA

Penetration:
Drilled-- 693 meters
Cored---- 99 meters
Total---- 792 meters
Recovery:
Basement- 1 cores
.4 meters
Total---- 11 cores
31 meters

Beginning in the Early Eocene, a lamprophyre flow was extruded. The clay mineralogy of the claystone suggests that this rock may represent devitrified pyroclastic material. In the Late Eocene, a mixed lithology of nanno chalk, silty claystone, and sandstone was deposited. The sand came from the land areas to the west and northwest which were emergent in the Late Eocene. In the Early Oligocene, clayey siltstones and claystones were laid down at a depth close to the lysocline, suggesting the possibility of sinking at this time. In the remaining Oligocene time, and continuing through Early Miocene time, there was a strong clastic influence (quartz and mica are dominant) with beds of silt and sand, some graded, from an unknown source area to the west. Sometime between Late Oligocene and earliest Middle Miocene the site began to rise, probably contemporaneously with post-Early Miocene uplift in Socotra. The detrital component in the sediments decreased, the sedimentation rate dropped to about 30 m/m.y., and mainly nanno chalk or ooze was laid down. Sometime between the early Middle and Late Miocene, biogenic silica began to form an appreciable proportion of the sediment, and this probably reflects the onset of monsoonal upwelling along the South Arabian coast.

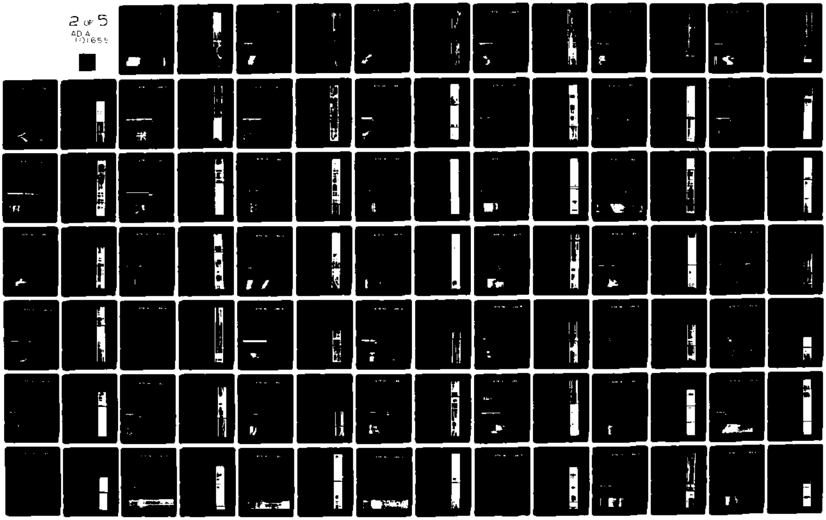
Calcareous sediment nannofossil rich.

1224

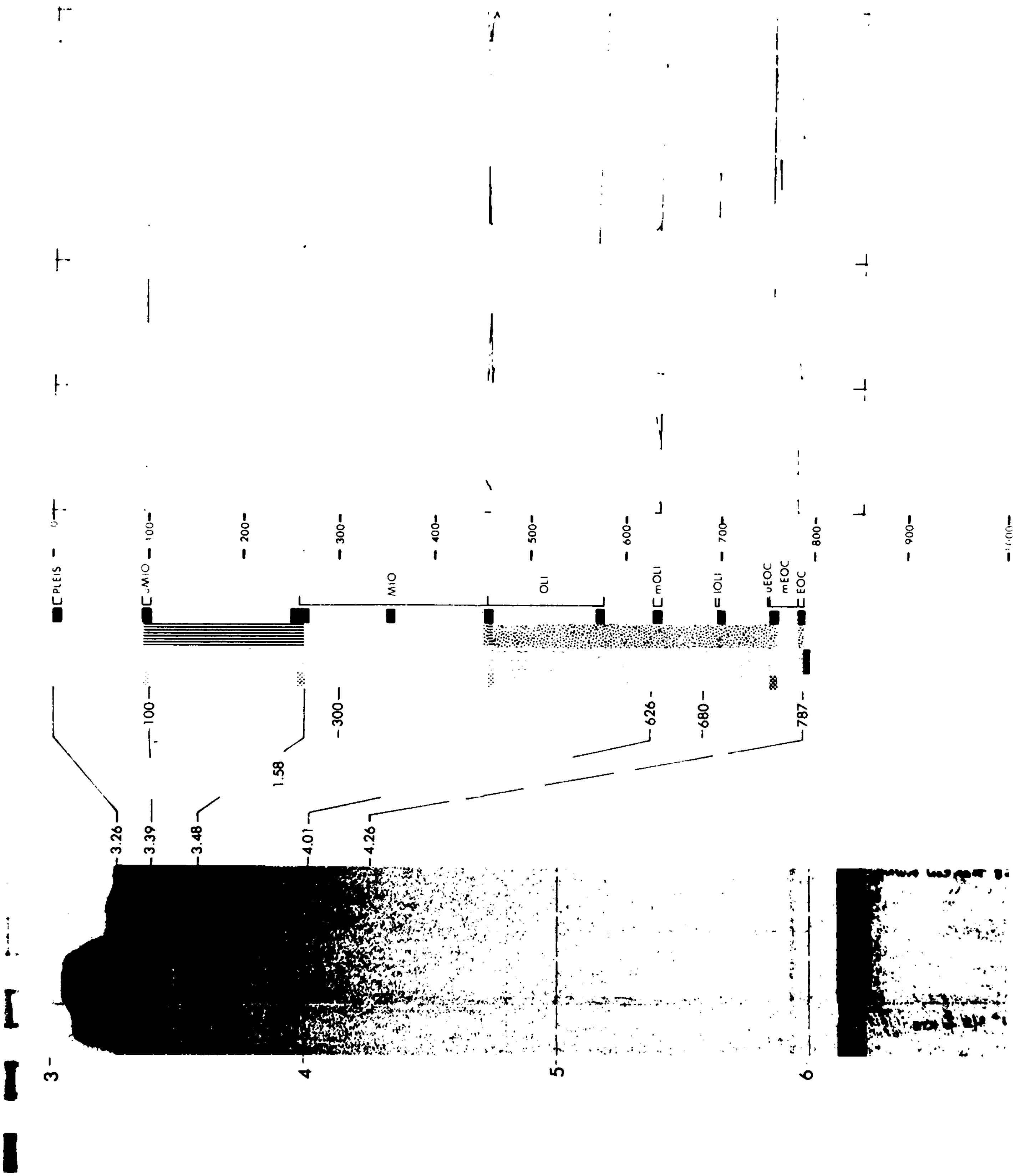


AD-A101 655 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 20/1
A SUMMARY OF SELECTED DATA: DSDP LEGS 20-44,(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL

2 of 5
AD A
101655



SITE 224 LEG 23



SITE DATA

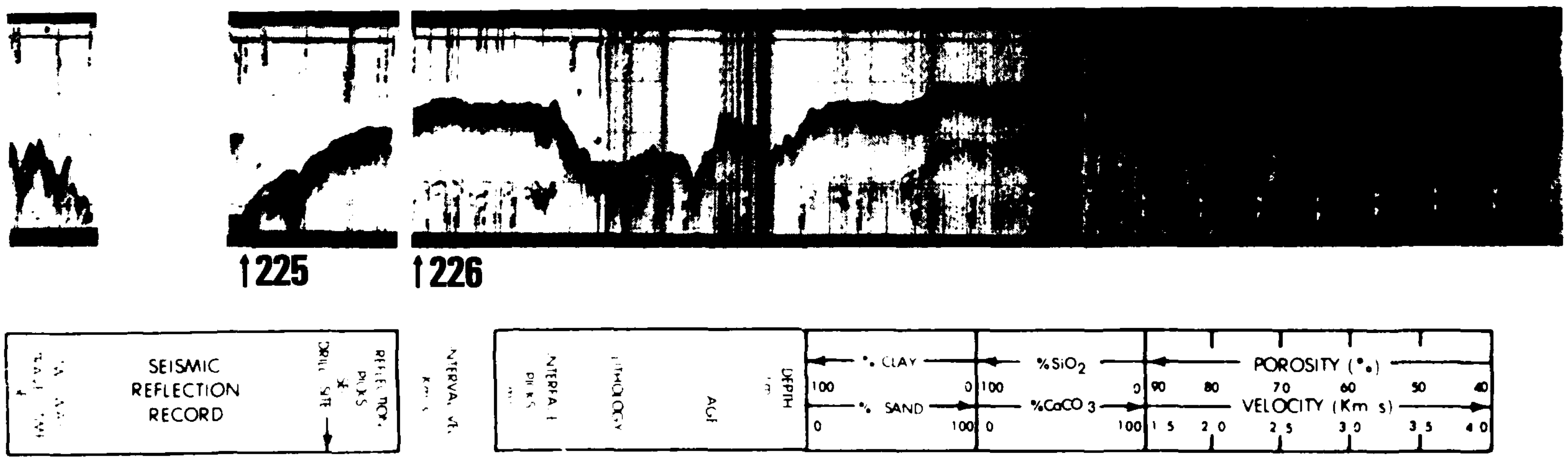
Position:
Latitude $21^{\circ}18.6'$ N
Longitude $38^{\circ}15.1'$ E
Date: 04/15/72
Time: 0450Z
Water depth: 1228 meters
Location: Red Sea

CORE DATA

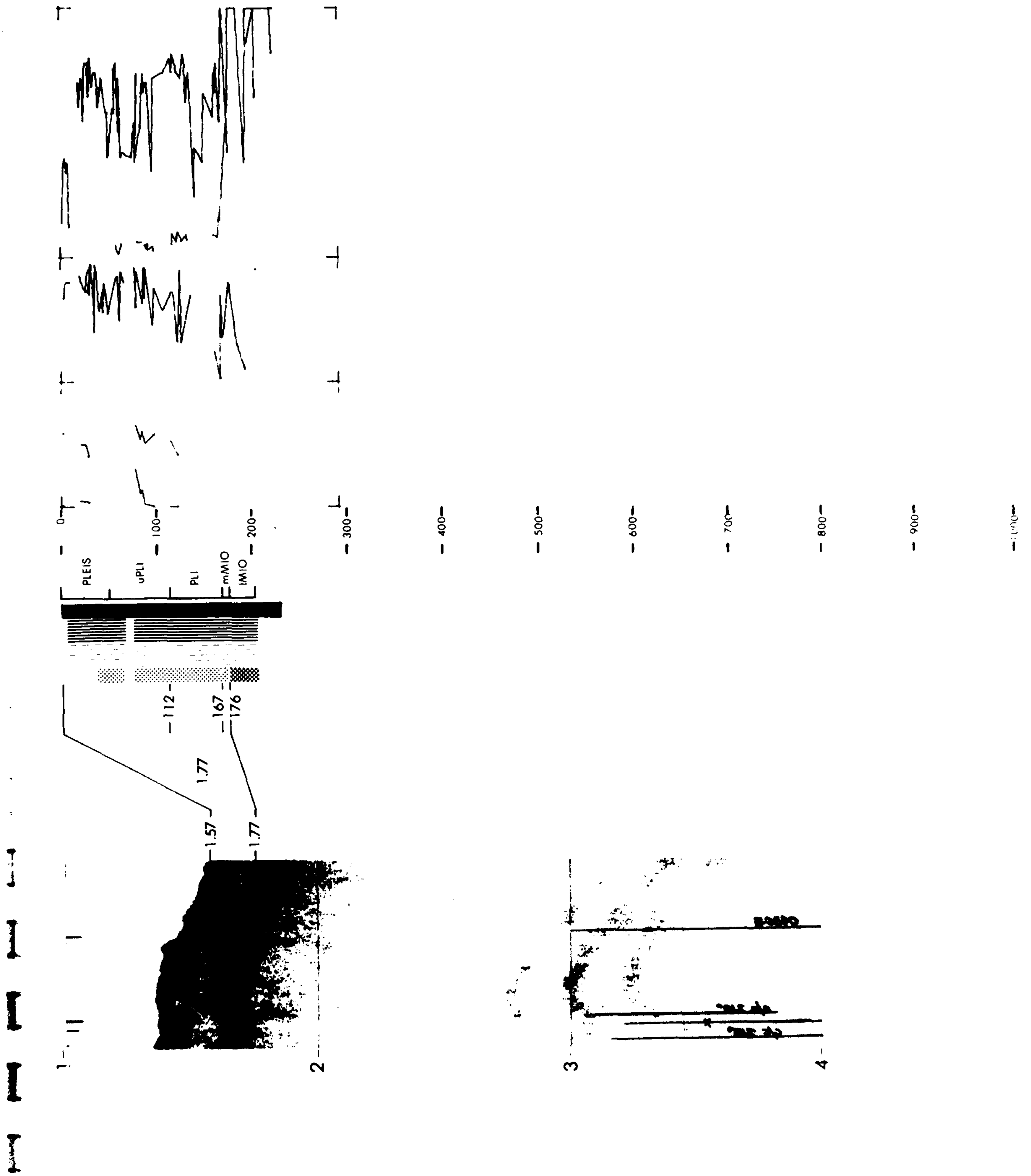
Penetration:
Drilled-- 0 meters
Cored---- 230 meters
Total---- 230 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 29 cores
137.5 meters

Site 225 was drilled on the seaward edge of the main trough about 16 km east of the Atlantic II Deep. The hole was continuously cored to a depth of 230 meters and was terminated 54 meters into a Late Miocene evaporite sequence. A distinct acoustic reflector, reflector S, mapped over much of the Red Sea, is due to the lithologic change from an overlying Early Pliocene claystone to an anhydrite marking the top of the evaporite sequence. Lithologic and paleontologic evidence indicates that shallow restricted evaporite conditions prevailed in the Miocene, gradually changing to more open sea conditions in the Pliocene and Pleistocene. Dark muds and shales above the evaporite sequence are occasionally enriched with iron, vanadium, and molybdenum. Within the evaporite sequence, shales contained smaller vanadium and molybdenum contents but considerable copper. Interstitial salinities increase with depth and form a typical diffusion curve characteristic of saturated sodium chloride. This phenomenon, similar to that observed in several other Red Sea sites, indicates the presence of halite at depth.

Calcareous sediments; occasionally nannofossil rich, in Miocene time oolite rich.



SITE 225 LEG 23



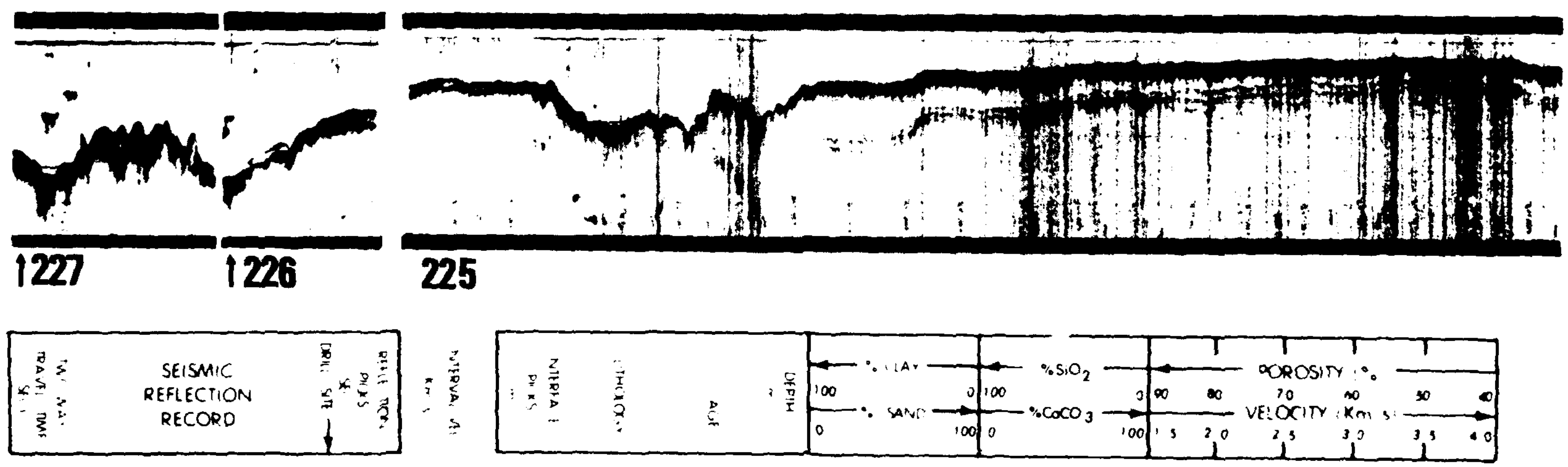
SITE DATA

Position:
Latitude 21°20.5' N
Longitude 38°04.9' E
Date: 04/17/72
Time: 0217Z
Water depth: 2169 meters
Location: Red Sea

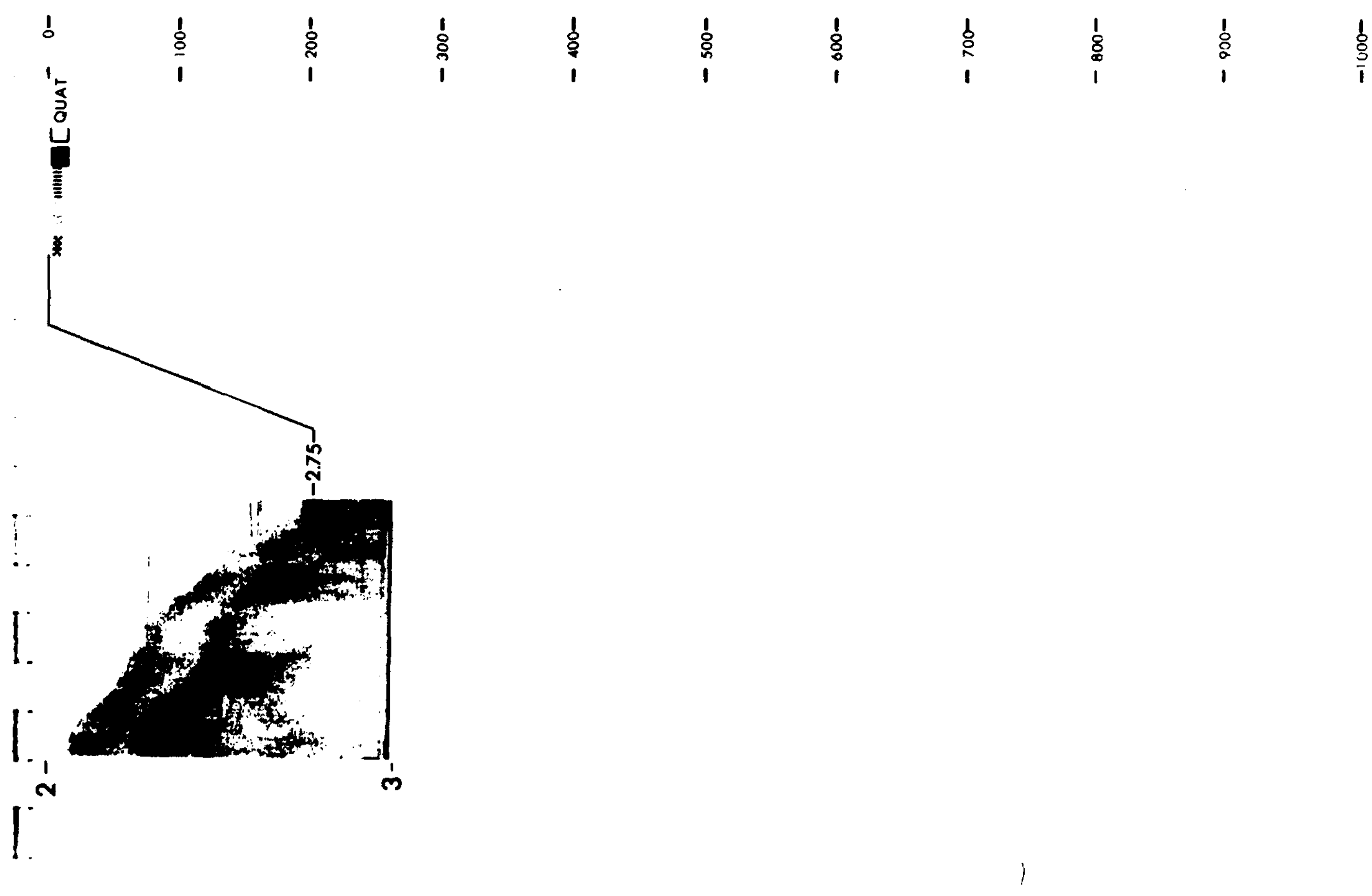
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 14 meters
Total---- 14 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 2 cores
8.9 meters

Site 225 was drilled in the central part of the axial trough in an area with bottom water of very high temperature and salinity (about 60°C and 260‰, respectively). The drilling was done in an area commonly known as the hot brine area, and more particularly, in the Atlantis II Deep. This was a high risk hole in that it was not clear if enough sediment was present to satisfactorily bury the drill string, and indeed, drilling attempts at three different offset positions failed to penetrate a shallow basalt. Only a total of 14 meters was penetrated before part of the bottom hole assembly was lost. The two cores we obtained contained sediments similar to those previously obtained from the area-a Late Quaternary mixed montmorillonite, anhydrite, and goethitehematite facies in the upper 5 meters with fresh basalt fragments in the lower 9 meters. The basalts, which show no indications of chemical reaction with the hot brines, are similar to previously described oceanic ridge basalts. Geochemically, the sediments recovered at Site 226 are similar to those previously collected except for the lower quantities of manganese and higher amounts of barium and lead.



SITE 226 LEG 23



SITE DATA

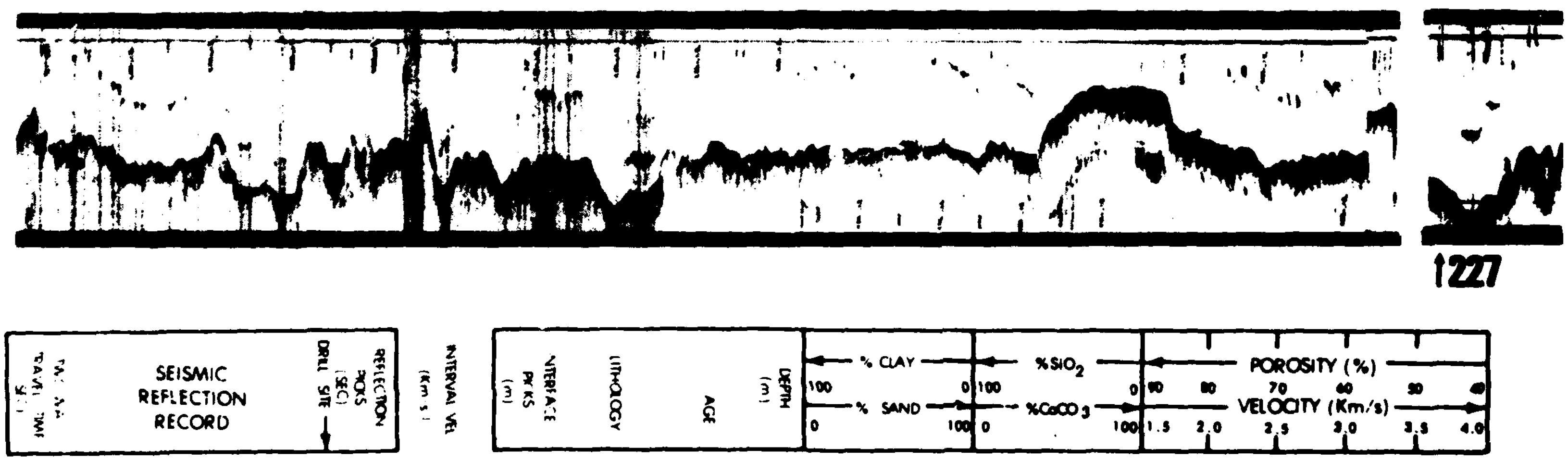
Position:
Latitude 21°19.9' N
Longitude 38°08.0' E
Date: 04/18/72
Time: 1230Z
Water depth: 1795 meters
Location: Red Sea

CORE DATA

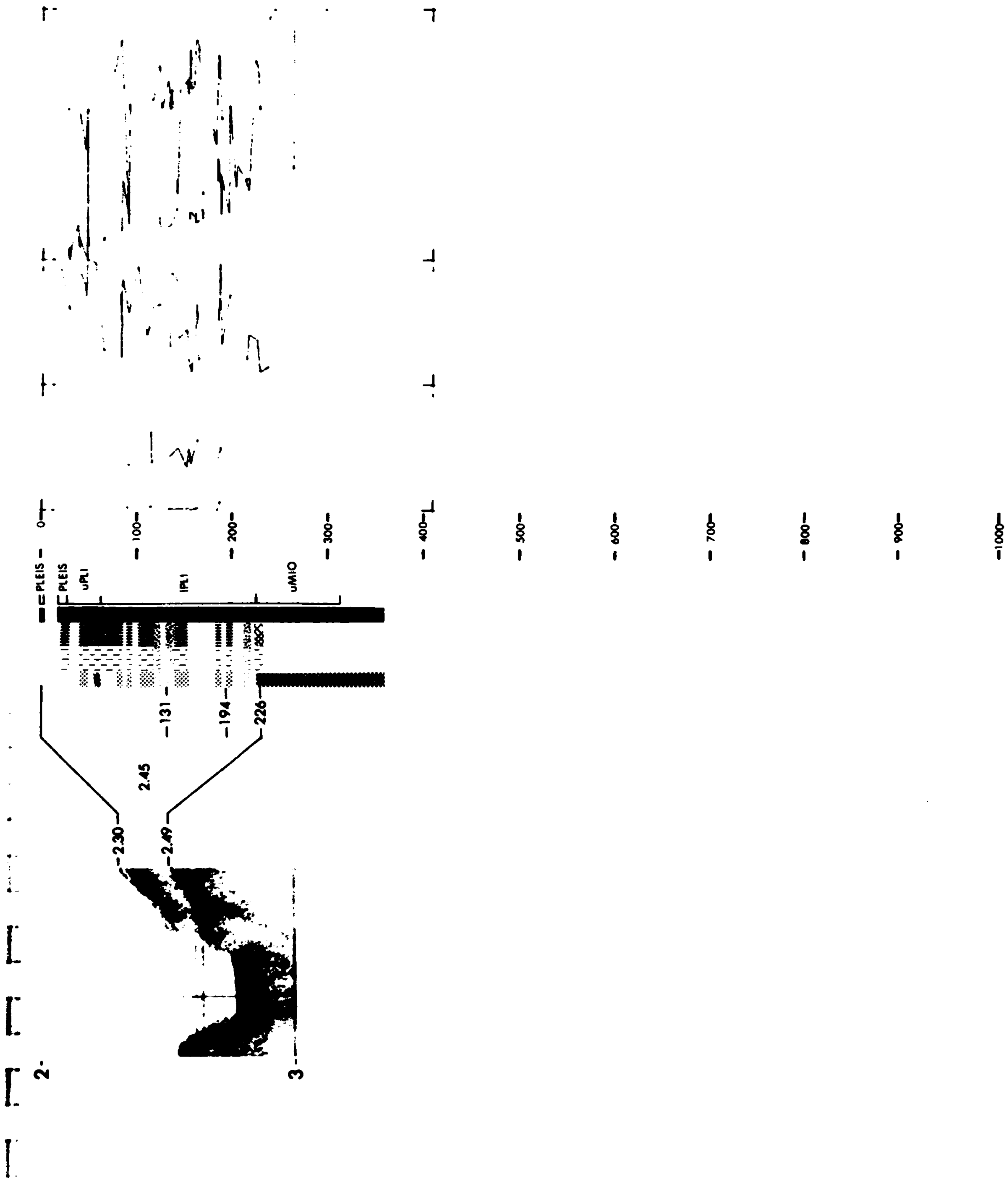
Penetration:
Drilled-- 15 meters
Cored---- 344 meters
Total---- 359 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 45 cores
123.5 meters

Site 227 was drilled on the edge of the axial trough about 5 km east of Site 226 and the Atlantic II Deep. Four distinct lithological units were identified which are similar to, and apparently correlatable with, sedimentary units penetrated at Site 225. Lithologic and paleontologic data suggest restricted evaporite conditions during the Miocene gradually evolving to more open ocean conditions which persisted in the Pliocene and Pleistocene. Interstitial water salinities, as at Sites 225 and 228, indicated the presence of the evaporites before they were reached by the drill. Variations of water content combined with geochemical data of other workers suggest occasional influxes of salt or fresh water during the Late Miocene evaporite period. As at Sites 225 and 228, the dark muds and shales in, and overlying, the evaporite sequence are occasionally enriched in vanadium, molybdenum, copper, and iron. This enrichment, so close to the hot brine area, suggests a close relationship—perhaps these sediments serve as a source for some of the heavy metals in the hot brine area.

Calcareous, occasionally nannofossil rich, sediment interbedded with few thin layers of detrital, rarely serpentine rich, sediment.



SITE 227 LEG 23



SITE DATA

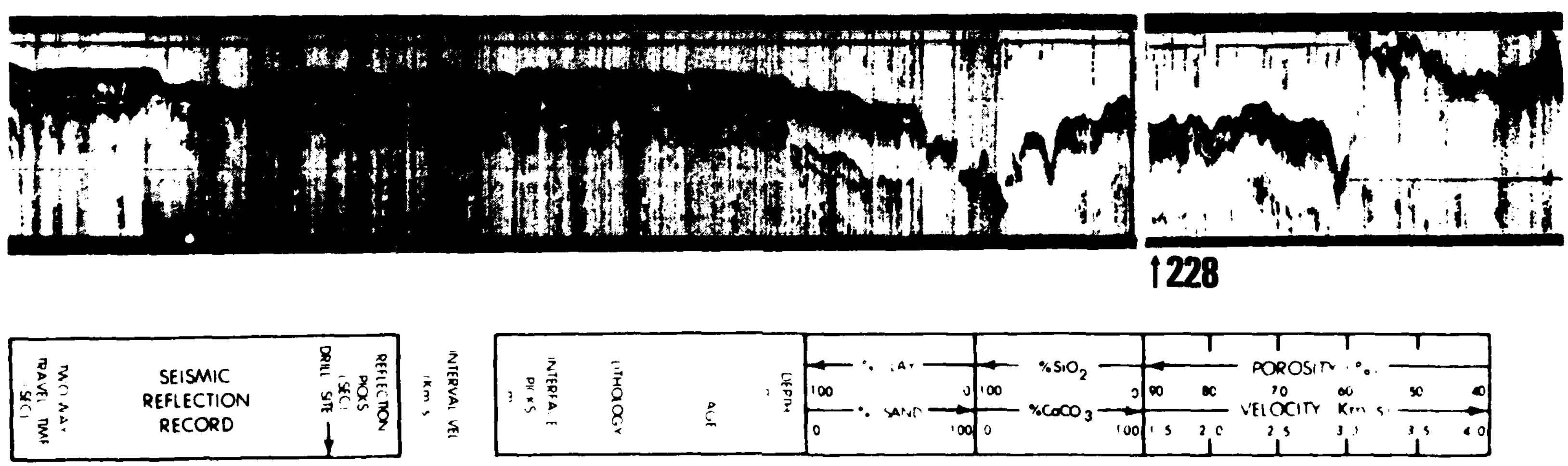
Position:
Latitude 19°05.2' N
Longitude 39°00.2' E
Date: 04/22/72
Time: 1220 Z
Water depth: 1038 meters
Location: Red Sea

CORE DATA

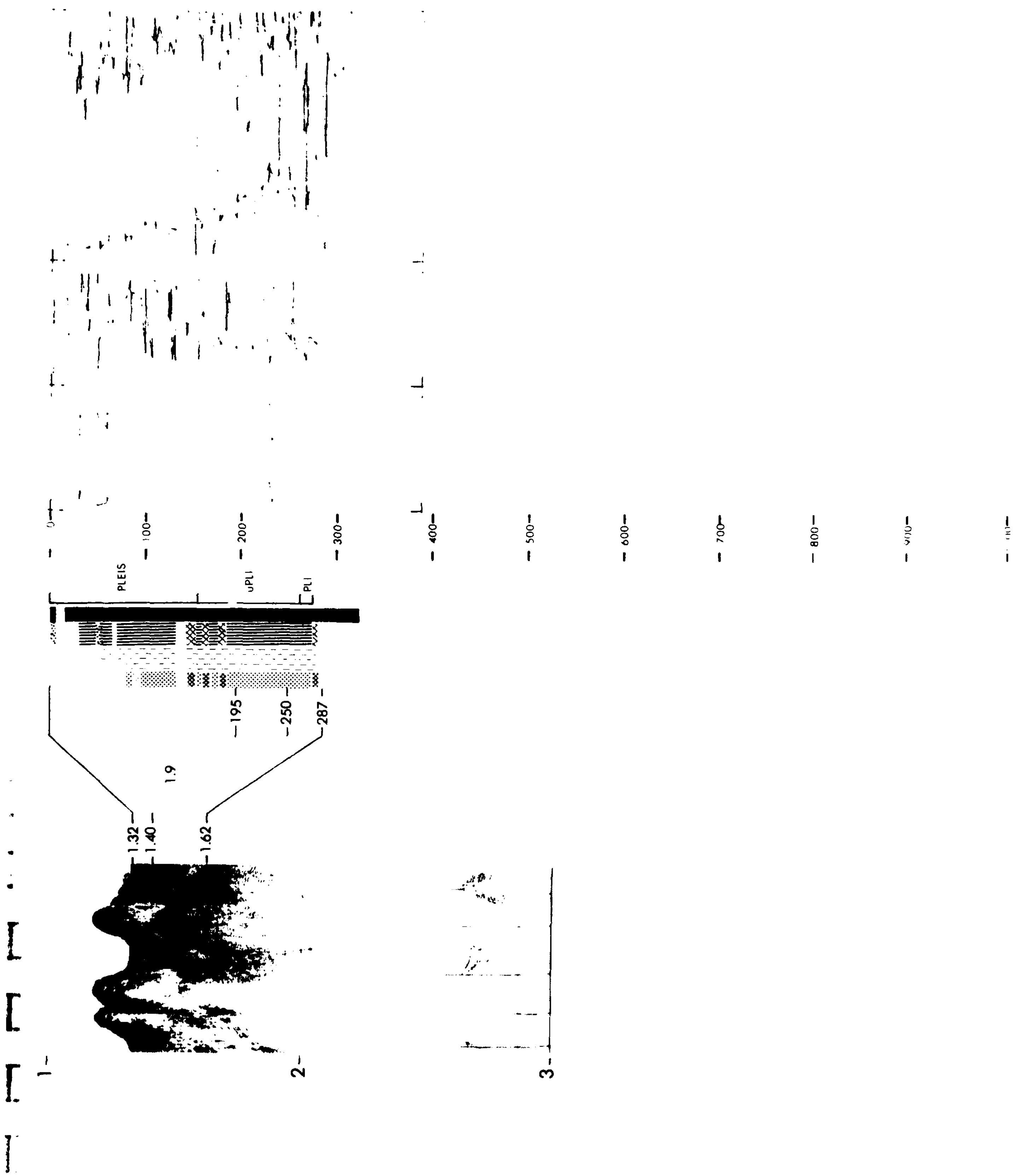
Penetration:
Drilled-- 10 meters
Cored---- 315 meters
Total---- 325 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 40 cores
184.7 meters

A sequence of Plio-Pleistocene siltstones and oozes overlies presumed Late Miocene anhydrite and siltstones. The latter siltstones are enriched in boron, zinc, lead, and copper. The postevaporite sequence is thicker than at Sites 225 and 227 due to an influx of detrital material from a delta forming off the Sundanese coast. The lithology grades upward from carbonaceous silty claystone to micarb siltstone to micarb nanno ooze or micarb-rich siltstone with carbonaceous beds rich in molybdenum and vanadium. The site is probably on the flank of a salt diapir, and deformation structures seen in the cores may reflect diapirism.

Calcareous, rarely nannofossil rich, sediment interbedded with few thin layers of detrital sediment.



SITE 228 LEG 23



SITE DATA

Position:
- Latitude: 14°46.1'N
- Longitude: 42°11.5'E

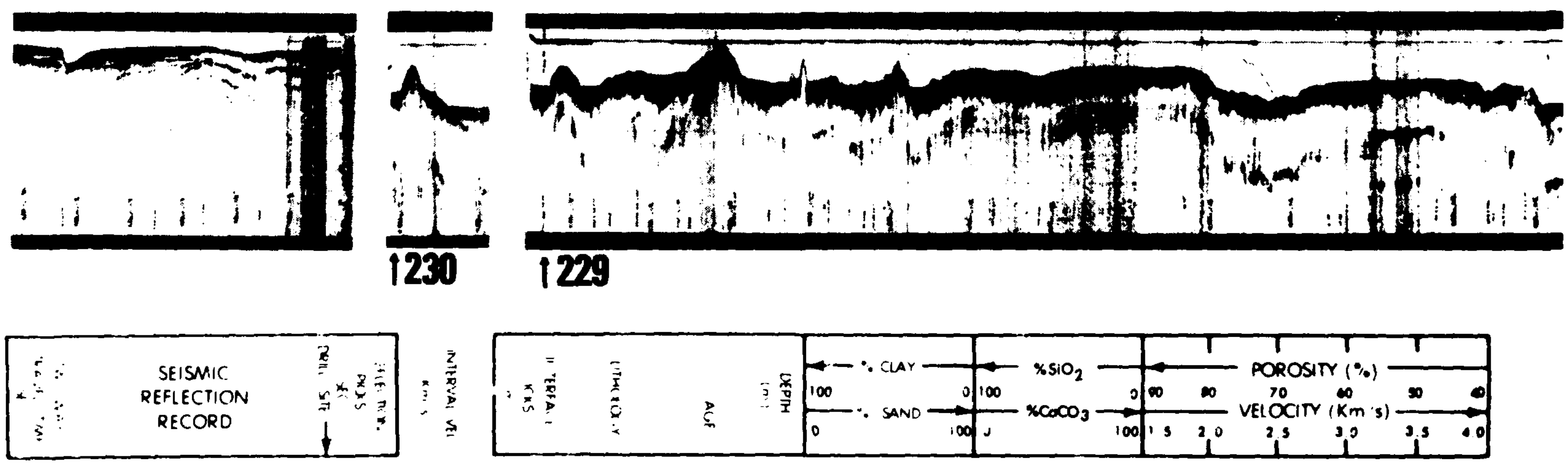
Date: 04/26/72
Time: 2320Z
Water depth: 852 meters
Location: Red Sea

CORE DATA

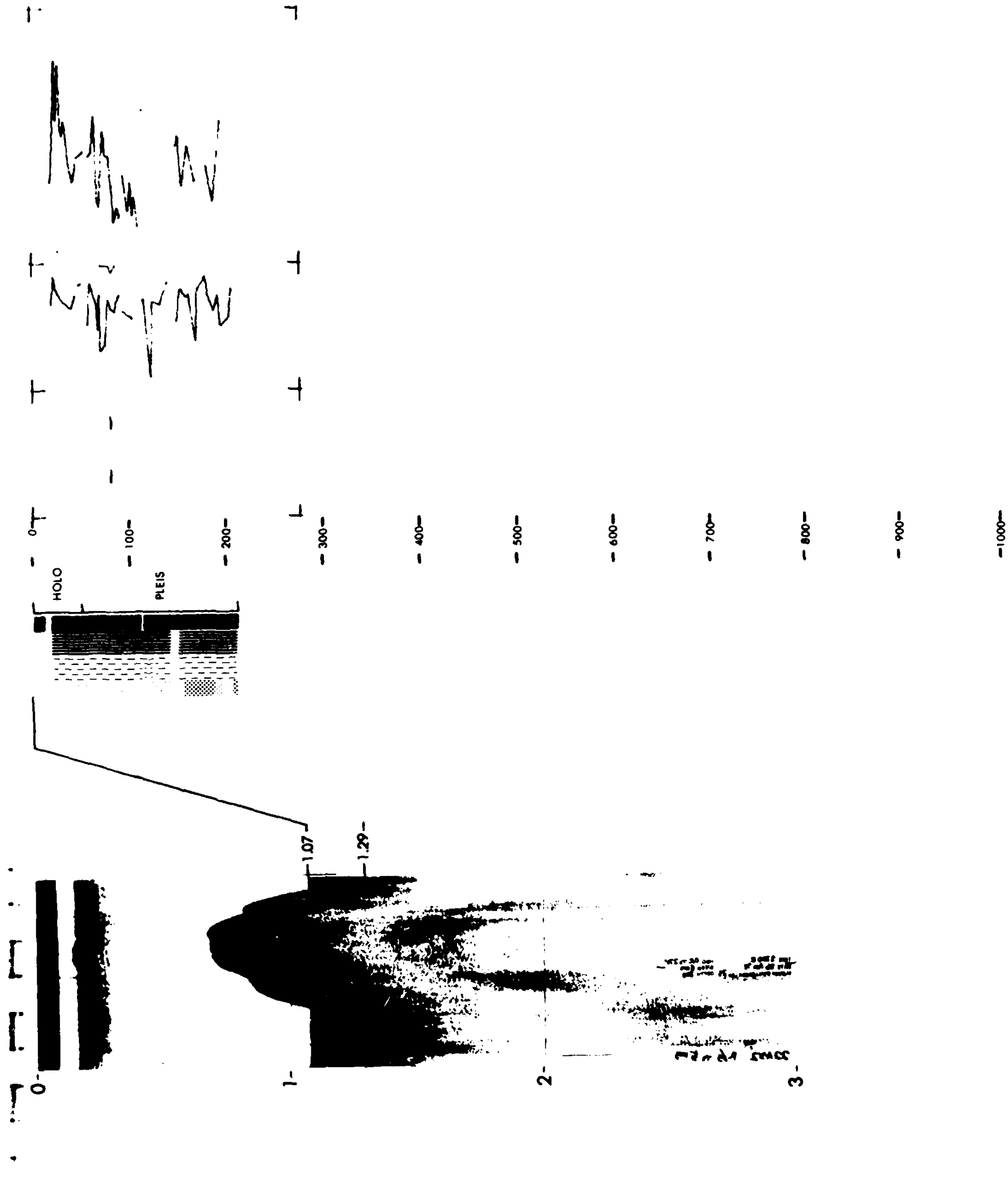
Penetration:	229	229A	
Drilled--	75	49	meters
Cored----	33	163	meters
Total----	108	212	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	5	18	cores
	29.1	119	meters

A rapidly deposited uniform sequence of clay-rich carbonate nanno ooze has been deposited in the last 350,000 years. The sediment is largely of biogenic origin and probably represents material swept from the shelves of the southern Red Sea into the basin south of Zebayir Island by seasonal currents. There has been intermittent volcanism. Large quantities of gas (including hydrocarbons) in the sediments led to the eventual abandonment of the site. The available evidence is not inconsistent with this site lying over the axial trough of the Red Sea.

Calcareous, occasionally nannofossil rich, sediment with one thin layer of detrital sediment.



SITE 229 LEG 23



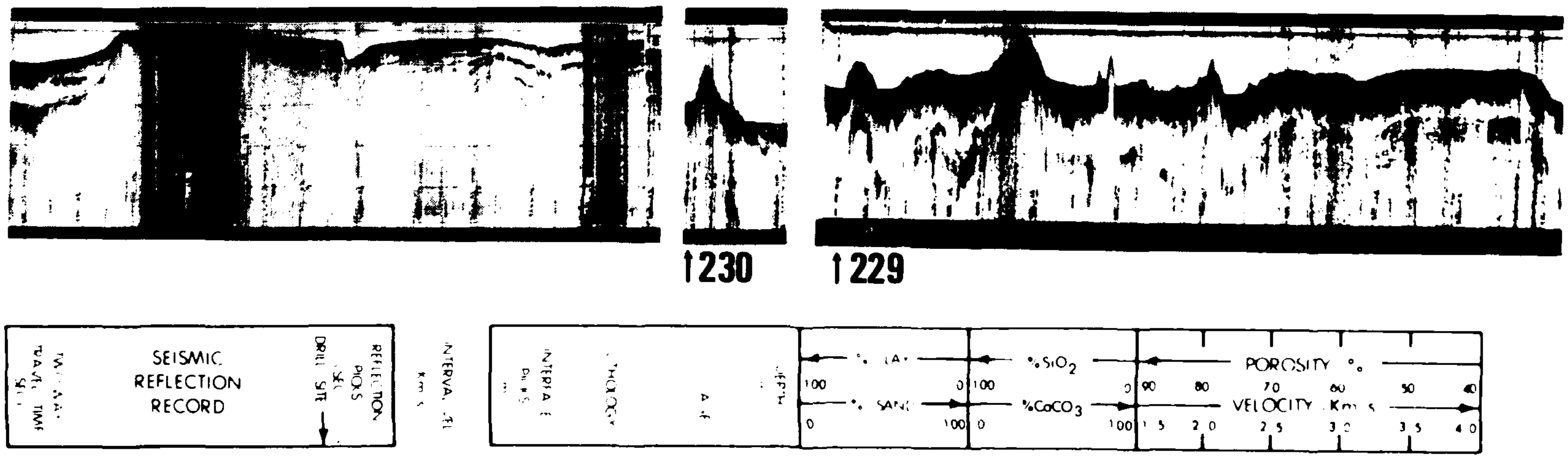
SITE DATA

Position:
Latitude 15°19.0' N
Longitude 41°50.0' E
Date: 04/28/72
Time: 1500Z
Water depth: 832 meters
Location: Red Sea

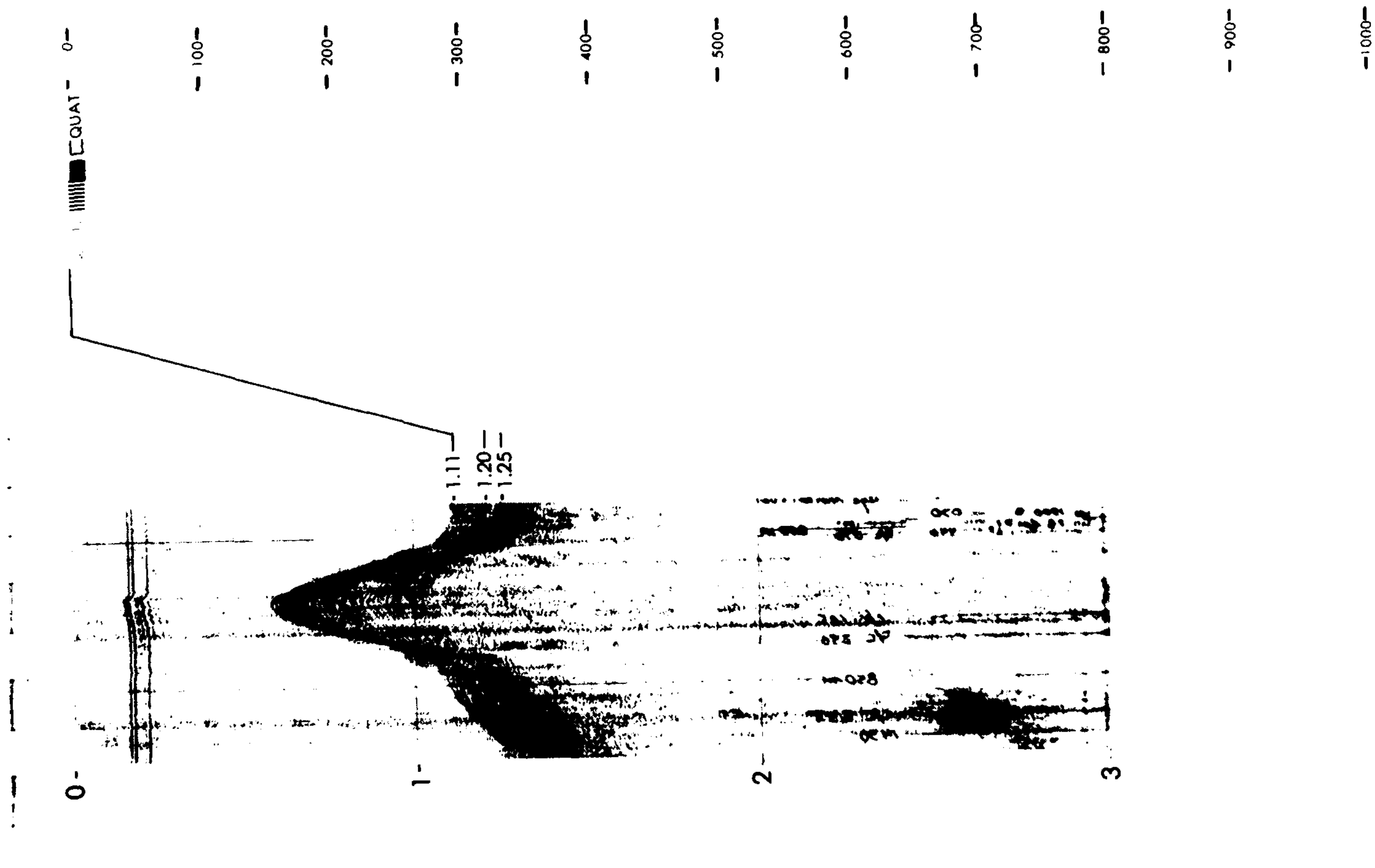
CORE DATA

Penetration:	
Drilled--	0 meters
Cored----	18 meters
Total----	9 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	2 cores
	13.4 meters

The site lay on the west side of the axial trough near the foot of a relatively steep slope leading up to the shallow shelf area of the southwestern Red Sea. A seismic profile oriented roughly north-south, obtained earlier on the approach to Site 229, had shown a distinct reflector similar to the S reflector seen further north. Due to operational difficulties, only a single core was obtained at this site. The core consisted of a Late Quaternary greenish carbonate nanno ooze with tests of pteropods, foraminifera and nannofossils, fine carbonate particles, and zeolite. There are also thin streaks of volcanic ash in the core. The nearby young volcanoes of Jebel at Tair and Zebayir are likely sources of this ash. The most interesting aspect of the core, however, was the salinity of the pore water. This water had a salinity of 59°/oo which is a 50% increase over the normal salinity of Red Sea water. This discovery strongly suggests that the interpretation of the underlying reflector as the top of the evaporites (anhydrite?) is correct and suggests, too, that halite exists not far below the reflector.



SITE 230 LEG 23



SITE DATA

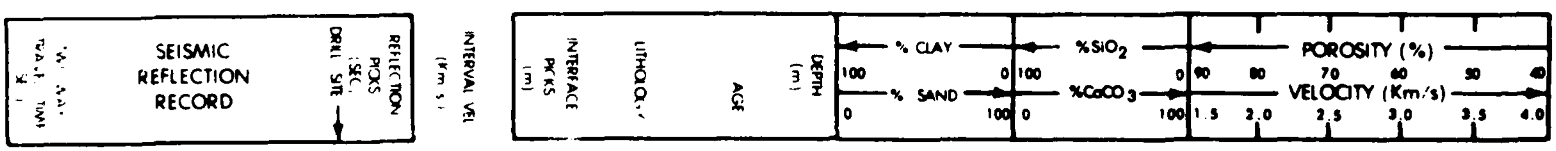
Position:
Latitude $11^{\circ}53.4'$ N
Longitude $48^{\circ}14.7'$ E
Date: 05/04/72
Time: 1900Z
Water depth: 2152 meters
Location: Gulf of Aden

CORE DATA

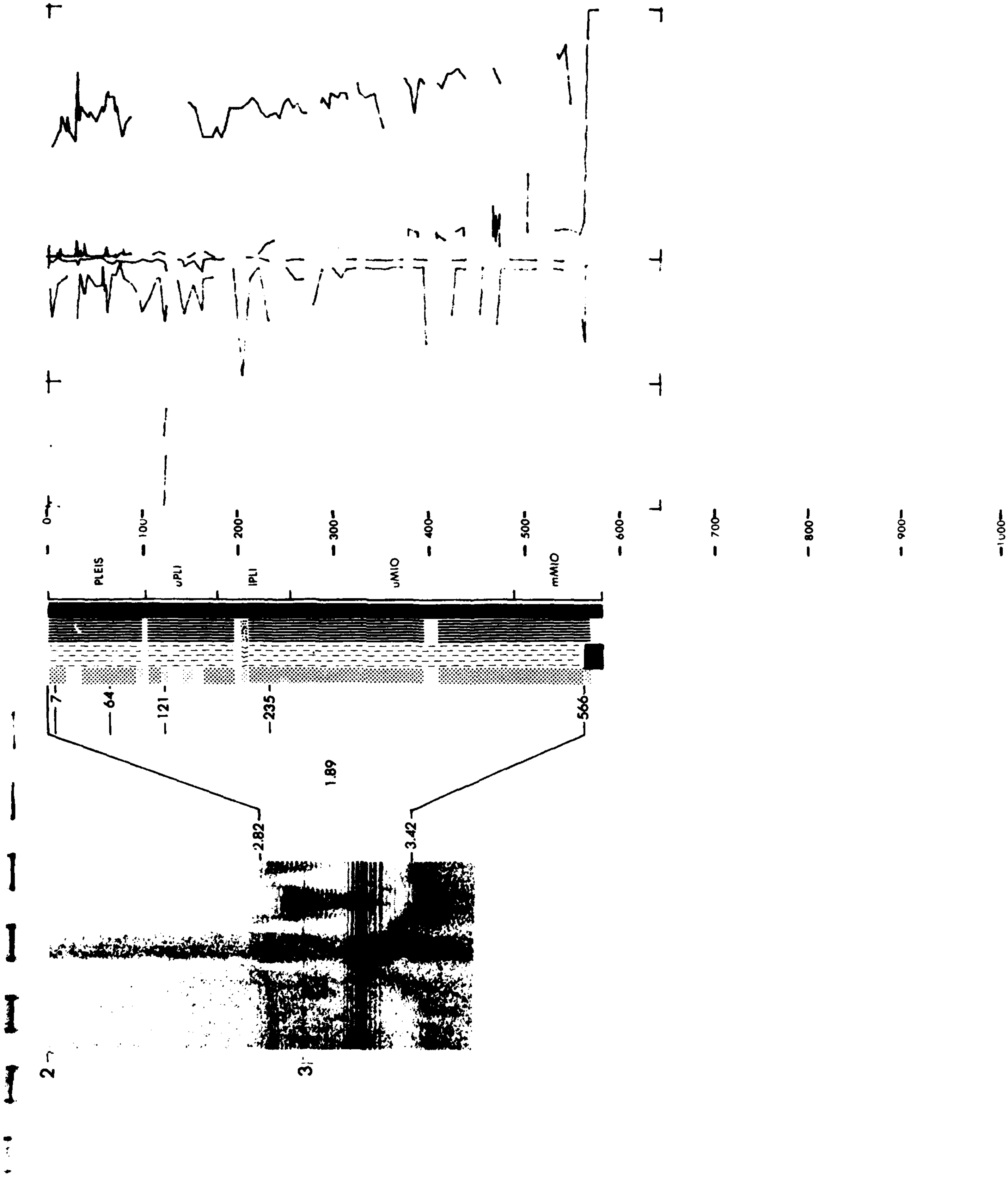
Penetration:
Drilled-- 0 meters
Cored---- 584 meters
Total---- 584 meters
Recovery:
Basement- 3 cores
7.7 meters
Total---- 64 cores
424.9 meters

The gross characteristics of the entire sediment section are surprisingly uniform, the sediments being nannoplankton-rich hemipelagic ooze. There is little or no variation even close to the basalt basement. This uniformity suggests near constant conditions of water depth, pelagic carbonate production, and detrital sediment input. Reef and other very shallow-water carbonate grains are largely limited to Units 1 and 2. The accession of shelf facies sediments to deep water may be related to Pleistocene low sea level periods, when the outer shelf edge became the reef growth locale. The fairly abundant very fine and silt-sized quartz, dolomite, calcite, and other detrital mineral grains found dispersed throughout the section may well be of eolian origin. Aridity in the potential detrital sediment source area of Somalia probably precluded large inputs of waterborne terrigenous sediment. In the basalt unit, nanno chalk layers are generally associated with chilled basaltic glass and may be indicative of continued sediment deposition between eruptive events or represent xenoliths.

Sediments mostly nannofossil rich, rarely foraminifera rich.



SITE 231 LEG 24



SITE DATA

Position:
Latitude 14°28.9' N
Longitude 51°94.9' E
Date: 05/10/72
Time: 1453Z
Water depth: 1743 meters
Location: Alula-Fartak Trench

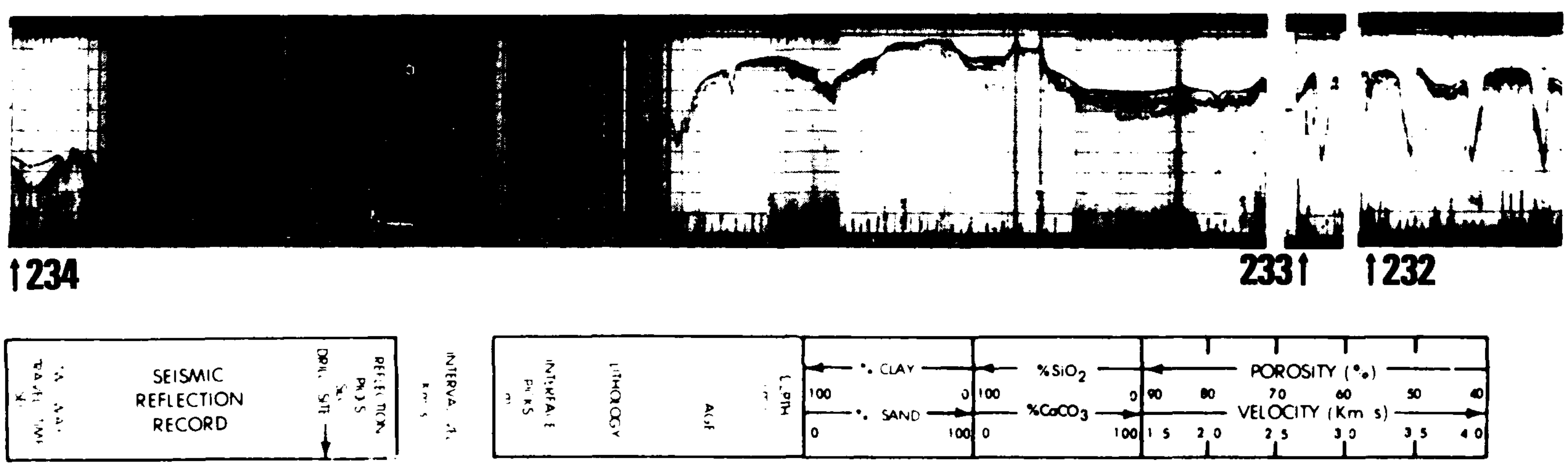
CORE DATA

Penetration:	232	232A	
Drilled--	0	159	meters
Cored----	173.5	275	meters
Total----	173.5	434	meters
Recovery:			
Basement-	0	5	cores
	0	1.5	meters
Total----	19	30	cores
	126.7	125.5	meters

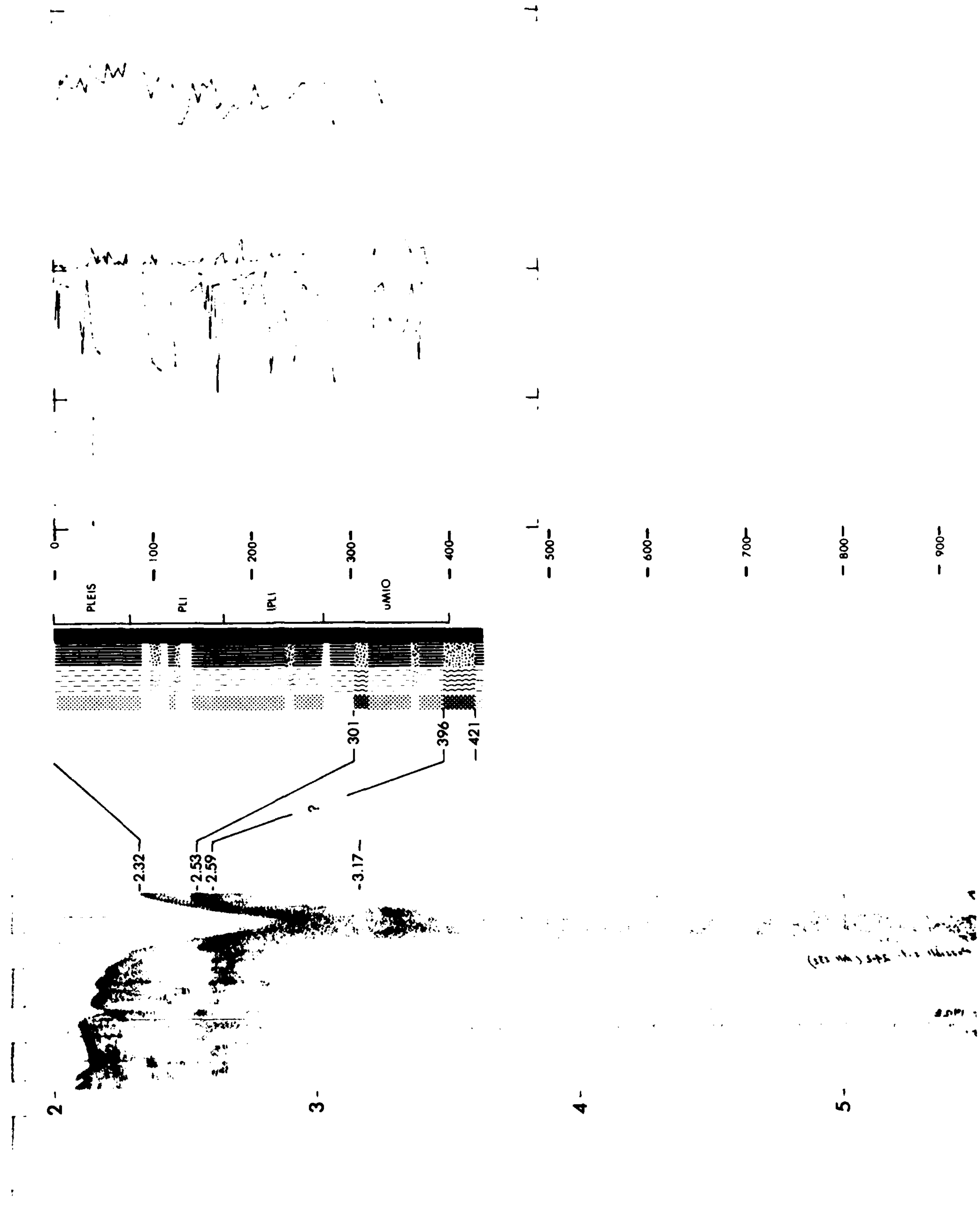
Units 1, 4 and 5, which comprise the major part of the section, are rather uniform, nannoplankton-rich, hemipelagic muds. This uniformity suggests near-constant water depth and stable conditions of pelagic carbonate production and detrital sediment input. The fairly abundant silt-sized quartz, biotite, calcite, and other detrital grains dispersed throughout the hemipelagic muds are probably of eolian origin. The two acid volcanic ash layers at 164 and 165 meters in Unit 1 may correlate with similar layers occurring at 170, 180, 188.5, and 203 meters at Site 231.

The very well lithified siltstone and quartz sandstone of Units 2, 3, and 5 exhibit characteristics suggestive of a shallow-water environment of deposition. Their degree of lithification also distinguishes them from the unlithified hemipelagic sediments. Structural emplacement as fault or slide blocks may have occurred.

Calcareous sediments; nannofossil rich, rarely foraminifera rich, interbedded with detrital sediments.



SITE 232 LEG 24



SITE DATA

Position:
Latitude 14°19.7'N
Longitude 52°08.1'E
Date: 05/13/72
Time: 1918Z
Water depth: 1839 meters
Location: Alula-Fartak Trench

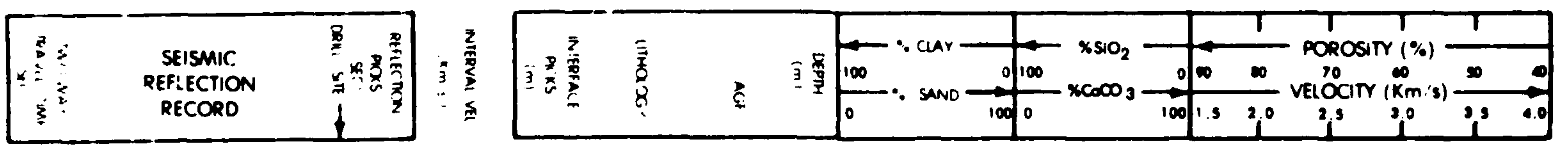
CORE DATA

Penetration:	233	233A	
Drilled--	0	168	meters
Cored----	176	103	meters
Total----	176	271	meters
Recovery:			
Basement-	0	6	cores
	0	2.6	meters
Total----	19	13	cores
	135.3	1025	meters

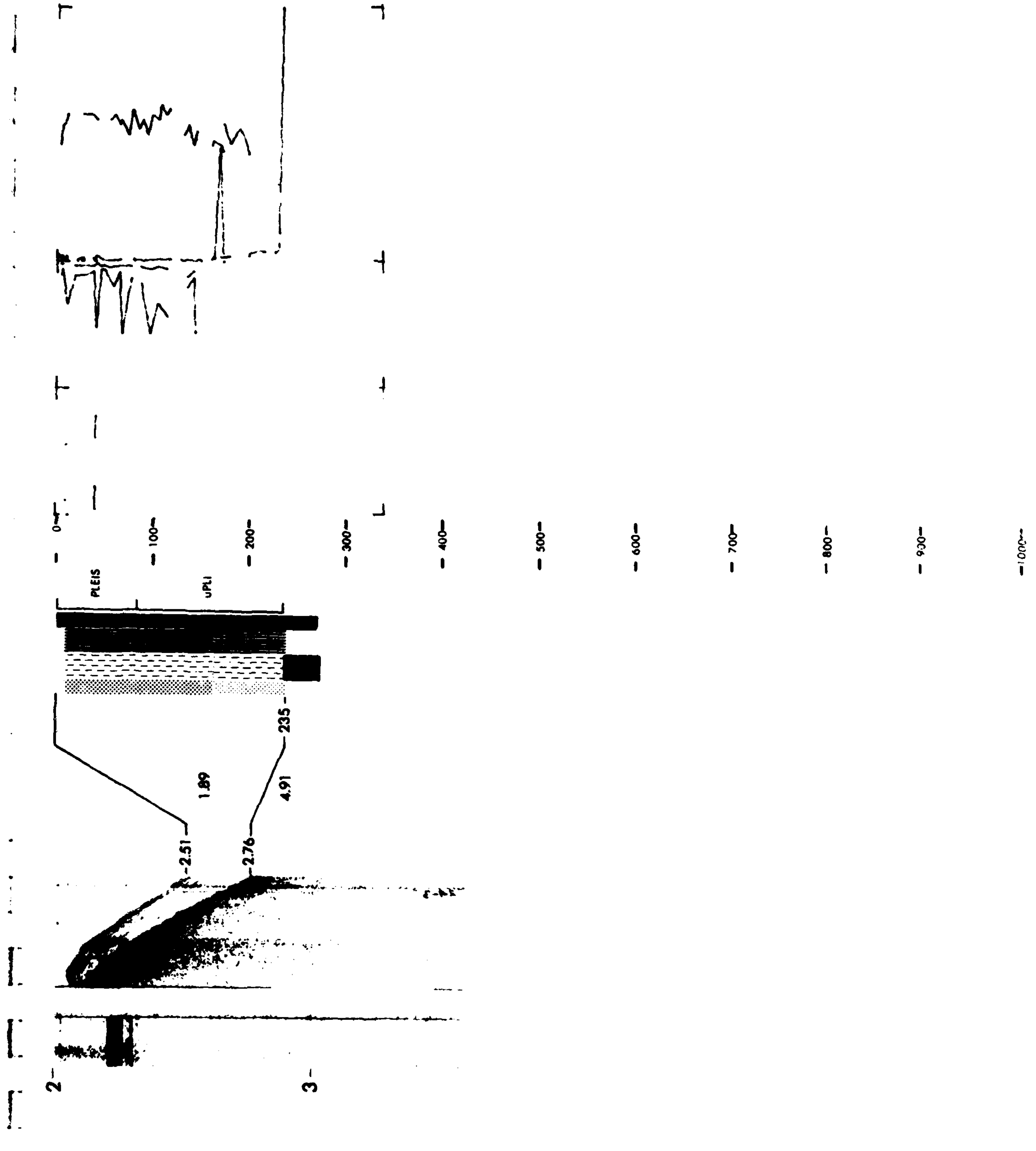
The microfossils and lithology indicate that slight changes in conditions of sedimentation are responsible for the facies variations distinguished at this site. The nanno ooze represents hemipelagic sedimentation. The micarb nanno ooze probably represents hemipelagic sedimentation with a large contribution of detrital eolian material. In addition, the increase in silt fraction in Units 2 to 7 tends to support this suggestion. The micarb nanno chalk has been metamorphosed by the diabase. The volcanic ash layer at 206.0 meters, at the base of Unit 6, may correlate with similar layers at Sites 231 (170.0-203.0m) and 232 (160.0-170.0m).

The sediments yielded common and well-preserved calcareous nannofossils as well as common to abundant and well-preserved radiolarian fauna throughout the section. Foraminifera are common and well to moderately preserved in the upper 100 meters, whereas they are rare and poorly preserved below this level.

Calcareous sediment nannofossil rich.



SITE 233 LEG 24



SITE DATA

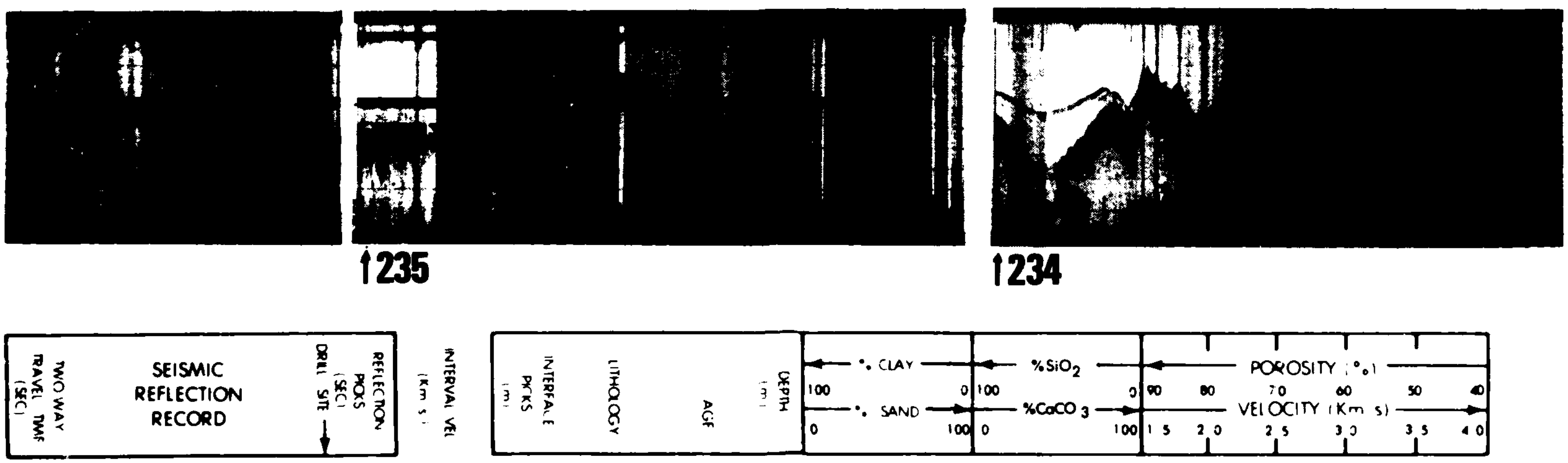
Position:
Latitude 4°29.0'N
Longitude 51°13.5'E
Date: 05/19/72
Time: 1020Z
Water depth: 4721 meters
Location: Somali Basin

CORE DATA

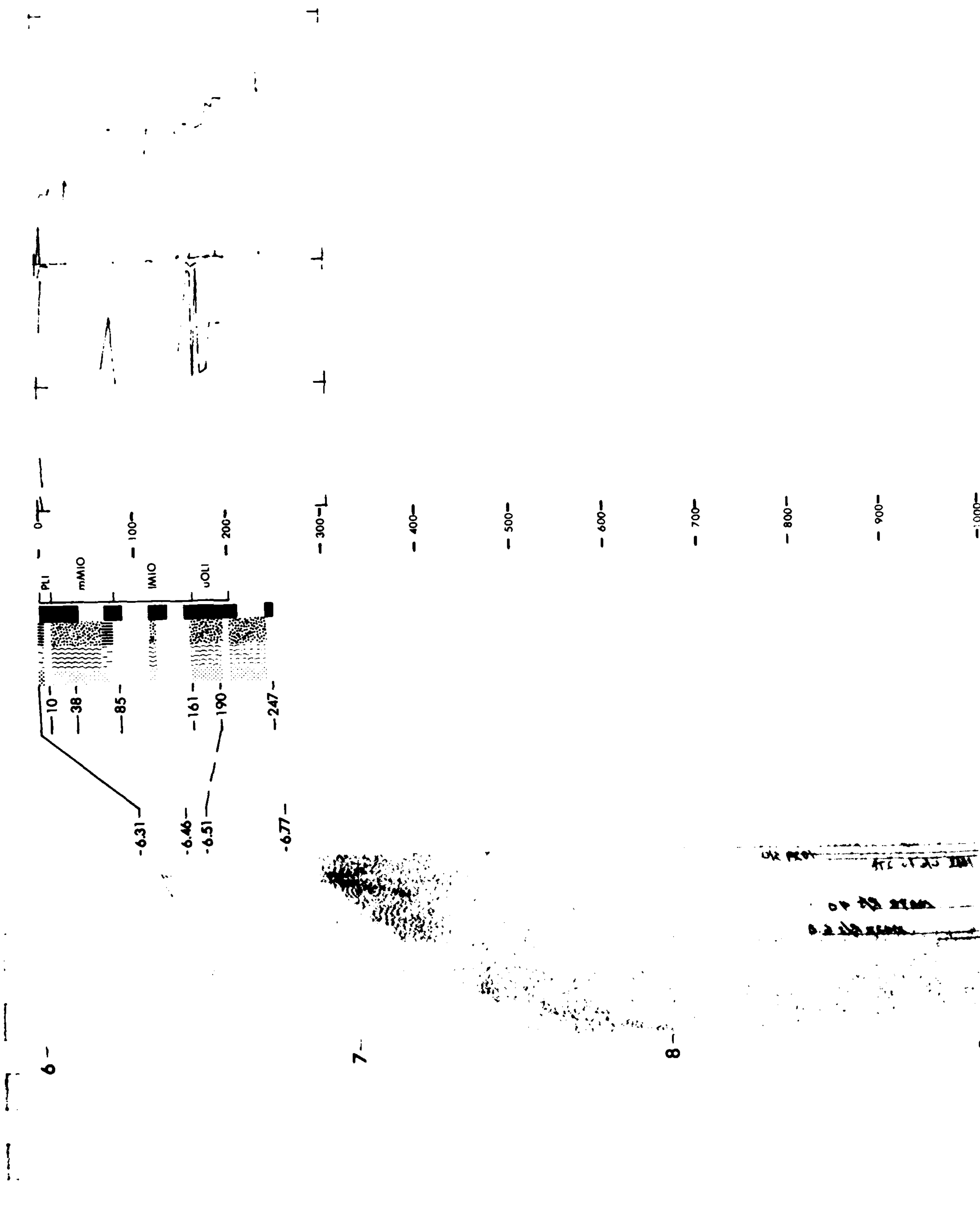
Penetration:	234	234A	
Drilled--	1045	237	meters
Cored----	1425	10	meters
Total----	247	247	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	15	1	cores
	90.1	1.4	meters

Unit 1 represents the normal distal hemipelagic nanno clay to nanno ooze facies, deposited close to the calcium carbonate compensation depth (CCD). Manganese nodules are indicative of an oxidizing environment and low sedimentation rates. Units 2 through 6 are dominated by clay minerals of unknown origin, while the bulk of the fossils ($CaCO_3$ and SiO_2) seem to be dissolved (with the exception of some nanno-bearing to nanno-rich horizons in Units 3, 5, and 6). Small percentages of glass in nearly all smear slides point to an important volcanic input to this area. Nowhere in the sediments of Site 234 were indications of a high input of terrigenous detrital or of shallow-water material found nor were there any indications of turbidite deposition. This suggests that the depositional area of these sediments was always far from land, and always on a topographic high that was not reached by turbidity currents.

Detrital sediments interbedded with thin layers of calcareous sediment, nannofossil rich.



SITE 234 LEG 24



SITE DATA

Position:
- Latitude $3^{\circ}14.1'$ N
- Longitude $52^{\circ}41.6'$ E

Date: 05/22/72
Time: 1122Z
Water depth: 5130 meters
Location: East flank of Chain Ridge

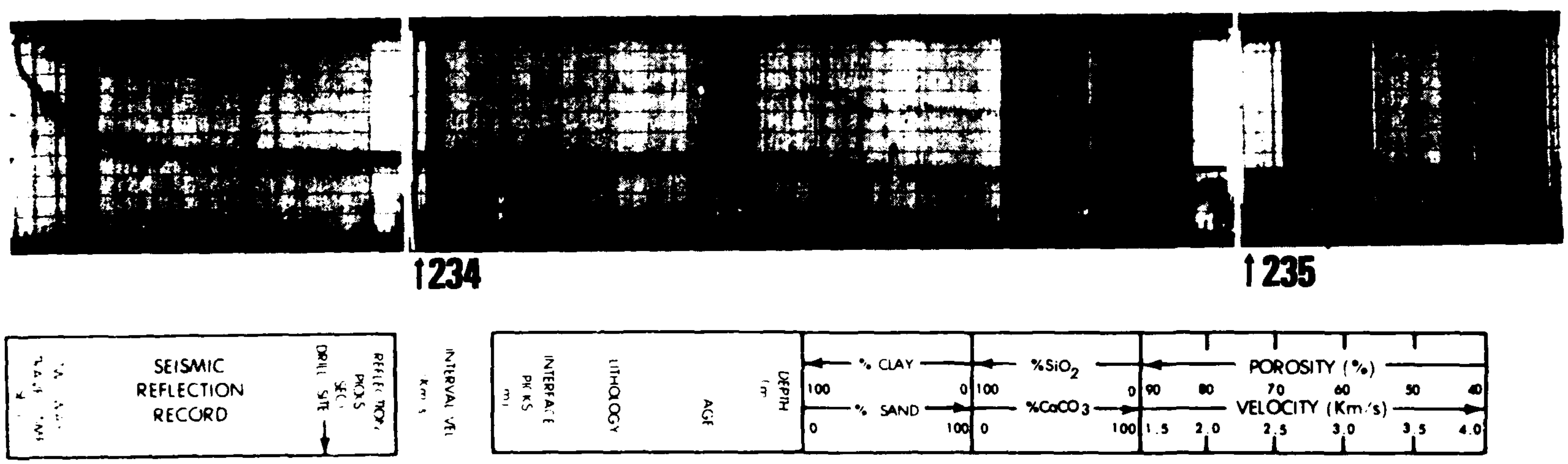
CORE DATA

Penetration:
- Drilled-- 494 meters
- Cored---- 190 meters
- Total---- 684 meters

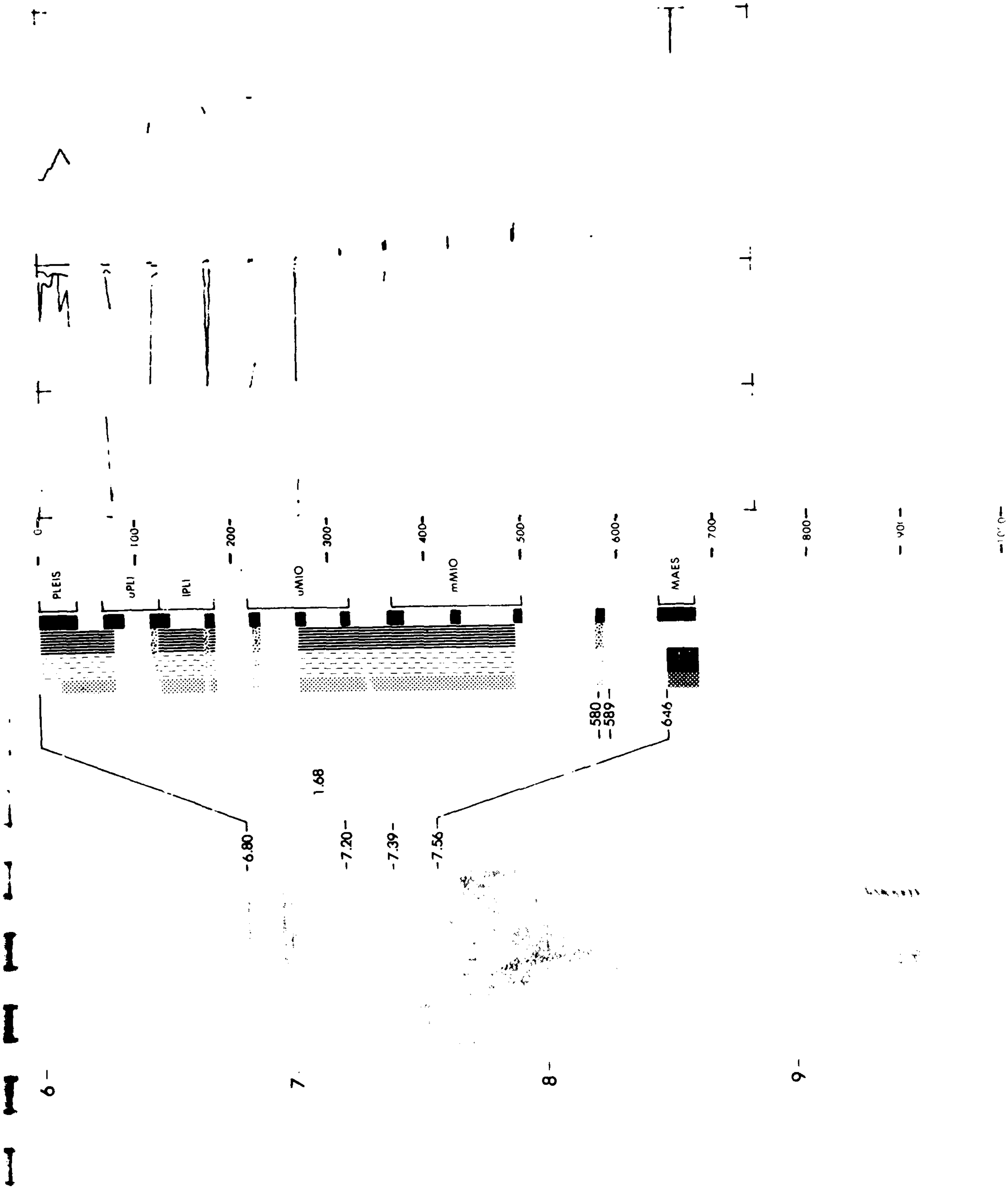
Recovery:
- Basement- 4 cores, 12.9 meters
- Total---- 20 cores, 98.1 meters

The area is one in which fluctuations of carbonate compensation depth have occurred while the sedimentary sequence has evolved from an oxidizing environment toward more reducing conditions. Minor turbidite deposits occur that may have originated on the northern slope of the abyssal plain or from Chain Ridge. The incidence of clay minerals, although no volcanic ash appeared in the cores recovered, may be related to the Tertiary volcanic activity as at Site 234. Major conclusions are: (a) basalt material was recovered at depth in agreement with the seismic-acoustic basement; (b) the floral assemblage (nannofossils only) of Site 234 is supplemented but not really extended; and (c) the transparent layer of the abyssal plain east of Chain Ridge appears to be formed of nanno ooze and nanno clay.

Calcareous sediments; nannofossil rich, interbedded with detrital sediments.



SITE 235 LEG 24



SITE DATA

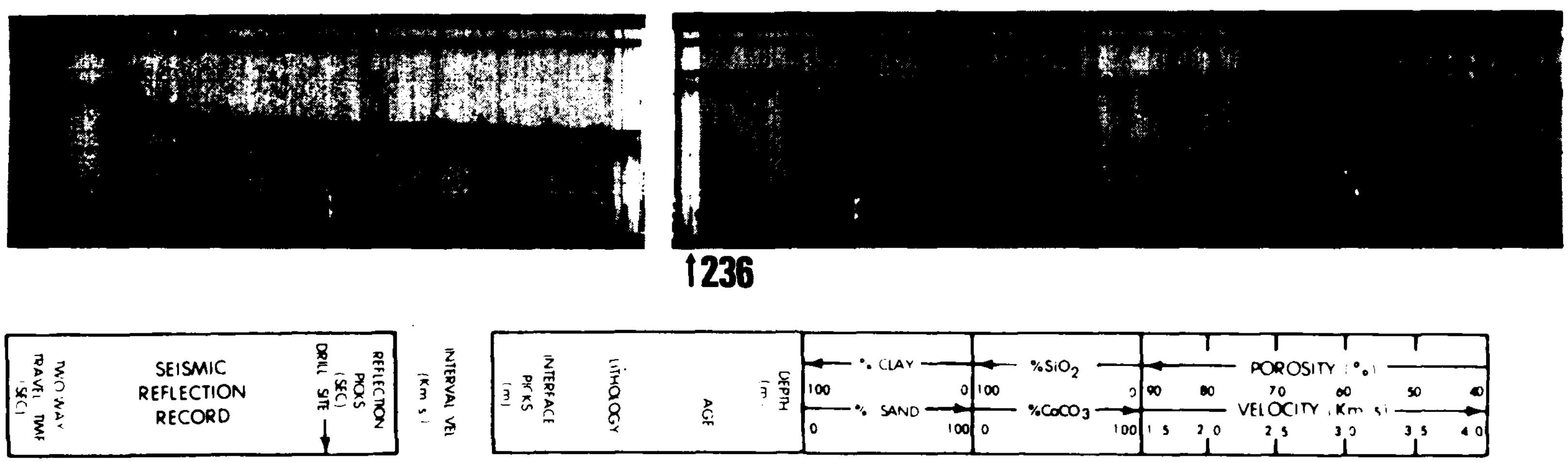
Position:
Latitude 1°40.6' S
Longitude 57°38.8' E
Date: 05/28/72
Time: 0830Z
Water depth: 4487 meters
Location: Northeast of the Seychelles Islands

CORE DATA

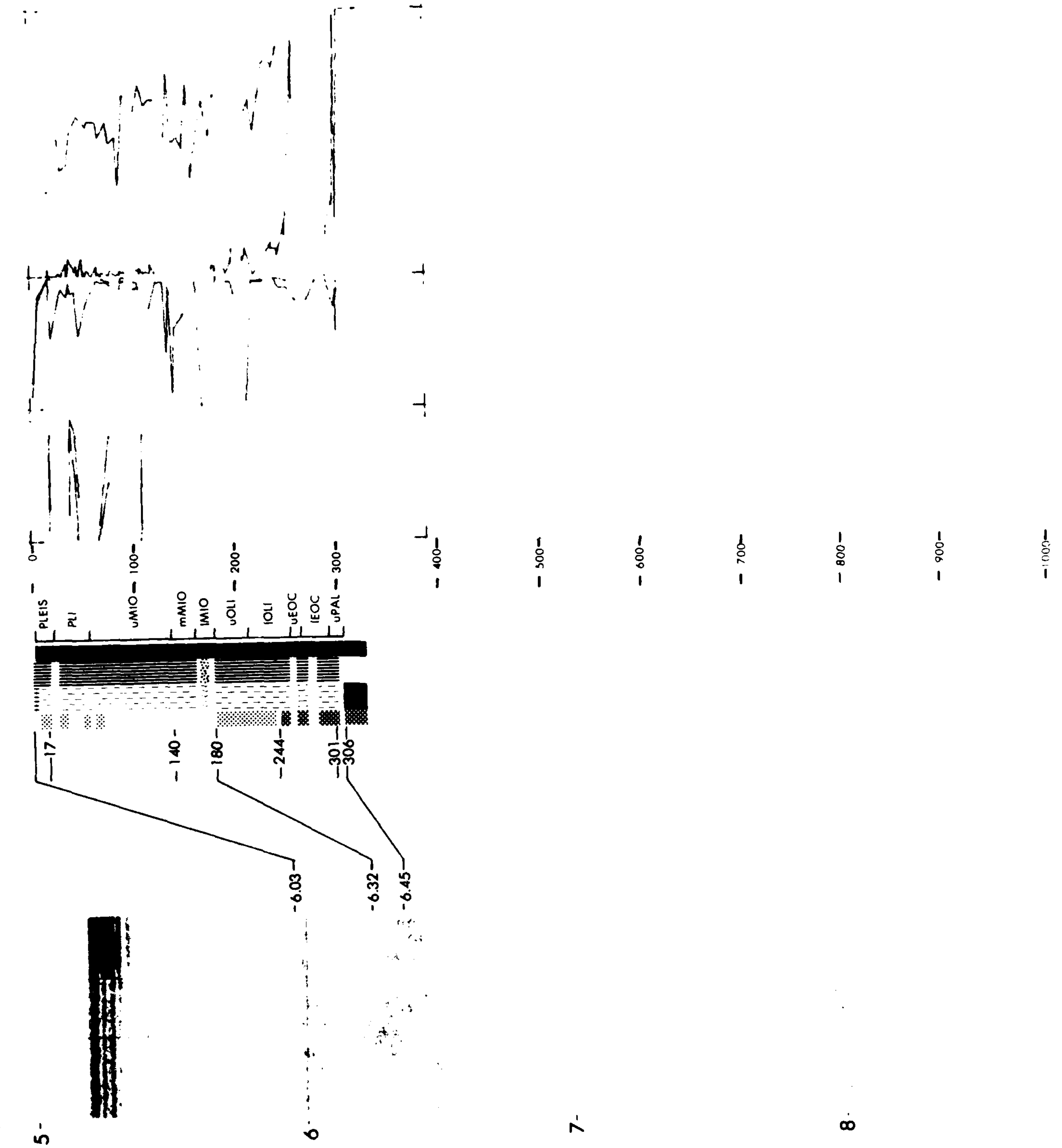
Penetration:
Drilled-- 0 meters
Cored----327.5 meters
Total----327.5 meters
Recovery:
Basement- 5 cores
10.5 meters
Total---- 37 cores
218.5 meters

The bulk of the sediment found at Site 236 is of biogenic origin, comprising the skeletons of pelagic organisms. The sediments overlie basaltic basement. Sediments a few centimeters above the basalt are fossiliferous and could therefore provide a minimum age for the underlying basement. The lower half of the sedimentary sequence is dominated by pure nanno chalks or nanno oozes; in the upper half, foram nanno ooze and radiolarian ooze layers are found intercalated with the nanno oozes. These three different facies are typical of the highly productive, low-latitude, open-oceanic environment. Terrigenous matter is represented by small amounts of clay minerals (and sometimes quartz) distrubuted throughout the whole sedimentary sequence. However, the terrigenous input was fairly high during sedimentation of the zeolite-bearing pale brown ferruginous clays of Unit 3. A few thin, distinct, volcanic ash layers found in the nanno chalks in the upper part of Unit 4 are mainly composed of glass (colorless, or nearly so).

Calcareous sediments mostly nannofossil rich, rarely foraminifera rich.



SITE 236 LEG 24



SITE DATA

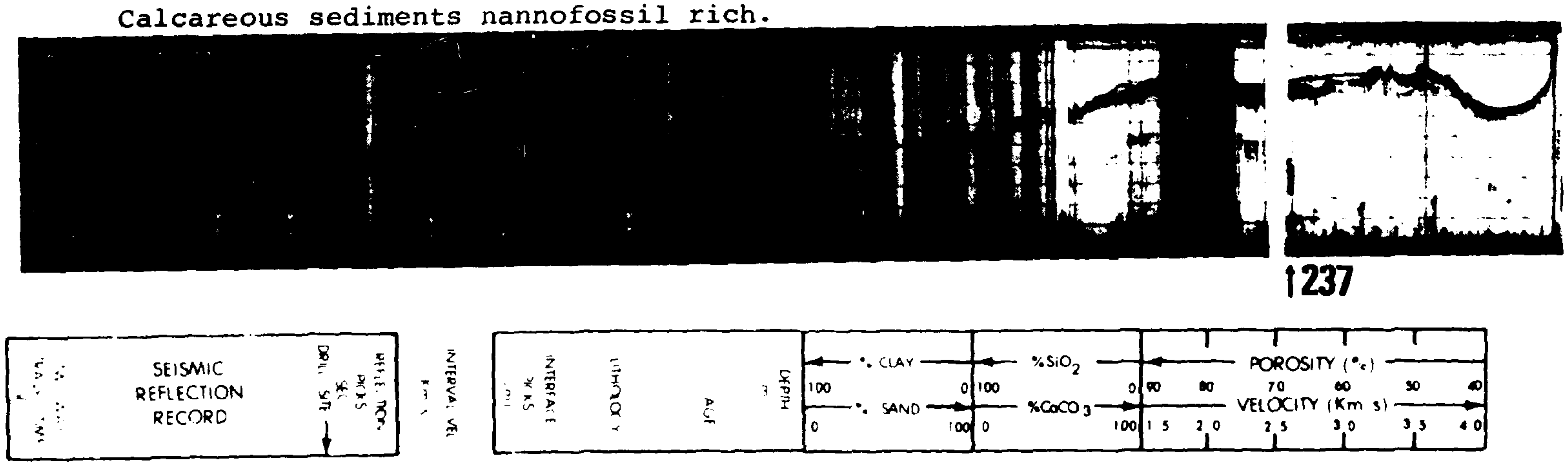
Position:
  Latitude 7°05.0' S
  Longitude 58°07.5' E
Date: 06/05/72
Time: 1947Z
Water depth: 1622 meters
Location: Mascarene Plateau

CORE DATA

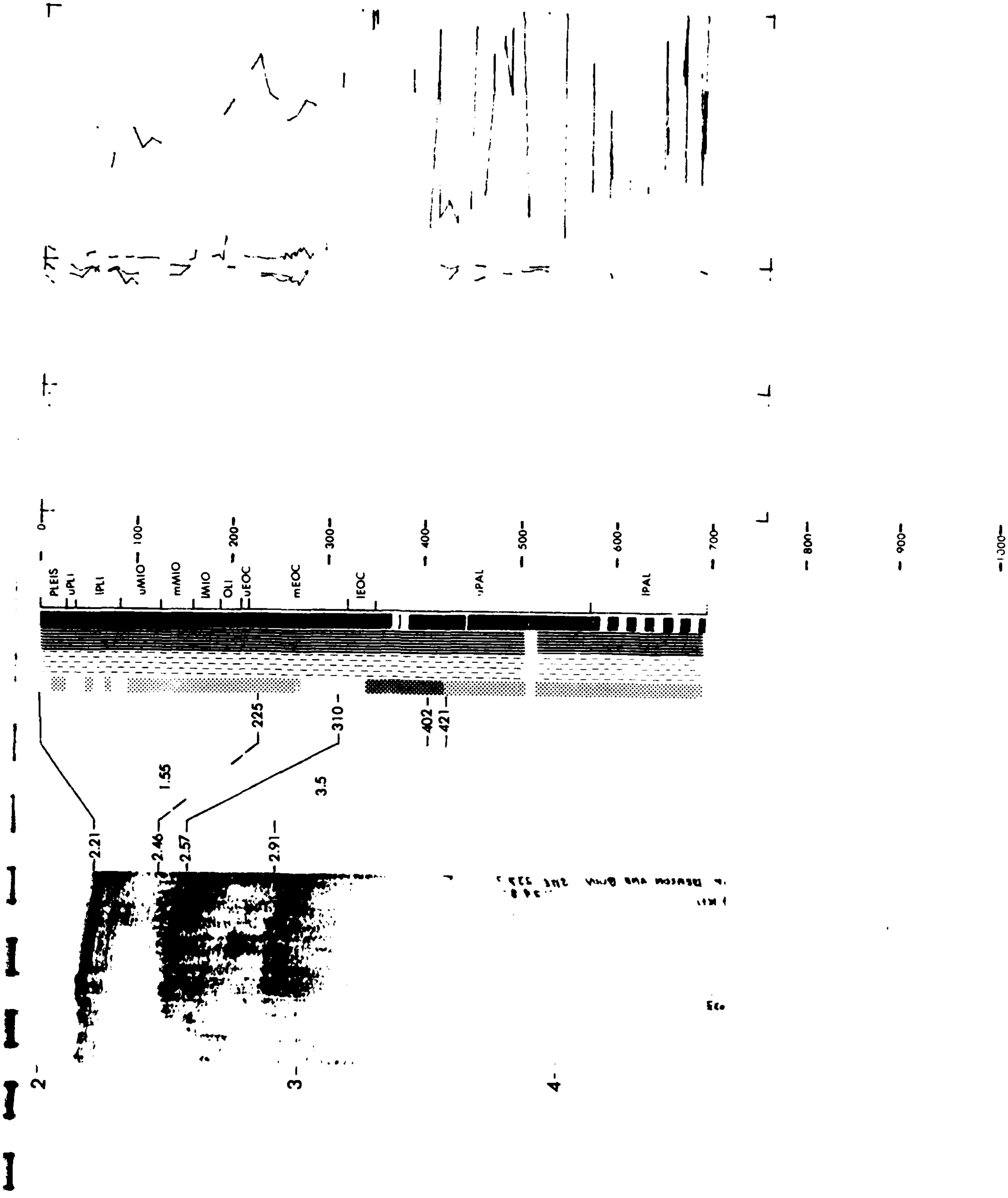
Penetration:
  Drilled-- 665 meters
  Cored---- 627 meters
  Total----693.5 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 67 cores
  312.1 meters

The presence of small amounts of basic volcanic ash at many horizons gives evidence of volcanic activity in this area since the lower Paleocene. The chert is of Eocene and Paleocene age. Most opaline skeletons are replaced by carbonate. The silica from opaline skeletons in part replaces calcareous fossils but is most common as a void filling. This location has been the site of pelagic carbonate sedimentation since at least the lower Paleocene. There are, however, several aspects of the older sediments (Eocene and Paleocene) which are suggestive of shallower water conditions than those of today such as: (a) presence of glauconite, (b) sedimentary structures lensing and lamination, and (c) reef debris. The site almost certainly never had a water depth shallower than 200 meters and probably not shallower than 500 meters. The reef associated debris forms a very minor fraction of the sediments and is probably slide or slump material derived from the north and northwest where the escarpment of the Seychelles Bank rises steeply. Present day water depth at Site 237 is close to 1650 meters and the base of the cored section lies at nearly 2350 meters. If the basal sediments of Unit 5, which are of Paleocene age were deposited in a water depth of only a few hundred meters, then this area has subsided about 2 km over the past 60 m.y.

Calcareous sediments nannofossil rich.



SITE 237 LEG 24



SITE DATA

Position:
Latitude 11°09.2' S
Longitude 70°31.6' E
Date: 06/16/72
Time: 1617Z
Water depth: 2826 meters
Location: Northeast end of Argo Fracture Zone

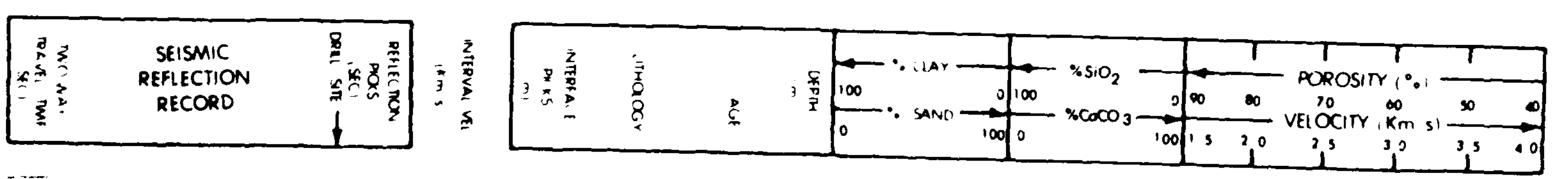
CORE DATA

Penetration:
Drilled-- 0 meters
Cored----586.5 meters
Total----586.5 meters
Recovery:
Basement- 10 cores
40.5 meters
Total---- 64 cores
424.5 meters

The sedimentary sequence continuously cored at Site 238 represents an apparently uninterrupted sequence from early Oligocene to Quaternary. Throughout the section, the sediments are nanno oozes and nanno chalks which contain abundant, diverse, and well to moderately preserved calcareous plankton. Radiolarians are common to abundant and moderately to well preserved in Cores 1 to 39 (middle Miocene to Quaternary) and absent below Core 39.

The sea floor at this site was always above the $CaCO_3$ compensation depth and under an area of relatively high carbonate productivity. Sedimentation rates were probably high during the deposition of Unit 1 but lower during that of Unit 2, as evidenced by the increasing concentration of Fe oxides down the section. The incidence of material of volcanic origin in Unit 3 points to the influence of continuing volcanism in this area after the final extrusion of the basement basalts.

Calcareous sediments mostly nannofossil rich.



SITE 238 LEG 24

SITE DATA

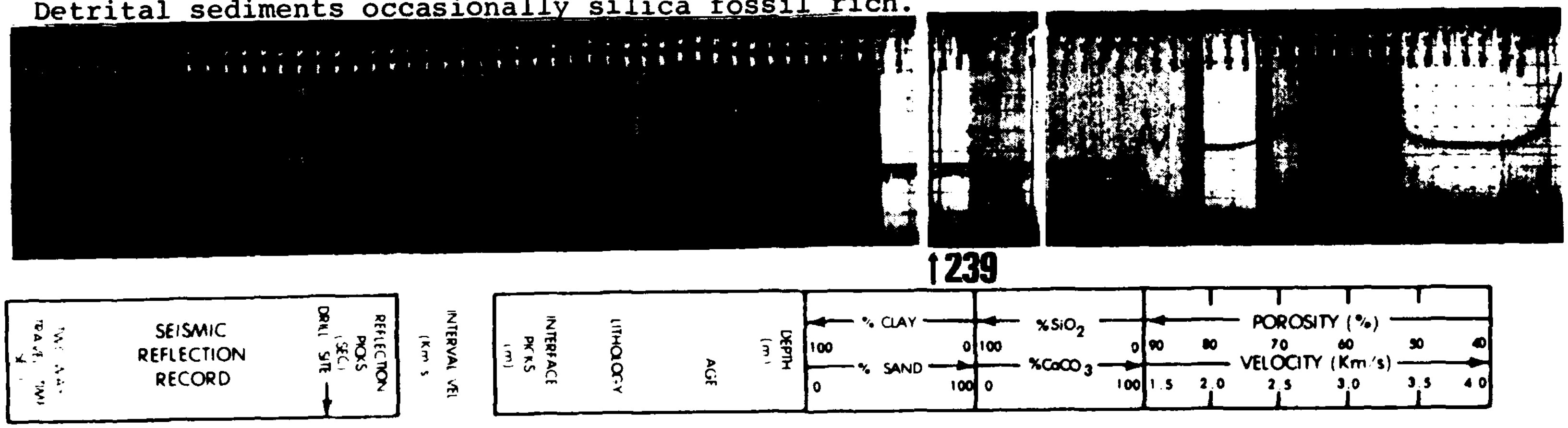
Position:
Latitude 21° 17.7' S
Longitude 51° 40.7' E
Date: 06/30/72
Time: 0735Z
Water depth: 4971 meters
Location: Southern Mascarene Basin

CORE DATA

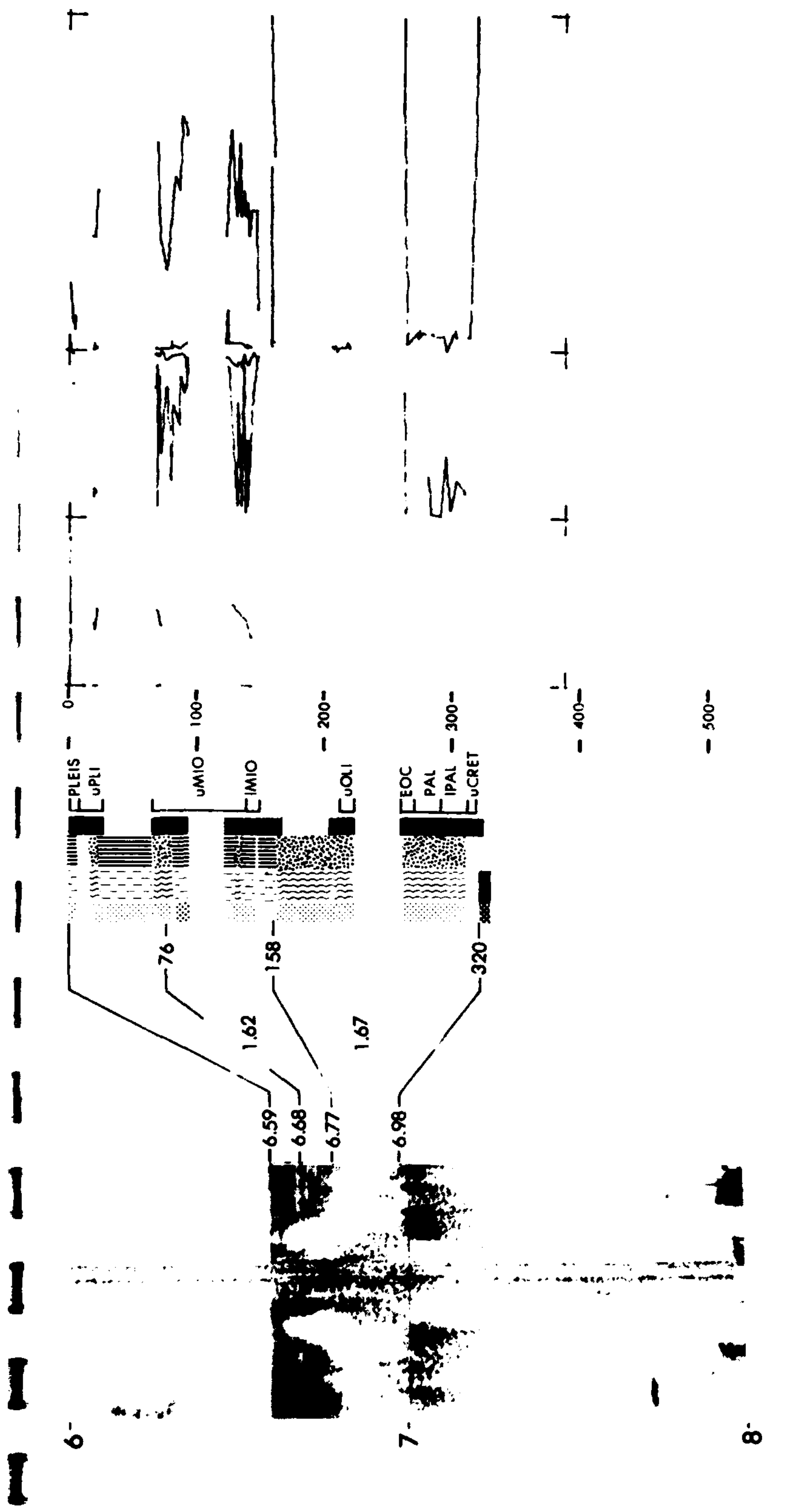
Penetration:
Drilled-- 151 meters
Cored---- 175 meters
Total---- 326 meters
Recovery:
Basement- 3 cores
2.3 meters
Total---- 21 cores
106.1 meters

The basalt flows probably represent true oceanic "basement" at this site. The nanno clay, clayey nanno ooze, and clay-rich nanno ooze in the lowest sedimentary subunit (IIB) probably were deposited on, or near, a spreading ridge crest above the regional carbonate compensation depth. Detritus from Madagascar was transported across the Mascarene Basin by turbidity and other bottom currents. The gypsum-rich silty limestone at the top of Unit II represents a turbidite silt that was cemented by secondary calcite and gypsum. Terrigenous sedimentation alternated with pelagic biogenic sedimentation in subunit IC. A logical conclusion is that Madagascar was uplifted during the middle Miocene. The thick nanno ooze sequence of subunit IB was deposited during a short time interval in the Miocene when either the landmasses were not contributing a great amount of material to the area. Also, the sea floor was higher than the regional carbonate compensation depth. Influxes of coarse-grained terrigenous sediments effectively masked accumulacions of biogenic components during Pliocene and Pleistocene times. Increased terrigenous sedimentation can be attributed either to increased erosion of landmasses because of renewed uplift or to greater sediment dispersal during lowered sea level.

Calcareous, nannofossil rich, and detrital sediments interbedded in thin layers. Detrital sediments occasionally silica fossil rich.



SITE 239 LEG 25



SITE DATA

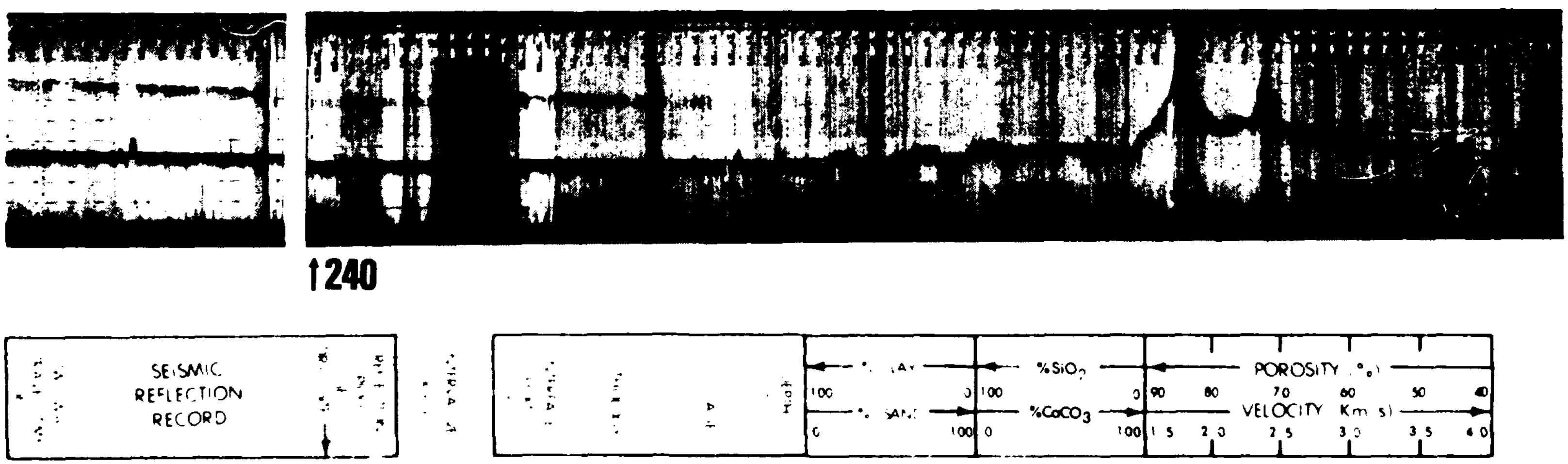
Position:
Latitude 3°29.2' S
Longitude 50°03.2' E
Date: 07/13/72
Time: 0845Z
Water depth: 5082 meters
Location: Somali Basin

CORE DATA

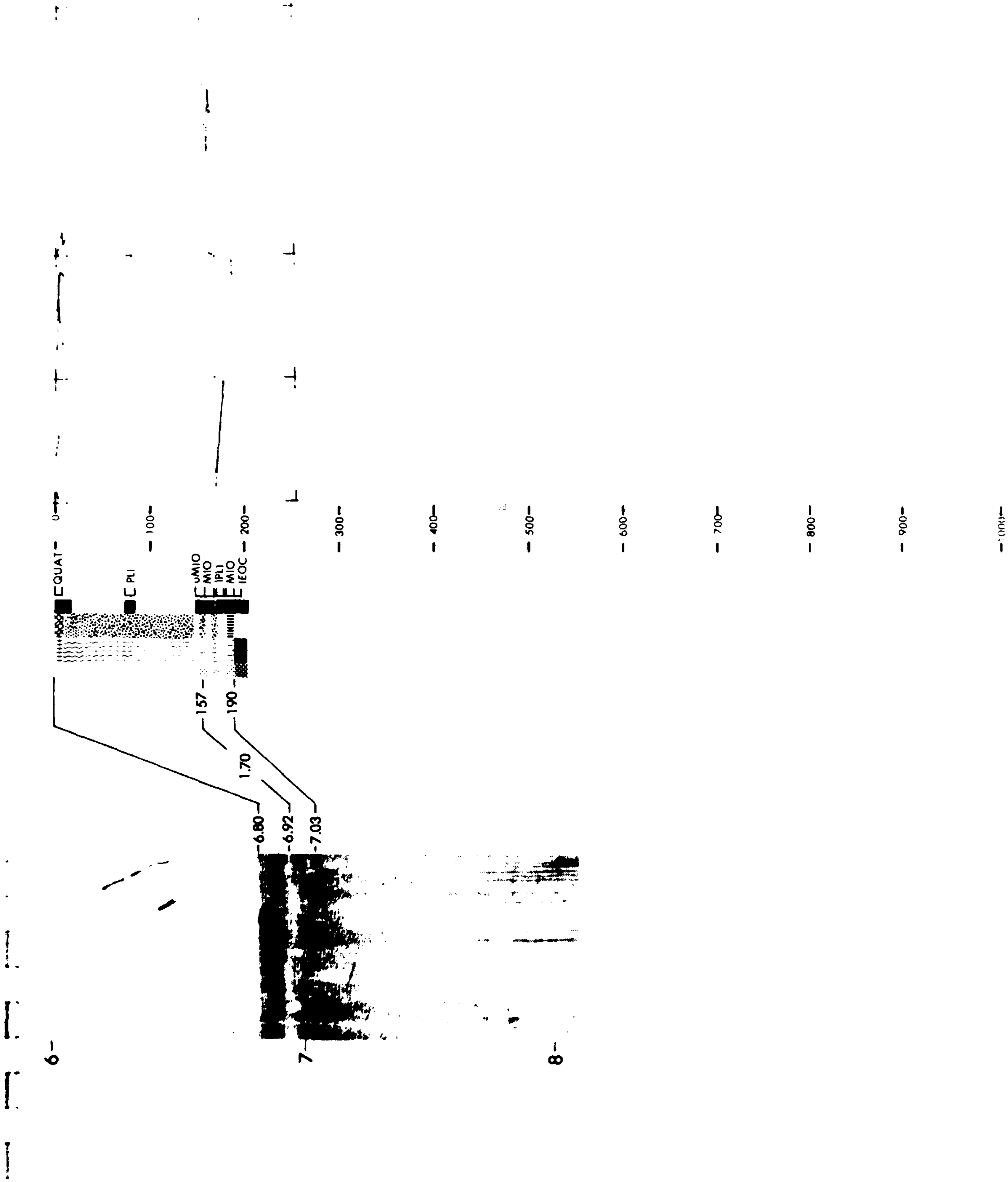
Penetration:	240	240A	
Drilled--	142	168	meters
Cored----	53	34	meters
Total----	195	202	meters
Recovery:			
Basement-	2	1	cores
	1.4	0	meters
Total----	8	4	cores
	25.1	3.2	meters

The basalt cooled rapidly at or near the surface of the sea floor. Thick glassy zones favor an extrusive origin as they may mark the outer parts of pillows or the margins of an irregular flow. Altered chalk fragments, however, indicate baking, leaving open the possibility that the basalt is a shallow intrusive. The coarse sands in Unit II represent proximal turbidite deposits, probably eroded from Madagascar or possibly the Seychelles. Landmasses apparently were closer during the early Eocene than during later parts of the Tertiary. The sequence in both Units I and II consists of alternating beds of pelagic oozes and detrital beds, which suggests that conditions changed often during sedimentation, probably reflecting changes in landmass uplift and erosion rather than great changes in ocean floor relief or movement. The site has been above the CCD throughout most of the sediment accumulation.

Detrital sediments with two thin layers of calcareous sediment, nannofossil rich, one of Quaternary Period and one of Miocene Epoch. One thin siliceous layer, radiolaria rich, occurs in Quaternary time also.



SITE 240 LEG 25



SITE DATA

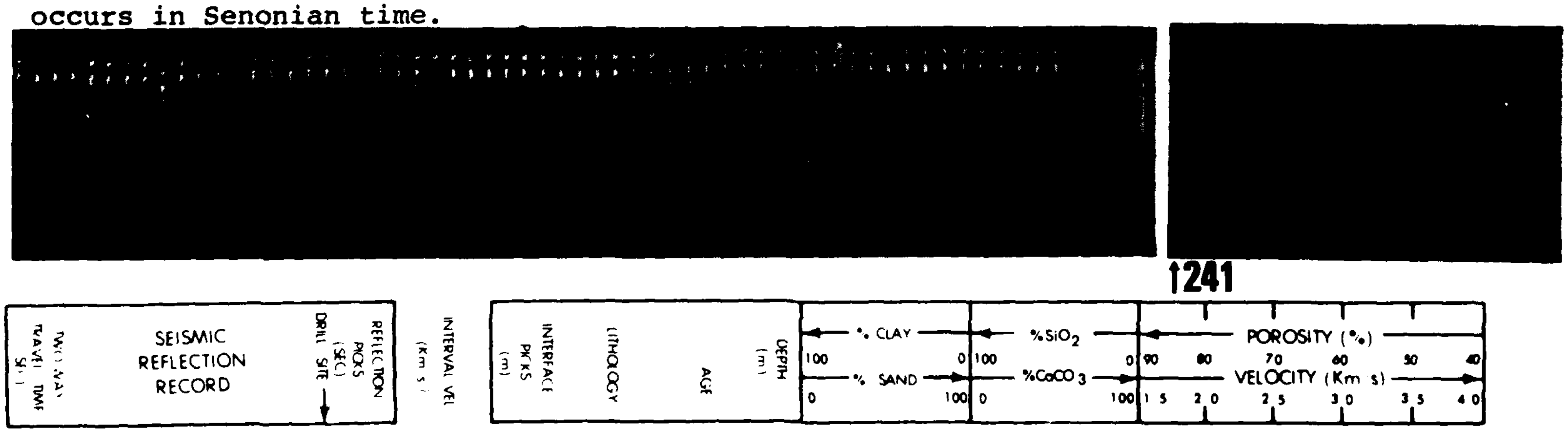
Position:
Latitude 2°22.2' S
Longitude 44°40.8' E
Date: 07/13/72
Time: 1440Z
Water depth: 4054 meters
Location: East African Continental Rise

CORE DATA

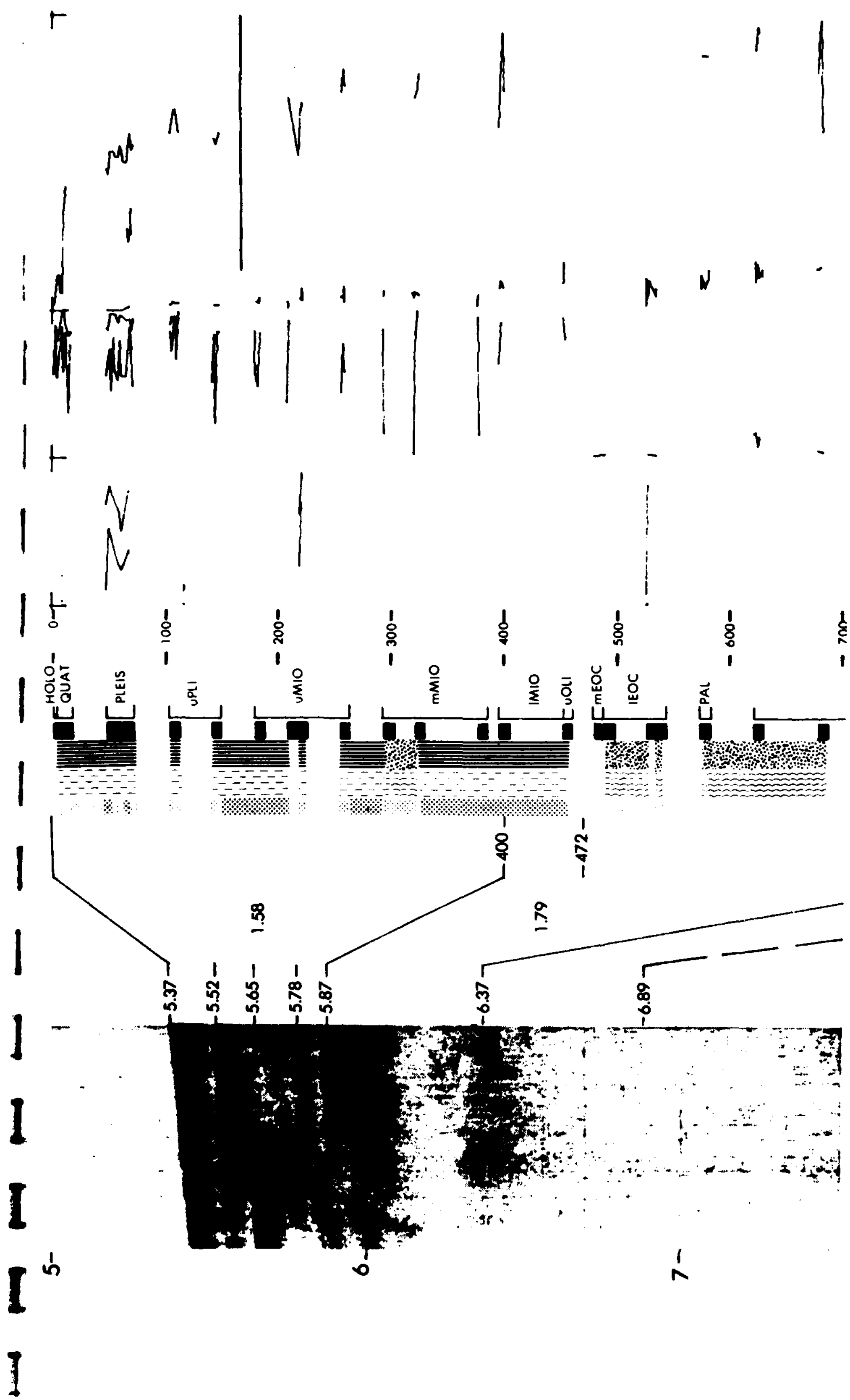
Penetration:
Drilled-- 922 meters
Cored---- 252 meters
Total----1174 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 29 cores
136.7 meters

The entire stratigraphic sequence cored at Site 241 is of deep-sea origin and consists of biogenic oozes, hemipelagic sediments, and turbidity current deposits. The sedimentary section shows a sharp decrease in calcareous biogenic detritus apparently coincident with the middle Eocene to late Oligocene hiatus. Unit II may be considered as having been deposited below the calcium carbonate compensation depth (CCD), in contrast to Unit I. An explanation of this fundamental lithologic change may include; severe dilution of the calcareous biogenic component by terrigenous influx, dissolution of calcareous biogenic material, or a change in oceanic circulation. Cores 25 to 29, Unit II, may be considered a flysch sequence. This section includes a range from relatively proximal (massive sandstone) to distal (fine-grained graded beds) turbidites. It is likely that these turbidites accumulated as channel levee and overbank deposits of a migrating submarine distributary system at the base of the Cretaceous continental slope. Any portion of the sequence of Site 241 is clearly more distal than the coarse massive sand cored at Site 240. If the sand of Site 240, on the abyssal plain, was derived from Africa it bypassed the continental rise (Site 241), possibly through relatively localized distributary channels.

Calcareous sediments nannofossil rich. One thin layer of calcareous sediment, occurs in Senonian time.



SITE 241



0
100
200
300
400
500
600
700
HOLO-QUAT
PLEIS
uPLI
uMIO
mMIO
lMIO
uOLI
mEOC
lEOC
PAL
400
472
1.58
1.79
5.37
5.52
5.65
5.78
5.87
6.37
6.89
5
6
7

SITE DATA

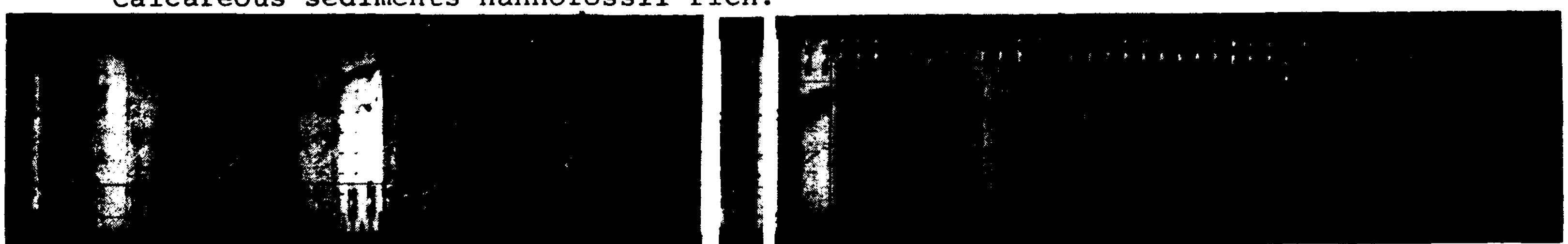
Position:
Latitude 15°50.6' S
Longitude 41°49.2' E
Date: 07/22/72
Time: 2340Z
Water depth: 2275 meters
Location: Mozambique Channel; Davie Ridge

CORE DATA

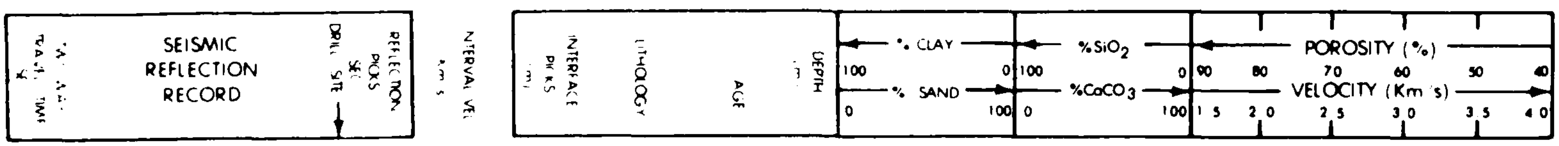
Penetration:
Drilled-- 542 meters
Cored---- 134 meters
Total---- 676 meters
Recovery:
Basement- 7 cores
22.1 meters
Total---- 19 cores
103.1 meters

The dominance of calcareous nannofossils plus the paucity of terrigenous detritus at Site 242 indicate that this site has been within a region of pelagic sedimentation at least since late Eocene time, which attests to the tectonic stability of the region for the past 40 million years. The average sediment accumulation rate for the section penetrated is approximately 20 m/m.y., a relatively high figure for pelagic sediments, probably due to the high biologic productivity characteristic of equatorial waters. The bottom at this site has probably been above the CCD throughout the entire time span of pelagic sedimentation. The site is situated in the lee of Davie Ridge, which would act as a barrier against terrigenous materials that may have been shed from the African continent. This may explain the paucity of land-derived detritus in the sediments. A very clear abrupt increase in clay content coincides with the division between Units I and II—a division selected on the basis of a change from soft, unconsolidated sediments to hard, semilithified ones. It thus seems apparent that lithification of pelagic sediments is directly related to the content of clay minerals. The strongly bioturbate condition of much of the sediment attests to the presence of abundant bottom dwellers.

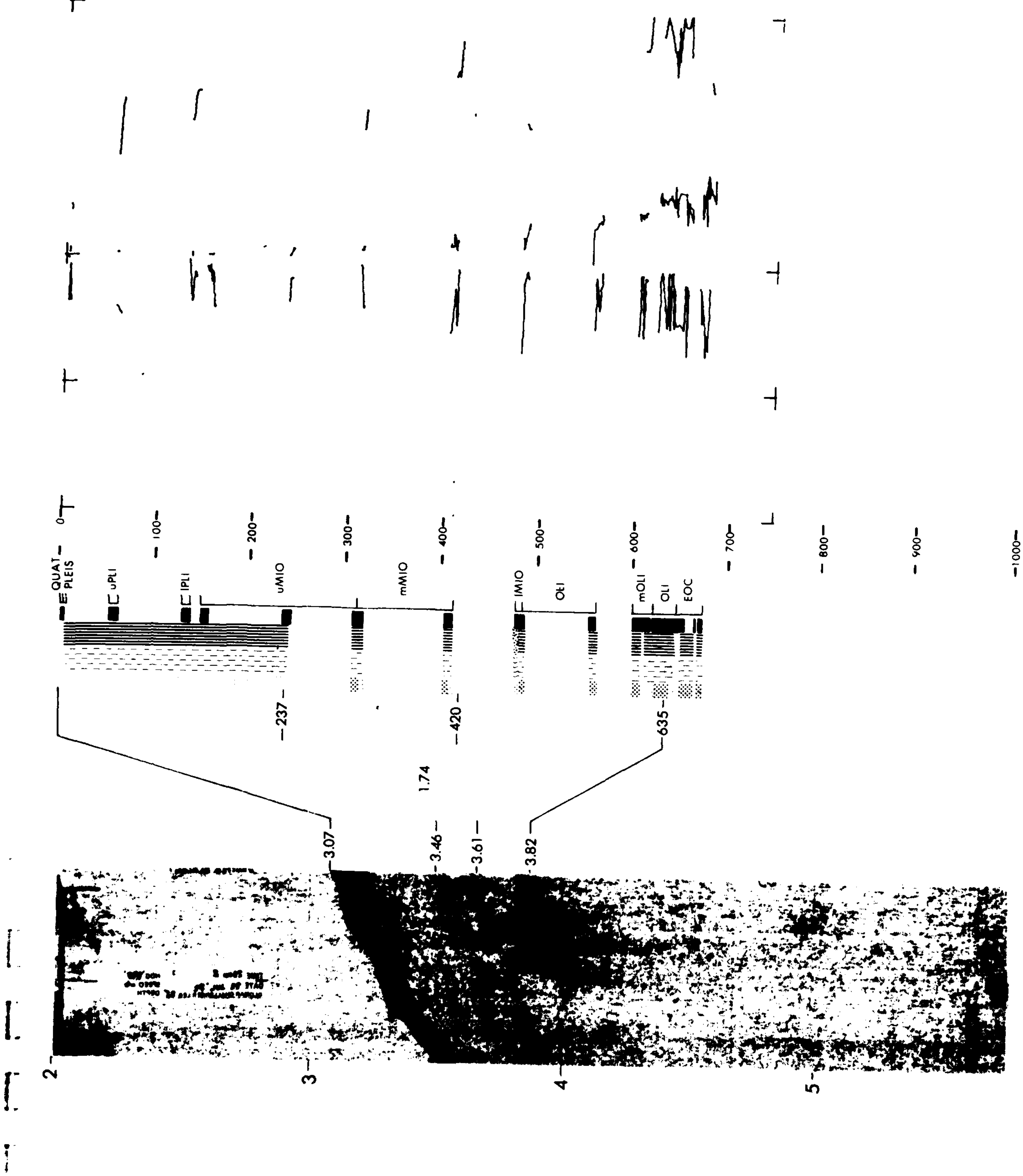
Calcareous sediments nannofossil rich.



242



SITE 242 LEG 25



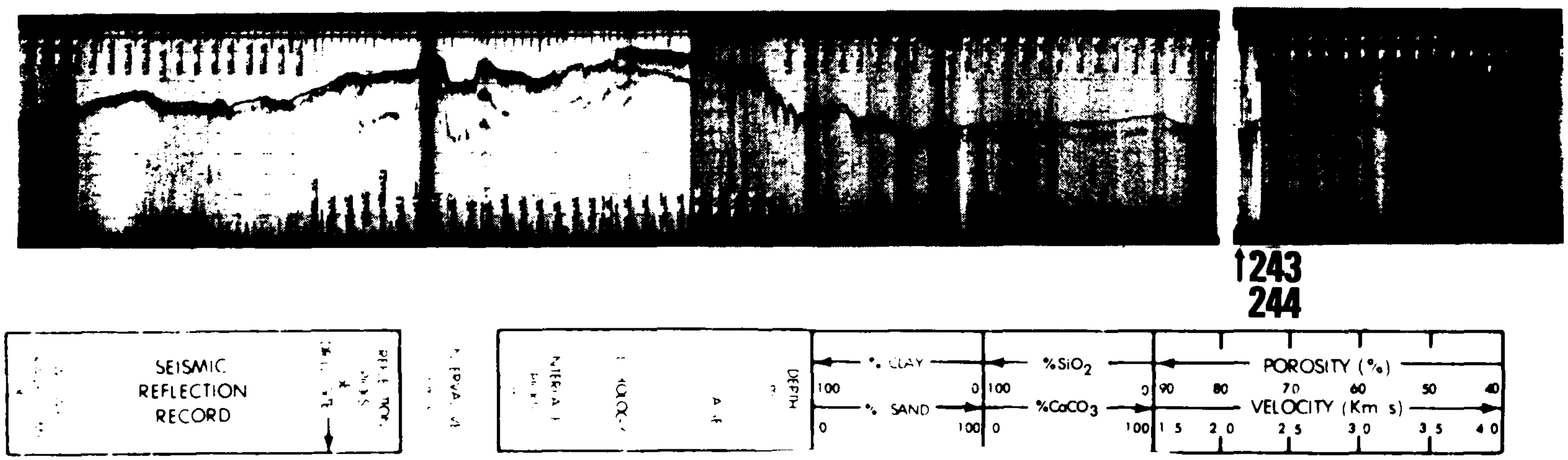
SITE DATA

Position:
Latitude $22^{\circ}54.5'$ S
Longitude $41^{\circ}24.0'$ E
Date: 07/28/72
Time: 0900Z
Water depth: 3879 meters
Location: Mozambique Channel

CORE DATA

Penetration:		
Drilled--	26	meters
Cored----	6	meters
Total----	32	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	1	cores
	.3	meters

Only one punch core, with very poor recovery, was taken between 0 and 6 meters below the sea floor. After penetration to 32 meters in unconsolidated coarse sand and fine gravel, it was decided, for technical reasons relating to instability of the hole, to abandon the site and to attempt another hole in the eastern lower slope of the canyon. The second site (244) is situated about 2.4 miles southeast of the first. The large grain size in the sample recovered from the canyon fill is a function of the competence of down-canyon flow mechanisms, while the high degree of rounding and the relatively high mineral (compositional) maturity can be attributed to several factors present in the Zambesi River Submarine Canyon system. These include: a long transport distance (Africa or Madagascar) with accompanying in-transit attrition, a high degree of weathering completeness in the provenance areas, the rock types of the provenance areas, possible winnowing effects by marine sedimentation agents adjacent to the Zambesi River mouth or on the continental shelf of western Madagascar, and the sedimentation characteristics of turbidity currents operating in the Zambesi Submarine Canyon system.



SITE 243 LEG 25

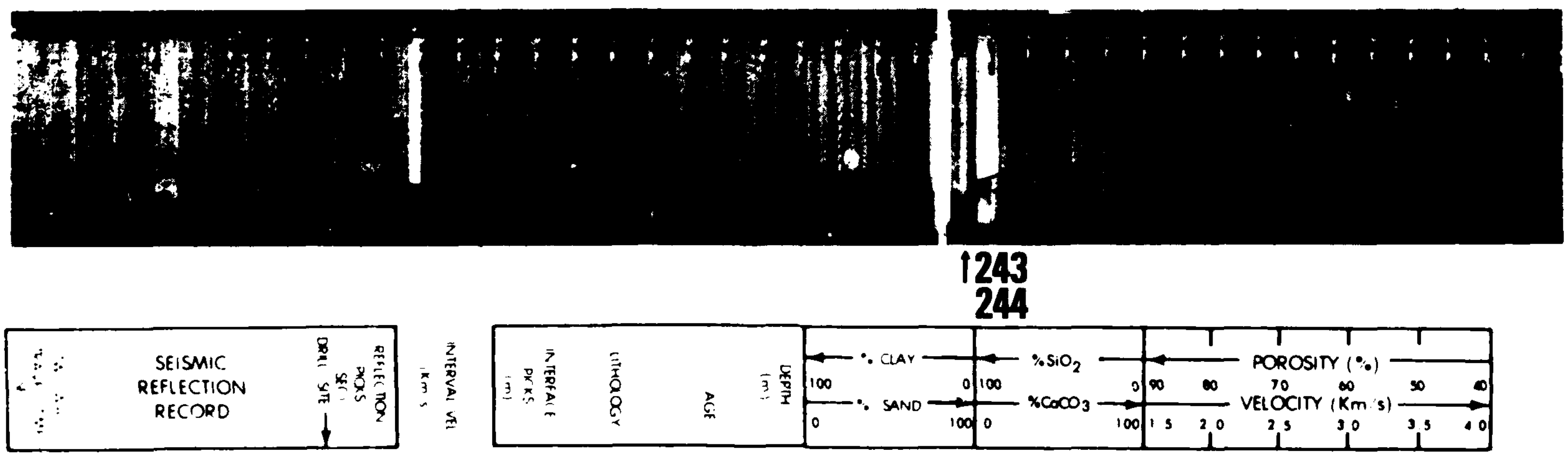
SITE DATA

Position:
Latitude 22° 55.9' S
Longitude 41° 26.0' E
Date: 07/29/72
Time: 0800 Z
Water depth: 3768 meters
Location: Mozambique Channel

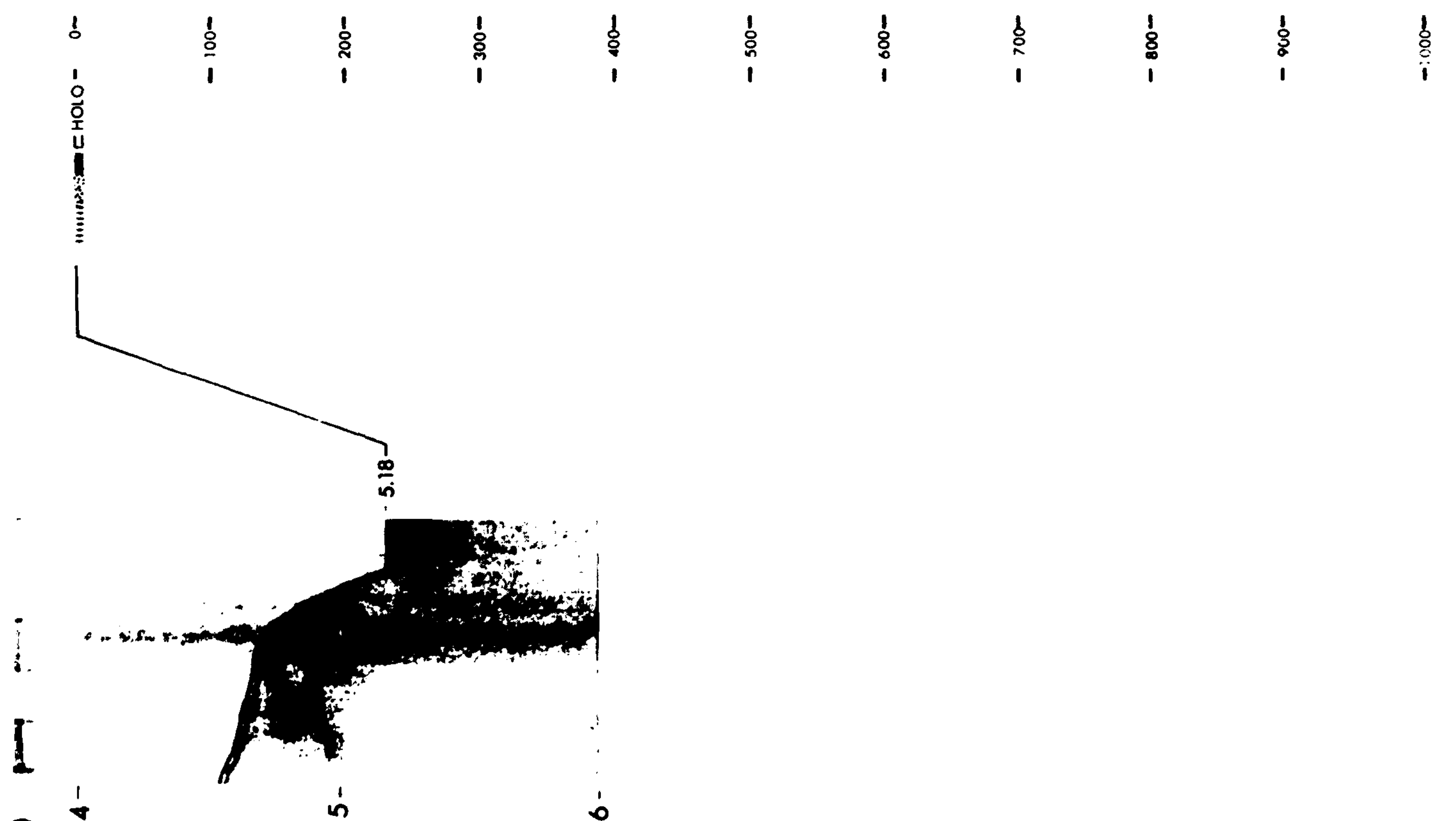
CORE DATA

Penetration:		
Drilled--	24	meters
Cored----	3	meters
Total----	27	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	1	cores
	.05	meters

As in Site 243, sediment conditions created poor hole stability, and this site was abandoned after retrieving only an initial core catcher sample. At Site 244, located on the eastern wall of the Zambesi Canyon about 30 meters above the canyon floor, the small punch core sample consists of greenish-gray clay and silty clay with some associated sand and gravel that are similar to the canyon floor sample at Site 243. The sample consists of 65-75 percent clay minerals, 2-5 percent authigenic pyrite and carbonate rhombs, and 25 percent detrital quartz, feldspar, rutile, garnet, and Pleistocene/Recent foraminifera. The whole sample clearly represents material that is in transit down the canyon towards the Mozambique Basin. The coarse sand and gravel samples recovered from both Sites 243 and 244 indicate that laterally-confined turbidity currents are capable of transporting detrital material which is at least 1.5 cm in diameter 800 km from the nearest source, and that similarly large grain sizes are occasionally swept up by turbulence (if not normally transported) at least to 30 meters above the floor of the canyon.



SITE 244 LEG 25



SITE DATA

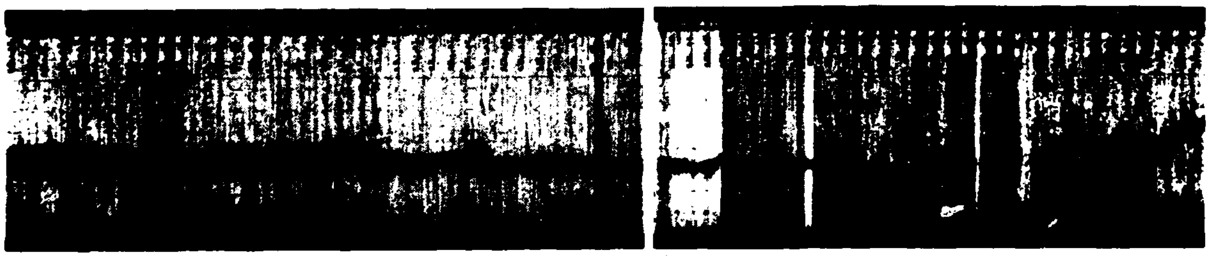
Position:
Latitude 31°32.0' S
Longitude 52°18.1' E
Date: 08/02/72
Time: 1929Z
Water depth: 4857 meters
Location: Southern Madagascar Basin

CORE DATA

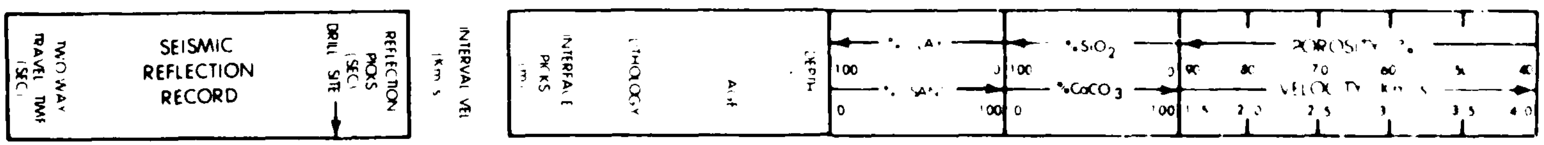
Penetration:	245	245A	
Drilled--	246	86	meters
Cored----	150.5	63	meters
Total----	396.5	149	meters
Recovery:			
Basement-	3	0	cores
	1.6	0	meters
Total----	19	7	cores
	82.1	47.4	meters

The oldest chalk deposit resting on the basement contains an abnormally high amount of Fe/Mn oxides, suggesting volcanic inputs. Metallic components might originate by the precipitation from seawater of metallic ions yielded by hydrothermal exhalations and/or by halmyrolysis of basalts and basaltic glass. Extremely heavy bioturbation throughout the chalk section indicates intense biologic activity on the sea floor. More than half of the thick (264 m) nannofossil deposits are early Eocene in age. Consequently, a fairly high rate of sedimentation of about 33 m/m.y. is calculated. This fact strongly suggests that (a) the sediments were deposited well above the calcium carbonate compensation depth zone; and (b) there was a fairly high productivity in the sea euphotic zone. At the beginning of the middle Eocene (Unit II), a relatively sudden appearance of silt occurs simultaneously with a sharp lowering of the sedimentation rate (about 9 m/m.y.). This fact suggests (a) increased sediment supply from a terrigenous source; and/or, (b) reduced biogenic productivity; and/or, (c) deepening of the sea floor close to the calcium carbonate compensation depth zone.

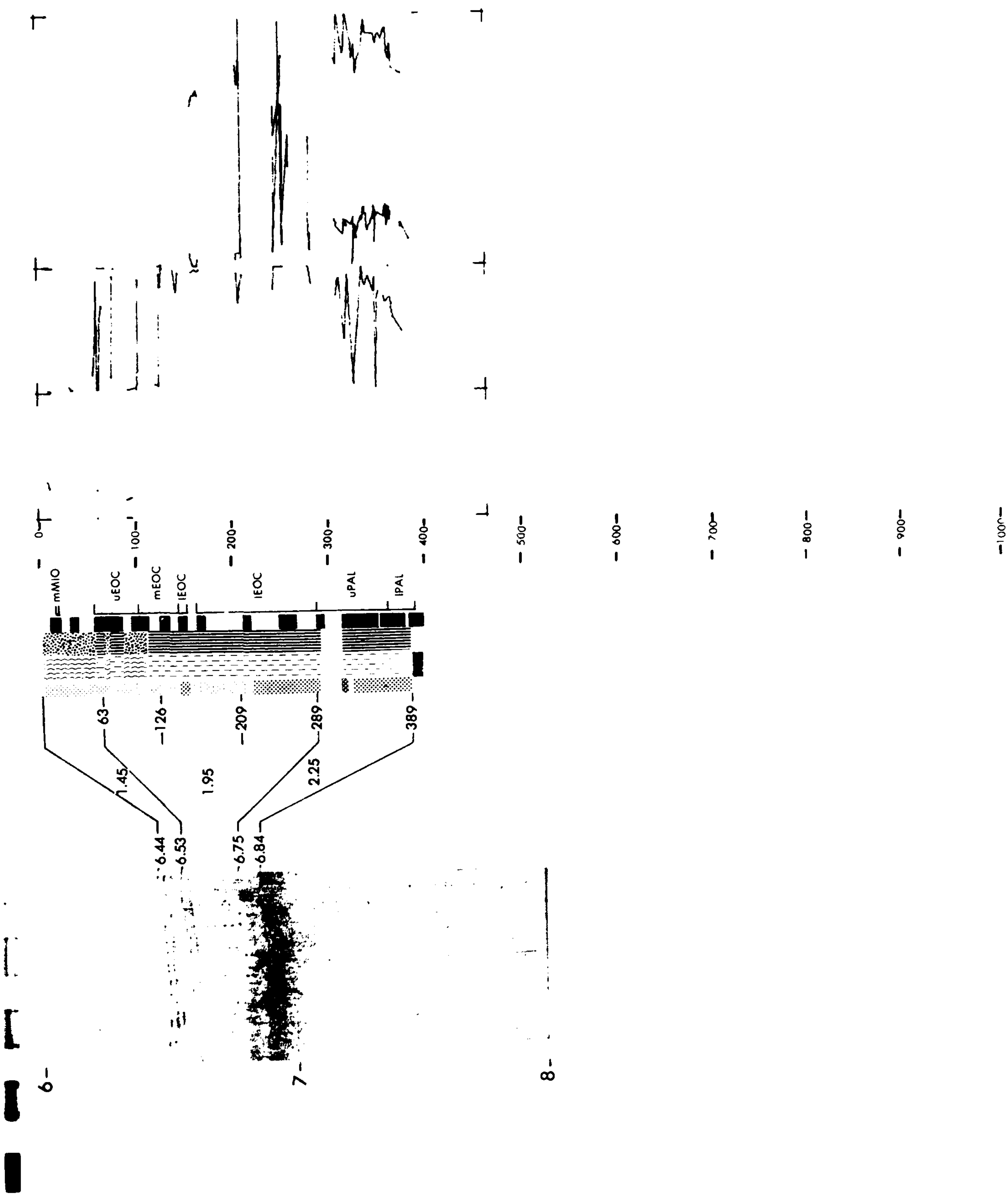
Middle Miocene and Upper Eocene detrital interbedded with thin layers of calcareous sediments, nannofossil rich. Other calcareous sediments also nannofossil rich.



↑245



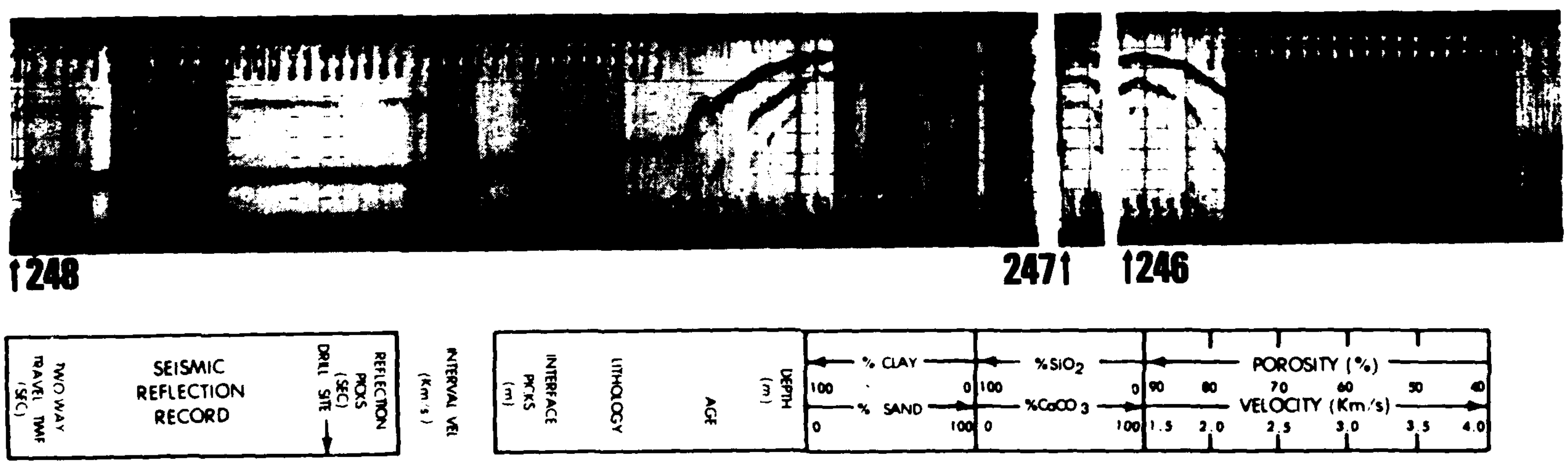
SITE 245 LEG 25



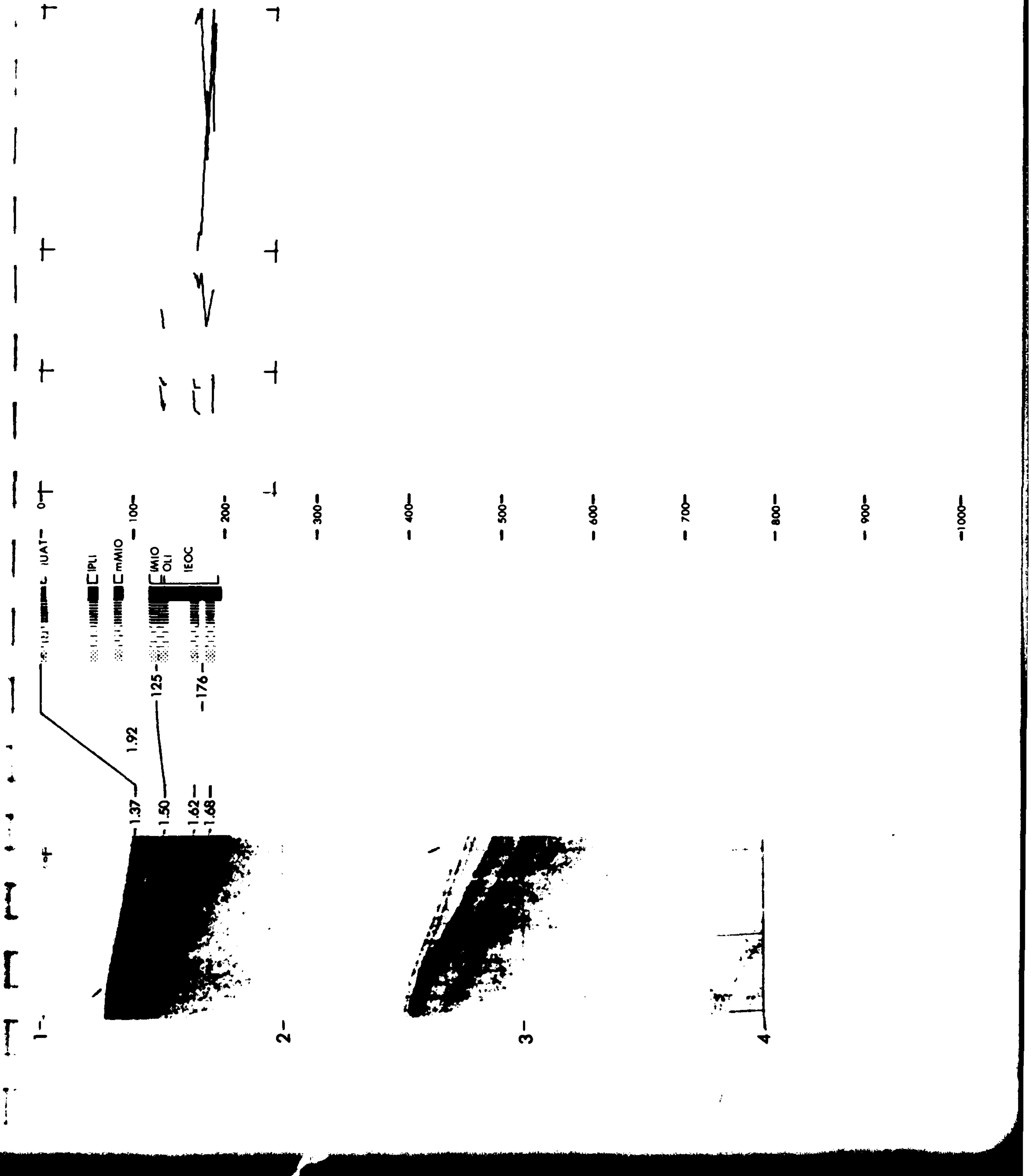
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	33°37.2' S	Drilled--	109 meters
Longitude	45°09.6' E	Cored----	94 meters
Date: 08/09/72		Total----	203 meters
Time: 1618Z		Recovery:	
Water depth: 1030 meters		Basement-	0 cores
Location: Madagascar Ridge			0 meters
		Total----	11 cores
			23.8 meters

Sites 246 and 247 are discussed together.

Large shallow-water pelecypod fragments, cross-bedded sand, and glauconite suggest that the sediments of Unit II and III accumulated in an agitated, relatively shallow-water environment (probably less than 300 m) (Porrenga, 1967). Terrigenous influx was low excepting periods of volcanic supply. A possibly similar depositional environment may presently exist in the vicinity of Walters Shoals (20 m deep), 60 miles distant from Site 246. A profound hiatus (30 m.y.) occurs within Unit II between Cores 4 and 5, yet no lithologic change was noted at this point. Therefore, it is likely that the Miocene calcareous sand of Core 4 is reworked from identical lower Eocene sediments (Cores 5-9). During early Miocene the sea floor in the area around Site 246 subsided from less than 300 meters to a depth sedimentologically indistinguishable from its present depth (about 1000 m). The accumulation of dominantly foram ooze from Miocene to Recent suggests the possibility of winnowing of nannofossils by bottom currents.



SITE 246 LEG 25



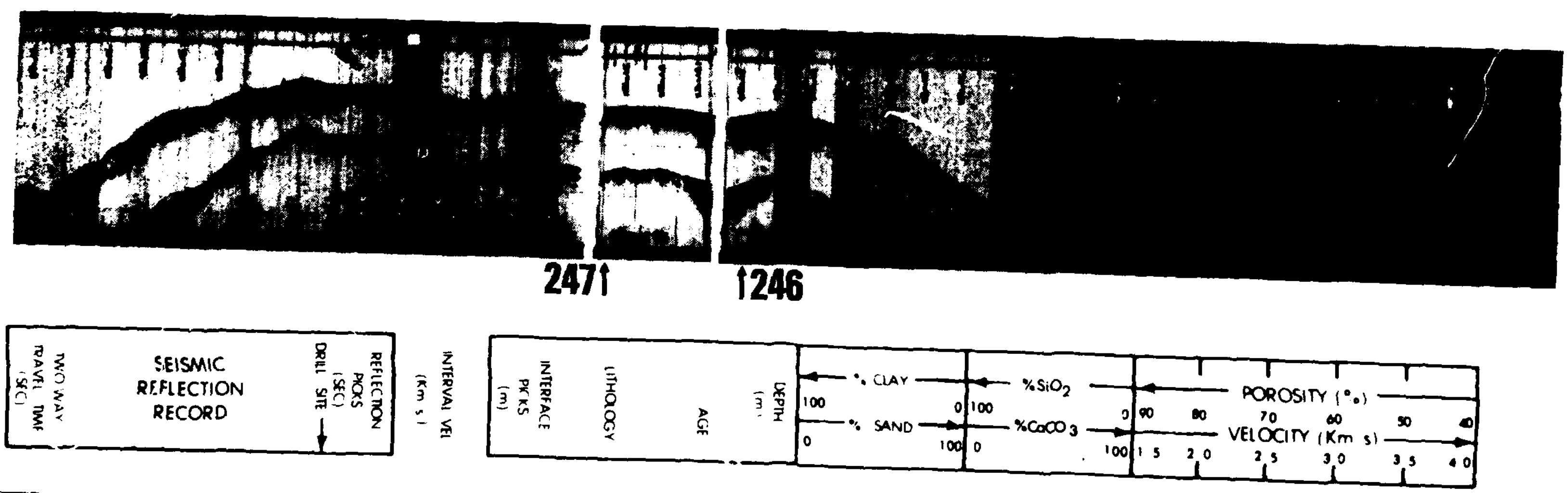
SITE DATA

Position:
Latitude 33°37.5' S
Longitude 45°00.7' E
Date: 08/10/72
Time: 1736z
Water depth: 944 meters
Location: Madagascar Ridge

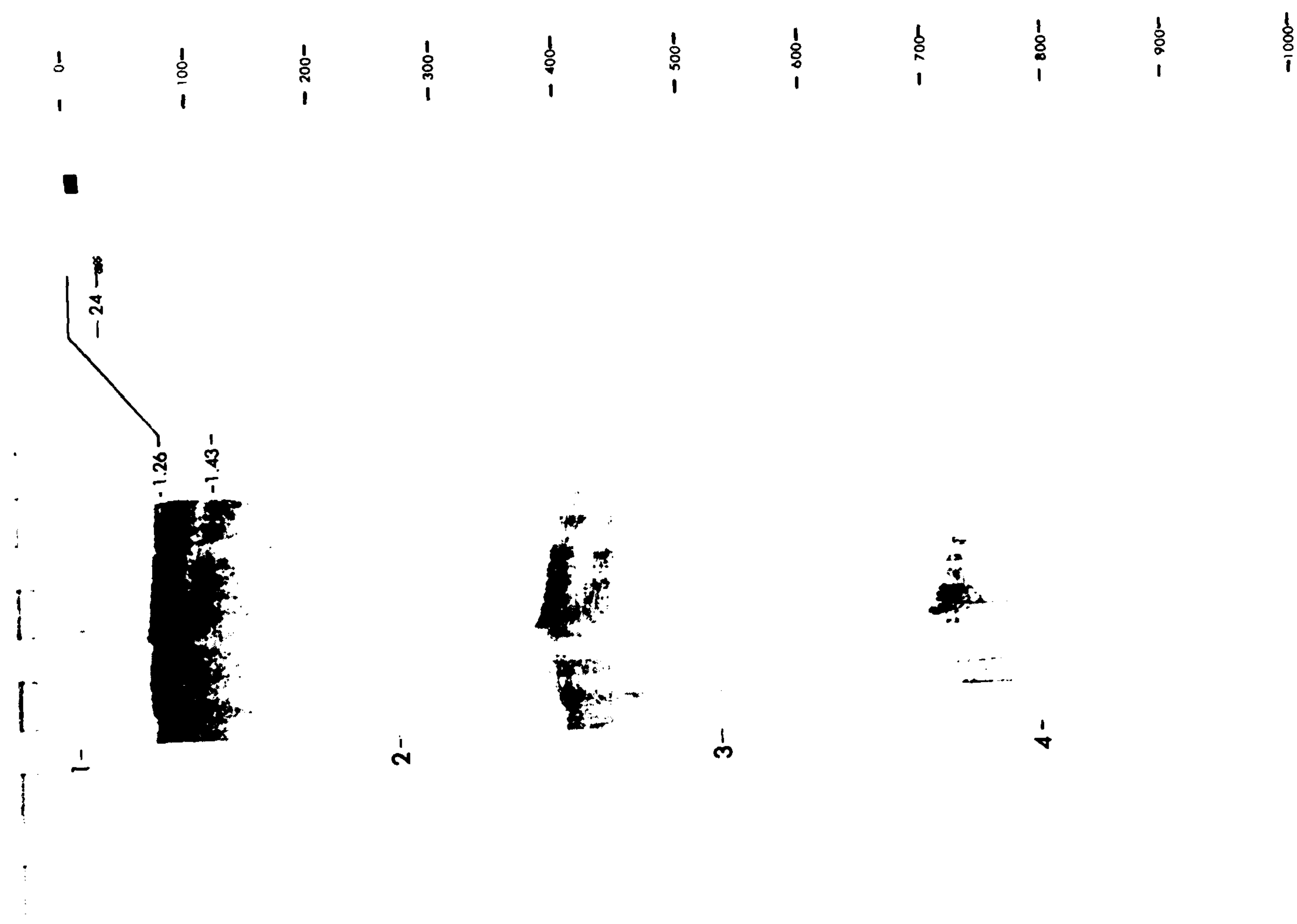
CORE DATA

Penetration:	
Drilled--	18 meters
Cored----	8 meters
Total----	26 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	1 cores
	.05 meters

Sites 246 and 247 are discussed together.



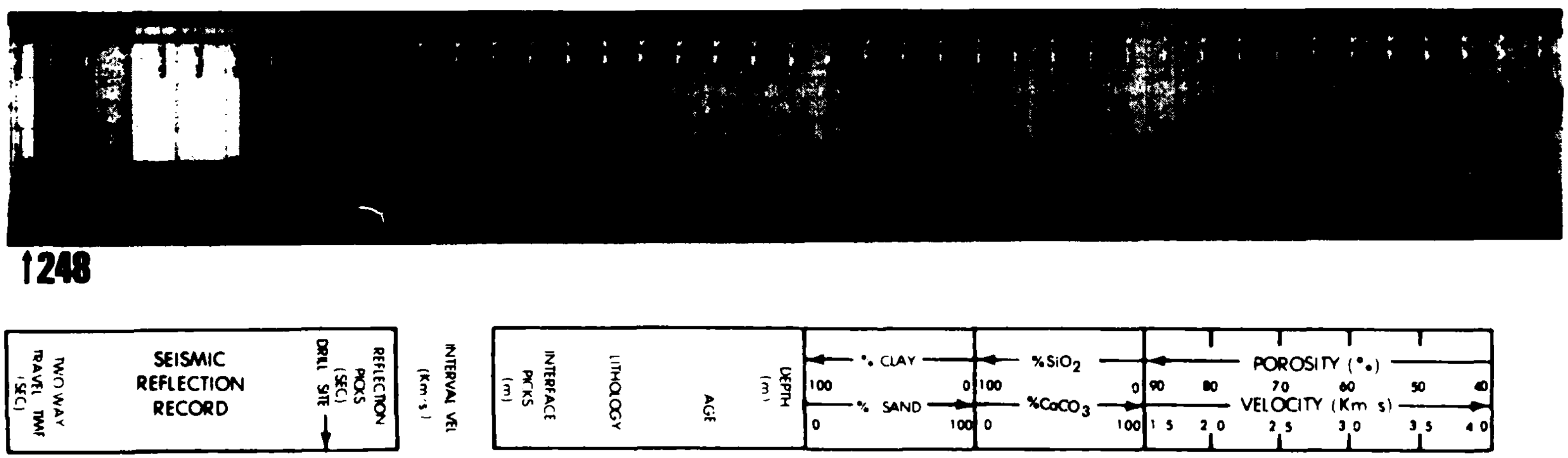
SITE 247 LEG 25



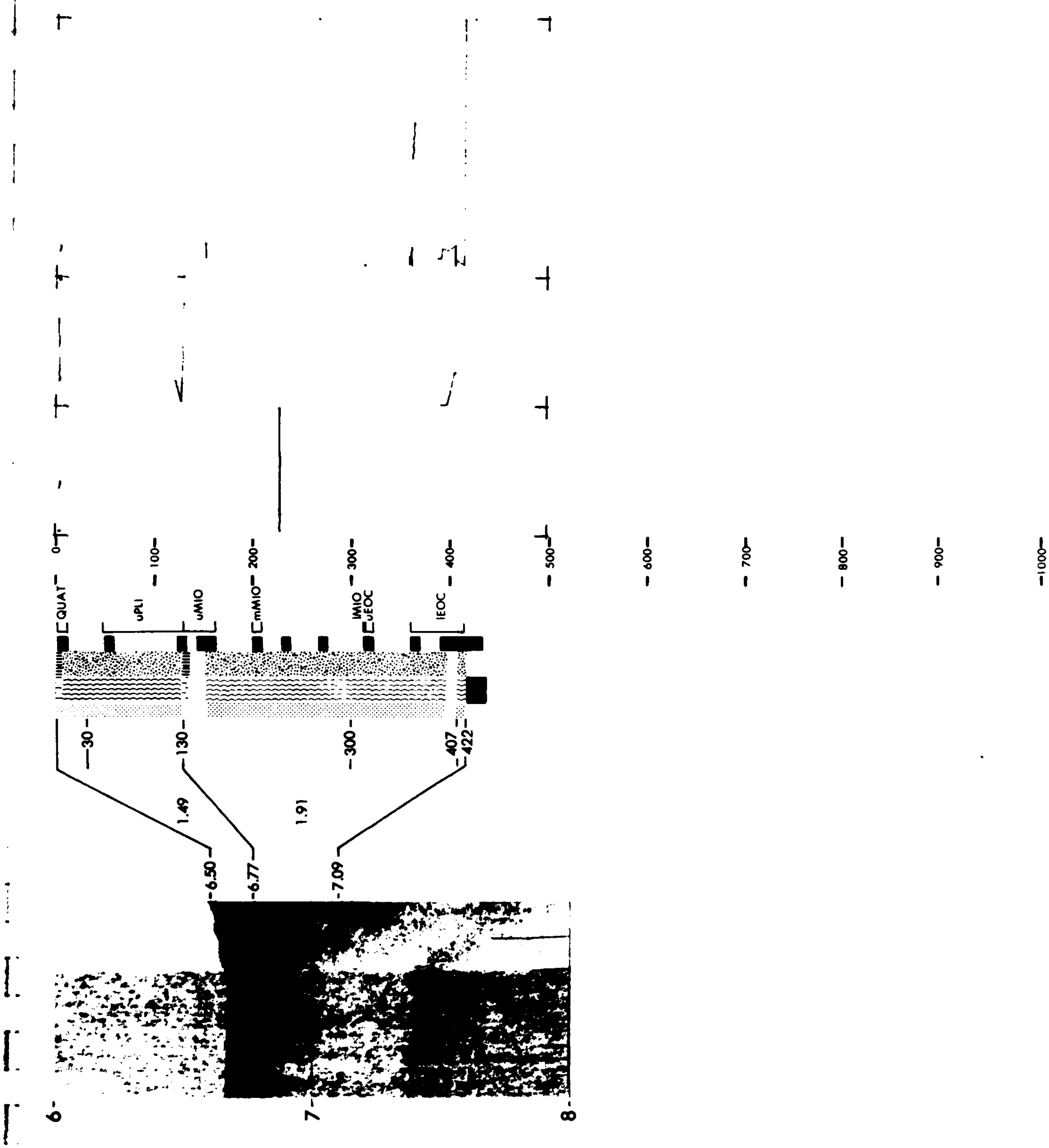
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	29°31.8' S	Drilled--	298 meters
Longitude	37°28.5' E	Cored----	136 meters
Date: 08/13/72		Total----	434 meters
Time: 1700 Z		Recovery:	
Water depth: 4994 meters		Basement-	3 cores
Location: Mozambique Basin			3.6 meters
		Total----	17 cores
			40.8 meters

The basalts probably were extruded onto the sea floor as lava flows. The brown clays of Unit III are pelagic sediments and were deposited below the regional CCD. Red and blackish-red iron-rich clays suggest submarine hydrothermal iron enrichment similar to that suggested for basal iron-rich sediments of Hole 245. The laminated sequence in Unit II was deposited mostly in deep water below the regional CCD. The sediments are mainly volcanogenic silts and clays. The volcanogenic sediments probably are mostly epiclastic in origin, eroded from a volcanic terrane, and transported to the deep ocean by turbidity currents. However, some beds may represent submarine pyroclastic flows and volcanic ash and dust which were transported mainly by wind to the site of deposition. Granitic/metamorphic terranes contributed more detritus to Unit II in the upper layers, thereby probably reflecting the unroofing of the older rocks. A strong terrigenous influx began in the middle Miocene when coarse turbidites, derived from the African continent and/or Madagascar, reached this part of the basin. The coarse-grained sediments suggest large-scale epeirogenic uplift of the provenance areas during the middle Miocene-Pleistocene interval.

Detrital sediments interbedded with thin layers; calcareous nannofossil rich.



SITE 248 LEG 25



SITE DATA

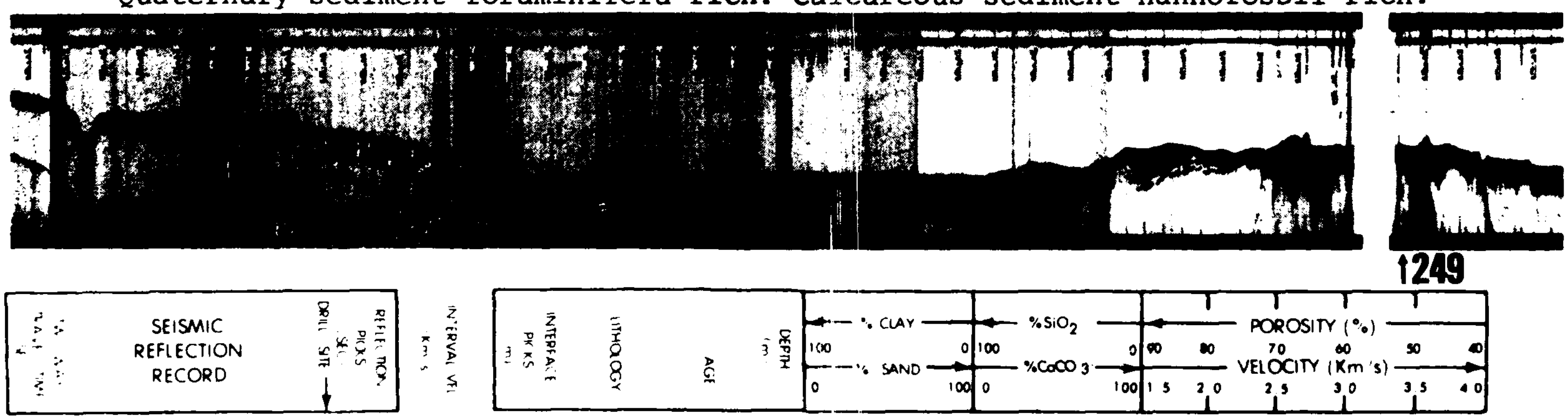
Position:
Latitude 29°57.0' S
Longitude 36°04.6' E
Date: 08/17/72
Time: 1242Z
Water depth: 2098 meters
Location: Mozambique Ridge

CORE DATA

Penetration:
Drilled-- 127 meters
Cored---- 285 meters
Total---- 412 meters
Recovery:
Basement- 2 cores
3.6 meters
Total---- 33 cores
221.4 meters

Unit 1 is composed of biogenic oozes and chalks with minor amounts of clay and silt and which has accumulated under tectonically quiescent conditions since middle Miocene time. The high sedimentation rate reflects the site's location beneath waters of high plankton production and its position above the CCD. The general lithologic character of Unit II is so similar to that of Unit I as to suggest that they were deposited under closely similar conditions although at widely separated times. A profound unconformity of 40 m.y. (middle Miocene-Late Cretaceous) separates Units I and II. The presence of silt (15%) which includes the heavy minerals zircon, rutile, and hematite in the top of Unit II may indicate the onset of tectonic instability which was followed by upwarp and erosion in this area. A second unconformity of about 14 m.y. duration separates Unit II (Campanian) from Unit III (Cenomanian). This break is recognized on both paleontologic and lithologic evidence. The contrasting natures of Units II and III indicate a radical change in the depositional environment for this site, and the tectonic process responsible for the unconformity led to the development of depositional conditions for Unit II. Unit III contains many distinctive features, that are indicative of tectonic instability accompanied by volcanism. Unit IV, the vesicular glassy basalt, suggests subaqueous extrusion.

Quaternary sediment foraminifera rich. Calcareous sediment nannofossil rich.



SITE 249 LEG 25

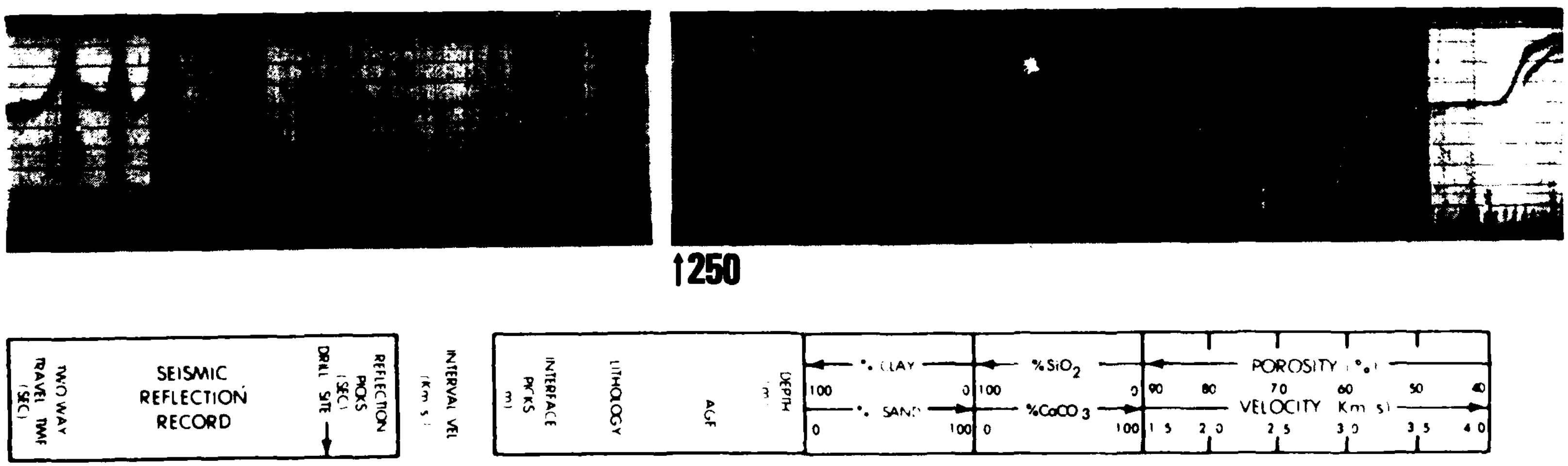
SITE DATA

Position:
Latitude 33°27.7' S
Longitude 39°22.1' E
Date: 09/08/72
Time: 1232Z
Water depth: 5119 meters
Location: Mozambique Basin

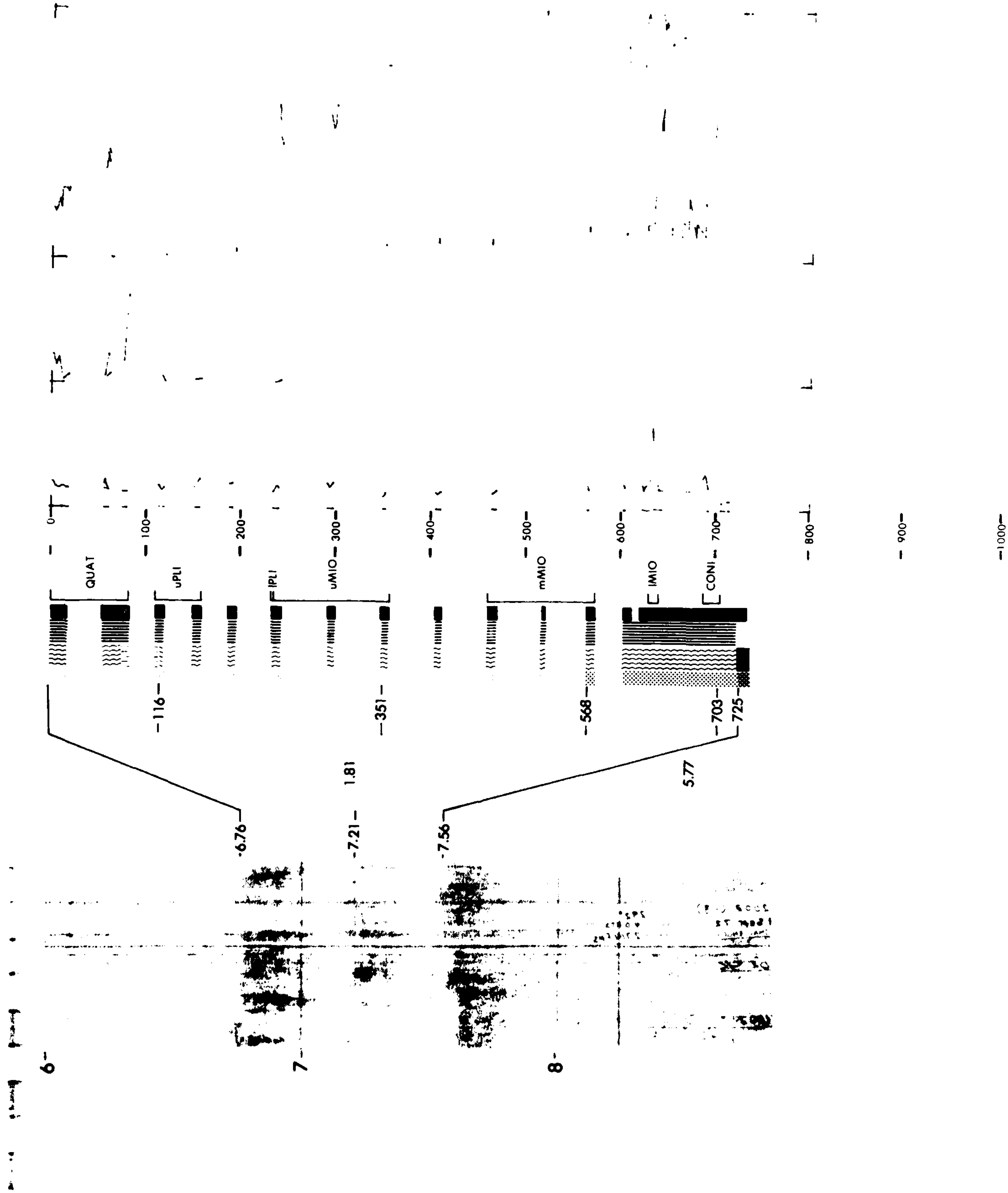
CORE DATA

Penetration:	250	250A	
Drilled--	37	498	meters
Cored----	28	240.5	meters
Total----	65	738.5	meters
Recovery:			
Basement-	0	2	cores
	0	11.2	meters
Total----	3	26	cores
	21.4	124.4	meters

It is apparent that sedimentation at this site has been under the control of active bottom current circulation since sometime in the Miocene. Sedimentation rates increased greatly in the Miocene and there was a major influx of terrigenous material in the Pliocene. Prior to the onset of active bottom current circulation, and after an initial accumulation of the basal detrital clay above the basalt, sedimentation seems to have proceeded from the Late Cretaceous into the Miocene at the much gentler pace associated with "normal" deep-ocean basin sedimentation. The sediments at Site 248 are much coarser than those at Site 250, consisting mostly of silty clays and clayey silts, even some sand layers, with a major influx of terrigenous material in the mid Miocene. This suggests tectonic events on land in the early Tertiary which resulted in a flood of terrigenous material into the western Mozambique Basin in mid Miocene times. The coarse material accumulated close to the source, but the finer material found at Site 250 was carried farther from the source by bottom currents.



SITE 250 LEG 26



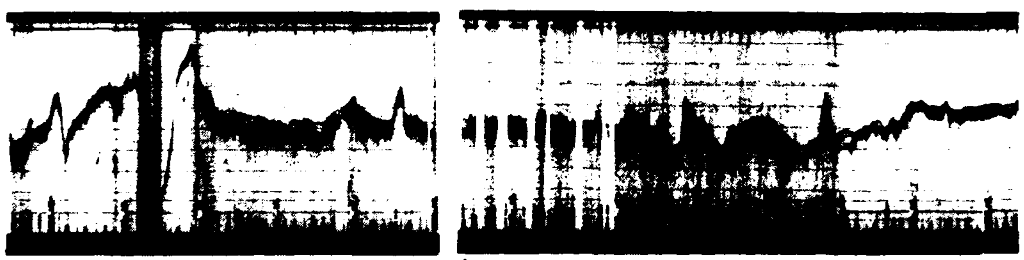
SITE DATA

Position:
Latitude 36°30.2'S
Longitude 49°29.1'E
Date: 09/17/72
Time: 0933Z
Water depth: 3499 meters
Location: Southwest Branch

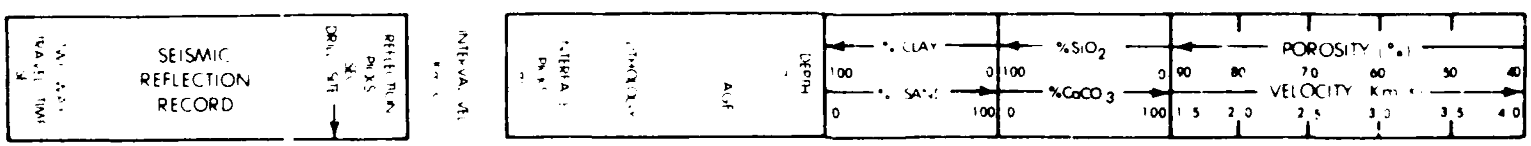
CORE DATA

	251	251A	
Penetration:			
Drilled--	0	223.5	meters
Cored----	87.5	276.5	meters
Total----	87.5	499	meters
Recovery:			
Basement-	0	3	cores
	0	6.6	meters
Total----	10	31	cores
	67.2	158.4	meters

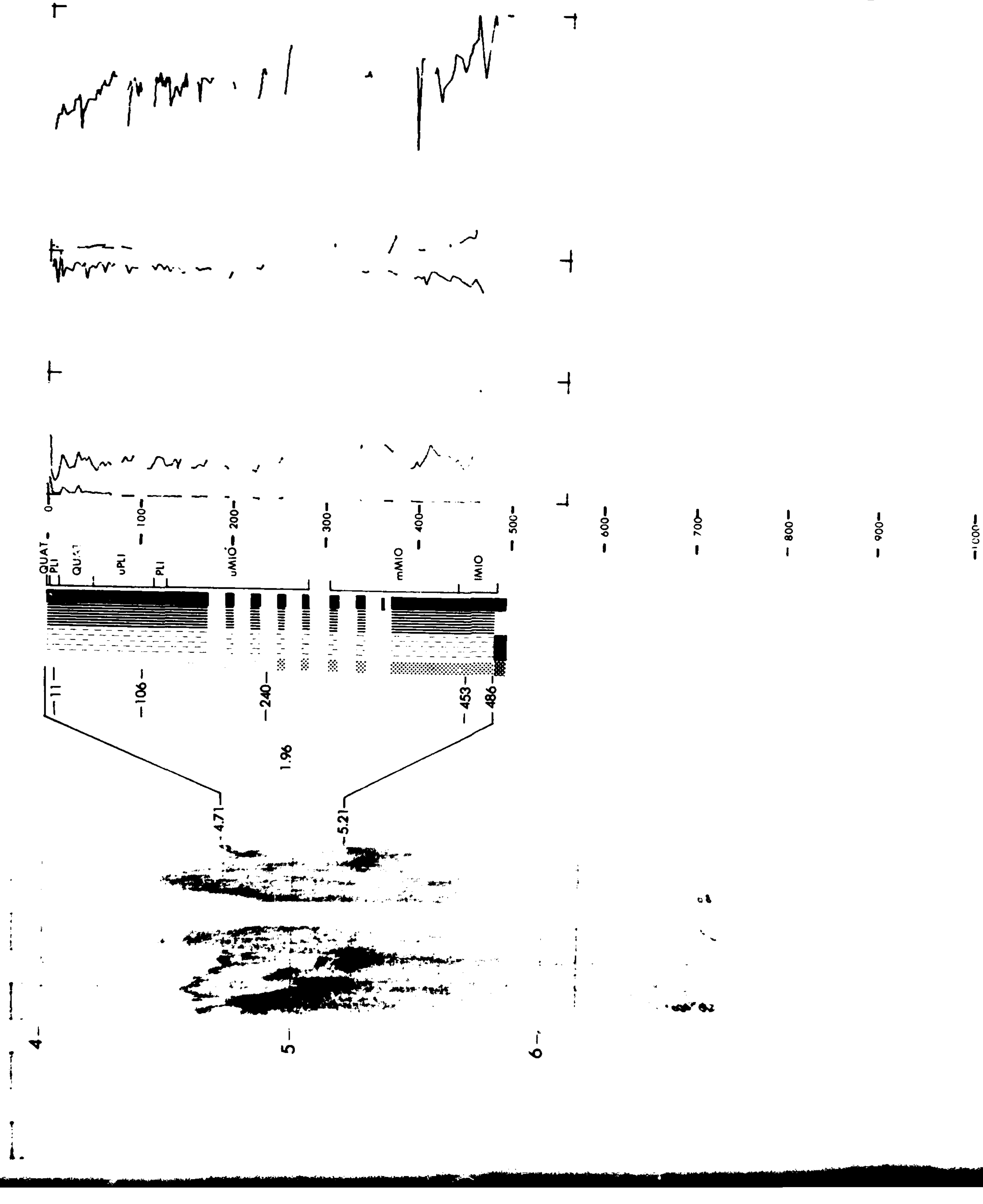
The sedimentary section at Site 251 represents a fairly uniform deposition of carbonate sediments since the creation of this area of sea floor on the axis of the Southwest Branch 17-18 m.y. ago. Selective dissolution effects on calcareous microfossils, steadily decreasing in strength up to about the lower Pliocene, suggest that either the site was initially below the now deeper lysocline and steadily shoaled or that the lysocline was at first shallower than the site and then deepened below deposition level. We favor the latter interpretation based on the observation that the floor of the world's ocean deepens with age (Sclater et al., 1971). Evidently, the lysocline was as shoal as 2500 meters in the lower Miocene and has been deeper than the deposition depth (~3000 m) only since the lower Pliocene. The age of the basement obtained at Site 251 helps in the solution of several tectonic problems of the Southwest Branch. The spreading rate determined from this age is 0.93 cm/yr averaged over 17 m.y. and measured in a north-northeast direction, or parallel to the fracture zones mapped in this region.



↑251



SITE 251 LEG 26



SITE DATA

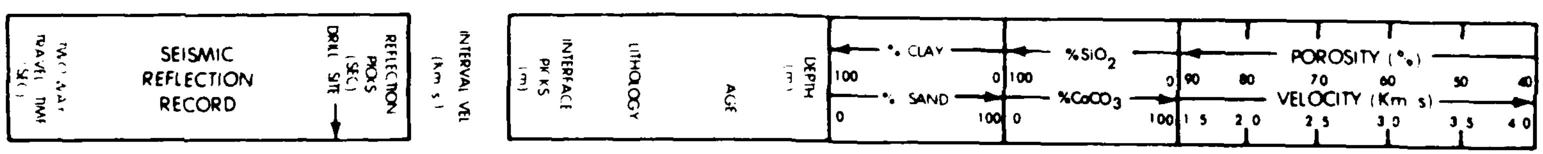
Position:
Latitude 37 °02.4' S
Longitude 59 °14.3' E
Date:09 /23/72
Time:0104 Z
Water depth: 5032 meters
Location:Crozet Basin

CORE DATA

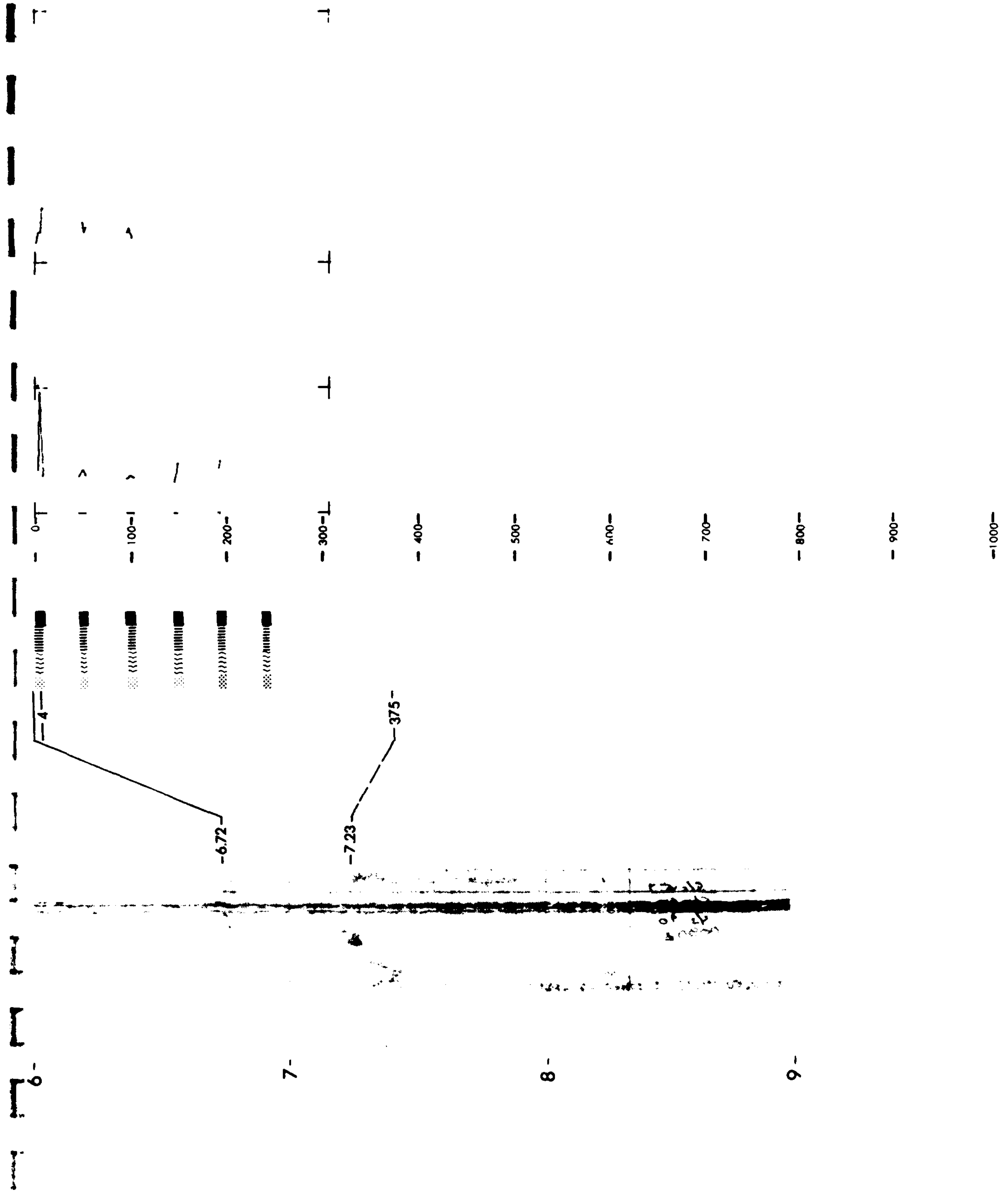
Penetration:
Drilled-- 190 meters
Cored---- 57 meters
Total---- 247 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 7 cores
41.5 meters

Site 245, DSDP Leg 25, lies northwest of Site 252 and the Southwest Branch along a line perpendicular to the ridge trend. Site 245, like Site 252, is also on crust of presumed Paleocene age. The Miocene through Recent section from the two sites can be compared. Site 245 has a very thin (20-50 m) middle Miocene section with no recognizable upper Miocene through Recent section or Oligocene through lower Miocene section. Site 252 has 247 meters of middle Miocene through Recent sediments which contain a uniform detrital component, indicating no significant changes in provenance or depositional rate. The missing Oligocene and lower Miocene section at Site 245 may be related to the pre mid Miocene flow of Antarctic Bottom Water. The thin and/or absent post middle Miocene section is probably related to the initiation of a northerly bottom current which is reported to flow in this area. This current is topographically controlled by the Southwest Branch and may prohibit or inhibit deposition at Site 245. On the other hand, this current may have had little effect on deposition at Site 252, where the sedimentary column is typical for a pelagic regime below the carbonate compensation depth

↑252



SITE 252 LEG 26



SITE DATA

Position:
- Latitude 24°52.6' S
- Longitude 87°22.0' E

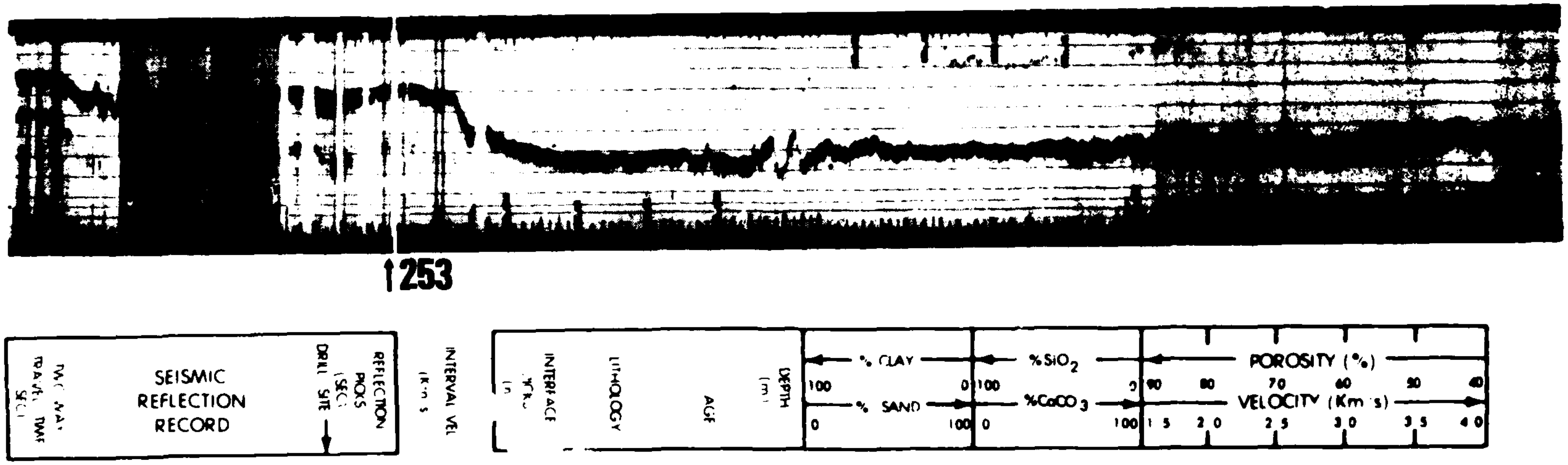
Date: 10/05/72
Time: 1200Z
Water depth: 1962 meters
Location: Top of Ninetyeast Ridge

CORE DATA

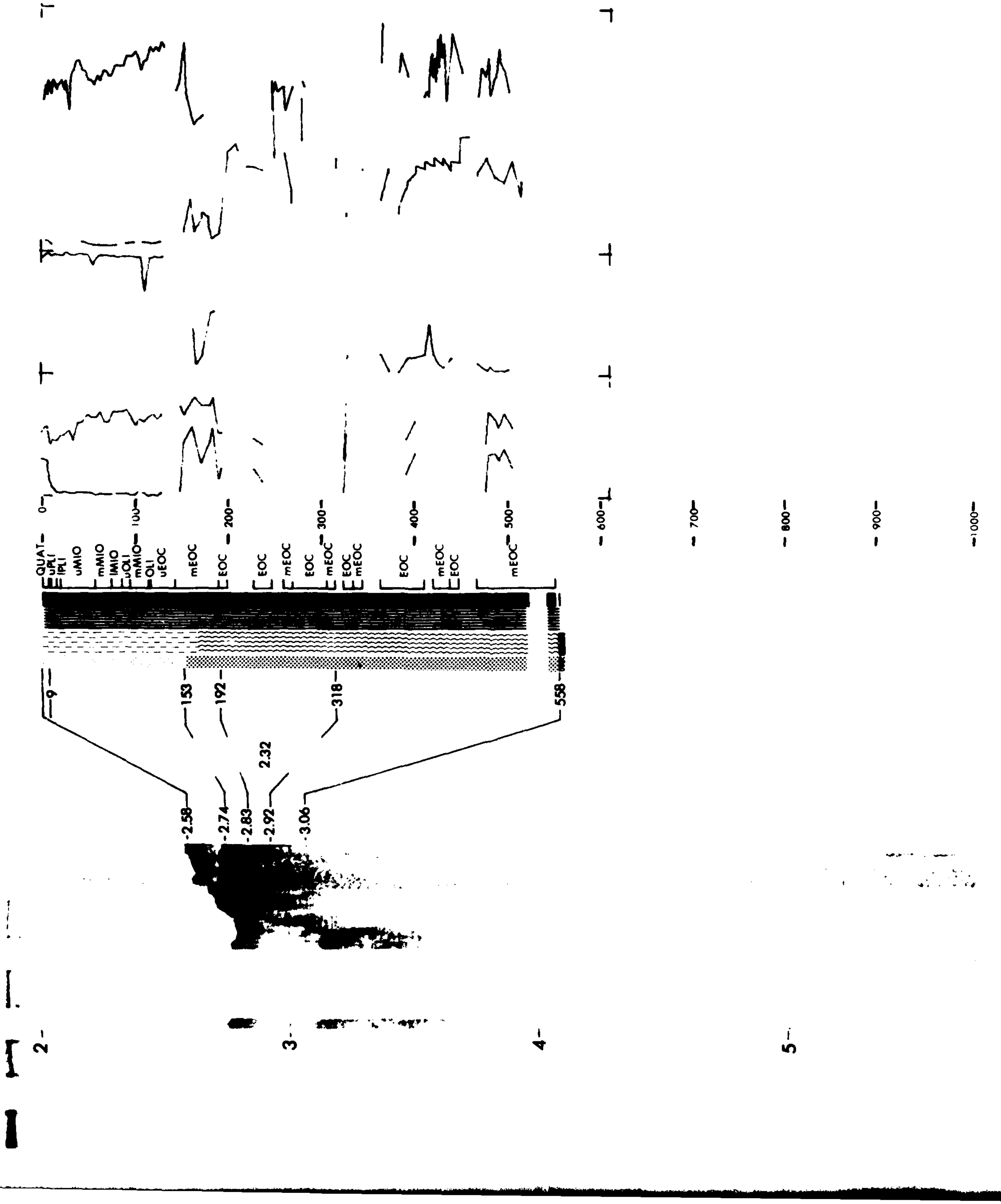
Penetration:
- Drilled-- 225 meters
- Cored----5365 meters
- Total---- 559 meters

Recovery:
- Basement- 1 cores
- .35 meters
- Total---- 58 cores
- 2701 meters

The most striking observation to make from the results of Site 253 is that near this site the Ninetyeast Ridge has been as shallow or shallower than it is now for its entire history. The age of this site is probably not much older than 46 m.y. Granted, the true basement may be some 100 meters below the basalt sampled in this hole, but the high sedimentation rate for the ash sequence implies that this distance may only represent about an extra million years. The shallow-water fauna in the ash sequence indicate that this area of the Ninetyeast Ridge was very close to sea level during its formation. Before much subsidence occurred, over 400 meters of ash had accumulated. The variable concentrations of macrofossils and burrows in the ash unit indicate that the sedimentation rate, although high, was variable. It cannot be determined from the observations whether the ash sequence originated from a subaerial or submarine source. In any event, the source was very close to the site because the generally well-preserved fauna indicate little horizontal transport. It is also curious that such a huge thickness of ash has so few lava flows within it.



SITE 253 LEG 26



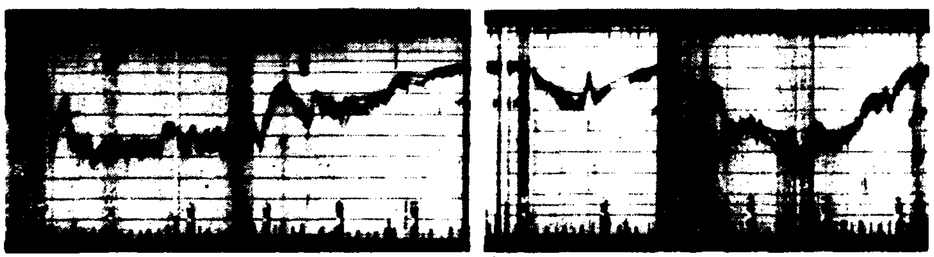
SITE DATA

Position:
Latitude 30°58.1' S
Longitude 87°53.7' E
Date: 10/07/72
Time: 0538Z
Water depth: 1253 meters
Location: South Ninetyeast Ridge

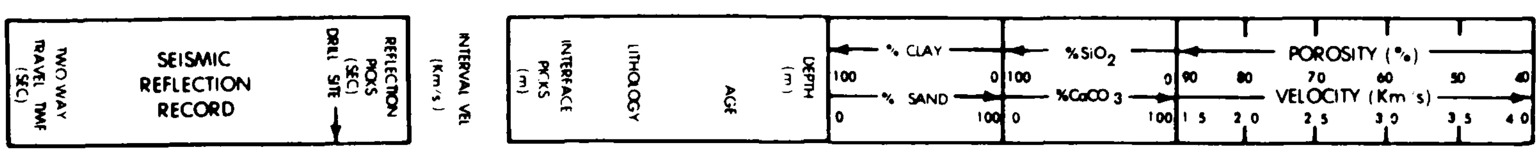
CORE DATA

Penetration:
Drilled-- 14.5 meters
Cored---- 329 meters
Total----343.5 meters
Recovery:
Basement- 6 cores
10.9 meters
Total---- 38 cores
150.5 meters

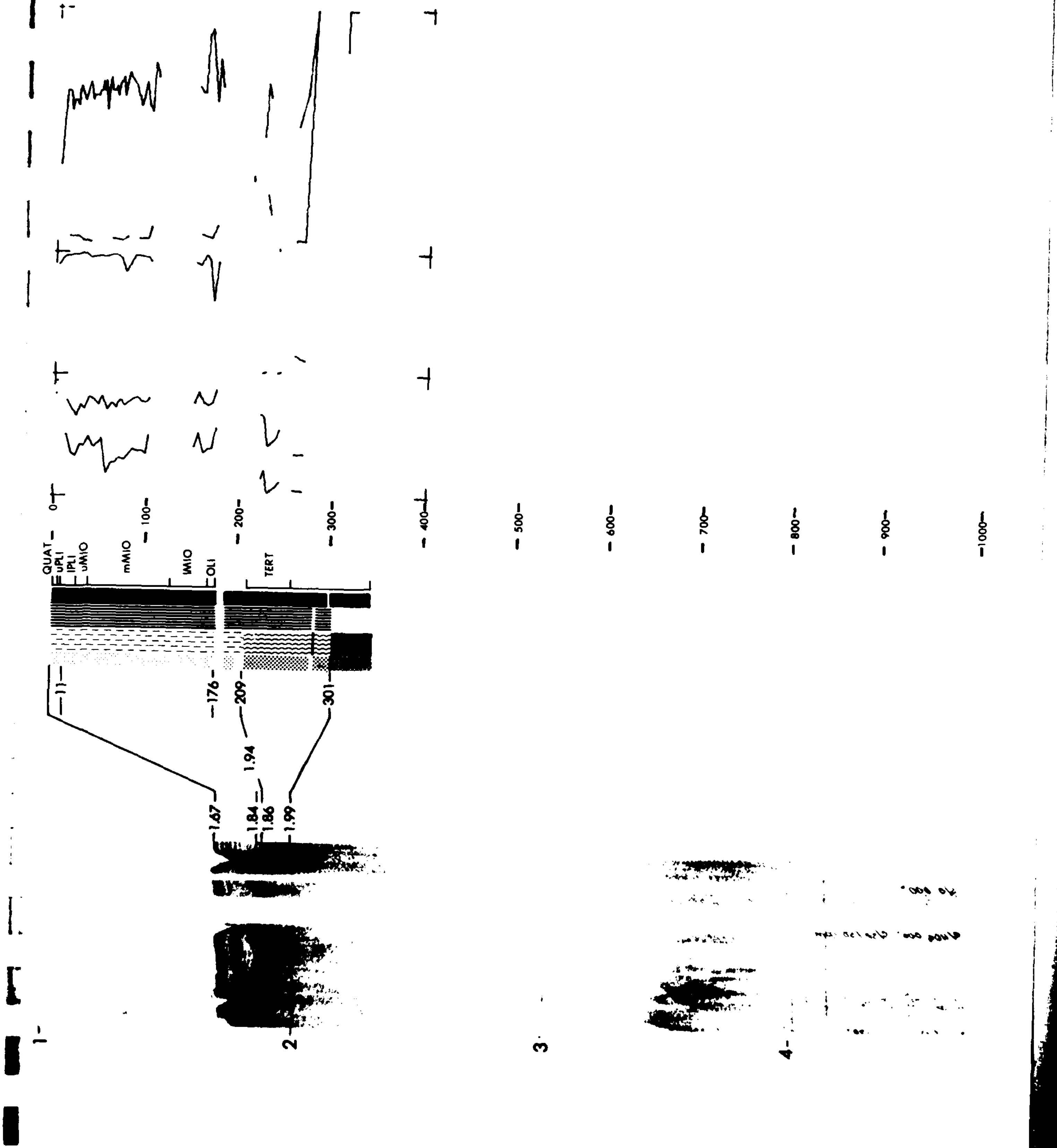
The clastic sediments of Unit 4 indicate weathering and erosion of a basaltic terrain adjacent to and composed of the same type of volcanic rocks as those found at the base of the section. There is no proven contemporaneous pyroclastic contribution to Unit 4. The poor sorting and lack of traction-current features indicate rapid deposition in quiet water, and the faunas suggest a shallow-water littoral or lagoonal type of environment. The rapid deposition is further substantiated by the intraformational breccias, which indicate contemporaneous instability of the sedimentary pile. During the deposition of the calcareous sediments (Units 1, 2, and 3), there was no basaltic or continental terrigenous sediment contribution, and all of the faunal evidence suggests an environment essentially similar to that of the present. The micarb ooze and chalk are most probably a diagenetic modification of normal coccolith oozes. In spite of their present petrographic contrast with the foram and coccolith oozes, these micarb-bearing oozes need not reflect any real change within the domain of sedimentation.



1254



SITE 254 LEG 26



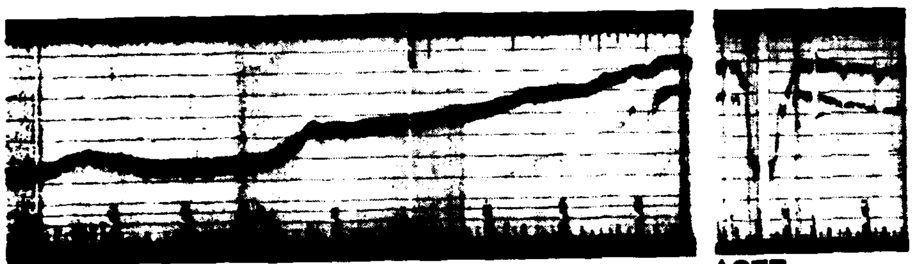
SITE DATA

Position:
Latitude 31°07.9' S
Longitude 93°43.7' E
Date: 10/10/72
Time: 1830Z
Water depth: 1144 meters
Location: Top of Broken Ridge

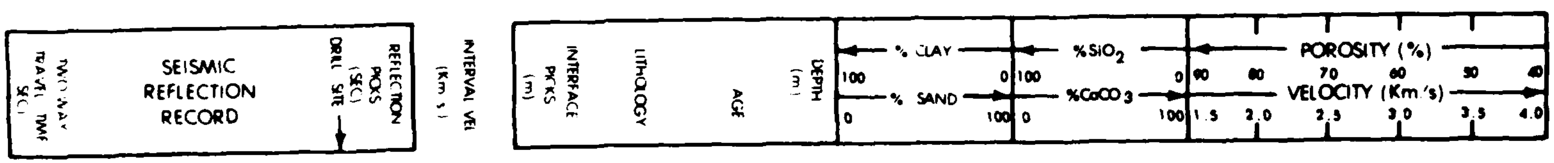
CORE DATA

Penetration:
Drilled-- 9.5 meters
Cored---- 99 meters
Total----1085 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 11 cores
7.9 meters

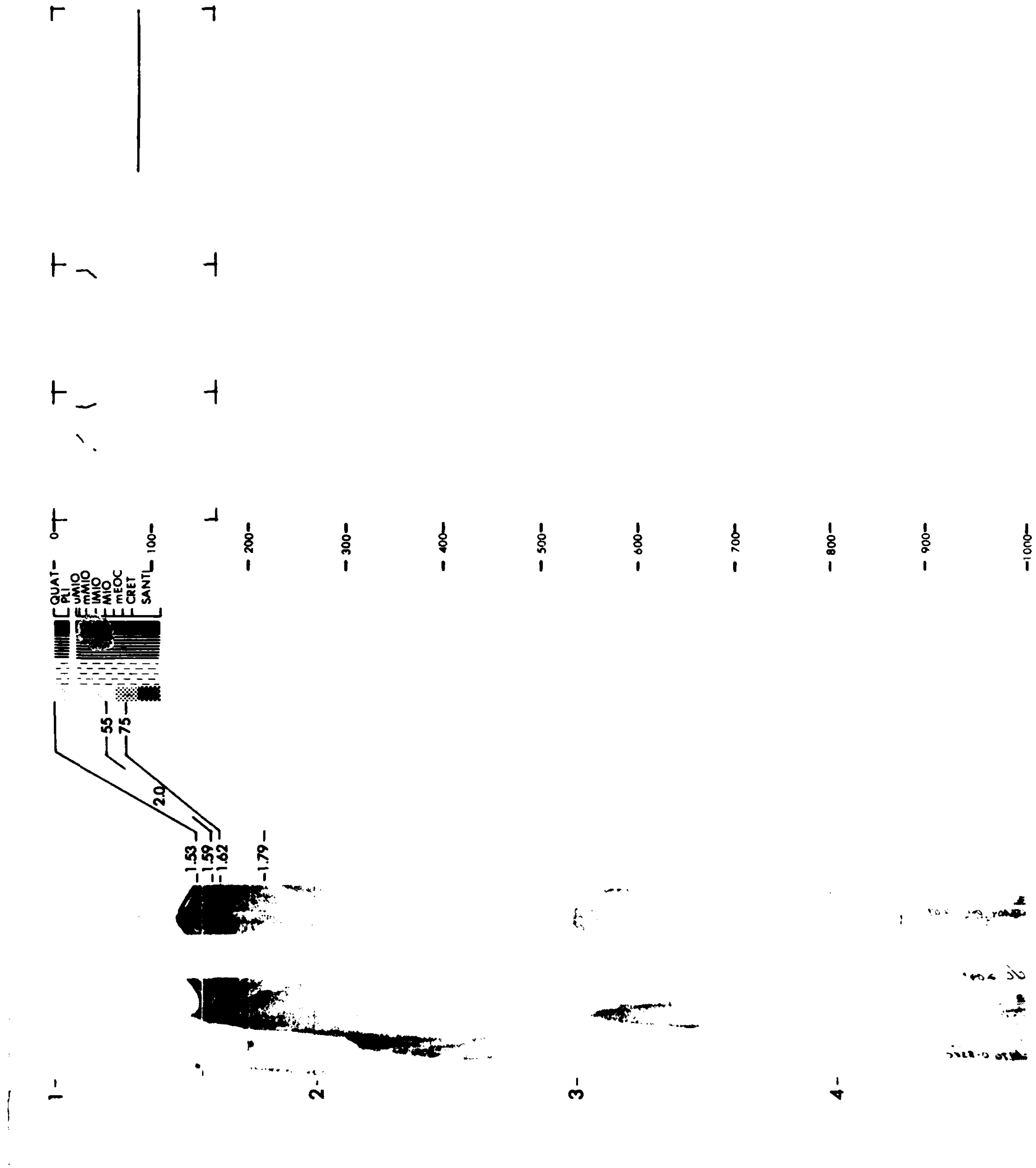
This portion of the sea floor has been generally shallow throughout its existence and has been uplifted to sea level at least once and possibly twice. A period of uplift evidently occurred between the Cretaceous and Eocene to truncate the Cretaceous limestone section and produce the Eocene littoral gravels. However, the absence of reworked Paleocene fauna in the section may imply erosion and removal of the Paleocene section prior to the Eocene. The seismic profiles approaching and leaving the site show that the truncated limestone unit extends north-south for 28.5 km. To the north it is conformably overlain by a dipping ooze section which is also truncated angularly near the site. The Eocene reflector can be traced north from the site until it dips conformably into the middle of the ooze section. Evidently, an Eocene uplift removed and truncated this Cretaceous to Eocene ooze section below the reflector, besides truncating the Cretaceous limestone. A Paleocene unconformity may mark the contact between the dipping ooze and limestone sections to the north.



1255



SITE 255 LEG 26



SITE DATA

Position:
- Latitude 23°27.3' S
- Longitude 100°46.5' E

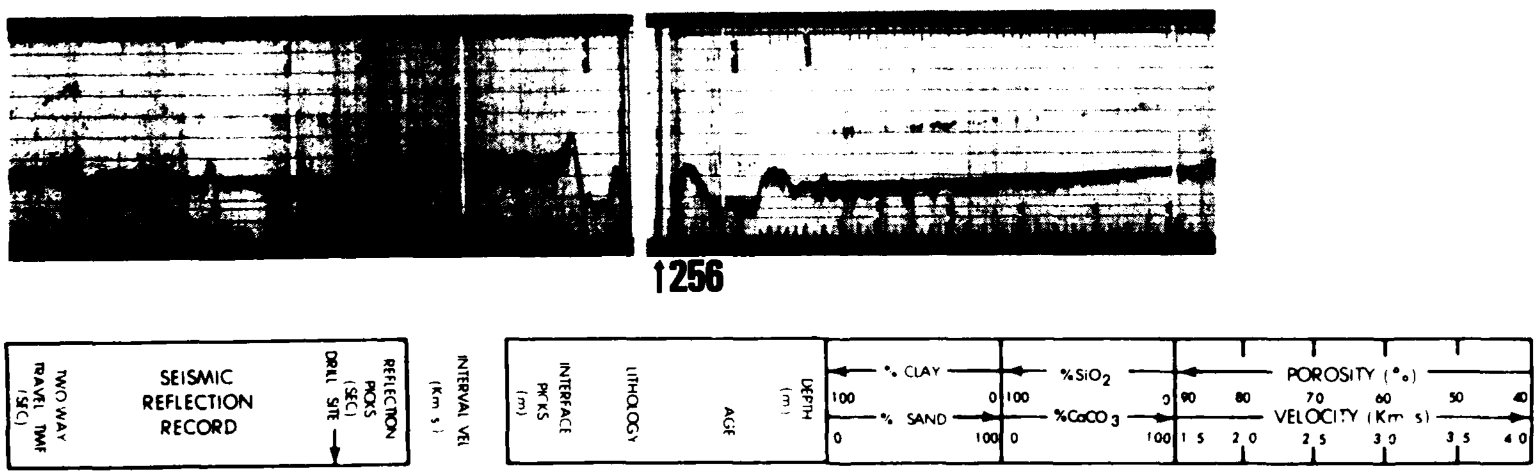
Date: 10/15/72
Time: 0332Z
Water depth: 5361 meters
Location: Wharton Basin

CORE DATA

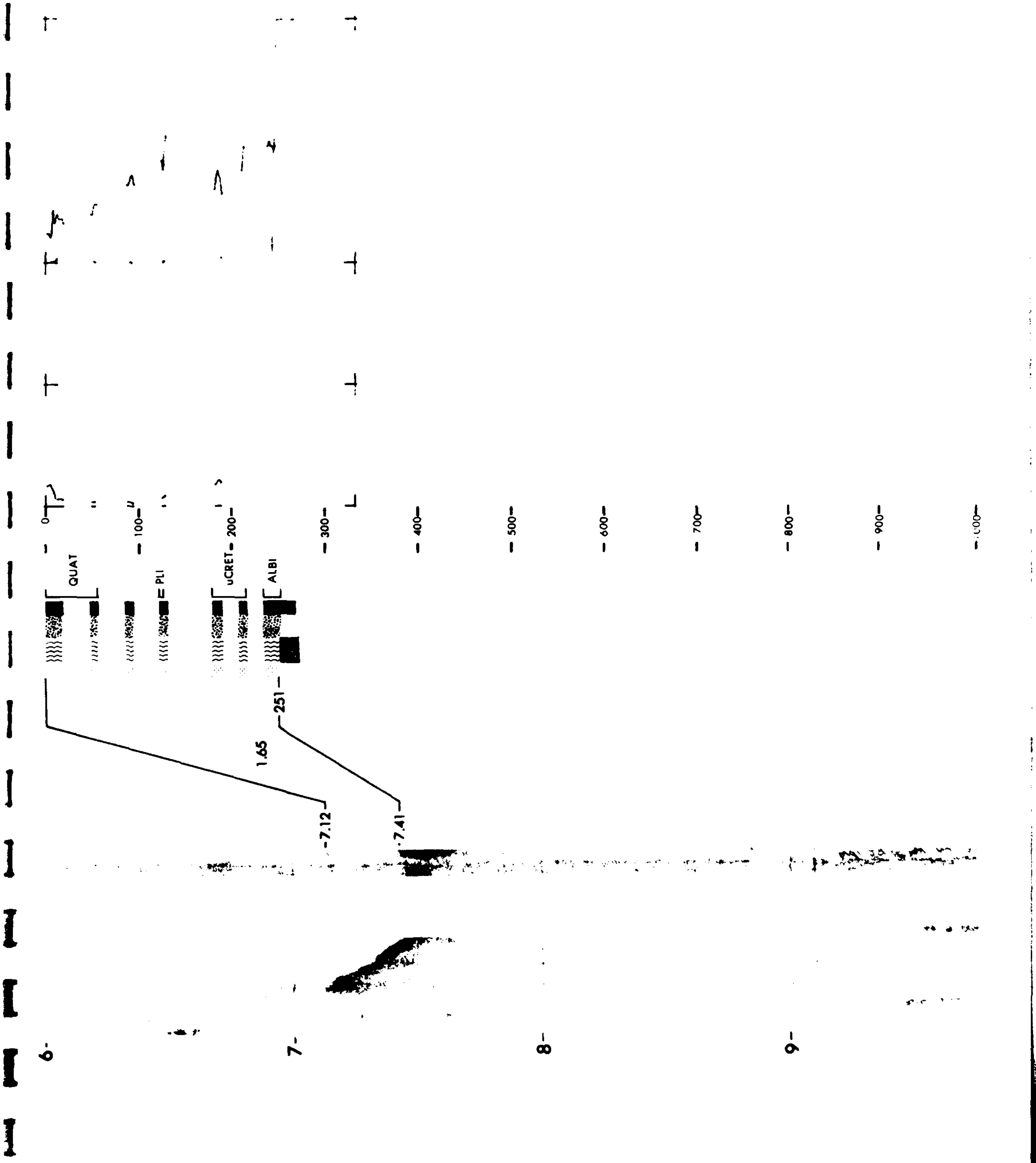
Penetration:
- Drilled-- 171 meters
- Cored---- 99 meters
- Total---- 270 meters

Recovery:
- Basement- 3 cores, 13.4 meters
- Total---- 11 cores, 78.4 meters

The relatively minor calcareous component in the section, and the etching of those forms present, suggest that this site has been within the lysocline during the Albian and below the carbonate compensation depth (CCD) since then. As with Site 251, this probably means that the lysocline and the CCD were higher than today during at least the late Cretaceous. The lack of faunal diversity suggests colder water at the site and therefore a more southerly latitude in the Cretaceous which is consistent with paleoreconstructions for this period. The age of 101 m.y. determined for this site is in good agreement with a north-south age gradient (older to south) determined for the northern Wharton Basin on Leg 22, DSDP. However, Site 212 (DSDP Leg 22) is probably not as old as the authors believe (von der Borch, Sclater, et al., 1974).



SITE 256 LEG 26



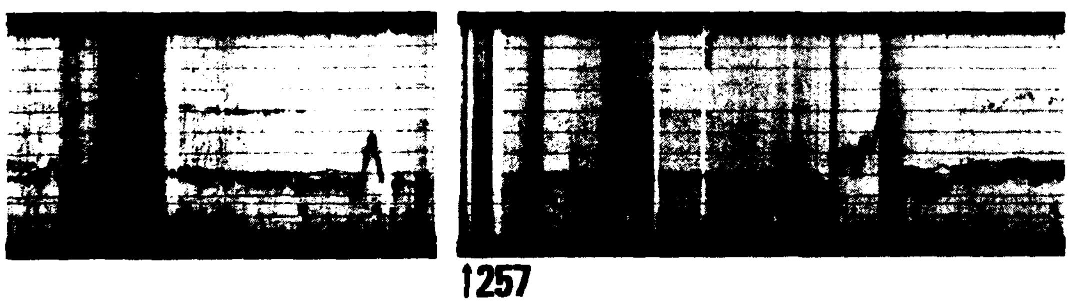
SITE DATA

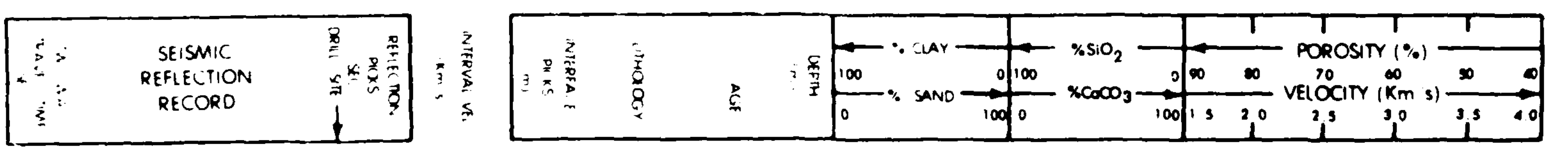
Position:
Latitude 30°59.2' S
Longitude 108°21.0' E
Date: 10/20/72
Time: 0832Z
Water depth: 5278 meters
Location: Wharton Basin

CORE DATA

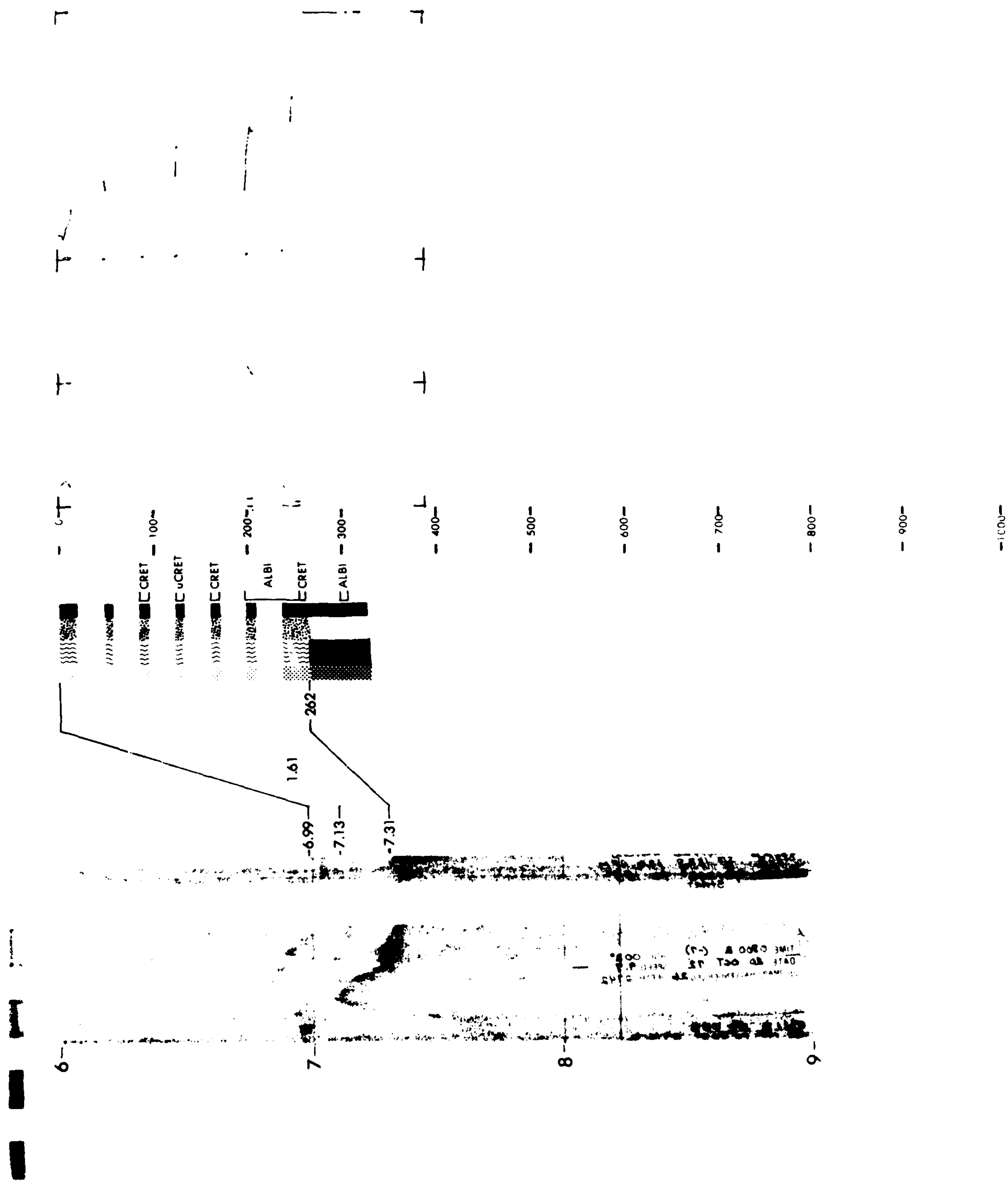
Penetration:
Drilled-- 171 meters
Cored----155.5 meters
Total----326.5 meters
Recovery:
Basement- 8 cores
32.4 meters
Total---- 17 cores
76.7 meters

The barren layer below the Albian coccolith clay at Site 257 indicates that, unlike Site 256, sedimentation began here below the CCD, rose above it for a short period, then again took place below it. A Cretaceous cold-water environment, and therefore a more southerly location, is indicated by the fauna here as at Site 256. Also, both sites show a rather thick Lower Cretaceous (Albian) sequence and a thin Upper Cretaceous through Tertiary section. It is tempting to correlate this decrease in sedimentation rate and/or hiatus to changes in oceanic circulation associated with the breakup of Australia-Antarctica in the Eocene, but lacking more precise dating, this is only speculation. It was disappointing that the sediment-basalt contact proved barren. The crust might be significantly older than middle Albian, but the high sedimentation rate for the lower section would argue against this. From tectonic arguments the crust here should be close to 120 m.y. The apparently young age could be explained by a disconformity at the base of the section or the basalt sequence being younger than the true basement. We saw no obvious changes in the lithology of the basalt sequence to indicate a disconformity.





SITE 257 LEG 26



SITE DATA

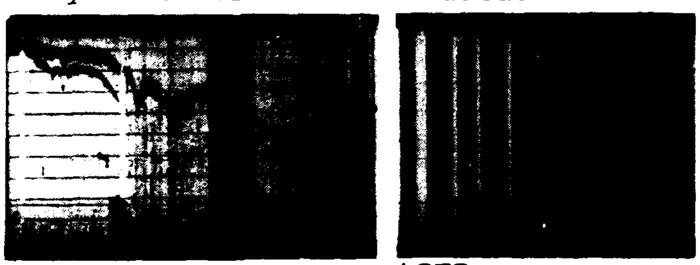
Position:
Latitude 33°47.7' S
Longitude 112°28.4' E
Date: 10/25/72
Time: 0612Z
Water depth: 2793 meters
Location: Northern Slope of the Naturaliste Plateau

CORE DATA

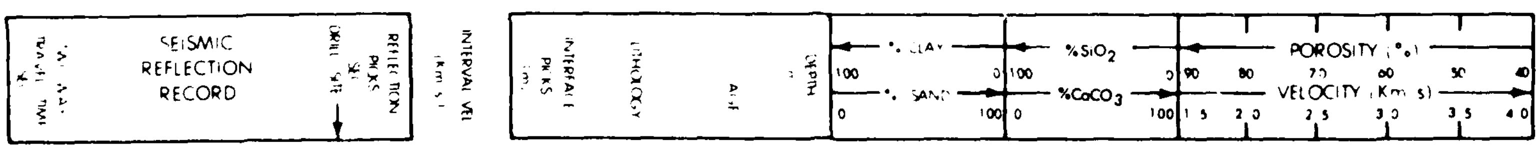
Penetration:	258	258A	
Drilled--	294.5	38	meters
Cored----	230.5	85.5	meters
Total----	525	123.5	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	25	9	cores
	115.6	65.5	meters

Five lithologic units can be recognized. From the surface down: white and gray soft oozes ranging form late Miocene to Recent in age. Unit 2, silicified limestones and chalks overlying micarb (recrystallized) chalks (Subunit 2b) ranging from Cenomanian to Santonian in age. The boundary between Units 1 and 2 is sharp and well defined. Unit 3, is a transitional unit with interbeds of chalk and the dark ferruginous clays of Unit 4. Unit 5 is a Lower Cretaceous (undefined range) sequence of glauconitic sands and muddy silts. The unconformity between the Santonian and the Miocene represents a gap in sedimentation of at least 66 m.y. Deep-water marine sediments have been accumulating here since at least middle Albian times. Unit 5 accumulated below the carbonate compensation depth and in cold water (high latitude) conditions as suggested by the low foraminiferal species diversity. Unit 4 accumulated within the lysocline and in more temperate conditions. Thus, there is a history of gradual shoaling of the sea floor or deepening of the carbonate compensation depth through the Cretaceous.

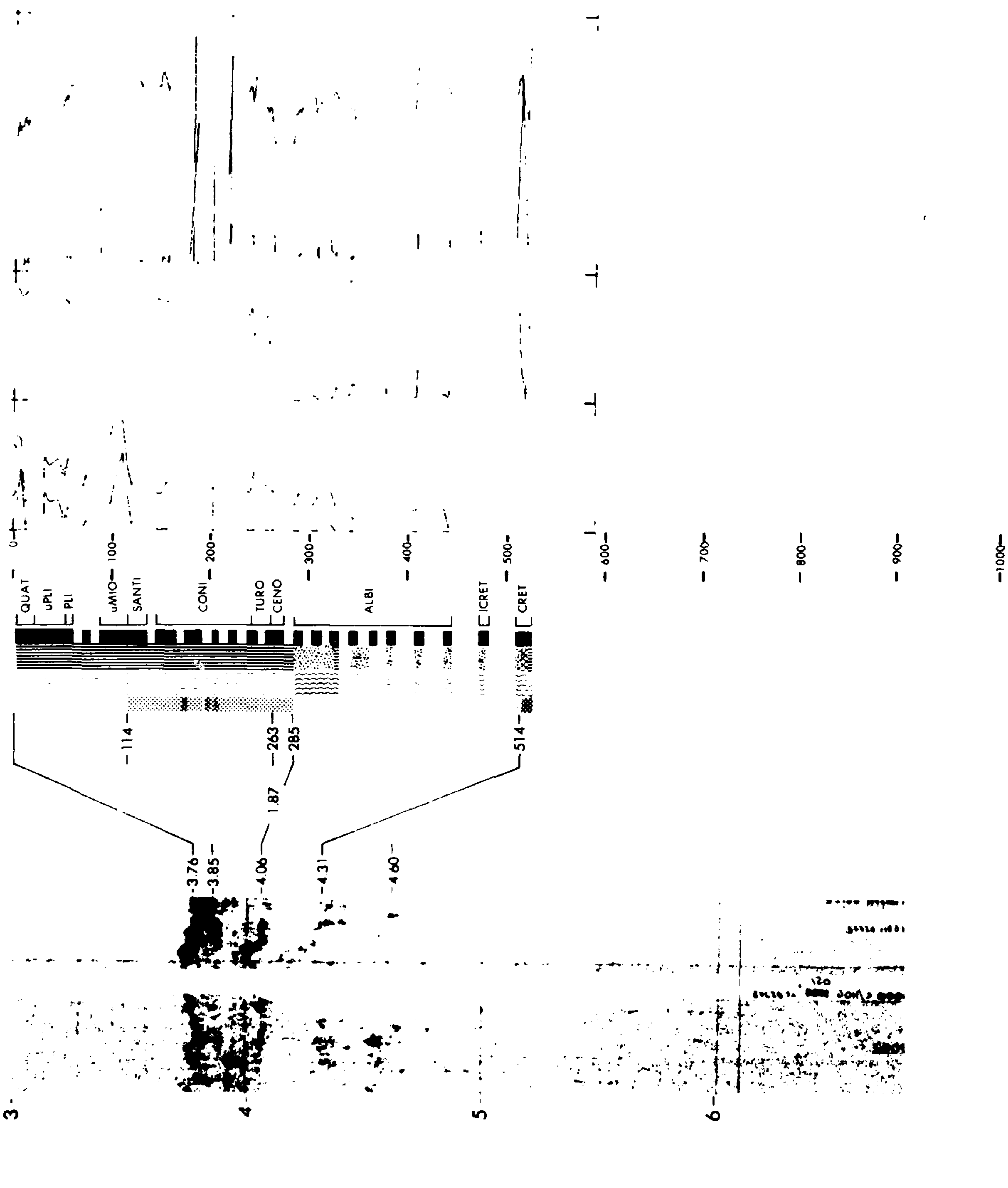
Calcareous sediment of Quaternary Period nannofossil rich, two calcareous thin layers of Cretaceous Period.



↑258



SITE 258 LEG 26



SITE DATA

Position:
Latitude 29°37.0' S
Longitude 112°41.8' E
Date: 11/02/72
Time: 2028Z
Water depth: 4696 meters
Location: Perth Abyssal Plain

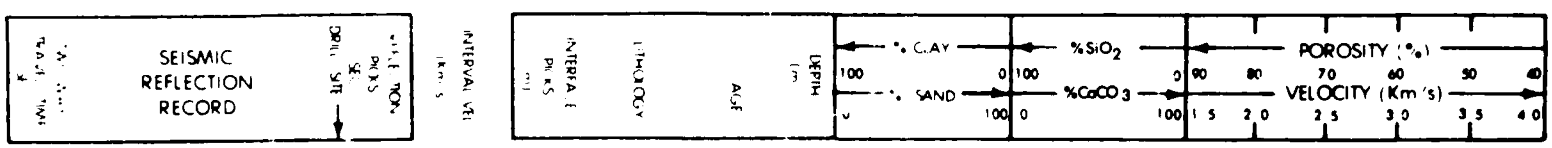
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 346 meters
Total---- 346 meters
Recovery:
Basement- 9 cores
21.6 meters
Total---- 41 cores
248.8 meters

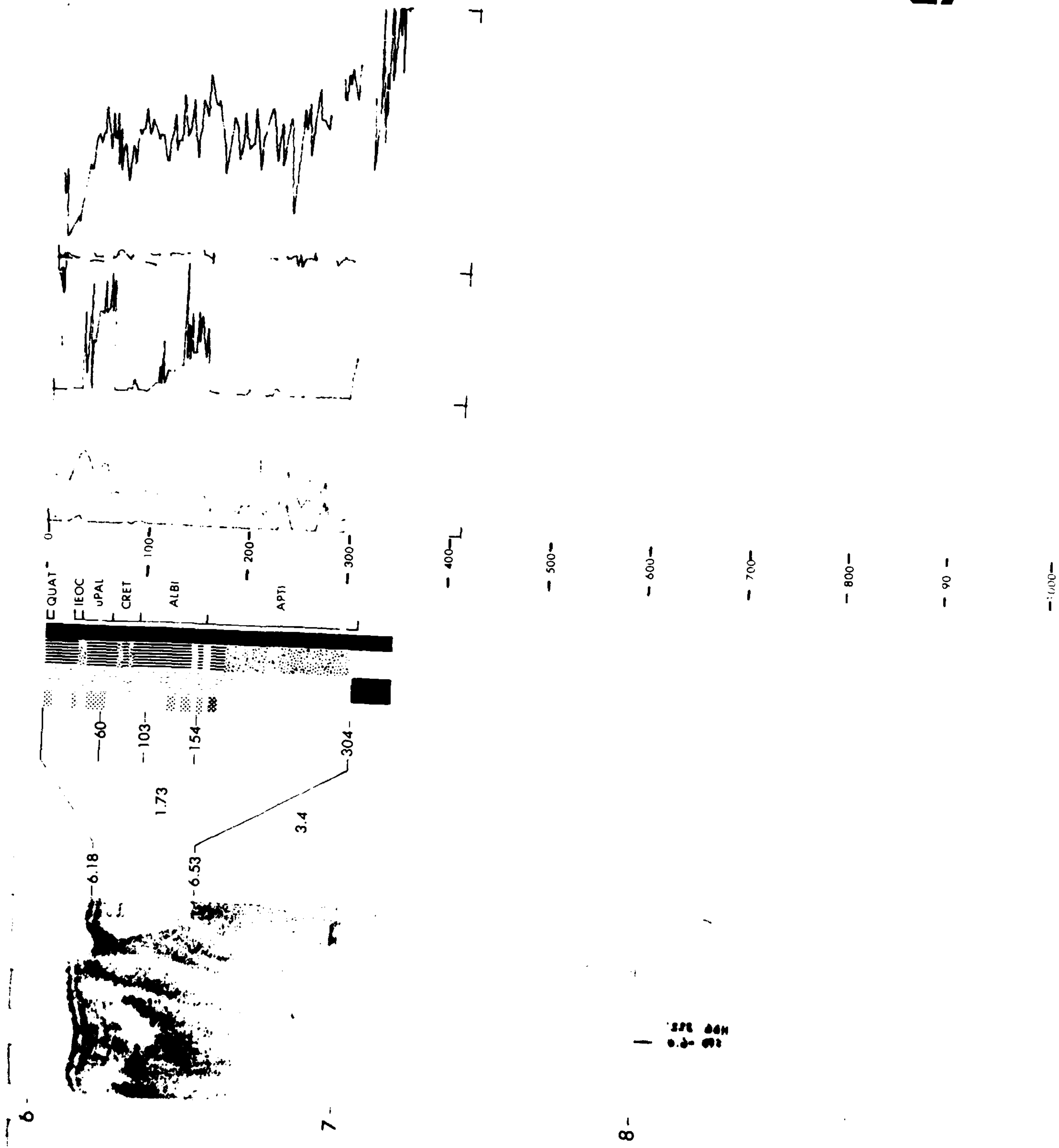
Carbonate fossils are abundant throughout Unit 1 suggesting that the depth was above the CCD in the early Tertiary. However, a hiatus occurs in the sequence so most of the Tertiary record is missing. Unit 2, which is Cretaceous in age, consists chiefly of zeolite clay. The existing fossils show strong dissolution effects suggesting that the scarcity of nannofossils in this unit is due to solution of carbonate below the carbonate compensation level rather than to changes in planktonic production. The reappearance of relatively abundant nannofossils in Unit 3 probably reflects a return to shallow water conditions. Unit 4, consisting of dark greenish-gray and black cristobalite claystone. The paucity of carbonate fossils and absence of terrigenous sand or silt suggest deposition in quiet, deep water. The mineralogy of the clay suggests a volcanic origin for much of the unit. The contact between the basal sediments and the basaltic basement appears to be normal, with no evidence of baking, hydrothermal alteration, or metasomatism in the sediments. The basement consists of fine-grained tholeiitic basalt typical of oceanic spreading centers.

Calcareous sediments occasionally nannofossil or foraminifera rich.

259



SITE 259 LEG 27



SITE DATA

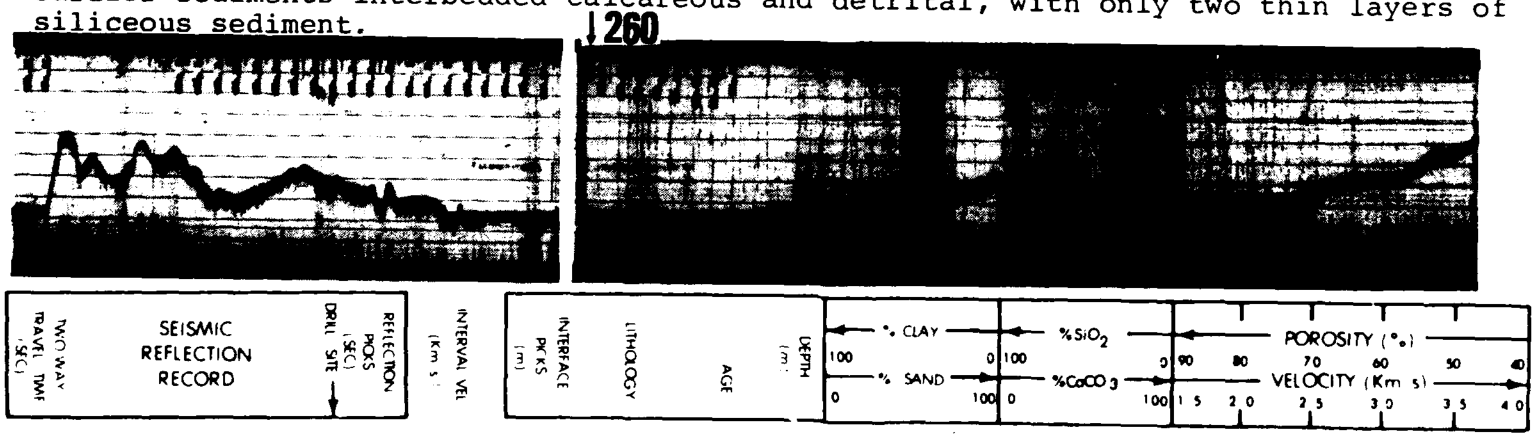
Position:
Latitude $16^{\circ}08.7'$ S
Longitude $110^{\circ}17.9'$ E
Date: 11/11/72
Time: 0300Z
Water depth: 5702 meters
Location: Southern Gascoyne Abyssal Plain

CORE DATA

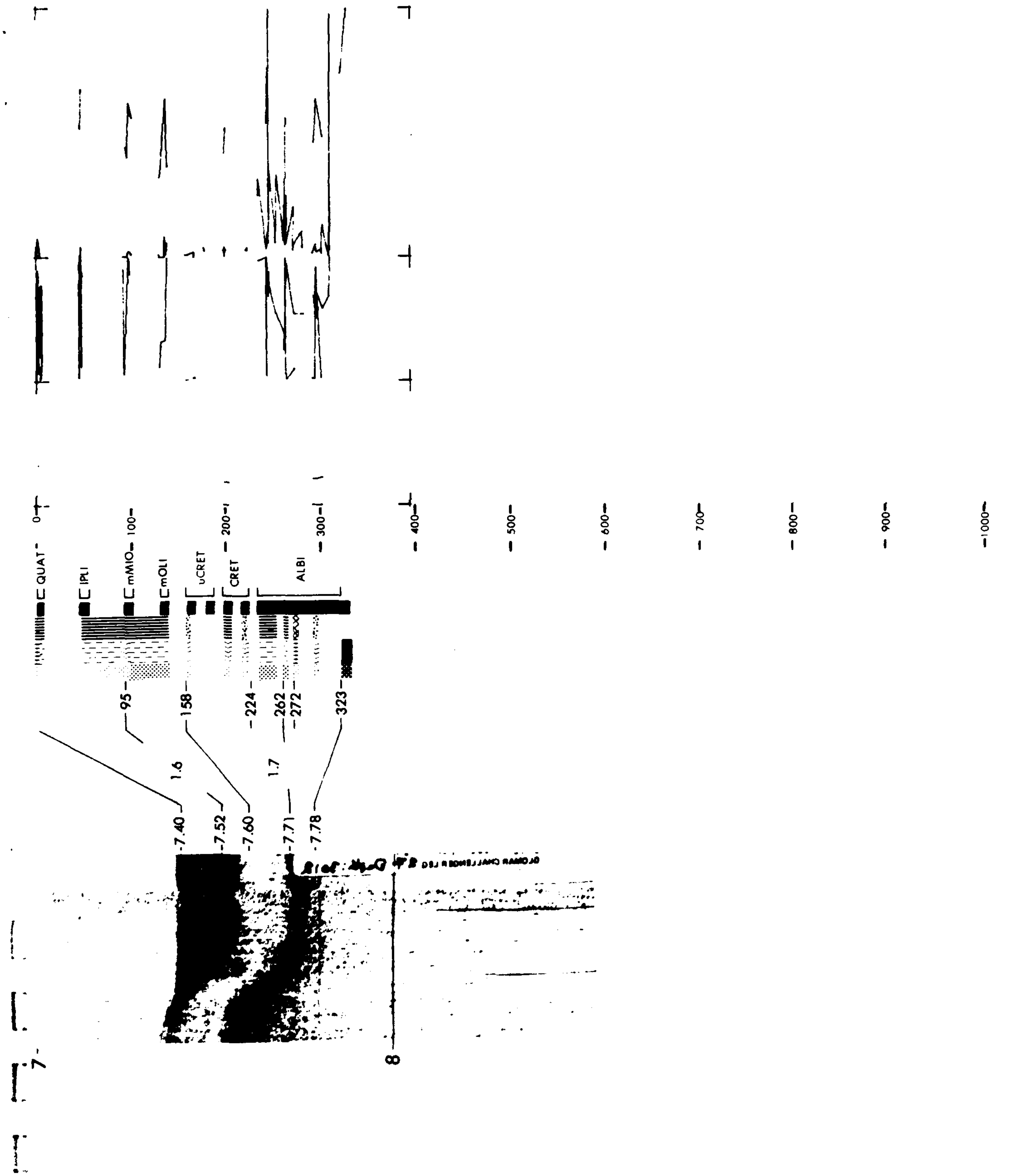
Penetration:
Drilled--161.5 meters
Cored----169.5 meters
Total---- 331 meters
Recovery:
Basement- 3 cores
1.2 meters
Total---- 20 cores
56.7 meters

Within the nanno ooze are graded beds which include shallow-water forms and mixed assemblages. The nature of these beds strongly suggests transport of material from the shelf to deeper water, whereas the radiolarian ooze and brown clay may represent normal deep-sea sedimentation. It is possible that the sea floor has remained below the CCD since Upper Cretaceous. The paucity of fossils indicate different conditions of deposition for Unit 2. Depth or circulation pattern differences in the Cretaceous resulted in destruction of all carbonate fossil material. The high zeolite content (up to 35%) may indicate a significant contribution of volcanic-derived material. Unit 3 is interpreted as having been deposited above the CCD because it lacks all evidence of transported fossil material such as that found in Unit 1. Unit 4 differs from the other units chiefly in its gray-green color. Nannos are abundant throughout this unit but Radiolaria are concentrated in certain horizons. It is not known whether this concentration is the result of selective solution of tests or variations in the original biologic productivity. The basal basalt is believed to be a sill that served as acoustical basement.

Quaternary sediments; interbedded thin layers of siliceous, (radiolaria rich) and calcareous oozes (nannofossil rich), and one thin bed of detrital sediment. Other earlier sediments interbedded calcareous and detrital, with only two thin layers of siliceous sediment.



SITE 260 LEG 27



SITE DATA

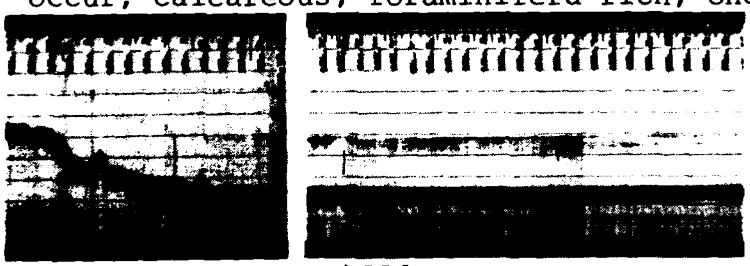
Position:
Latitude 12°56.8' S
Longitude 117°53.6' E
Date: 11/16/72
Time: 1546Z
Water depth: 5667 meters
Location: Argo Abyssal Plain

CORE DATA

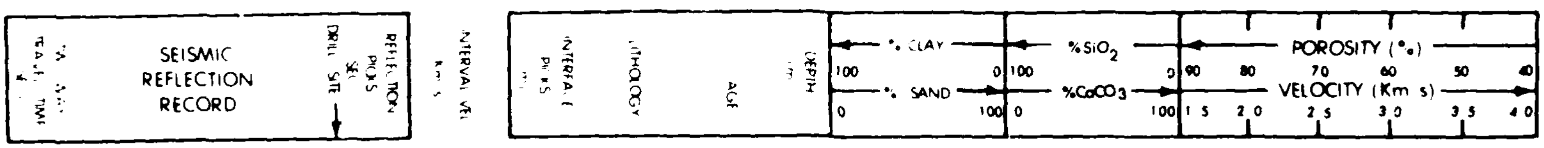
Penetration:
Drilled--237.5 meters
Cored---- 342 meters
Total----579.5 meters
Recovery:
Basement- 7 cores
24.3 meters
Total---- 39 cores
125.8 meters

The Quaternary sediments of the area, are greenish-gray clay containing chiefly Radiolaria but also other siliceous fossils. The unit is interpreted as an abyssal pelagic sediment which formed below the calcium carbonate compensation depth. The high calcium carbonate content of Unit 2 is in marked contrast to Unit 1. Unit 2 consists chiefly of nanno ooze with some detrital foram ooze and clay, indicating a predominantly pelagic sequence with a few calcareous turbidite layers. The zeolite-bearing brown clay of Subunit 3A contains allochthonous Quaternary nannofossils, whereas the predominantly gray claystone of Unit 3B contains Radiolaria. The clays are probably pelagic sediments formed below the carbonate compensation depth (CCD). The minor calcareous beds may represent turbidite intercalations. The claystone of Unit 4 resembles that of Subunit 3B in some respects, but it is predominantly brown in color and intermittently calcareous. The clay is probably a pelagic sediment deposited in a gradually deepening environment, until finally the sea bed lay below the CCD.

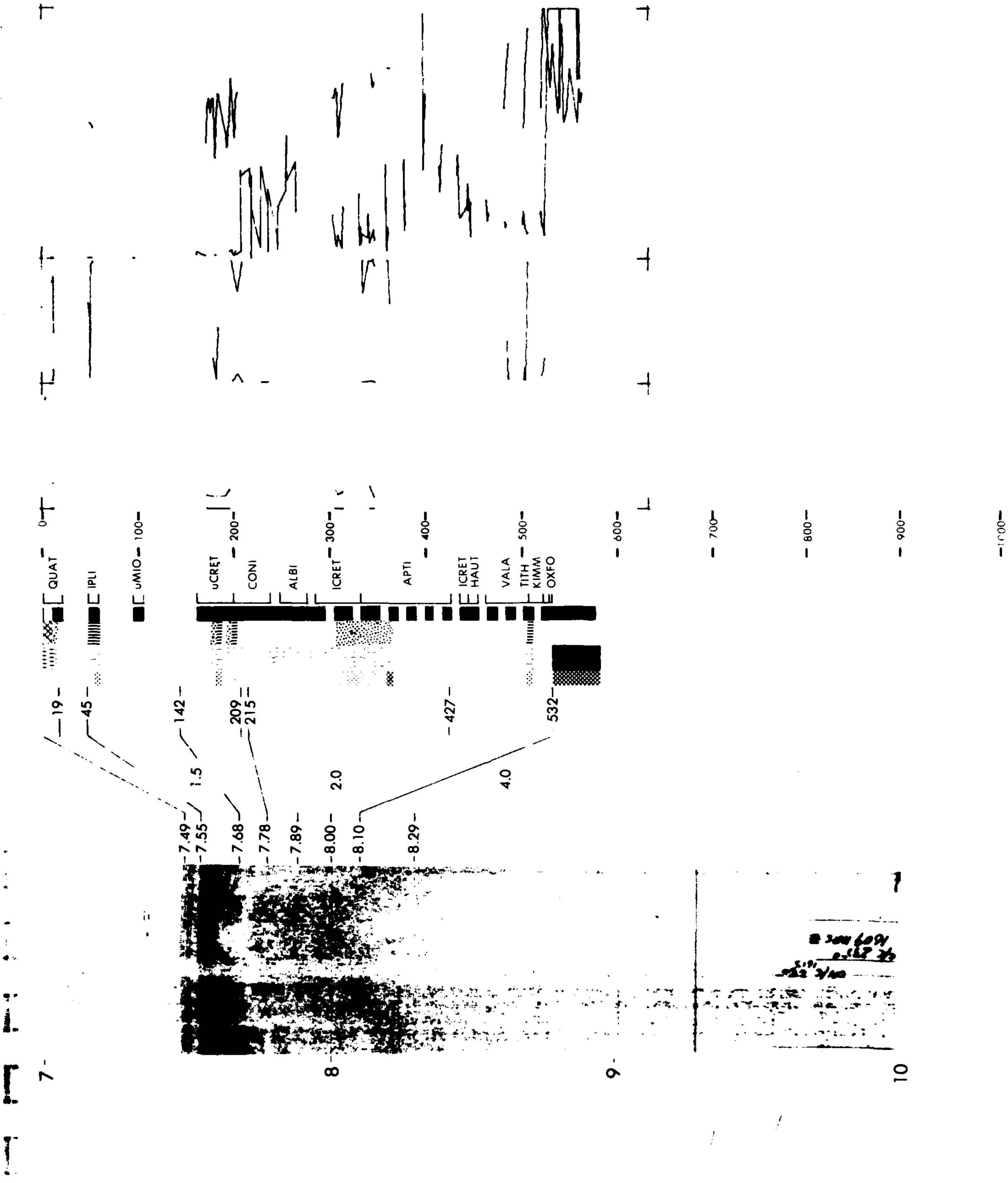
Surface sediment; siliceous, transitional, and soft. Other Quaternary sediments detrital. Pliocene calcareous sediments mostly nannofossil rich. Two thin layers occur, calcareous, foraminifera rich, one in Upper Cretaceous and one in Tithonian time.



261



SITE 261 LEG 27



SITE DATA

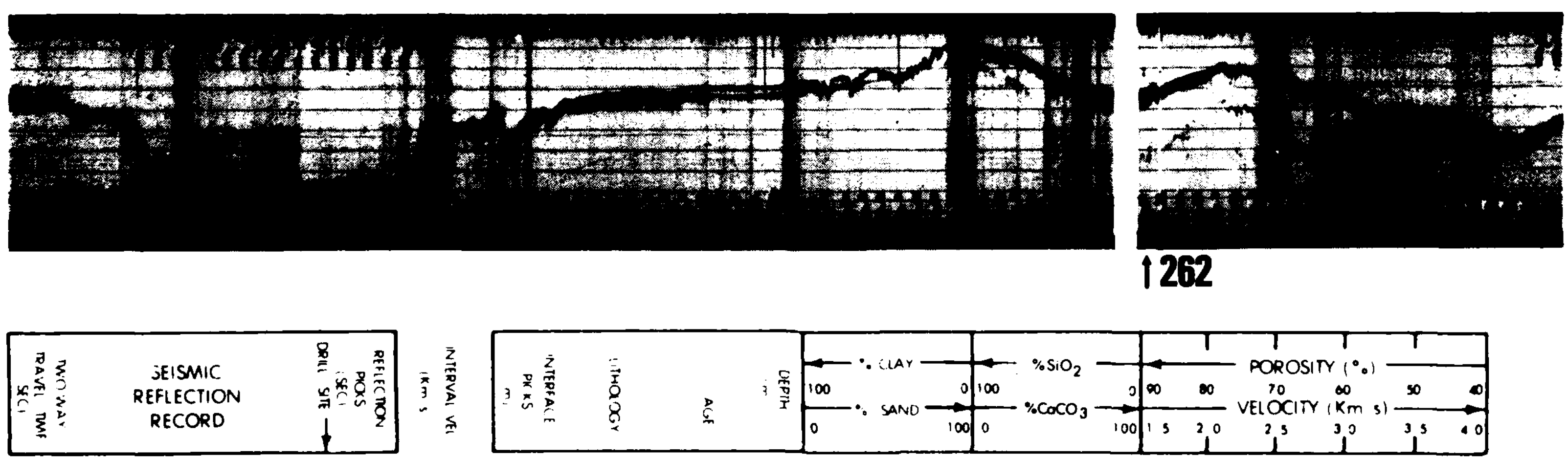
Position:
Latitude $10°52.2'$ S
Longitude $123°50.8'$ E
Date: 11/23/72
Time: 1645z
Water depth: 2298 meters
Location: Timor Trough

CORE DATA

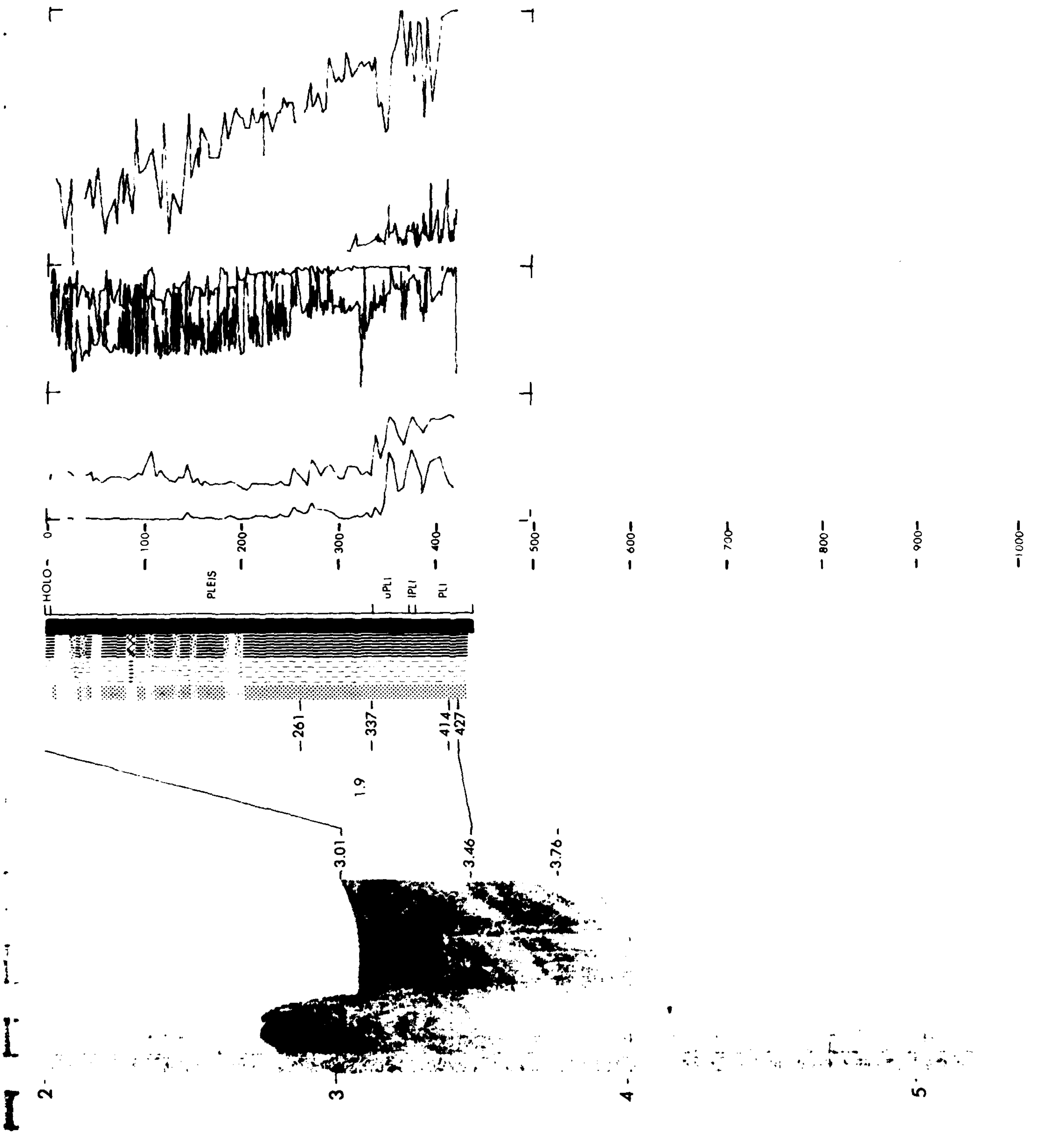
Penetration:
Drilled-- 0 meters
Cored---- 442 meters
Total---- 442 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 47 cores
365.5 meters

Unit 5, dolomitic shell calcarenite, was probably deposited in shallow marine water. The foram-rich dolomitic mud of Unit 4, consists of 14% benthonic foraminifera set in matrix of sand- and silt-size dolomite rhombohedra. The forams are very shallow-water benthonic forms. Either of the following origins is possible for this unit: (a) dolomitization of original micrite containing low-Mg foraminifera; or (b) deposition of primary dolomite that was later diagenetically recrystallized. Unit 3, nanno-rich foram ooze, accumulated in shallow to deep water. The sudden disappearance of benthonic foraminifera and the appearance of abundant planktonic forms in Core 42 suggest a rapid and continual deepening of the trough, probably to a depth approaching that of today. The nanno oozes of Units 1 and 2 are infraneritic deposits that formed above the regional carbonate compensation depth in an environment similar to that which exits in the Timor Trough today. Foram sands in Unit 1 are composed chiefly of planktonic foraminifera with little or no clay.

Calcareous sediments; mostly nannofossil rich, occasionally foraminifera, and rarely oolite rich: interbedded with few thin layers of detrital or siliceous sediment.



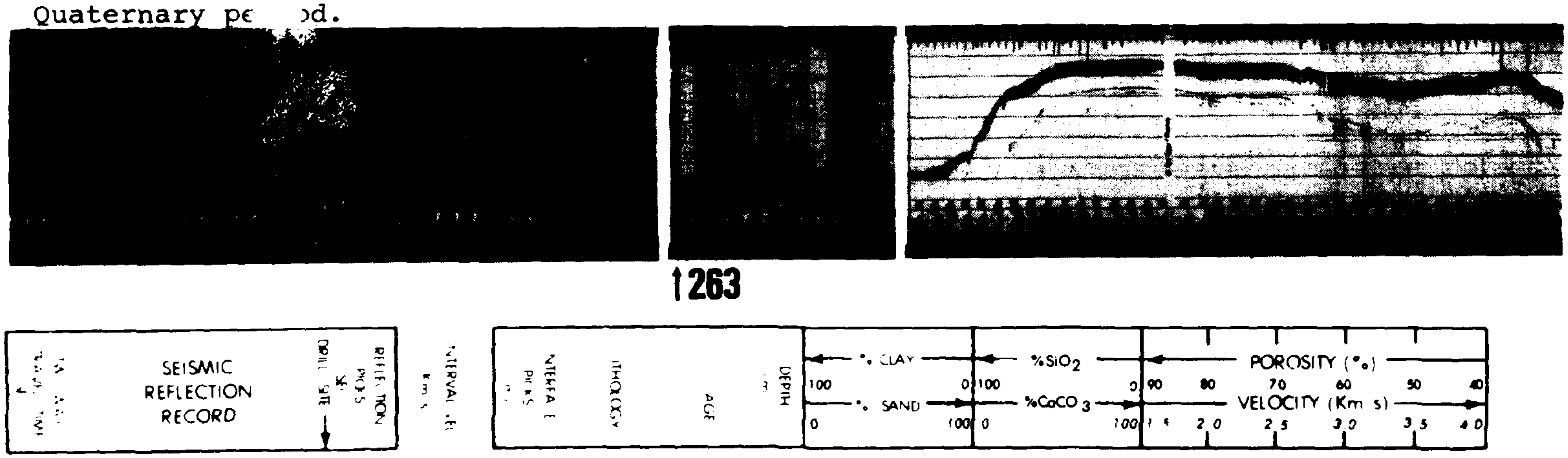
SITE 262 LEG 27



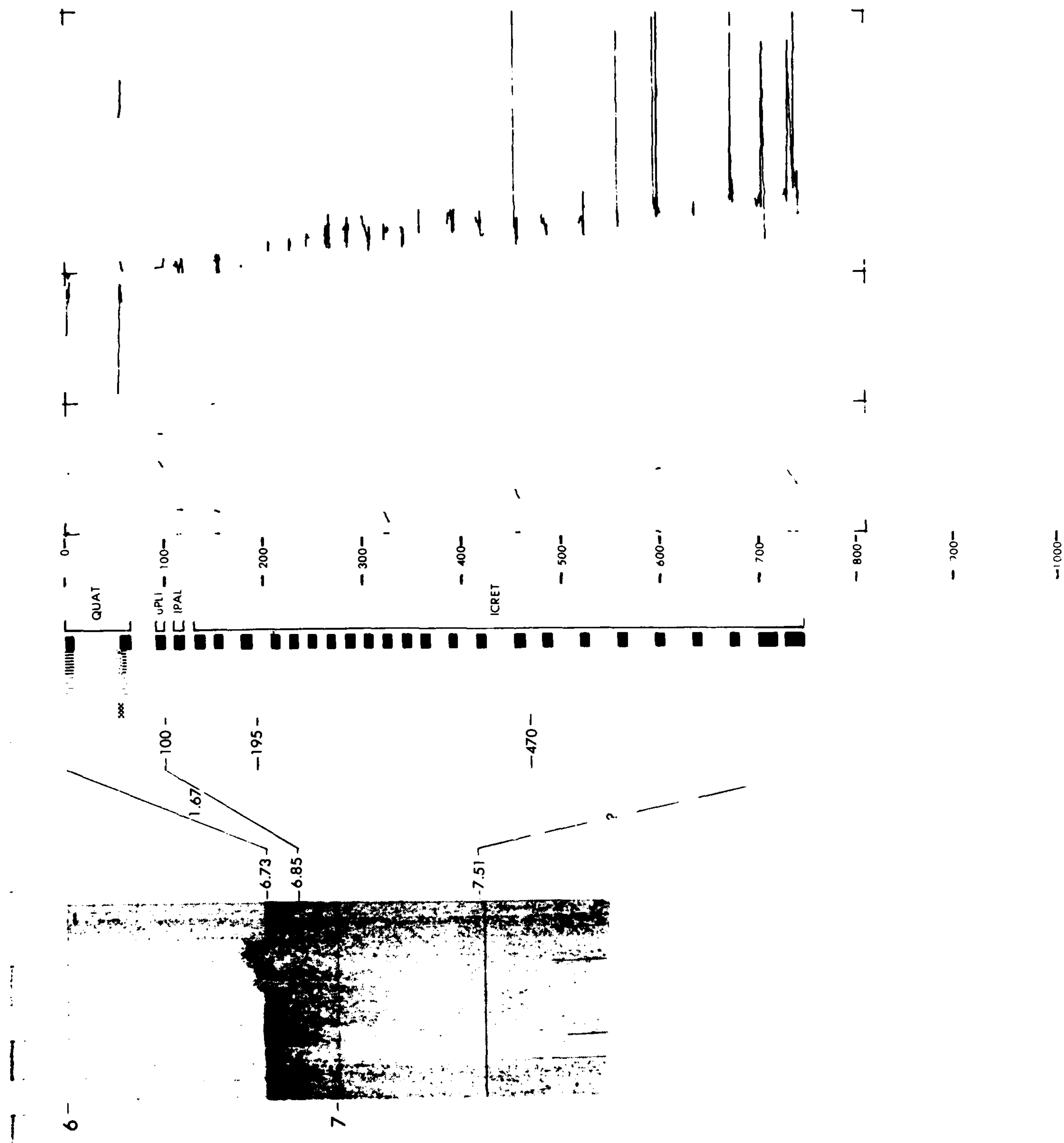
SITE DATA	CORE DATA
Position:	Penetration:
Latitude 23°19.4' S	Drilled-- 475 meters
Longitude 110°57.8' E	Cored---- 271 meters
Date: 12/01/72	Total---- 746 meters
Time: 0056Z	Recovery:
Water depth: 5048 meters	Basement- 0 cores
Location: Curvier Abyssal Plain	0 meters
	Total---- 29 cores
	163.5 meters

Unit 4, the lowest unit encountered, is distinguished from the other units by its comparative abundance of terrigenous silt-size grains. The comparatively high organic-carbon content is probably an indication of comparatively shallow water. During the deposition of Unit 3, the sea floor apparently subsided, perhaps below the lysocline. Despite this gradual subsidence of the sea floor, there was apparently little change in the sediment source, as the mineralogical assemblage is prodominantly continental. The most viable model would seem to be that of a comparatively large though sluggish river debouching onto the continental shelf with the suspended load being carried over the edge of the slope. Later in the Cretaceous there was possibly some uplift which elevated the sea floor above the lysocline. The sharpness of the contact between Units 2 and 1 suggests a pre-Pliocene erosive phase. Site 263 has probably been located on an abyssal plain, at or below the lysocline, from at least the Pliocene to the present day. Despite this, calcareous sediments predominate. This is probably due to mass transport of biogenic calcareous sediments from the slope into the abyssal plain by turbidity flows.

Calcareous sediment nannofossil rich. One thin layer of detrital sediment, Quaternary pe od.



SITE 263 LEG 27



SITE DATA

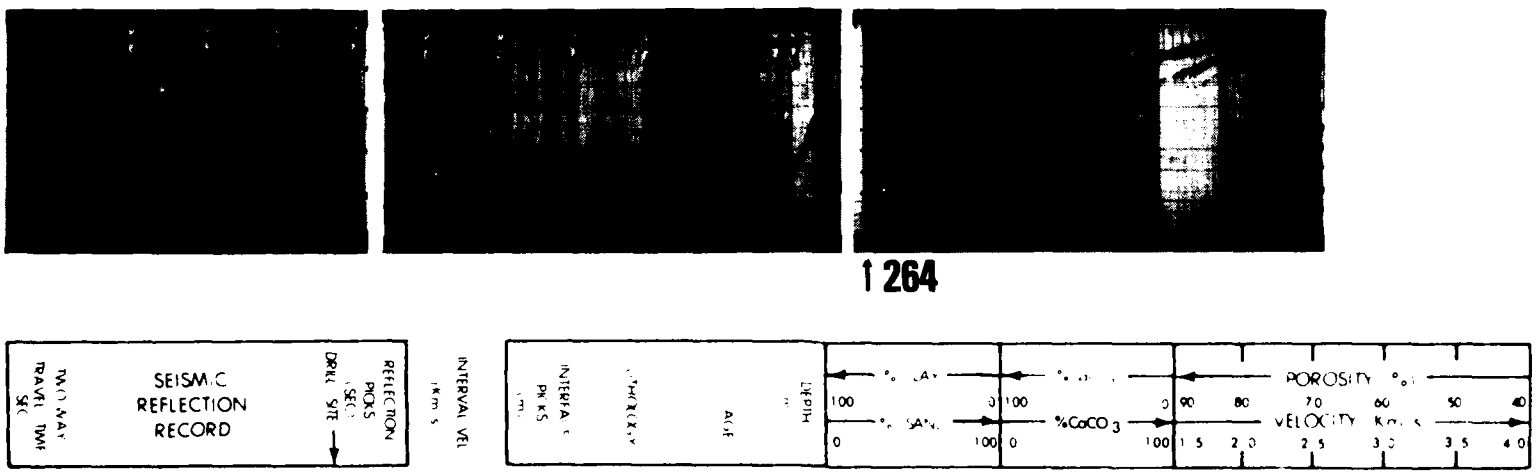
Position:
Latitude 34°58.1'S
Longitude 112°02.7'E
Date: 12/21/72
Time: 1620Z
Water depth: 2873 meters
Location: Southern Naturaliste Plateau

CORE DATA

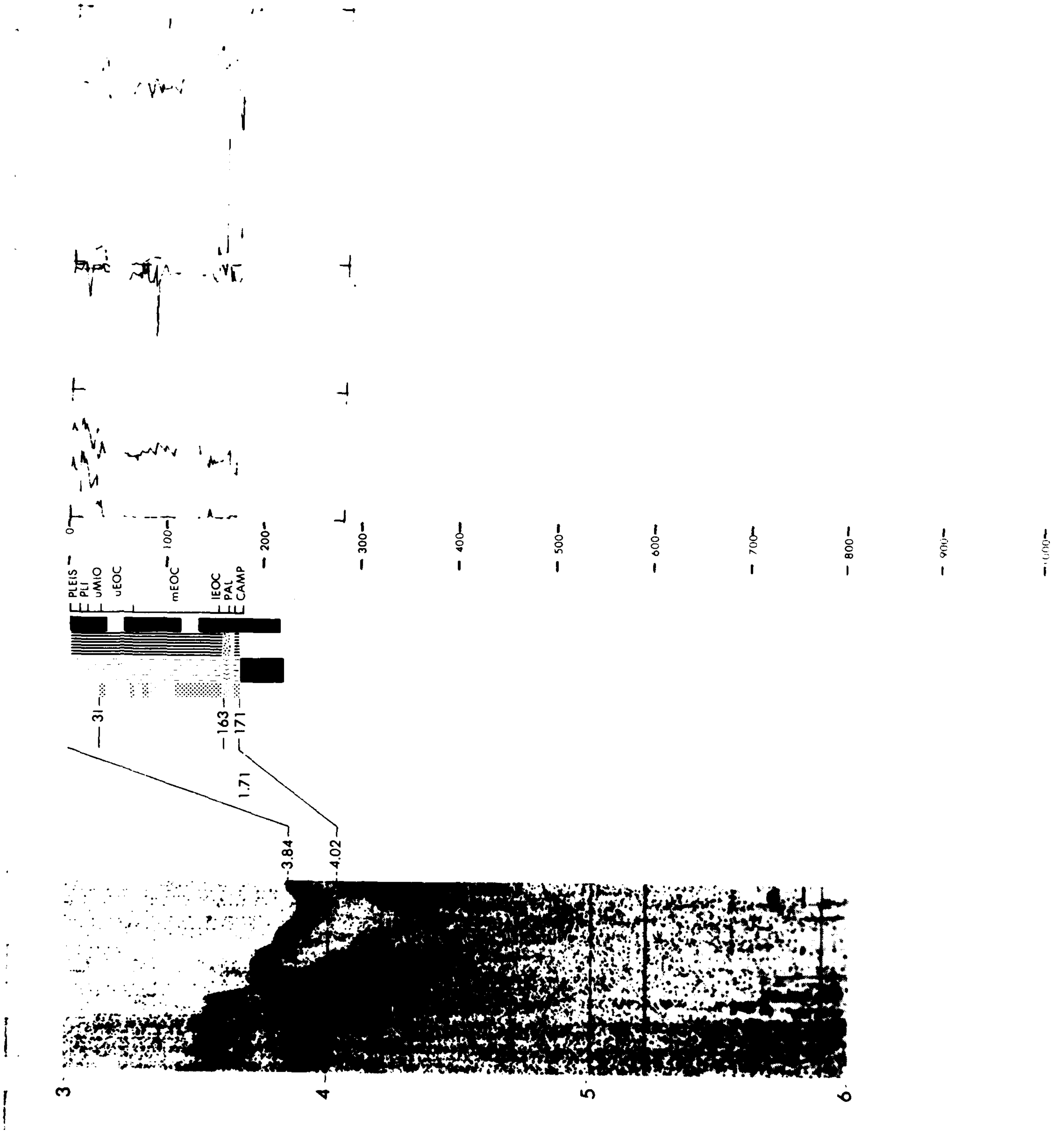
Penetration:	264	264A	
Drilled--	83	1205	meters
Cored----	1425	38	meters
Total----	2155	1585	meters
Recovery:			
Basement-	9	0	cores
	.4	0	meters
Total----	19	4	cores
	65.6	33.2	meters

A thin Neogene and a well-developed Paleogene sequence of carbonate oozes and chalks, with some chert, was cored at this site. The oldest material taken, beneath Cenomanian/Santonian chalks, was Cenomanian or pre-Cenomanian volcaniclastic conglomerate, but yielded poor recovery. The inferred average velocity of the carbonate sediments of 1.71 km/sec is consistent with the interpretation that the top of the volcaniclastic conglomerate corresponds to the strong acoustic basement reflector. The question of continental versus oceanic nature of true crystalline basement remains unresolved. The unconformities recorded here span the following intervals: (1) upper Miocene-upper Eocene, (2) lower Eocene-mid Paleocene, (3) mid Paleocene-?/Santonian. The Eocene section cored at Site 264 has no known counterpart in the onshore Perth Basin or in DSDP sites east of the Ninetyeast Ridge. A cool subtropical deep-water environment prevailed (with some fluctuations) at this site from at least Late Cretaceous to Present.

Calcareous sediment nannofossil rich. Two thin layers of detrital sediment occur in Eocene time.



SITE 264 LEG 28



SITE DATA

Position:
- Latitude 53°32.4' S
- Longitude 109°56.7' E

Date: 12/29/72
Time: 1515Z
Water depth: 3582 meters
Location: Southeast Indian Ridge

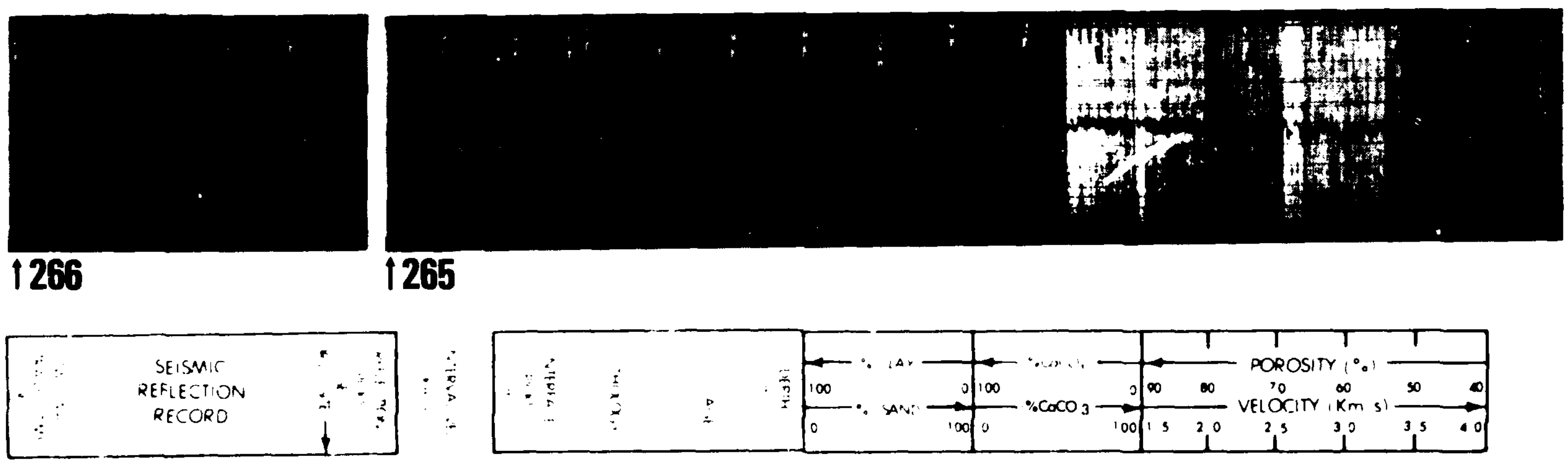
CORE DATA

Penetration:
- Drilled-- 293 meters
- Cored---- 169 meters
- Total---- 462 meters

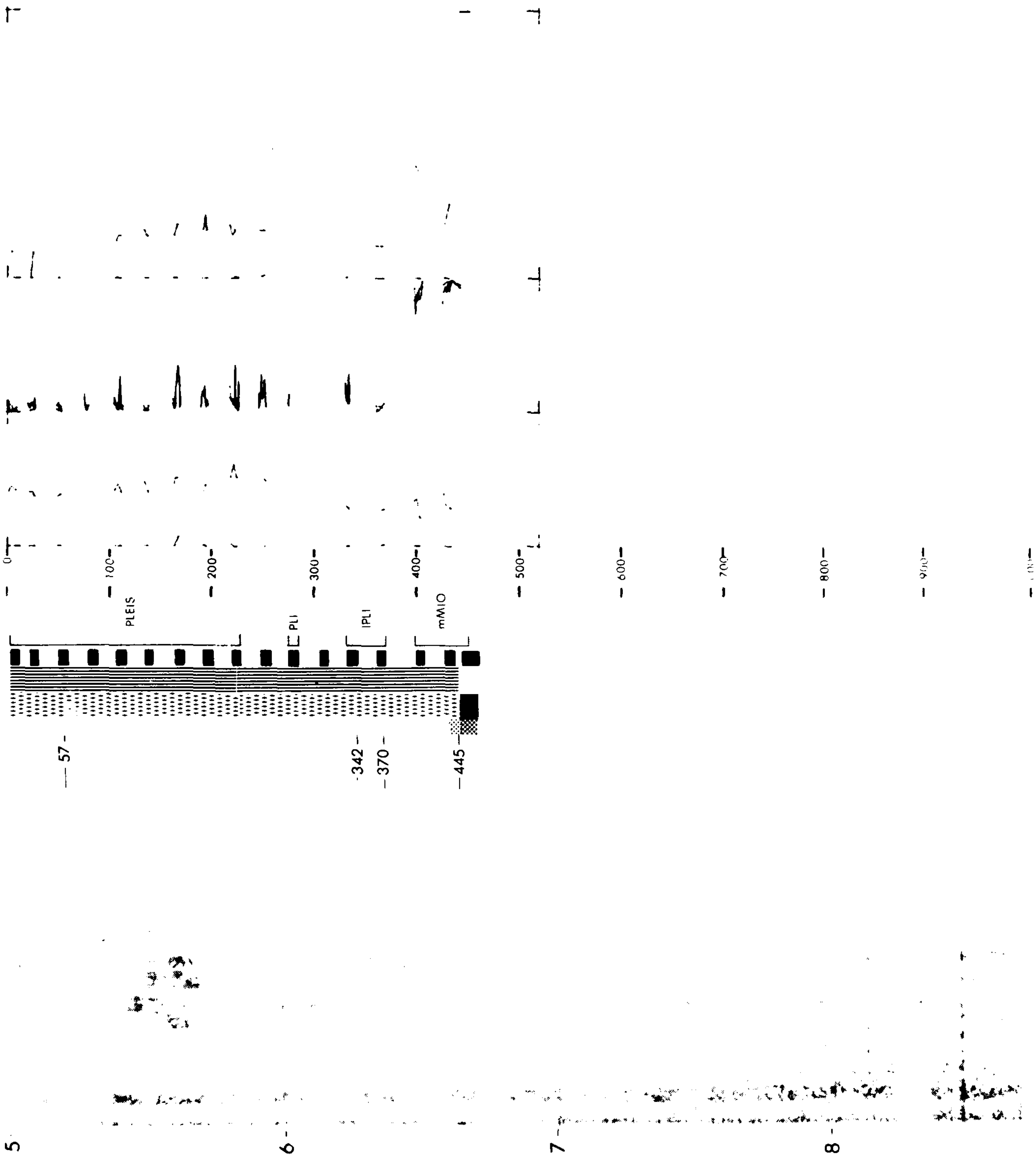
Recovery:
- Basement- 2 cores, 3.7 meters
- Total---- 18 cores, 108 meters

About 370 meters of predominantly diatom oozes of Recent to early Pliocene age overlie about 75 meters of nannofossil ooze and chalk of late to mid Miocene age. The significance of the marked lithologic change and the precise time (somewhere in the interval 10 m.y. to 4 m.y.) at which the change occurred is not yet known. The lithologic change may relate to a major climatic event such as the initiation of the Antarctic Convergence in the middle Gilbert (~ 4 m.y.B.P.) as suggested by Hays (1965). Sedimentation rates are extremely high during the Quaternary, occasionally exceeding 130 m/m.y. Relatively fresh, coarse-grained tholeiitic basalt was recovered below the ooze. The age of the basal sediment resting on the basalt is middle Miocene, in excellent agreement with the age of the basement as predicted from magnetic lineations.

Sediment diatom rich.



SITE 265 LEG 28



SITE DATA

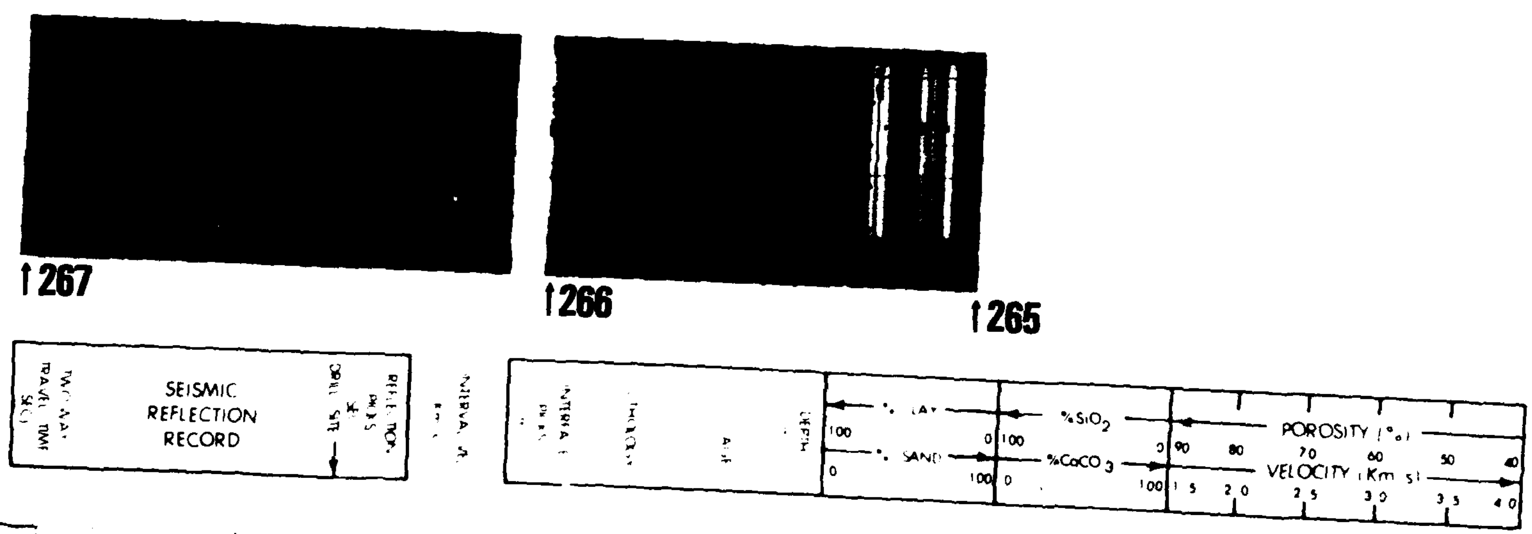
Position:
Latitude 56°24.1′ S
Longitude 110°06.7′ E
Date: 01/04/73
Time: 0800Z
Water depth: 4173 meters
Location: Flank of Southeast Indian Ridge

CORE DATA

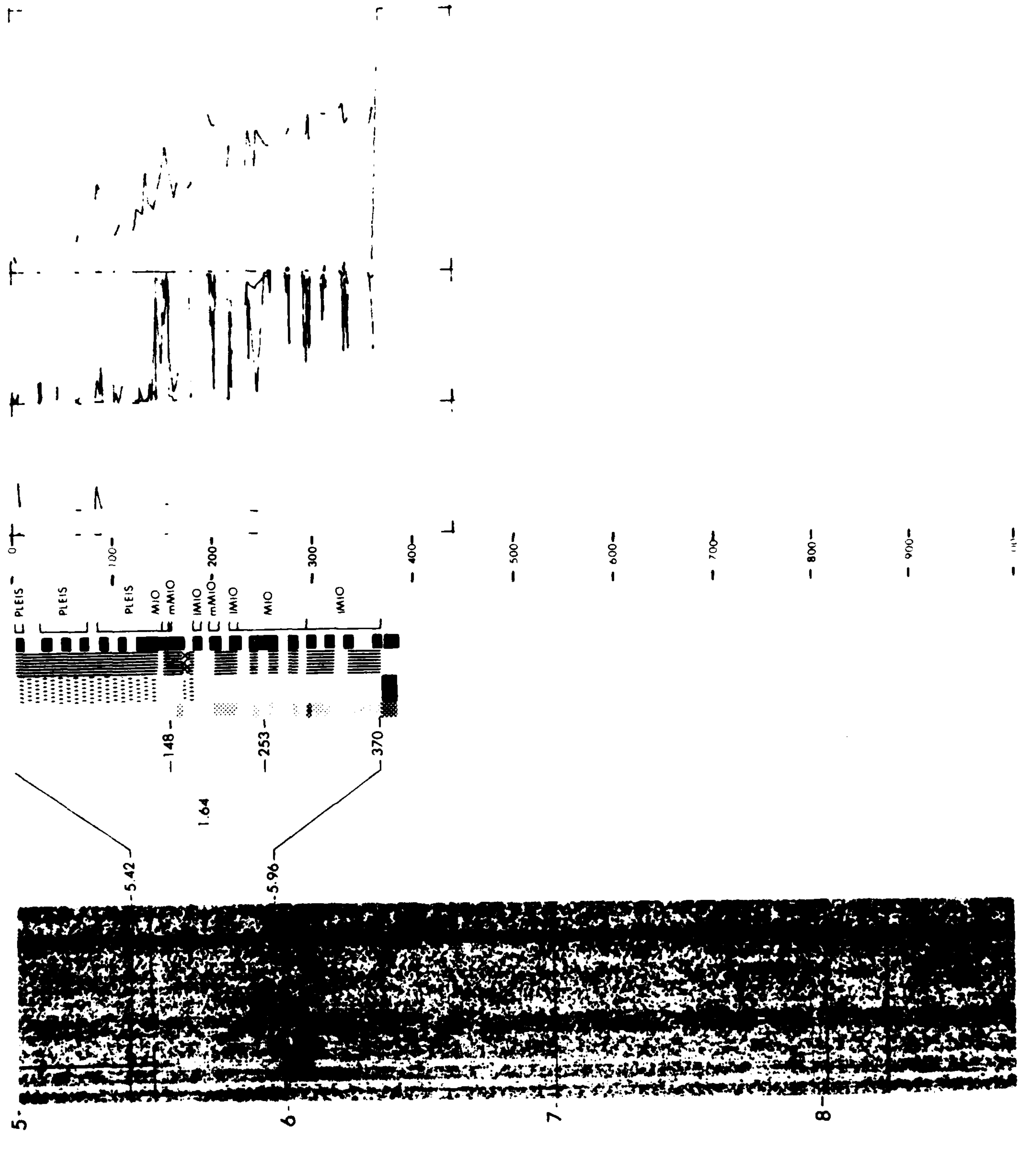
Penetration:
Drilled-- 164.5 meters
Cored---- 219.5 meters
Total---- 384 meters
Recovery:
Basement- 2 cores
2 meters
Total---- 24 cores
145.2 meters

One hundred forty-eight meters of predominantly diatom ooze of Quaternary to late Miocene age grade down into 105 meters of mixed nanno ooze, nanno clay, diatom clay, and diatom ooze of late to middle Miocene age. The latter unit overlies 117 meters of nanno chalk and claystone of early Miocene/late Oligocene age. The sediments rest on basaltic glass at a subbottom depth of 370 meters, and age of the basal sediments is in good agreement with that predicted on the basis of magnetic anomaly lineations. The sedimentary sequence suggests a gradual cooling at the site from late Oligocene to the present. Ice-rafted detritus found in the upper unit confirms the existence of icebergs in this area by the late Miocene.

Siliceous sediment; diatom rich. Calcareous sediment; nannofossil rich. Two thin layers of detrital sediment occur in Miocene time.



SITE 266 LEG 28



SITE DATA

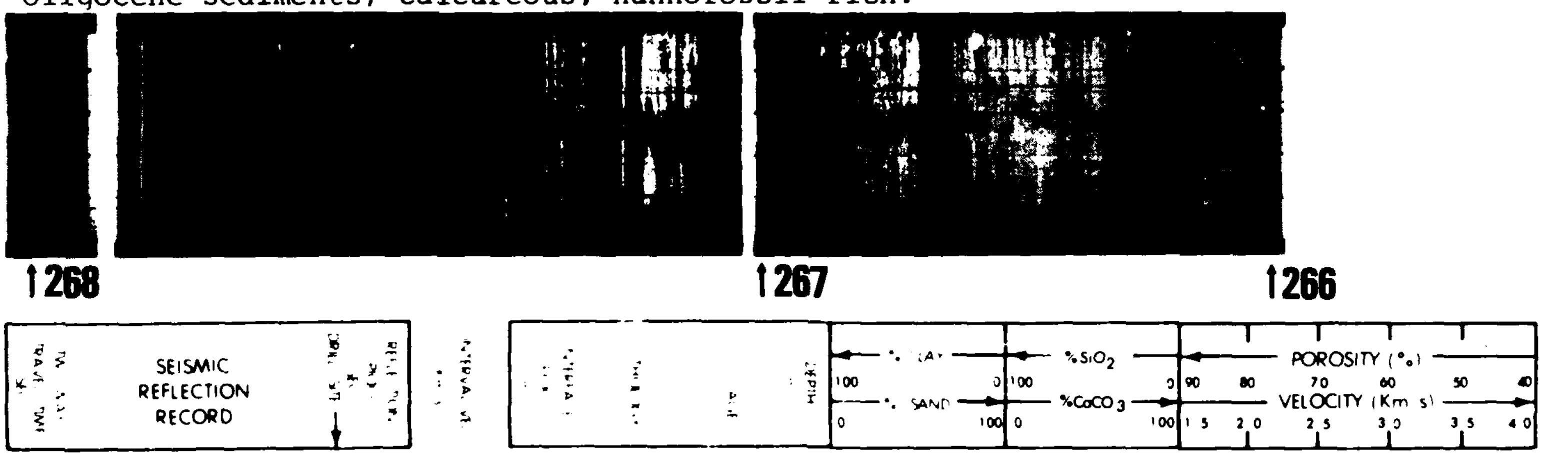
Position:
Latitude 59 15.7' S
Longitude 104°29.3' E
Date: 01/05/73
Time: 1137Z
Location: Basin south of Southeast Indian Ridge
Water Depth: 4539 meters

CORE DATA

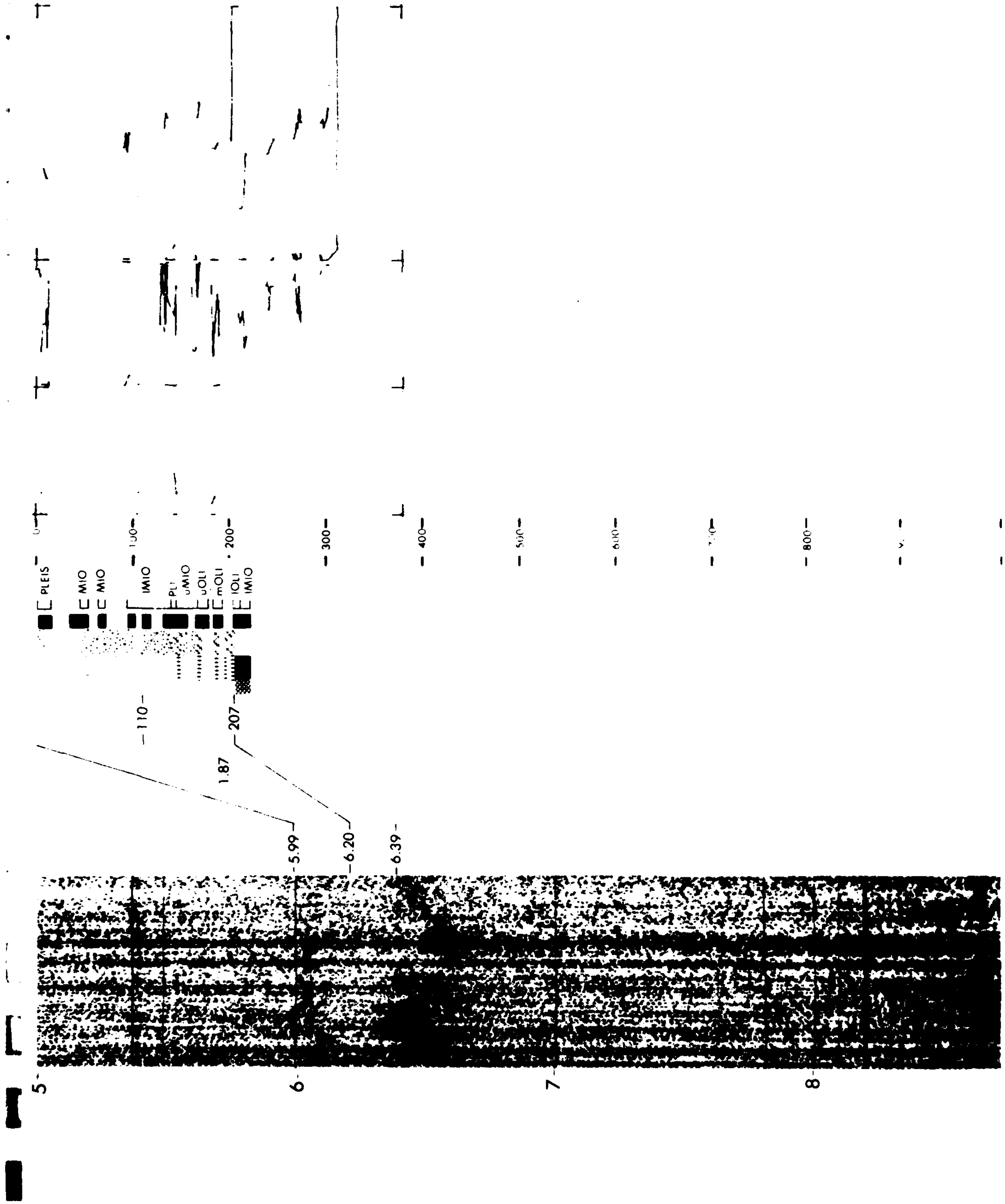
Penetration:	267	267A	267B	
Drilled----	161.5	42	228	meters
Cored----	58	28.5	95	meters
Total----	219.5	70.5	323	meters
Recovery:				
Basement-	2	0	1	cores
	2.4	0	.3	meters
Total----	7	3	10	cores
	25.9	11.6	53.5	meters

The section penetrated in these two holes consists of about 100 meters of Quaternary and Pliocene silty clays overlying lower Oligocene to lower Miocene nanno oozes and chalks. The contact between these units occurs somewhere in the unsampled interval between 99 and 127.5 meters subbottom. Glassy basaltic rock was encountered at 205 meters and about 16 meters were cored. The lower Oligocene age of basal sediment, though not well determined, does not conform precisely with the upper Eocene age suggested by magnetic anomalies. This discrepancy suggests the possibility of a basal unconformity or that the basalt represents a sill. A major climatic change is suggested by the appearance in the clay of ice-rafted grains, after an interval of carbonate deposition. This inferred climatic change probably took place in the middle or late Miocene, but it is not clear whether the initiation of ice rafting preceded, coincided with, or followed this major change in the nature of sedimentation. Thus, it is still uncertain whether the change from carbonate to clay deposition reflects the birth of the Antarctic Convergence, passage of the sea floor below the carbonate compensation depth (CCD), or a sharp rise of the CCD.

Pleistocene sediments; siliceous, diatom rich. Miocene sediments; detrital. Oligocene sediments; calcareous, nannofossil rich.



SITE 267 LEG 28



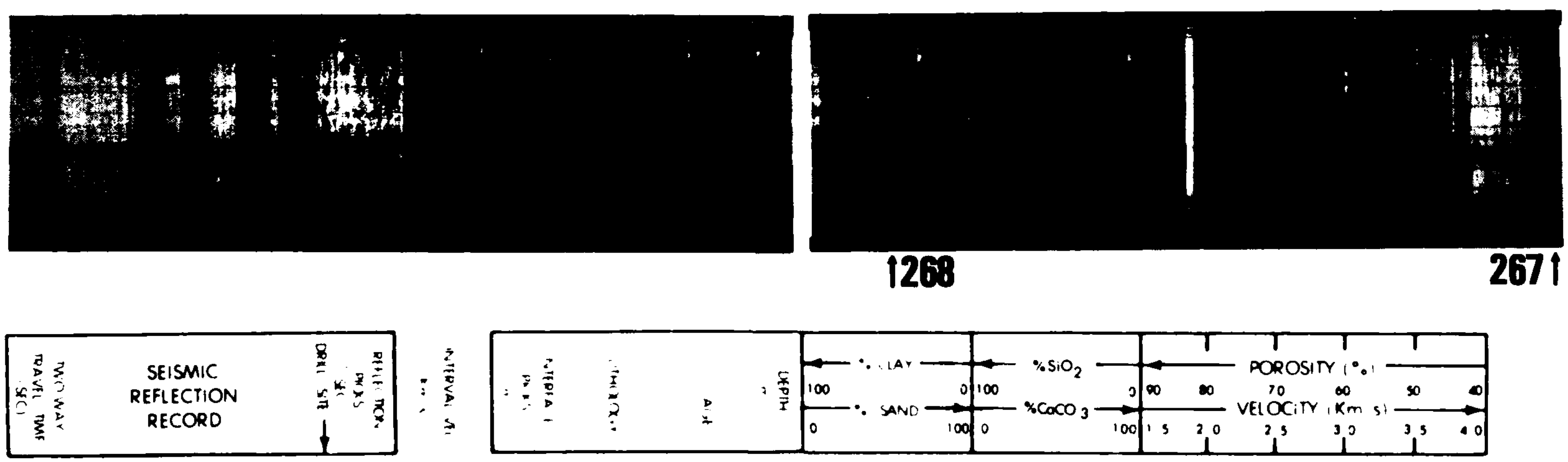
SITE DATA

Position:
Latitude 63°57.0' S
Longitude 105°09.3' E
Date: 01/09/73
Time: 2215Z
Water depth: 3544 meters
Location: North of Knox Coast, Antarctica

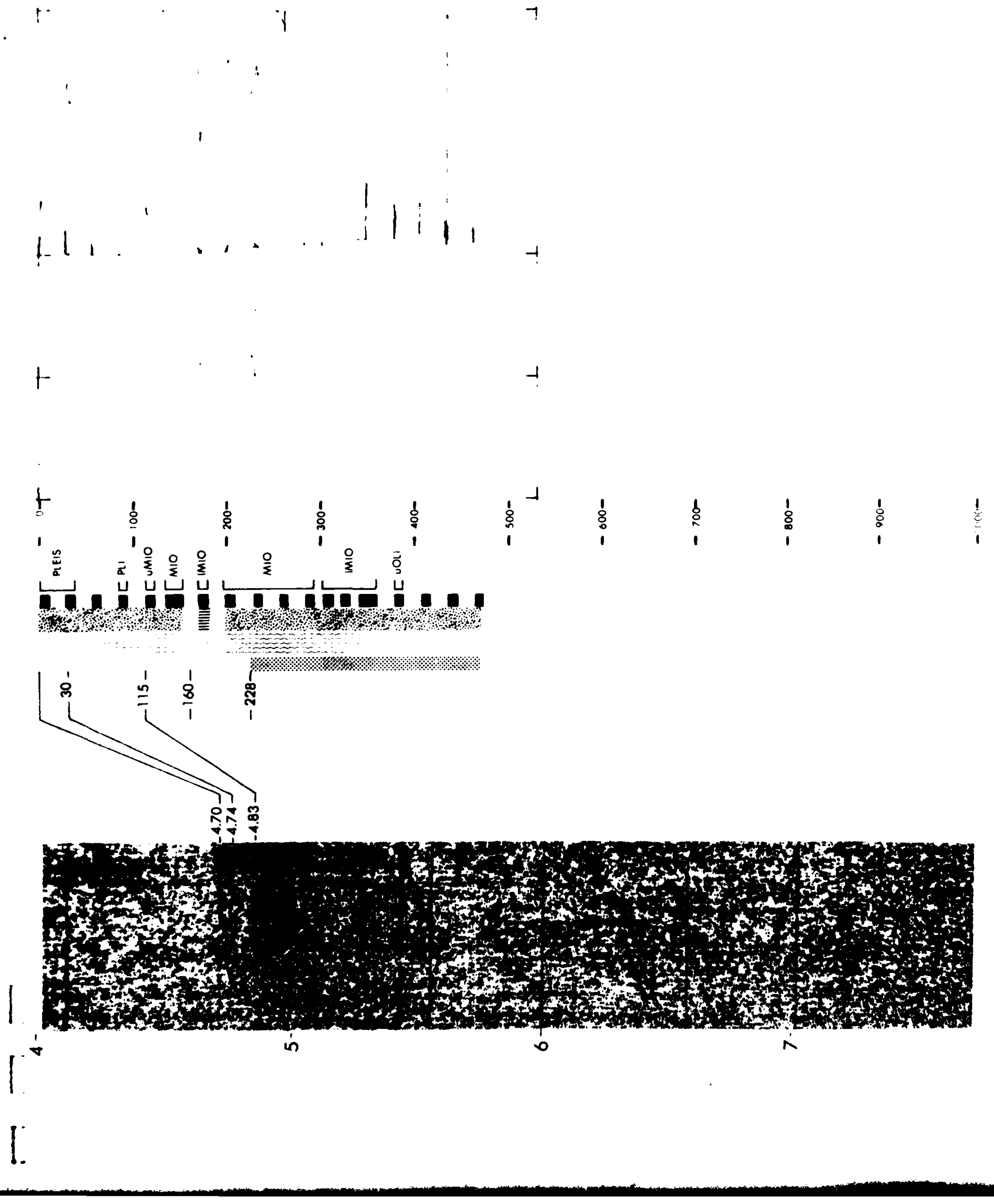
CORE DATA

Penetration:
Drilled-- 285 meters
Cored----189.5 meters
Total----474.5 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 20 cores
65.6 meters

Clayey sediments totaling about 474 meters thick and ranging in age from Quaternary to late Oligocene were cored at Site 268. Ice-rafted pebbles and granules are common well down into the lower Miocene part of the section, and isolated granules occur in the Oligocene sequence. Sediments in which chert has formed were deposited prior to the interval of abundant ice rafting—in the Oligocene and earliest Miocene. Thin sand and silt laminae found in the upper 150 meters probably represent turbidite deposition. Silty clays in the lower two-thirds of the section show few structural characteristics of turbidites and the dominant sedimentation process is inferred to have been related to deep ocean currents.



SITE 268 LEG 28



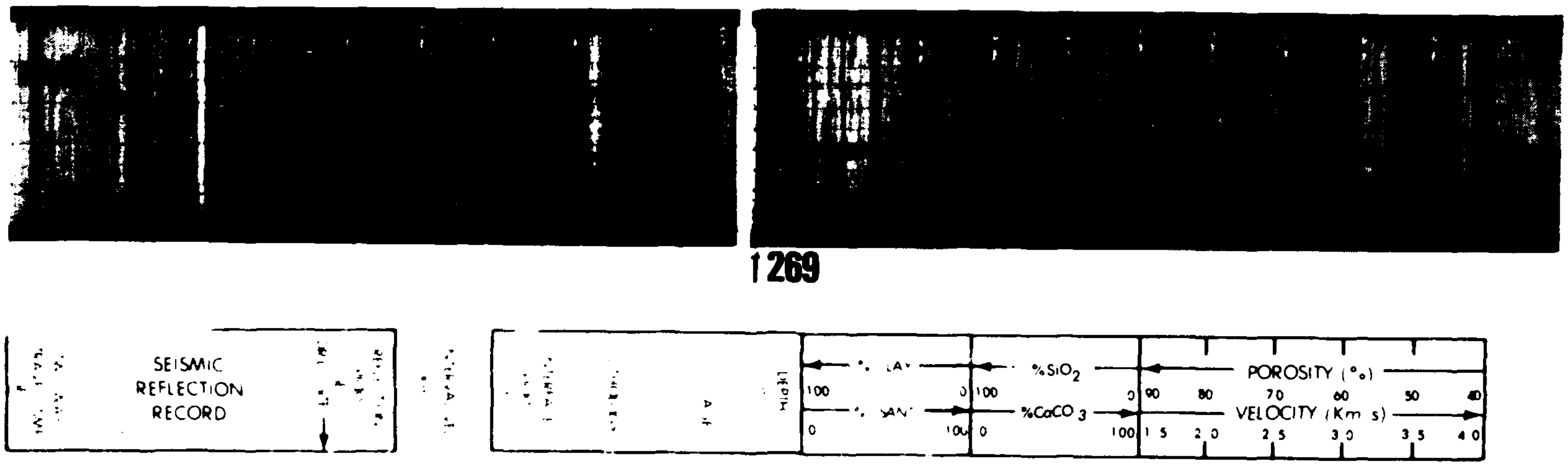
SITE DATA

Position:
Latitude 61°40.6'S
Longitude 140°04.2'E
Date: 01/17/73
Time: 0500Z
Water depth: 4285 meters
Location: South Indian Abyssal Plain

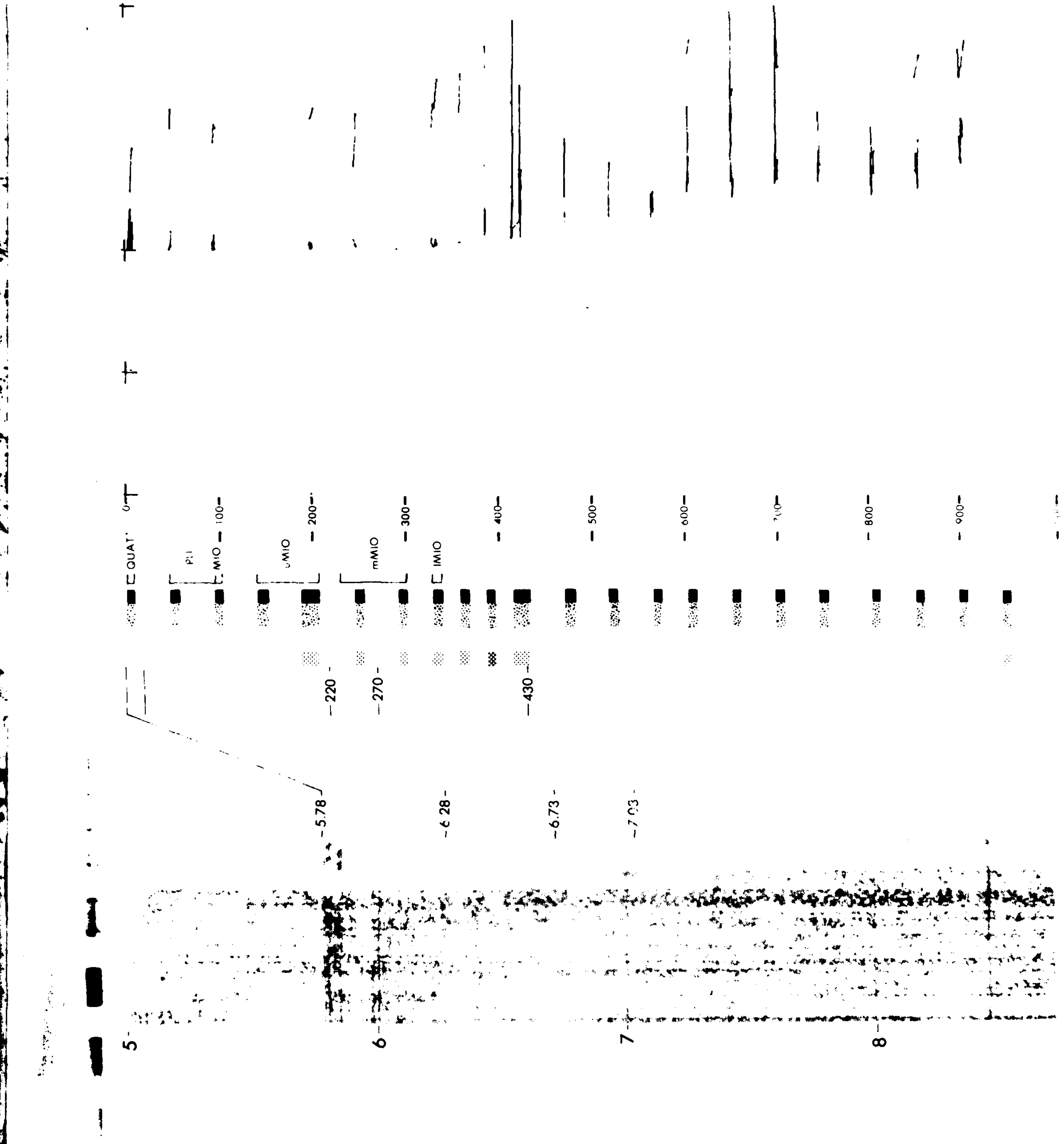
CORE DATA

Penetration:	269	269A	
Drilled--	294.5	834.5	meters
Cored----	103	123.5	meters
Total----	397.5	958	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	11	13	cores
	38.8	55.4	meters

A 958-meter-thick sequence of largely Neogene turbidites and silts deposited by bottom currents were penetrated in two holes at Site 269. The deepest hole bottomed in similar sediments which are at least as old as late Oligocene. Infrequent limy bands provided the only material suitable for dating the sediments, and the lowest of these is located about 50 meters above the bottom of the hole. Ice-rafted sediments are much less obvious here than at Site 268, and pebbles and granules have been observed only in the upper 100 meters of the section. Chert occurs within a 100-meter-long sequence which is poorly dated as lower to middle Miocene, and which, like the remainder of the sediments, is detrital. The youngest chert units coincide roughly with the oldest diatom-rich claystones. Basement was not sampled and is judged to lie 200-300 meters below the deepest penetration here. The inferred average Paleogene sedimentation rates at Site 269 are extremely low.



SITE 269 LEG 28



SITE DATA

Position:
Latitude $77^{\circ}26.5'$ S
Longitude $178^{\circ}30.2'$ W
Date: 02/02/73
Time: 1610Z
Water depth: 634 meters
Location: Ross Sea

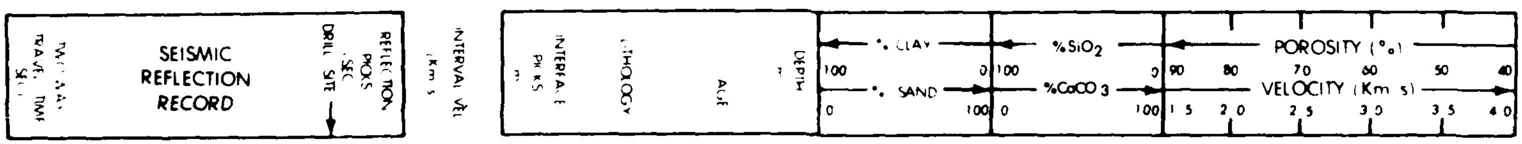
CORE DATA

Penetration:
Drilled-- 0 meters
Cored----422.5 meters
Total----422.5 meters
Recovery:
Basement- 6 cores
18 meters
Total---- 49 cores
263.7 meters

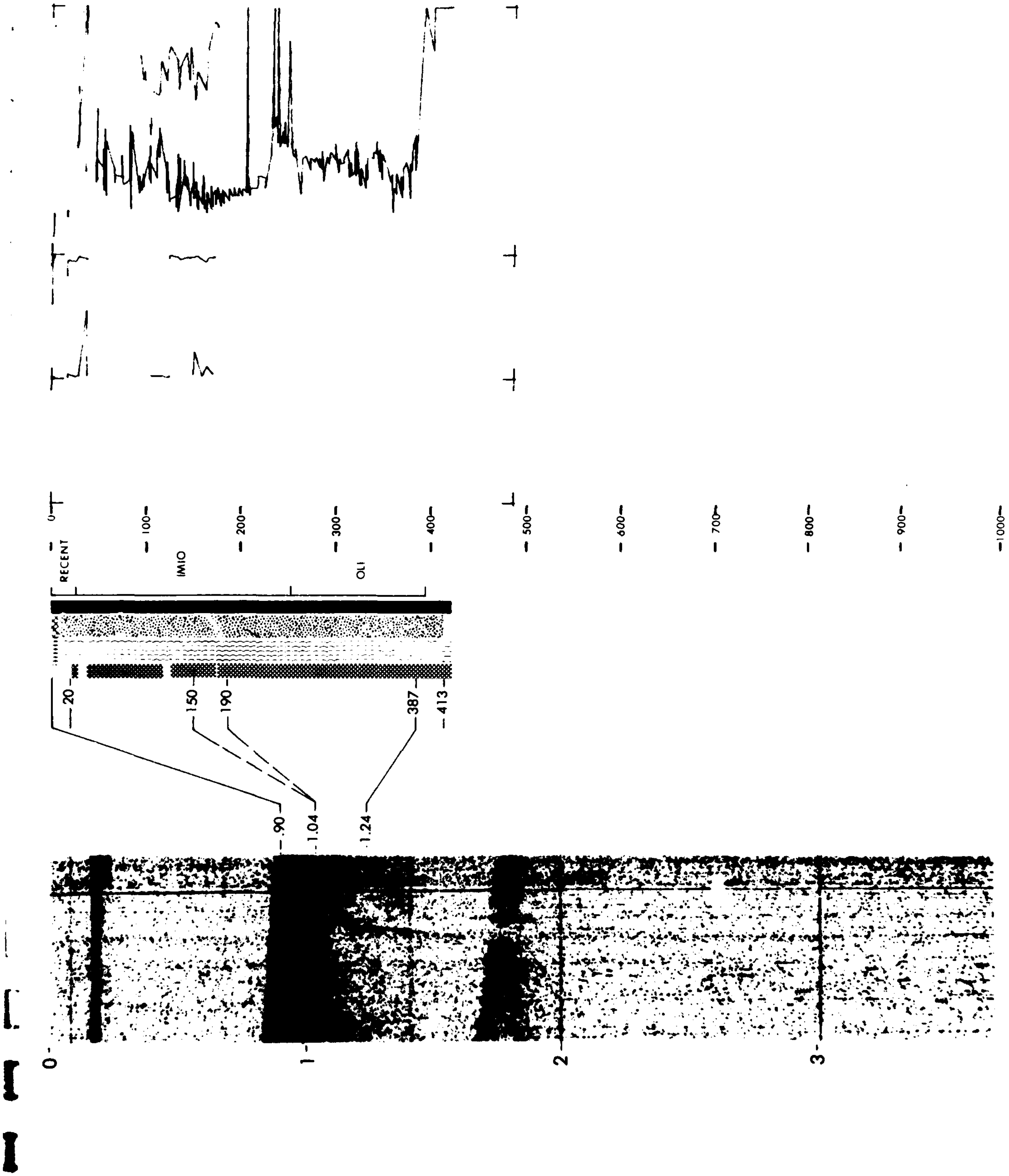
Glacial deposits, most bearing marine invertebrate fossils, occur to a subbottom depth of about 385 meters and range in age from Recent back to late Oligocene. The angular unconformity apparent on the seismic profile is present at about 20 meters subbottom, a marked increase in lithification and an early Pliocene to early Miocene stratigraphic hiatus. As rock types typical of the Transantarctic Mountains were rarely found, the likely source area for much of the glacial debris may have been Marie Byrd Land, although this area is poorly known geologically. Below the glacial sediments 2-5 meters of glauconitic sand and carbonaceous sandstone of middle/late? Oligocene age occurs. This in turn is underlain by a sedimentary breccia about 30 meters thick. The breccia probably represents a nearby source of metamorphic and igneous rocks as typically found in continental areas (e.g., granite, diorite, granite gneiss, etc.). The breccia rests nonconformably on gray foliated marble and calscilicate gneiss of possible early Paleozoic age. The marble/gneiss unit exhibits high compressional wave velocities (~4 km/sec) and corresponds to the topographic high in the "acoustic basement" anticipated near 400 meters subbottom.

Recent siliceous sediment; diatom rich.

↑272 ↑271 ↑270



SITE 270 LEG 28



SITE DATA

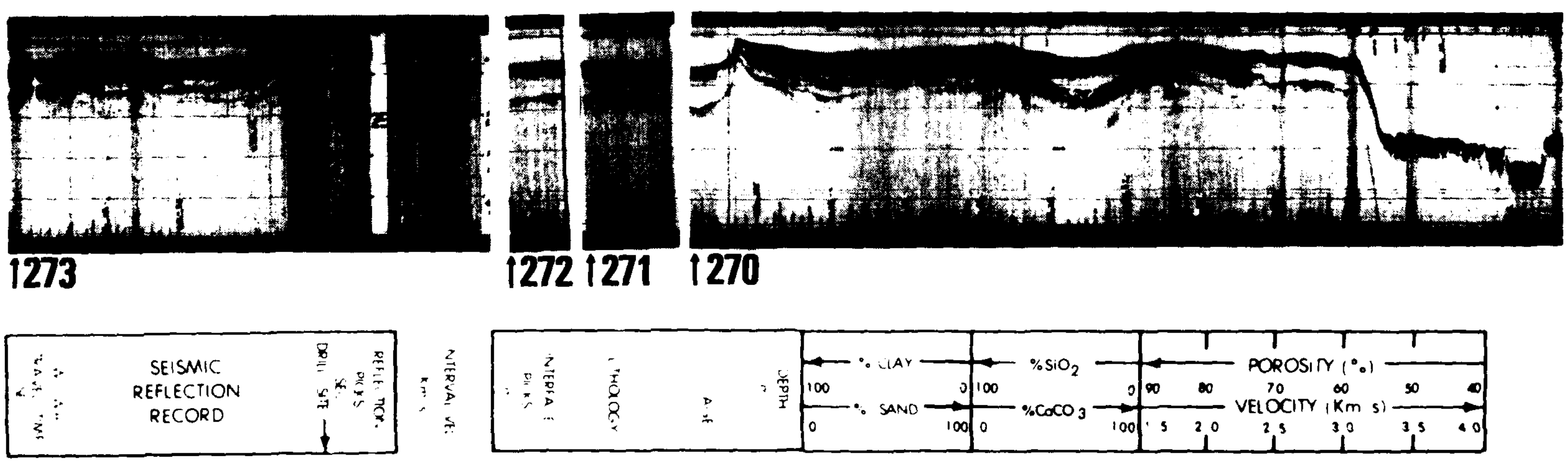
Position:
Latitude 76°43.3' S
Longitude 175°02.9' W
Date: 02/05/73
Time: 1000Z
Water depth: 554 meters
Location: Ross Sea

CORE DATA

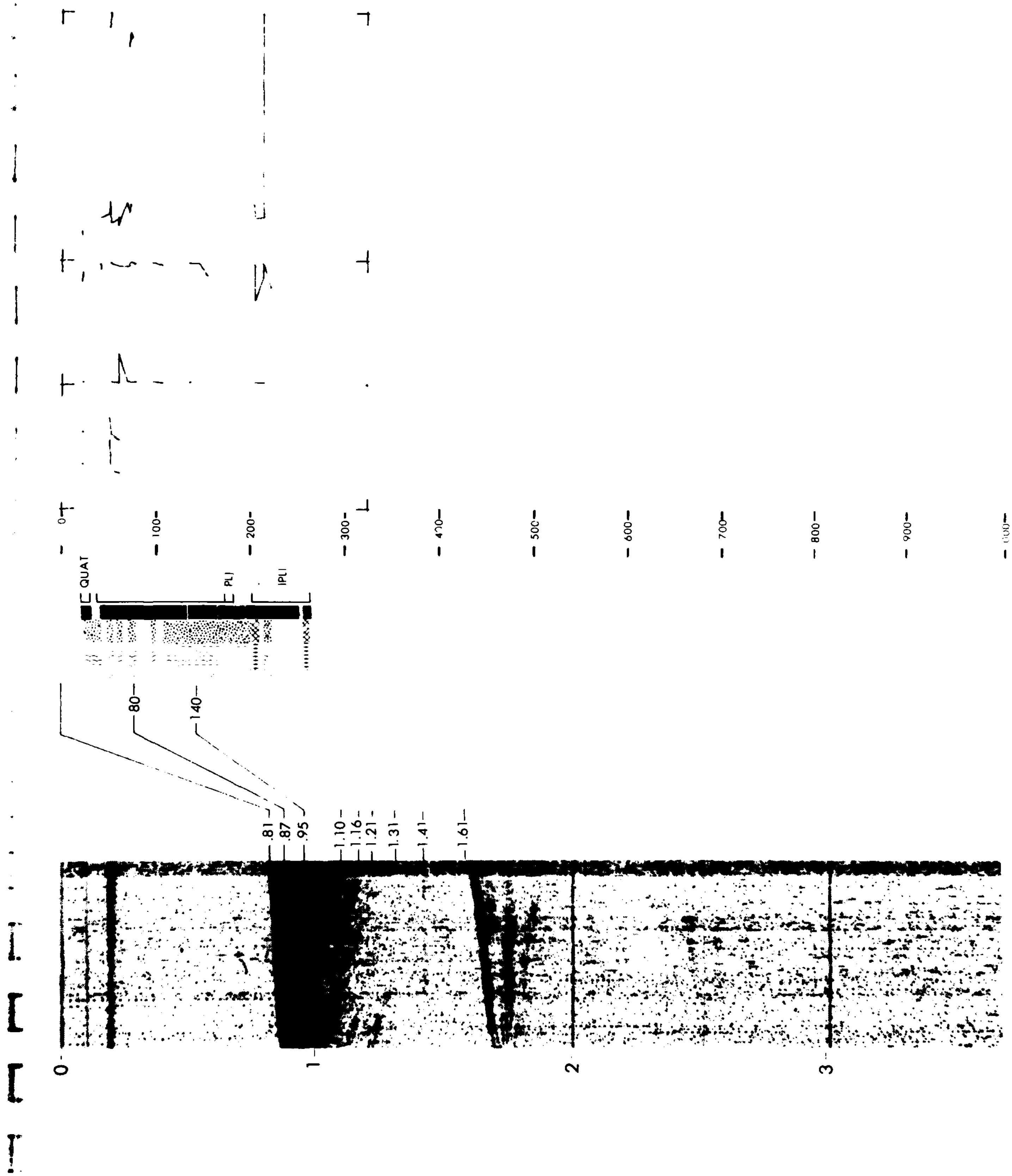
Penetration:
Drilled-- 32 meters
Cored---- 233 meters
Total---- 265 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 24 cores
15.3 meters

Poor recovery at Site 271 allows little to be concluded about depositional conditions other than that a marine environment with iceberg rafting was in existence for most of the time back to the early Pliocene/late Miocene. Clasts are very abundant here, and their abundance was probably a contributing factor to the low recovery. Their concentration may reflect either high iceberg melting in the Neogene or the preferential location of the site near iceberg tracks. In view of the lack of stratification in the cores, reentrainment of fine-grained sediment, leaving a lag deposit of coarser materials as at Site 270, does not seem likely. Clast types are comparable with those at Site 270, suggesting no major change in provenance. The hole was terminated when the first evidence of gas was found in Core 24. The gas included small, but significant fractions of ethane and ethylene, in addition to methane.

Two thin beds of siliceous, diatom rich sediment occur in lower Pliocene time. One thin detrital layer, mica rich.



SITE 271 LEG 28



SITE DATA

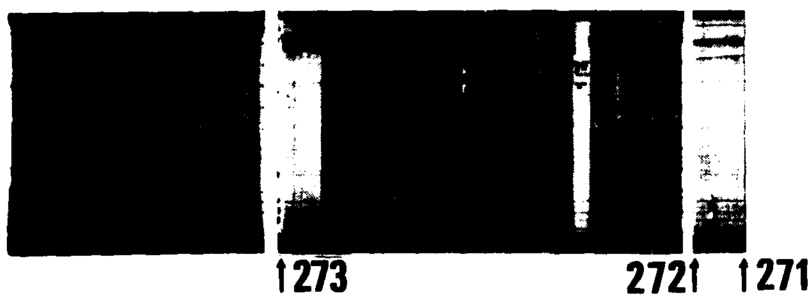
Position:
Latitude 77°07.6' S
Longitude 176°45.6' W
Date: 02/05/73
Time: 1304Z
Water depth: 629 meters
Location: Ross Sea

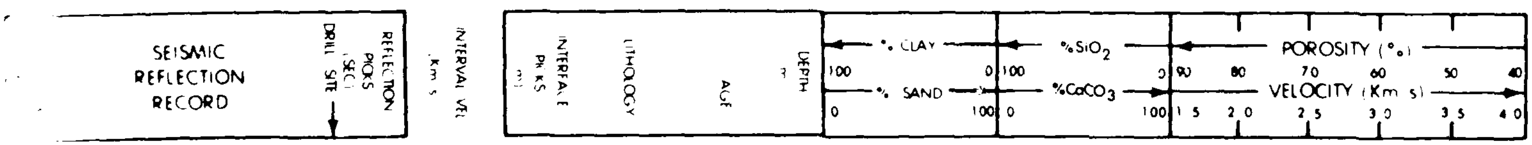
CORE DATA

Penetration:
Drilled-- 4 meters
Cored---- 439 meters
Total---- 443 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 48 cores
162 meters

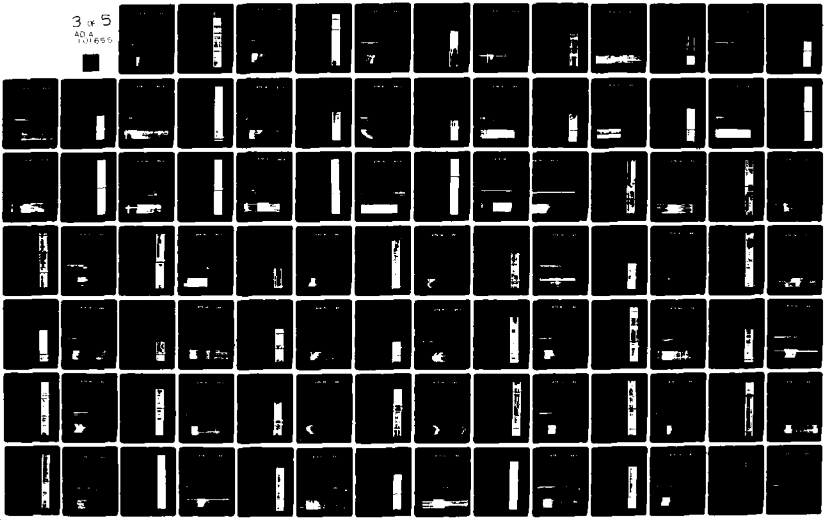
The sedimentary sequence consists of diamicton, diamictite, and grades of pebbly mud and mudstone, all of which show local, poorly developed stratification. Deposition of these sediments was in an open marine environment including sediment rafting by icebergs. Clast types suggest that Marie Byrd Land is likely the major source area, as in the older glacial deposits encountered at Site 270. Methane and trace quantities of ethane were encountered from about 45 meters downward, but showed no significant increase downhole. Extremely poor recovery within the lower 60 meters of the cored section is interpreted as an indication of dominantly sand layers there. The angular unconformity apparent on the seismic records is represented by an increase in lithification at about 25 meters subbottom and probable early mid Pliocene to late Miocene stratigraphic hiatus. The hole was terminated prematurely, as a safety precaution.

Siliceous sediments; diatom rich. One thin layer of calcareous sediment occurs in upper Miocene time.

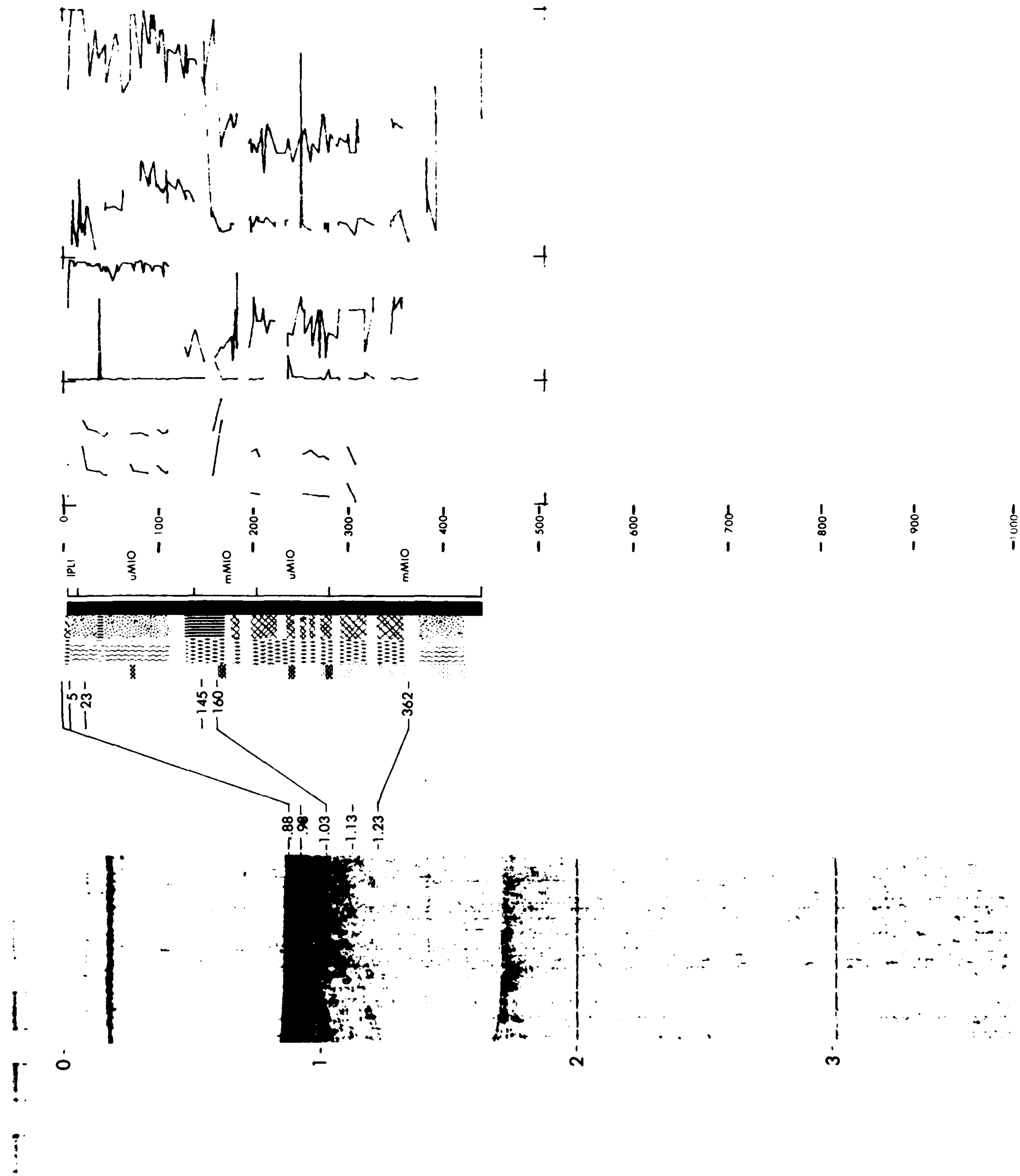




AD-A101 655 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 20/1
A SUMMARY OF SELECTED DATA: DSDP LEGS 20-44,(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL



SITE 272 LEG 28



SITE DATA

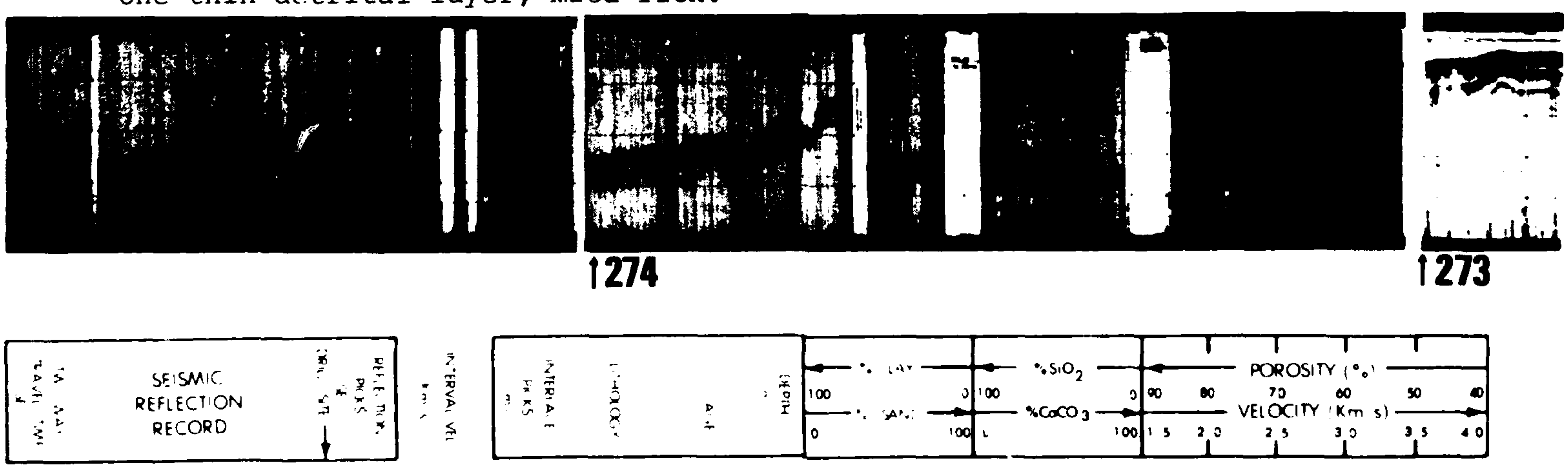
Position:
Latitude 74°32.3' S
Longitude 174°37.6' E
Date: 02/09/73
Time: 1716Z
Water depth: 495 meters
Location: Ross Sea

CORE DATA

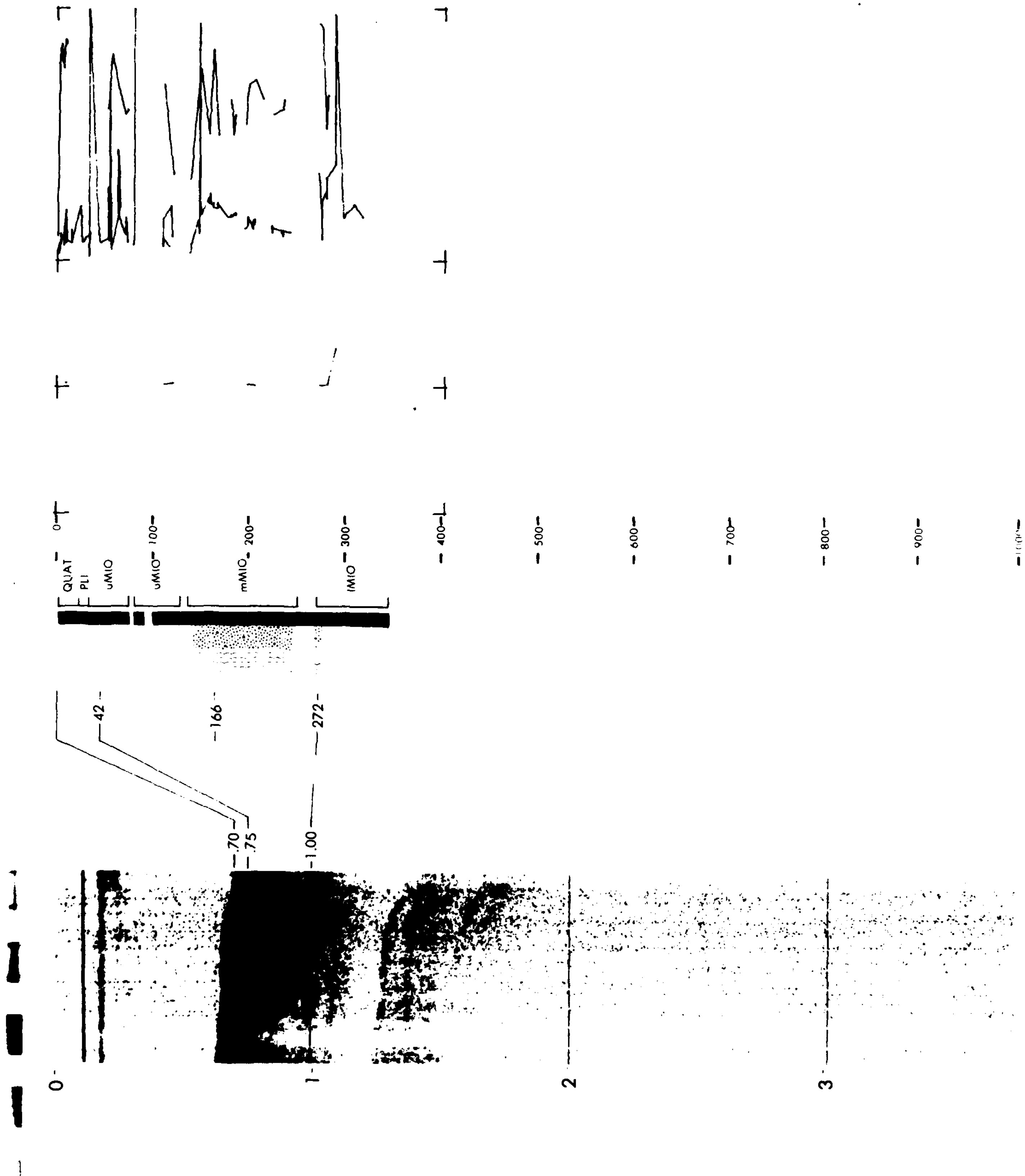
Penetration:	273	273A	
Drilled--	0	90	meters
Cored----	76	256.5	meters
Total----	76	346.5	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	9	29	cores
	27.9	55.5	meters

The post-Miocene portion of the section here is extremely condensed or more likely missing in large part and was probably removed by the glacial erosion event ($\sim$ 3-5 m.y.) that truncated dipping beds at Sites 270-272. Lithified silty clay constitutes the predominant lithology and, as elsewhere, it is mostly unstratified and contains marine microfossils. The environment of deposition for these strata is accordingly considered to be a seaway which received icebergs from the adjacent land areas and probably from shelf ice. Clasts in the Miocene clays differ from those in the eastern Ross Sea and those of Pliocene age in that diabase and basement rock types are present which are characteristic of the rocks exposed in the Transantarctic Mountains. The fact that the sequence dates back to at least the middle Miocene indicates that ice has been eroding the Transantarctic Mountains from mid-Miocene to Pliocene time. A pronounced reflecting horizon lying at 0.3 sec subbottom appears to mark an earlier erosional or scoured surface and can be traced over many tens of miles and which must be pre middle Miocene in age. A sharp increase in the hardness and velocity of the silty clay was encountered at 276 meters subbottom and probably accounts for the seismic horizon.

One thin detrital layer, mica rich.



SITE 273 LEG 28



SITE DATA

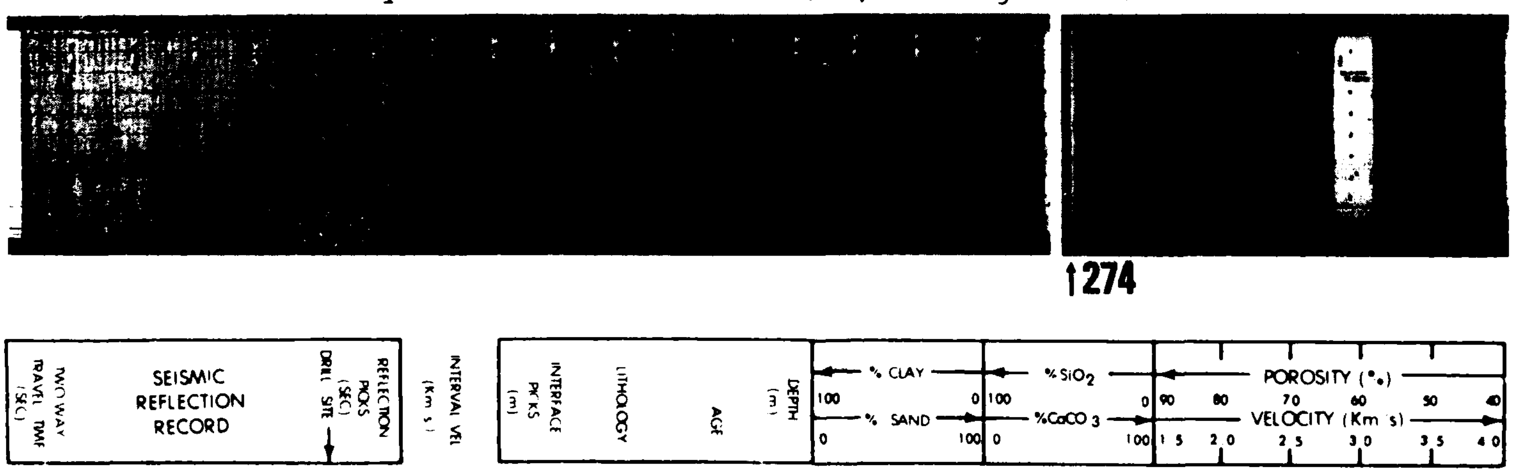
Position:
Latitude 68°59.8' S
Longitude 173°25.6' E
Date: 02/15/73
Time: 1200Z
Water depth: 3326 meters
Location: North of Cape Adare, Antarctica

CORE DATA

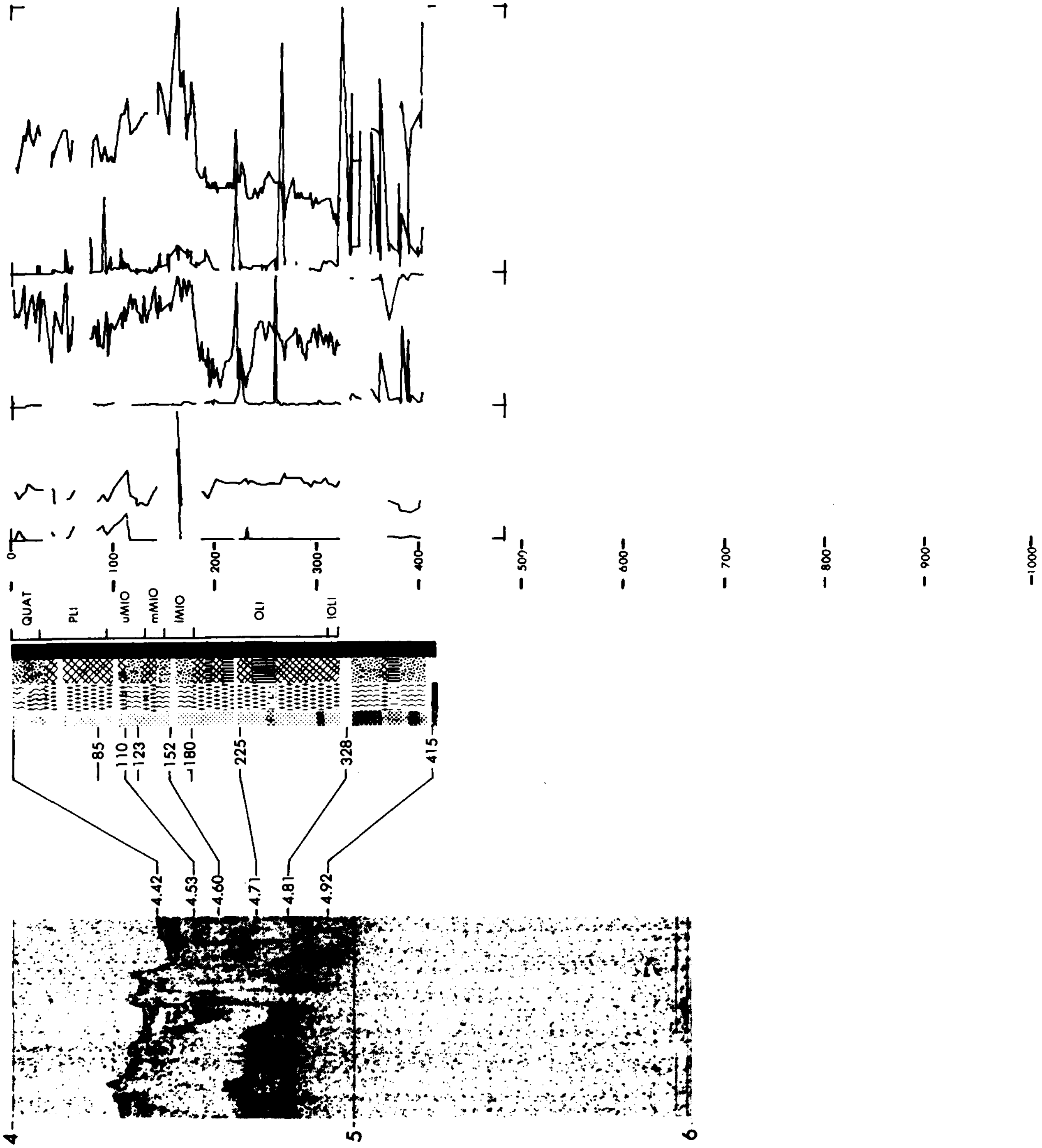
Penetration:
Drilled-- 0 meters
Cored---- 421 meters
Total---- 421 meters
Recovery:
Basement- 2 cores
3.6 meters
Total---- 45 cores
279.1 meters

A largely terrigenous sedimentary sequence about 415 meters thick and ranging in age from Quaternary to (?) early Oligocene overlies basalt at this site. Ice-rafted clasts occur in strata at least as old as early Miocene/late Oligocene, and possible early Oligocene. Abundant diatoms occur in the top of the sequence and small quantities of nannofossils near the base; their age distribution overlaps the early Miocene-late Eocene section. This biogenic facies change may represent the same, possibly ecologically significant, transition as is seen at Sites 265, 266, 267, and 268, although the microfossils recovered are less abundant at Site 274 than elsewhere. Silt does not occur as discrete beds in strata younger than late Miocene, and this may result from formation of a major graben structure which served as a sediment trap between the site and the continent. Sedimentation rates during Miocene time (2-10 m/m.y.) are much slower than the rates for before and after the Miocene. The estimated age of the oldest sediments is in reasonable agreement with that estimated from magnetic lineation data.

Interbedded thin layers of detrital and siliceous sediment. Siliceous; diatom rich. Three thin layers of calcareous sediment, in Oligocene time.



SITE 274 LEG 28



SITE DATA

Position:
Latitude $50^\circ 26.3'$ S
Longitude $176^\circ 19.0'$ E
Date: 03/04/73
Time: 0630Z
Water depth: 2800 meters
Location: Campbell Plateau

CORE DATA

Penetration:		
Drilled--	19	meters
Cored----	43	meters
Total----	62	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	5	cores
	17.5	meters

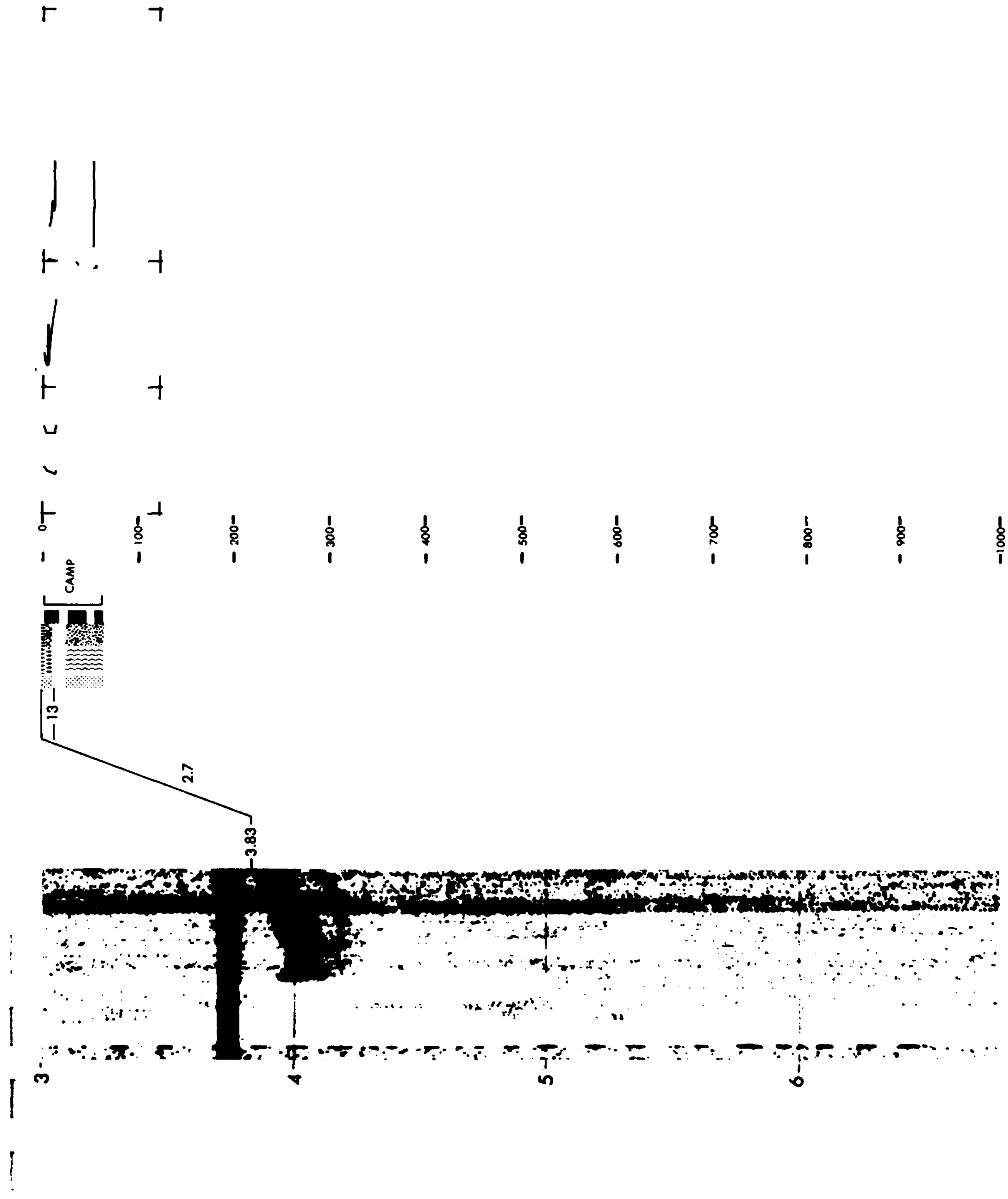
The clay-rich nature of the poorly-sorted sediments of Unit 2, the preservation of some stratification, and the presence of at least a limited infauna, unoxidized authigenic glauconite, and organic carbon, suggest that moderate rates of sedimentation and average circulation conditions, neither totally restricted nor vigorous, prevailed. The sediment probably accumulated in a basin associated with a plateau of undulating topography. Unit 2 is comparable with, and possibly correlative to, the upper part of the Garden Cove Formation of Campbell Island. The oxidized nature of the glauconite and the moderately well-sorted nature of the detritus suggests that the Unit 1 sediments accumulated under oxidizing conditions characteristic of open circulation. Bottom currents were strong enough to transport the detritus, but were not sufficiently strong to fragment the delicate siliceous microfossils. The angular and fresh nature of the detritus suggests derivation from a relatively nearby source, probably the schists, and acid and intermediate igneous rocks of the elevated parts of the Campbell Plateau (Summerhayes, 1969). The sediments accumulated on the outer edge of the plateau, possibly at a shallower depth than at present.

Siliceous sediment; radiolaria or diatom rich.

275

TWO-WAY TRAVEL TIME SEC | SEISMIC REFLECTION RECORD | REFLECTION PICKS SEC DRILL SITE | INTERVAL VEL (Km/s) | INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100–0 / % SAND 0–100 | % SiO_2 100–0 / % $CaCO_3$ 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 275 LEG 29



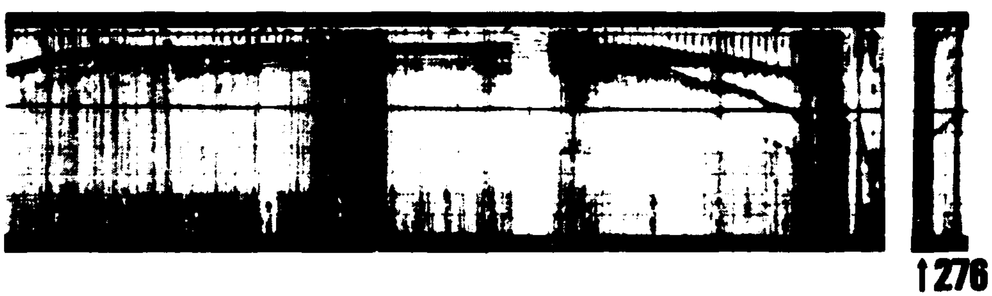
SITE DATA

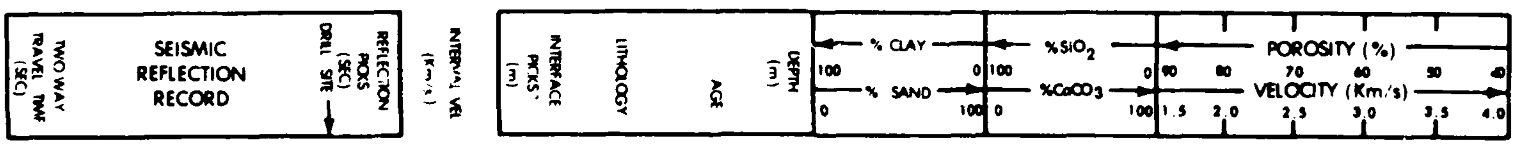
Position:
Latitude 50°48.1' S
Longitude 176°48.4' E
Date: 03/06/73
Time: 1352Z
Water depth: 4671 meters
Location: Southwest Pacific Basin

CORE DATA

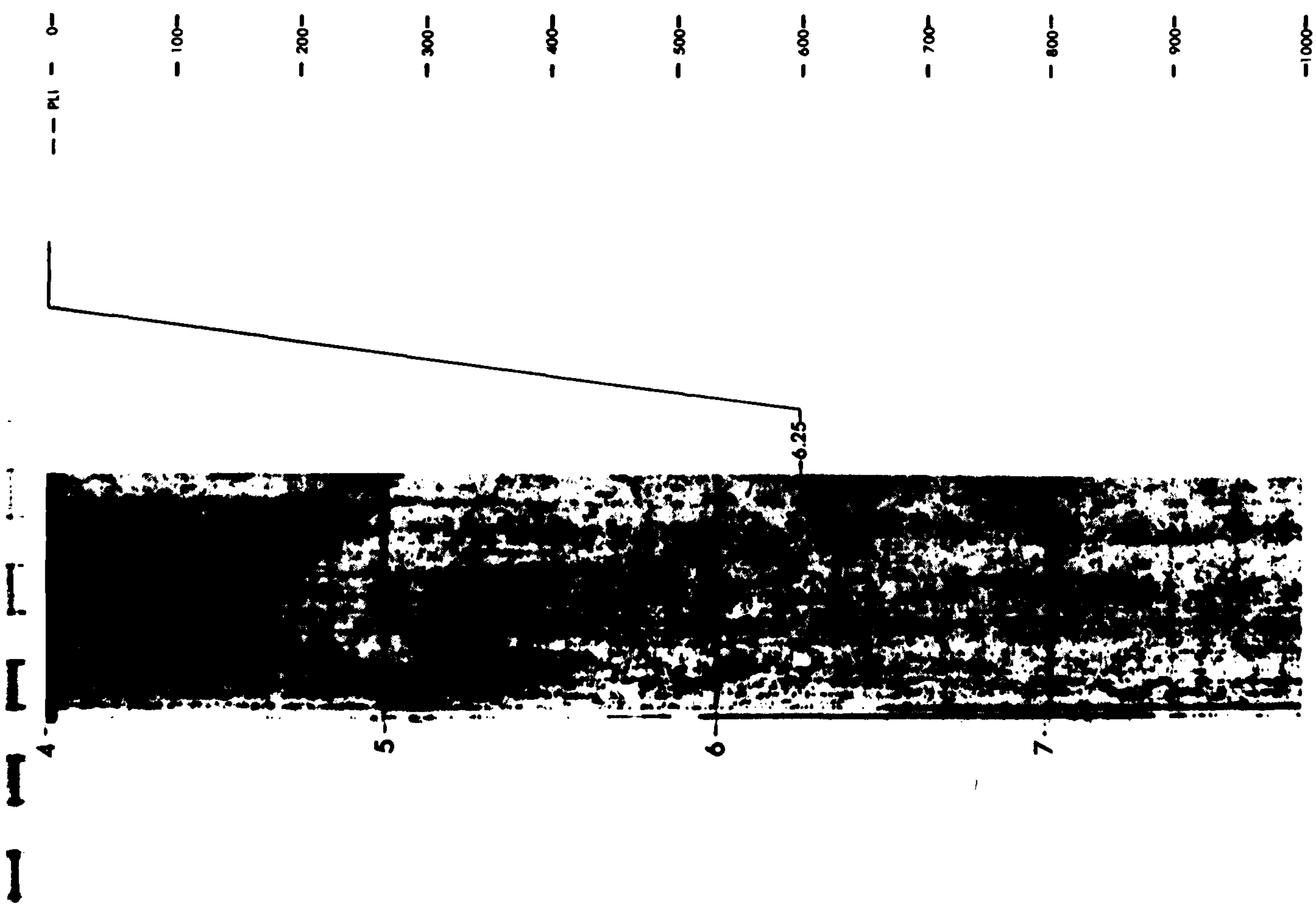
Penetration:
Drilled-- 23 meters
Cored---- 1 meters
Total---- 23 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 1 cores
.03 meters

The sediment at Site 276 consists of a surficial layer of sand and gravel of middle Pliocene age formed by erosion and winnowing of the western boundary current. The surficial deposits are underlain by an unknown thickness of silicitite of possible Oligocene age that contains abundant reworked older Paleogene material. The most important result derived from the evidence at Site 276 is that erosion by the western boundary current has cut down to a Paleogene sequence (possible Oligocene). The presence of microfossils of various ages within the Paleogene may indicate extensive reworking during its deposition. This reworking may have been caused by a similar current system that was a predecessor to the present western boundary current. Less probably, the mixed assemblage is an artifact of drilling. The fragments of plutonic and metamorphic rocks in both samples possible reflect the proximity of Site 276 to the Campbell Plateau since at least the Oligocene. Ice rafting of these materials from Antarctica seems less likely.





SITE 276 LEG 29



SITE DATA

Position:
Latitude 52°13.4' S
Longitude 166°11.5' E
Date: 03/10/73
Time: 1834?
Water depth: 1208 meters
Location: Cathedral Depression; Campbell Plateau

CORE DATA

Penetration:
Drilled-- 38 meters
Cored----434.5 meters
Total----472.5 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 46 cores
258.9 meters

The late Oligocene to middle Paleocene sequence of nannofossil ooze and chalk was deposited under uniform, fully oceanic conditions on the Campbell Plateau over a period of 35 m.y., with no influence of terrigenous sedimentation. Depths of deposition were probably much the same throughout, well above the lysocline. The sequence can be correlated with the Tucker Cove Formation on Campbell Island which ranges from early Eocene to middle Oligocene. The sequence represents a good example of highly uniform sediments that have undergone diagenesis with depth of burial. The Neogene appears to be absent over much of the Plateau. This is due to a major increase in bottom-water circulation over the Campbell Plateau at some time since the late Oligocene, resulting in erosion and nondeposition. Continuous sedimentation throughout the Paleogene and erosion-nondeposition during the Neogene is the converse of Tasman Sea sedimentation (Leg 21), and appears to be related to major changes in bottom-water movement during the Cenozoic in the southwest Pacific.

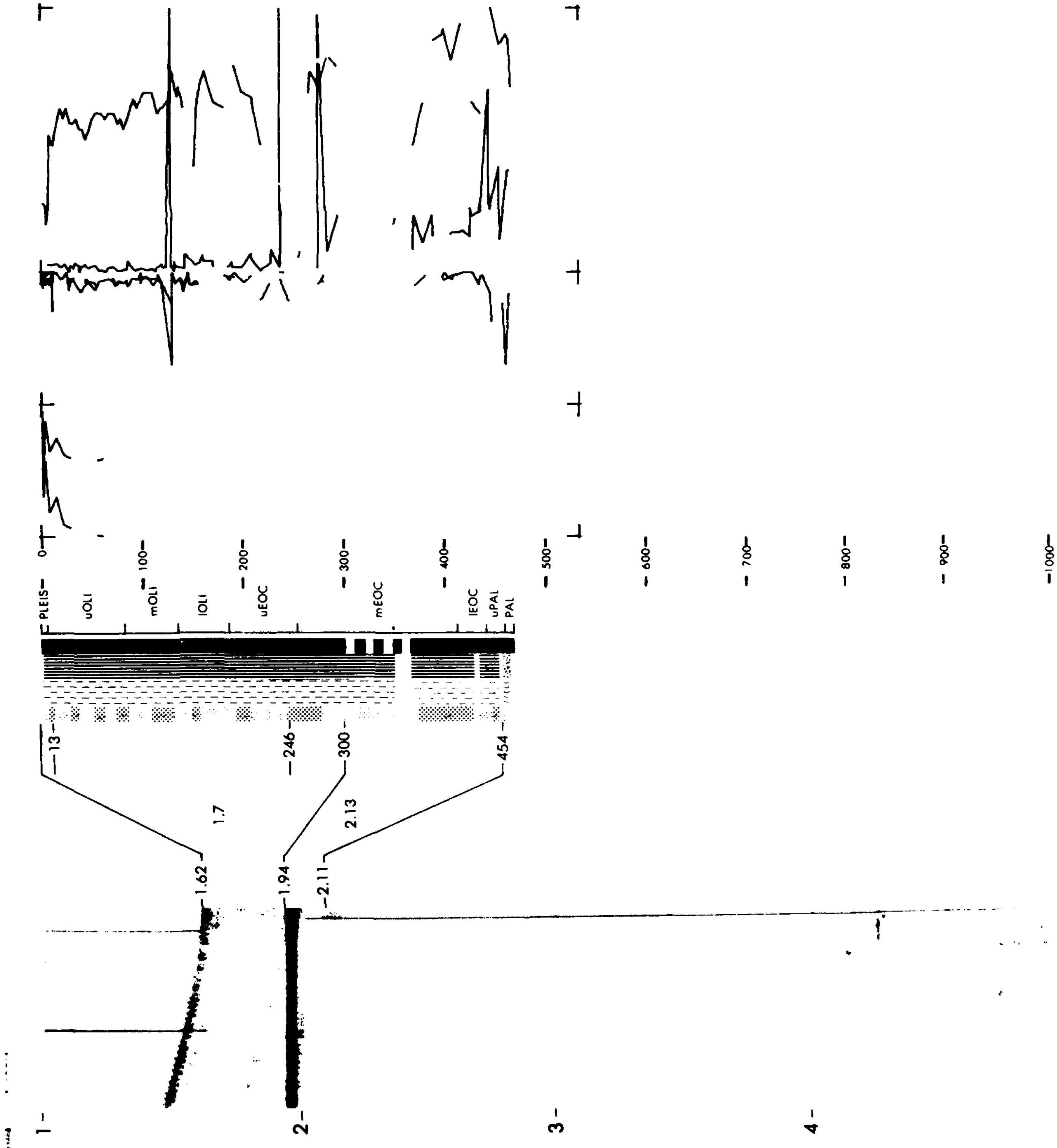
Sediments mostly nannofossil rich, rarely foraminifera rich (Pleistocene). One detrital thin layer in upper Paleocene time.

277

TWO WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE	INTERVAL VEL (Km/s)

INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	% CLAY 100–0 / % SAND 0–100	% SiO_2 100–0 / % $CaCO_3$ 0–100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 277 LEG 29



SITE DATA

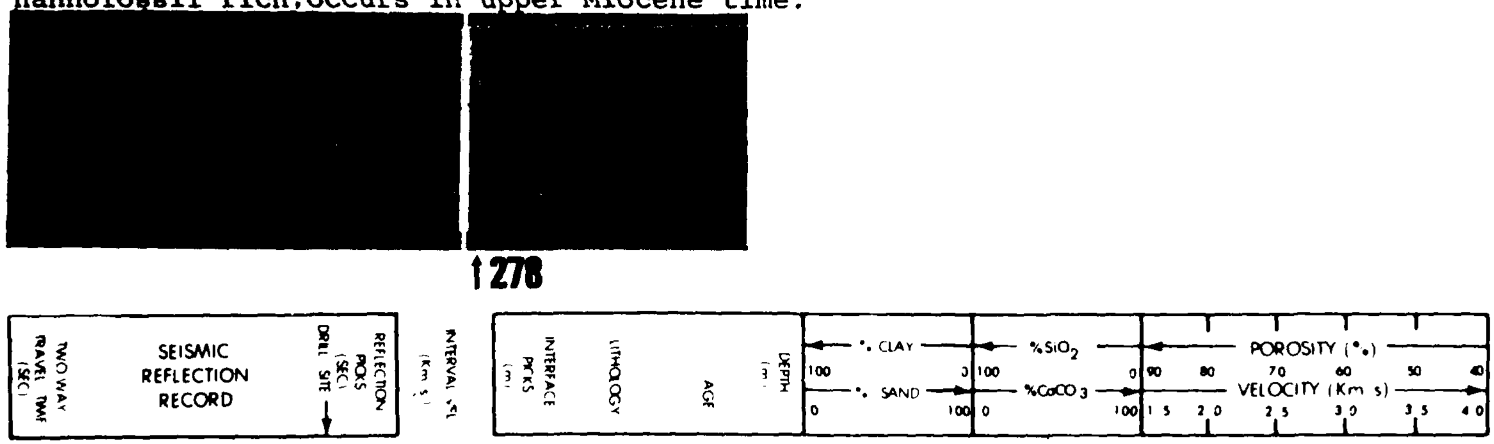
Position:
Latitude $56^\circ 33.4' S$
Longitude $160^\circ 04.3' E$
Date: 03/14/73
Time: 0800Z
Water depth: 3669 meters
Location: Emerald Basin

CORE DATA

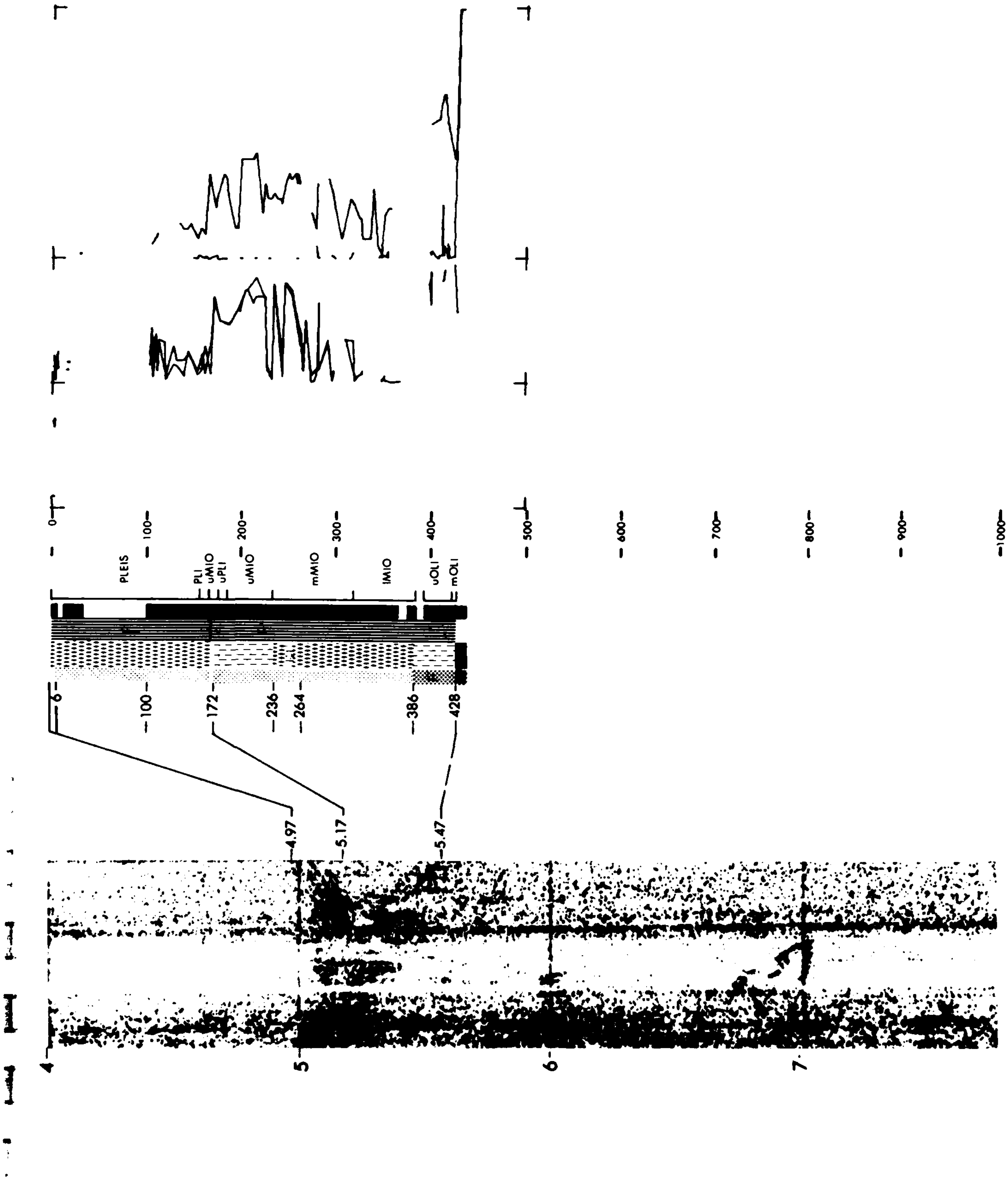
Penetration:	278	278A	
Drilled--	114	15.5	meters
Cored----	324.5	19	meters
Total----	438.5	34.5	meters
Recovery:			
Basement-	2	0	cores
	5.3	0	meters
Total----	35	2	cores
	277.7	7.5	meters

This site is of interest because of its location at the present-day Antarctic Convergence. The fluctuations in lithology from nannofossil ooze to siliceous diatom ooze may indicate changes in the location and strength of the convergence, with the siliceous oozes representing times when the convergence was nearby. Significant fluctuations in the abundance of glacial marine sediments occur in the Pleistocene and late Pliocene sediments. Lesser amounts occur in the early Pliocene/late Miocene sediments, and no older ice-rafted grains were found at this site. The transition zone of mixed siliceous and calcareous sediments (Unit 4) is mid Miocene and may represent a time during which the Antarctic Convergence repeatedly fluctuated from near its present position to south of it. The middle-late Miocene siliceous nannofossil oozes of Unit 3 may represent a time during which the convergence was south of its present position. Unit 2, a late-Pliocene-Pleistocene siliceous ooze, represents a time when the convergence was located near its present position and of similar intensity. Unit 1 is similar to Unit 2, except that it contains undissolved foraminifera and more ice-rafted material.

Siliceous sediment occasionally diatom rich. One layer of calcareous sediment, nannofossil rich, occurs in upper Miocene time.



SITE 278 LEG 29



SITE DATA

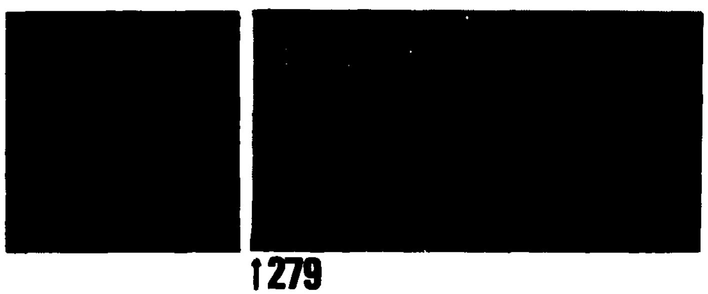
Position:
Latitude 51°20.1' S
Longitude 162°38.1' E
Date: 03/19/73
Time: 2208Z
Water depth: 3351 meters
Location: Northern Macquarie Ridge

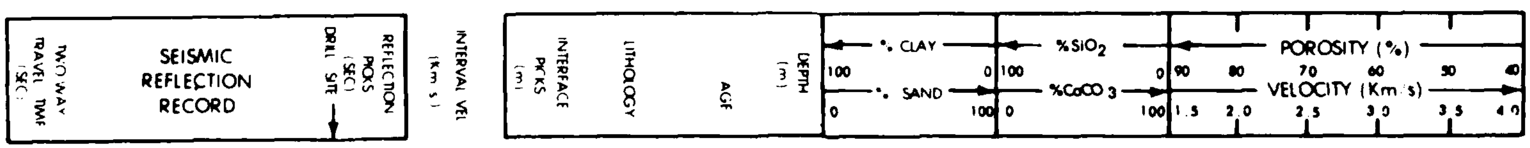
CORE DATA

Penetration:	279	279A	
Drilled--	0	92	meters
Cored----	1	110	meters
Total----	1	202	meters
Recovery:			
Basement-	0	2	cores
	0	3.4	meters
Total----	1	13	cores
	.6	79.8	meters

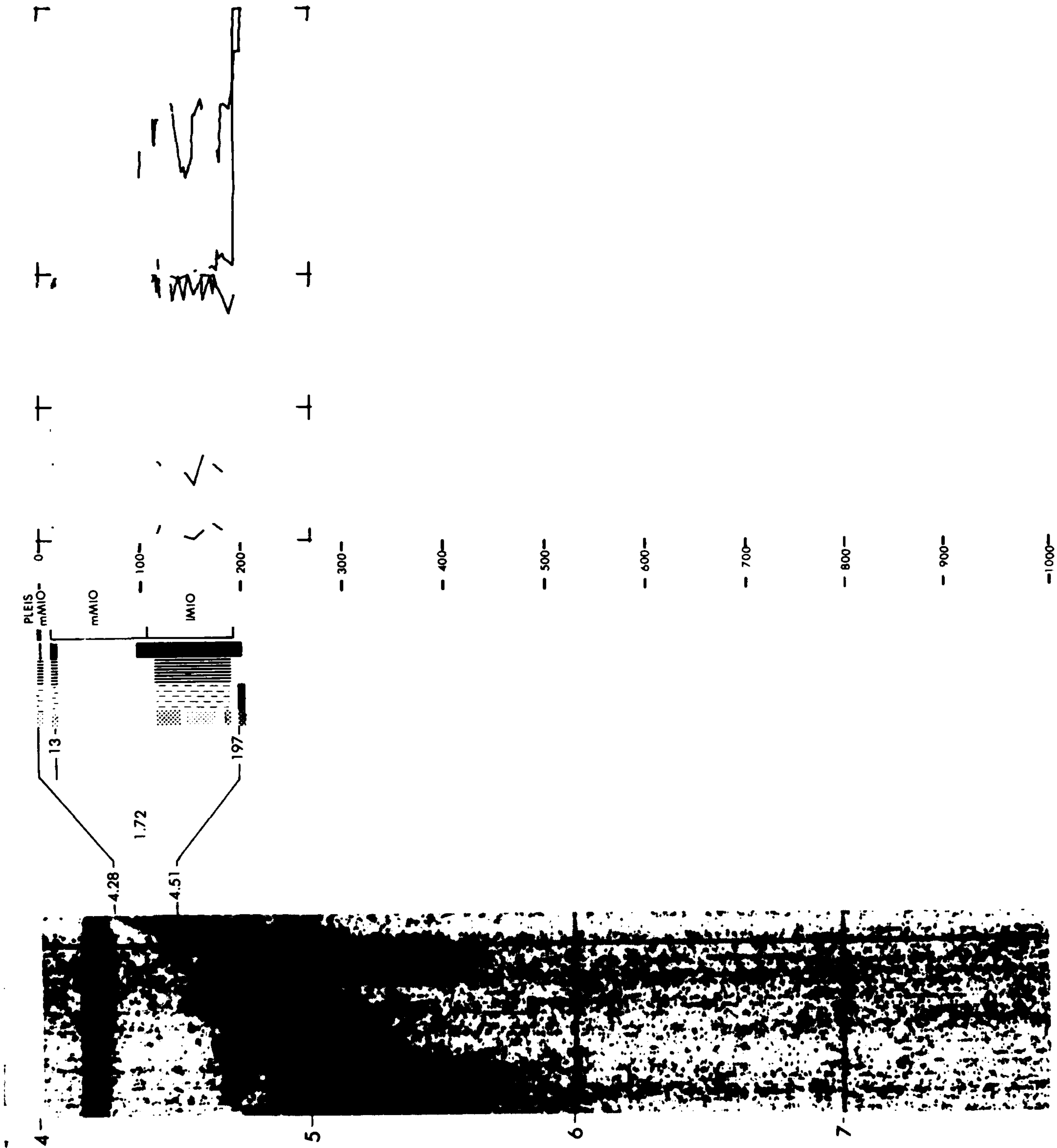
Site 279 represents a sequence of nannofossil oozes that shows relatively uniform, slow rates of sediment deposition throughout the early and middle Miocene with no apparent breaks in sedimentation. Preservation of the calcareous biogenic components indicates deposition above the lysocline. Increased activity of the bottom water in the region has removed the upper Cenozoic although a veneer of Pleistocene-(?) Recent foraminiferal ooze has subsequently been deposited. The sampling of early Miocene sediments directly overlying a fine-grained vesicular basalt at Site 279 indicates that the Macquarie Ridge was probably (but not necessarily) beginning to form at that time. The middle early Miocene age of the Macquarie Ridge is younger than major paleocircula-tion changes that occurred in the southeast Pacific during the Oligocene. Before the late Oligocene, erosive bottom waters were active in the northern Tasman Sea-Coral Sea areas, after which they were diverted to areas south and east of New Zealand and have been important in this region throughout the Neogene. The development of the Macquarie Ridge does not coincide with and thus probably did not cause these changes.

Sediment mostly nannofossil rich.





SITE 279 LEG 29



SITE DATA

Position:
Latitude 48°57.4'S
Longitude 147°14.1'E
Date: 03/26/73
Time: 0705Z
Water depth: 4186 meters
Location: South of the South Tasman Rise

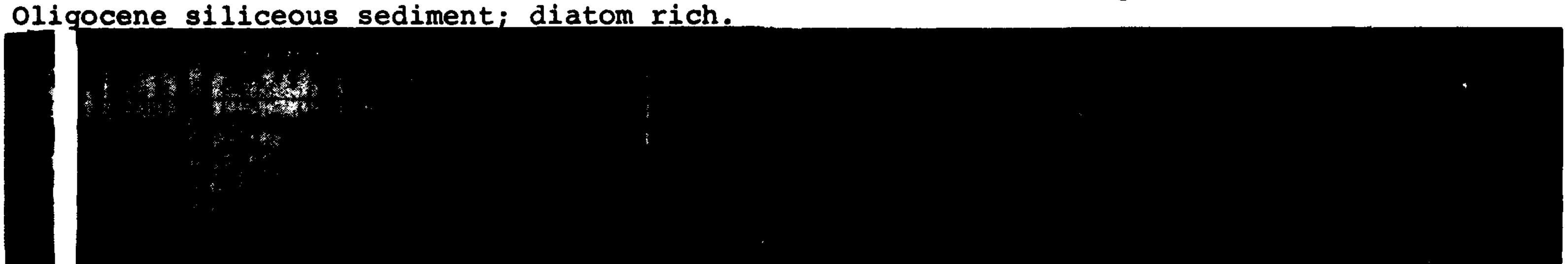
CORE DATA

Penetration:	280	280A	
Drilled--	0	323	meters
Cored----	6	201	meters
Total----	6	524	meters
Recovery:			
Basement-	0	2	cores
	0	5	meters
Total----	1	23	cores
	5.5	97.2	meters

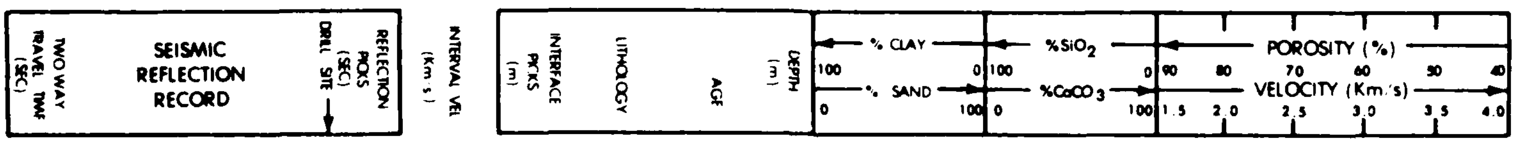
The predominance of detrital minerals in the very thick Unit 5, and their relatively high rate of accumulation, suggest deposition occurred close to a basin margin and relatively near a source of detrital sediments. The lack of primary sedimentary structures and the poor sediment sorting suggest that bottom-water circulation was rather restricted. Siliceous productivity was negligible during middle Eocene, and considerable during middle-late Eocene and early Oligocene. At the same time, detrital sediments deposition decreased, reflecting the depositional site moving away from the supply source. The continuous sedimentation record is abruptly terminated near the end of the Paleogene.

The basal sediments and intrusive basalts at Site 280 suggest that by the middle Eocene, a central volcanic ridge had begun to form. Initially, deposition occurred in a basin with highly restricted circulation and terrigenous deposition. During the later half of the Eocene and the Oligocene, conditions were less restrictive and more biogenically productive. Active deep bottom currents were developed south of Australia as the result of initial circumpolar current development. Consequently the Neogene sequence is poorly represented because of extensive deep-sea erosion.

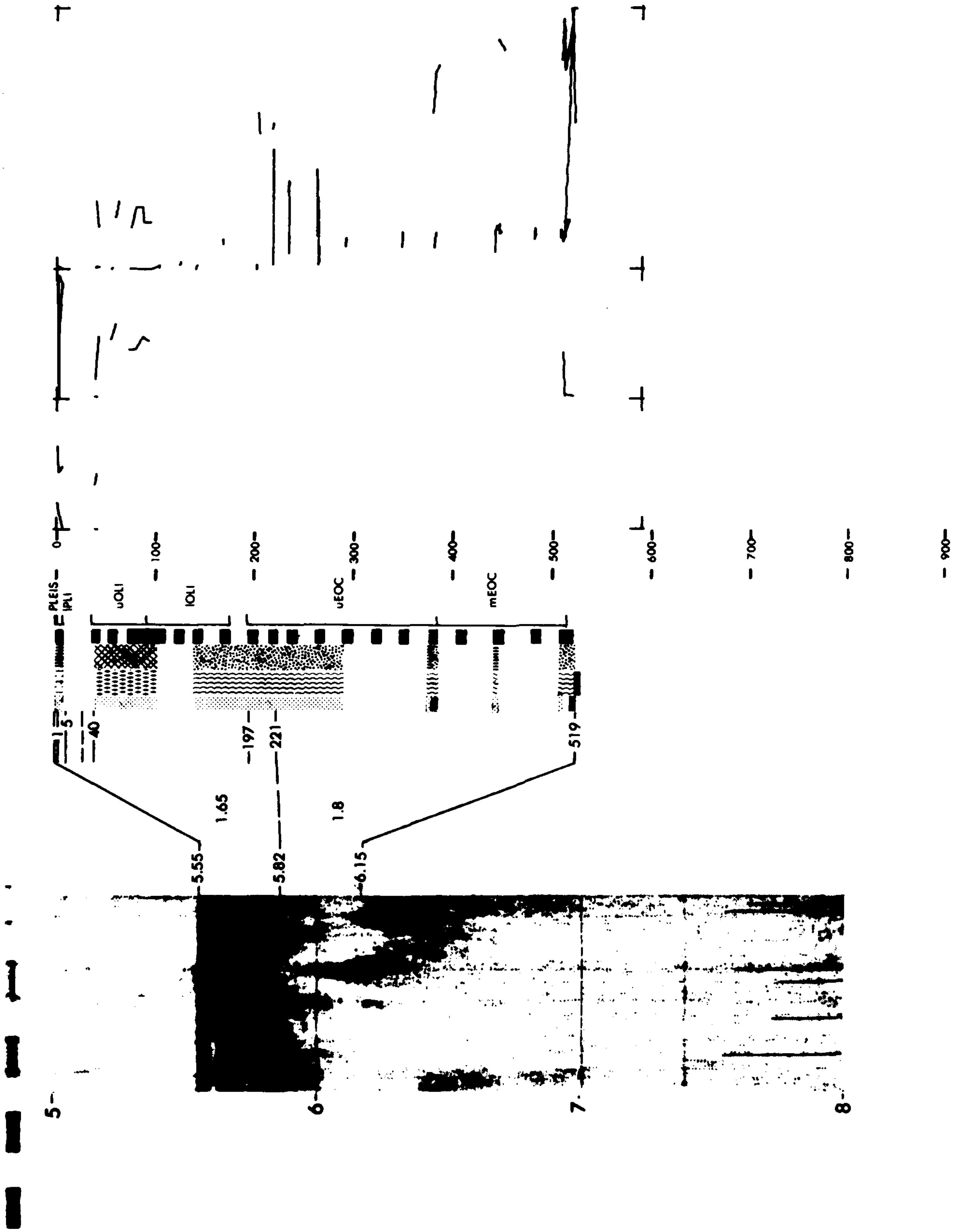
Pleistocene; calcareous, nannofossil rich, with one thin layer of siliceous sediment. Oligocene siliceous sediment; diatom rich.



280



SITE 280 LEG 29



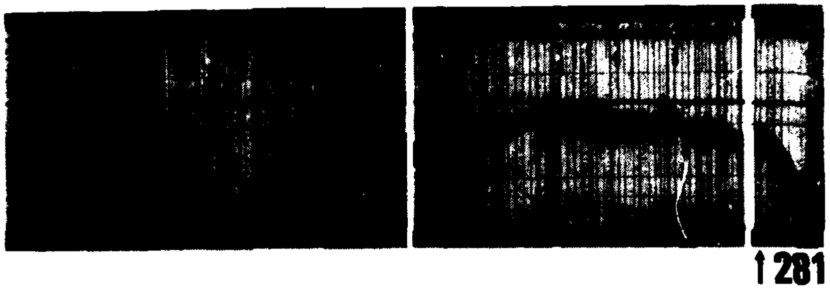
SITE DATA

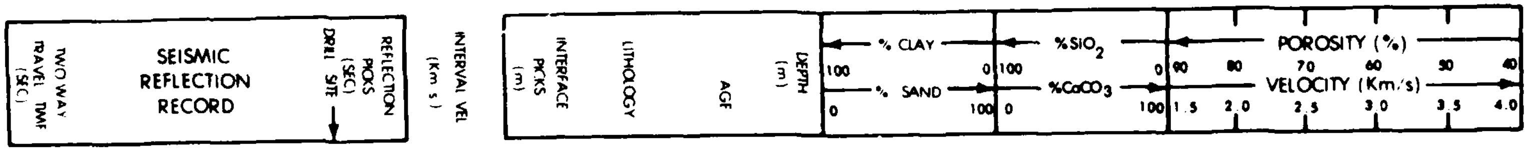
Position:
Latitude 47°59.8' S
Longitude 147°45.8' E
Date: 03/30/73
Time: 2353Z
Water depth: 1595 meters
Location: South Tasman Rise

CORE DATA

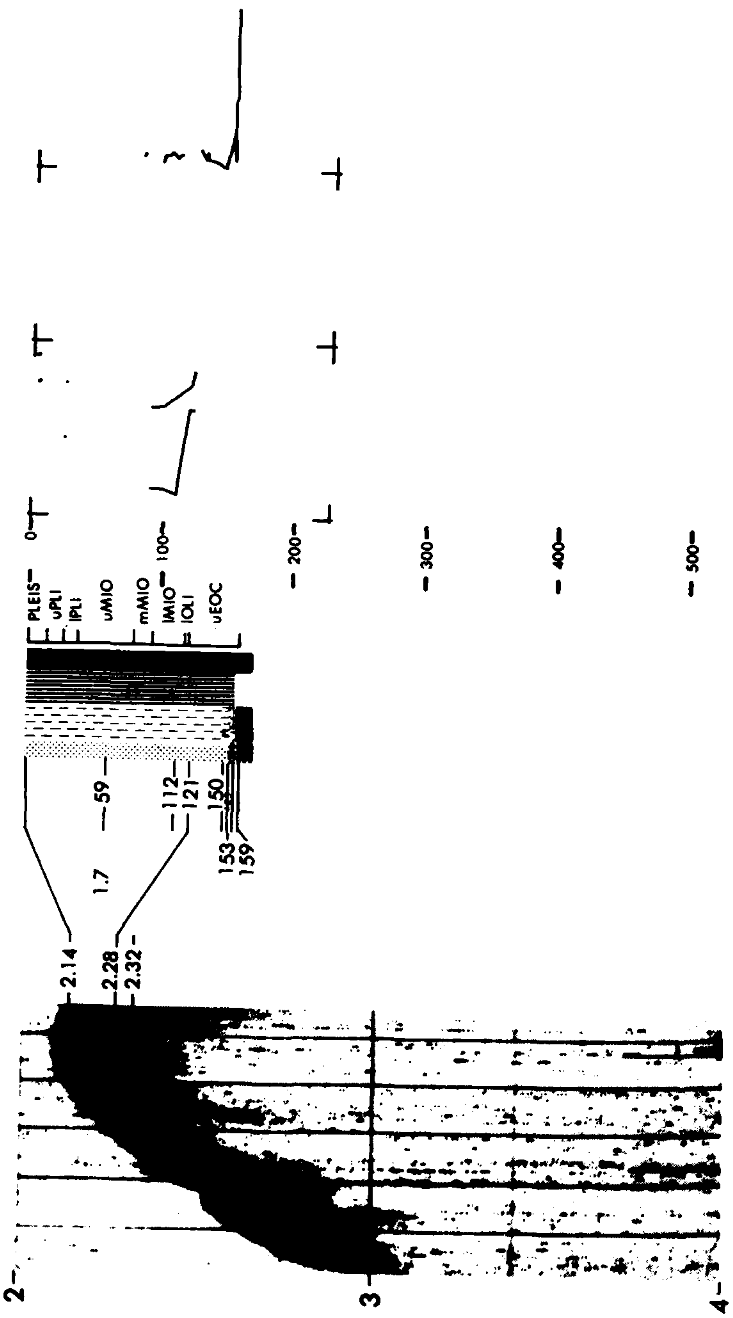
Penetration:	281	281A	
Drilled--	0	17	meters
Cored----	169	28.5	meters
Total----	169	45.5	meters
Recovery:			
Basement-	3	0	cores
	.06	0	meters
Total----	19	3	cores
	105.6	7.1	meters

The quartz-mica schist continental basement, part of the southernmost extremity of Australia that formed the last connection with Antarctica. The overlying, poorly sorted schist breccia probably is locally derived. It was deposited in a high-energy, marginal marine environment during the initial transgression of the subsiding South Tasman Rise in the late Eocene. Shallow-water and lower energy conditions (neritic-upper bathyal) prevailed during deposition of Units 3 and 4. At the top of Unit 3, within the late Eocene, current intensity increased to transportational or erosional regimes producing the late Eocene-early Oligocene disconformity between Unit 3 and the base of Unit 2. Currents temporarily waned to deposit early Oligocene glauconitic sand at the base of Unit 2, but strengthened again to produce a disconformity spanning most of the Oligocene. The late Oligocene glauconitic sand in Unit 2 was deposited by a current with a gradually decreasing load of coarse detrital sand and glauconite. After migration of the "proto circumpolar current" to the south, Site 281 became an area of pelagic biogenic sedimentation that continues to the present day, forming the foraminiferal-nannofossil oozes of Unit 1.





SITE 281 LEG 29



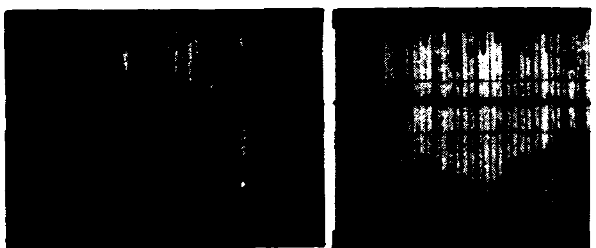
SITE DATA

Position:
Latitude 42°14.8' S
Longitude 143°29.2' E
Date: 04/05/73
Time: 0410Z
Water depth: 4212 meters
Location: Magnetic Quiet Zone west

CORE DATA

Penetration:
Drilled-- 143 meters
Cored----167.5 meters
Total----310.5 meters
Recovery:
Basement- 3 cores
7.2 meters
Total---- 20 cores
63.7 meters

The well-preserved pillow structures of the basalt and the incorporated sediment indicates that fairly pure calcareous material (probably a nannofossil ooze) was being deposited at the time that the basalt was extruded onto the ocean floor. Units 4-7, late Eocene to middle Oligocene, appear to have been deposited continuously at a fairly rapid rate. Direct sediment contribution by basic volcanic activity appears to be restricted to the very base of the sediment sequence, and even this basal sequence contains a high proportion of sand- and silt-size quartz apparently derived from the adjacent continent. At 55 meters subbottom depth, the probably middle Oligocene to early Miocene unconformity marks a reduction of the total detrital content in the overlying Unit 3. This is accompanied by a decrease in sponge spicules and micronodules. Late Miocene Unit 2 is a thin nannofossil ooze layer with no significant terrigenous contribution. The presence of the unconformity, an increase in biogenic material, and reduction of the terrigenous contribution must indicate increasing oceanic circulation following the mid Oligocene. The uppermost thin unit reflects the fluctuating sea level and climatic conditions of the Pleistocene.

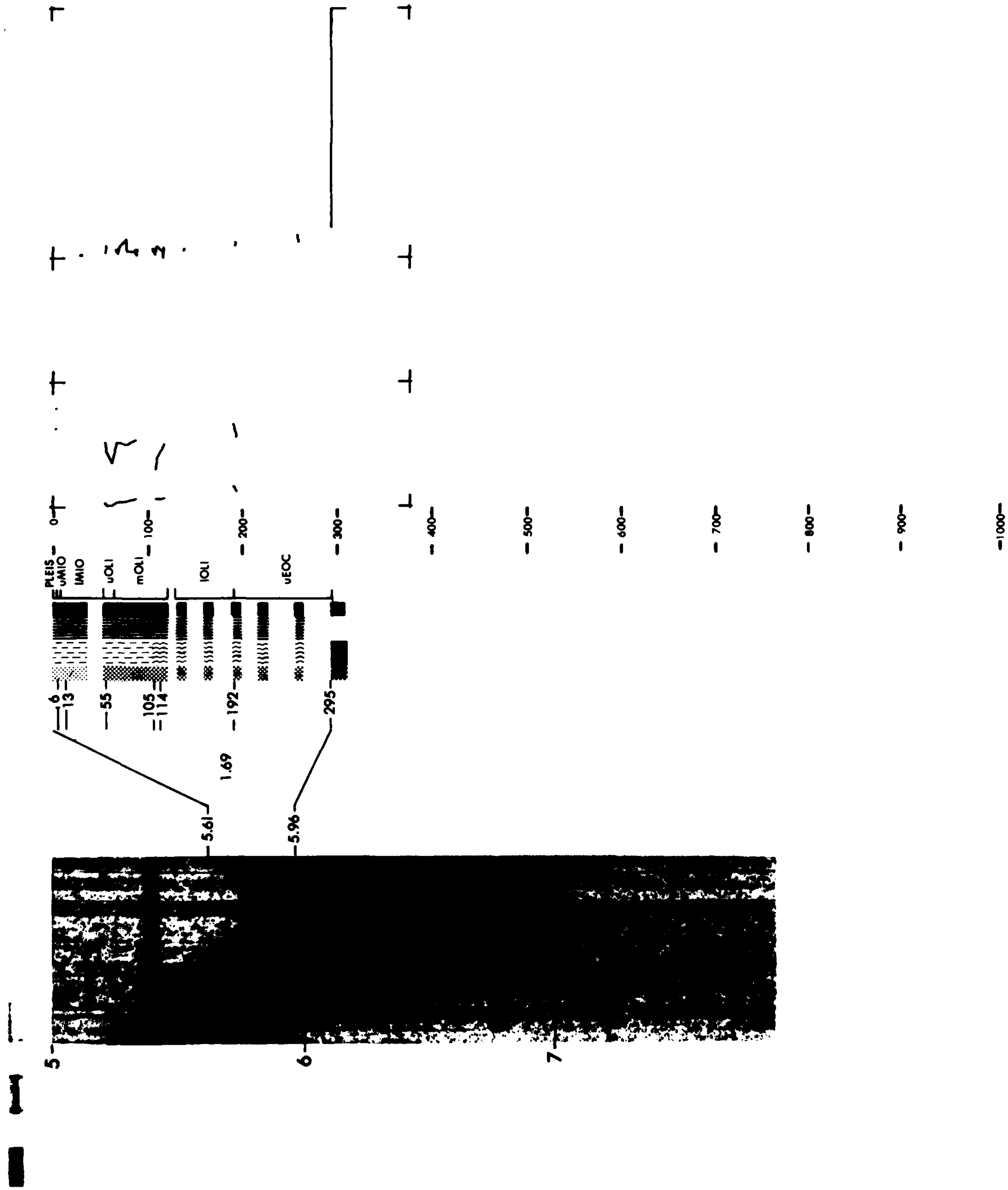


282

TWO WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | REFLECTION PICKS (SEC) | DRILL SITE | INTERVAL VEL (Km/s)

INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100–0 / % SAND 0–100 | %SiO2 100–0 / %CaCO3 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 282 LEG 29



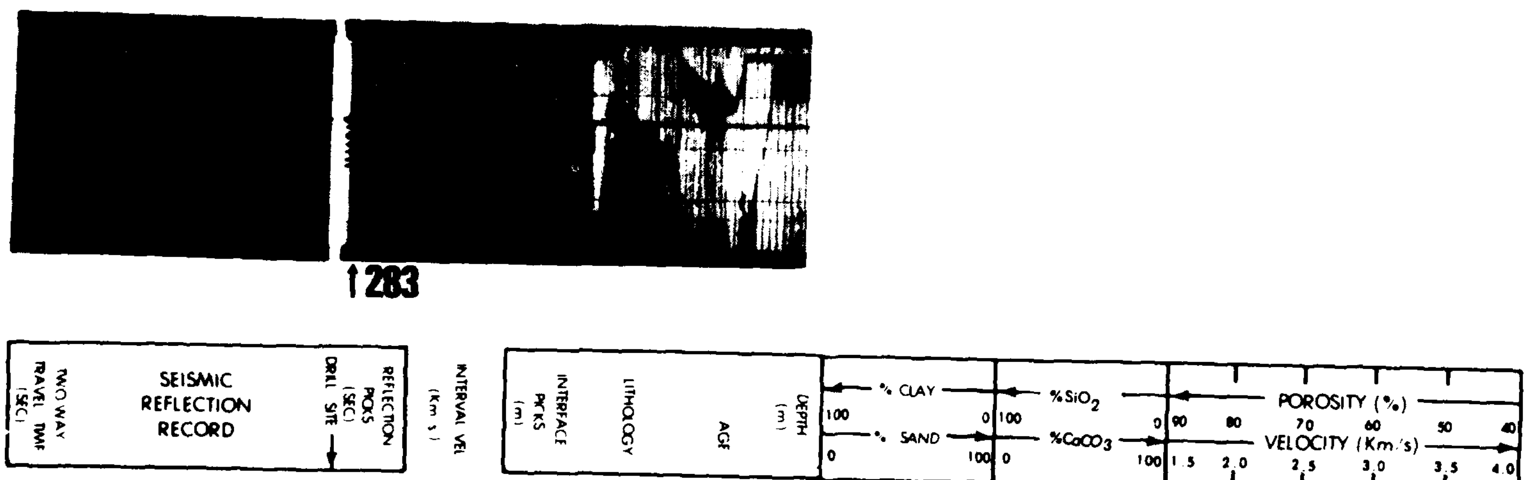
SITE DATA

Position:
Latitude $43^{\circ}54.6'$ S
Longitude $154^{\circ}17.0'$ E
Date: 04/09/73
Time: 2317Z
Water depth: 4729 meters
Location: Central Tasman Sea

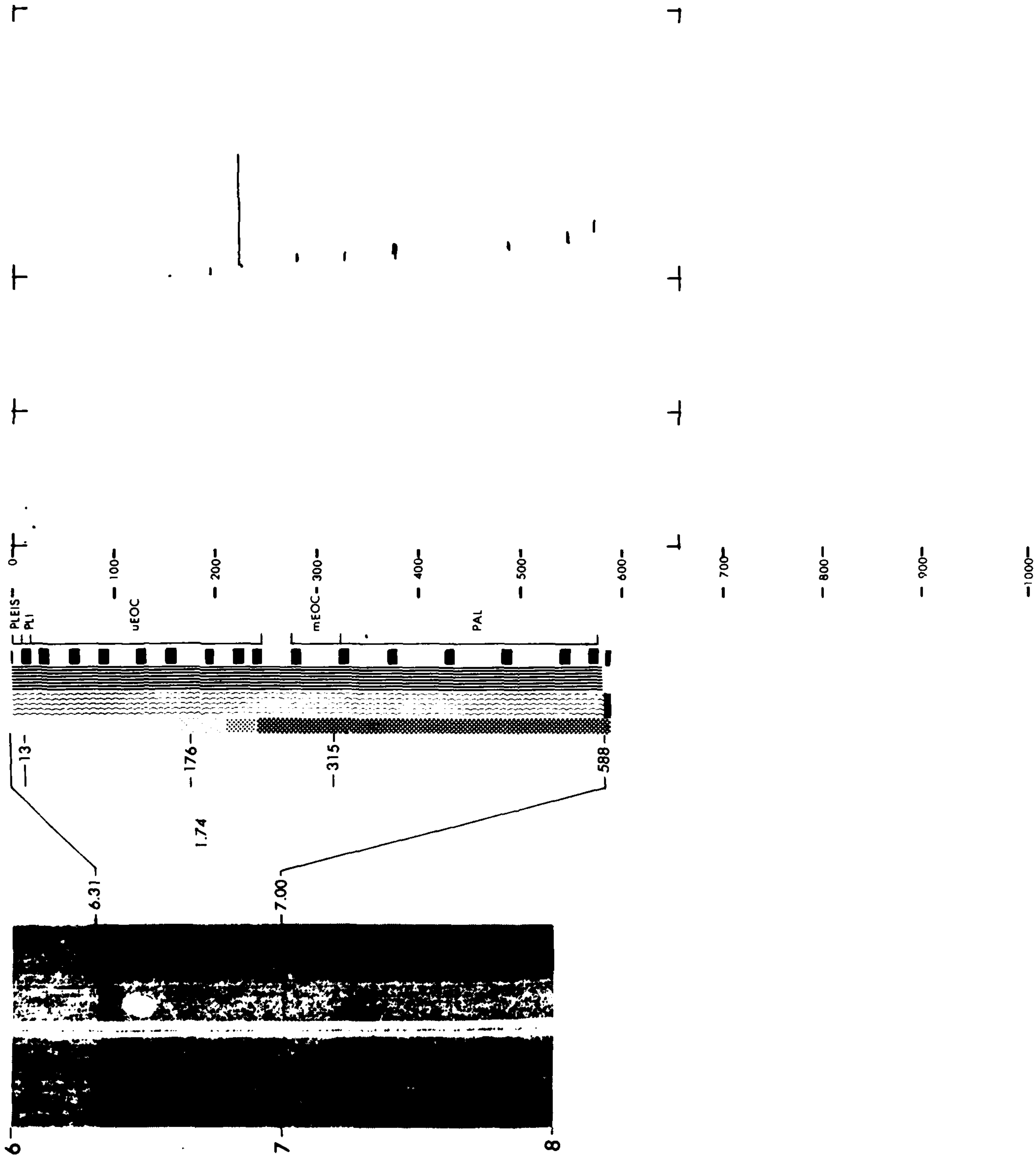
CORE DATA

Penetration:	283	283A	
Drilled--	0	9.5	meters
Cored----	156	11	meters
Total----	592	20.5	meters
Recovery:			
Basement-	2	0	cores
	1.5	0	meters
Total----	19	2	cores
	61.1	10.5	meters

The depositional episode spanning Paleocene-late Eocene records no change in the nature, and probably the rate of influx, of terrigenous components (quartz, silt, clays) that reached Site 283 from sources in Australia. In the early part (Units 3 and 4) of the episode, however, the depositional site lay at depths greater than the silica and calcium carbonate compensation depth, whereas in the later part (Unit 2), water conditions had changed sufficiently for these fossils to have been preserved. The time of this change (mid to late Eocene) coincides with, or follows shortly after, the termination of spreading in the Tasman Sea and the onset of the continental drift of Australia from Antarctica. Conditions of nondeposition represented by the late Eocene-late Plio-Pleistocene unconformity prevailed during most of the rest of the Cenozoic at Site 283. Late Plio-Pleistocene time is represented by less than 15 meters of sparingly fossiliferous zeolitic clays developed by the alteration of fine-grained volcanic constituents.



SITE 283 LEG 29



SITE DATA

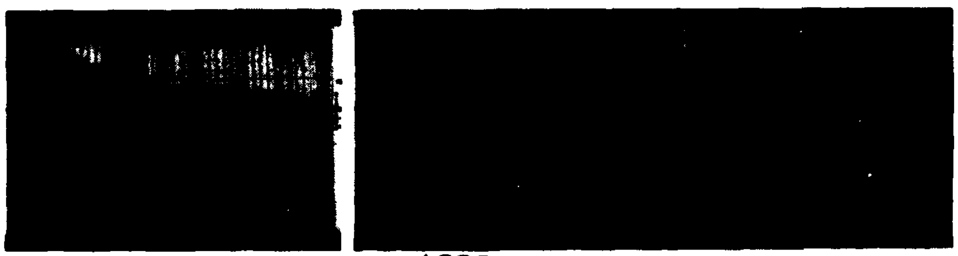
Position:
Latitude 40°30.5'S
Longitude 167°40.8'E
Date: 04/15/73
Time: 0600Z
Water depth: 1060 meters
Location: Challenger Plateau

CORE DATA

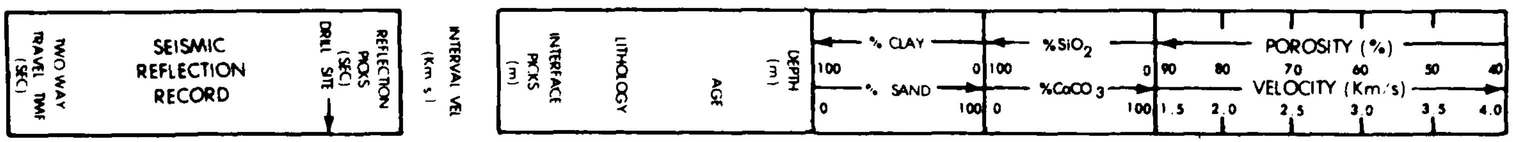
Penetration:	284	284A	
Drilled--	0	46.5	meters
Cored----	208	28.5	meters
Total----	208	75	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	22	3	cores
	166.8	22.4	meters

This sequence is very consistent in its lithologic nature, and thus represents deposition in an environment which has changed little in depth and tectonic setting since the late Miocene. Lack of ice-rafted debris indicates that the site has been north of the iceberg limit since the late Miocene. The scarcity of terrigenous sediments indicates that bottom currents in this region have not been important, nor has the area been exposed to turbidity currents. The small amount of volcanic material present in sediments at this site indicates that the prevailing westerlies have existed since the late Miocene, and very little wind-blown volcanic debris has been transported from New Zealand. However, the mica and very fine-grained material may have been transported by prevailing westerlies from Australia, or by subaqueous suspension from the area of New Zealand. The color changes which occur are interpreted as follows: Subunit 1A was deposited during a period of strongly fluctuating paleoclimatic conditions, resulting in alternating beds of light and dark colors. Subunit 1B, uniform in color, was deposited during the less rapidly fluctuating climatic conditions during the Pliocene and late Miocene.

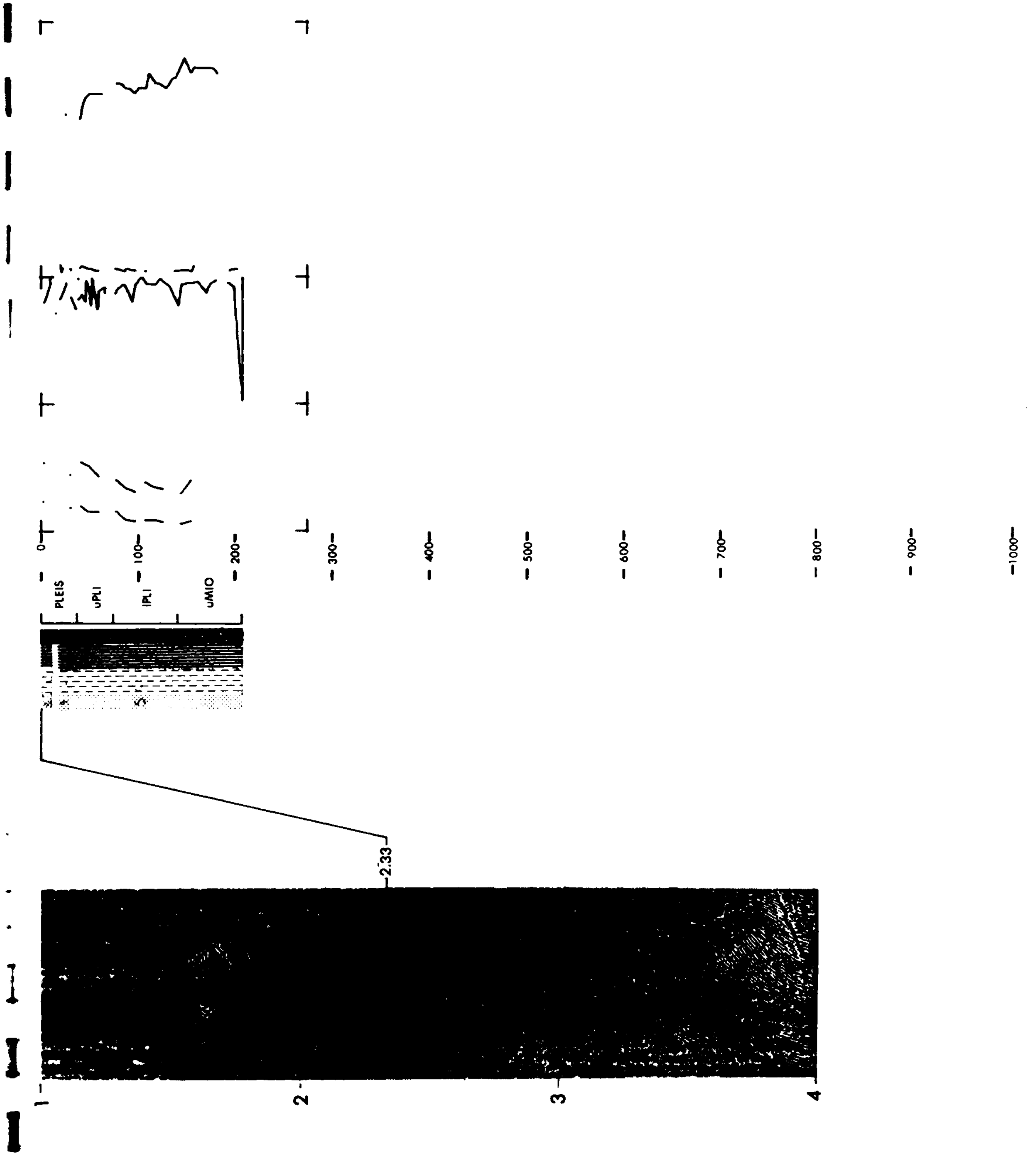
Pleistocene sediment nannofossil rich.



↑284



SITE 284 LEG 29



SITE DATA

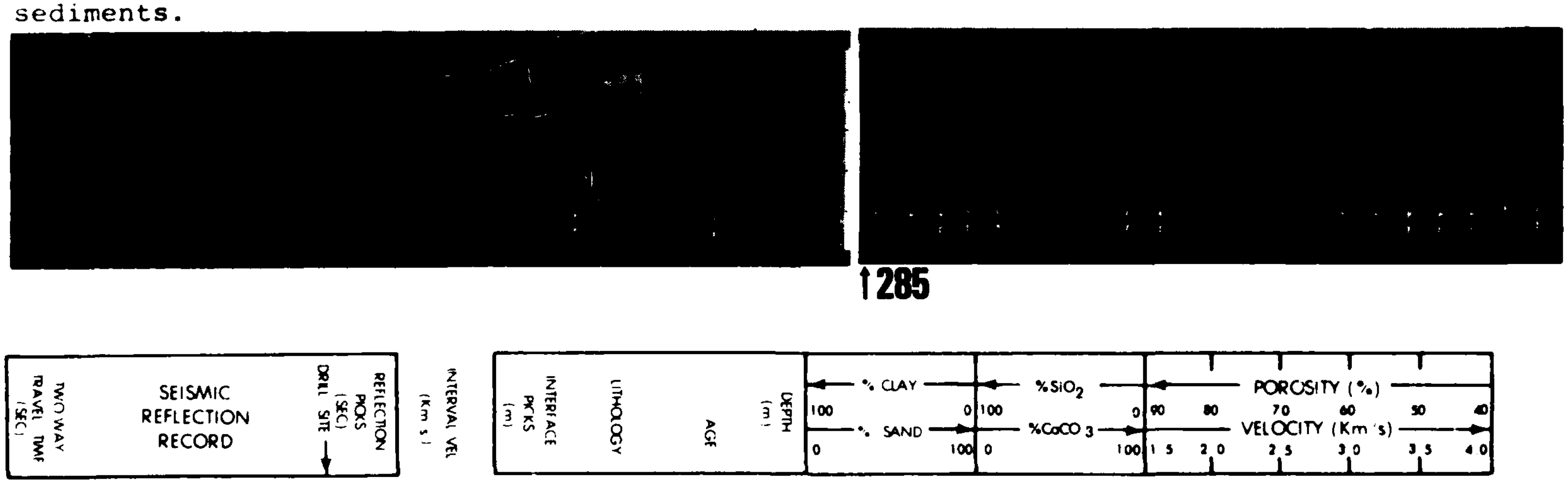
Position:
Latitude 26° 49.2' S
Longitude 175° 48.2' E
Date: 04/29/73
Time: 1031Z
Water depth: 4658 meters
Location: South Fiji Basin

CORE DATA

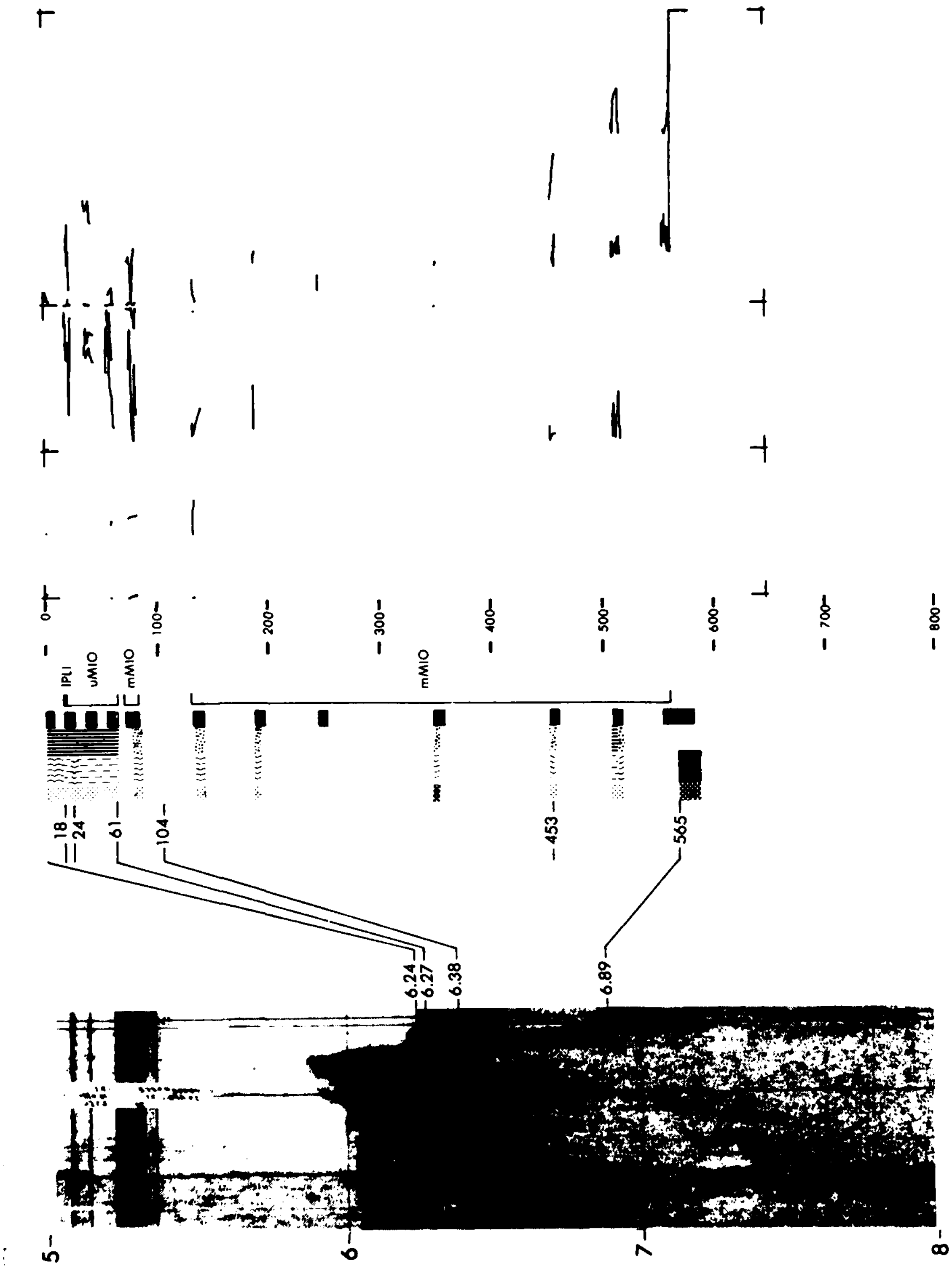
Penetration:	285	285A	
Drilled--	38	499	meters
Cored----	45	85	meters
Total----	83	584	meters
Recovery:			
Basement-	0	3	cores
	0	10	meters
Total----	5	9	cores
	42	47	meters

Pyroclastics were deposited at Site 205 on late Oligocene oozes and transported ashes laid down at Site 285. The latter was located in the deeper part of the basin. The intensity of the volcanism decreased through the Miocene. Derived shallow-water fossils are occasionally incorporated in the sediments. Post mid-Miocene intrusion of the diabase sill occurred along the Oligocene/Miocene hiatus. If the Lau Ridge is the source of the volcanism, then it is important to note that activity on the Lau Ridge postdates formation of the South Fiji Basin. In the latest Miocene, biogenic deposits laid down near the calcium carbonate compensation depth predominated. Tectonic activity at about the end of the Miocene exposed the Oligocene to early Miocene sequence within the basin and submarine erosion redeposited some of the sediment in the highest Miocene and early Pliocene sediments. The ?latest Pliocene to Recent deposits were deposited in water below the carbonate compensation depth either as a result of basin subsidence (possibly due to decrease in heat flow) and/or rise in the carbonate compensation depth due to fall in bottom-water temperature.

Interbedded calcareous, nannofossil rich, and detrital, mica or serpentine rich sediments.



SITE 285 LEG 30



SITE DATA

Position:
- Latitude $16^{\circ}31.9'$ S
- Longitude $166^{\circ}22.2'$ E

Date: 05/07/73
Time: 0650Z
Water depth: 4465 meters
Location: New Hebrides trenches

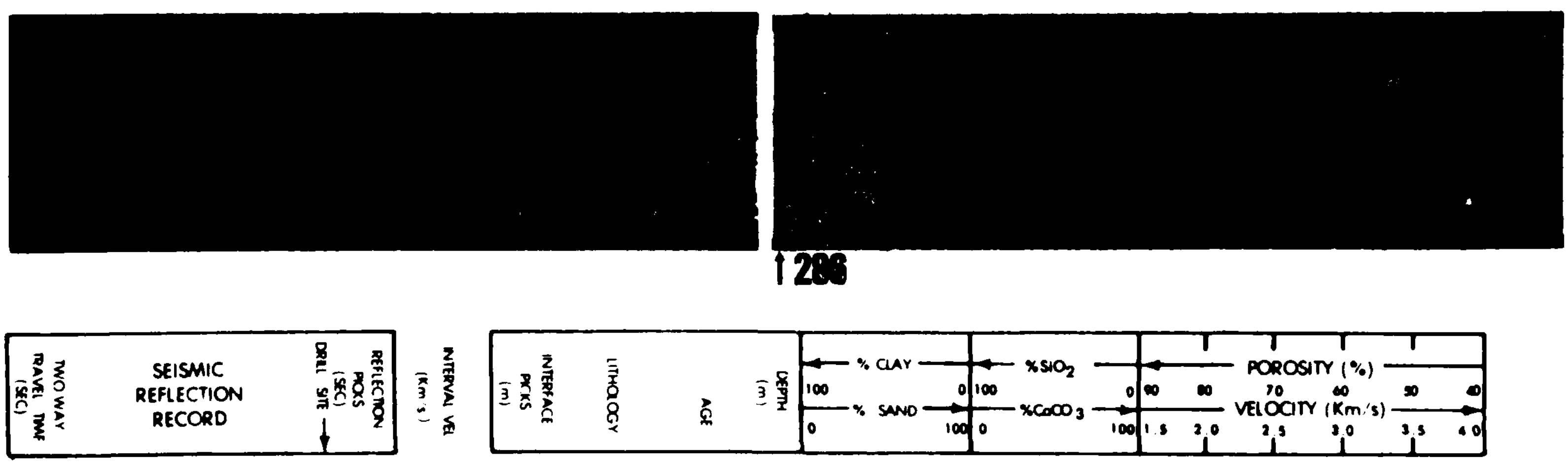
CORE DATA

Penetration:
- Drilled-- 323 meters
- Cored---- 383 meters
- Total---- 706 meters

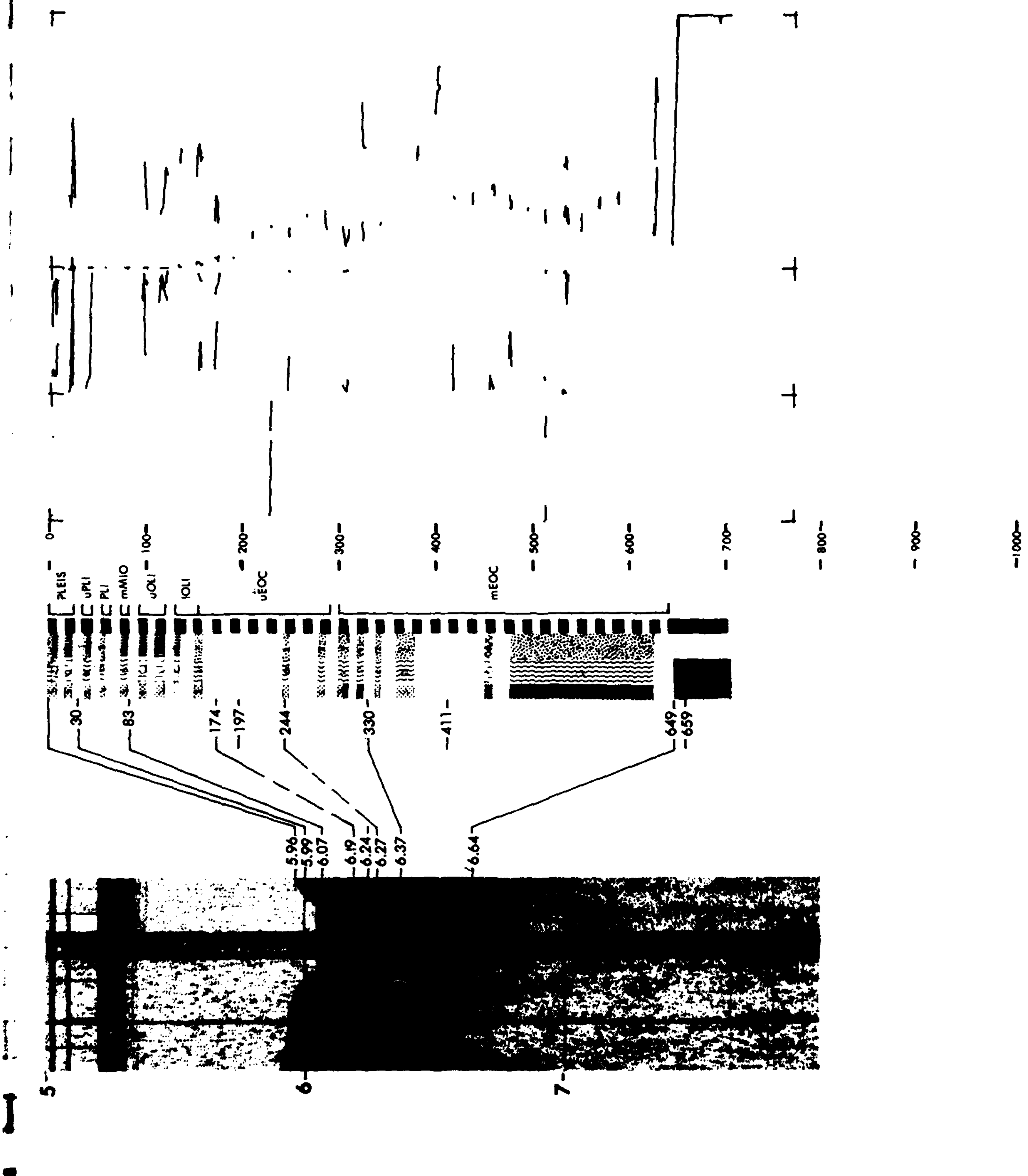
Recovery:
- Basement- 6 cores, 39 meters
- Total---- 41 cores, 170 meters

Rapid deposition of a submarine fan at the base of a volcanic ridge took place directly on basaltic flows in middle Eocene time. Active andesitic volcanism continued until near the end of the Eocene. Deposition of the siltstone-sandstone sequences was probably by turbidity currents in relatively deep water, but above the foram solution depth. The nonbedded conglomerates were possibly formed by debris-flow. Volcanic activity declined sharply during the late Eocene and Oligocene. Mainly biogenic sediments were deposited in late Eocene and Oligocene with small amounts of ash throughout Unit 2. The depositional surface was below the foram solution depth and above the nanno solution depth. In the latest Oligocene to perhaps Miocene time, abyssal clay rich in glass shards was deposited below both the foram and nanno solution depths. A period of nondeposition or erosion may have occurred before the early Pliocene sediments. Volcanic activity was more or less continuous throughout the Pliocene and Pleistocene. Reworked fossils, suggest erosion of older shelf deposits nearby (?New Hebrides or Loyalty Islands) during the Pleistocene.

Interbedded calcareous, nannofossil rich, and detrital, mica or serpentine rich sediments.



SITE 286 LEG 30



SITE DATA

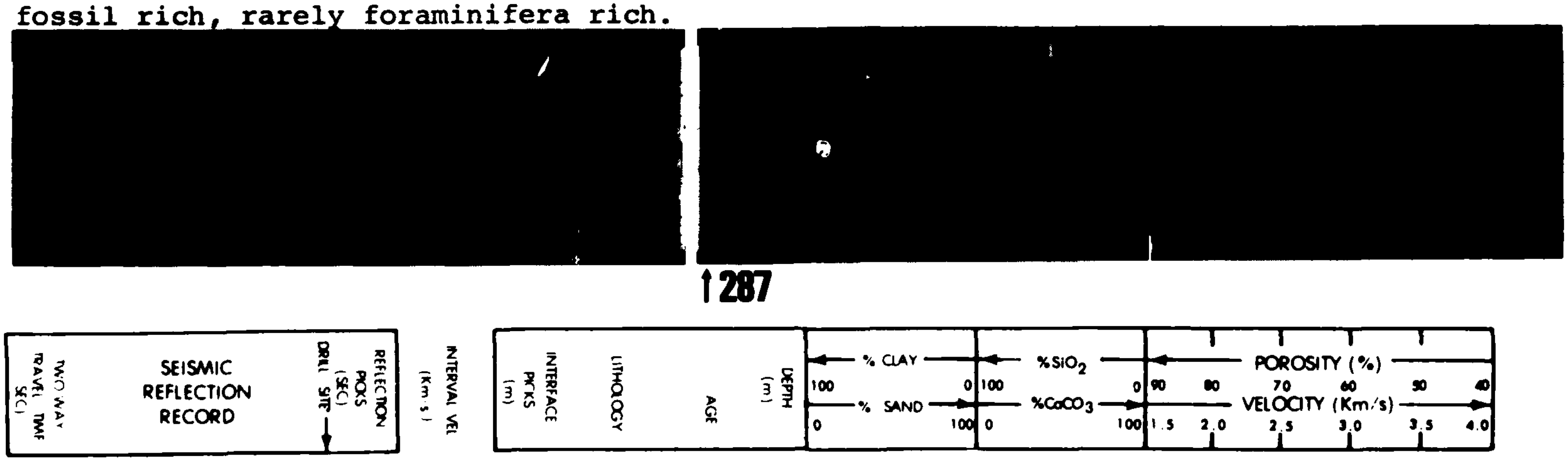
Position:
Latitude 13°54.7' S
Longitude 153°15.9' E
Date: 05/14/73
Time: 2112Z
Water depth: 4632 meters
Location: Coral Sea

CORE DATA

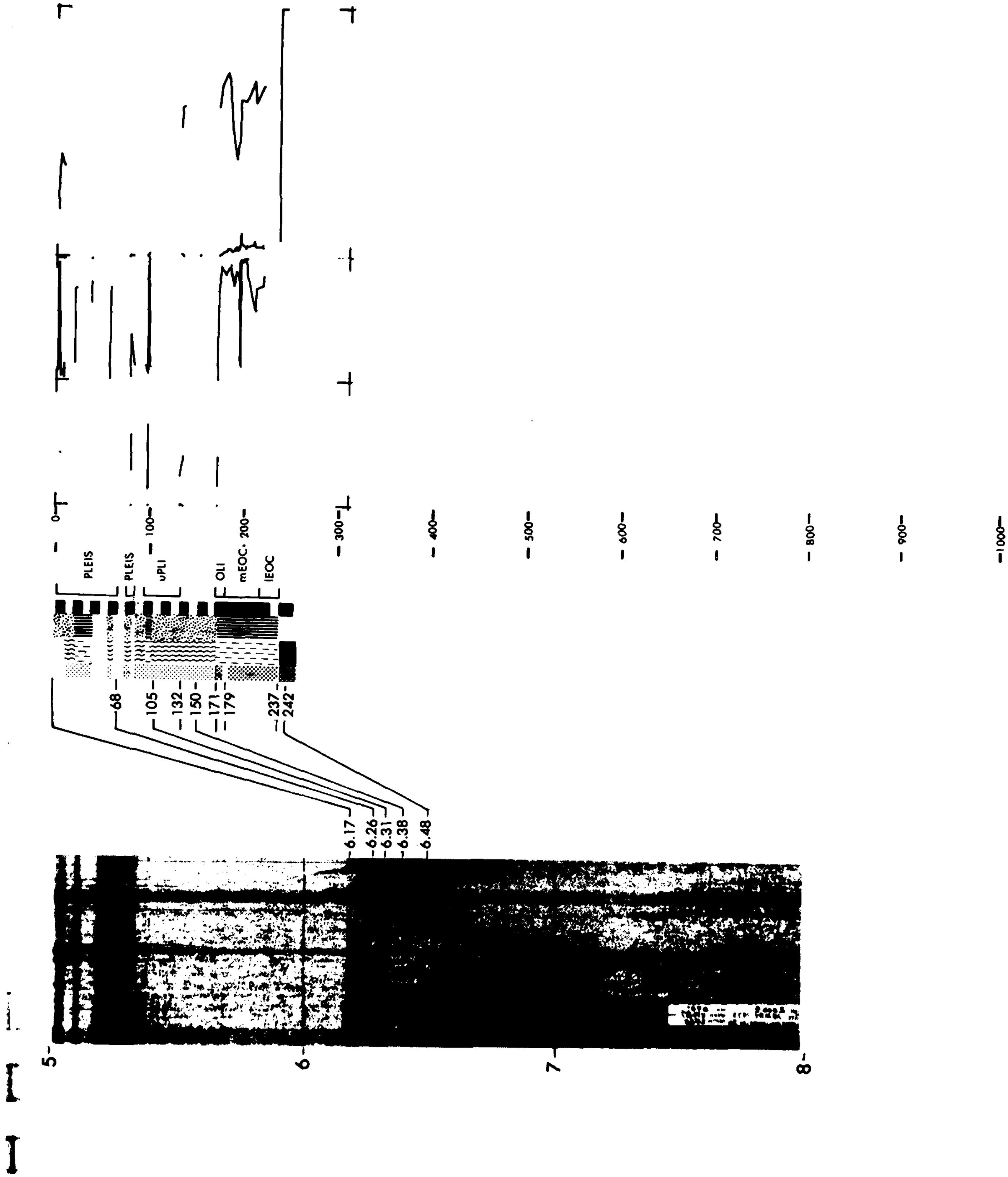
Penetration:
Drilled-- 95 meters
Cored---- 157 meters
Total---- 252 meters
Recovery:
Basement- 3 cores
5 meters
Total---- 18 cores
72 meters

Because a hiatus was found between the corresponding units at Site 210 (42 km to the west), a similar break is suggested between Units 3 and 4 at this site. Unit 3 is an unfossiliferous brown abyssal clay which is in turn overlain by unfossiliferous green silty clay (Unit 2). These sediments of Unit 2 are thought to form a transgressive sheet deposited by bottom suspension flows. If this interpretation is correct, there is probably a hiatus between Units 2 and 3 and the sedimentation rate increases upwards as the elevation of the abyssal plain approached that of the hill on which the site is located. The average rate of deposition of Unit 2 is probably substantially less than the rate from 50-80 m/m.y. for the upper Pliocene to 120-180 m/m.y. for the Quaternary for Unit 1. Unit 1 shows an upward increase in sedimentation rate. Like Unit 3, Units 1 and 2 were deposited below or near the nanno solution depth. Reworked fossils are common in Unit 1. Nannofossils as old as Upper Cretaceous were encountered, but forams older than upper Pliocene were not recorded. In the oldest beds of Unit 5 (early Eocene) reworking was noted in both the nanno and foram assemblages, including forams as old as Danian.

Interbedded calcareous and detrital sediments. Calcareous sediment; mostly nannofossil rich, rarely foraminifera rich.



SITE 287 LEG 30



SITE DATA

Position:
Latitude 5°58.3' S
Longitude 161°49.5'E
Date: 05/20/73
Time: 1800Z
Water depth: 3000 meters
Location: Ontong-Java Plateau

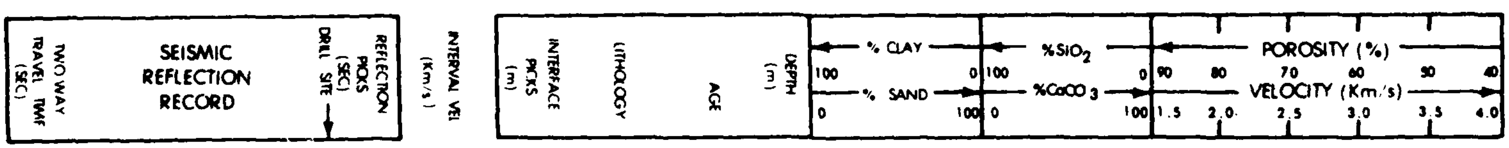
CORE DATA

Penetration:	288	288A	288B	288C	
Drilled--	140	704	147	146	meters
Cored----	98	284	3	4	meters
Total----	238	988	150	150	meters
Recovery:					
Basement-	0	0	0	0	cores
	0	0	0	0	meters
Total----	11	30	1	1	cores
	50	61	3	4	meters

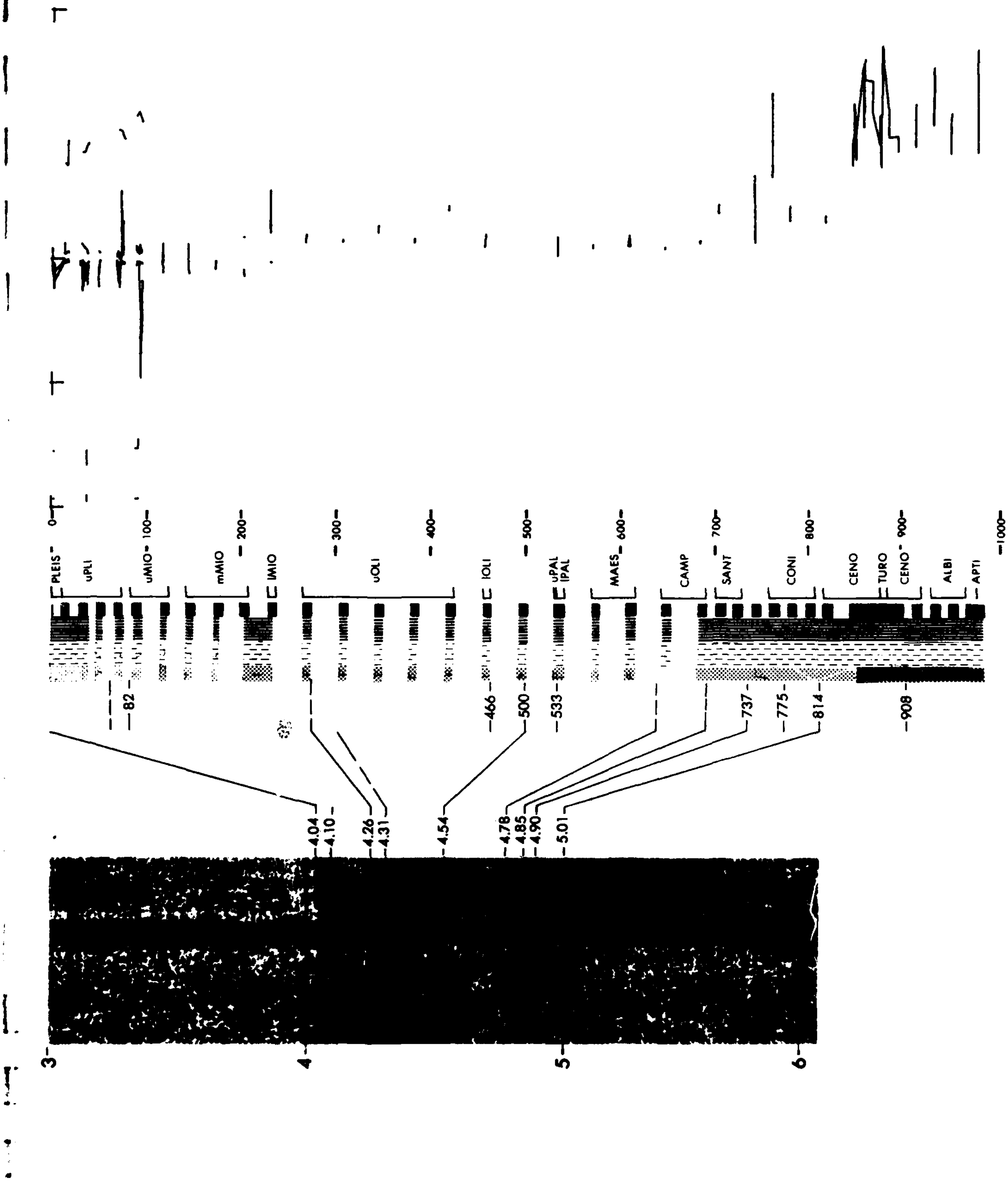
During the early Eocene, Site 288 and its vicinity became a current-swept slope upon which sediment deposition was intermittent and sometimes associated with extensive resedimentation of material from the plateau surface and margin. The highest upper Eocene and lower Oligocene are lost in a further and final discontinuity. This break is widespread in the western Pacific and suggestions of an angular unconformity at some localities might suggest pre-Oligocene tectonism. The aftermath of this episode is recorded in Hole 288, Core 6 (Rupelian). Currents continued to flow down the Site 288 slope, but they deposited. The resulting sediment was particularly rich in late Eocene derived foraminifera. Further increase in bottom current activity could have halted accumulation in the later Chattian. Intense reworking and leaching resulted in the intra-late Oligocene discontinuity. Comparatively prolonged, continuous accumulation now set in during the latest early Miocene and persisted through early late Miocene. The period of Pliocene accumulation may have been brief (the deposits being disconformable upwards against Late Pleistocene) and conceivably they represent the slumping of highly fluid Mio-Pliocene sediments.

Sediments mostly; foraminifera or nannofossil rich.

↑288



SITE 288 LEG 30



SITE DATA

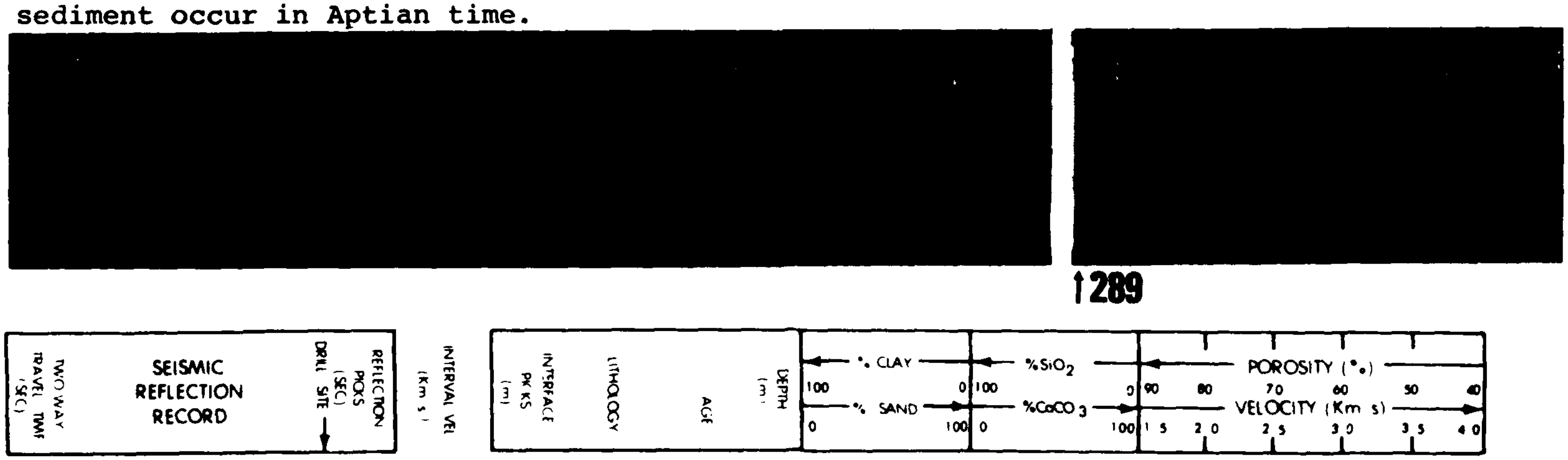
Position:
Latitude 0°29.9' S
Longitude 158°30.7' E
Date: 05/31/73
Time: 0536Z
Water depth: 2206 meters
Location: Ontong-Java Plateau

CORE DATA

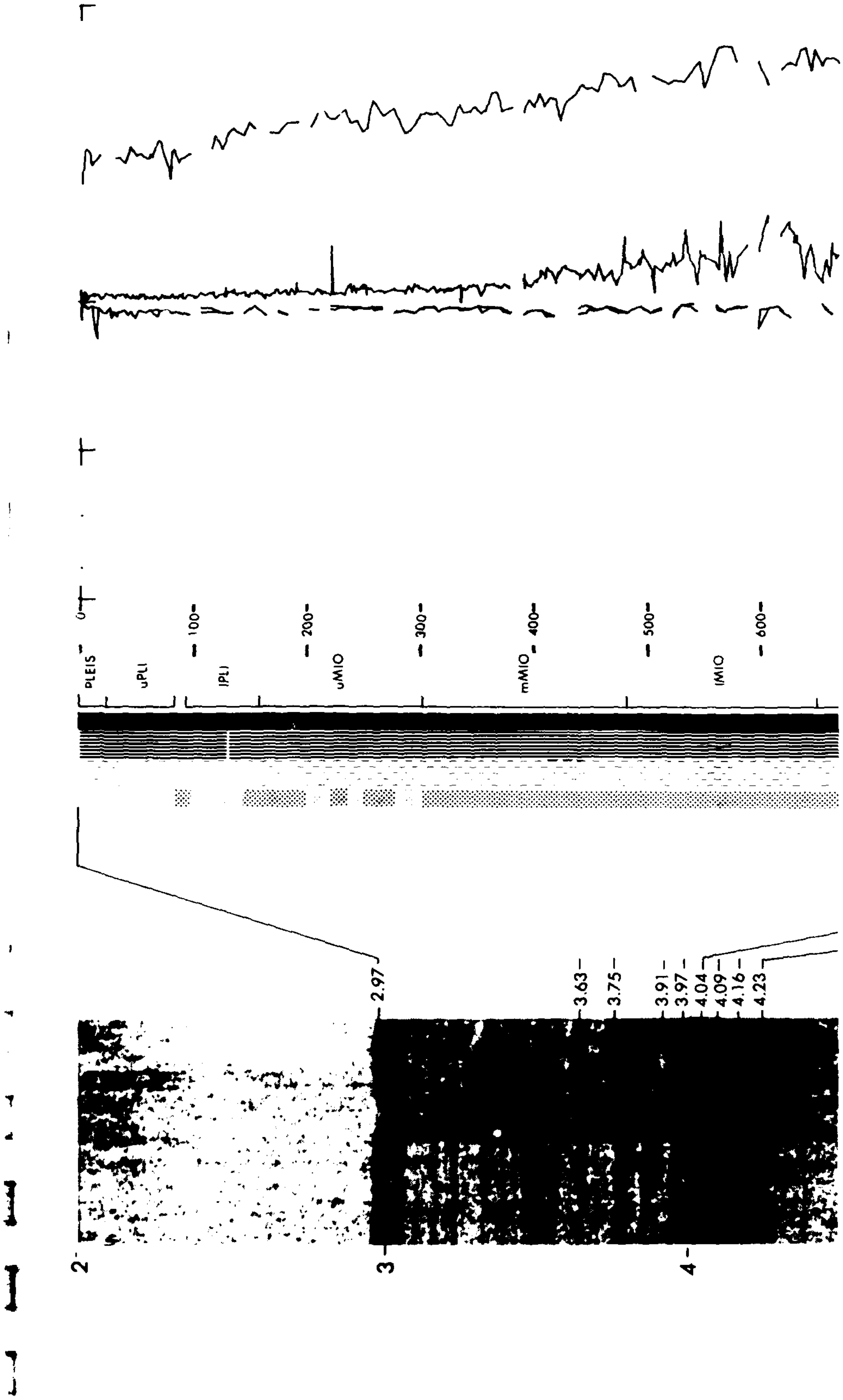
Penetration:
Drilled-- 0 meters
Cored----1271 meters
Total----1271 meters
Recovery:
Basement- 2 cores
5 meters
Total---- 133 cores
713 meters

The sequence of events began with the extrusion of tholeiitic basaltic lava flows. Following basalt extrusion, deposition of vitric tuff occurred, followed by biogenic sedimentation above the foram solution depth. A period of nondeposition or erosion followed from late Aptian into Campanian. Biogenic sedimentation during Campanian time was below the foram solution depth. During latest Maestrichtian and earliest Paleocene time, a second period of nonaccumulation occurred. Biogenic sedimentation above the foram solution depth continued during the late Paleocene. A third period of nonaccumulation occurred and persisted into the early Eocene. A short period of continued biogenic sedimentation above foram solution depth occurred during the early Eocene followed by a fourth hiatus. Biogenic sedimentation occurred continuously during the middle and late Eocene. A minor period of higher productivity of Radiolaria occurred during the entire late Eocene. A fifth period of nonaccumulation occurred at the end of Eocene time and persisted into the earliest Oligocene. From the beginning of the early Oligocene until the Holocene, continuous biogenic sedimentation of foraminifera and nannofossils has occurred.

Sediment mostly; foraminifera, or nannofossil rich. Two thin layers of detrital sediment occur in Aptian time.

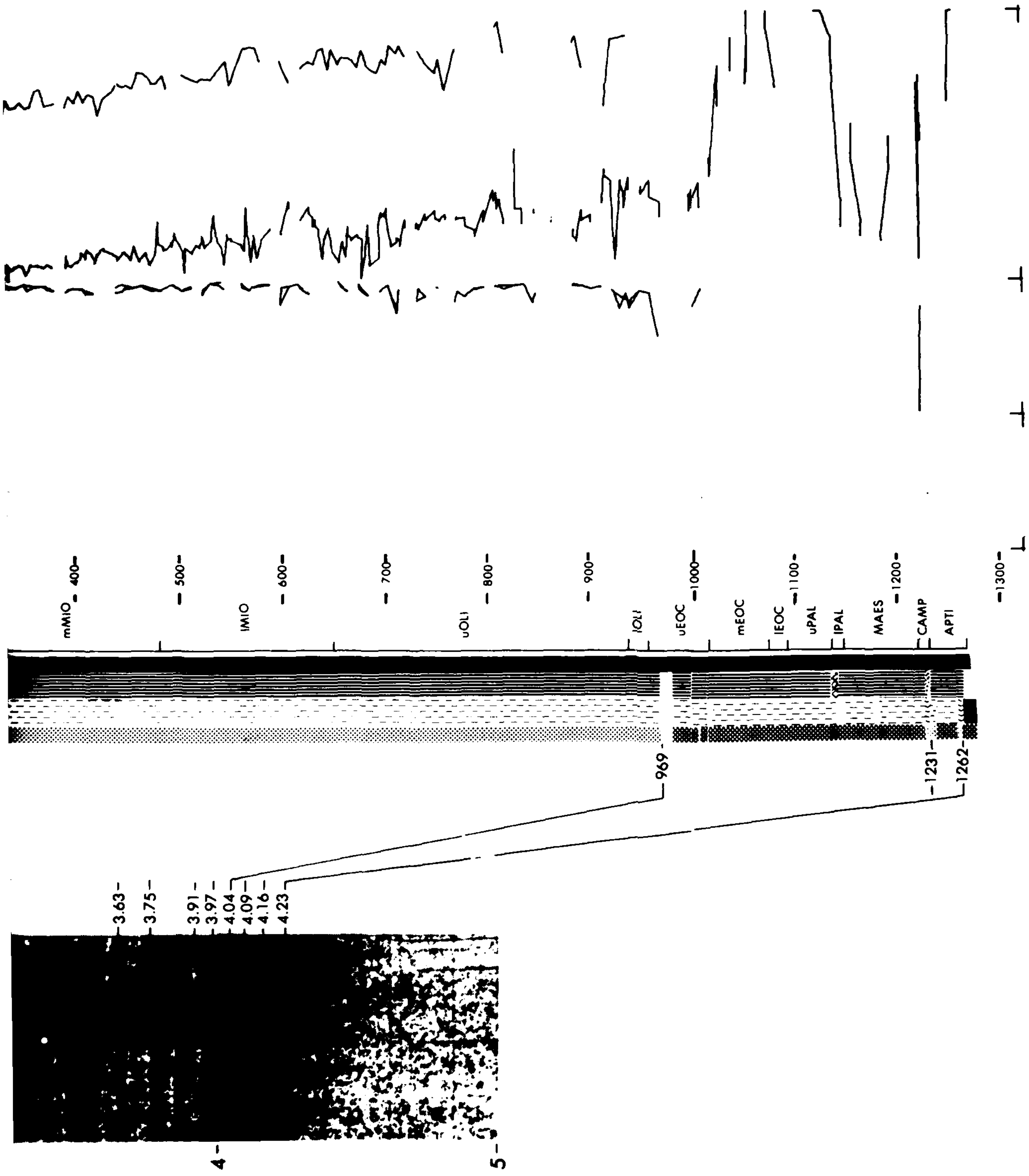


SITE 289



0
100
200
300
400
500
600
PLEIS
uPLI
lPLI
uMIO
mMIO
lMIO
2.97
3.63
3.75
3.91
3.97
4.04
4.09
4.16
4.23
2
3
4

ITE 289 LEG 30



2

SITE DATA

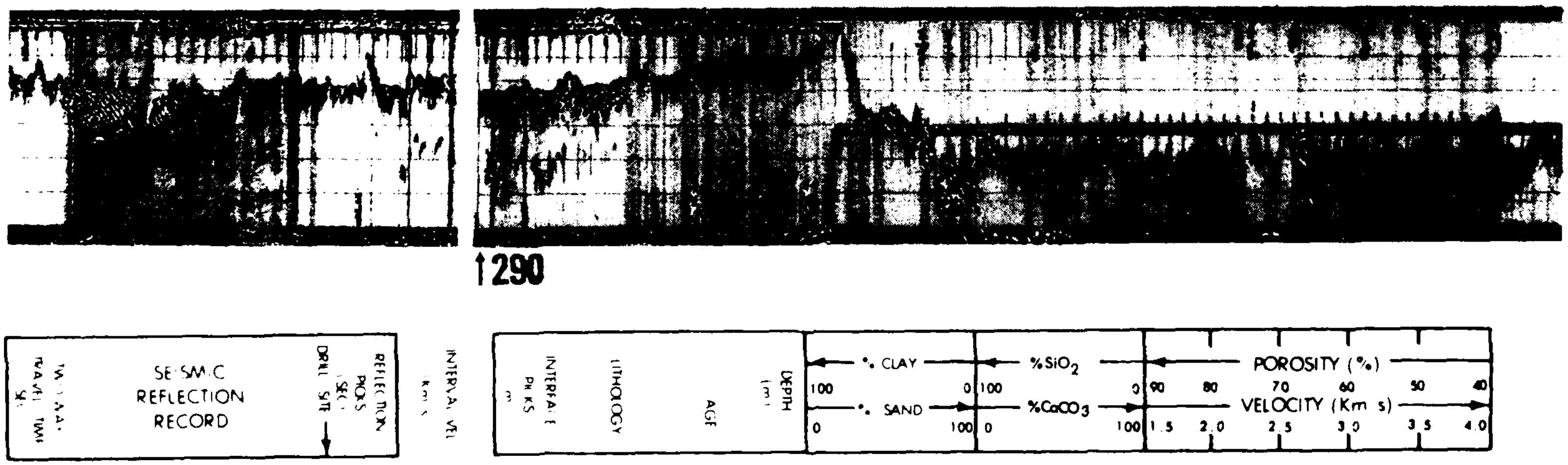
Position:
Latitude 17°44.8' N
Longitude 133°28.1' E
Date: 06/18/73
Time: 0330Z
Water depth: 6062 meters
Location: West Philippine Basin

CORE DATA

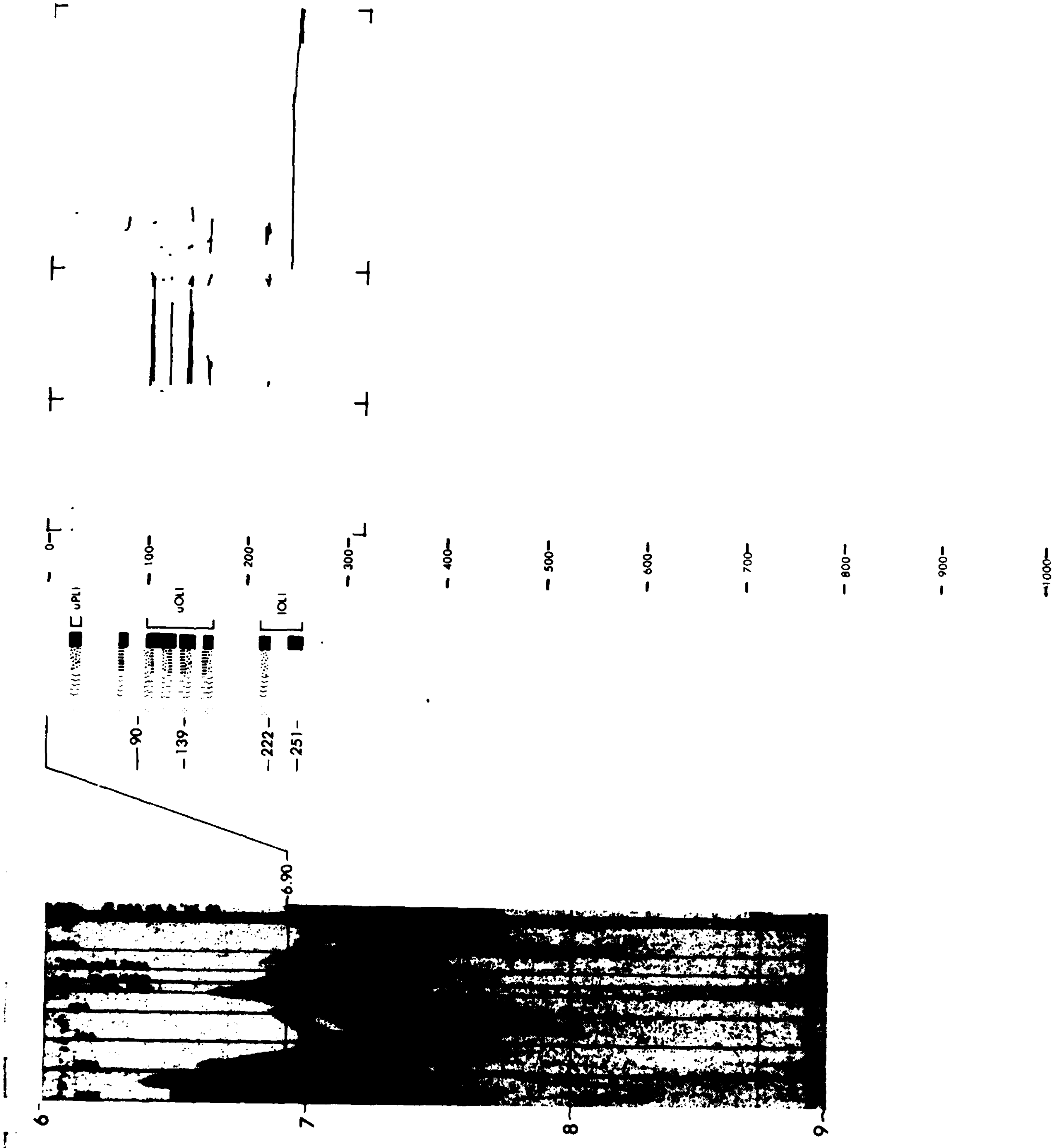
Penetration:	290	290A	
Drilled--	175	121	meters
Cored----	80	19	meters
Total----	255	140	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	9	2	cores
	39	2	meters

The brown clay of Unit 1 appears to represent the pelagic blanket which overlies the sediment apron on regional reflection profiles. The volcanic ash from 70 to 80 meters, may reflect the eruptive activity related to the opening of the Parece Vela Basin. The upward increase in zeolite content and decrease in volcanic ash is thought to reflect waning volcanic activity and a decrease in sedimentation rate. Unit 2 thus would mark the end of the major volcanic pulse represented by volcaniclastics of Unit 3. Although only 86 meters of volcanic silts were penetrated in Hole 290, they undoubtedly represent the distal facies of the apron west of the Paulau-Kyushu Ridge. Unit 4, the volcanic conglomerate, probably represents a debris flow, which moved down the adjacent ridge from the north or east. The predominance of angular basalts clasts, the nannofossil-bearing matrix, and a few clasts of manganese-encrusted sediments all suggest that the entire sediment cover and some basement was involved in the slumping. For this reason it is assumed that the Eocene-Oligocene age of both clasts and matrix is a fair indicator of the local basement age.

Upper Oligocene sediment interbedded calcareous; nannofossil rich, and detrital sediments.



SITE 290 LEG 31



SITE DATA

Position:
- Latitude $12^{\circ}48.4'$ N
- Longitude $127^{\circ}49.8'$ E

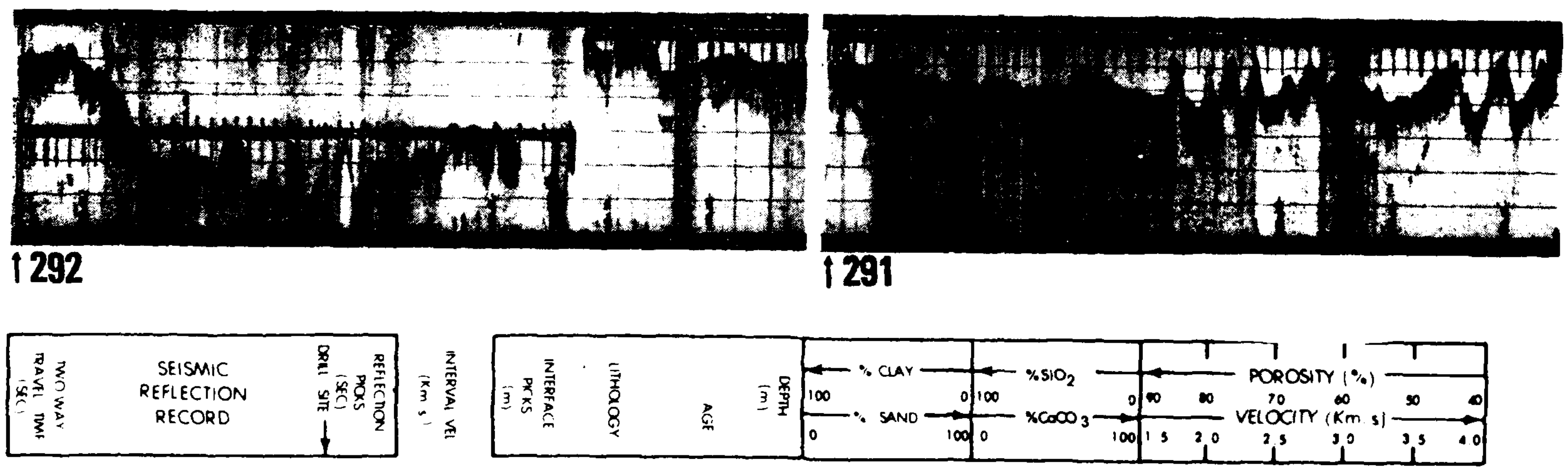
Date: 06/23/73
Time: 0812Z
Water depth: 5217 meters
Location: Philippine Trench

CORE DATA

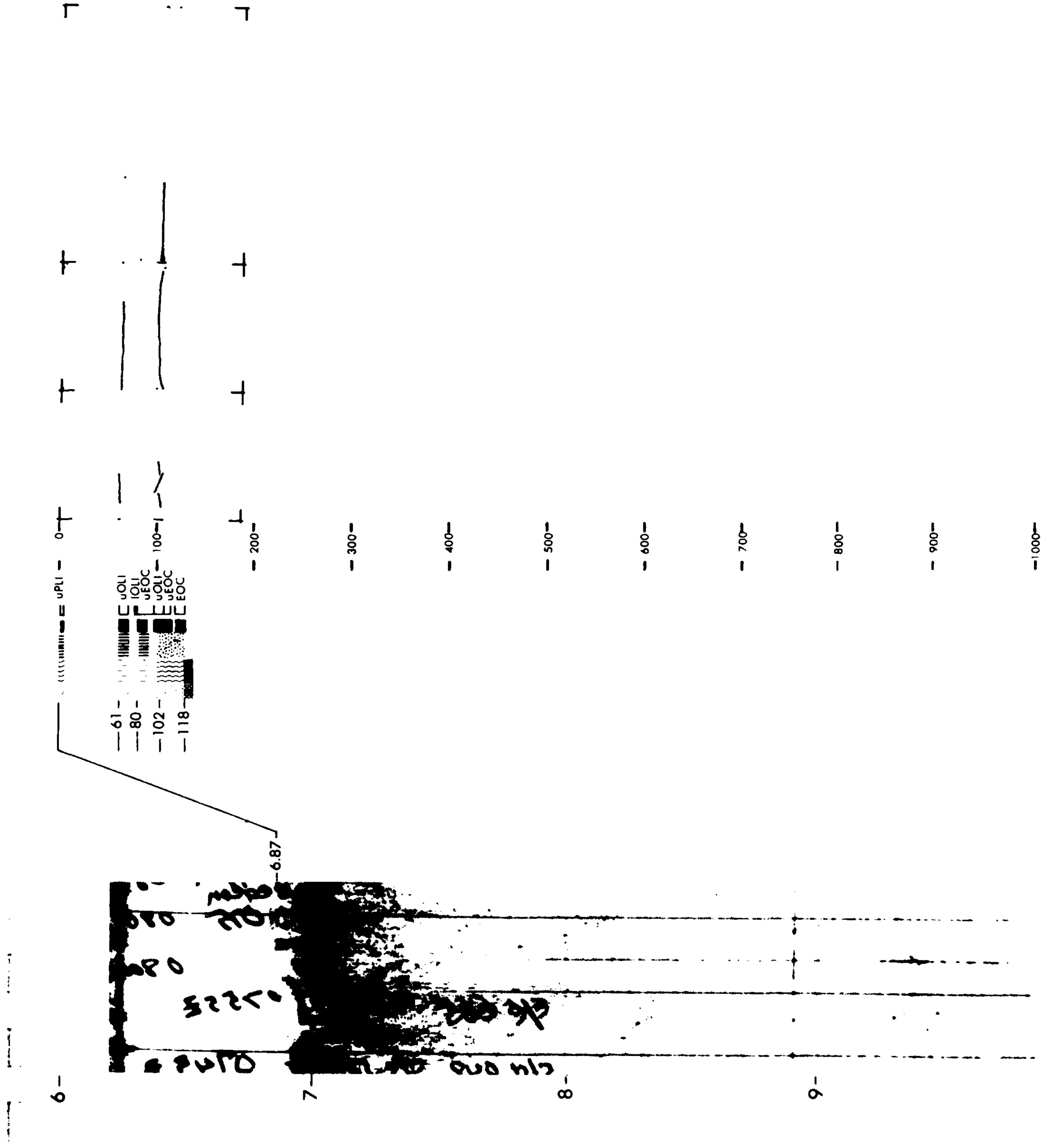
Penetration:	291	291A	
Drilled--	84	98	meters
Cored----	41	16	meters
Total----	126	114	meters
Recovery:			
Basement-	1	0	cores
	1	0	meters
Total----	5	3	cores
	10	1	meters

The sedimentary section at Site 291 consisted entirely of pelagic deposits, but the widely spaced cores and very poor core recoveries led to ambiguity and lack of agreement as to the position of lithologic breaks. The interlayers of brown clay and nannofossil ooze and the lack of calcareous material in the basal dark brown clay unit require a much more complicated explanation for the history of the basin crust than simple creation at a shallow spreading center and subsequent subsidence, which sufficed at Site 290. The extrusive nature of the tholeiitic basalt is indicated by its glassy surface. Fluctuating drill rates, plus the inflow of basalt pieces behind the bit in this cored section is suggestive of thin flows and rubbly interbeds. Seismic reflection profiles delineate N20-30W trending basement benches, on one of which both holes were located. The 120-meter northeasterly offset to Hole 291A was perpendicular to the trend of this bench, and the intersection of basalt 9 meters shallower in Hole 291A indicates a shallow basement dip away from the bench edge.

Calcareous sediment; nannofossil rich, with one thin layer of detrital sediment.



SITE 291 LEG 31



SITE DATA

Position:
- Latitude 15°49.1' N
- Longitude 124°39.0' E

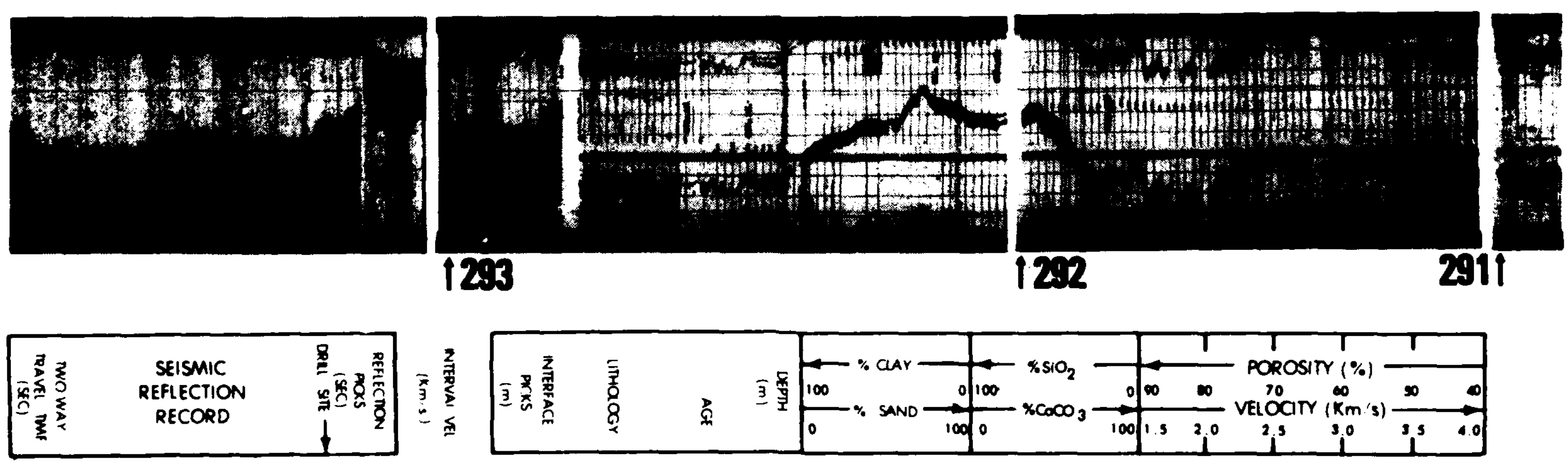
Date: 06/26/73
Time: 0632Z
Water depth: 2953 meters
Location: Benham Rise

CORE DATA

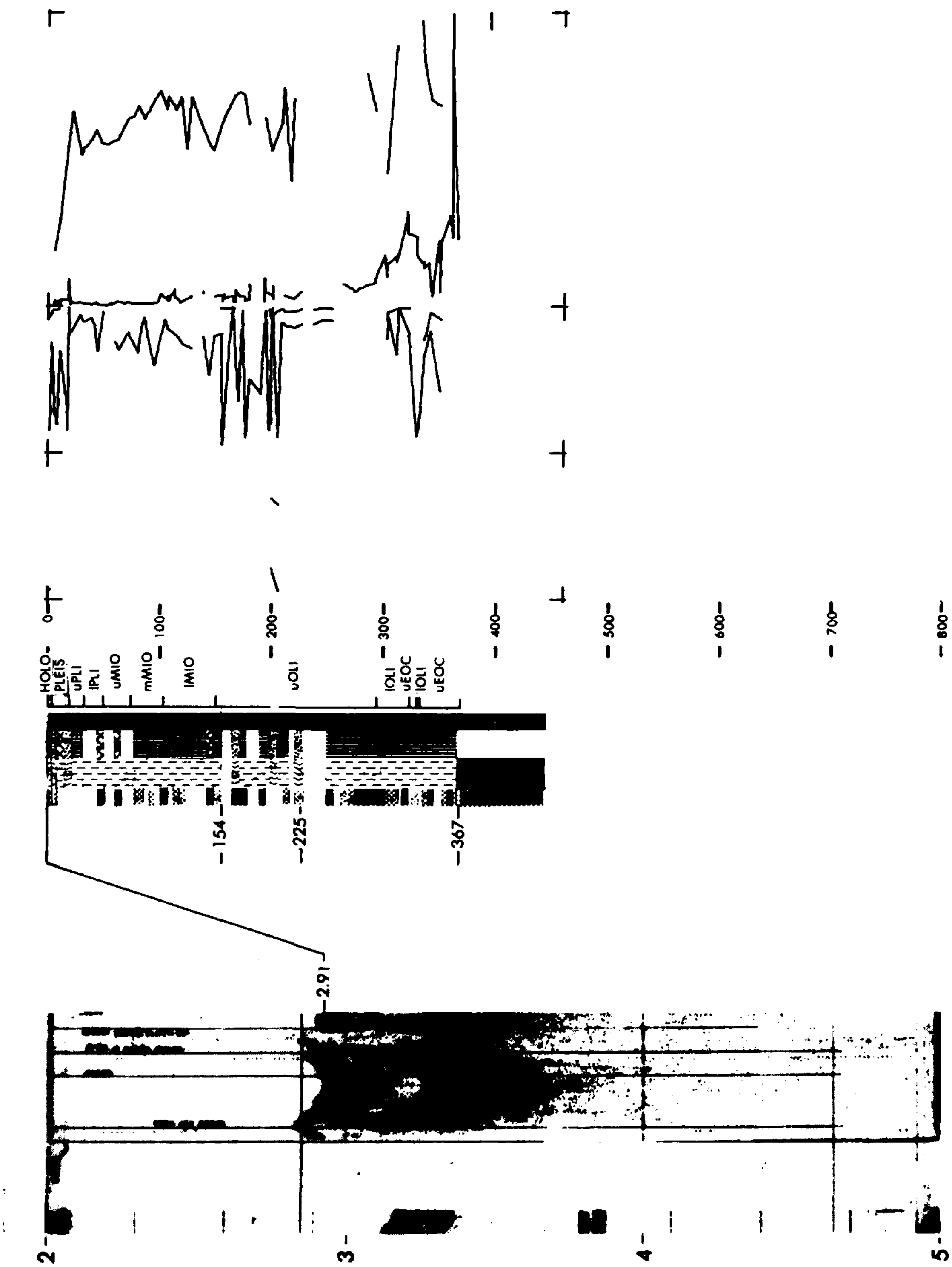
Penetration:		
Drilled--	0	meters
Cored----	443	meters
Total----	443	meters
Recovery:		
Basement-	8	cores
	35	meters
Total----	47	cores
	243	meters

Continuous coring at Site 292 revealed that the sedimentary blanket covering the southeastern flank of Benham Rise consists of 367.5 meters of Pleistocene through late Eocene calcareous oozes and chalks representing a superb record of planktonic productivity over the rise during the past 37 m.y. Distinct lithologic breaks are absent in the sedimentary sequence, as it represents one long series of nannofossil oozes that have been lithified into chalk at depth. Subtle lithologic boundaries within the ooze-chalk column thus represent diagenetic events rather than distinct changes in the nature of sedimentation. The age of the basalt is consistant with the late Eocene fossil age determined for chalks immediately overlying the basalt at Site 292, and indicates deposition above the calcium carbonate compensation depth begins almost immediately after formation of the basalt. No evidence of a baked contact was encountered and an extensive basalt sequence is assumed. The size and nature of vesicules in the basalt indicate it was extruded at a water depth of 500 meters or less.

Interbedded layers of calcareous and detrital sediment. Calcareous; mostly nannofossil rich.



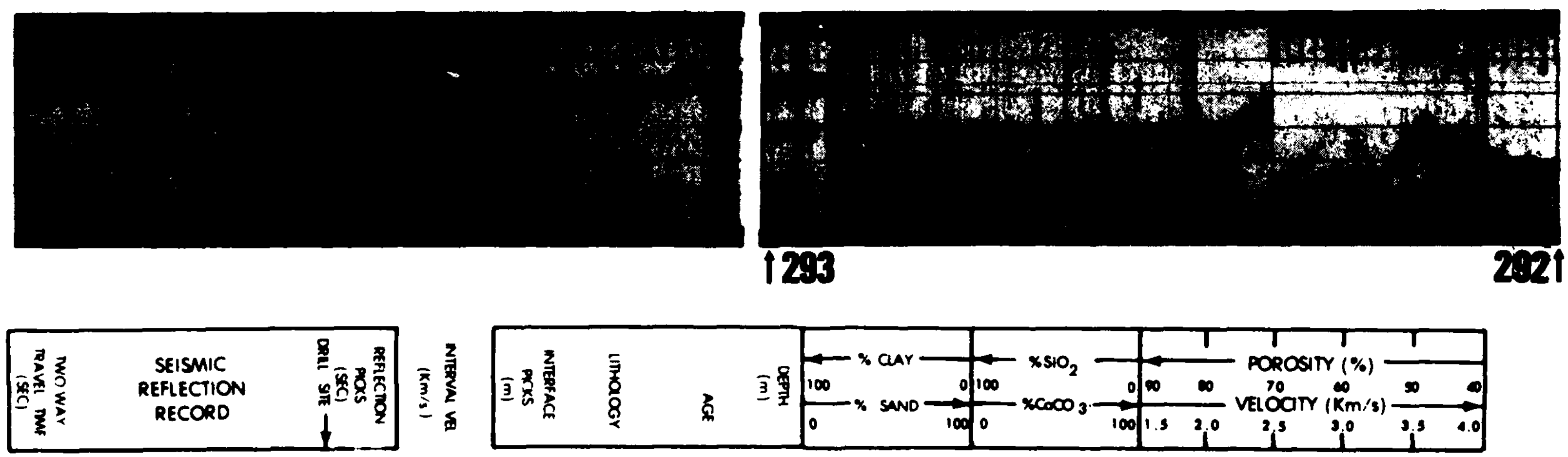
SITE 292 LEG 31



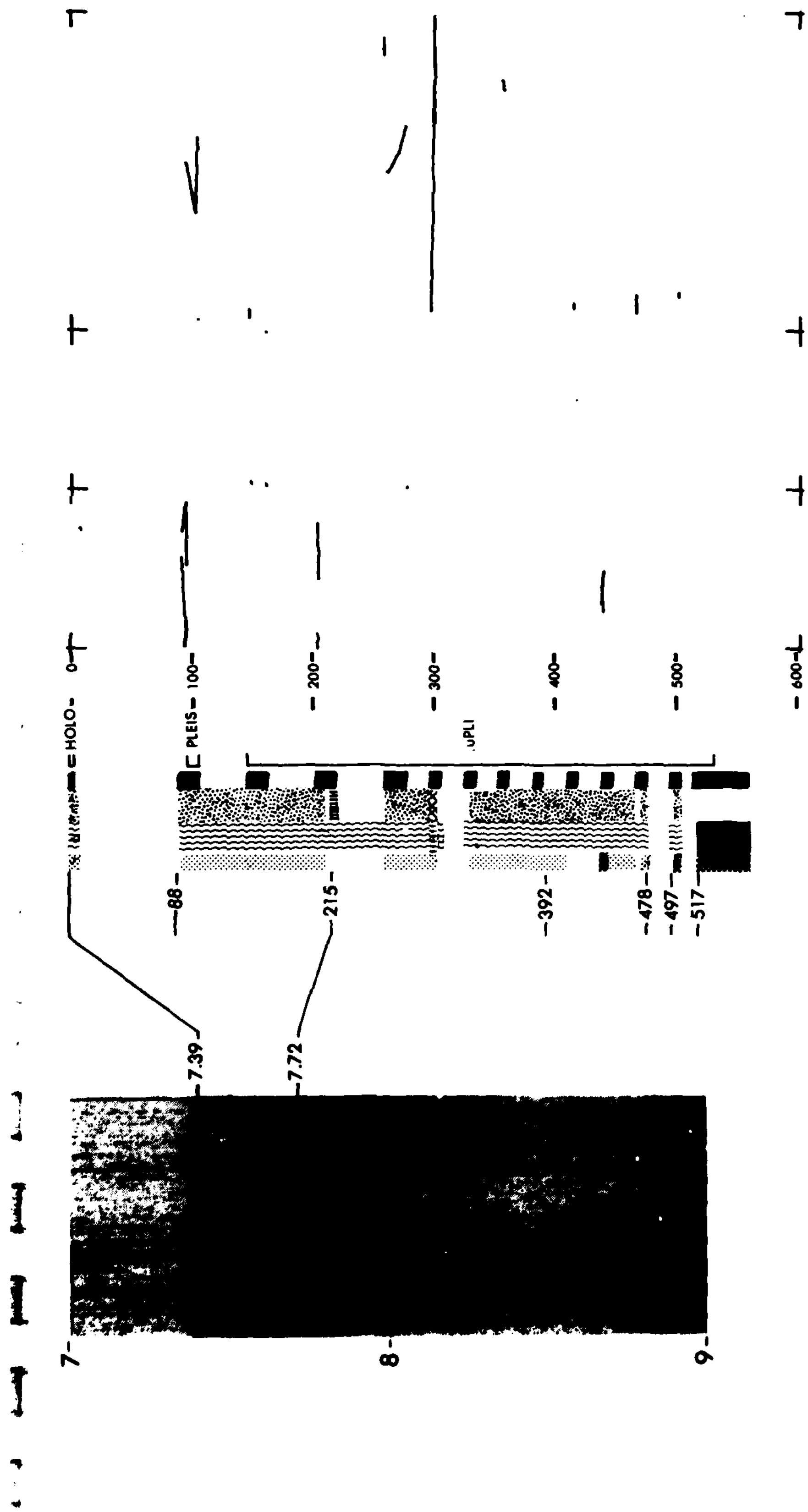
SITE DATA	CORE DATA
Position:	Penetration:
Latitude 20°21.2' N	Drilled-- 356 meters
Longitude 124°05.6' E	Cored---- 207 meters
Date: 06/30/73	Total---- 563 meters
Time: 2230Z	Recovery:
Water depth: 5599 meters	Basement- 0 cores
Location: Central Basin Fault Zone	0 meters
	Total---- 23 cores
	79 meters

Site 293 penetrated a 517-meter sequence of turbidites and mudstones overlying a tectonic breccia basement at the distal end of a sedimentary apron off the northeast flank of Luzon. The section could not easily be divided into stratigraphic units because of the gradual and subtle transitions in lithology. As a first approximation, the upper 400 meters has been classified as a turbidite sequence, possibly overlain by a surficial contourite subunit, and the lower 117 meters as a pelagic to hemipelagic mudstone. The sediments overlie a breccia, comprised of igneous rocks ranging from metabasalt to quartz dioritic gneiss. The altered basalt intervals could be flows or large breccia fragments. This lithology could best be interpreted as a fault breccia, but must have slid slightly downhill to incorporate a few late middle Miocene to late Pliocene discoasters. The thickness is unknown, but extends at least from 517 meters to total depth at 563.5 meters.

Detrital sediments rarely serpentine rich.



SITE 293 LEG 31



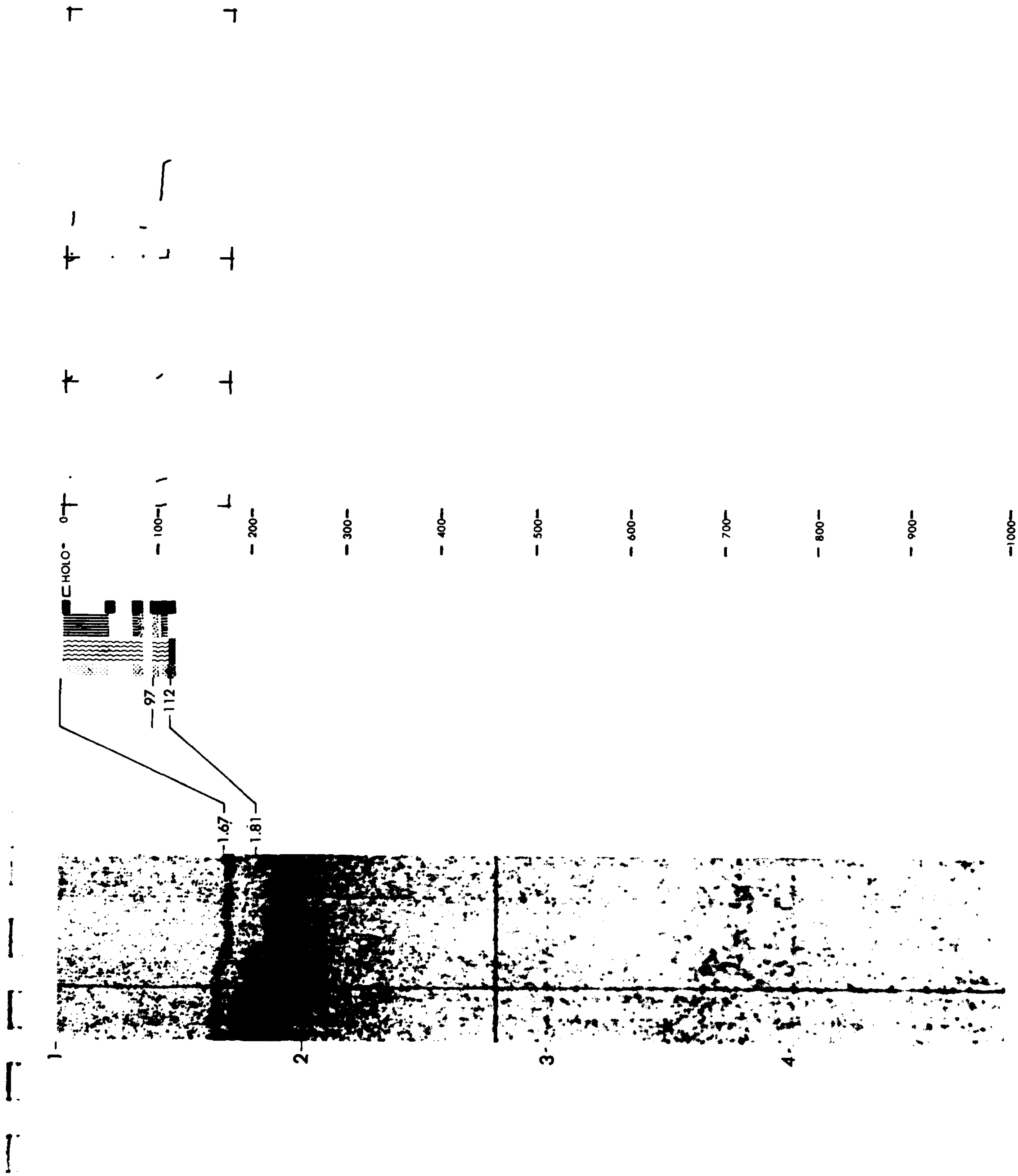
SITE DATA	CORE DATA
Position:	Penetration:
Latitude 22° 34.7' N	Drilled-- 67 meters
Longitude 131° 32.1' E	Cored---- 51 meters
Date: 07/06/73	Total---- 118 meters
Time: 0626Z	Recovery:
Water depth: 5784 meters	Basement- 1 cores
Location: West Philippine Basin	.7 meters
	Total---- 7 cores
	23 meters

Sites 294/295 were drilled in the low relief, undulating topography of the north-eastern sector of the West Philippine Basin. Drilling revealed that the entire 100-150 meter pelagic cover overlying the acoustic basement in this region consists of brown clay. The oceanic crust beneath this locality seemingly has remained within essentially the same oceanic environment since its formation. It has formed and remained beneath the carbonate compensation depth, accumulating fine-grained inorganic debris, with infalls of tephra. The increase of volcanogenic components in Unit 2 of both holes is indicative of nearness to a source area such as a volcanic arc or continental margin. Calculated sedimentation rates are in agreement with average rates established for "brown clays." Continuous reflection profiles convey the impression that the basement in the area around Sites 294/295 consists of topographic highs, separated by flat areas. This morphology might result from the ponding of basalt flows in the trough of a ridge-trough topography which is typical of marginal basins. The deeper reflector could represent the trough floor beneath a fill of basalt flows and possible interbedded sediments.

↑294

TWO WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE	INTERVAL VEL (Km/s)	INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	% CLAY 100–0 / % SAND 0–100	%SiO₂ 100–0 / %CaCO₃ 0–100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 294 LEG 31



SITE DATA

Position:
- Latitude 22°33.8' N
- Longitude 131°22.0' E

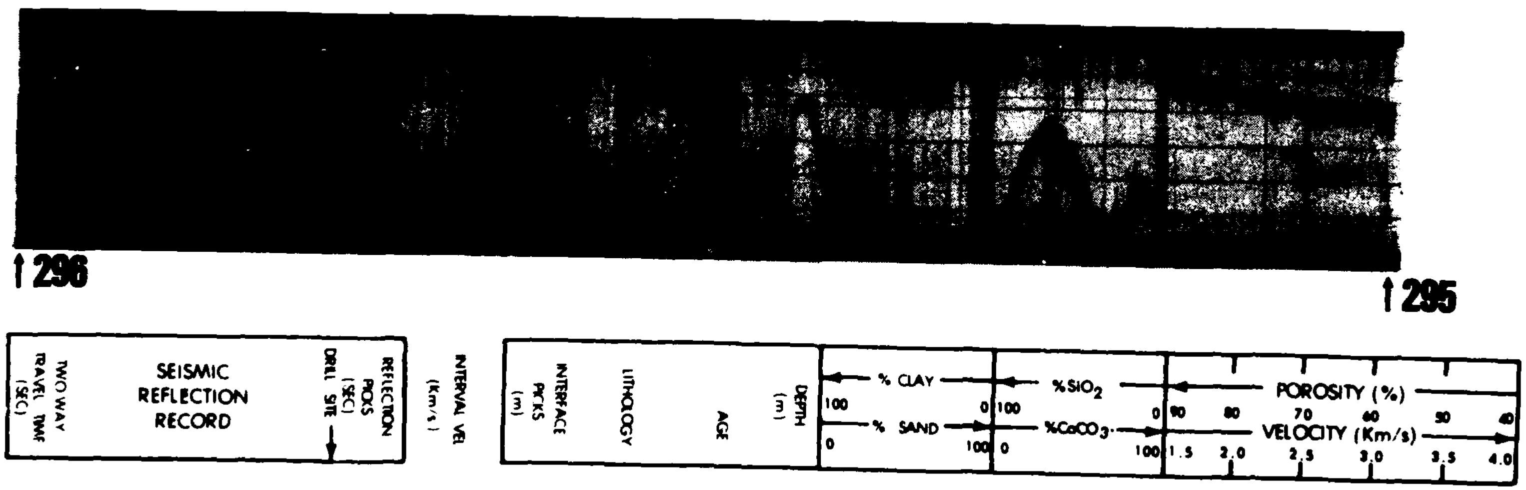
Date: 07/08/73
Time: 0800Z
Water depth: 5802 meters
Location: West Philippine Basin

CORE DATA

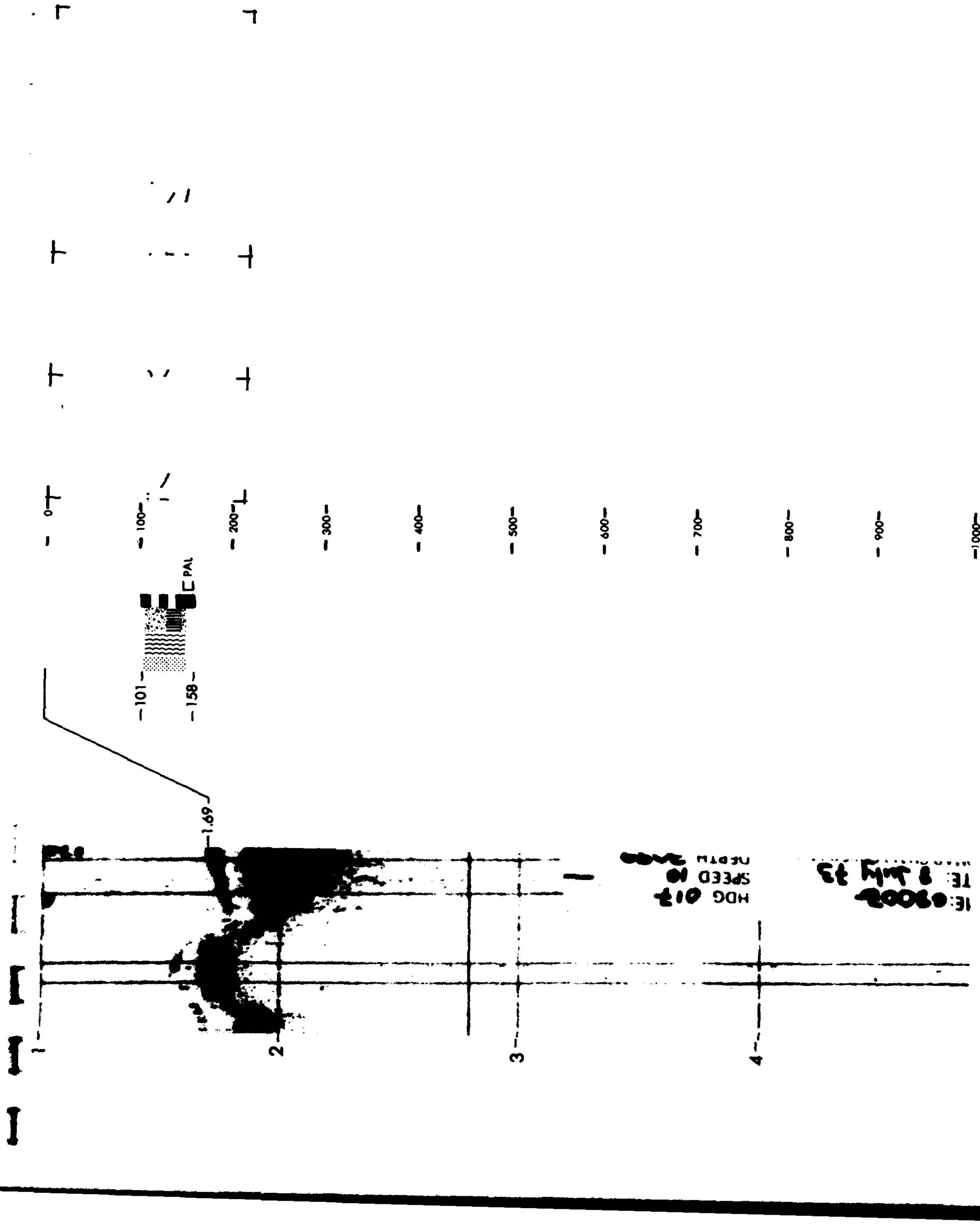
Penetration:
- Drilled-- 130 meters
- Cored---- 28 meters
- Total---- 158 meters

Recovery:
- Basement- 0 cores
  - 0 meters
- Total---- 3 cores
  - 20 meters

Discussed with Site 294.



SITE 295 LEG 31



SITE DATA

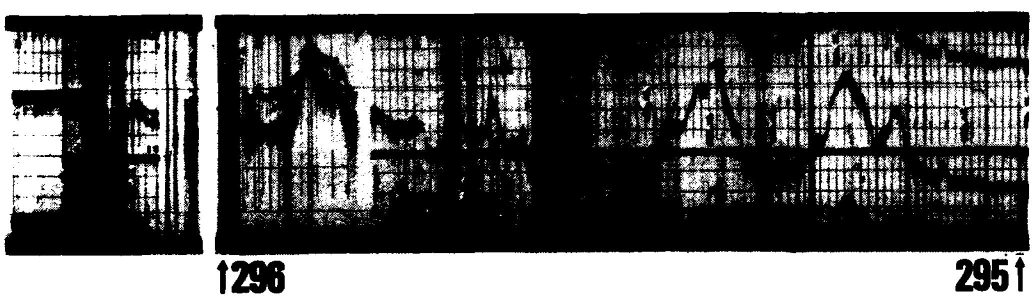
Position:
Latitude 29°20.4' N
Longitude 133°31.5' E
Date: 07/10/73
Time: 0603Z
Water depth: 2920 meters
Location: Palau-Kyushu Ridge

CORE DATA

Penetration:
Drilled--1037 meters
Cored---- 612 meters
Total----1833 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 65 cores
312 meters

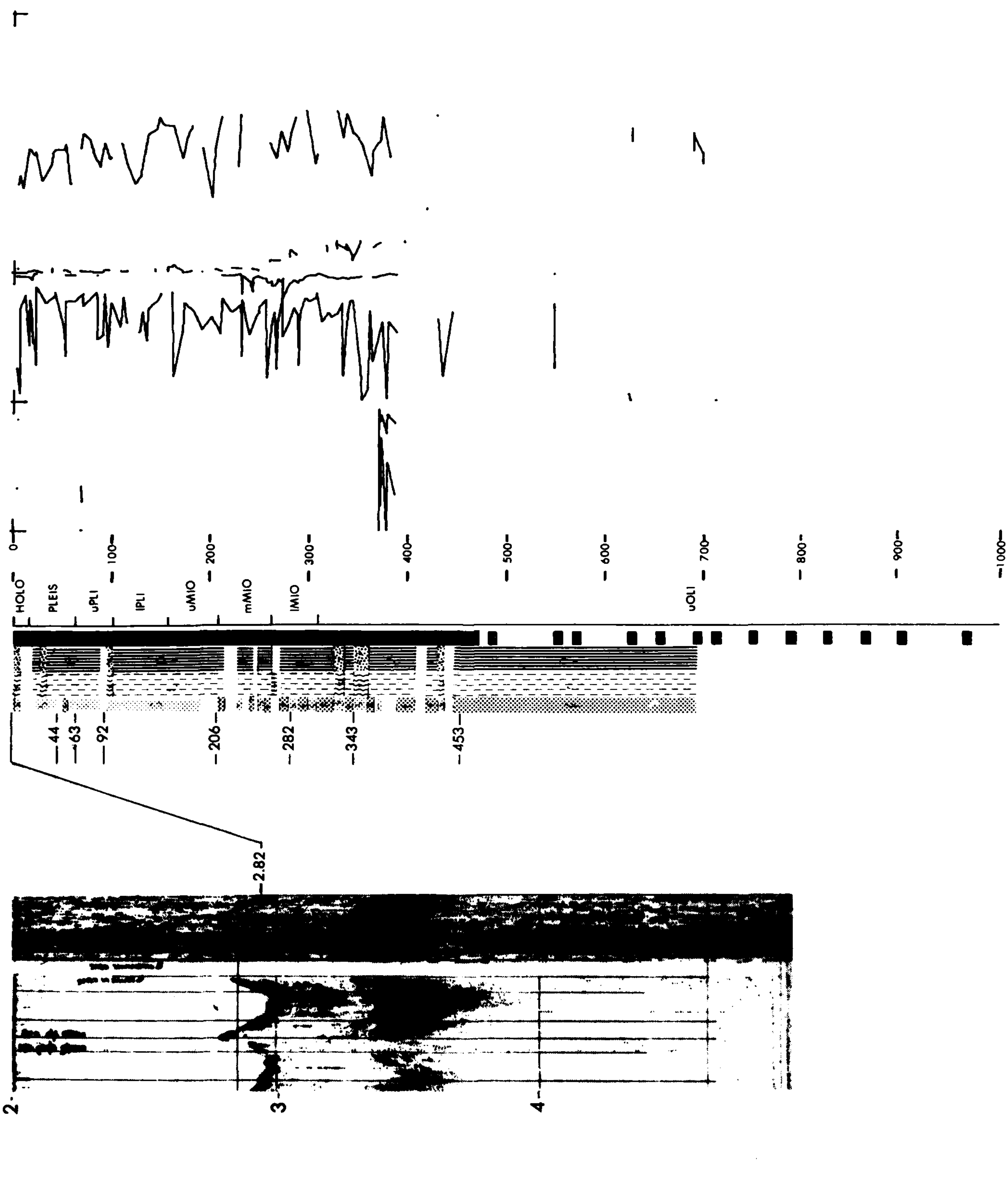
The geologic history of the Site 296 area is characterized by a dominant eruptive volcanic phase up through late Oligocene. This activity waned from late Oligocene to the Holocene, being replaced by pelagic nannofossil sedimentation. The volcanogenic subunits illustrate the combined effects of pyroclastic accumulation by settling through the water column, depositional characteristics associated with settling, and minor redistribution by gravity transfer and bottom current mechanisms. The clayey chalk-ooze interval provides an excellent biostratigraphic reference section and record of Neogene planktonic events beneath the Kuroshio Current. Displaced littoral foraminifera indicate that portions of the ridge were at or near sea level during the late Oligocene, whereas Neogene bathyal species document later subsidence of the ridge. The boundary between Oligocene volcaniclastics and younger chalks may coincide with rifting of the ridge after initial opening of the Parece Vela Basin in the late Oligocene.

Calcareous sediment; nannofossil rich, interbedded with thin layers of detrital, rarely mica or serpentine rich, sediments.



TWO WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | DRILL SITE | REFLECTION PICKS (SEC) | INTERVAL VEL (Km/s) | INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100 – 0 / % SAND 0 – 100 | %SiO$_2$ 100 – 0 / %CaCO$_3$ 0 – 100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 296 LEG 31



SITE DATA

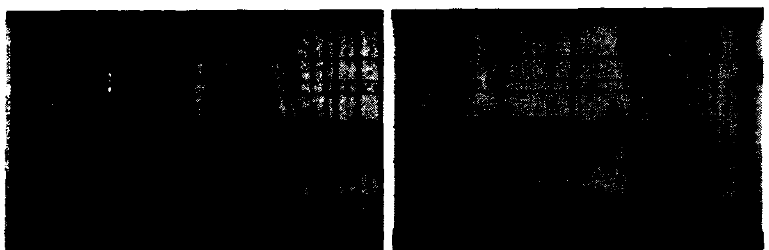
Position:
Latitude 30°52.4'N
Longitude 134°09.9'E
Date: 07/18/73
Time: 2100Z
Water depth: 4458 meters
Location: Shikoku Basin

CORE DATA

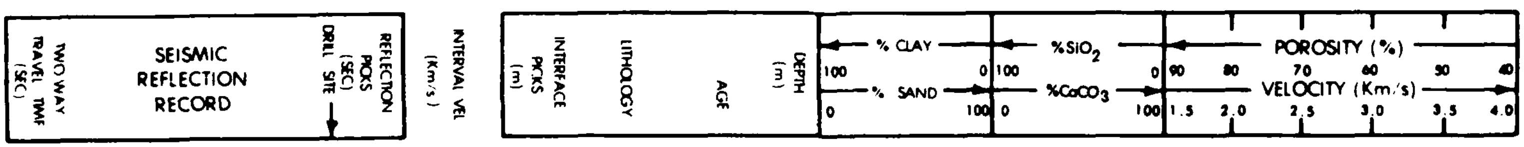
Penetration:	297	297A	
Drilled--	437	200	meters
Cored----	242	0	meters
Total----	679	200	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	27	0	cores
	124	0	meters

The Shikoku Basin has a thick sediment cover compared to the rest of the Philippine Sea. This is because of its proximity to Japan and because there apparently was no trench along the basin-flanking margin southwest Japan throughout most of the basin history. The hemipelagic nature and northern source of the upper transparent unit are demonstrated by its slow southward thinning over a distance of several hundred kilometers and by its pelagic geometry, especially at the southern part of its range. The lower two acoustic units, the reflective turbidite sequence and the basal semitransparent ash and claystone, thin more rapidly southward and cannot be identified more than 150 km south of the trench. This transition from hemipelagic to turbiditic deposition in the late Miocene (?) may mark uplift of southwest Japan, perhaps as an early manifestation of a subduction pulse. Turbidite deposition terminated in the Pliocene (3 m.y.) when the Nankai Trough developed sufficiently to trap these terrigenous sediments.

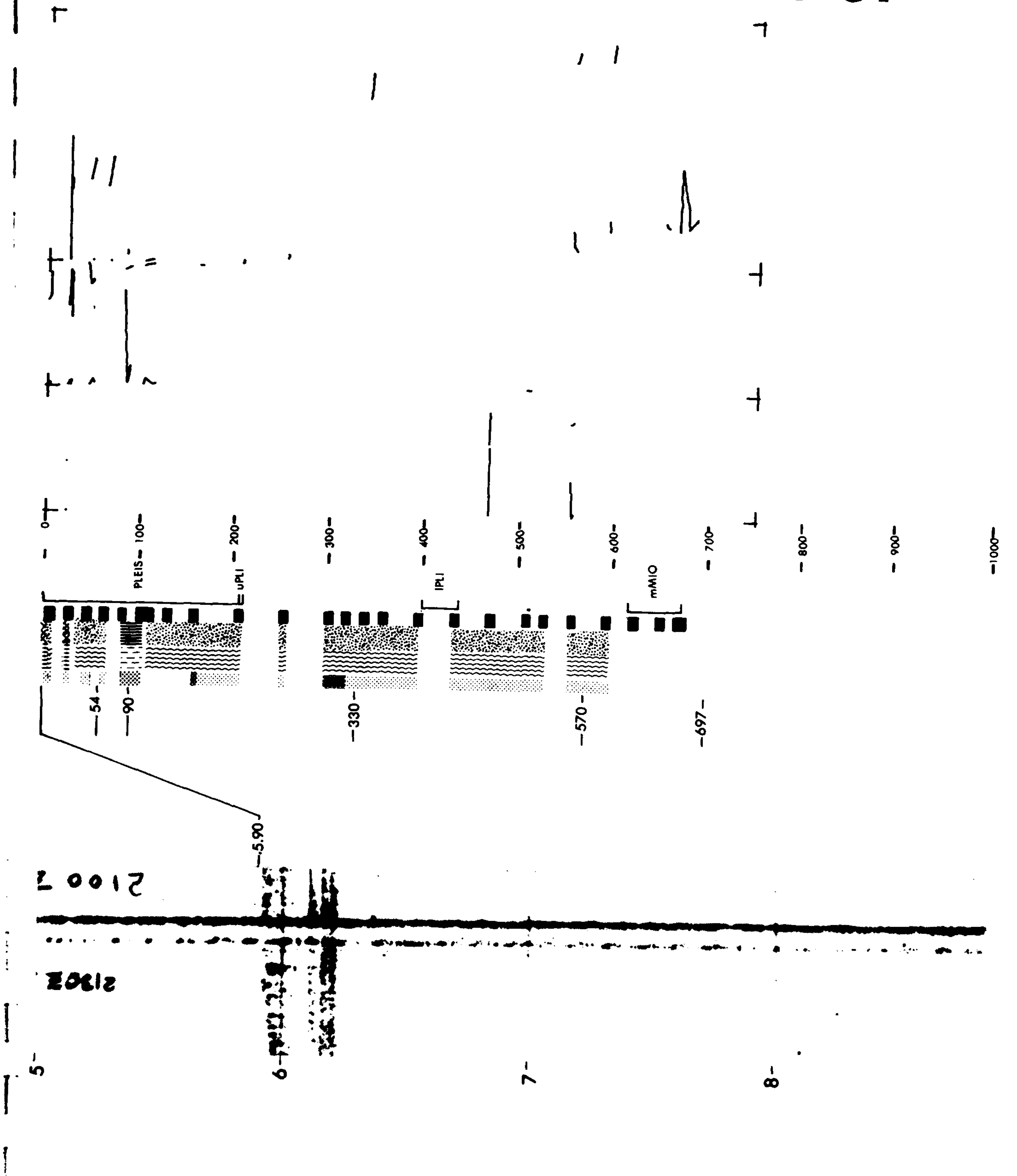
Three thin layers of siliceous sediment; diatom rich, occur in upper Pleistocene time. One thin layer of calcareous sediment; nannofossil rich, occurs in lower Pleistocene time.



297↑ 296↑



SITE 297 LEG 31



SITE DATA

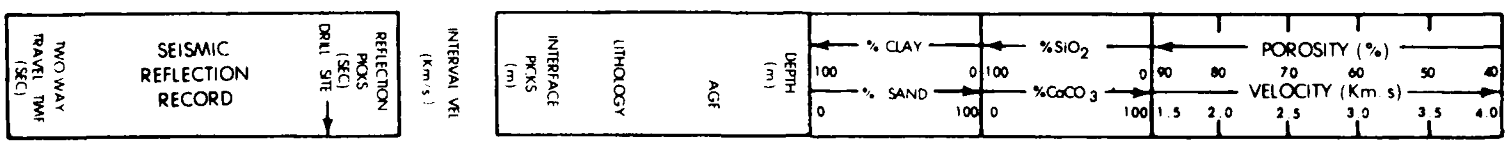
Position:
Latitude 31°42.9′N
Longitude 133°36.2′E
Date: 07/23/73
Time: 0426Z
Water depth: 4622 meters
Location: Nanki Trough off Shikoku Island, Japan

CORE DATA

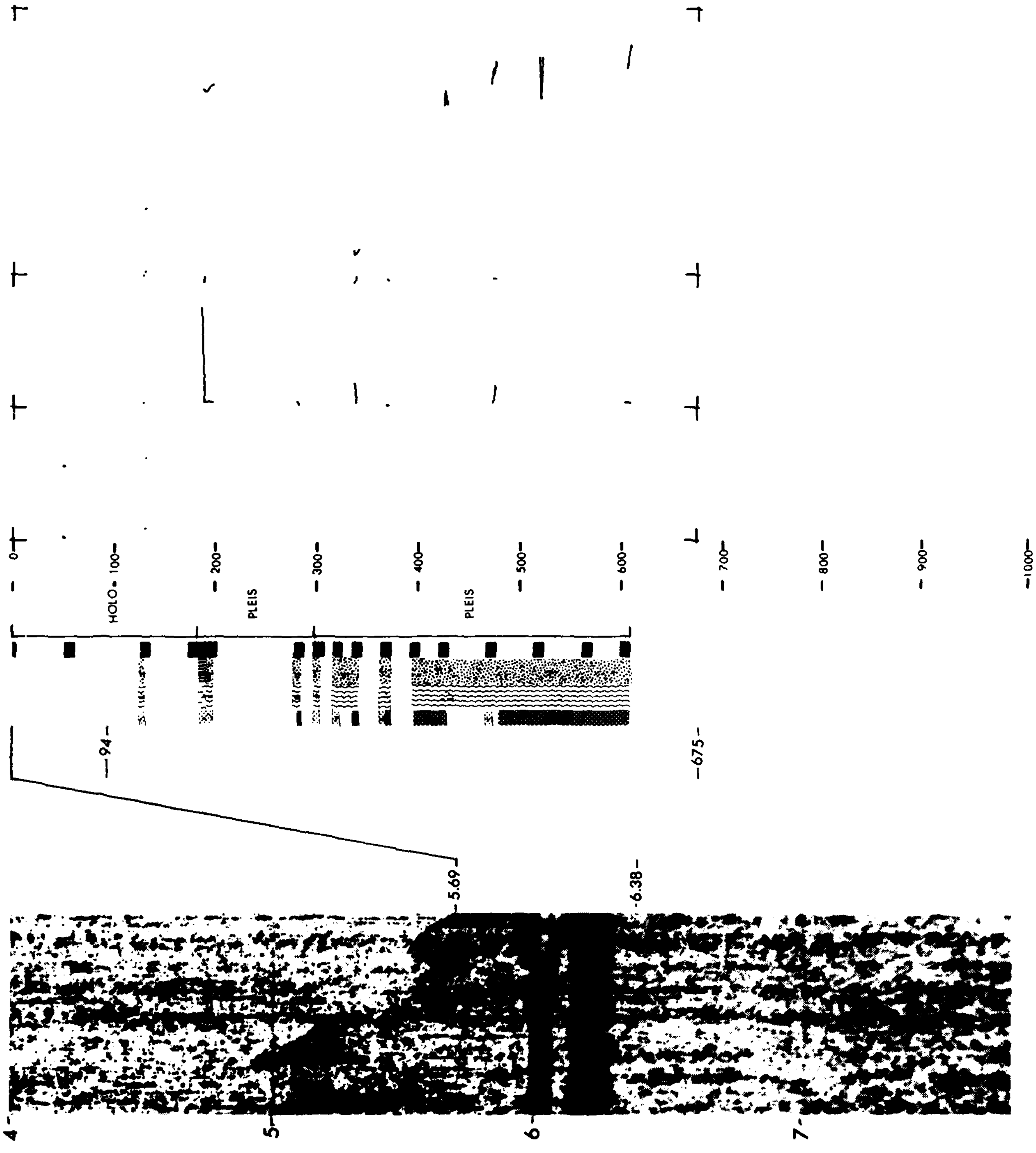
Penetration:	298	298A	
Drilled--	466	89	meters
Cored----	145	9	meters
Total----	611	98	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	16	1	cores
	67	.4	meters

Both Units 1 and 2 are composed of an interbedded sequence of hemipelagic muds and turbidity current deposits. Significant concentrations of nannofossils, but only traces of foraminifera in the hemipelagic muds, indicate deposition above the local carbonate compensation depth probably near the lysocline. The ubiquity of density current deposits suggests ponding of Units 1 and 2 in a basinal environment, probably the Shikoku Trench. A minor part of Unit 1 may have accumulated in synformal depressions of the trench inner wall during uplift; however, neither the seismic reflection profile nor PDR record show any ponded sediment. Anomalous compaction and small-scale structures become evident below a depth of 300 meters and increase in intensity downward. Below 500 meters, the beds are overturned, with dips averaging 13°. Structures in Hole 298, together with reflection profiles, demonstrate the accretion of an overturned fold consisting of tectonically dewatered trench sediments as a result of subduction at a rate of 3 cm/yr.

One thin layer of calcareous, pelagic, sediment occurs in upper Pleistocene time. Detrital sediment; occasionally siliceous fossil rich, rarely mica rich.



SITE 298 LEG 31



SITE DATA

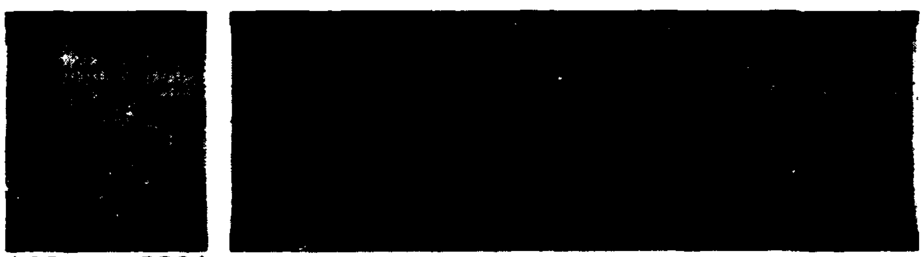
Position:
Latitude 39°29.7' N
Longitude 137°39.7' E
Date: 07/28/73
Time: 1244Z
Water depth: 2599 meters
Location: Yamato Basin;
Sea of Japan

CORE DATA

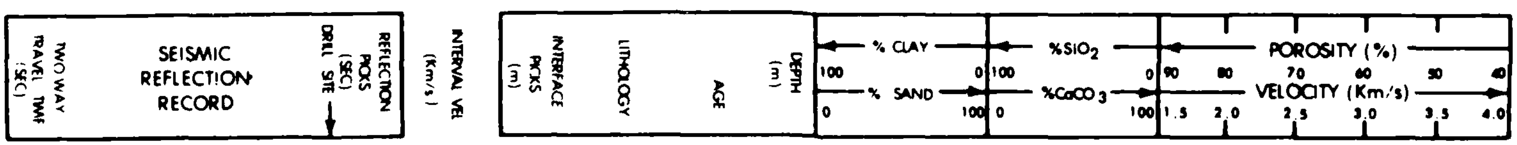
Penetration:
Drilled-- 171 meters
Cored---- 361 meters
Total---- 532 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 38 cores
172 meters

The lithologic characteristics of the sediments at Site 299, together with a few distinguishable sedimentary structures, favor a complex submarine fan environment over outer proximal and distal turbidites. Transport mechanisms in a fan area vary between extremes and encompass slumping, debris flow, channelized bottom currents, bottom traction, and hemipelagic/pelagic deposition. The hole location also makes it possible that the sediment series started with distal turbidites that overlie undifferentiated clays. The turbidites then become more proximal, and finally fan deposits accumulated. The proximity of a deep channel may preclude real turbidity current throughways, in which case all sediments indicate a fan complex.

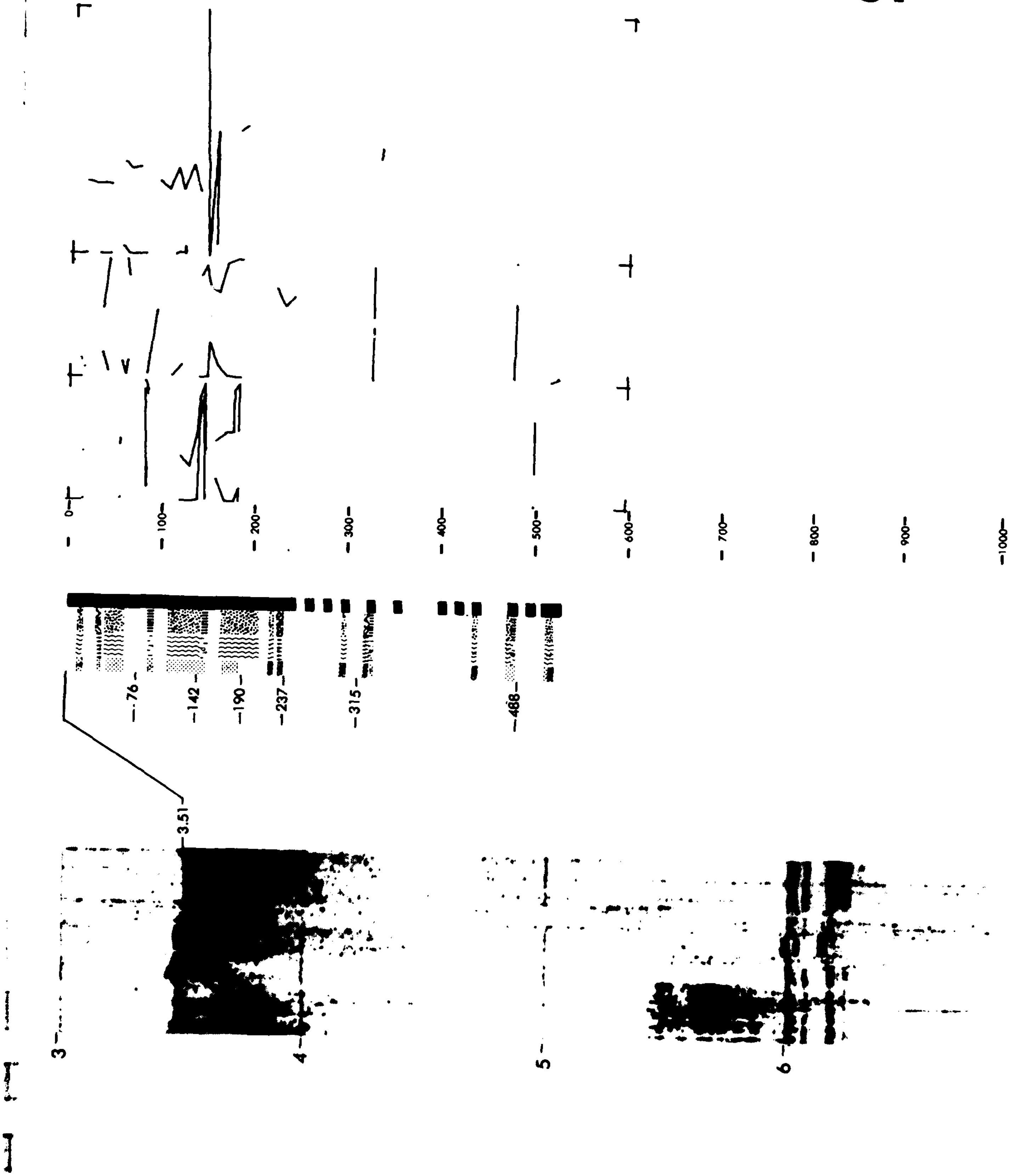
Detrital sediment interbedded with calcareous and siliceous sediments. Siliceous; diatom rich. Detrital; rarely mica rich.



1300 299



SITE 299 LEG 31



SITE DATA

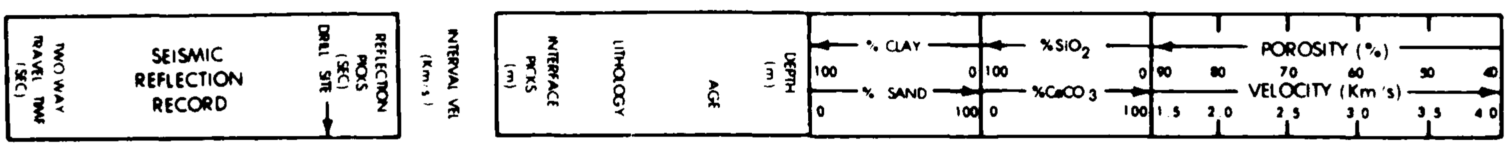
Position:
  Latitude $41^{\circ}03.0'$ N
  Longitude $136^{\circ}06.3'$ E
Date: 07/29/73
Time: 0119Z
Water depth: 3427 meters
Location: East Central Japan Abyssal Plain

CORE DATA

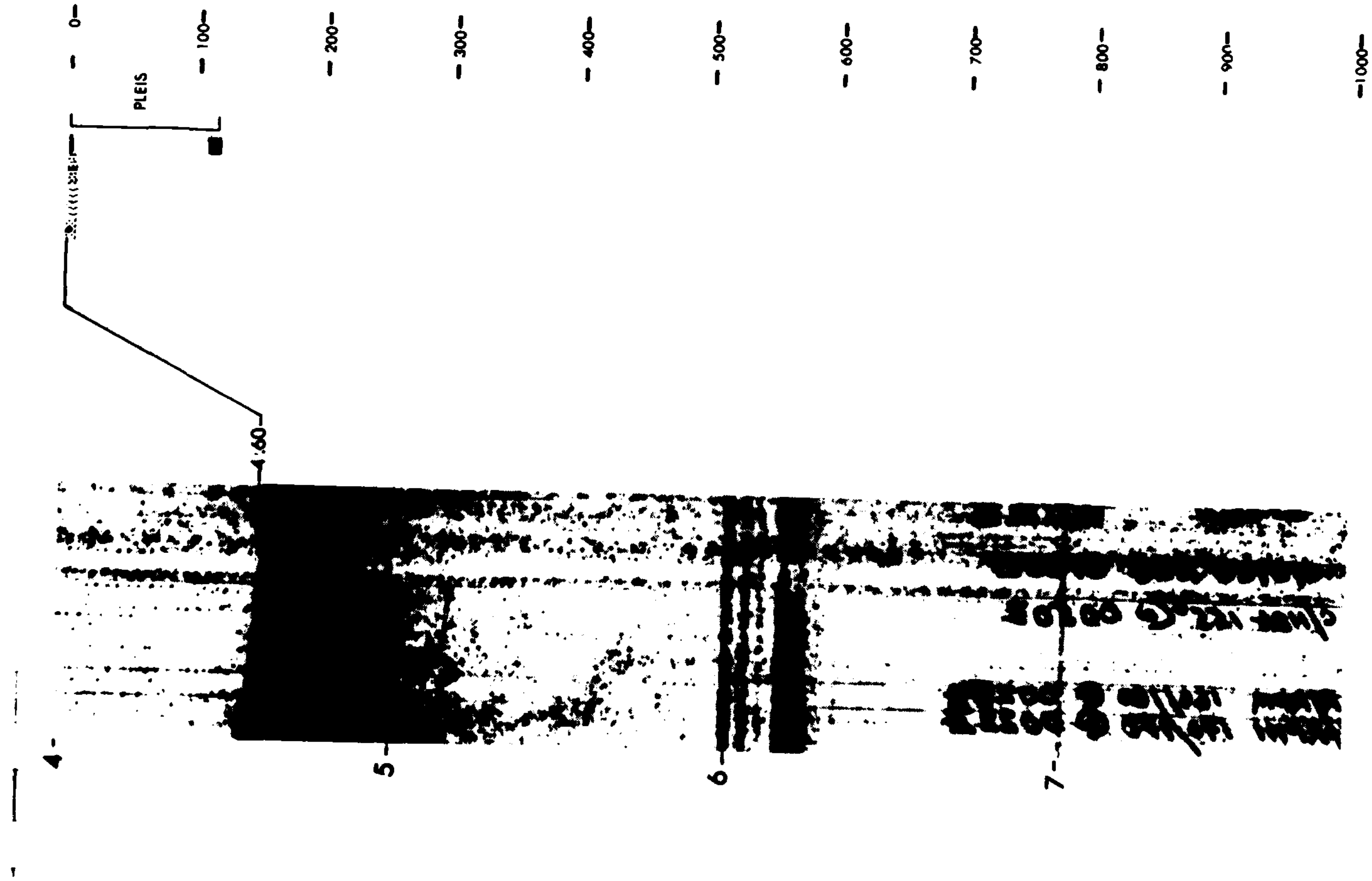
Penetration:
  Drilled-- 107 meters
  Cored---- 10 meters
  Total---- 117 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 2 cores
  .4 meters

Site 300 was located in the east central portion of the Japan Abyssal Plain (or Japan Basin) adjacent to the north flank of the Yamato Rise. Difficulty was encountered in taking an initial punch core due to the presence of coarse sand and gravel at the surface. Only traces of this material were recovered. The hole was then washed, apparently through sand, to 117 meters in order to seat drill collars. Attempted retrieval of a second core was halted by caving in the hole, a stuck pipe, and a stuck core barrel, forcing abandonment of this site due to the prospect of further caving in the unexpectedly friable sand section. The small sample of sediment recovered from 117 meters indicates this unit represents late Pleistocene/Holocene turbidite (channel?) deposits derived via the extensive distributary fan system emanating from the Toyama Trough. Diatom floras in two samples from Core 2 are dominated by reworked Miocene species, in all likelihood, transported from exposures along western Honshu.

300



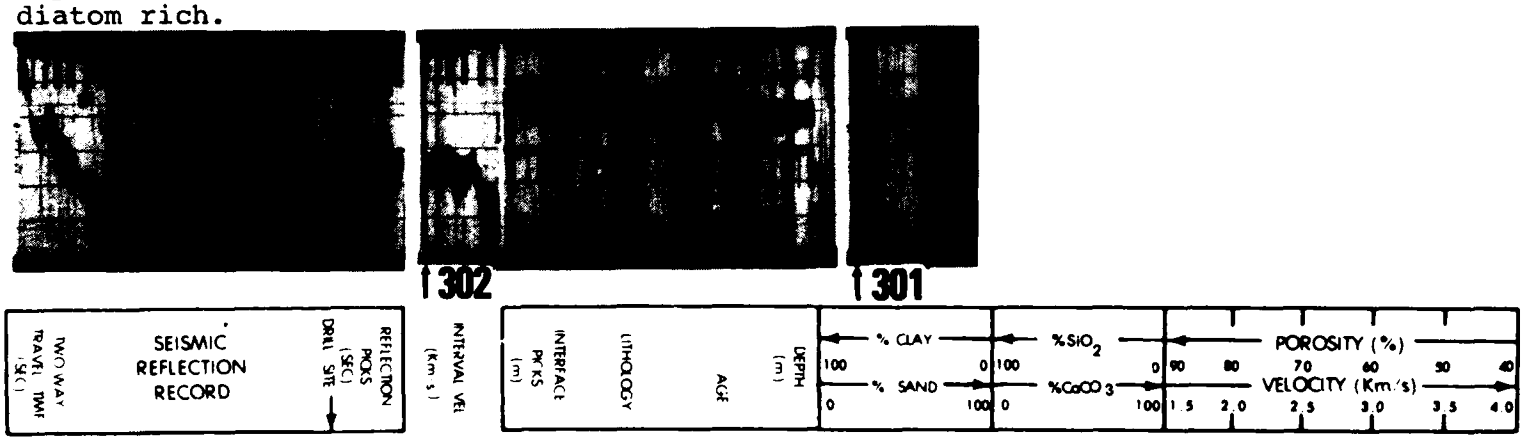
SITE 300 LEG 31



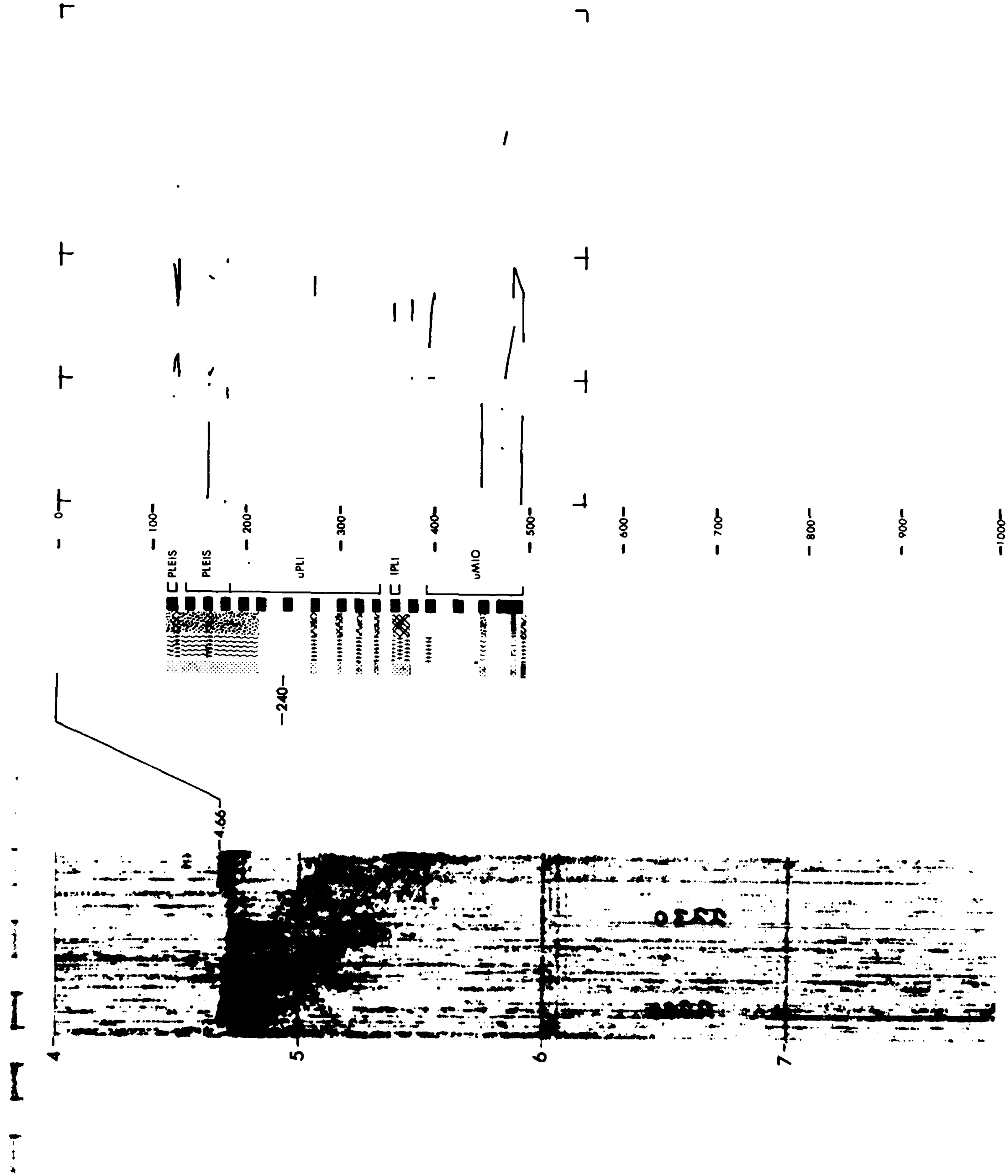
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	41°03.7' N	Drilled--	314 meters
Longitude	134°02.9' E	Cored----	183 meters
Date:	07/29/73	Total----	497 meters
Time:	2320Z	Recovery:	
Water depth:	3520 meters	Basement-	0 cores
Location:	East Central Japan		0 meters
	Abyssal Plain	Total----	20 cores
			50 meters

Unfortunately, the site had to be abandoned before completing objectives due to critically high ethane/methane ratio similar to that found at Site 299. The earliest Pliocene sediments encountered include coarse terrigenous clastics of turbidite origin which likely represent an expression of lowered sea level and consequent increased rate of sediment transport from the shelf margins during the waning stages of a widely recognized late Miocene interval of polar refrigeration. Relatively undiluted diatomaceous sediments continued to accumulate in this area at a rate of about 100 m/m.y. until the latest Pliocene, when a thin prograding wedge of terrigenous sediments began to cover the underlying biogenous material and dilute the coincident rain of diatom frustules. The rate of sedimentation is somewhat less (85 m/m.y.) during preglacial conditions of higher sea level in the early Pleistocene, but increasing amounts of terrigenous material seriously diluted diatom frustules. A major increase in rate of sedimentation to 140 m/m.y. occurs at the beginning of the late Pleistocene period of sustained glacial climatic conditions about 0.7 to 0.9 m.y.B.P. in concert with a similar increase noted in the Toyama Trough-Yamato Basin area (Site 299).

One thin layer of siliceous sediment occurs in upper Pleistocene time. One thin layer of calcareous sediment, occurs in upper Miocene time. Siliceous sediment; diatom rich.



SITE 301 LEG 31



SITE DATA

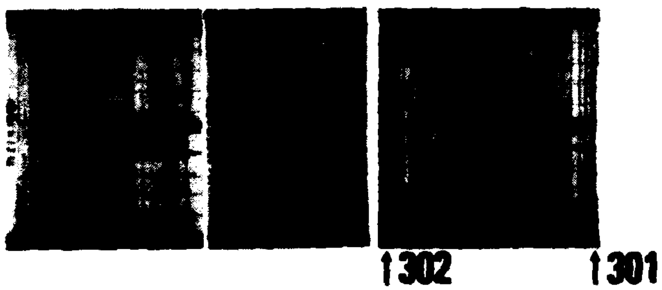
Position:
Latitude 40°20.1' N
Longitude 136°54.0' E
Date: 08/02/73
Time: 0157Z
Water depth: 2399 meters
Location: Yamato Rise; Sea of Japan

CORE DATA

Penetration:
Drilled-- 367 meters
Cored---- 164 meters
Total---- 531 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 18 cores
91 meters

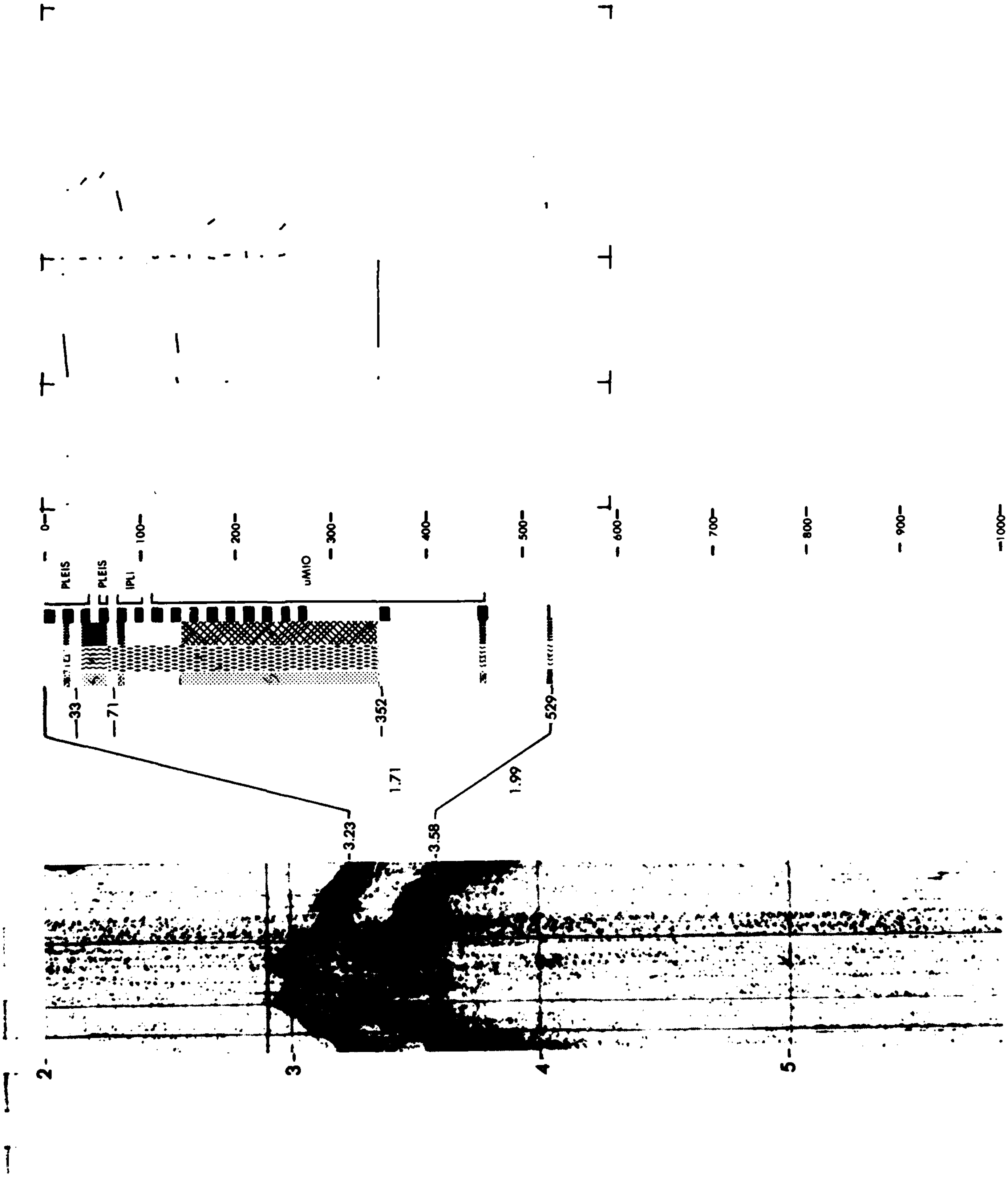
Due to medical emergency, had to rapidly drill to acoustic basement with only three cores pulled below 275 meters. Upper half of column represents good siliceous biostratigraphic reference section with dominantly boreal biofacies. Reworked (?) Oligocene nannofossils and green tuffs at base of hole tend to support mid-Tertiary opening of the sea. The geologic history begins with a period of pre-late Miocene volcanic activity. Seismic profiles indicate that this activity may have deposited thick volcanogenic piles of sediments in this area. The subsequent history is one of continuous pelagic sedimentation, in regions which were sufficiently cold so that calcareous fossils are either absent or present only in small amounts. It is possible that the carbonate compensation depth (CCD) has been abnormally shallow. Variations in the generally uniform pelagic sedimentation are seen during the early Pliocene to late Miocene to the latter part of the Pleistocene when diatoms are especially abundant. The age of the basement is somewhat ambiguous although displaced nannofossils of Oligocene age would suggest a minimum age.

One thin layer of upper Pleistocene Epoch; calcareous, pelagic. Siliceous sediment diatom rich.



TWO WAY TRAVEL TIME (SEC)
SEISMIC REFLECTION RECORD
REFLECTION PICKS (SEC)
DRILL SITE
INTERVAL VEL (Km/s)
INTERFACE PICKS (m)
LITHOLOGY
AGE
DEPTH (m)
% CLAY 100 0
% SAND 0 100
% SiO_2 100 0
% $CaCO_3$ 0 100
POROSITY (%) 90 80 70 60 50 40
VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 302 LEG 31



SITE DATA

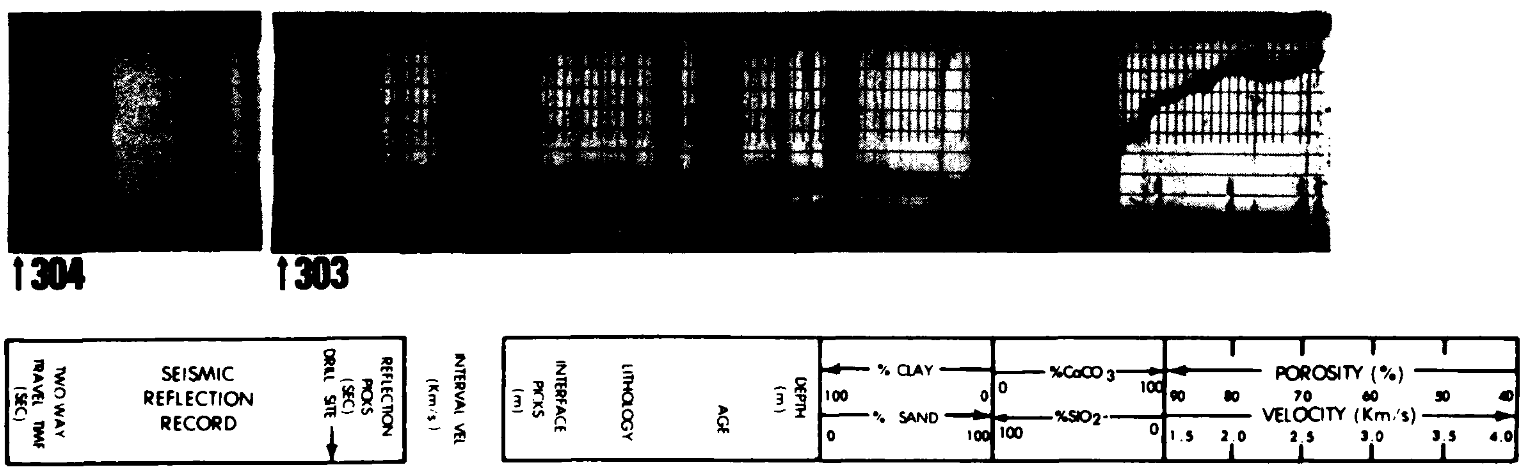
Position:
Latitude $40°48.5'$ N
Longitude $154°27.1'$ E
Date: 08/18/73
Time: 1318Z
Water depth: 5609 meters
Location: Japanese Magnetic Lineations

CORE DATA

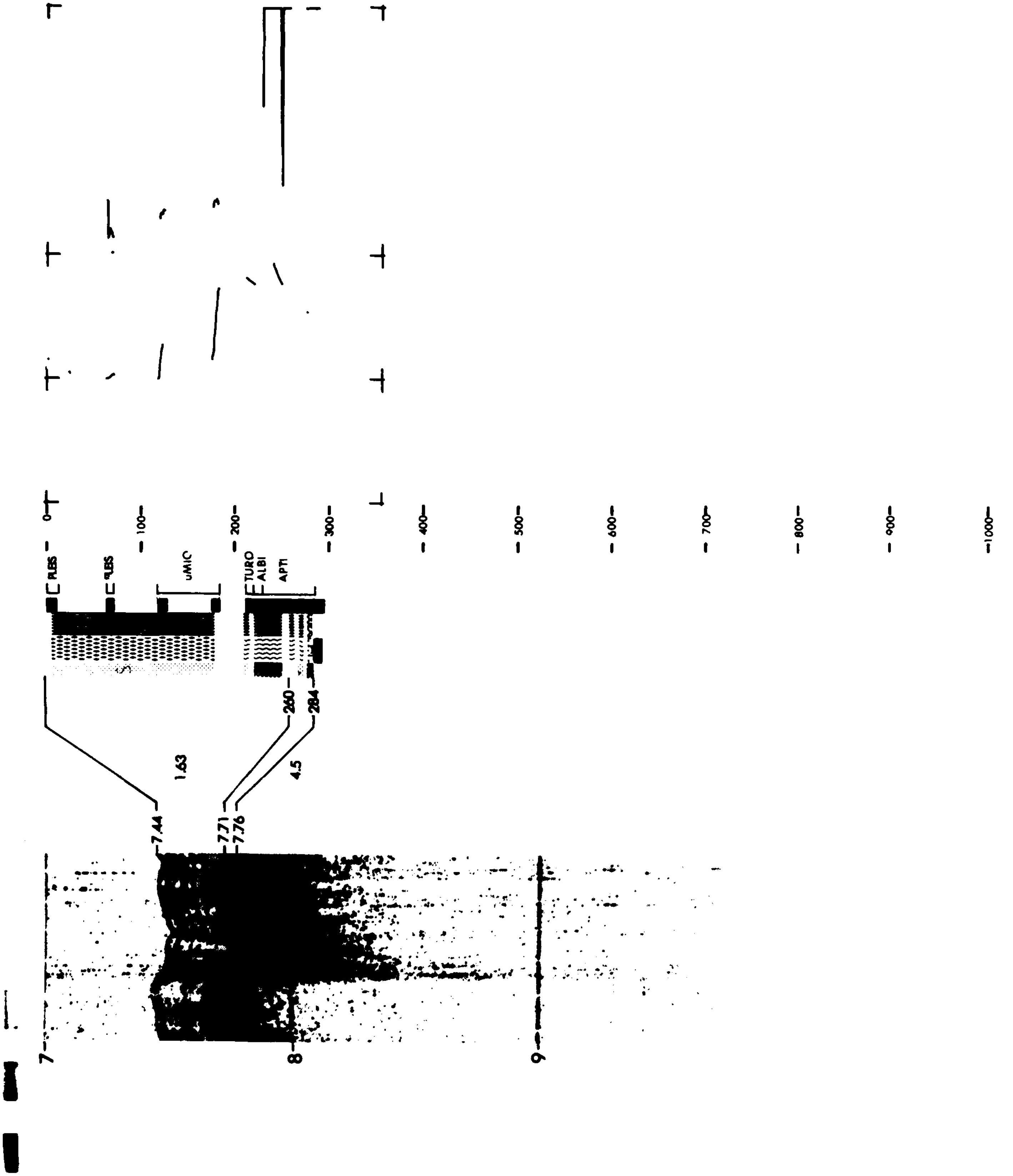
Penetration:	303	303A	
Drilled--	175	211	meters
Cored----	54	82	meters
Total----	229	293	meters
Recovery:			
Basement-	0	2	cores
	0	1	meters
Total----	6	10	cores
	26	6	meters

Most of the section consists of sediments deposited below the carbonate compensation depth except for the lowermost layers recovered immediately above basement. The relatively high rates of sedimentation observed in the upper part probably result from a combination of high productivity related to the Kuroshio-Oyashio current system as well as contributions from volcanogenic components. A major unsampled hiatus is probably present at the base of the Tertiary and top of the Cretaceous, and the upper Mesozoic section appears to be very thin. This interval was probably deposited in areas of rather low productivity north of the equatorial zone. The carbonate-rich layers recovered at the base of the section appear too thin to account for accumulation of "ridge flank" and "equatorial" types of sedimentation. This suggests that the crust at this site was not generated under the equatorial zone of high productivity. It is probable that the crust was generated south of the equator and that the equatorial crossing is recorded by large amounts of siliceous deposits after the area had subsided beneath the carbonate compensation depth (CCD).

One thin layer of calcareous, nannofossil rich sediment occurs in Aptian time. One thin layer of detrital sediment occurs in Turonian time.



SITE 303 LEG 32



SITE DATA

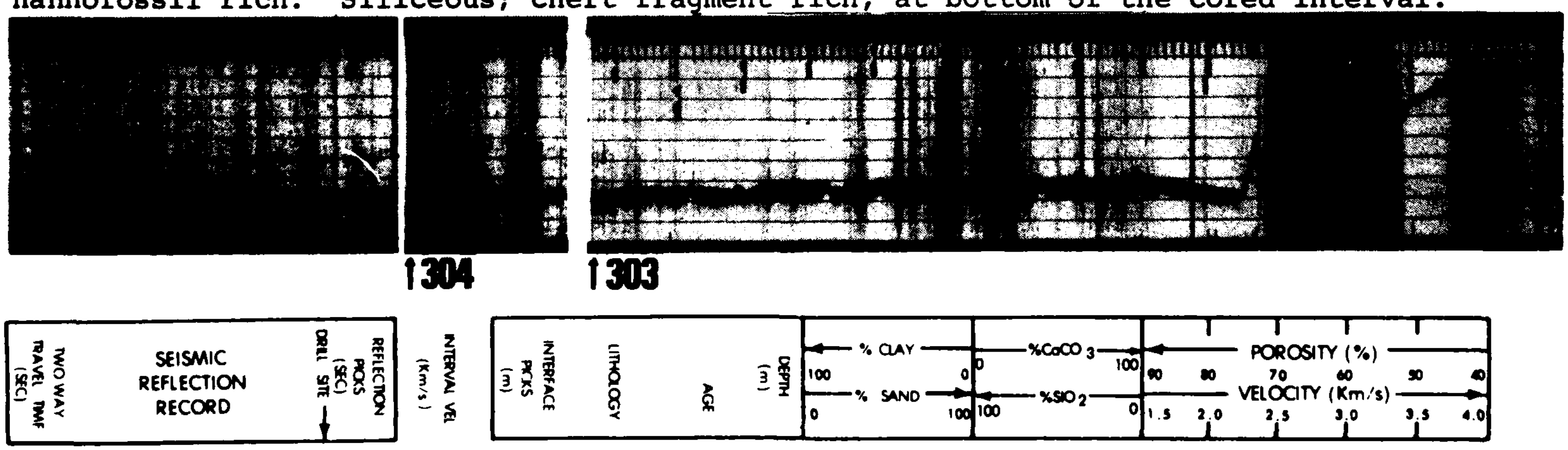
Position:
Latitude 39°20.3' N
Longitude 155°04.2' E
Date: 08/24/73
Time: 0756Z
Water depth: 5630 meters
Location: Japanese Magnetic Lineations

CORE DATA

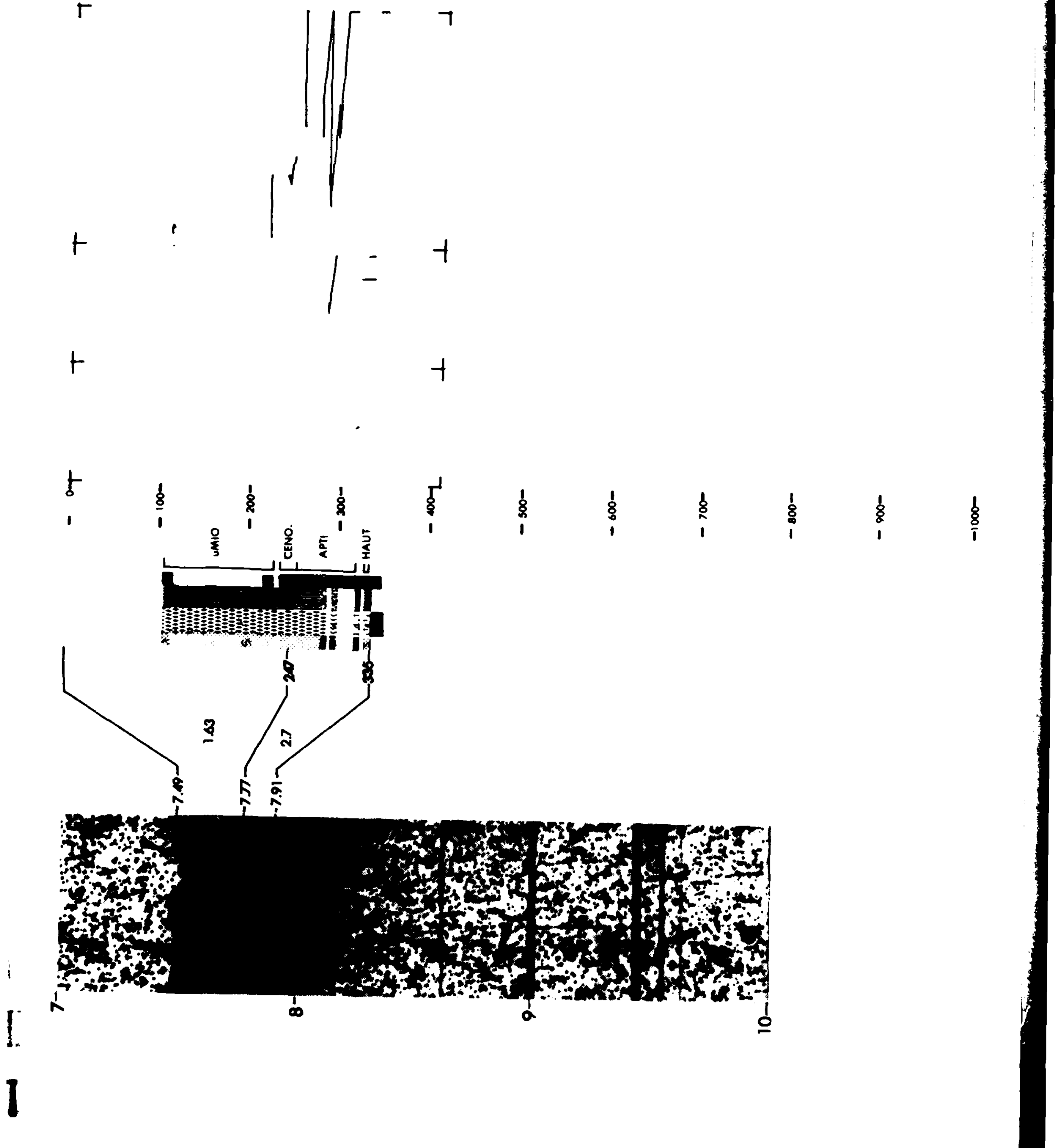
Penetration:
Drilled-- 216 meters
Cored---- 131 meters
Total---- 347 meters
Recovery:
Basement- 3 cores
12 meters
Total---- 17 cores
30 meters

The lithologies sampled at Site 304 are essentially identical to the section sampled at Site 303. The bottommost sediments recovered, the nanno ooze unit (Cores 12-14), represent sediments accumulated just above the carbonate compensation depth (CCD). The thickness of the Cretaceous section is not as large as would be expected from a high productivity zone such as the equator. These sediments were most likely deposited toward the outer edge of the equatorial high productivity area, yet above the CCD. An unrecovered unconformity (also inferred from Site 303) probably exists between the Upper Cretaceous and the Miocene as suggested by the sedimentation rates. The time represented by the hiatus was the time that sedimentation shifted from above to below the CCD. The clays and partially crystallized cherts of Unit 2 represent a dissolution facies deposited on the outer margin of a high productivity zone below the CCD. The radiolarian-diatom ooze of Unit 1 is simply the uncrystallized equivalent of Unit 2. The moderate average accumulation rates for these two units (16 m/m.y.) suggest they are not abyssal clay facies, which typically have rates an order of magnitude less than this.

One thin layer of detrital sediment occurs in Aptian time. Calcareous sediment; nannofossil rich. Siliceous; chert fragment rich, at bottom of the cored interval.



SITE 304 LEG 32



SITE DATA

Position:
- Latitude $32^{\circ}00.1'$ N
- Longitude $157^{\circ}51.0'$ E

Date: 09/03/73
Time: 0950Z
Water depth: 2903 meters
Location: Shatsky Rise

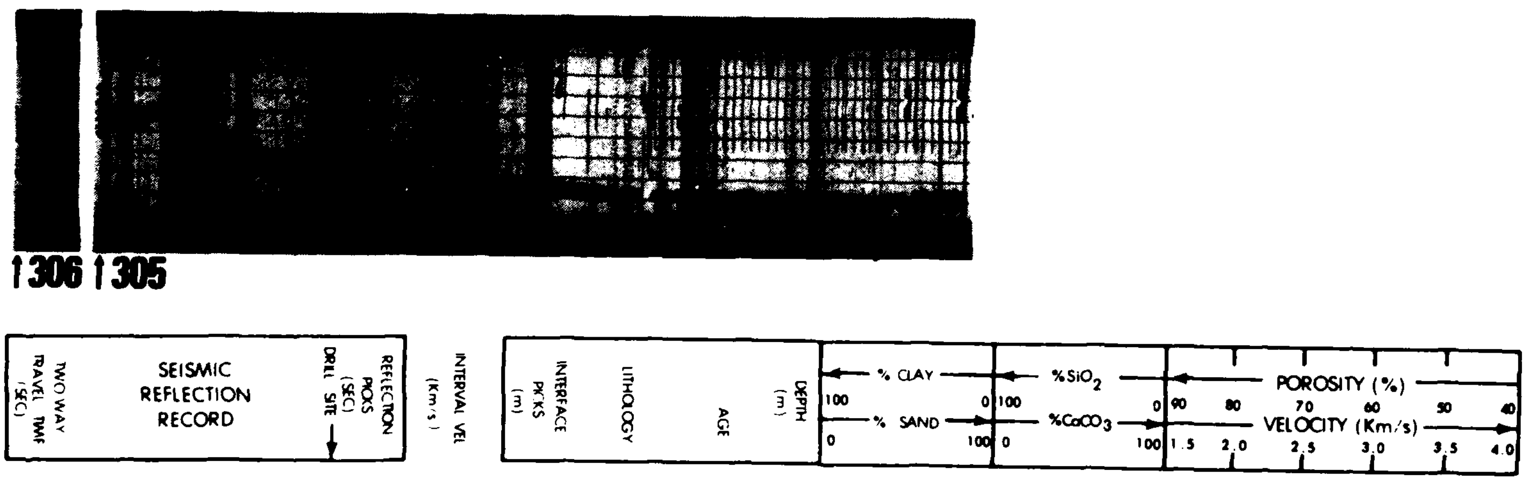
CORE DATA

Penetration:
- Drilled-- 9 meters
- Cored---- 631 meters
- Total---- 640 meters

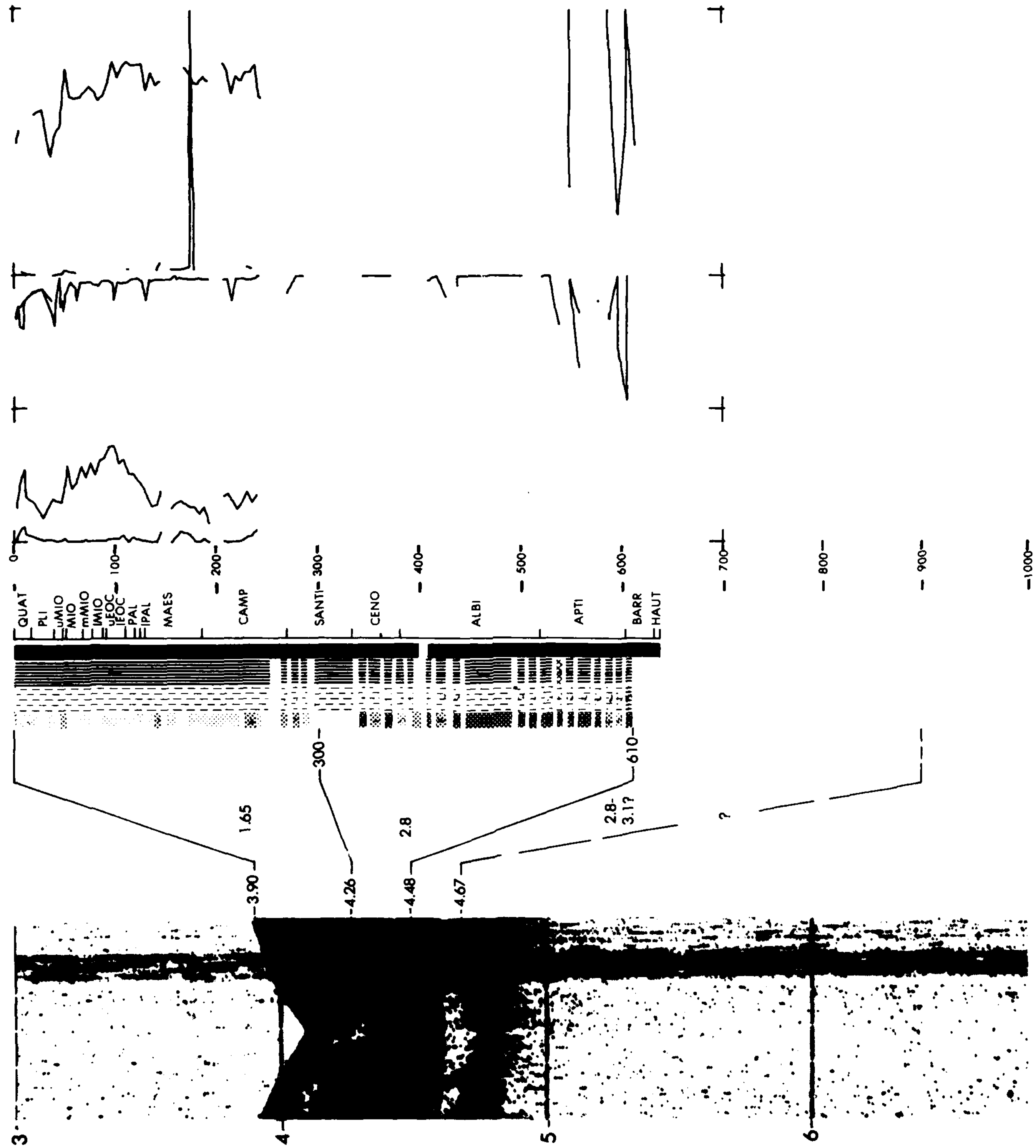
Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 68 cores
- 211 meters

The unsatisfactory state of preservation of the fossils decreases the value of Shatsky Rise as a Paleogene and late Mesozoic microfossil reference section. The foraminifera generally were the most useful for correlation, but there was not enough noncherty rock recovered below the Albian for good foraminifer control in the lowest sediments. Coccoliths were abundant wherever any carbonate was obtained in the cores, but their value was diminished by their poor to moderate preservation. Radiolaria were absent in the Paleogene and were present only in a spotty distribution in the Cretaceous. The sedimentation rates suggest that this southern part of Shatsky Rise was under the equator about 90 m.y. ago. Mainly that date is selected because it is the middle of the steepest slope of the sediment-accumulation curve. We were able, as planned, to core an apparently continuous early Paleogene-latest Cretaceous section below the Miocene unconformity that had been identified on Leg 6. Unfortunately, the era boundary fell between cores.

Calcareous sediment mostly nannofossil rich. One thin layer of siliceous sediment; radiolaria rich, occurs in Aptian time.



SITE 305 LEG 32



SITE DATA

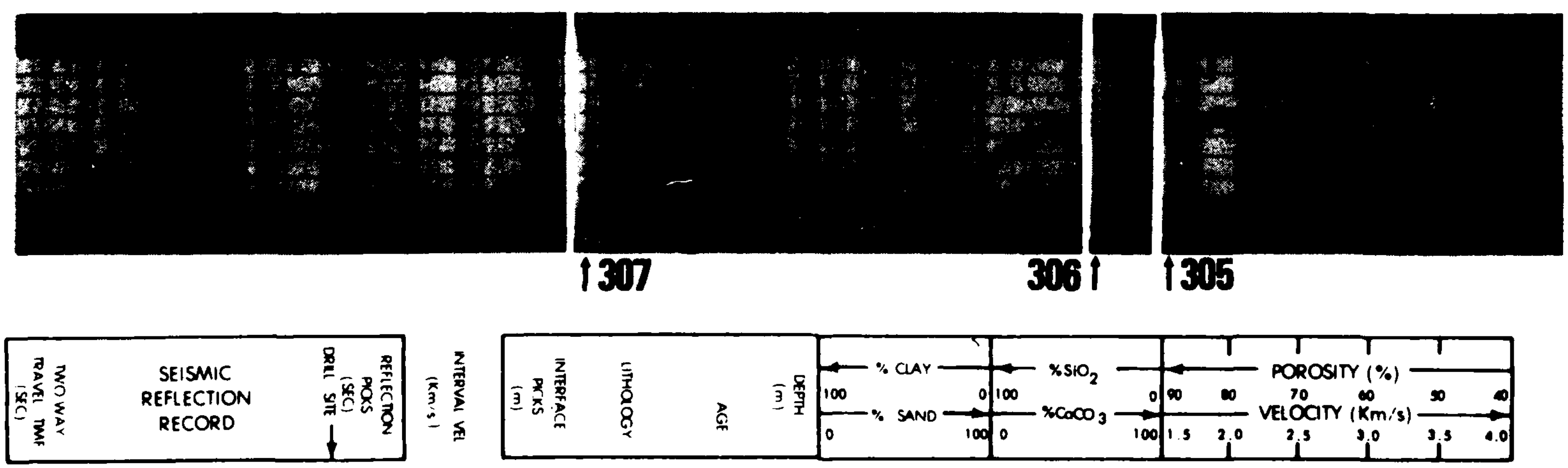
Position:
Latitude 31°52.0' N
Longitude 157°28.7' E
Date: 09/03/73
Time: 1312Z
Water depth: 3399 meters
Location: Shatsky Rise

CORE DATA

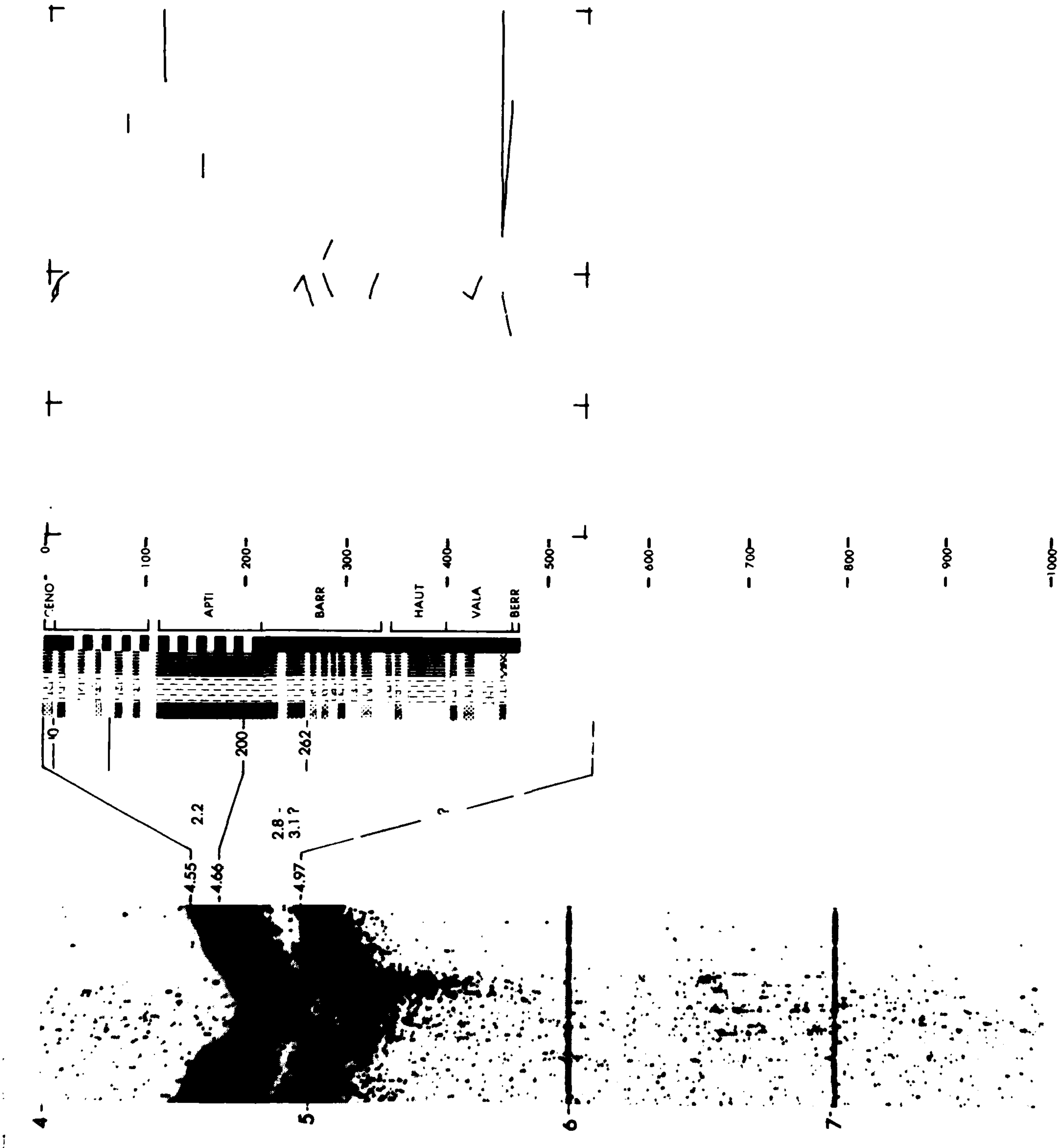
Penetration:
Drilled-- 95 meters
Cored---- 380 meters
Total---- 475 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 42 cores
27 meters

The principal result of drilling at Site 306 was the penetration of nearly a half kilometer of cherts and carbonate rocks, mainly of Early Cretaceous age. It had not been expected that the lower transparent layer of the reflection profiles would turn out to be so cherty. Much of it was impure, with clay and carbonate admixtures, typical of many porcellanites, but nevertheless resisted drilling. Like Site 305, a sufficient amount of fossil material was recovered at Site 306 that the progress of the hole could be followed, and a correlation with Site 305 could be made. The nature and age of basement remain unknown. As estimated from the reflection record, the 475-meter total depth of the hole was probably about 80 meters above basement. The increase in volcanogenic components in the lowest few cores suggest some proximity to basement, by analogy with the base of the sedimentary section on the Ontong-Java and Magellan plateaus.

Calcareous sediment, mostly nannofossil rich, once (Cenozoic) foraminifera rich.



SITE 306 LEG 32



SITE DATA

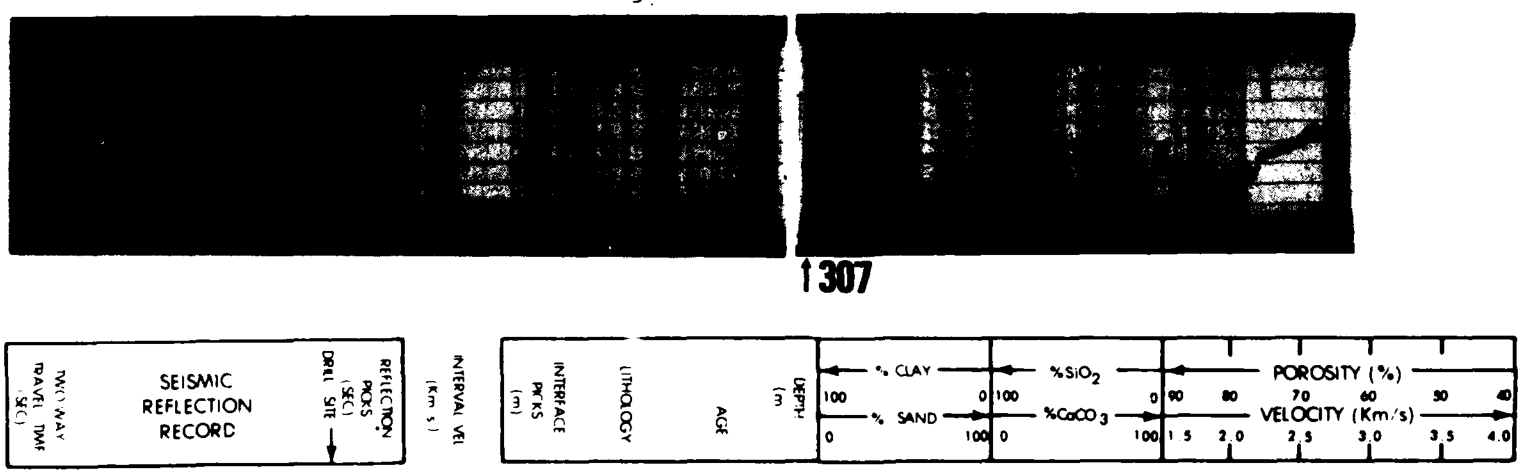
Position:
Latitude 28°35.3' N
Longitude 161°00.3' E
Date: 09/09/73
Time: 0535Z
Water depth: 5696 meters
Location: Hawaiian Magnetic Lineations

CORE DATA

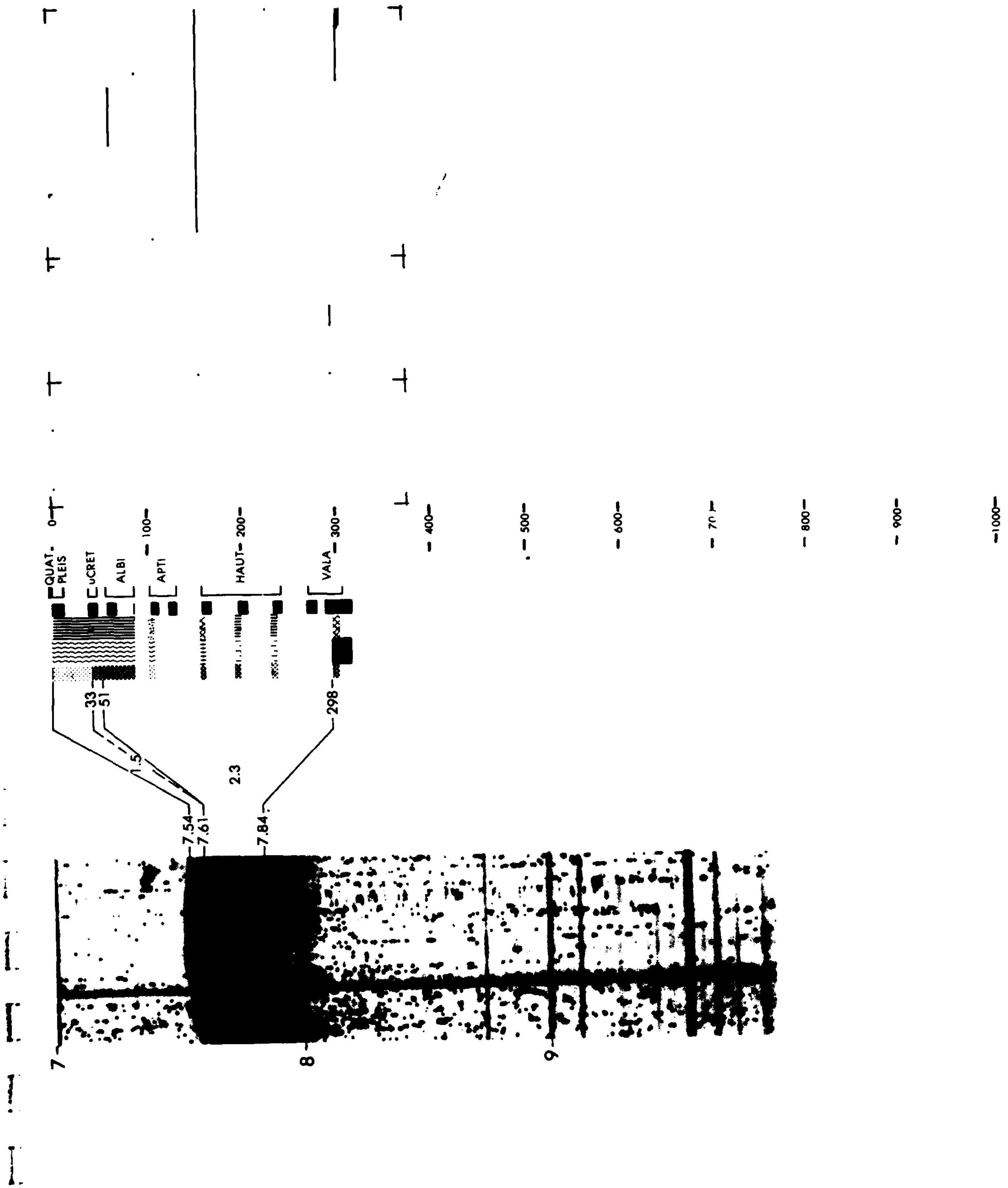
Penetration:
Drilled-- 205 meters
Cored---- 111 meters
Total---- 316 meters
Recovery:
Basement- 2 cores
5 meters
Total---- 13 cores
19 meters

The estimate of Late Jurassic or Earliest Cretaceous as the age of magnetic anomaly M-21 is the most significant result of Site 307. The top 33 meters of the section is a brown, zeolitic pelagic clay that is the result of slow deposition in deep water north of the equatorial zone of productivity. Below that the zeolitic clay is mixed with porcellanite and chert of Middle Cretaceous age. These sediments are present down to at least 167 meters and probably indicate the time when Site 307 was moving across the zone of equatorial productivity. This probably occurred from the late Neocomian to the early Late Cretaceous (Cenomanian?). From 195 meters down to basement at 298 meters the cherts and porcellanites are mixed with calcareous material indicating probably deposition at ridge crest depths from the middle Neocomian down to the basement of Berriasian age. The sedimentation rates yield this same generalized picture that indicates deposition at 5 to 10 m/m.y. from early Late Cretaceous down to basement. The basement lava is very obviously of extrusive origin, consisting of several thin flow units and a large percentage of hyaloclastite. It is extremely weathered.

Calcareous sediment nannofossil rich. Siliceous sediment occurs in thin layers, one in Hauterivian and one in Valanginian time.



SITE 307 LEG 32



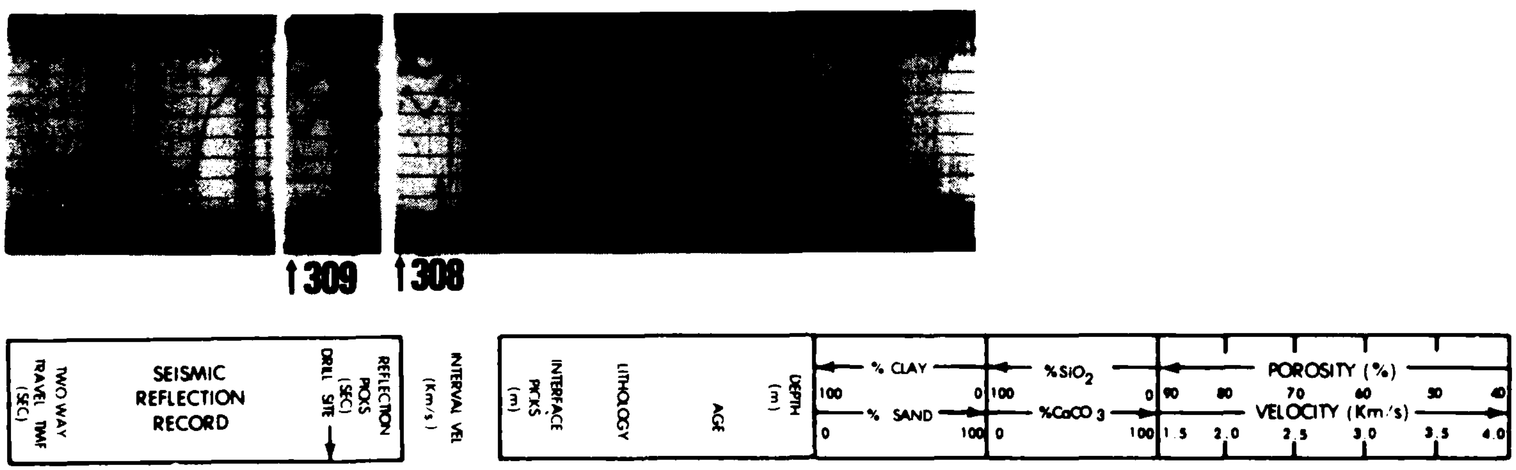
SITE DATA

Position:
Latitude $34°58.9'$ N
Longitude $172°09.0'$ E
Date: 09/16/73
Time: 0620Z
Water depth: 1331 meters
Location: Kōko Guyot

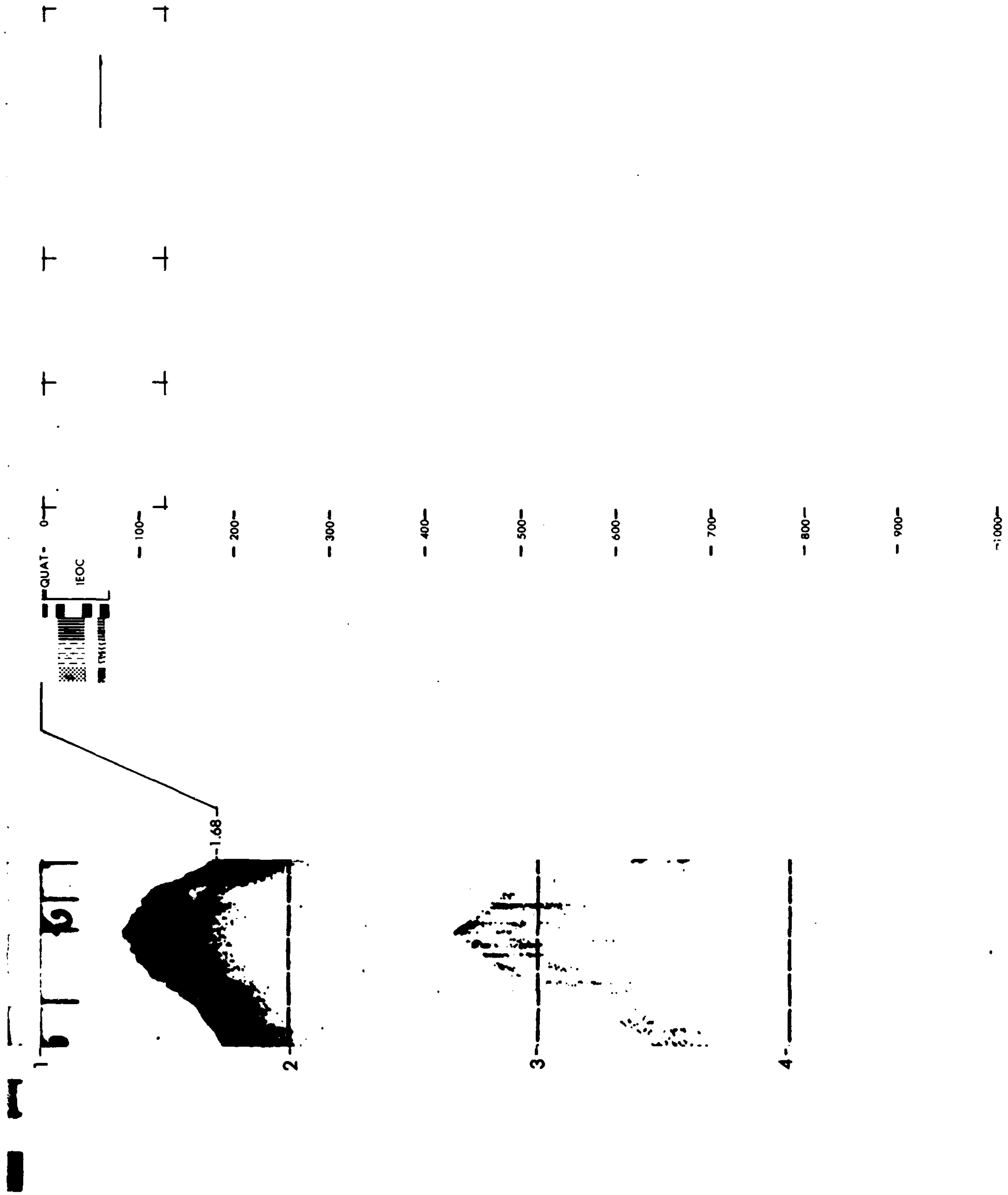
CORE DATA

Penetration:	
Drilled--	38 meters
Cored----	30 meters
Total----	68 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	4 cores
	7 meters

The type of sediment recovered and the character of the profiler records across the guyot support the theory for the origin of guyots that most investigators favor: the characteristic topography of guyots is formed in shallow water by the erosional truncation of the volcanic edifice coupled with paralic sedimentation. The sediments recovered at Site 308 are generally similar in composition and texture to those now forming at depths between sea level and a few hundred meters around the Hawaiian Islands (Moberly, 1968). The main differences are the calcite cement, due to the age, and the high bryozoan content, perhaps due to a different faunal province or to cooler water, of the Kōko samples. The wealth of oxtracodes and rarity of planktonic foraminifers suggest that these Kōko sediments formed near sea level, probably no deeper than 60 meters. Therefore, the guyot at Site 308 has subsided at least 1300 meters. The moat shown on reflection profiles suggests that subsidence continues even today.



SITE 308 LEG 32



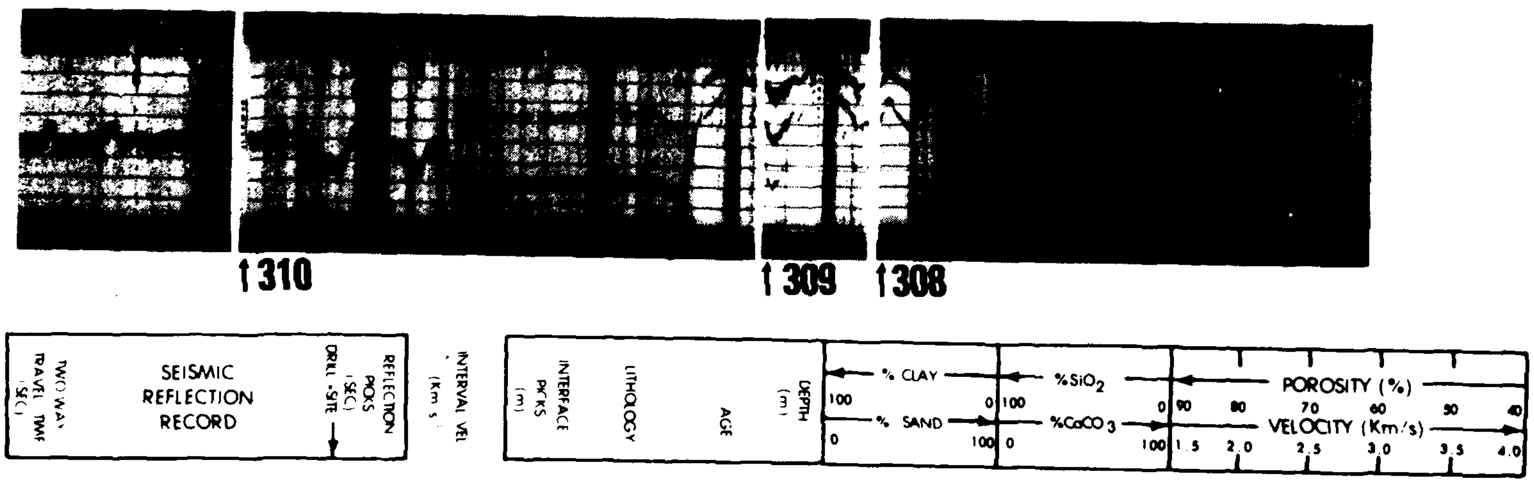
SITE DATA

Position:
Latitude $34^{\circ}59.0'$ N
Longitude $171^{\circ}33.7'$ E
Date: 09/17/73
Time: 0732Z
Water depth: 1454 meters
Location: Kōko Guyot

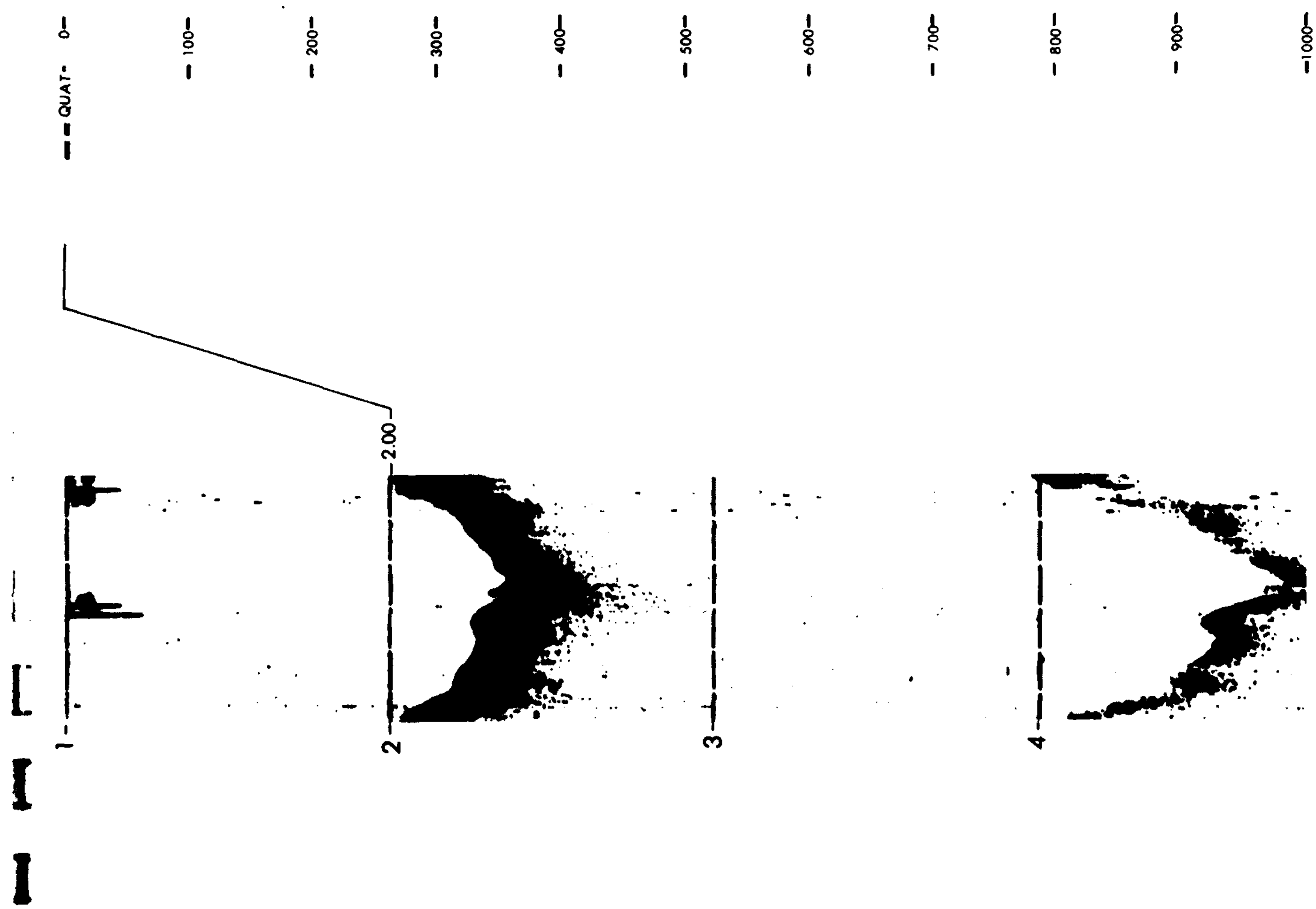
CORE DATA

Penetration:	
Drilled--	10 meters
Cored----	2 meters
Total----	12 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	1 cores
	.2 meters

The meager information given by the few grams of sediment recovered at Site 309 tends to support the general conclusions for Site 308, also on Kōko Guyot. These are, that no magnetic paleolatitude or igneous petrologic studies can be made from Leg 32 material, and that the guyot has subsided more than 1000 meters during the Cenozoic. The Site 309 region of Kōko Guyot, or an area upslope from it, was relatively shallow in the late Oligocene or early Miocene. Volcanism may have recurred well after the 6-m.y. long period of volcanism recorded by fossils at Site 308 and by dates on rocks dredged from the guyot (Clague and Dalrymple, 1973). Another, perhaps less likely, possibility is that the west side (Site 309) of the large guyot may have been formed as a volcanic edifice at the same time as the east side (Site 308), but some accident of faulting, tilting, or perhaps erosion of Kōko Island, put the west side in shallower water in the late Oligocene. Certainly the history of linear volcanic chains is more complicated than some have speculated.



SITE 309 LEG 32



SITE DATA

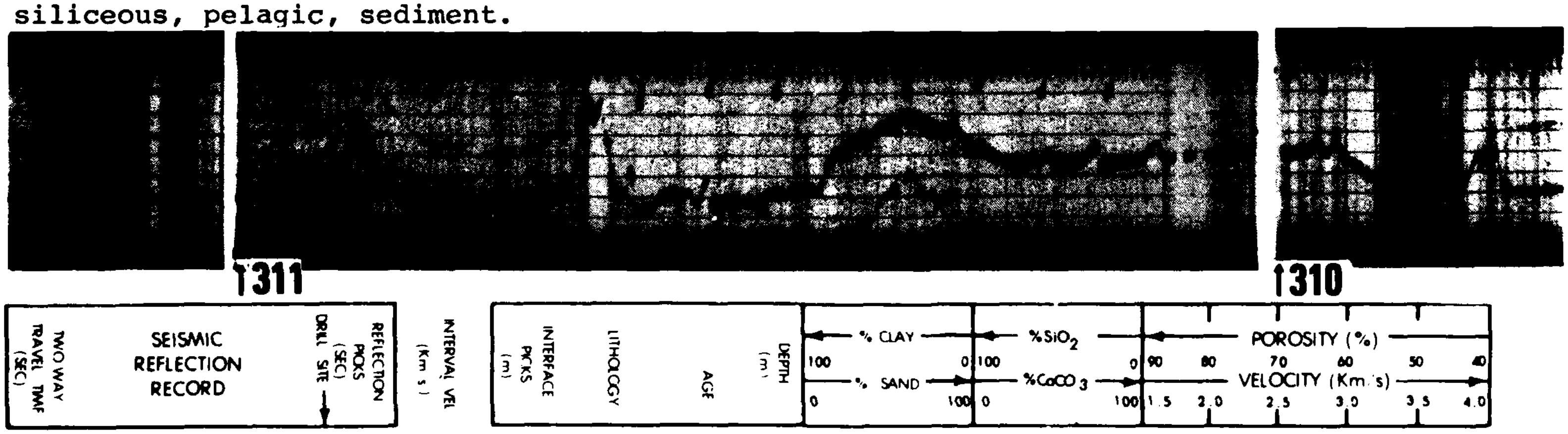
Position:
Latitude 36°52.1'N
Longitude 176°54.1'E
Date: 09/19/73
Time: 1020Z
Water depth: 3516 meters
Location: Hess Rise

CORE DATA

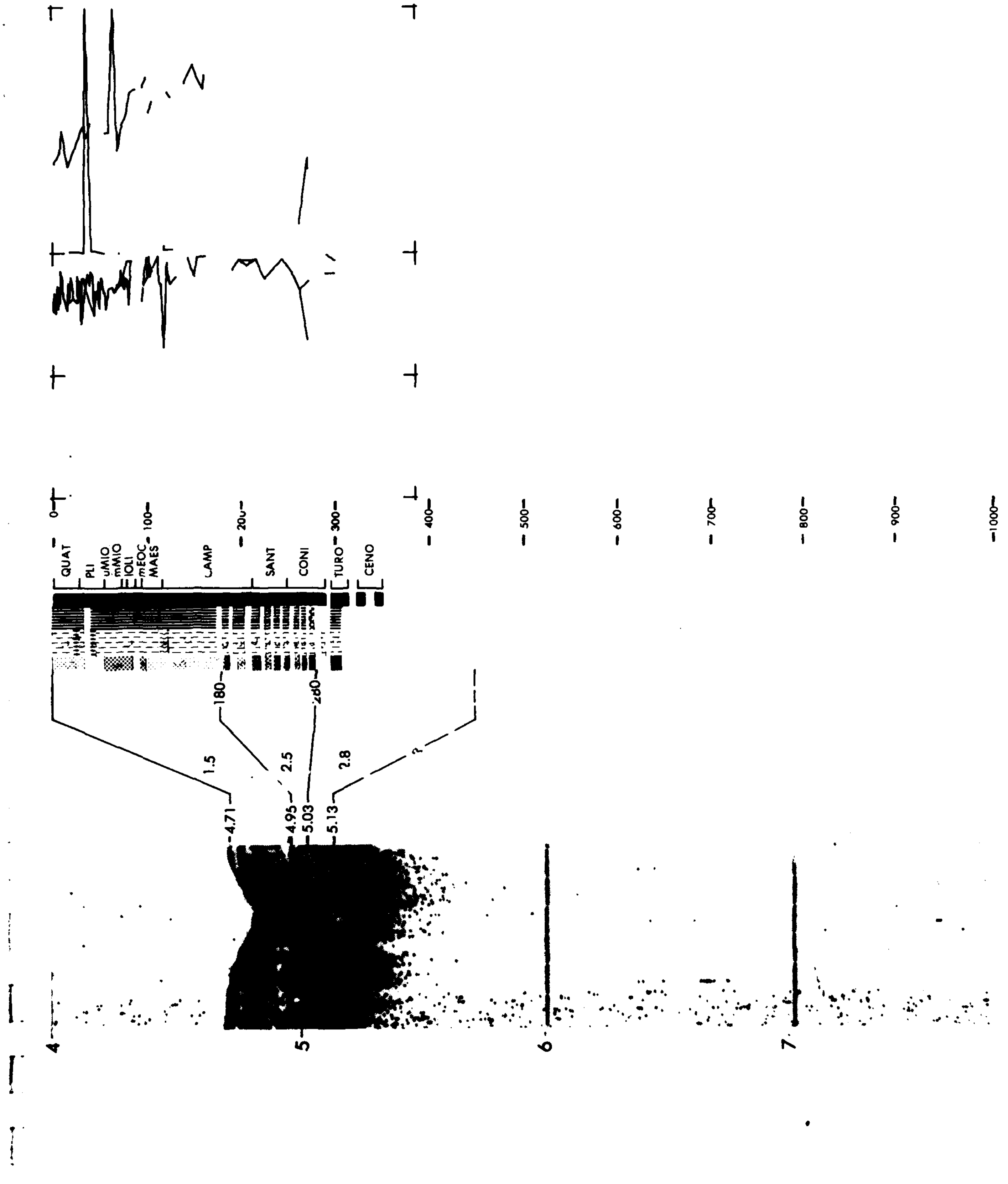
Penetration:	310	310A	
Drilled--	0	189	meters
Cored----	193	163	meters
Total----	193	352	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	21	18	cores
	145	27	meters

The Paleogene was a time of disruption in sedimentation, now evidenced by missing fossil zones and by zeolitic sediments. The lack of radiolarians and strong evidence of solution of foraminifera and coccoliths indicate that corrosion of the planktonic component of the sediment was as important or probably more important than erosion. Deposits of early Miocene age are missing. At least six other unconformities, or perhaps greatly compressed sections, exist in the upper part of the section. There was no recovery of the late Eocene or of the Paleocene, but those gaps are between cores rather than within the cores. Their exact depth and extent therefore are open to speculation. In the Cretaceous section recovery was poor, close zonation of the section is not possible, but all the stages appear to be represented. The nature and age of basement of Hess Rise remain unknown. Almost certainly the basement is basalt. Estimates of age are based on a number of assumptions, of which the most critical is the one that pelagic chalk, ooze, and chert are the dominant sediments between the total depth of the hole and basement.

Calcareous sediment: mostly nannofossil rich. Two thin layers in Pliocene time of siliceous, pelagic, sediment.



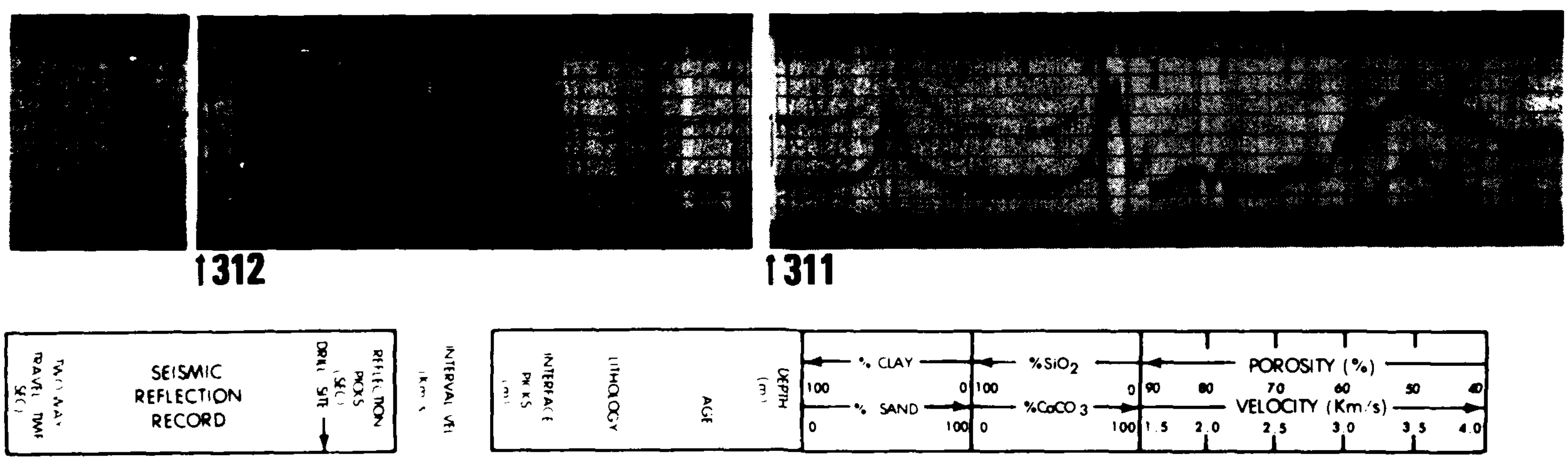
SITE 310 LEG 32



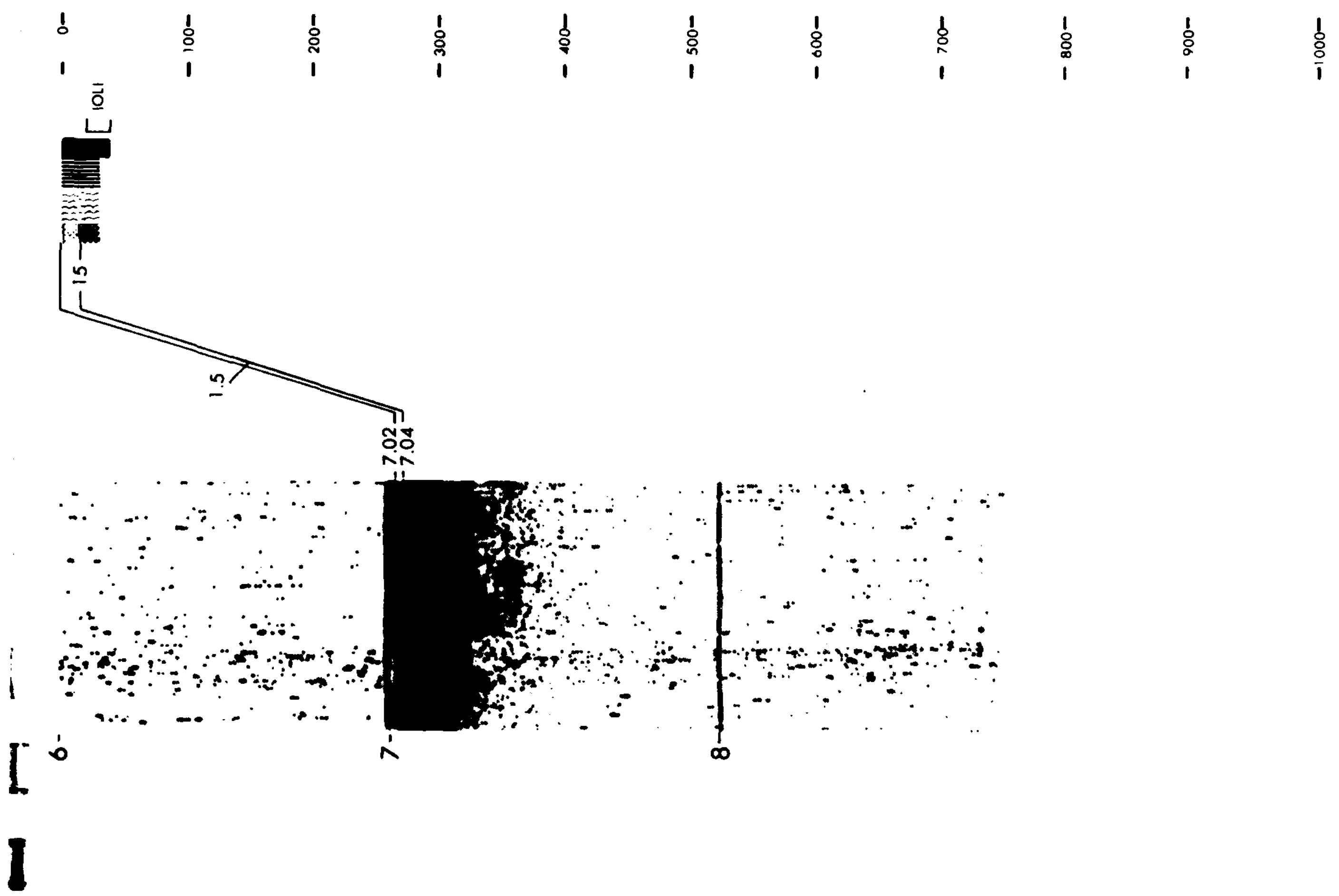
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	28° 07.5' N	Drilled--	0 meters
Longitude	179° 44.2' E	Cored----	37 meters
Date:	09/26/73	Total----	37 meters
Time:	1528Z	Recovery:	
Water depth:	5775 meters	Basement-	0 cores
Location:	Hawaiian Magnetic Lineations		0 meters
		Total----	5 cores
			19 meters

The Sphenolithus distentus flora of Core 3 is early late Oligocene in age and indicates that the archipelagic apron of this part of the Hawaiian volcanic chain was built by the middle of the Oligocene. Undoubtedly the nearby Hawaiian Seamount was the source of the debris of fresh and palagonitized hyaloclastic glass, and lesser amounts of fresh hyaloclastic and reworked pyroclastic glass and lithic volcanic grains. The early late Oligocene age of about 27 to 30 m.y. is a minimum one, because we did not penetrate to the initial volcanic turbidite beds. We conclude that the vector of relative motion between the Pacific plate and the melting anomaly has been constant in direction but that the rate was slower prior to the formation of Midway. This result also suggests that the vector change that occurred at the Emperor-Hawaiian "elbow" was more one of direction than rate. The only history subsequent to the volcanic events at this site is the change from turbidite to pelagic sedimentation by Miocene time. Unfortunately, the loss of part of the bottom-hole assembly precluded any chance of dating the young end of the sequence of Mesozoic magnetic reversals.

Calcareous sediment; occurs in one thin layer.

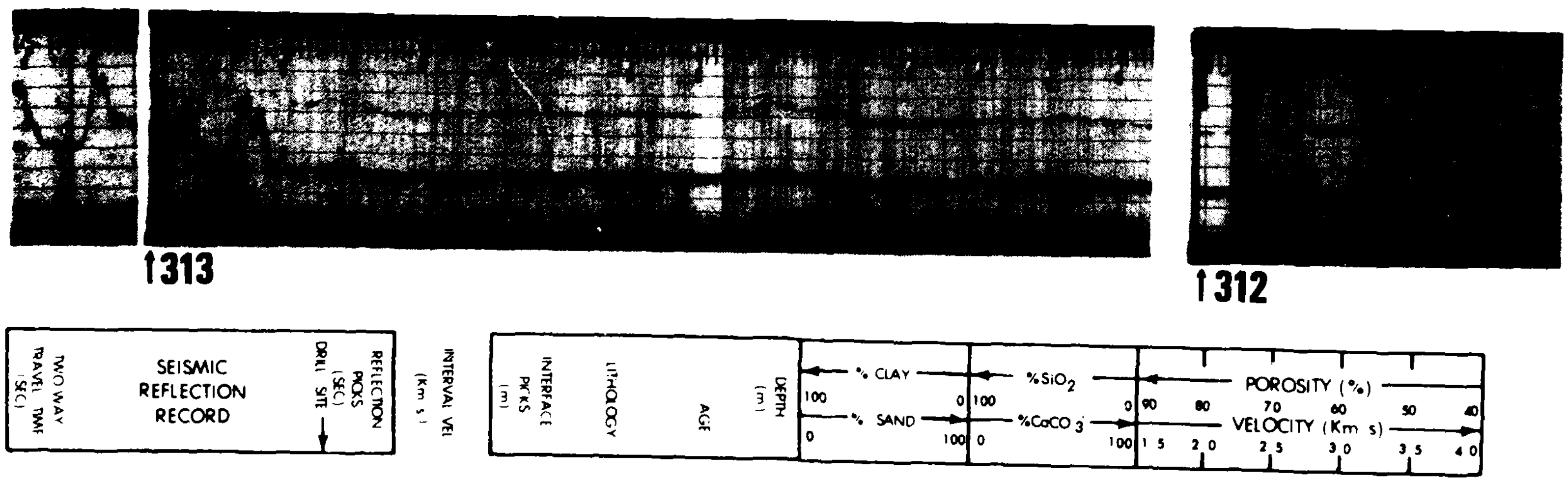


SITE 311 LEG 32

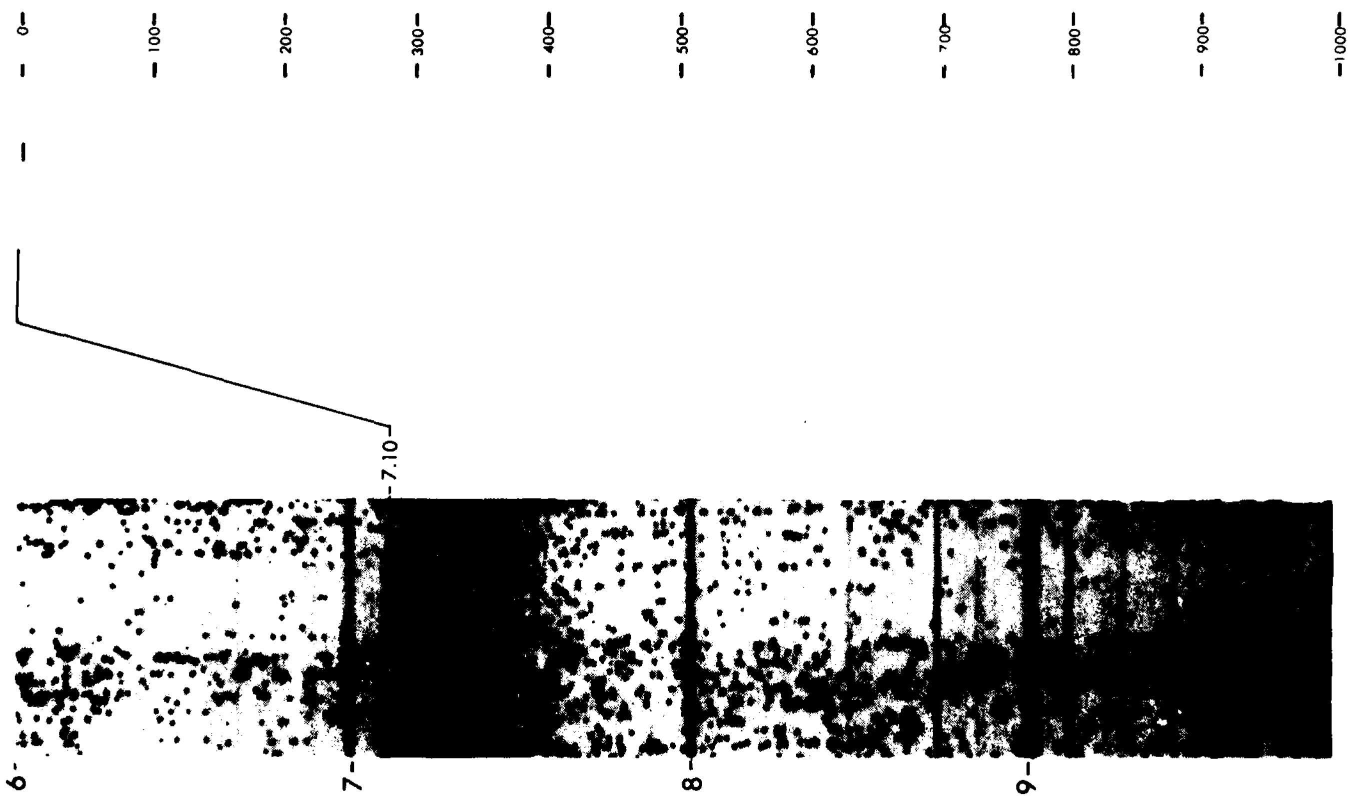


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	25° 34.7′ N	Drilled--	0 meters
Longitude	178° 08.0′ W	Cored----	0 meters
Date:	09/29/73	Total----	0 meters
Time:	2028Z	Recovery:	
Water depth:	5345 meters	Basement-	0 cores
Location:	Hawaiian Magnetic Lineations		0 meters
		Total----	0 cores
			0 meters

Being unable to run in any of the drill string other than the bottom-hole assembly, because of the heavy swell and wind from a nearby storm, not enough time remained to drill and core to achieve our primary objective of dating basement, and then travel to Honolulu. After a little more than one day we abandoned the site without having reached the sea floor. A site number was assigned to account for the expenditure of the beacon and ship's time. We departed eastward.



SITE 312 **LEG 32**



SITE DATA

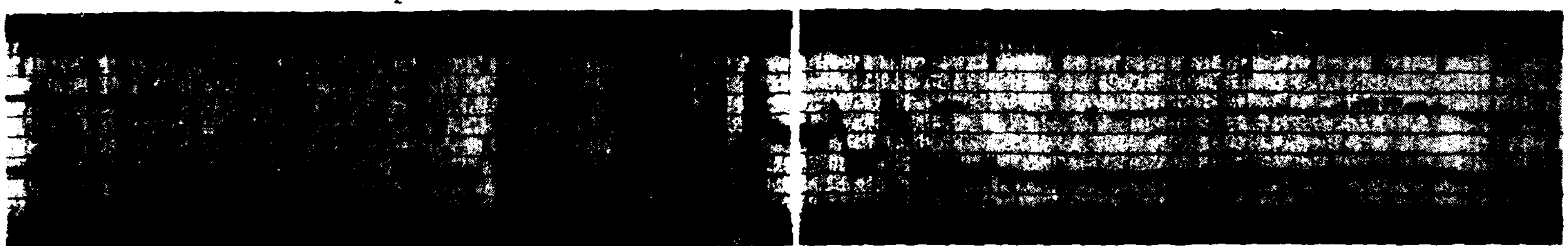
Position:
Latitude 20°10.2' N
Longitude 170°57.1' W
Date: 10/03/73
Time: 1133Z
Water depth: 3484 meters
Location: Mid-Pacific Mountains

CORE DATA

Penetration:
Drilled-- 212 meters
Cored---- 394 meters
Total---- 606 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 44 cores
220 meters

The basal sedimentary unit represents a time of rapid deposition by turbidity currents and gravity slides from the nearby volcanic mountains. There is no evidence of shal -water detritus so it is assumed that the source areas for the sediment remaine. well below sea level. The mountains provided the basaltic volcanic detritus and calcareous material for the turbidites. Intervening quiet periods allowed some pelagic carbonate deposition and burrowing to occur. As the basin filled and the supply of volcanic detritus decreased, a more calcareous facies developed consisting of turbidite and pelagic deposition. Lithification begins in the carbonate at 149.5 m and increases down the hole. Diagenetic dolomite rhombs occur in limestone at the base of the hole. The cement in the volcanic sandstone (Unit 2) consists of radiating sheaves of zeolite (phillipsite) and green clay (celadonite, nontronite) formed from the alteration of the volcanic glass and palagonite. The very fine grain size, as well as the possibility of multiple cooling units, suggest that the basalt is extrusive. The basalt is alkalic, suggesting that it formed somewhat late in the development of the nearby seamounts.

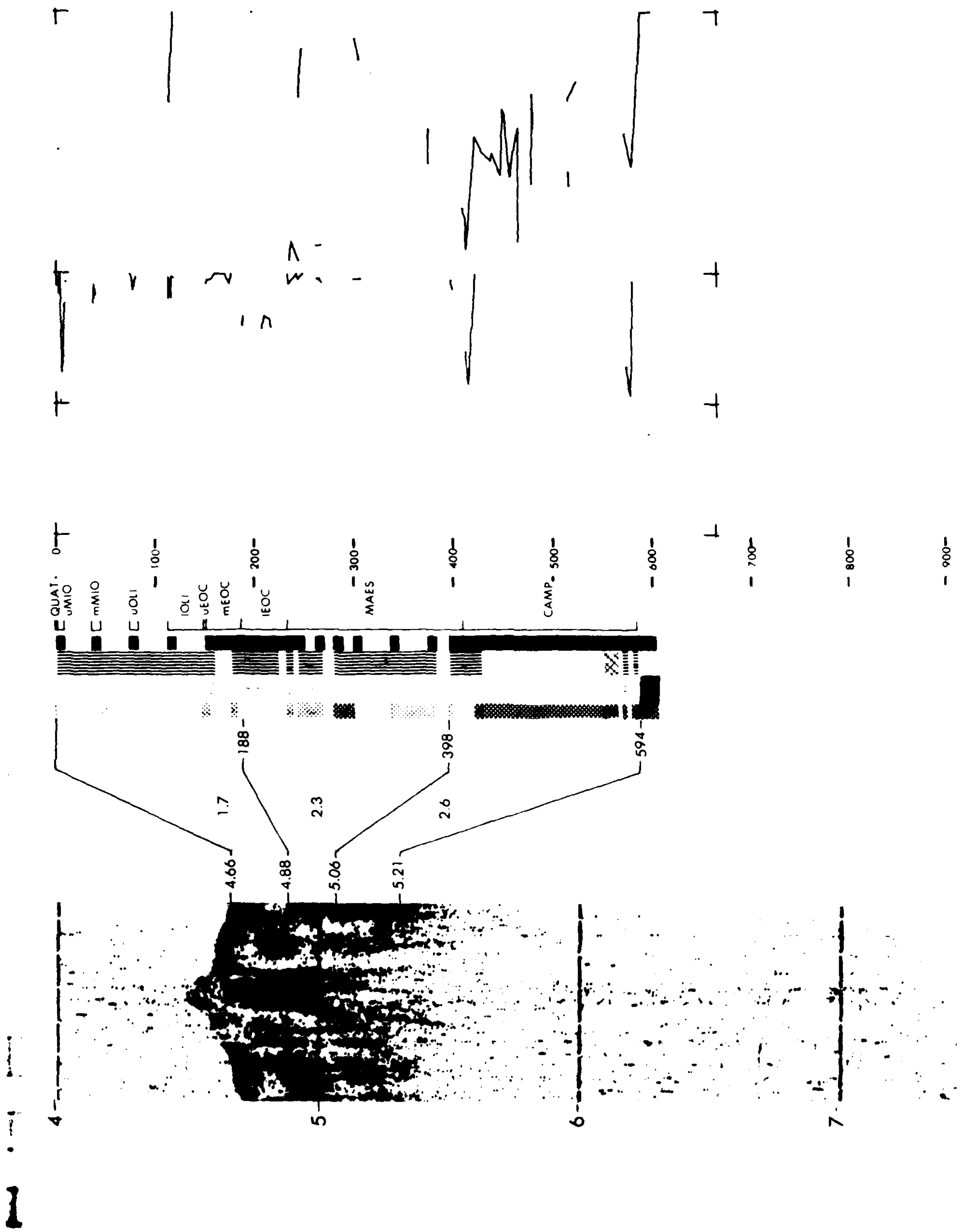
Calcareous sediment; occasionally nannofossil rich. One thin layer of detrital sediment occurs in Campanian time.



↑313

TWO-WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | REFLECTION PICKS (SEC) | DRILL SITE | INTERVAL V. (Km/s) | INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100–0 / % SAND 0–100 | % SiO_2 100–0 / % $CaCO_3$ 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 313 LEG 32



SITE DATA

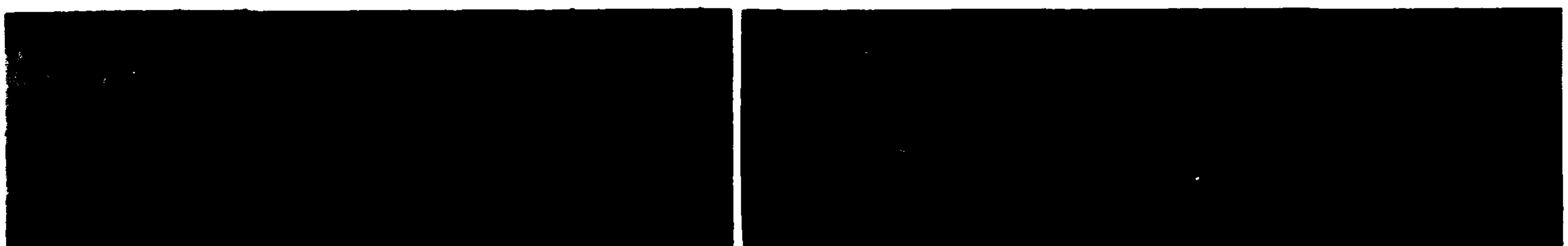
Position:
Latitude $15^{\circ}54.8'$ N
Longitude $168^{\circ}28.1'$ W
Date: 11/06/73
Time: 0630Z
Water depth: 5214 meters
Location: Johnston Island Trough

CORE DATA

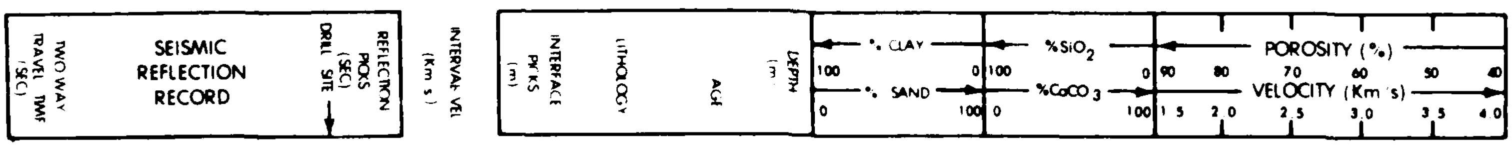
Penetration:
Drilled-- 28 meters
Cored---- 17 meters
Total---- 45 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 3 cores
.1 meters

Poor recovery at this site, yielding sediment of uncertain stratigraphic position, imposed severe restrictions on the description and interpretation of samples. Only a few grams of material could be scraped from the corecatcher teeth from Cores 1 and 3. Samples available consisted of a few grams of brown clay from the core catcher of Core 1 and various fragments retained in the core catcher of Core 3. In an attempt to supplement these sparse samples, scrapings were taken from sediment left clinging to the outer drill collars. These scrapings may originate anywhere between the sea floor and 45 meters below.

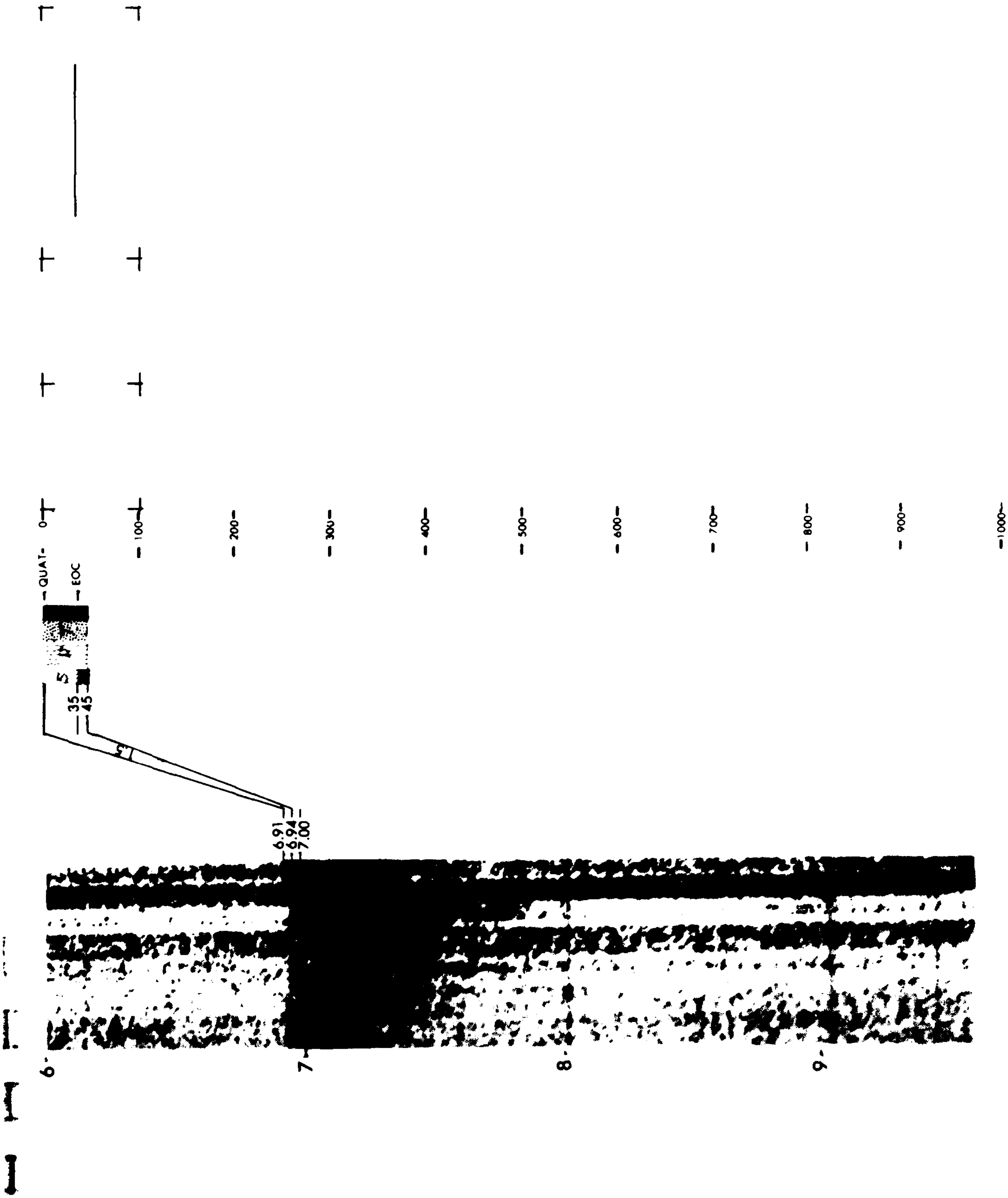
The following lithological units were defined: Unit 1—Brown zeolitic clay (probably 0-35 m): 1, CC (scrapings; and Unit 2—Silicified claystone and porcellanite (probably from 35 to 45 m): 3, CC.



1314



SITE 314 LEG 33



SITE DATA

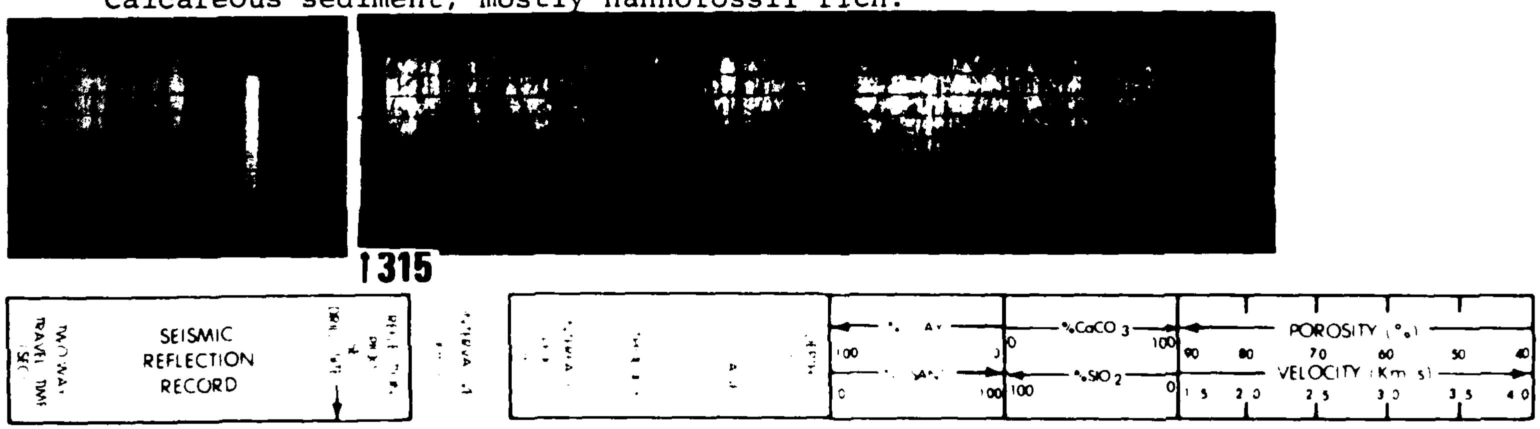
Position:
Latitude $4^{\circ}10.3'$ N
Longitude $158^{\circ}31.5'$ W
Date: 11/13/73
Time: 0200Z
Water depth: 4152 meters
Location: Fanning Fan East

CORE DATA

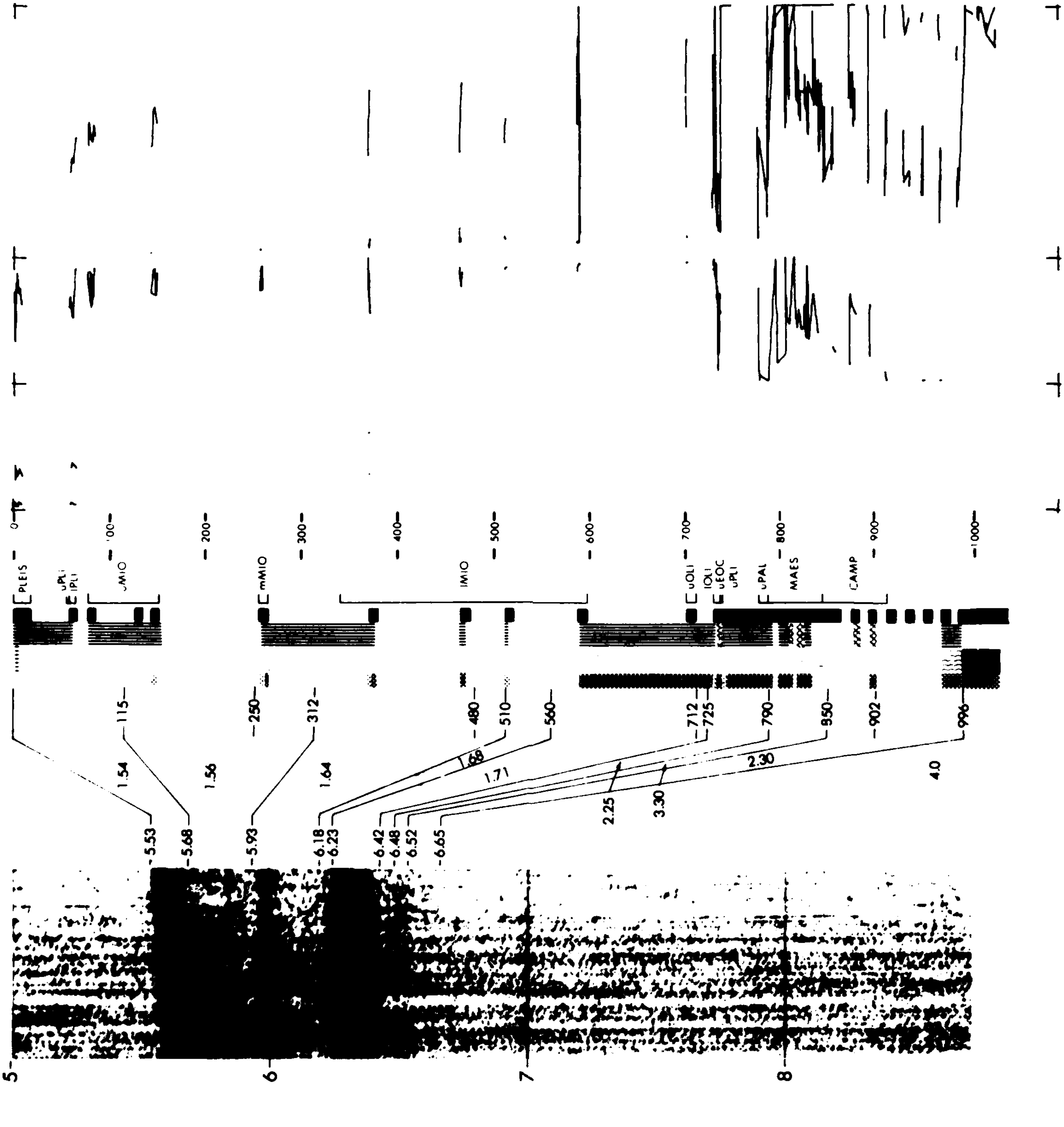
Penetration:	315	315A	
Drilled--	48	711	meters
Cored----	37	323	meters
Total----	85	1034	meters
Recovery:			
Basement-	0	4	cores
	0	7	meters
Total----	4	34	cores
	17	130	meters

Site 315 comprises biogenic calcareous oozes and limestones. However, recovery is biased toward the cherty and volcanogenic sediments due to spot coring in the calcareous sediments of the upper 710 meters. In addition, soft clays and clayey sediments in the lower cores may have been missed as a result of the alternate coring and washing-ahead technique used. This site is characterized by a very thick section with a large proportion of diverse graded, redeposited sediment. In the upper part (0-710 m) numerous graded foraminiferal sands are commonly accompanied by bits of volcanogenic material. Where induration increases, there is ample evidence of redeposition of fine-grained calcareous material. Typically, a clearly graded thin, basal zone with volcanogenic grains is present, overlain by a thick, undifferentiated body, which usually grades upward to a zone with darker coloration and increasing evidence of burrowing. Calcareous graded beds tend to become thinner down-section and are supplanted by increasing amounts of volcaniclastic graded sandstone to claystone. This parallels the general trend of decreasing carbonate content downhole. The volcanogenic layers show a variety of sedimentary structures generally associated with turbidites. Tops are typically burrowed and show an "exponential" decrease of activity. These sands probably record the growth and erosion of the volcanic edifice of Fanning Island. The probable alhalic basalt represents at least six flow units related to the Fanning edifice.

Calcareous sediment; mostly nannofossil rich.



SITE 315 LEG 33



SITE DATA

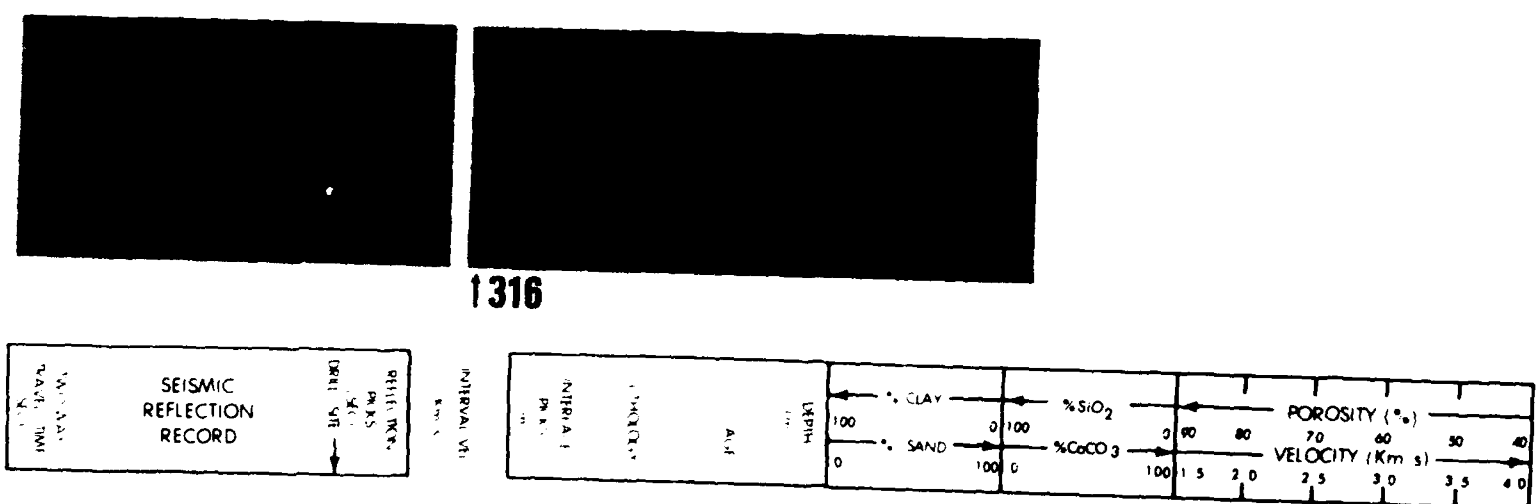
Position:
Latitude $0^{\circ}05.4'$ N
Longitude $157^{\circ}07.7'$ W
Date: 11/22/73
Time: 0708Z
Water depth: 4451 meters
Location: Southern Line Islands Trough

CORE DATA

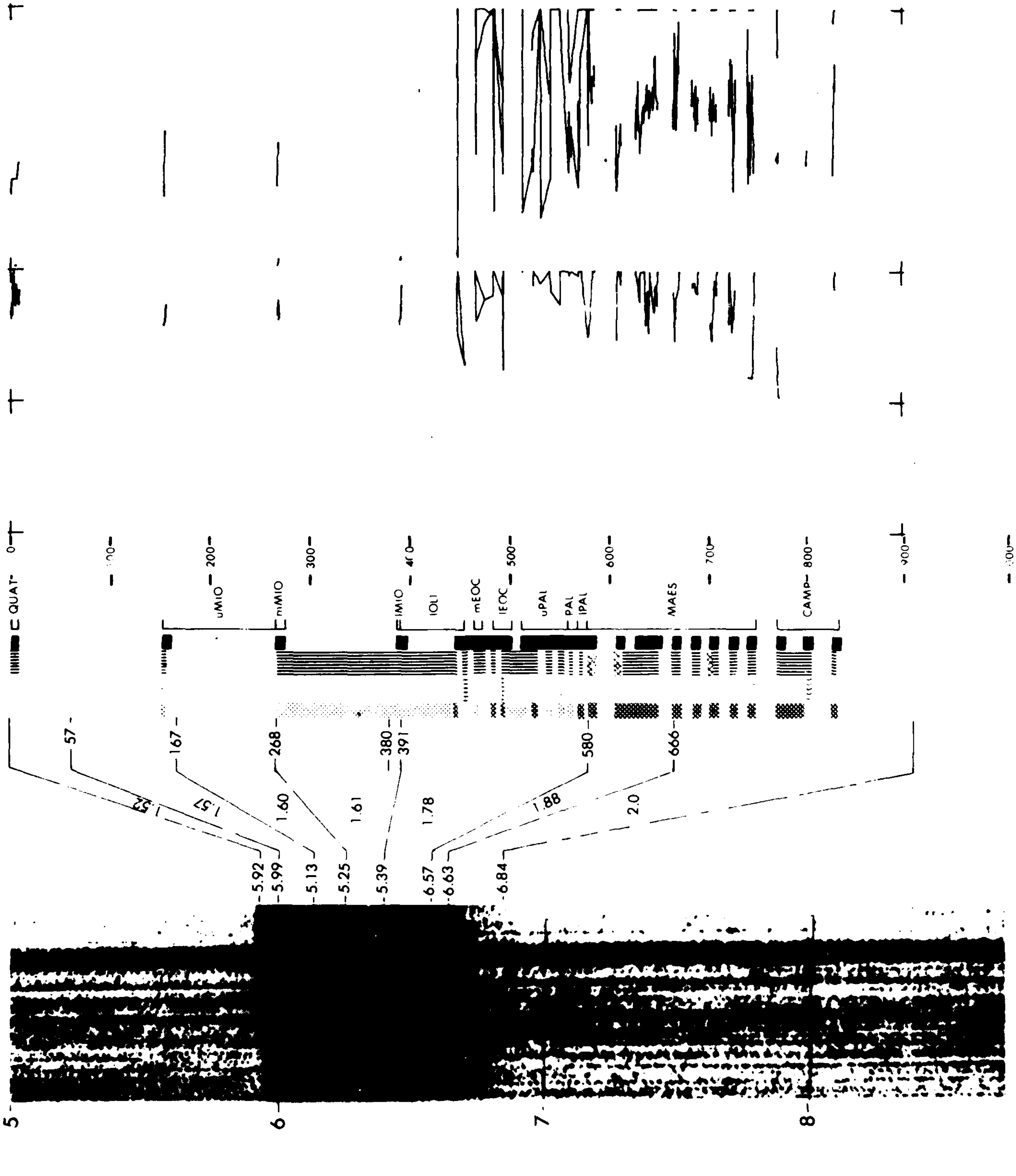
Penetration:
Drilled-- 552 meters
Cored---- 285 meters
Total---- 837 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 30 cores
103 meters

The thin, volcanogenic sands of Maestrichtian age represent late erosional products of earlier volcanism, but the thick middle and lower Campanian volcanogenic debris appears to represent the nearly simultaneous growth and rapid erosion of nearby Line Islands edifices. It also seems apparent that the youngest volcanic rocks in the Line Islands seamount chain do not young to the south, at least in the approximately 1270-km distance along the chain between Sites 165 and 316. On leaving the site, a seamount or ridge was crossed approximately 10 n. mi. southeast of the site, which may have been a principal source of the redeposited volcanogenic sediments.

Calcareous sediment; occasionally nannofossil or foraminifera rich, rarely oolite rich, interbedded with two thin layers of siliceous sediment (Eocene) and one thin layer of detrital sediment (Campanian).



SITE 316 LEG 33



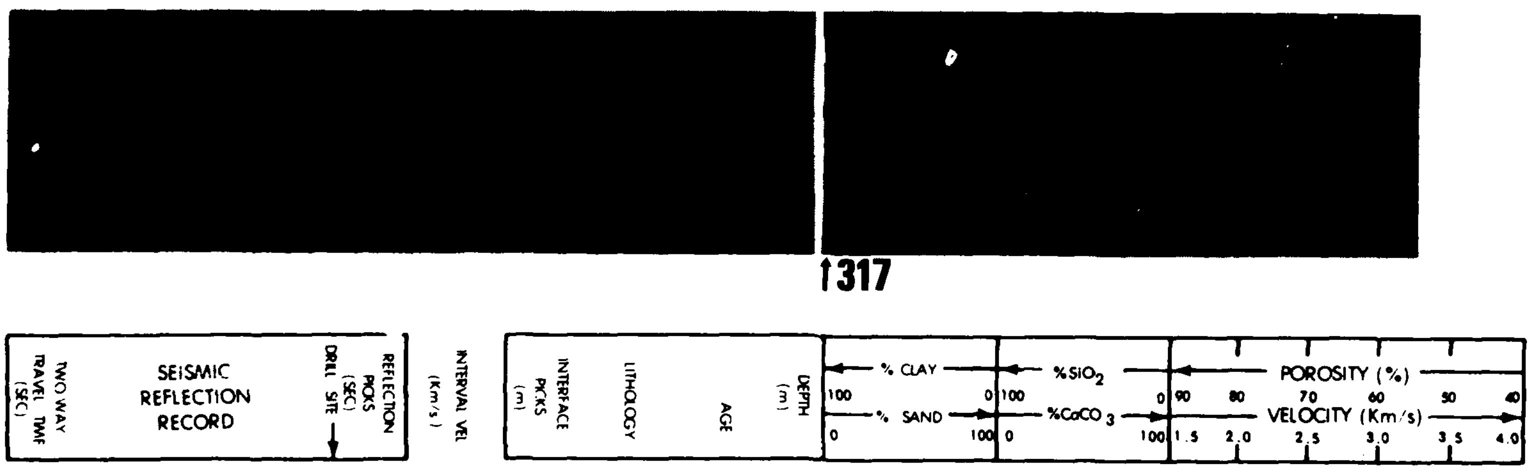
SITE DATA

Position:
Latitude 11°00.1' S
Longitude 162°15.8' W
Date: 11/30/73
Time: 0914Z
Location: Manihiki Plateau

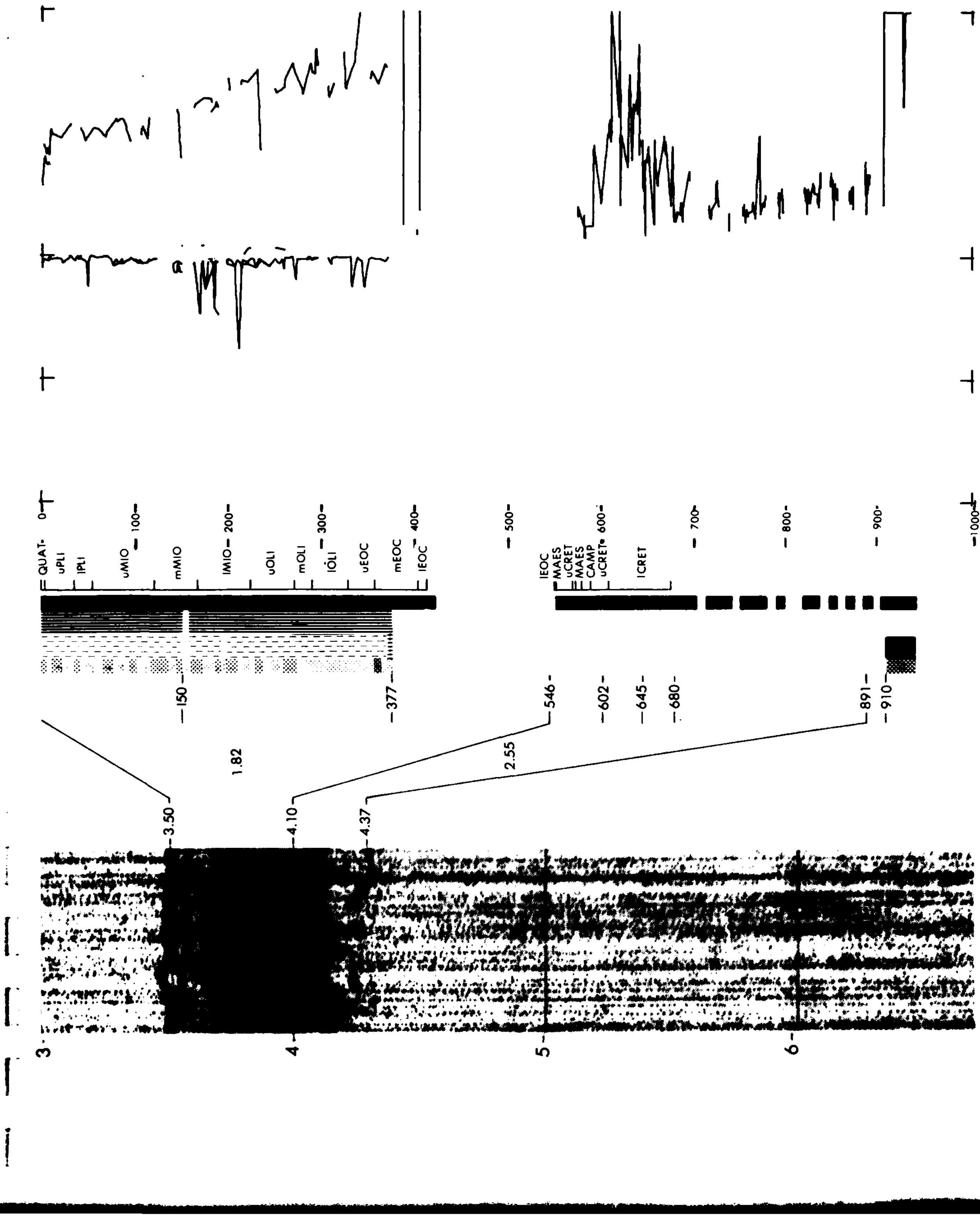
CORE DATA

Penetration:	317	317A	317B	
Drilled--	323	630	0	meters
Cored----	28	313	424	meters
Total----	351	943	424	meters
Recovery:				
Basement-	0	4	0	cores
	0	29	0	meters
Total----	3	34	45	cores
	19	163	308	meters

A simplified geologic history is summarized; (1) eruption



SITE 317 LEG 33



SITE DATA

Position:
- Latitude $14^\circ 49.6'$ S
- Longitude $146^\circ 51.5'$ W

Date: 12/13/73
Time: 0535Z
Water depth: 2641 meters
Location: Tuamotu Chain Trough

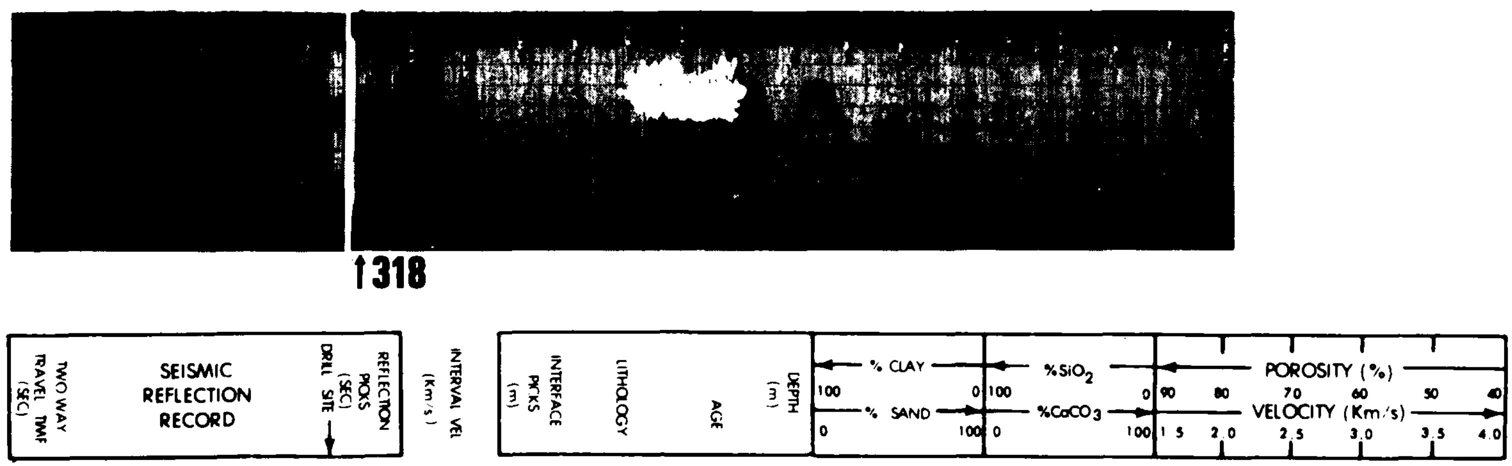
CORE DATA

Penetration:
- Drilled-- 447 meters
- Cored---- 298 meters
- Total---- 747 meters

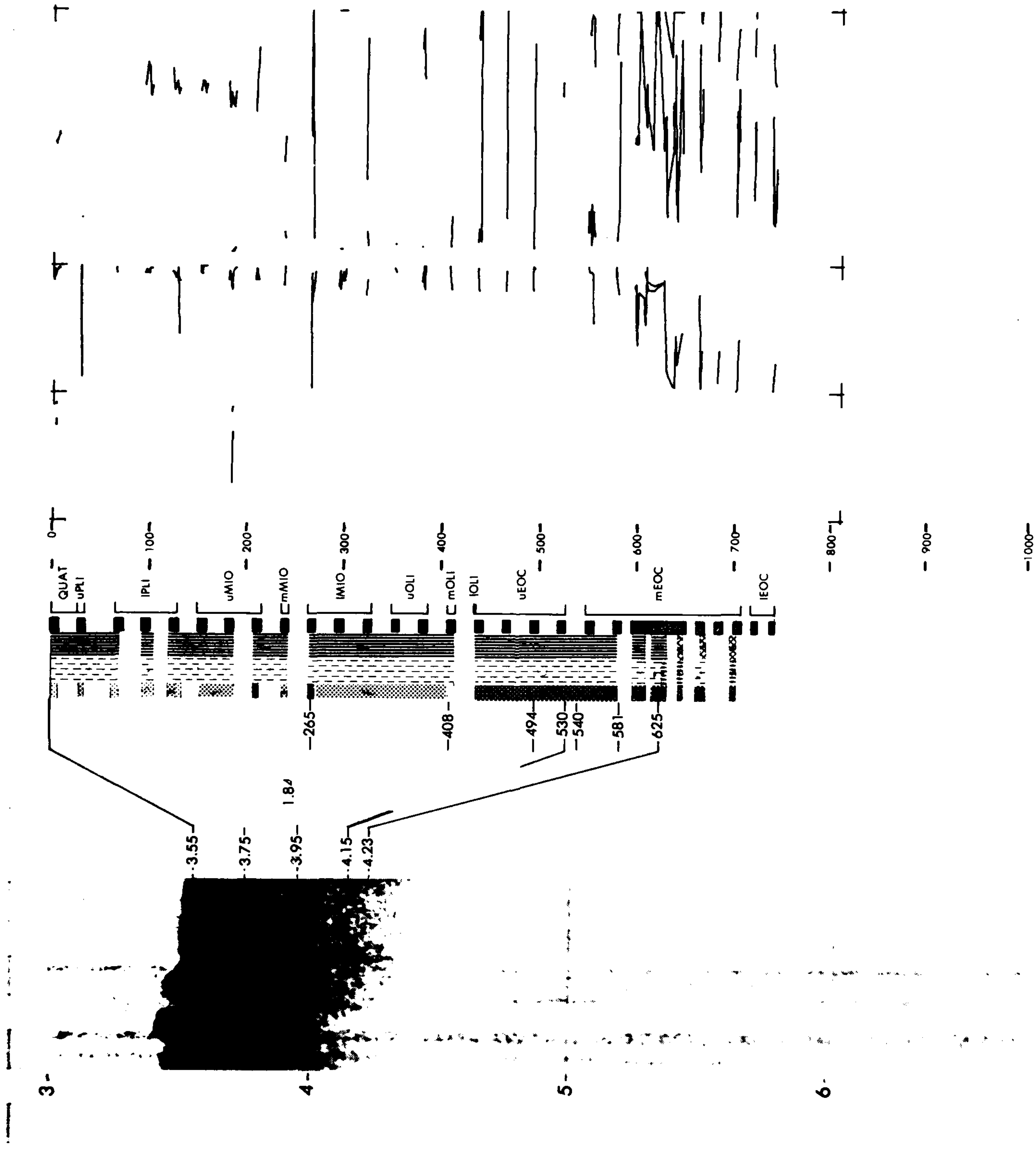
Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 32 cores
- 147 meters

A simplified geological history at the site may be given as follows: Eruption of basaltic edifices on older oceanic sea floor at some time prior to 49-51 m.y.B.P. Deposition of volcaniclastic sandstones and siltstones of shallow water origin at rates averaging 65-70 m/m.y. as these edifices were eroded. Formation of reefs, at least as old as 49-50 m.y.B.P. Pelagic sedimentation from early Eocene time to the present, with at least three interruptions. Floods of reefal debris entered the basin as turbidite units during middle Eocene and early Miocene time. Comparison with other ages in the Tuamotu chain suggests that volcanism has been episodic, like that of the Hawaiian chain. Reflectors in the basin are irregular and discontinuous; this irregularity may be due to influx of sediments from ridges bounding it. Comparison of reflectors with drilling results at this site is complex but suggests that the 0.56 to 0.60 (underway) and 0.68 (sonobuoy) sec reflectors, represent an unconformity in the Eocene at a depth of approximately 530 meters and the top of very hard limestones at a depth of about 620 meters, respectively.

Calcareous sediment; occasionally nannofossil or foraminifera rich. One thin layer of siliceous, transitional, spicule rich, sediment occurs in middle Eocene time.



SITE 318 LEG 33



SITE DATA

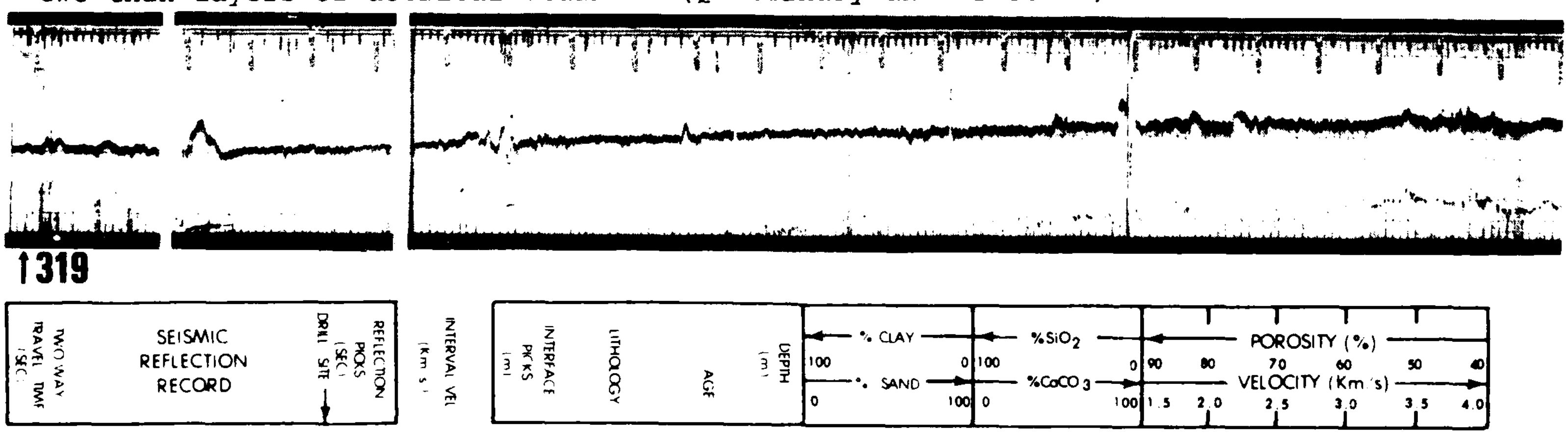
Position:
Latitude 13°01.0' S
Longitude 101°31.5' W
Date: 01/04/74
Time: 2005Z
Water depth: 4290 meters
Location: Bauer Deep

CORE DATA

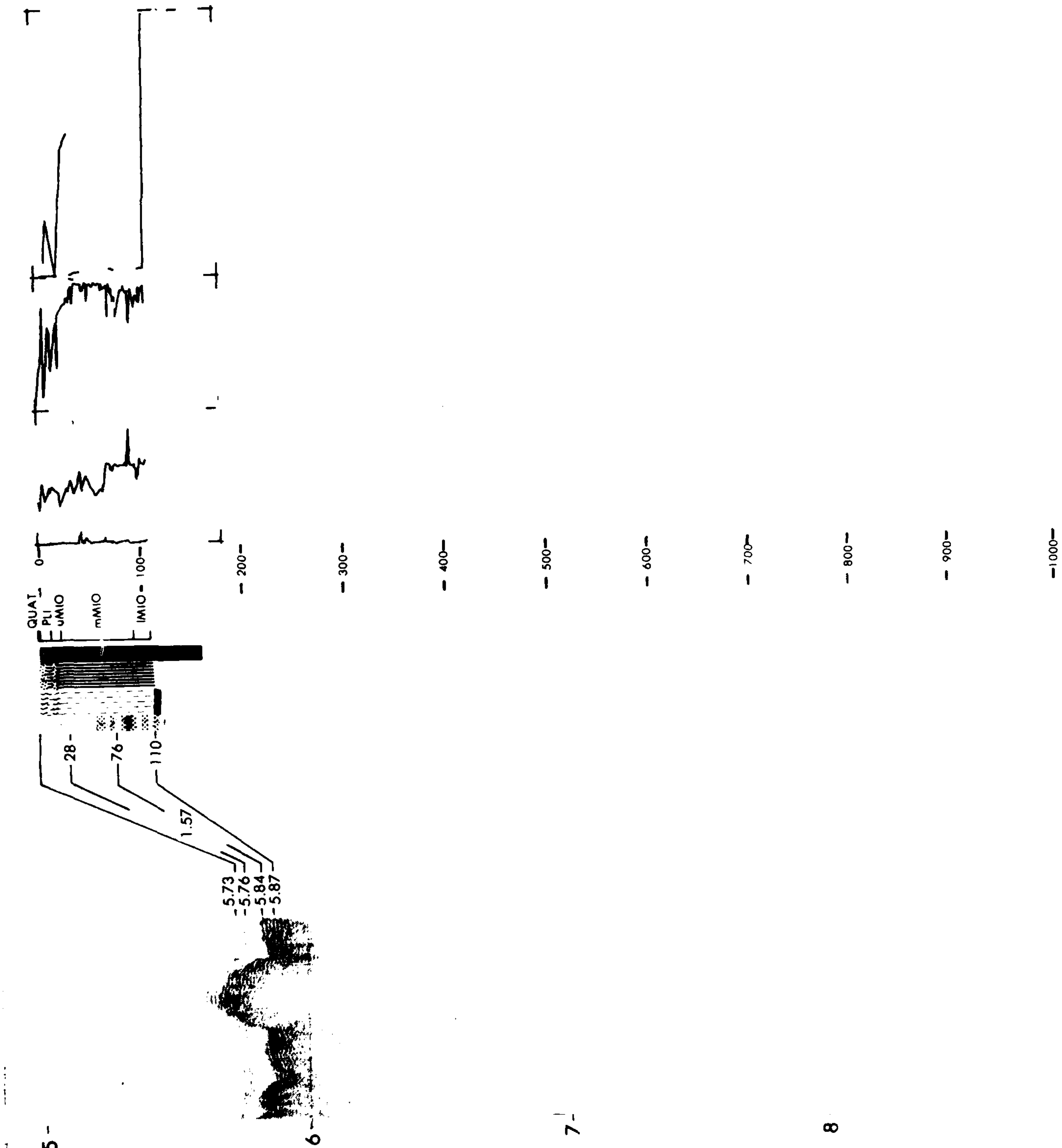
Penetration:	319	319A	
Drilled--	0	108	meters
Cored----	116	59	meters
Total----	116	157	meters
Recovery:			
Basement-	2	7	cores
	1	14	meters
Total----	14	7	cores
	85	14	meters

The sediments of the Bauer Deep that have high concentrations of metalliferous components are restricted to the surficial few meters deposited during the Quaternary. Yet metalliferous components are present throughout the section. The sedimentation rate of $CaCO_3$ decreases up-section partly because the area subsided below the CCD in the late Pliocene-Pleistocene and also because of decreased productivity. The accumulation rate of metalliferous components was highest during deposition of the lower part of the core, three or four times higher than for higher parts of the core, suggesting that the accumulation rate for these components is strongly influenced by proximity to an active spreading center, in this case, the extinct Galapagos Rise. A striking feature of the fossil assemblage is the virtual absence of opaline silica. Apparently, siliceous organisms were present in the original biota, but depositional or postdepositional conditions promoted the dissolution of silica throughout most of the sedimentary history of the Bauer Deep. The igneous rocks represent a suite of rapidly cooled basaltic rocks, probably flows with pillowed and massive portions, which were erupted in a fairly short interval of time (less than 1000 yr).

Calcareous sediment; nannofossil rich, rarely foraminifera rich, interbedded with two thin layers of detrital sediment (Quaternary and Pliocene).

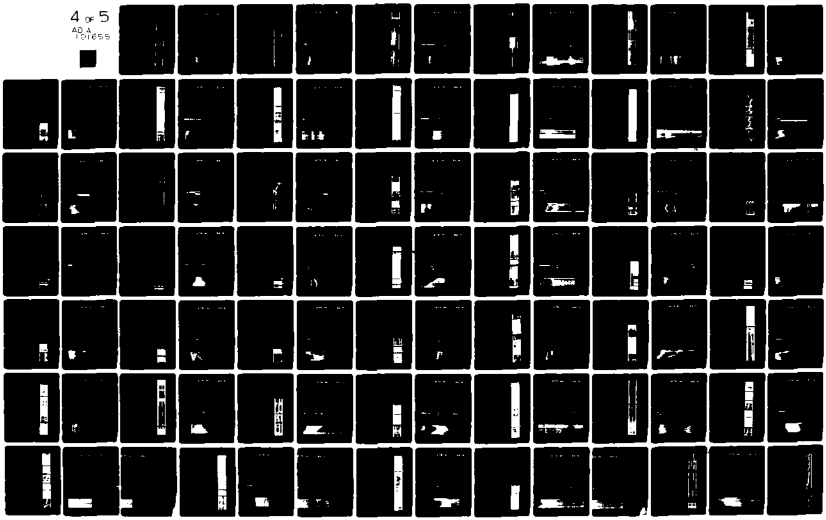


SITE 319 LEG 34



AD-A101 655 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 20/1
A SUMMARY OF SELECTED DATA: DSDP LEGS 20-44.(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL

4 OF 5
AD A
101655



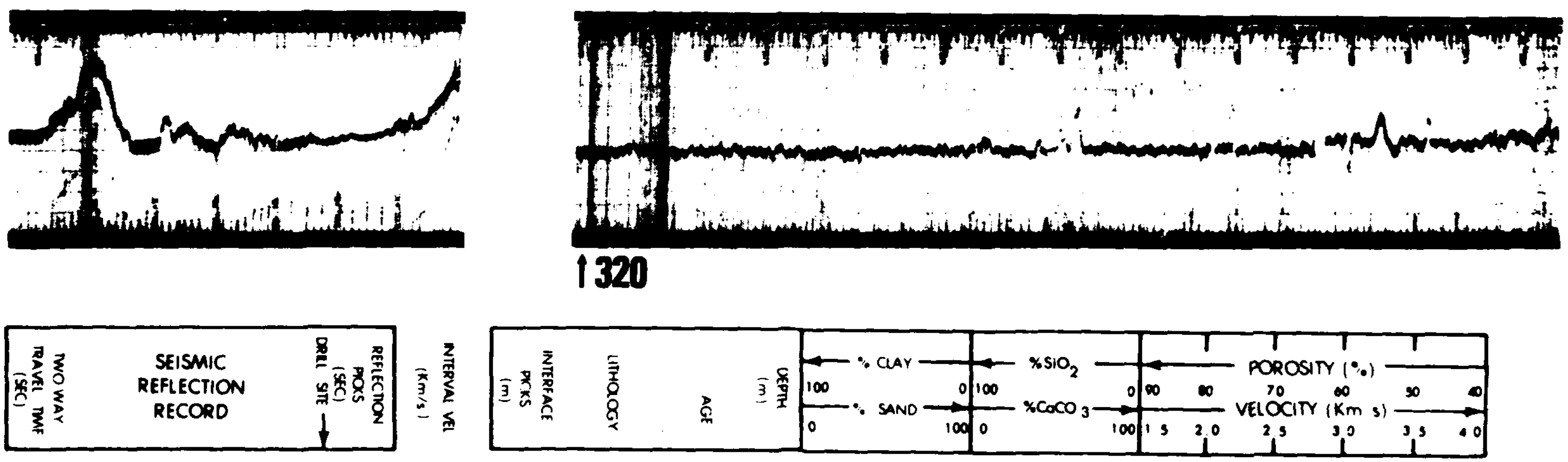
SITE DATA

Position:
Latitude 9°00.4' S
Longitude 83°31.8' W
Date: 01/22/74
Time: 0038Z
Water Depth: 4483 meters
Location: East edge of Nazca plate; Peru Basin

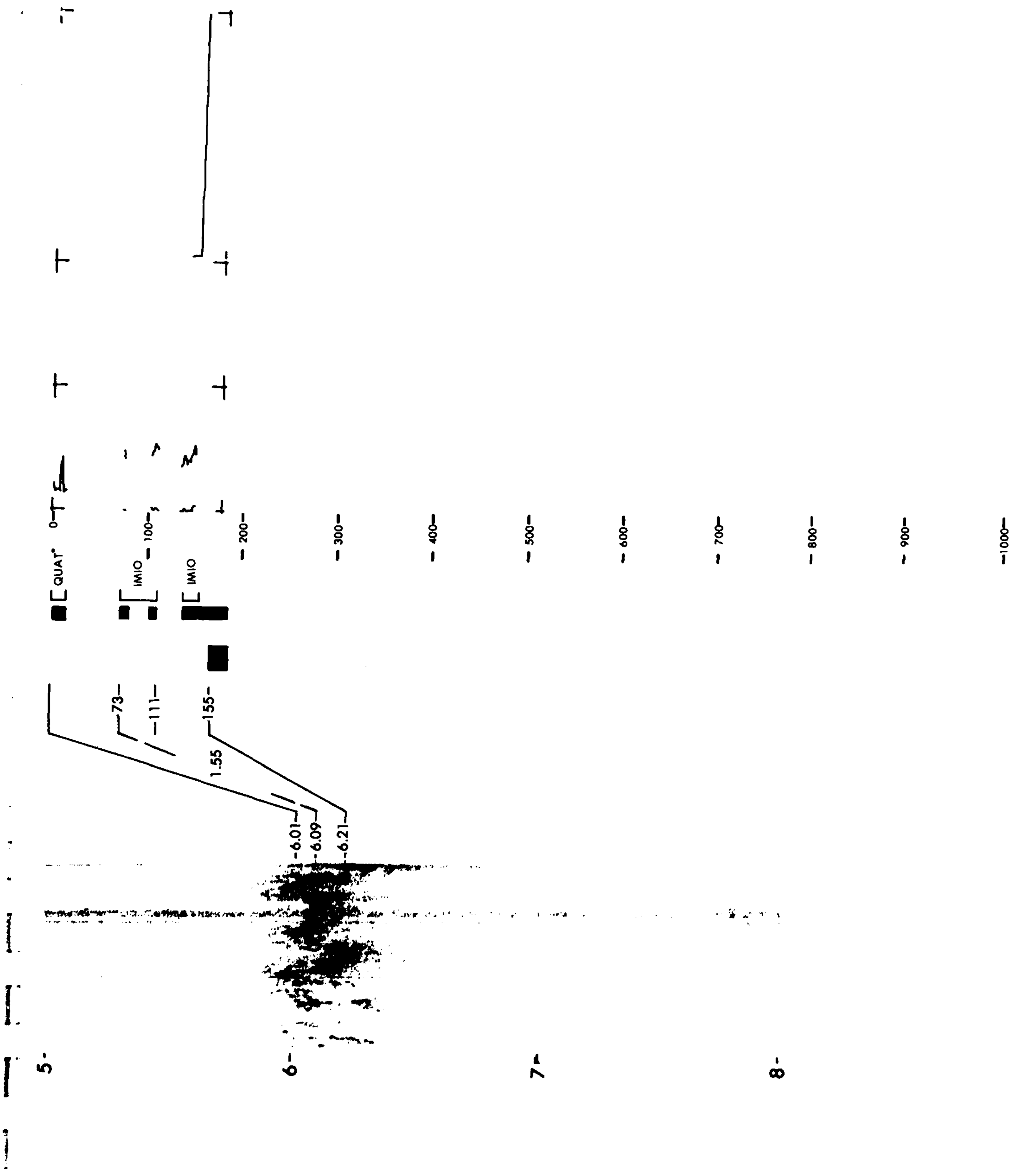
CORE DATA

Penetration:	320	320A	320B	
Drilled--	83	0	136	meters
Cored----	28	9	47	meters
Total----	111	9	183	meters
Recovery:				
Basement-	0	0	2	cores
	0	0	19	meters
Total----	3	1	5	cores
	19	9	18	meters

The siliceous clay of the top unit has a rich and diverse suite of opaline fossils. Below the mudline, the section is Holocene and/or Pleistocene in age. The lack of diversity of foram faunas and the presence of a cooler water faunal assemblage than is normally found at this latitude indicate that these sediments were deposited under the influence of the Pleistocene ancestor of the strong, north-flowing Humboldt (Peru) Current. The iron-rich nanno ooze of the lower unit ranges in age from late Oligocene to early Miocene. As at Site 319, metalliferous components (RSOs) are found throughout the unit. The absence of RSOs in the siliceous clay and their presence in the older unit suggest that RSO concentration may be related to the proximity to a spreading center, the fossil Galapagos Rise. The foram fauna is of low diversity, particularly in the Miocene, suggesting a cool water regime. The suggestion of Mammerickx et al. (1975), based on bathymetry, that the Galapagos Rise is offset right-laterally across the Mendaña Fracture Zone is in agreement with the observation of younger basal sediments and shallower basement to the north of the fracture zone. There is more glass in Site 320 basalts than in those of Site 319 which indicates that the drill penetrated many pillows or several thin flows.



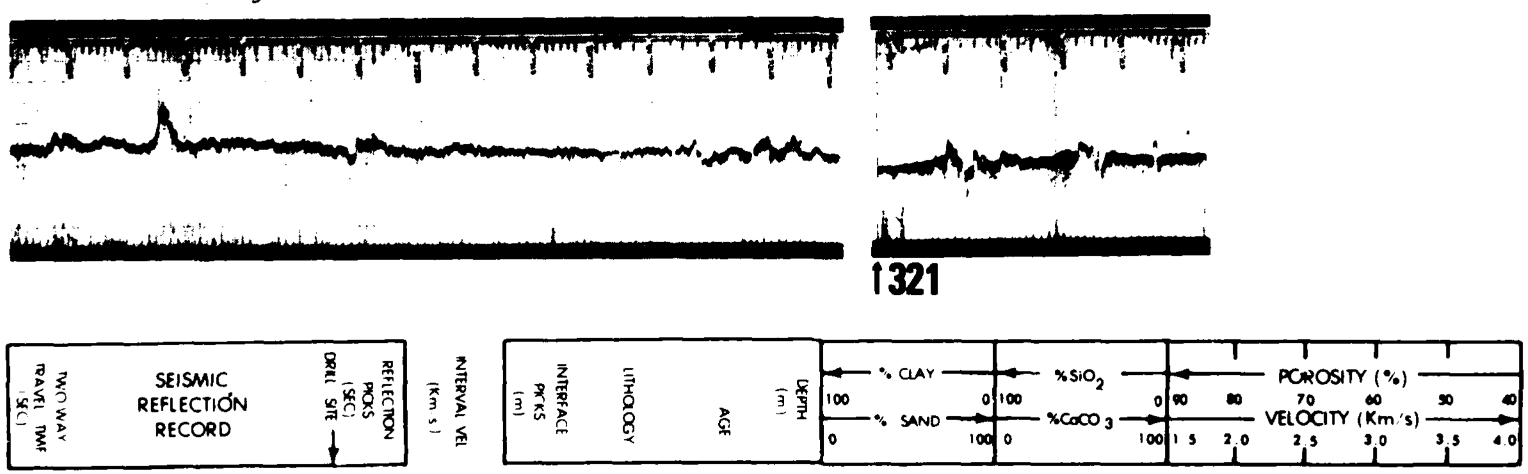
SITE 320 LEG 34



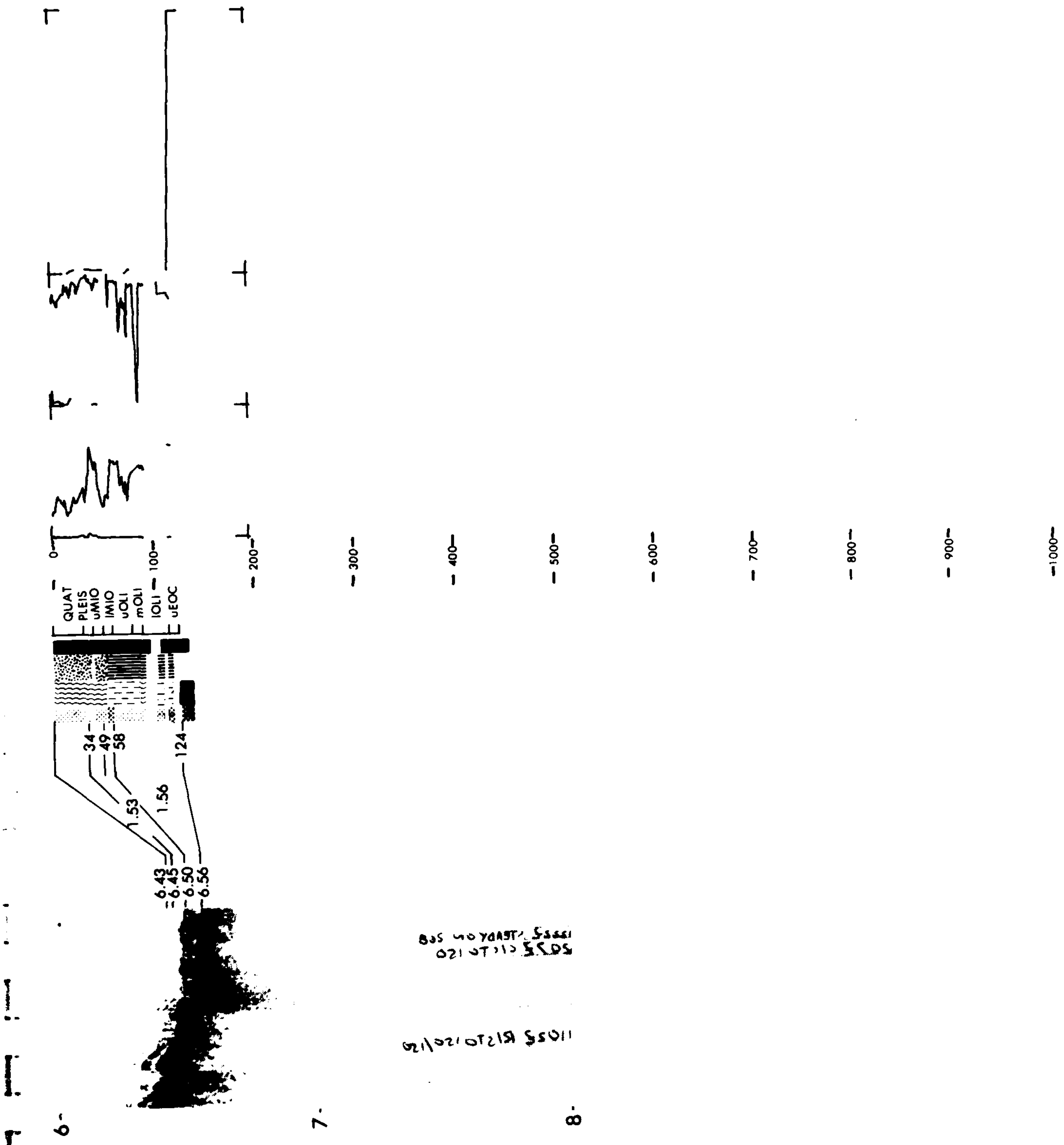
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	12°01.3' S	Drilled--	9 meters
Longitude	81°54.2' W	Cored----	125 meters
Date: 01/29/74		Total----	134 meters
Time: 1250Z		Recovery:	
Water depth: 4817 meters		Basement-	1 cores
Location: South of Mendaña Fracture Zone			5 meters
		Total----	14 cores
			86 meters

The uppermost 34.5 meters of green clay suggests a terrigenous origin, presumably from South America. The absence of coarse-grained sediments indicates that the Peru-Chile Trench has been an effective barrier to sediments transported by bottom currents. No calcareous fossils were found, and the sediments were presumably deposited below the CCD. The next lower unit consists of 14.5 meters of light yellow-brown clay. Most of the clay is smectite derived from the alteration of volcanic sediments. This clay is underlain by 10 meters of zeolite-bearing brown clay which is unfossiliferous except for trace amounts of nannofossils. The rest of the section is light brown ferruginous nanno ooze. Because some faunas in the upper part of the nanno ooze show dissolution effects, the lithologic transition (to zeolitic clay) probably marks subsidence of the site through the CCD. The abundance of basaltic minerals and altered palagonite in the basal sediments suggests that the contact is depositional. Textures are intergranular to almost subophitic in the coarse-grained rocks except for quenched mesostases which suggest rapid cooling, hence flows or shallow sills.

Calcareous sediment nannofossil rich. One thin layer of detrital sediment occurs in middle Oligocene time.



SITE 321 LEG 34



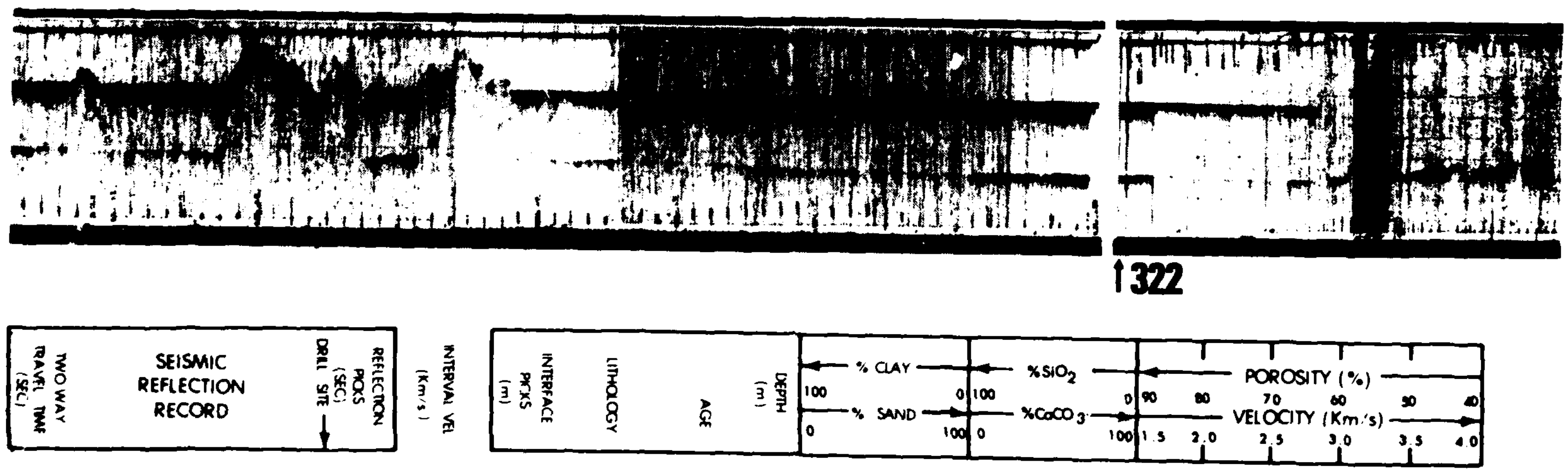
SITE DATA

Position:
Latitude $60^{\circ}01.4'$ S
Longitude $79^{\circ}25.5'$ W
Date: 02/28/74
Time: 0030Z
Water depth: 5026 meters
Location: Bellingshausen Abyssal Plain

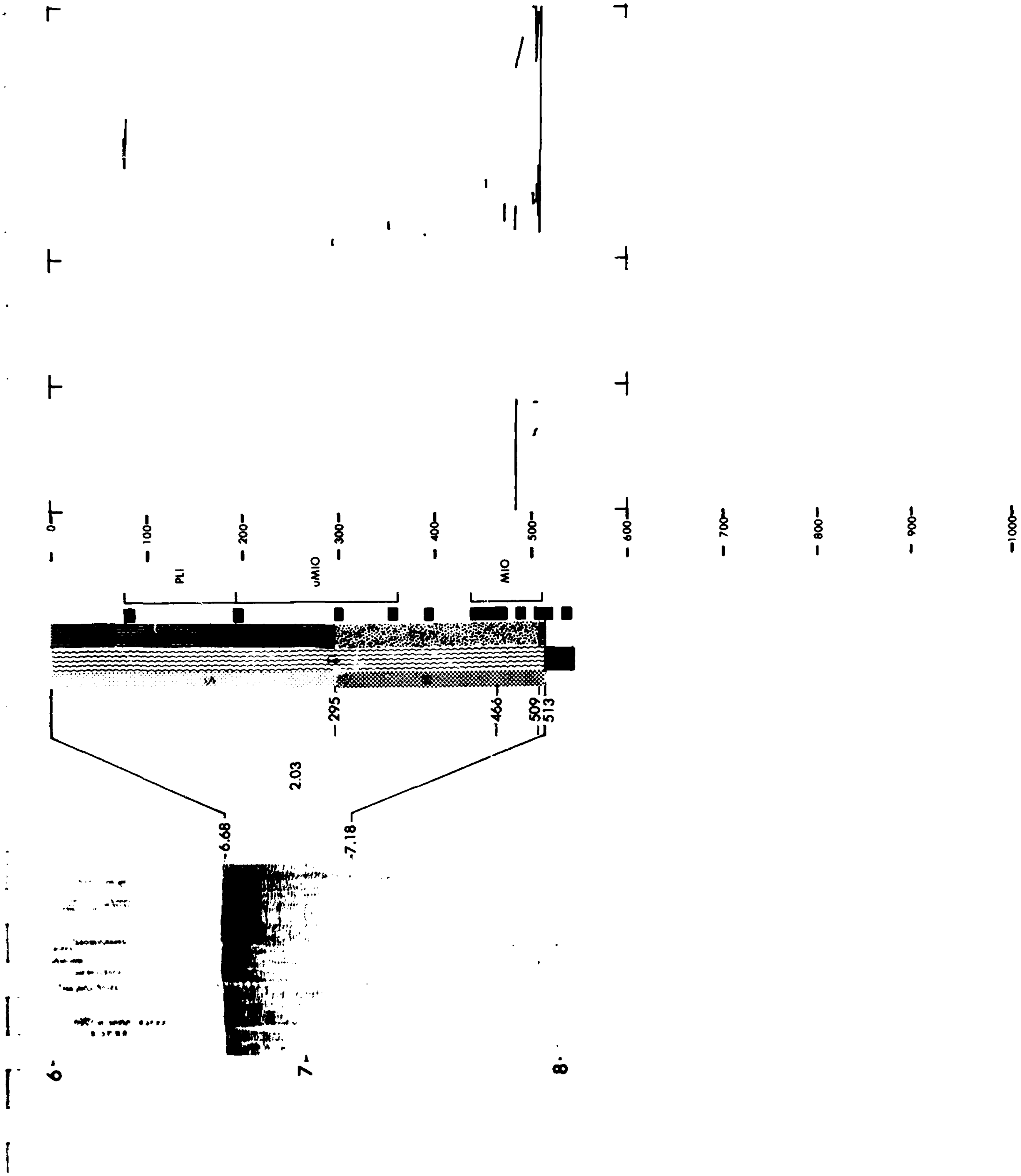
CORE DATA

Penetration:
Drilled-- 419 meters
Cored---- 125 meters
Total---- 544 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 14 cores
34 meters

On the basis of amygdules, glassy veins on inferred pillows, and hyaloclastite breccia, this rock is interpreted as a submarine lava flow. If the overlying claystone, which contains arenaceous benthonic foraminifers of bathyal to abyssal type, is conformable, then the eruption occurred in "deep" water relative to the mid-Tertiary calcium carbonate compensation depth. If an unconformity separates the basalt and the overlying sedimentary seqeuence, a significantly older age for the igneous rock is possible. It is not clear whether this igneous rock represents crustal basement, or whether older sedimentary beds may underlie it. The position of the site on the abyssal plain and the southward continuity of stratigraphic units in the seismic profiles indicate that most of the detritus in the sedimentary sequence came from Antarctica. The scarcity of sedimentary features common in turbidites suggests that bottom currents were the agent for the final deposition of many of these sediments. The scarcity of fossils in the deeper cores from this site probably results from extensive dissolution of tests rather than from limited populations in these seas during the Cenozoic.



SITE 322 LEG 35



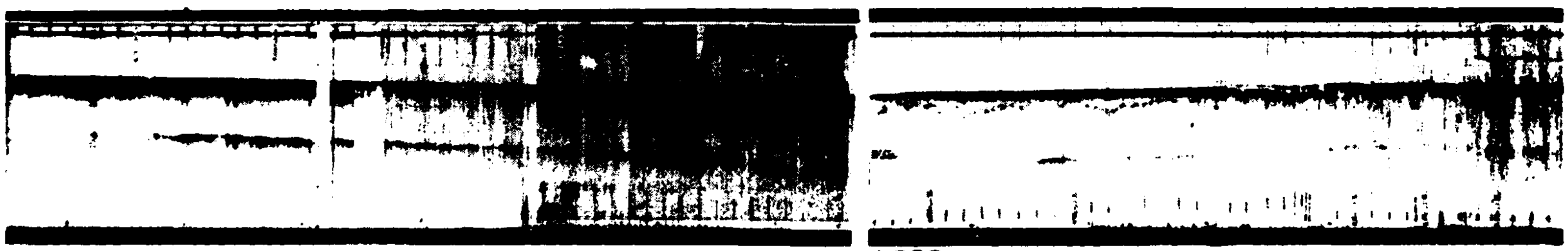
SITE DATA

Position:
Latitude 63°40.8' S
Longitude 97°59.7' W
Date: 03/06/74
Time: 1845Z
Water depth: 5004 meters
Location: Bellingshausen Abyssal Plain

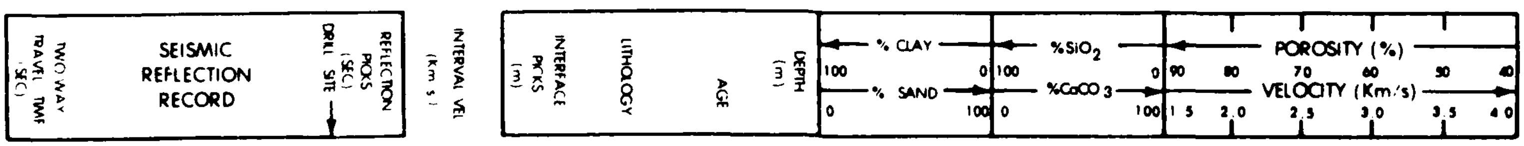
CORE DATA

Penetration:
Drilled-- 532 meters
Cored---- 199 meters
Total---- 731 meters
Recovery:
Basement- 3 cores
9 meters
Total---- 21 cores
76 meters

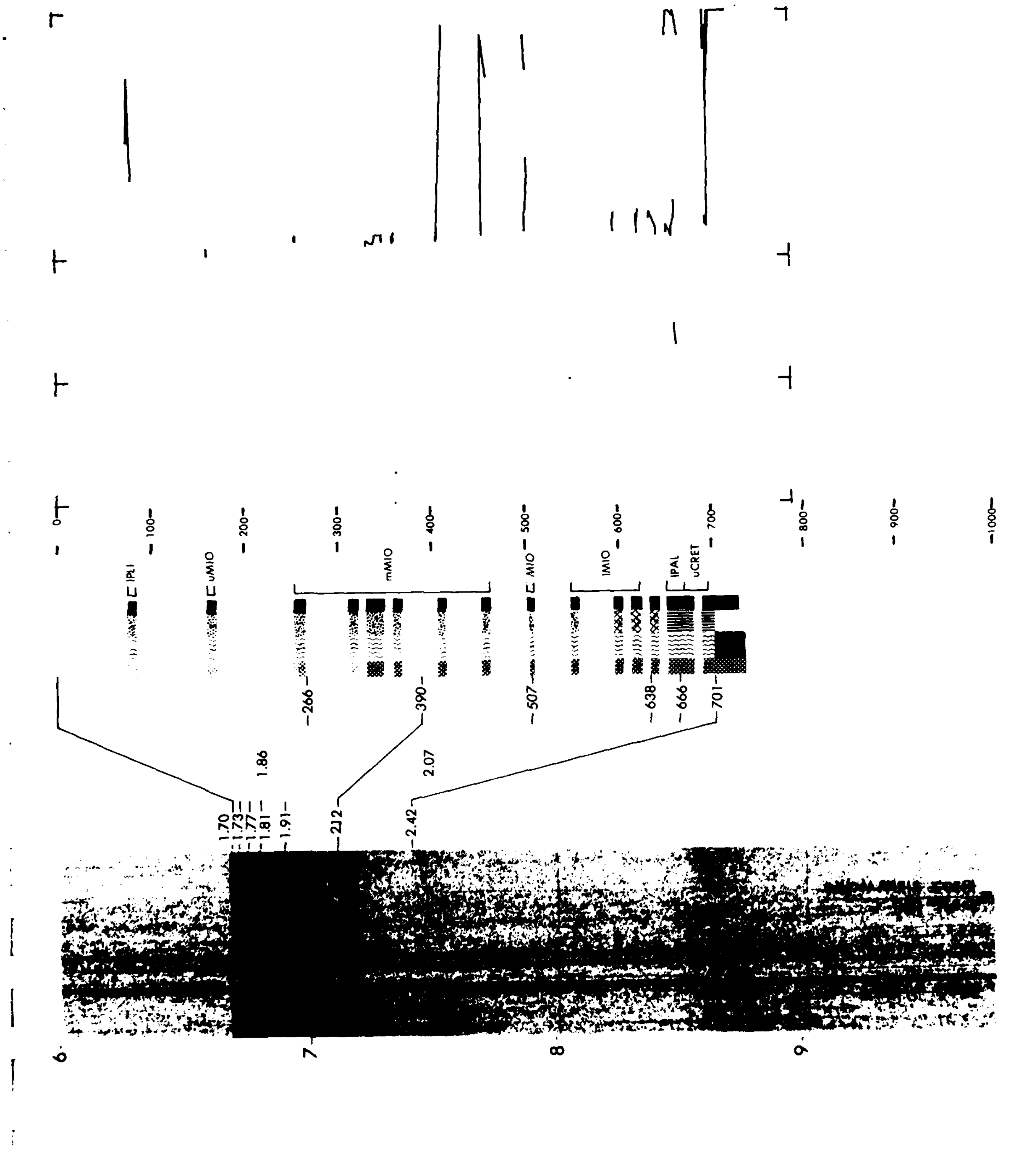
The aphanitic holocrystalline basalt correlates with the deepest observed seismic reflector and probably represents one or more sills which have been intruded into sedimentary rocks. The brown iron-rich pelagic clay just above the basalt was probably deposited in tranquil, isolated environment mostly below the carbonate compensation depth. A diverse Danian benthonic foram assemblage and abundant well preserved nannoplankton occur 30 meters higher in the hole; these fossils suggest deposition of this unit above the carbonate compensation depth. An unconformity is indicated by the presence of ?Oligocene to early Miocene gray silty claystone 23 meters above the Danian nannofossil claystone. A subsequent abrupt increase in terrigenous detritus (between 500-640 m) with rare biogenic components suggests rapid deposition of continental rise hemipelagic silt and clays, probably originally transported downslope from Antarctica by turbidity currents, and penecontemporaneously entrained and redeposited by bottom currents flowing as part of the newly developed abyssal circulation.



323



SITE 323 LEG 35



SITE DATA

Position:
- Latitude 69°03.2' S
- Longitude 98°47.2' W

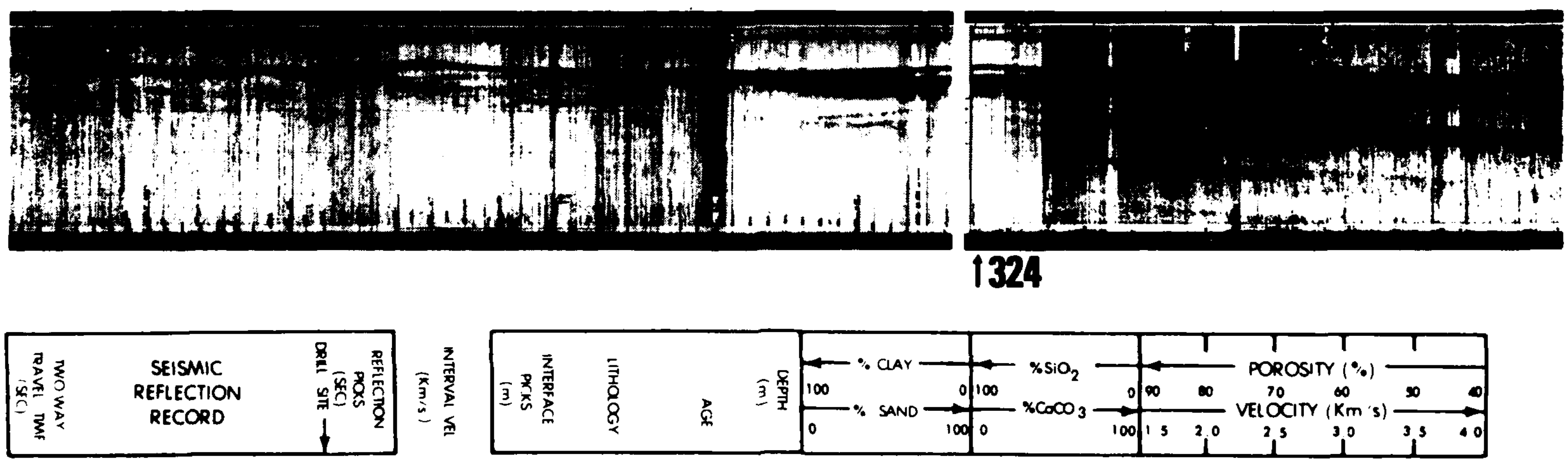
Date: 03/13/74
Time: 0611Z
Water depth: 4433 meters
Location: Continental Rise; Anarctica

CORE DATA

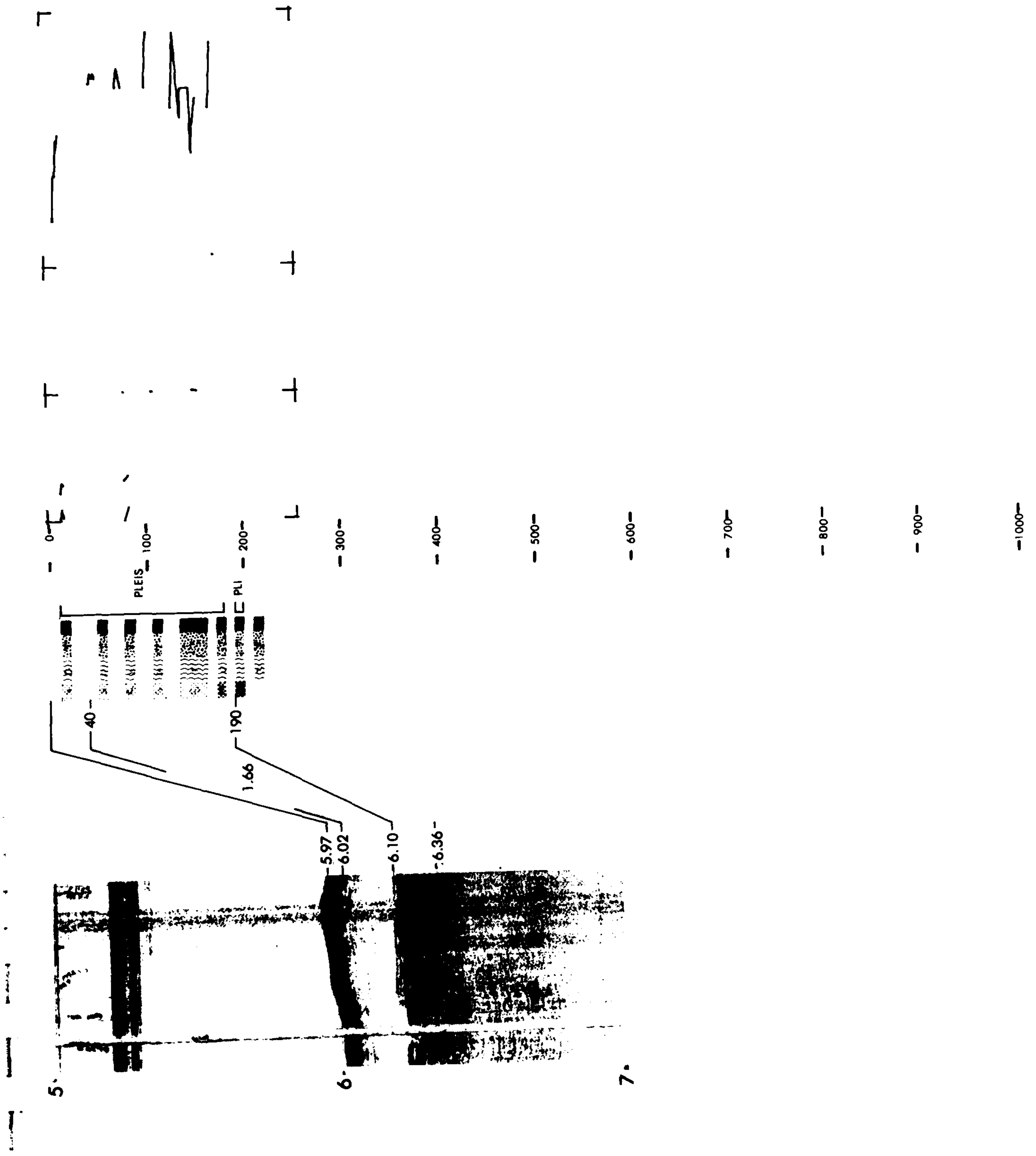
Penetration:
- Drilled-- 123 meters
- Cored---- 95 meters
- Total---- 218 meters

Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 10 cores
- 48 meters

The processes by which the clays, silty clays, and silts at this site were deposited are not fully understood. The geologic location and composition of the sediments show that these detrital materials were derived from Antarctica. Interbedded clays and well-sorted silt beds may be laterally graded beds deposited by contour currents. Several pronounced changes occurred in the depositional environment at this site during the last 2 m.y. There was a sharp upward decrease in the number of silt layers deposited, perhaps indicating a diminished importance of contour currents. Moreover, there was a complementary increase in the abundance of ice-rafted detritus and diatoms abounded in great numbers. These changes in sedimentation pattern are probably related to changes in the extent of the Antarctic ice sheet, but their exact significance is not clear. The increase in ice-rafted debris may imply a more vigorous continental glaciation during the Quaternary than during the Pliocene. On the other hand, the appearance of diatoms may indicate the disappearance of pack-ice, which existed during the Pliocene, from this site during the Quaternary.

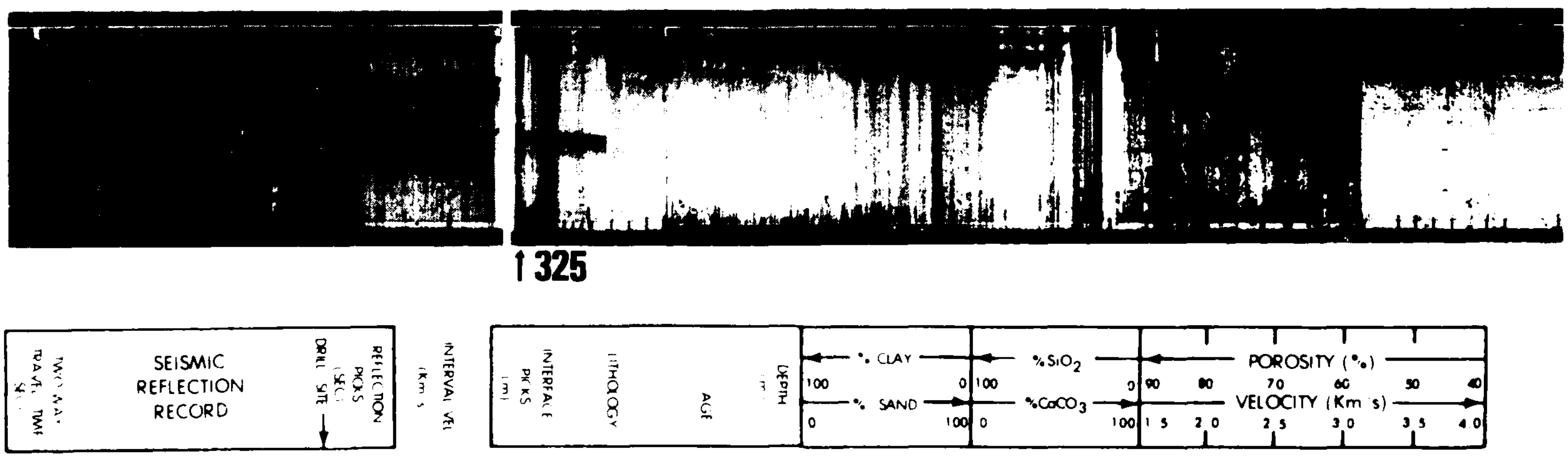


SITE 324 LEG 35

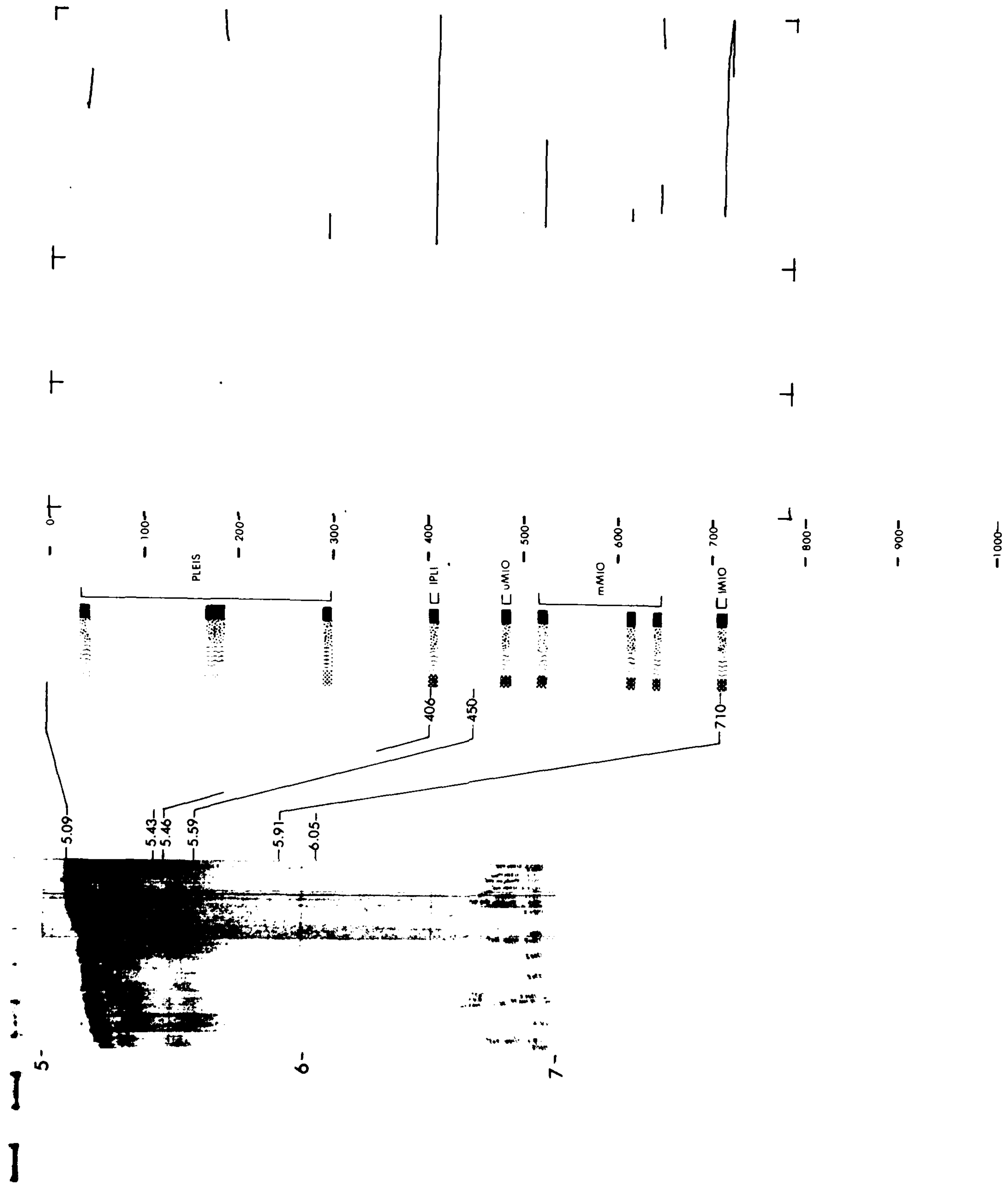


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	65°02.8' S	Drilled--	623 meters
Longitude	73°40.4' W	Cored----	95 meters
Date: 03/19/74		Total----	718 meters
Time: 1512Z		Recovery:	
Water depth: 3748 meters		Basement-	0 cores
Location: Continental Rise; Anarctica			0 meters
		Total----	10 cores
			34 meters

Turbidity current deposition along with ice rafting are the two dominant processes of sedimentation at this site. The percentage of quartz embedded within the clay and claystone varies inversely with the frequency of silt laminae. The quantity of quartz silt supplied to this region has apparently been constant, and the variation in mode of occurrence is probably directly related to the presence or absence of contour currents. An accumulation rate of 12-15 cm/1000 yr calculated for early to middle Pliocene suggests vigorous continental erosion during this time. The oldest ice-rafted debris occurs in lower Miocene claystone, which agrees well with the age of the first occurrence of ice-rafted sediment in a similar deep-sea environment encountered during Leg 28 just off East Antarctica. Geochemistry data show that there is a source for calcium and sink for magnesium within the upper sediments and, in general, the data suggest that postdepositional alteration reactions of volcanic debris are significant in these sediments. The high velocity (5.3 km/sec) calcite-cemented siltstone from 406 meters appears to correlate well with a 0.37-sec reflector near the base of the upper acoustically laminated sequence.



SITE 325 LEG 35



SITE DATA

Position:
  Latitude 56°35.0' S
  Longitude 65°18.2' W
Date: 04/05/74
Time: 1716Z
Water depth: 3812 meters
Location: Southeast of Cape Horn

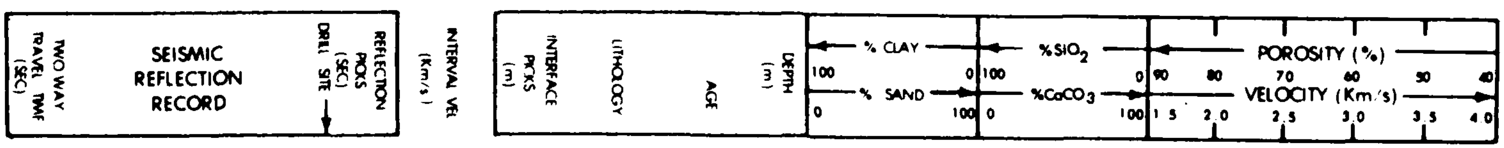
CORE DATA

Penetration:	
Drilled--	0 meters
Cored----	9 meters
Total----	9 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	1 cores
	.5 meters

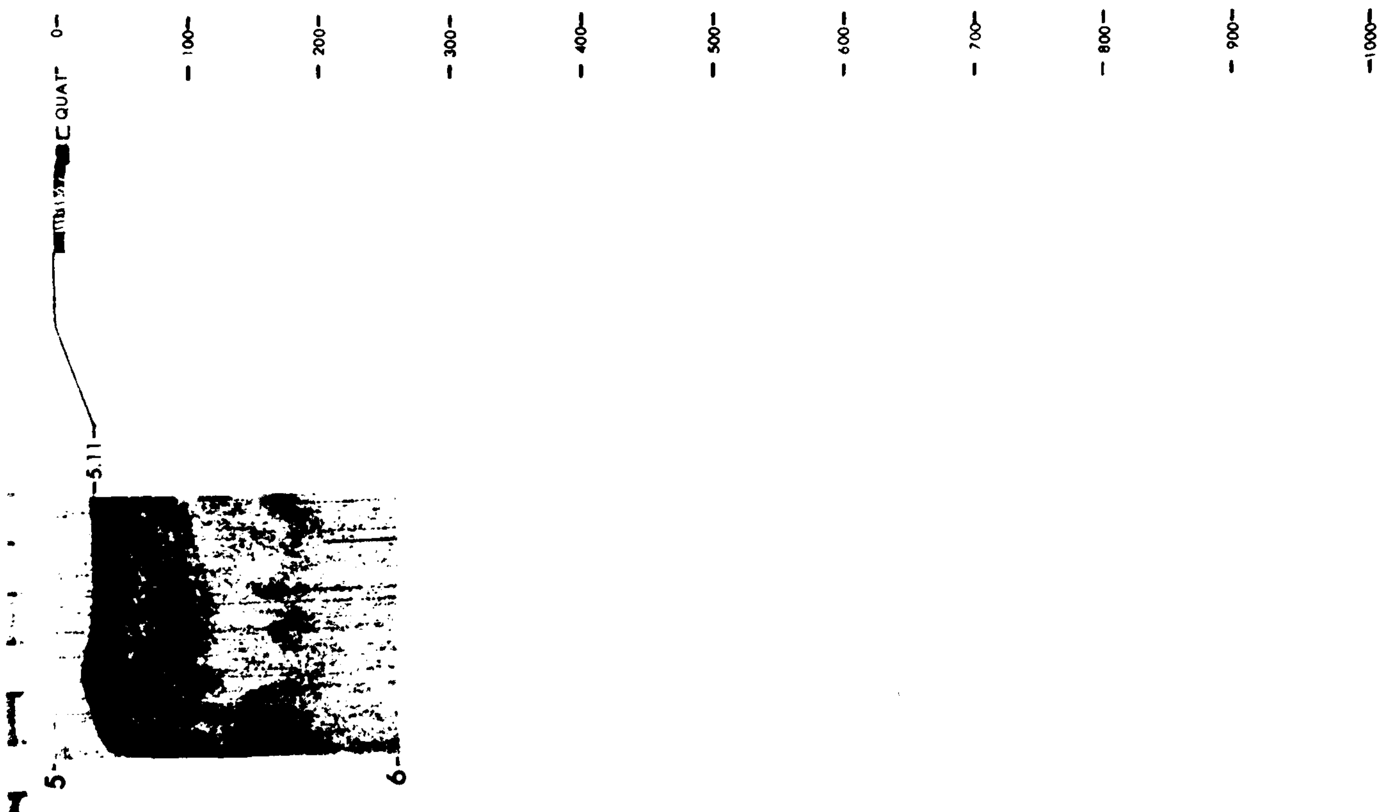
None of the site's objectives was attained. Some 3800 meters of drill string, including four bumper subs, were lost, and the combination of continued poor weather and strong currents could well have rendered the hole impossible even had this not occurred.

The single short core obtained was of Quaternary sediment, probably derived in large part by turbidity currents from the adjacent continental margin, with subsidiary amounts of ice-rafted debris. The sediment was reworked by strong bottom currents as the reflection profile had suggested.

326



SITE 326 LEG 36



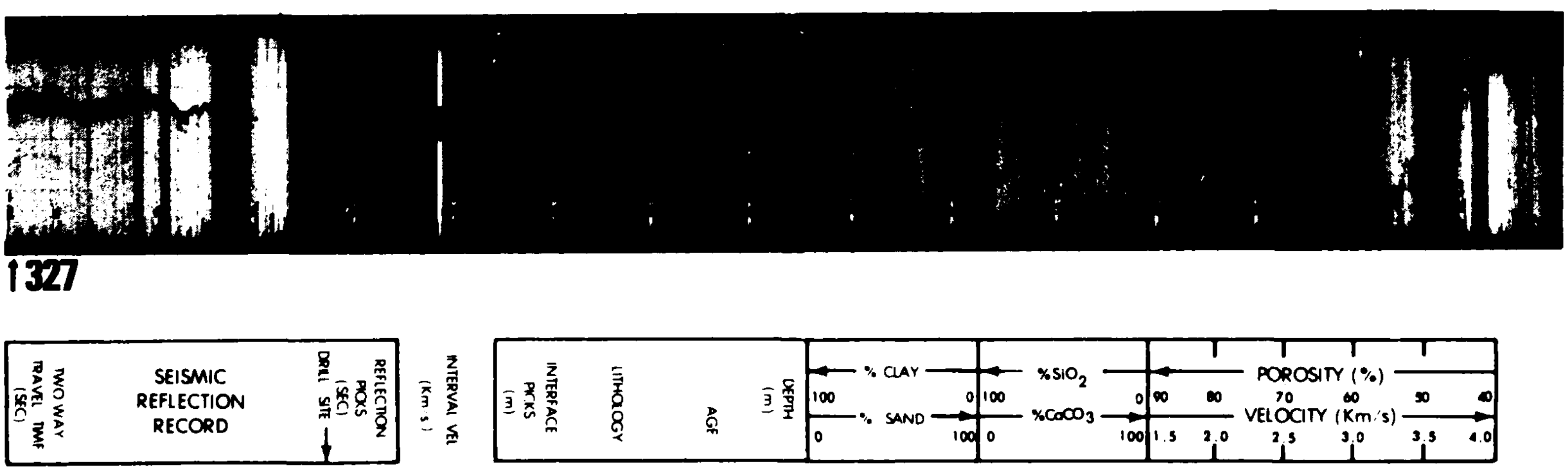
SITE DATA

Position:
Latitude 50°52.3′S
Longitude 46°47.0′W
Date: 04/13/74
Time: 1000Z
Water depth: 2400 meters
Location: Maurice Ewing Bank

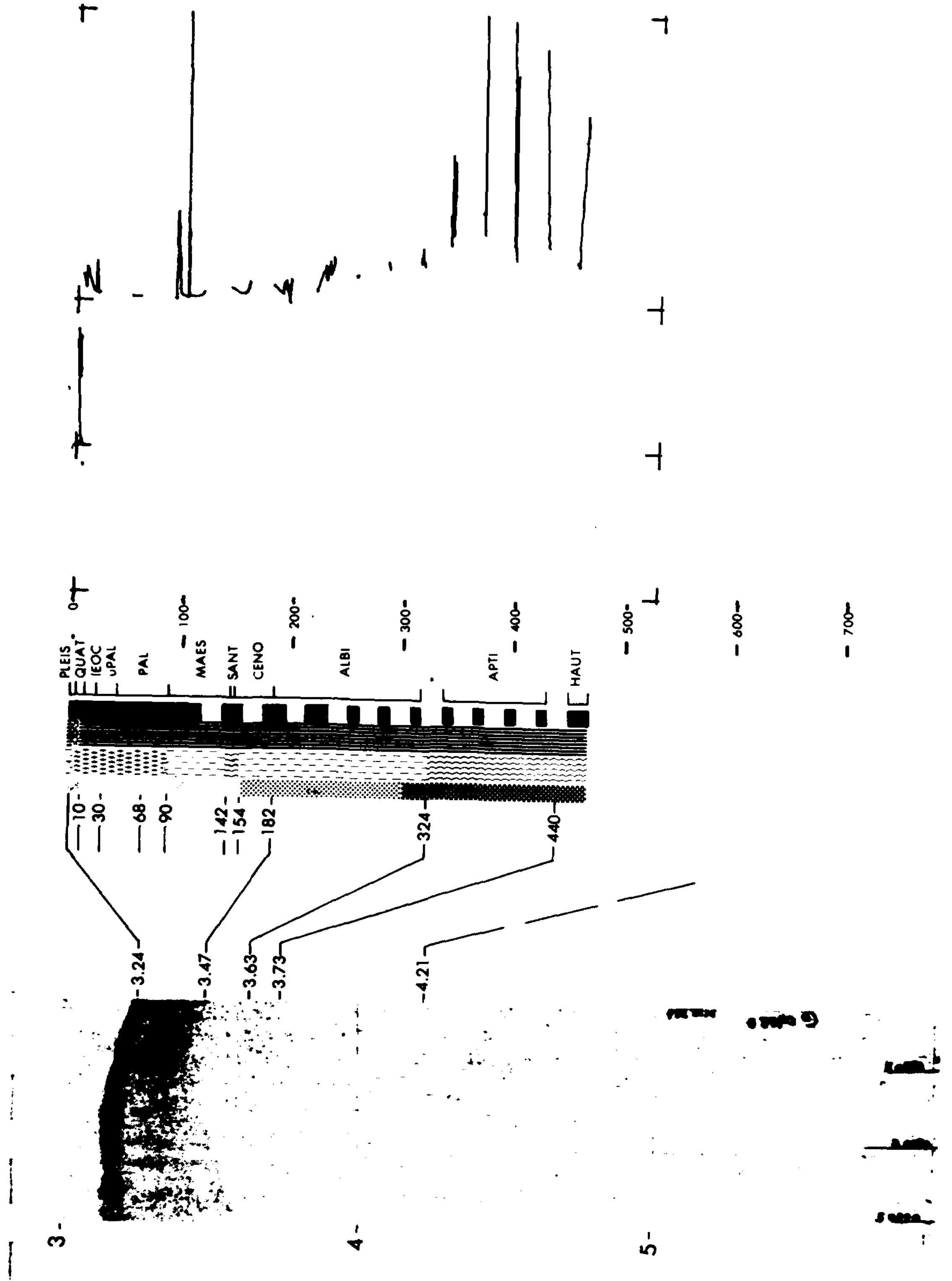
CORE DATA

Penetration:	327	327A	
Drilled--	0	213	meters
Cored----	5	256	meters
Total----	5	469	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	27	cores
	5	128	meters

The uppermost unit, 10 meters thick, comprises Quaternary sands and gravels with associated manganese nodules, interbedded with diatomaceous clay. Unit 2, a zeolitic clay extending to 30 meters, is poorly fossiliferous but dated as late Paleocene to early Eocene. Unit 3 consists of 38 meters of upper Paleocene diatom-rich radiolarian ooze. Unit 4 is 22 meters of middle to upper Paleocene zeolitic clay. The underlying 52 meters of foram nanno ooze, of Campanian to mid Maestrichtian age, forms Unit 5. Further fluctuation in the relative depth of the CCD is indicated by Unit 6, clay of Santonian age. Unit 7 is a 170-meter-thick clay-rich nannofossil ooze or chalk, largely of early to middle Albian age. Unit 8 is a indurated sapropelic claystone. The history of the Maurice Ewing Bank is one of a deepening marine environment, developing open oceanic circulation after an initial restricted basin stage. The CCD has clearly fluctuated considerably relative to the sea bed at the site and variations in both temperature and bottom current strength are revealed.



SITE 327 LEG 36



SITE DATA

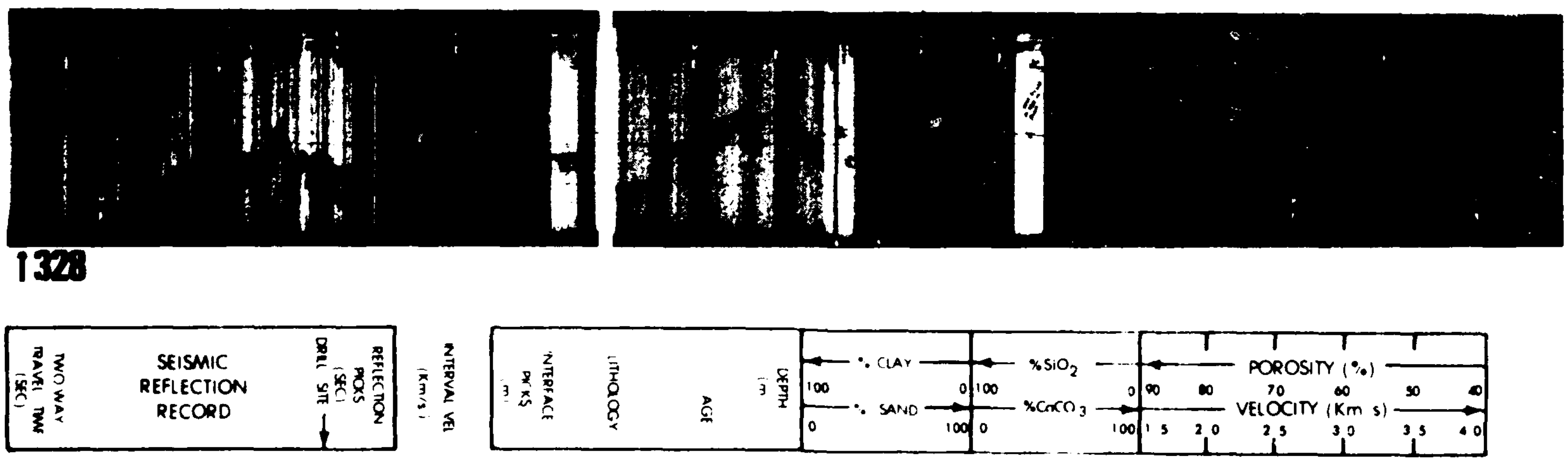
Position:
Latitude 49°48.7' S
Longitude 36°39.5' W
Date: 04/24/74
Time: 0705Z
Location: Mavinas Outer Basin

CORE DATA

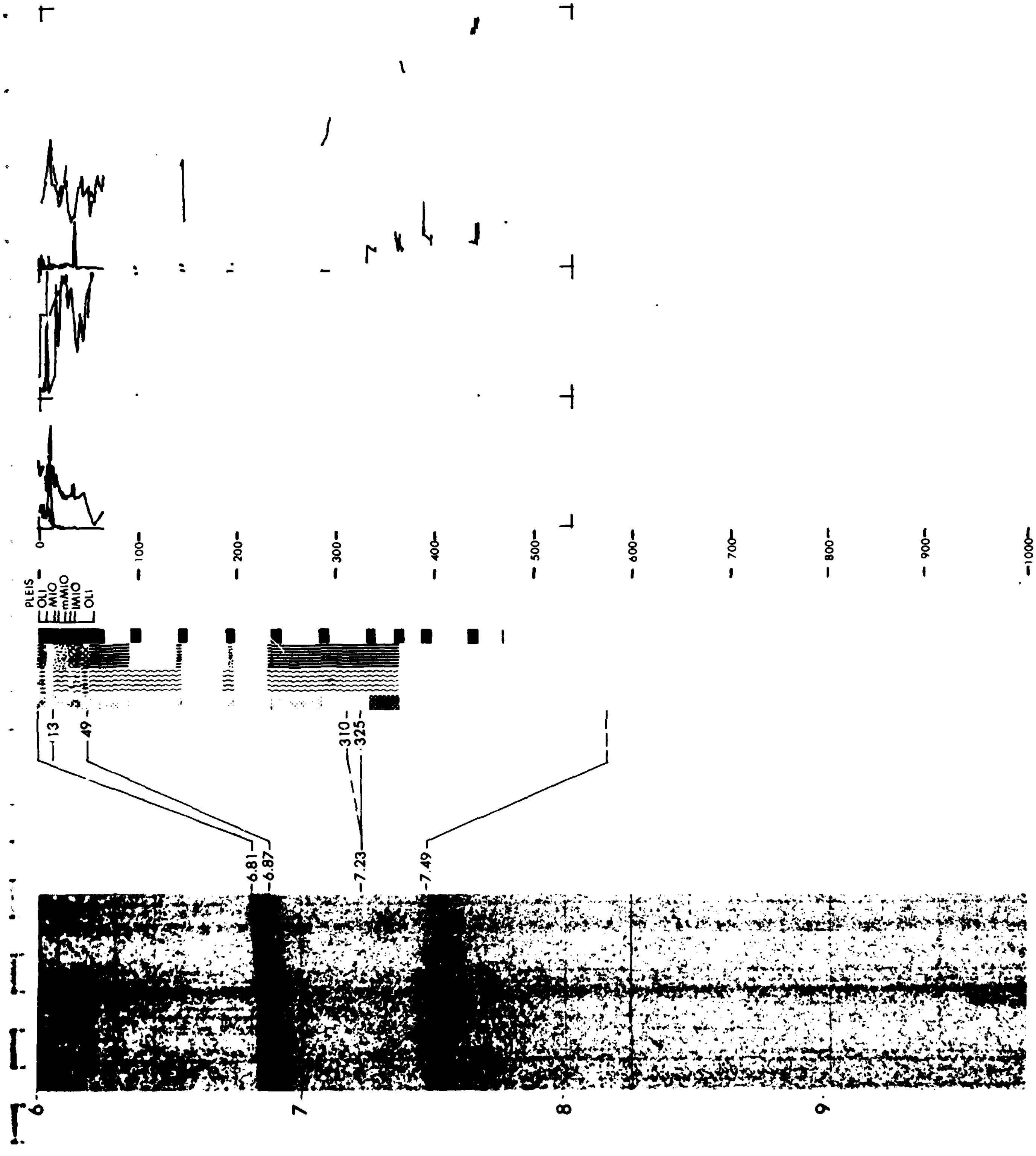
Penetration:	328	328A	328B	
Drilled--	285	0	378	meters
Cored----	112	17	66	meters
Total----	397	17	444	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	12	2	7	cores
	62	44	62	meters

Four lithologic units are distinguished in the cores recovered at Site 328. Unit 1 was penetrated by all three holes, and Units 2, 3, and 4 by Holes 328 and 328B. Unit 1 consists of diatomaceous ooze with abundant manganese nodules, sand, and large clasts. Unit 2 consists of upper Eocene-upper Miocene silty, biogenic siliceous clay. The underlying Unit 3 consists of Upper Cretaceous or Paleocene to upper Eocene siliceous clay and (towards the base) claystone. Unit 4 is wholly made up of Upper Cretaceous zeolitic claystone except for a thin (1-1.5 cm) graded silty sandstone. The reflector correlated with Horizon A of the Argentine Basin occurs within the upper part of this unit and at this site appears to represent a gradual diagenetic change to claystone rather than a particularly distinctive lithologic layer. The smooth acoustic basement at 0.68 sec TW reflection time subbottom, tentatively correlated with Horizon B of the Argentine Basin by Ewing and Lonardi (1971).

Siliceous sediment; diatom rich.



SITE 328 LEG 36



SITE DATA

Position:
- Latitude 50°39.3' S
- Longitude 46°05.7' W

Date: 05/04/74
Time: 0120Z
Water depth: 1519 meters
Location: Western end of the Maurice Ewing Bank

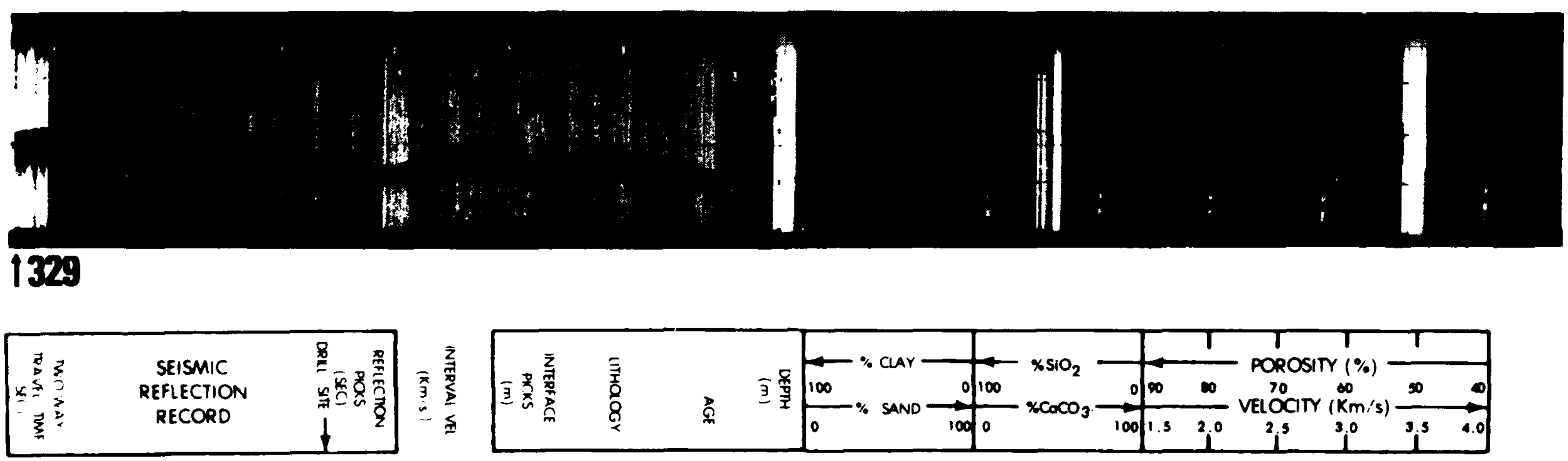
CORE DATA

Penetration:
- Drilled-- 152 meters
- Cored---- 312 meters
- Total---- 464 meters

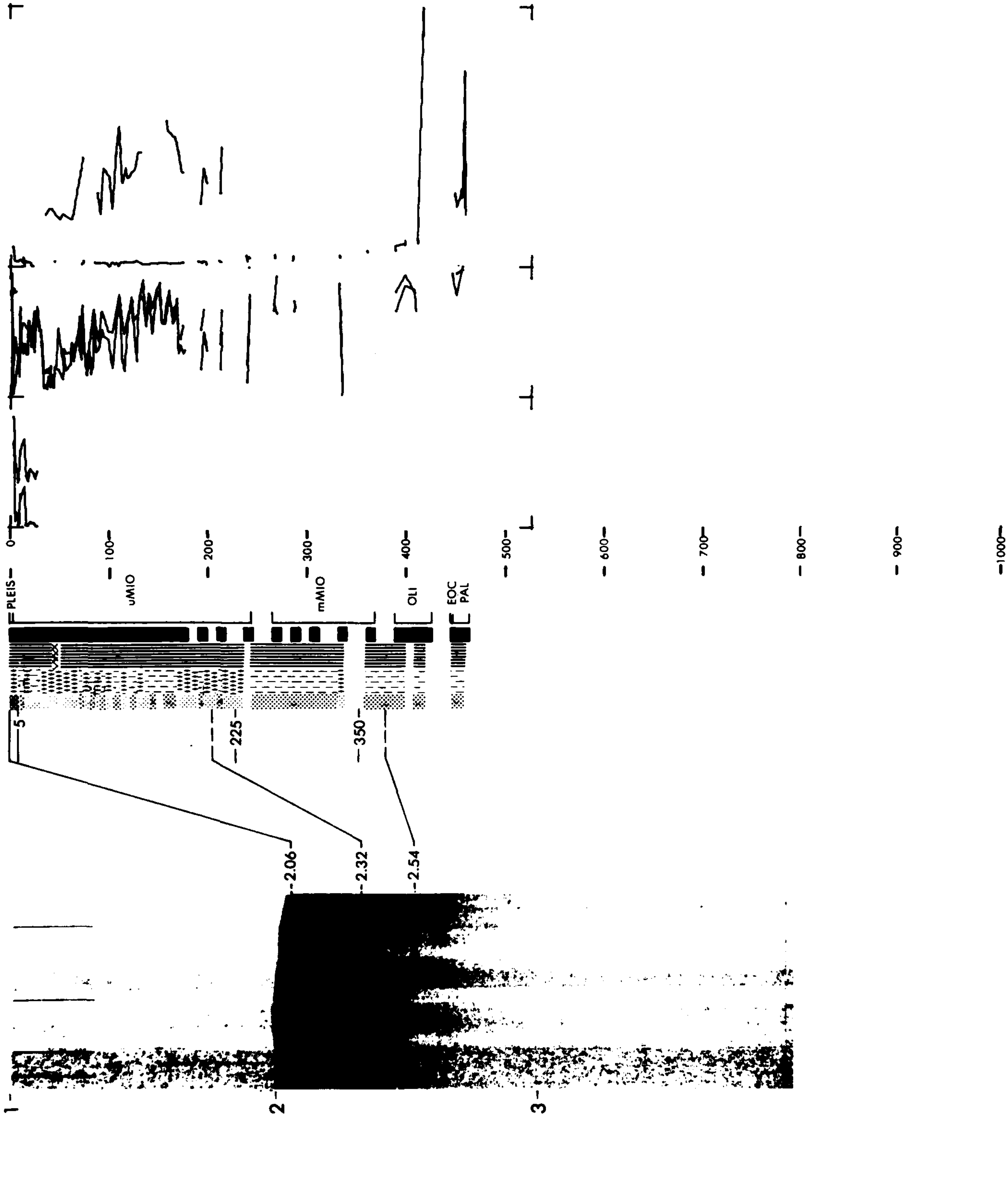
Recovery:
- Basement- 0 cores, 0 meters
- Total---- 33 cores, 215 meters

The entire section at Site 329 is biogenic, and divides into two lithologic units, an upper unit of green ooze and chalk and a lower unit of gray chalk. Miocene sediments indicate that strong bottom currents swept the region and may have contributed to unusually high local rates of accumulation. The profiles are consistent with the virtual absence of post-Miocene sediments. Milder climatic conditions apparently prevailed during the Paleocene than during the later Paleogene and early Neogene. Miocene fossils are cold water forms, although a moderately warm water interval is seen in Cores 14 and 15. A present best estimate of the age of initial opening of Drake Passage is 20 to 30 m.y. (Barker, in press); the consequent completion of a circumpolar current path, combined with an Antarctic continental glaciation starting in the late Oligocene (Hayes and Frakes, 1975) may be expected to produce the strong surface and bottom currents, and zones of high productivity, which appear to have goverened Neogene sedimentation on the Falkland Plateau.

Calcareous sediment; mostly nannofossil rich, interbedded with siliceous sediment; diatom rich, thin layers occurring in Miocene time.



SITE 329 LEG 36



SITE DATA

Position:
- Latitude 50°55.2' S
- Longitude 46°53.0' W

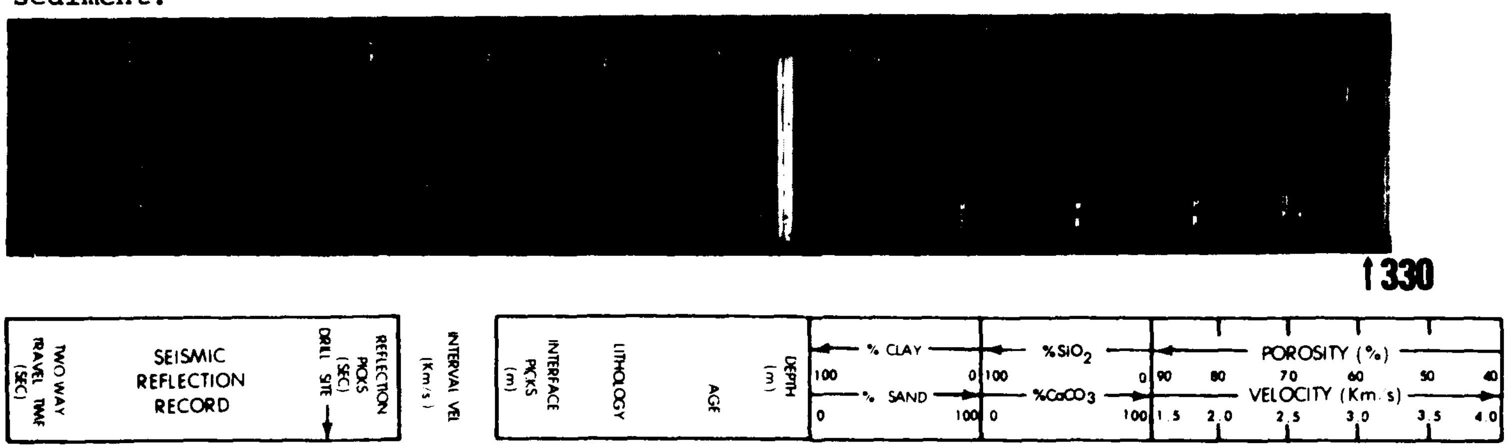
Date: 05/08/74
Time: 2214Z
Water depth: 2626 meters
Location: Elongate rise in east Falkland Plateau

CORE DATA

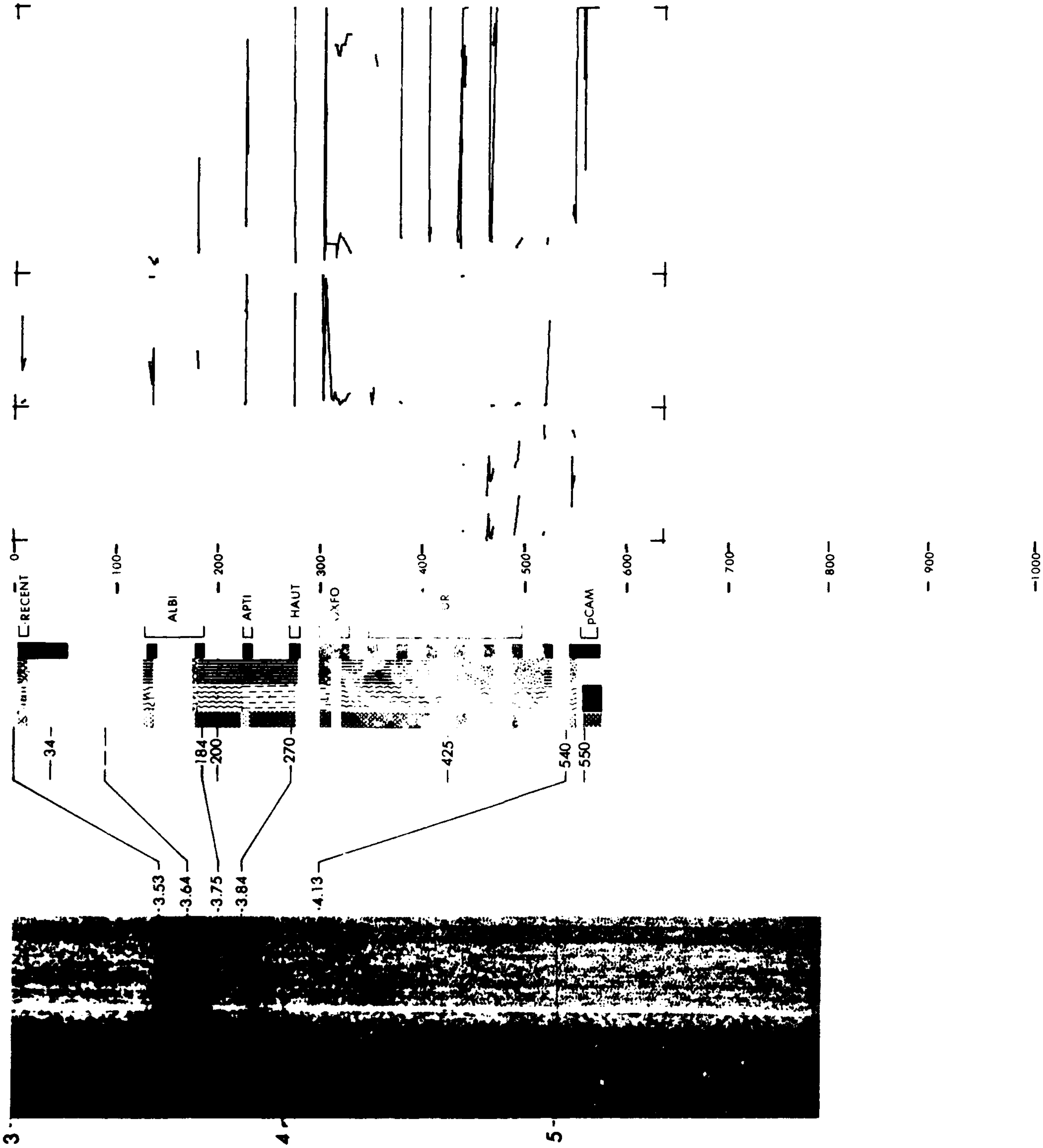
Penetration:	330	330A	
Drilled--	414	6	meters
Cored----	161	47	meters
Total----	575	53	meters
Recovery:			
Basement-	2	0	cores
	19	0	meters
Total----	17	5	cores
	85	4	meters

Seven lithologic units are distinguished. The uppermost unit consists of diatomaceous silty clay and diatom ooze. It is underlain by approximately 166 meters of Albian-Cenomanian zeolite-rich nanno clay. 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. 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. Unit 5 is a subarkosic sandstone layer of which only 20 cm was recovered, but which could be much thicker. 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.

Recent siliceous sediment; diatom rich. Calcareous sediment; nannofossil rich in the Albian. One thin layer of calcareous sediment occurs in the earlier detrital sediment.



SITE 330 LEG 36



SITE DATA

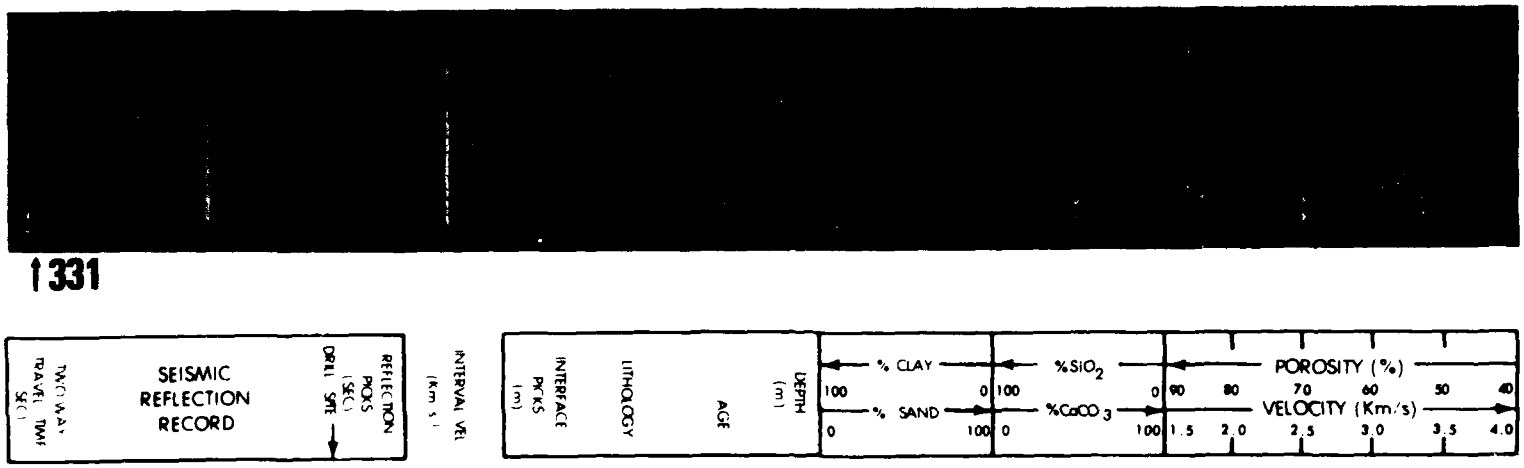
Position:
Latitude 37°53.0' S
Longitude 38°06.9' W
Date: 05/13/74
Time: 0000Z
Water depth: 5067 meters
Location: Argentine Basin

CORE DATA

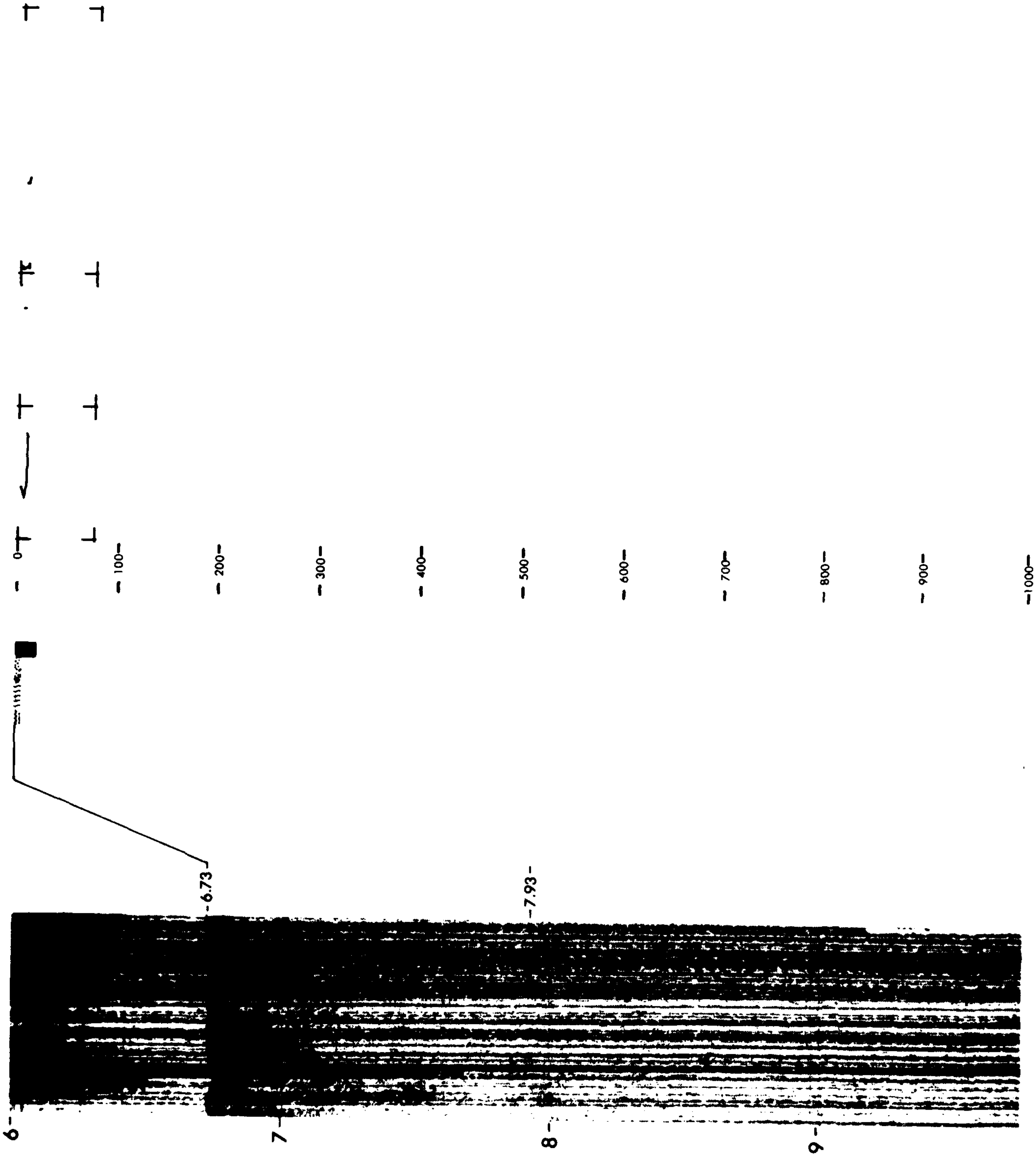
Penetration:
Drilled-- 0 meters
Cored---- 18 meters
Total---- 18 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 2 cores
8 meters

The sediment is immature and clay rich. It contains large diatoms and Radiolaria with Antarctic affinities as well as forms characteristic of more temperate waters. The silt and sandy silt layers in the sediment are well sorted and contain a high proportion of heavy minerals.

From the evidence available at Site 331 it is apparent that at least during the lower Pleistocene a deep, sediment-rich current of Antarctic Bottom Water was active in the vicinity of Site 331. This was transporting as a nepheloid layer and winnowing material derived both from the Antarctic region and from the continental margin of South America. As bottom current activity was vigorous in the Quaternary it is possible that silt and even sand-sized material was transported into the Argentine Basin by the Antarctic Bottom Current at that time. However, the coarse fraction and heavy minerals were more likely derived, with the brackish water diatoms, from the continental margin of South America.



SITE 331 LEG 36



SITE DATA

Position:
- Latitude 36°32.7'N
- Longitude 33°38.5'W

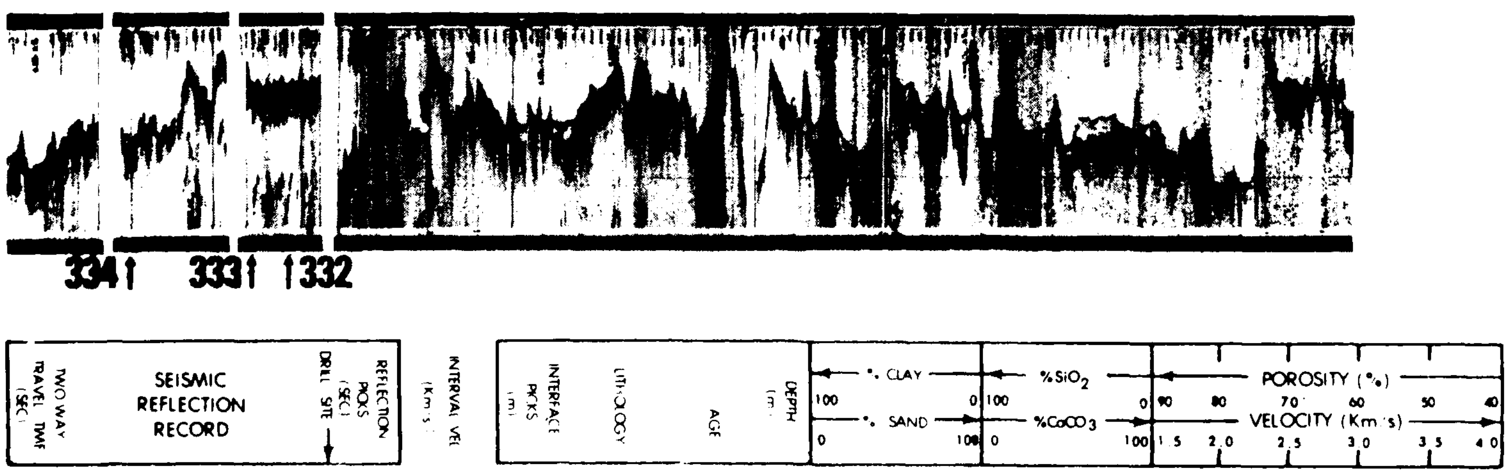
Date: 7/07/74
Time: 0140Z
Water depth: 1818 meters
Location: Deep Drill Valley

CORE DATA

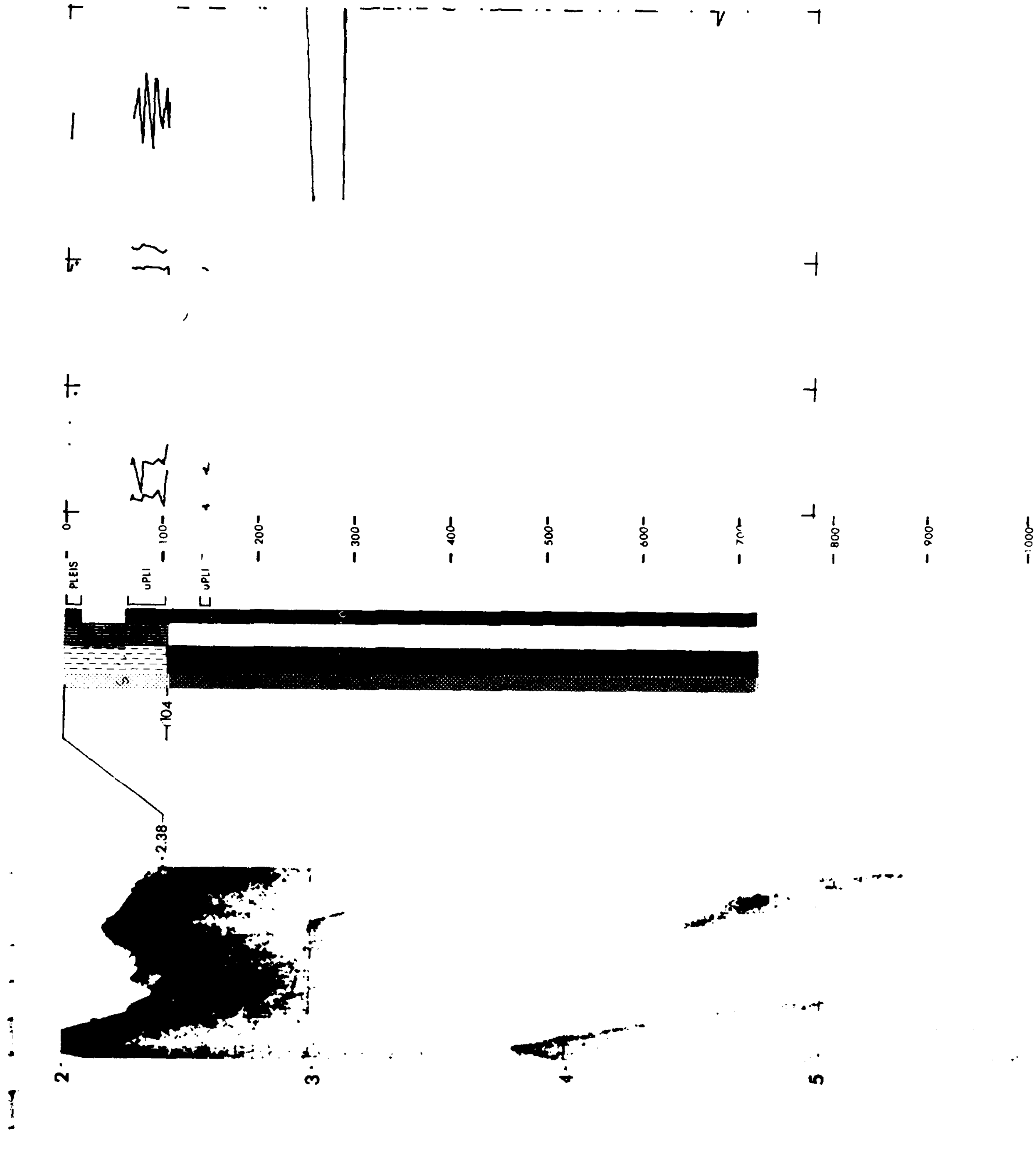
	332	332A	332B	332C	332D	
Penetration:						
Drilled--	66	57	132	149	142	meters
Cored----	7	380	589	9	6	meters
Total----	73	437	721	158	148	meters
Recovery:						
Basement-	0	33	48	1	0	cores
	0	37	121	1	0	meters
Total----	1	40	48	1	1	cores
	4	67	121	1	.3	meters

Acoustic basement is overlain by 100 to 150 meters of foram-bearing nannofossil ooze, with a few thin layers of gray volcanic ash and scattered pumice fragments. Basement consists of a largely extrusive sequence of massive to pillowed basalts with interlayered nannofossil ooze and chalk, and probable zones of breccia or basaltic rubble. Hole 332A penetrated 333 meters into acoustic basement. Small-scale lithologic breaks are common in the igneous sequence indicating that individual units are thin, probably pillow lavas,thin flows, or intrusive bodies. Individual cooling units, however, are often difficult to recognize because of poor core recovery. The chemistry of the basalts fits the general definition of ocean ridge tholeiite but is highly variable with some evidense of eruptive cycles.

The magnetic stratigraphy includes normal, reversed, and transitional zones. Magnetic evidence suggests that thick sections of petrographically and geochemically similar units were erupted over short time intervals of 10 to 1000 yr. The entire sequence is believed to have formed within the Median Valley in mid to late Pliocene over a period of 100,000 to 200,000 yr.



SITE 332 LEG 37



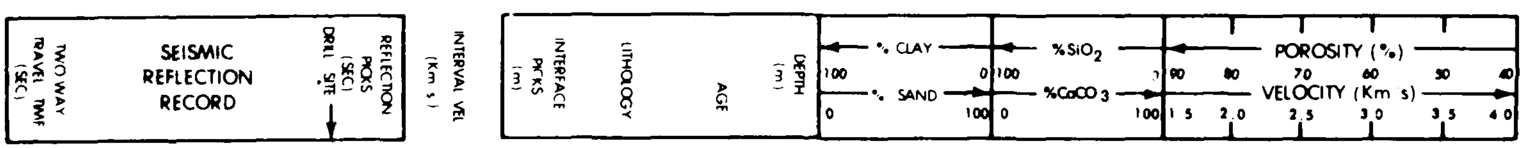
SITE DATA

Position:
Latitude 36°50.4'N
Longitude 33°40.0'W
Date: 07/07/74
Time: 0325Z
Water depth: 1666 meters
Location: Deep Drill Valley

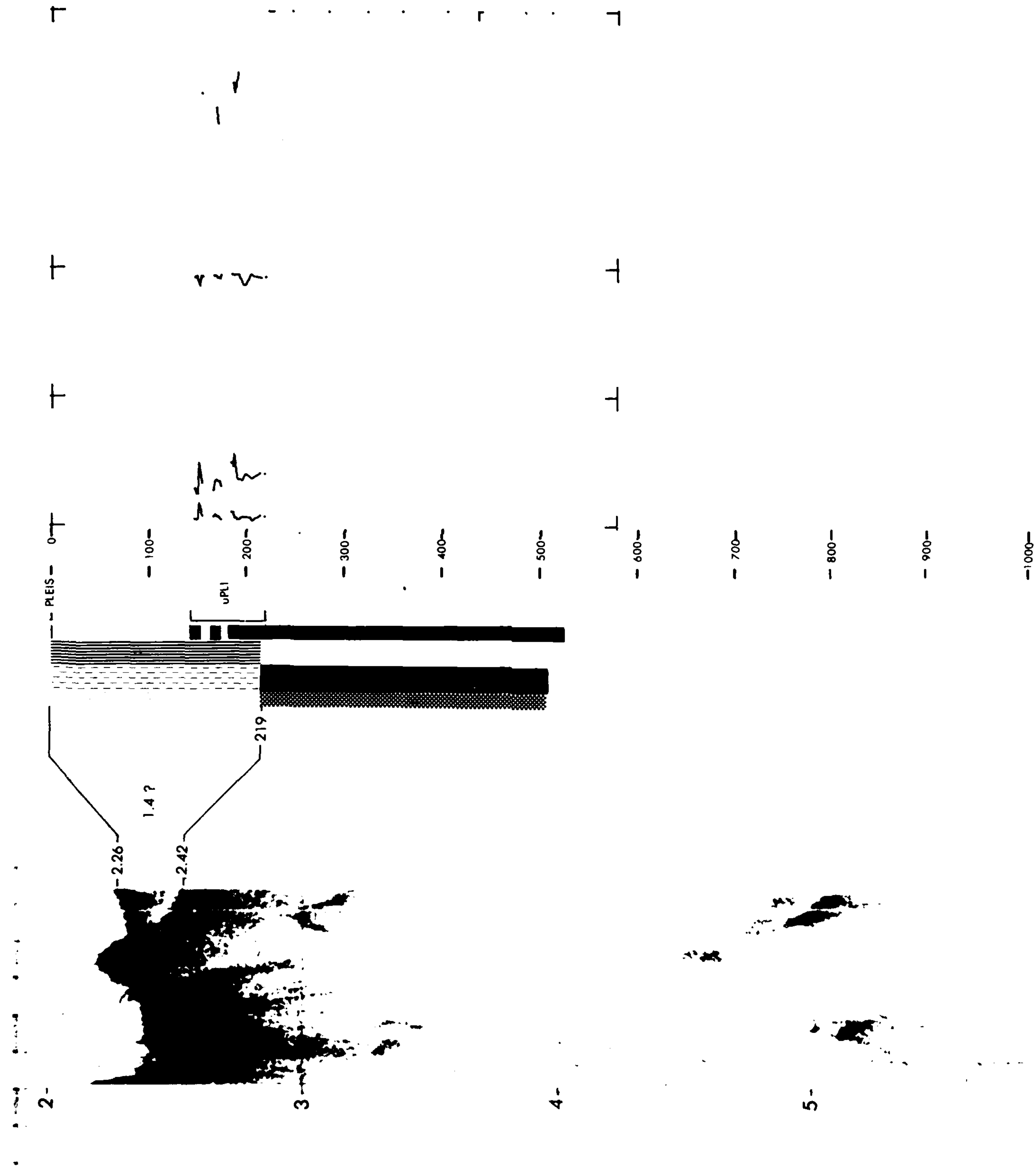
CORE DATA

Penetration:	333	333A	
Drilled--	162	217	meters
Cored----	69	312	meters
Total----	231	529	meters
Recovery:			
Basement-	2	11	cores
	.1	24	meters
Total----	9	11	cores
	38	25	meters

Two holes were drilled at Site 333 which is located near the base of a postulated fault scarp on the west side of Deep Drill Valley, approximately 1.8 km southwest of Site 332. About 220 meters of Recent to late Pliocene nanno-foram ooze overlie acoustic basement. Of 310.5 meters drilled into basement, 23.3 meters of heterogenous, largely extrusive basalt with considerable rubbly material, sedimentary breccia, and soft sediment interbeds were recovered. Basalts appear to correlate best with the middle to lower basalt sequence in Hole 332B, but correlations are difficult because of the very low core recovery. One re-entry was accomplished in Hole 333A, but unstable hole conditions caused the bit to stick irretrievably at 529 meters below the mud line. Results at this site suggest that deeper material may be recovered by drilling at the base of a fault scarp, but that drilling is more difficult.



SITE 333 LEG 37



SITE DATA

Position:
- Latitude $37^{\circ}02.1'$ N
- Longitude $34^{\circ}24.9'$ W

Date: 07/14/74
Time: 1125Z
Water depth: 2619 meters
Location: Magnetic Anomaly 5; west of the Mid-Atlantic Ridge

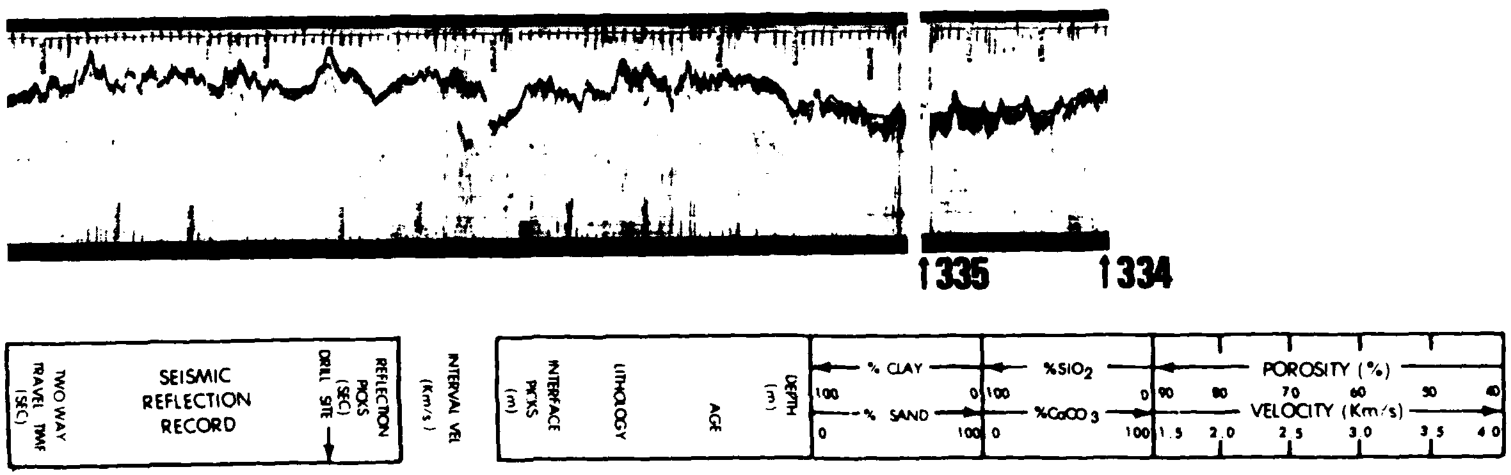
CORE DATA

Penetration:
- Drilled-- 123 meters
- Cored---- 253 meters
- Total---- 376 meters

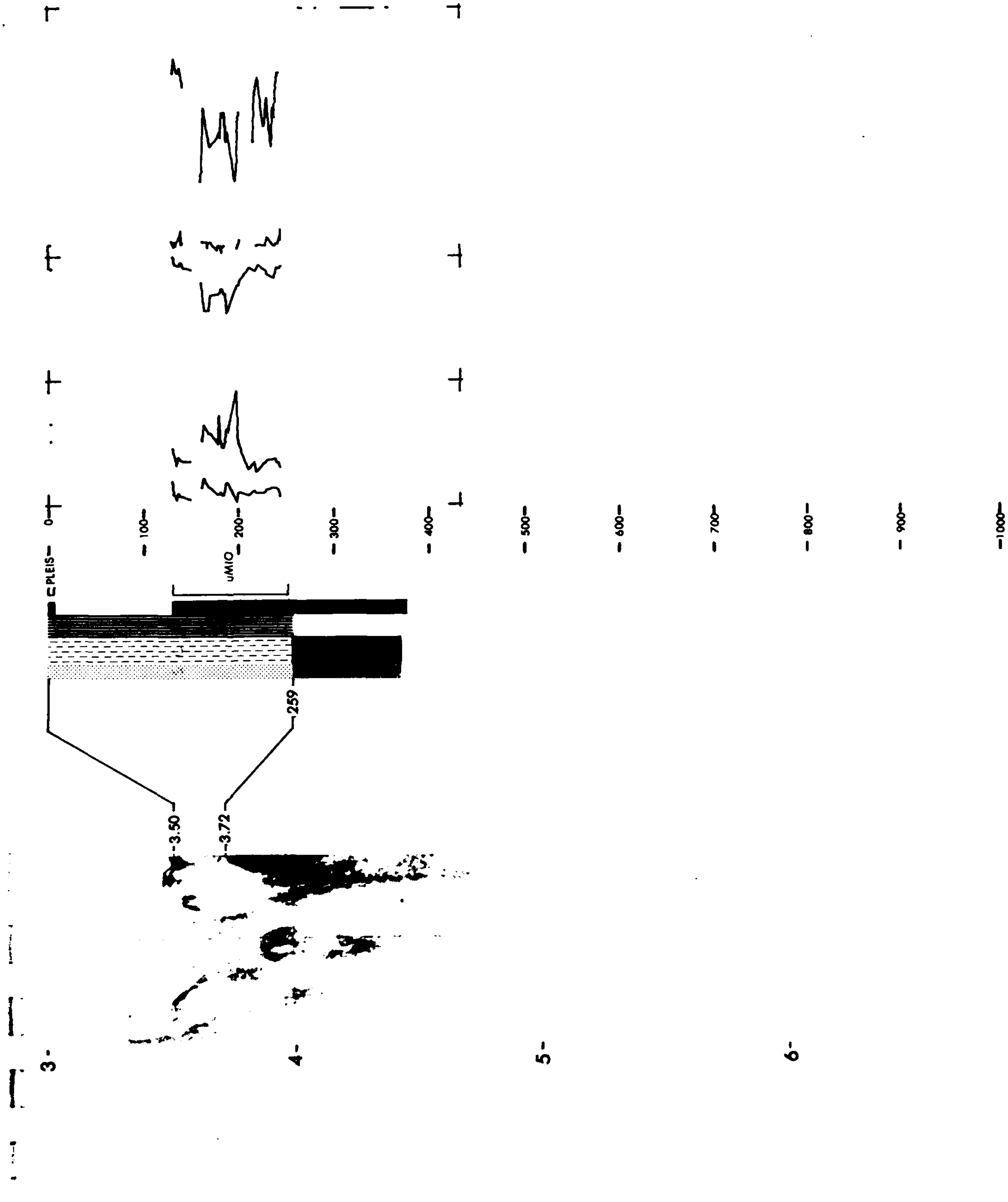
Recovery:
- Basement- 13 cores, 24 meters
- Total---- 27 cores, 99 meters

Site 334 was drilled on a steep east-facing slope in a small, deep basin near the middle of magnetic anomaly 5. Acoustic basement lies beneath 259.5 meters of Recent to early late Miocene foram-bearing nannofossil ooze and was drilled 123.5 meters with 20% recovery. Basement consists of an upper 50-meter-thick section of fresh, coarse-grained gabbro, serpentinized olivine gabbro, serpentinized peridotite, and breccia. Such a shallow occurrence of a plutonic assemblage was not expected at this site.

Breccias with gabbro and peridotite clasts in a nannofossil-foram ooze matrix are interlayered with the plutonic rocks and may reflect exposure of a mélange in or near the Median Valley of the Mid-Atlantic Ridge prior to burial by later basaltic extrusions. It is probable that uplift along the east-facing slope also assisted in bringing the gabbro-peridotite complex to shallow depths. The plutonic rocks show mainly primary igneous textures suggestive of a cumulative origin for the peridotites and some of the gabbros.



SITE 334 LEG 37



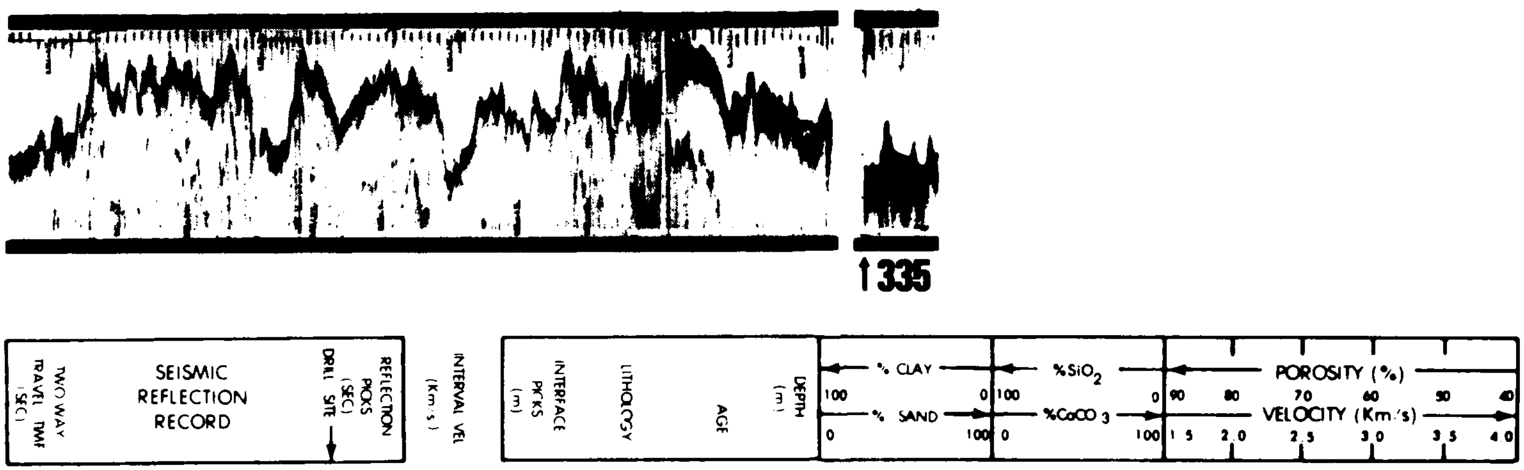
SITE DATA

Position:
    Latitude   37°17.7' N
    Longitude   35°11.9' W
Date: 07/18/74
Time: 0205Z
Water depth: 3188 meters
Location: West of the Mid-Atlantic Ridge

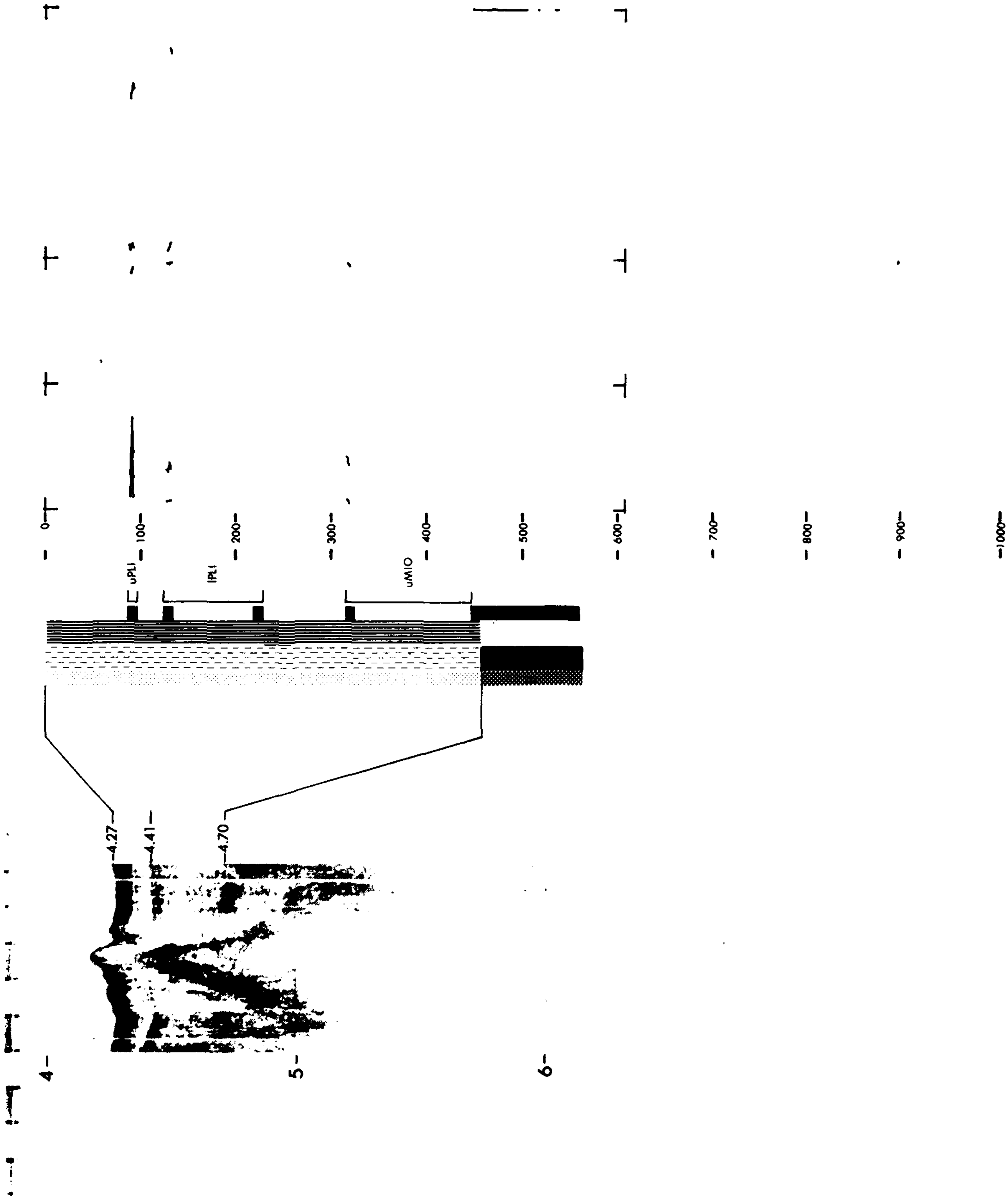
CORE DATA

Penetration:
    Drilled-- 410 meters
    Cored---- 152 meters
    Total---- 562 meters
Recovery:
    Basement- 12 cores
              41 meters
    Total---- 16 cores
              59 meters

Acoustic basement underlies a 454-meter thick sequence of foram-bearing nannofossil ooze. The sediments are white to light gray calcareous oozes with occasional thin purple layers and rare pyrite nodules. An average composition is 95%-97% nannofossils, 2%-4% foraminifers, and traces of Radiolaria, sponge spicules, and volcanic glass. A few layers containing over 50% foraminifers are present. Acoustic basement consists of a very uniform sequence of pillow basalts with numerous glass rinds and intercalations of nannofossil chalk. The basalts are aphyric to sparsely phyric with 1-5 modal percent of plagioclase and olivine phenocrysts. Sparse crystals of green clinopyroxene are present in a few specimens. The basalts are very uniform in composition suggesting that they are comagmatic. Generally well-developed alteration by seawater at close to ocean bottom temperatures has strongly influenced the magnetic properties of the pillow basalts. Indications of present-day subbottom water flow are evident from in-hole temperature measurements. Horizontal flow of water at 10°C must be taking place at close to the base of the 454-meter-thick sediment section in order to explain the temperature profile in the section.



SITE 335 LEG 37



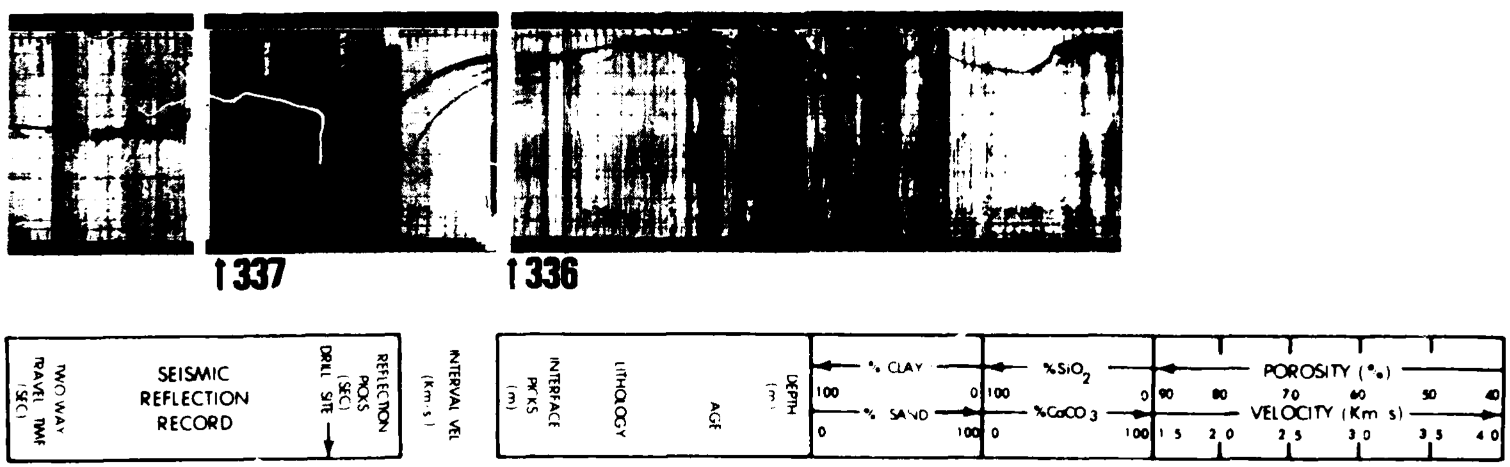
SITE DATA

Position:
Latitude 63°21.1' N
Longitude 7°47.3' W
Date: 08/06/74
Time: 2023Z
Water depth: 811 meters
Location: Iceland-Faeroe Ridge

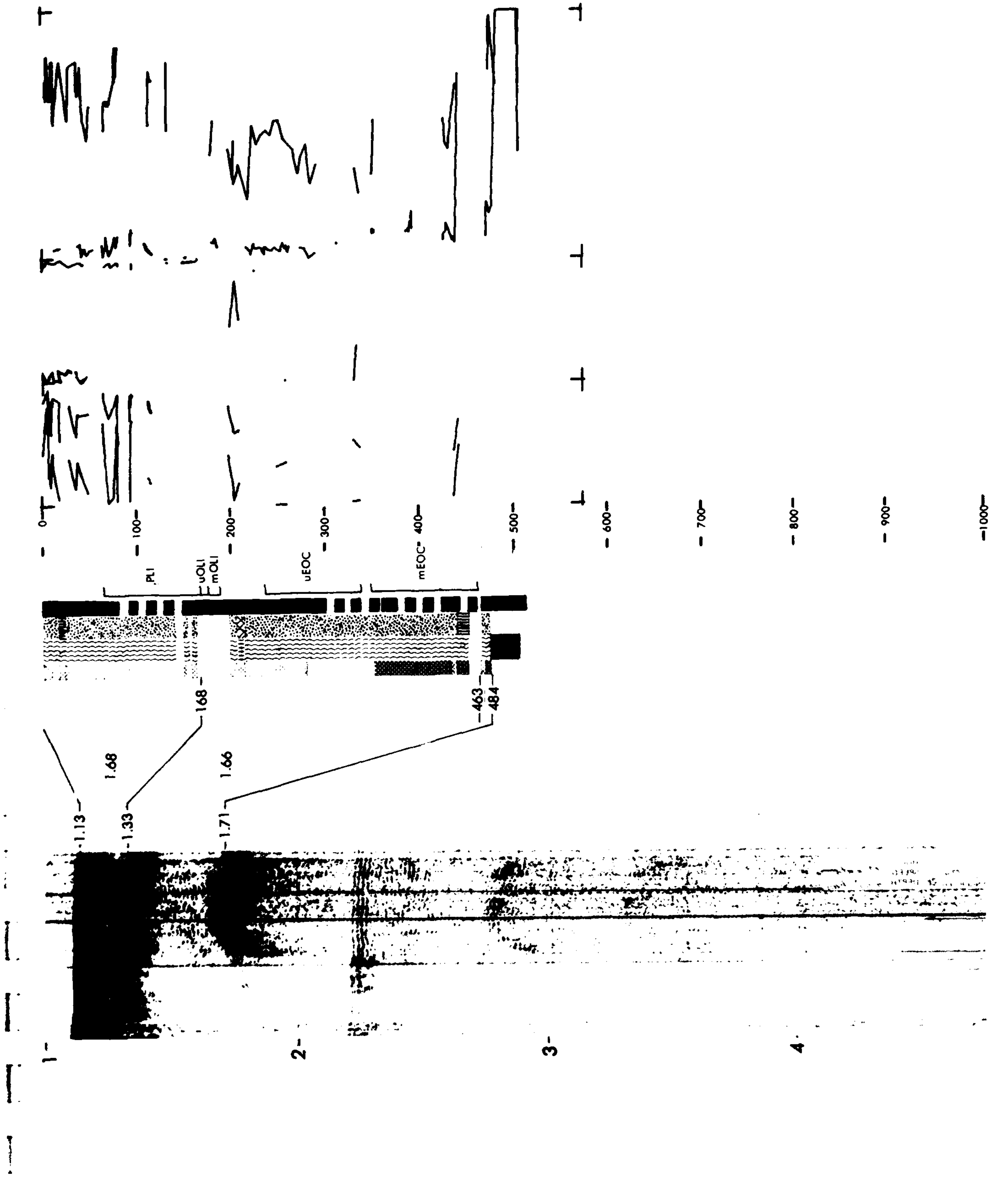
CORE DATA

Penetration:
Drilled-- 119 meters
Cored---- 396 meters
Total---- 515 meters
Recovery:
Basement- 6 cores
14 meters
Total---- 44 cores
221 meters

The geologic history, following extrusion of the basalt, of this part of the Iceland-Faeroe Ridge consists of: Weathering or erosion of the basalt to yield all of Unit 3. This was followed by mineralization(?). Eocene (?) to Oligocene hemi-pelagic sedimentation with sporadic deposition of volcanic ash. A stratigraphic hiatus from the late Oligocene to the Pliocene (?) is present in Unit 1. A hiatus of any extent may reflect a history of emergence, increased bottom water erosion, or non-deposition. The latter reflects climatic trends particularly in Arctic regions (where most of the cold bottom water is generated at present). It is also possible to invoke a combination of factors, where topographically high submarine areas may cause an increase in current speeds of newly formed water masses, resulting in non deposition and/ or erosion. Unit 1 indicated an initial low sedimentation rate, increasing upwards. The sediments are admixed with coarse ice-rafted debris, which contributed to a high sedimentation rate during the Pliocene (?)-Pleistocene.



SITE 336 LEG 38



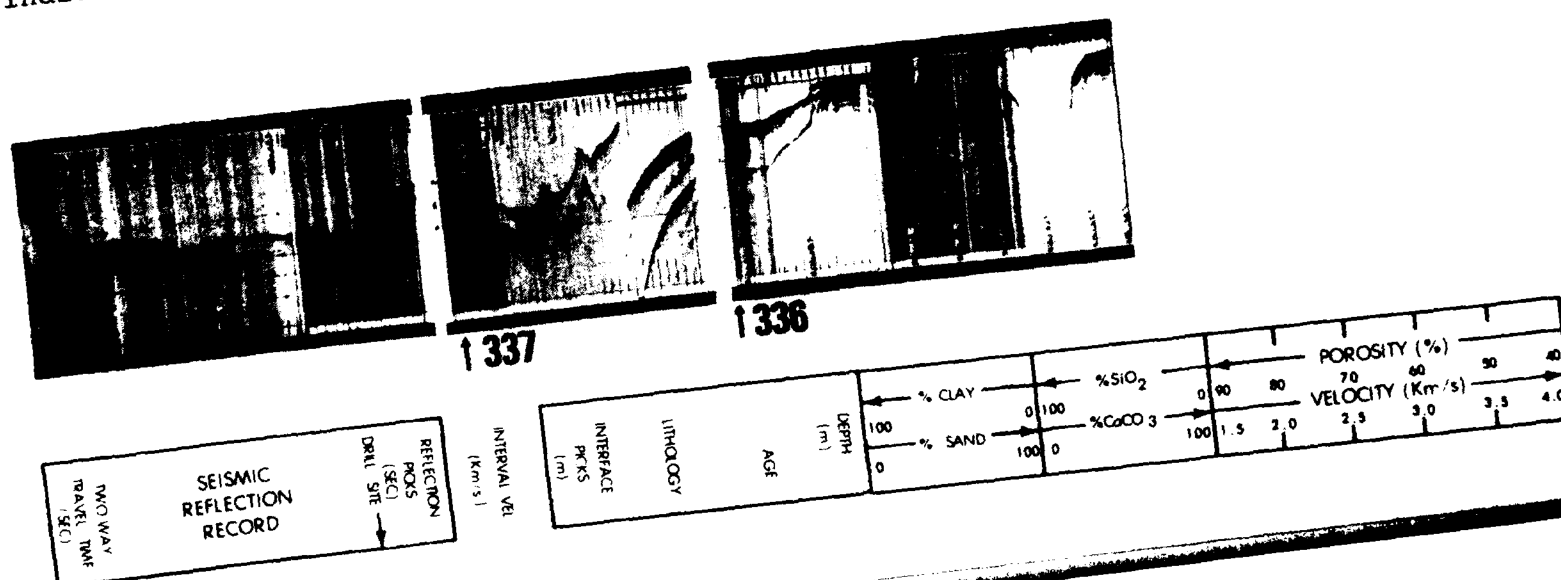
SITE DATA

Position:
Latitude 64°52.3' N
Longitude 5°20.5' W
Date: 08/10/74
Time: 1046Z
Water depth: 2637 meters
Location: Norway Basin

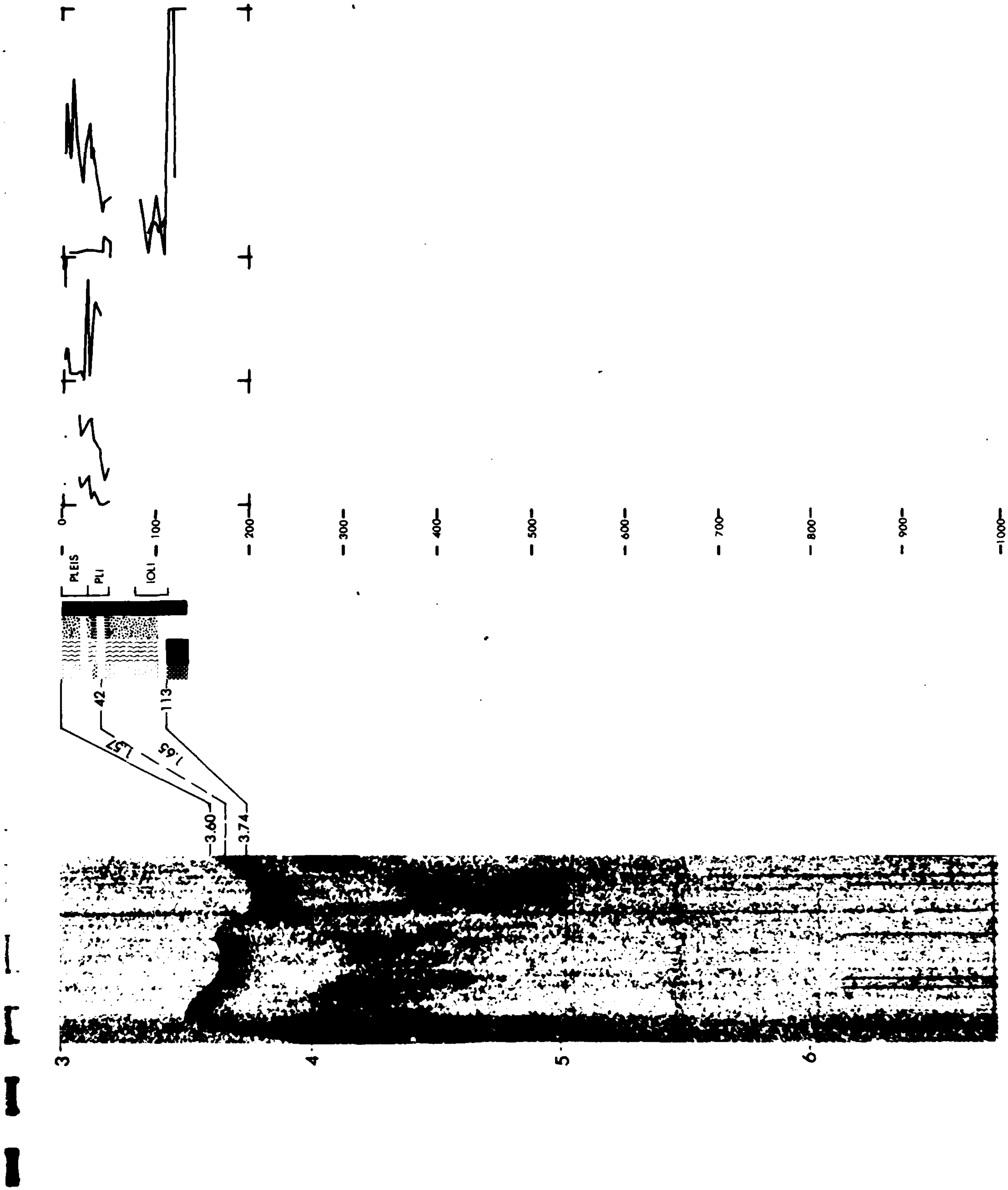
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 132 meters
Total---- 132 meters
Recovery:
Basement- 3 cores
12 meters
Total---- 15 cores
98 meters

Unit 2 overlies the basalt and appears to represent a thick accumulation of pelagic clay below the CCD, during the lower (?) Oligocene. Calcareous fossils are nonexistent, while siliceous fossils are present in limited amounts, but increasing below Core 9. Volcanic ash zones (or strata), zeolite clay zones indicate a substantial volcanic contribution to the Norway Basin sediments during this time. Mn micronodules and trace amounts of glauconite, indicate a reasonably low sedimentation rate. Subunit B, the lowest subunit of Unit 1 represents deposition of sediments derived from terrigenous sources. The deposition of Subunit A was probably gradational from Subunit B, seemingly indicating a similar depositional process. The presence of pebbles points to ice rafting as a significant sediment contributor. Volcanic ash is present, but the relative amounts seem less compared to Unit 2, considering the different rates of sedimentation. As in Subunit B, the presence of nannofossil oozes and foraminifera indicates deposition above the CCD.



SITE 337 LEG 38



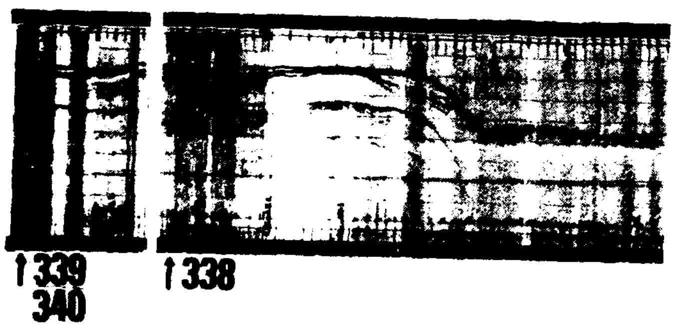
SITE ATA

Position:
Latitude $67^{\circ}47.1'$ N
Longitude $5^{\circ}23.3'$ E
Date: 08/13/74
Time: 2200Z
Water depth: 1297 meters
Location: West of the Vøring Plateau Escarpment

CORE DATA

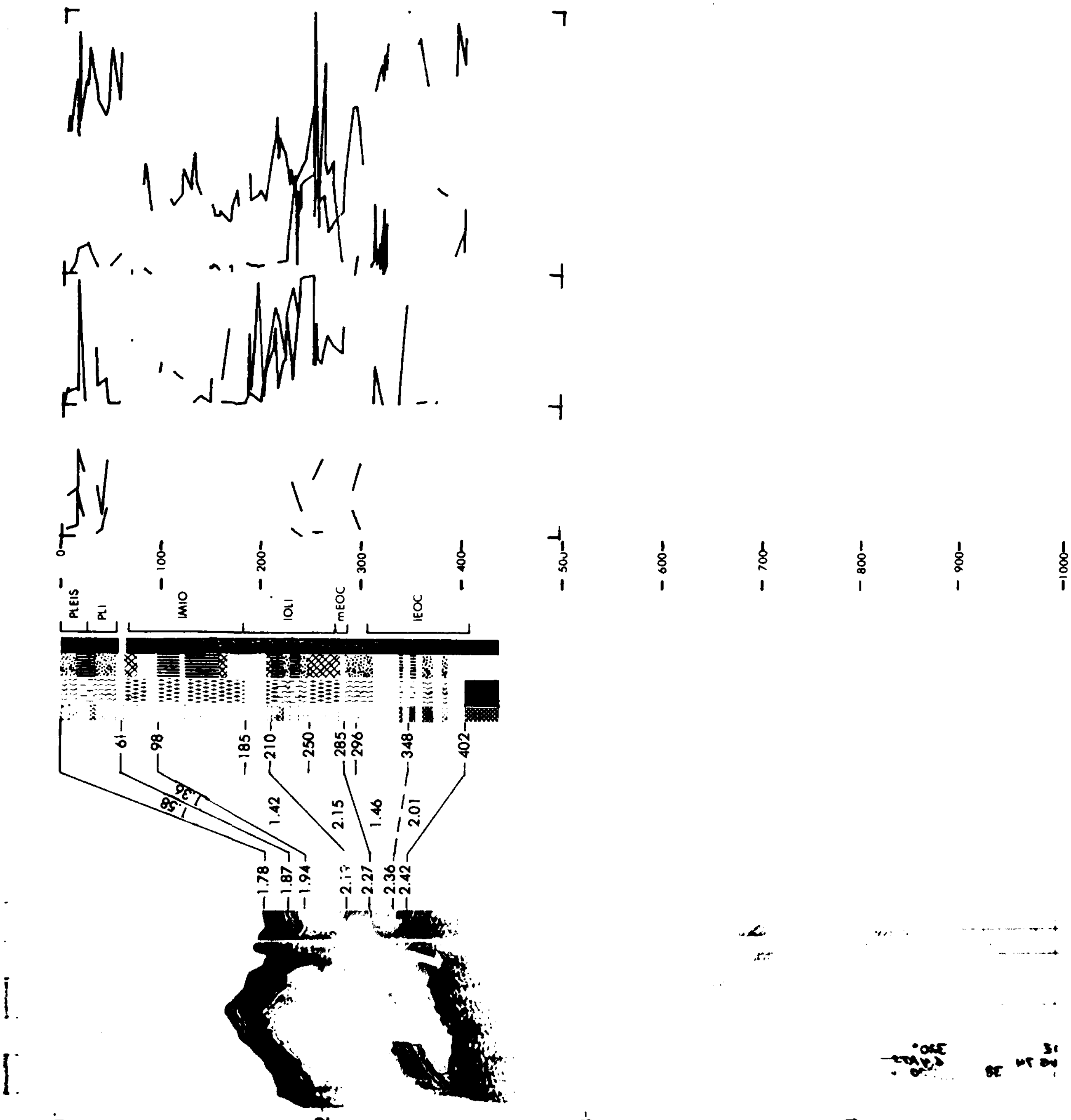
Penetration:
Drilled-- 10 meters
Cored---- 427 meters
Total---- 437 meters
Recovery:
Basement- 4 cores
13 meters
Total---- 45 cores
209 meters

It is suggested that the sediments recovered provide evidence for the progressive subsidence of the outer part of the Vøring Plateau with respect to sea level throughout the Tertiary. The lithified basaltic breccia and sandy limestone immediately overlying basement are presumably derived from the immediately underlying basalt. The sandy limestone appears to have been deposited in a subacqueous environment, but otherwise the nature of the weathering or erosive process responsible for the breccia is not clear. Of interest is the very considerable difference in lithification between these sediments and those of the overlying Subunit 3C. The Unit 3/Unit 2 boundary represents a very considerable change in sedimentation pattern, with terrigenous sedimentation below, pelagic sedimentation above. It is also relevant to note that glauconitic sandy muds of Subunit 3A must have formed in response to some significant change in the environmental conditions at about the middle Eocene. Pelagic sedimentation continued until the middle Miocene (top of Subunit 2B). Unit 1 is considered to have been deposited by glacial processes.



TWO WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE	INTERVAL VEL (Km/s)	INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	100 ← % CLAY 0 / 0 % SAND → 100	100 %SiO$_2$ 0 / 0 %CaCO$_3$ 100	← POROSITY (%) 90 80 70 60 50 40 / 1.5 2.0 2.5 3.0 3.5 4.0 VELOCITY (Km/s) →

SITE 338 LEG 38



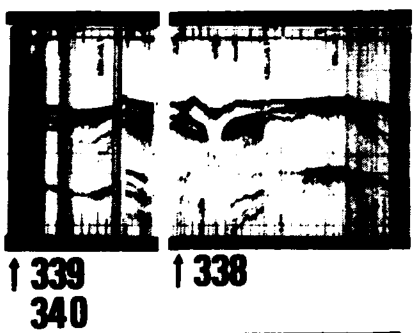
SITE DATA

Position:
Latitude 67°12.6' N
Longitude 6°19.0' E
Date: 08/16/74
Time: 2110Z
Water depth: 1262 meters
Location: Diapir; Vøring Plateau Basin

CORE DATA

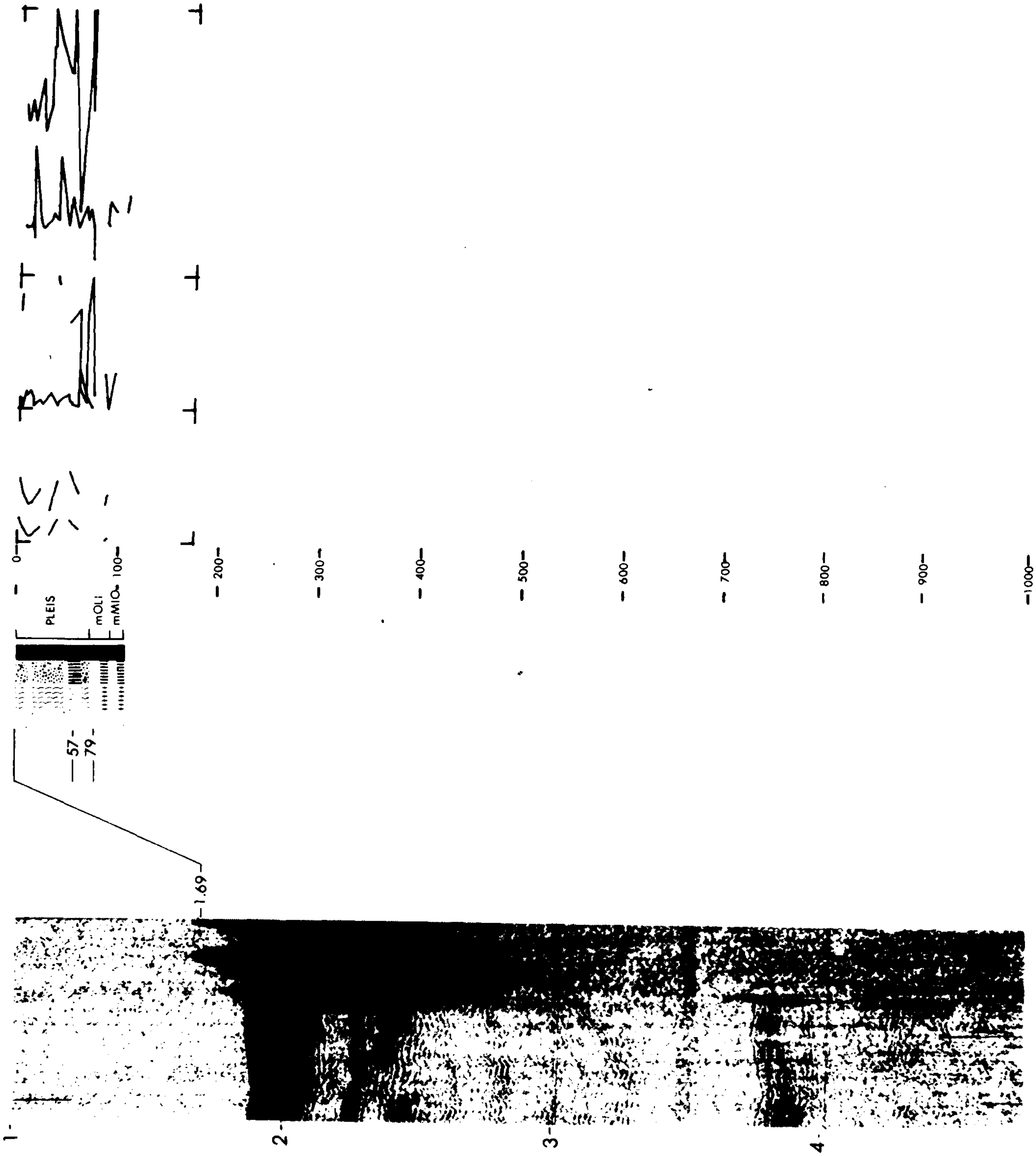
Penetration:
Drilled-- 0 meters
Cored---- 108 meters
Total---- 108 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 12 cores
50 meters

General comments concerning the nature and time of formation of the diapir are given in the Site 340 Report. The Oligocene oozes represented by Unit 2 need not, of course, be typical of the complete Oligocene succession within the Vøring basin, neither are they likely to represent a conformable sequence. They may nevertheless be taken as representative of the composition of the oozes deposited during the early to mid-Oligocene. This indicates that pelagic sedimentation was probably dominant within the basin during this time, with a moderate terrigenous contribution (up to 30%), which is considerably higher than the very low terrigenous proportion (maximum 15%) recorded in the Eocene oozes at Site 340.



TWO WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | REFLECTION PICKS (SEC) | DRILL SITE | INTERVAL VEL (Km/s) | INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100 0 | % SAND 0 100 | %SiO2 100 0 | %CaCO3 0 100 | POROSITY (%) 90 80 70 60 50 40 | VELOCITY 1.5 2.0 2.5 3.0 3.5 4.0

SITE 339 LEG 38



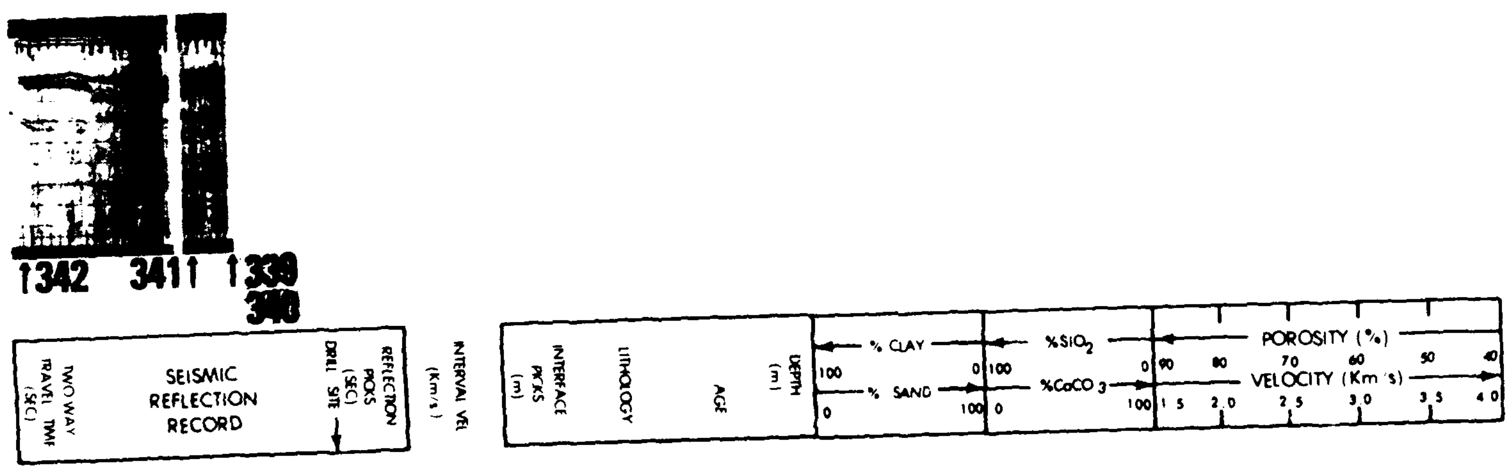
SITE DATA

Position:
Latitude $67^{\circ}12.5'$ N
Longitude $6^{\circ}18.4'$ E
Date: 08/17/74
Time: 1615Z
Water depth: 1206 meters
Location: Diapir; Vøring Plateau Basin

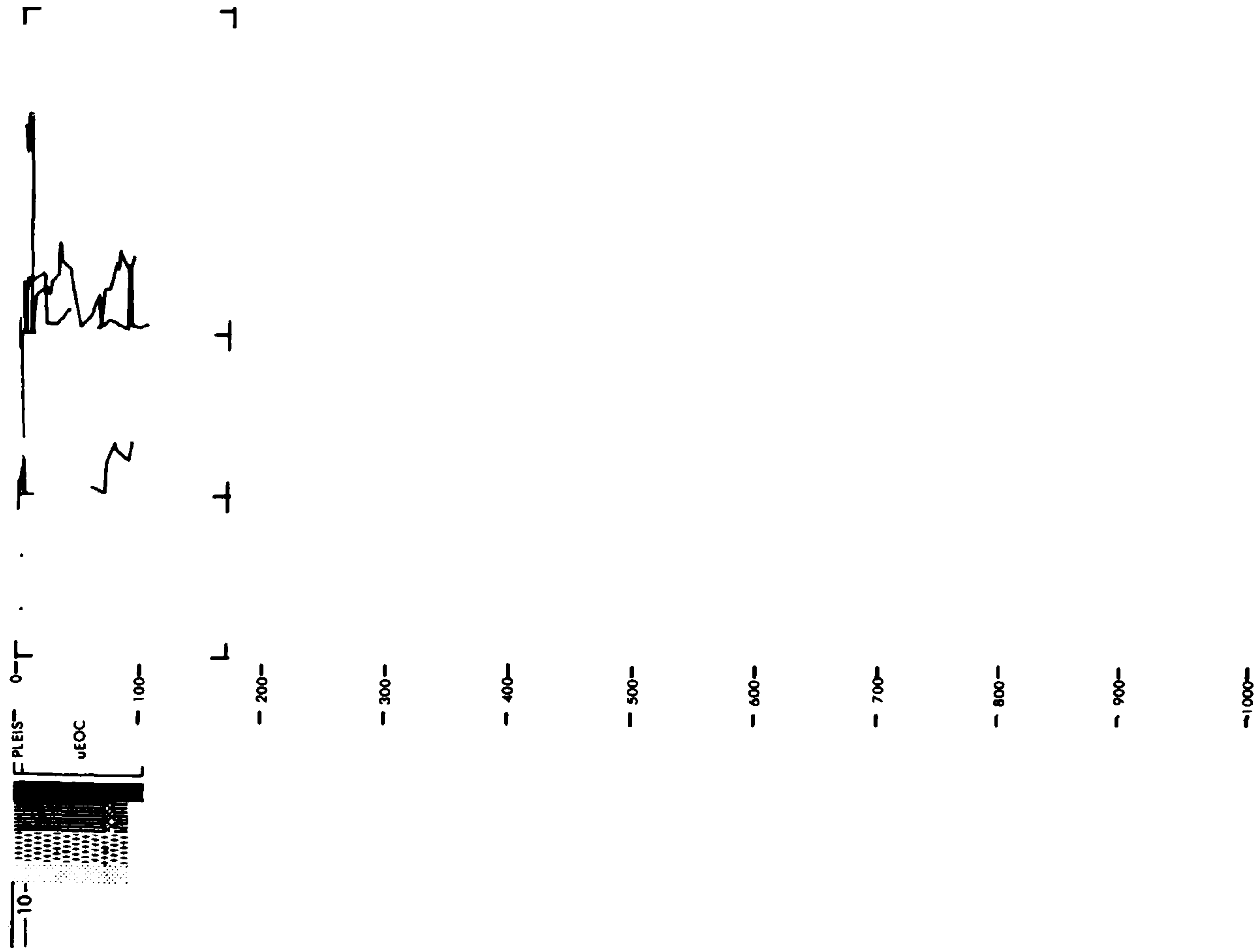
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 104 meters
Total---- 104 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 11 cores
67 meters

Because the Eocene diatom oozes were drilled within a diapir, and are presumably not in situ, they are not necessarily typical of the complete Eocene succession within the Vøring basin. Neither are they likely to represent a continuous sequence, although preservation of presumed original layering indicates that individual "blocks" of ooze, retaining a certain amount of their original structure, were carried up within the diapir core. There is no evidence favoring salt tectonics in the diapir formation. The diapirs appear to be located immediately above a structural high in the (?) pre-Tertiary, and it is suggested that this feature may have been responsible for some tectonic deformation within the overlying strata. Date of the present diapir formation is not known. However, on the basis of displaced Miocene oozes within the "glacial" sediments at Site 341 it is suggested that the diapiric movements commenced in post-Miocene times. The diapir core material is exposed or virtually exposed at the surface of the sea bed at the crest of at least one diapir. Post-Pleistocene movement of the diapir is the most satisfactory explanation for these observations.



SITE 340 LEG 38



SITE DATA

Position:
Latitude 67°20.1' N
Longitude 6°06.6' E
Date: 08/18/74
Time: 0930Z
Water depth: 1439 meters
Location: Vøring Plateau Basin

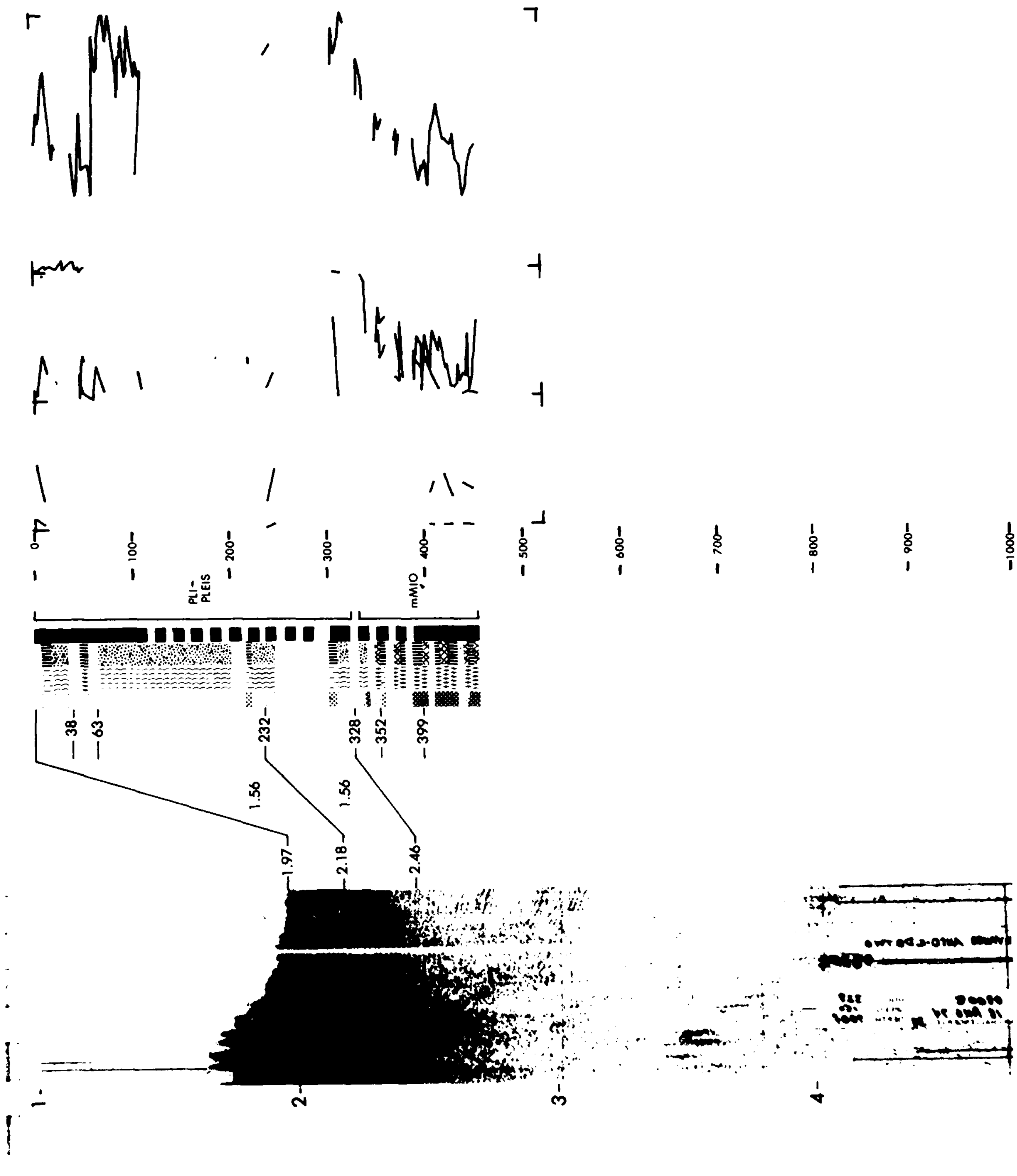
CORE DATA

Penetration:
Drilled-- 143 meters
Cored---- 313 meters
Total---- 456 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 34 cores
213 meters

This site has by far the greatest thickness (~ 328 m) of "glacial" sediments recorded on the Vøring Plateau This implies: (1) that the pre-Miocene (and probably pre-Tertiary) configuration of the present plateau originally consisted of a linear deep-water basin lying to shoreward of, and bounded to the northwest by, a major positive relief feature forming the Vøring Plateau Escarpment, and that the history of the area has been the gradual infilling of this basin throughout the Tertiary, or (2) that the Escarpment represents a fault that has been active throughout the Tertiary, permitting the basin to subside at a greater rate than the crust to the northwest. The "raft" of allochthonous Oligocene to Pliocene ooze found within the "glacial" sediments (Subunit 1B) is approximately 31 meters thick. It is possible that this may represent a large glacial "erratic" carried into position by ice rafting. An alternative mechanism, which attributes the presence of the ooze to upward movement within the diapir during the Pleistocene, and subsequent downslope movement to its present position. This, fairly considerable, amount of displacement could perhaps indicate the period of maximum diapiric activity.

TWO WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | REFLECTION PICKS (SEC) DRILL SITE | INTERVAL VEL (Km/s) | INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100–0 / % SAND 0–100 | %SiO$_2$ 100–0 / %CaCO$_3$ 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

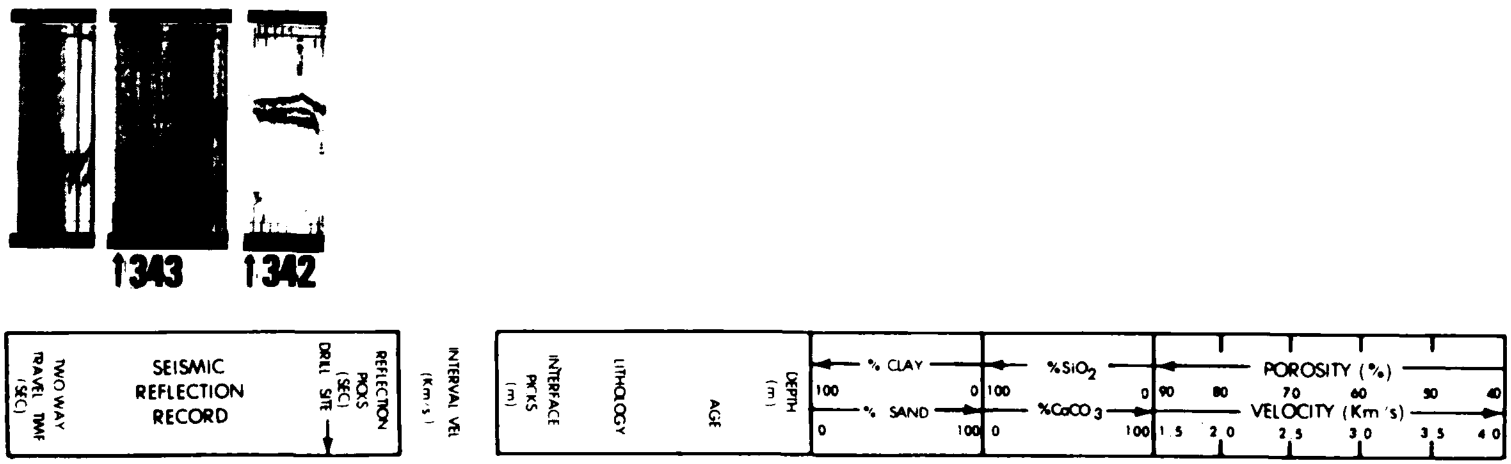
SITE 341 LEG 38



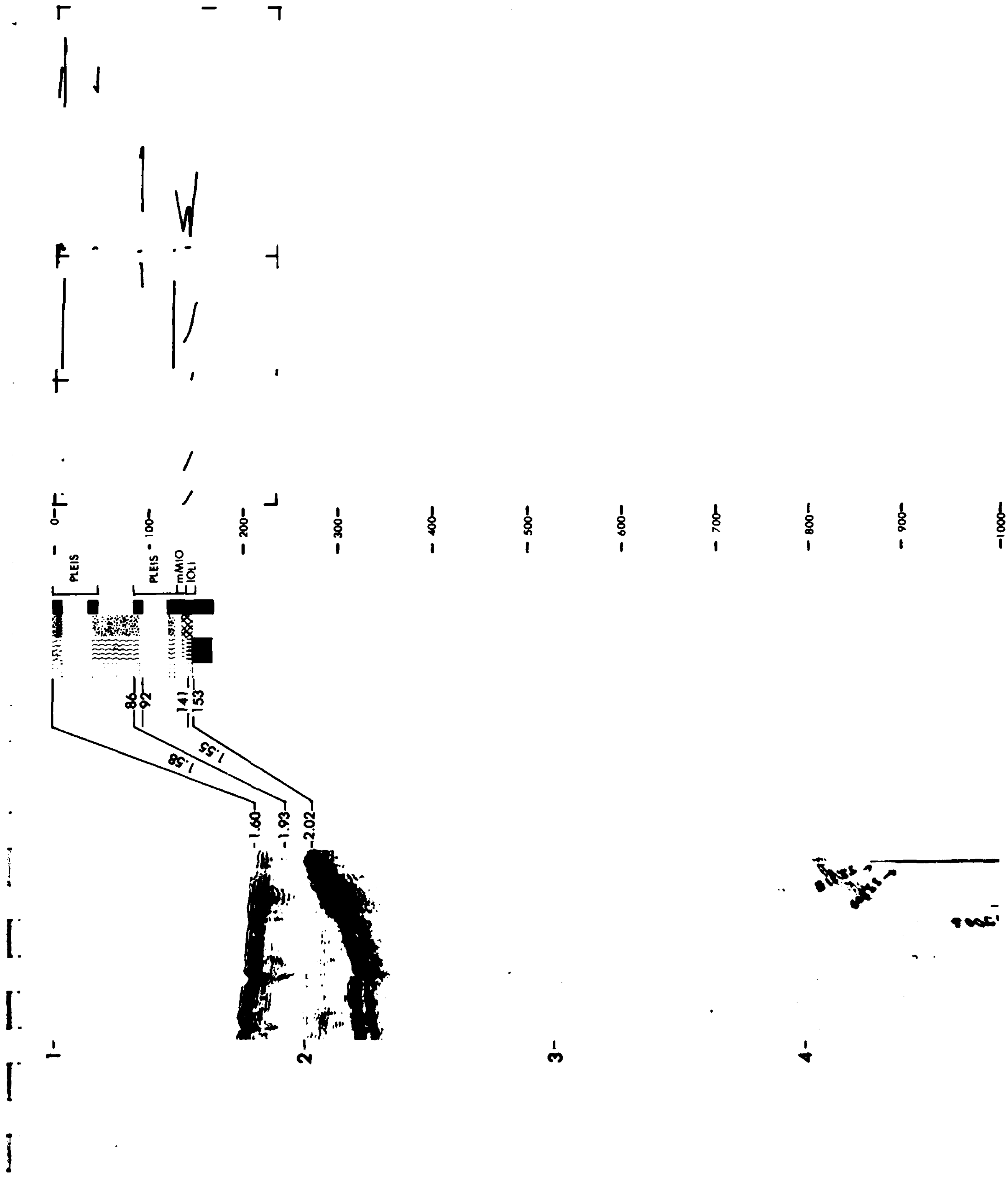
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	67°57.0' N	Drilled--	95 meters
Longitude	4°56.0' E	Cored----	75 meters
Date: 08/20/74		Total----	170 meters
Time: 2241Z		Recovery:	
Water depth: 130? meters		Basement-	2 cores
Location: West of the Vøring			10 meters
Plateau Escarpment		Total----	8 cores
			48 meters

Site 342 was drilled about 46 km to the northwest of Site 338 in the same water depth, but at a point where the underlying basement was at a shallower depth below sea bed. From the airgun profile (Figure 7) it was apparent that the lowermost layers penetrated by Site 338 appeared to thin out against this basement "high," and were nonexistent on top. This was confirmed by Site 342 which passed from "glacial" muds through siliceous oozes of early Miocene age and into basaltic basement at 153.2 meters.

Two principal sedimentary units have been recognized, the second of which has been divided into three subunits. Since only the lowest 30 meters of sediment were continuously cored, determination of the true thicknesses of subunits 2A and 2B must necessarily be approximate.



SITE 342 LEG 38



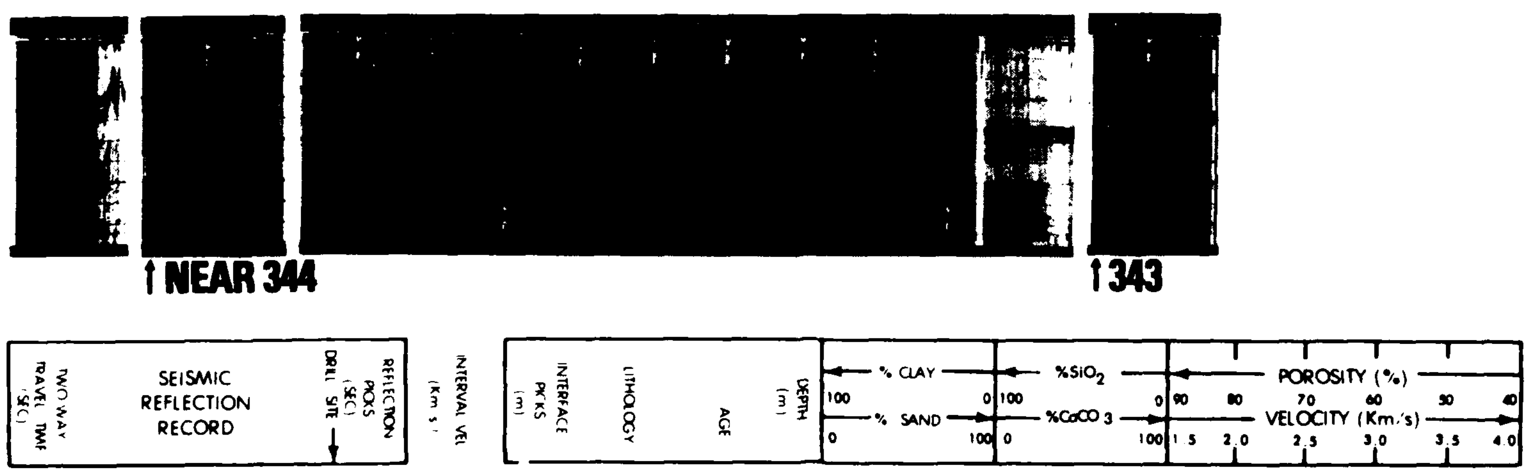
SITE DATA

Position:
Latitude 68°42.9' N
Longitude 5°45.7' E
Date: 08/22/74
Time: 1106Z
Water depth: 3131 meters
Location: Eastern Lofoten Basin

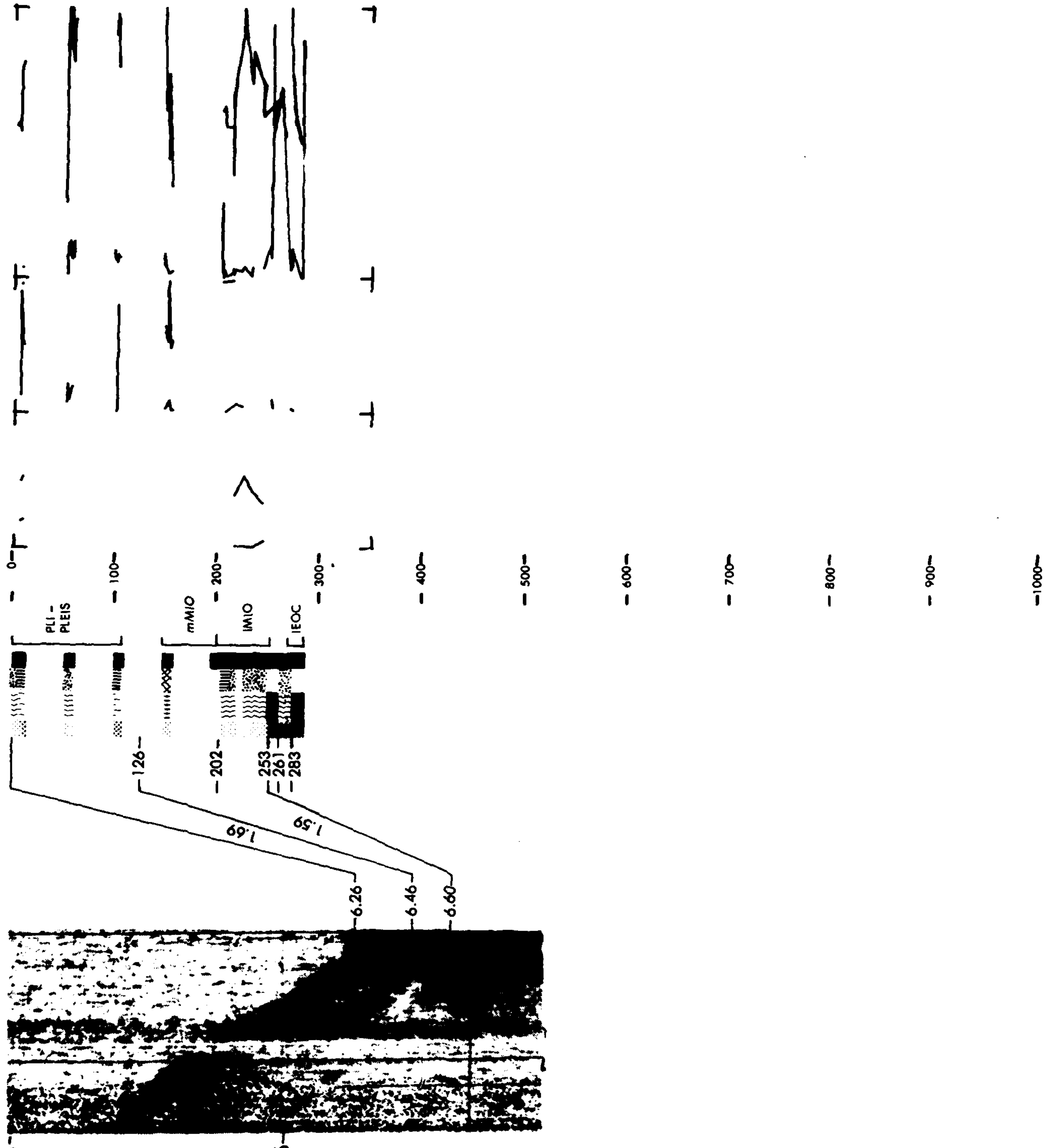
CORE DATA

Penetration:
Drilled-- 152 meters
Cored---- 132 meters
Total---- 284 meters
Recovery:
Basement- 4 cores
8 meters
Total---- 16 cores
59 meters

The lowest Eocene age sediments cored, those of Unit 4, are fairly fine grained, are poorly sorted, and have features suggesting that they were deposited perhaps in relatively deep water, but adjacent to a shallow-water environment. The turbidite sequence of unit 3 supports the idea that Site 343 lay at or near the base of a paleo slope during the early Eocene. These sediments were succeeded in the middle Eocene (Unit 2) by muddy siliceous oozes, suggesting that at this time the source of terrigenous clay particles was becoming less significant. The evidence thus suggests that soon after the onset of sedimentation in the early Eocene Site 343 lay at or near the base of a paleo slope, and that the time span represented by Units 4 through 2 saw a progressive decrease in the amount of terrigenous sediment deposited at the site. There is a hiatus (middle Eocene to Plio-Pleistocene) between the ages of the sediments seen in Units 2 and 1. The contact of Unit 3B above the basalt—the base of the turbidite layer with a basal conglomerate of mudstone clasts—is clearly of sedimentary origin, thus strongly suggesting that this basalt layer at least was extrusive, and not still intruded into an existing sedimentary sequence.



SITE 343 LEG 38



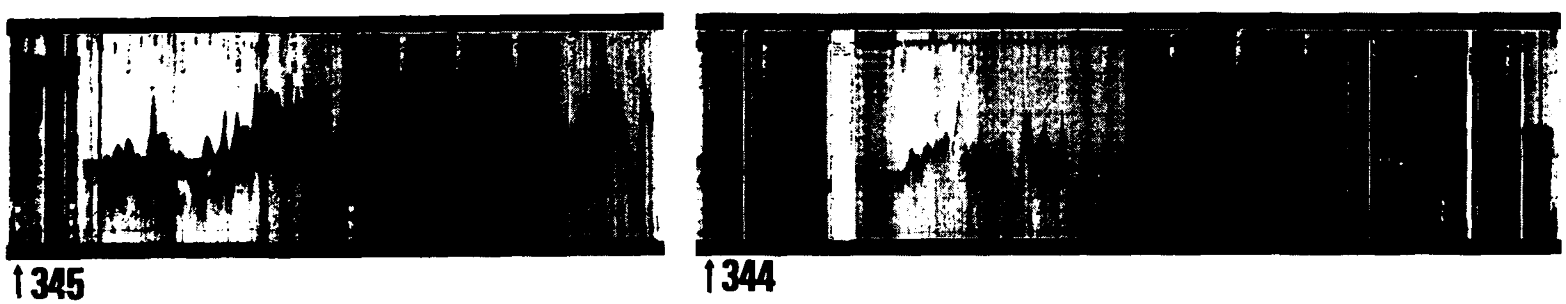
SITE DATA

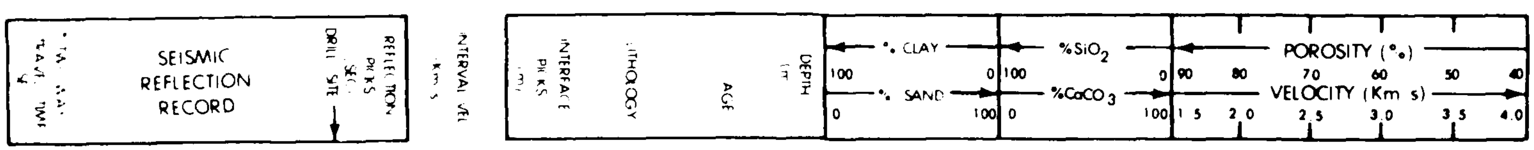
Position:
Latitude 76°09.0' N
Longitude 7°52.5' E
Date: 08/26/74
Time: 2010Z
Water depth: 2154 meters
Location: East of Knipovich Ridge

CORE DATA

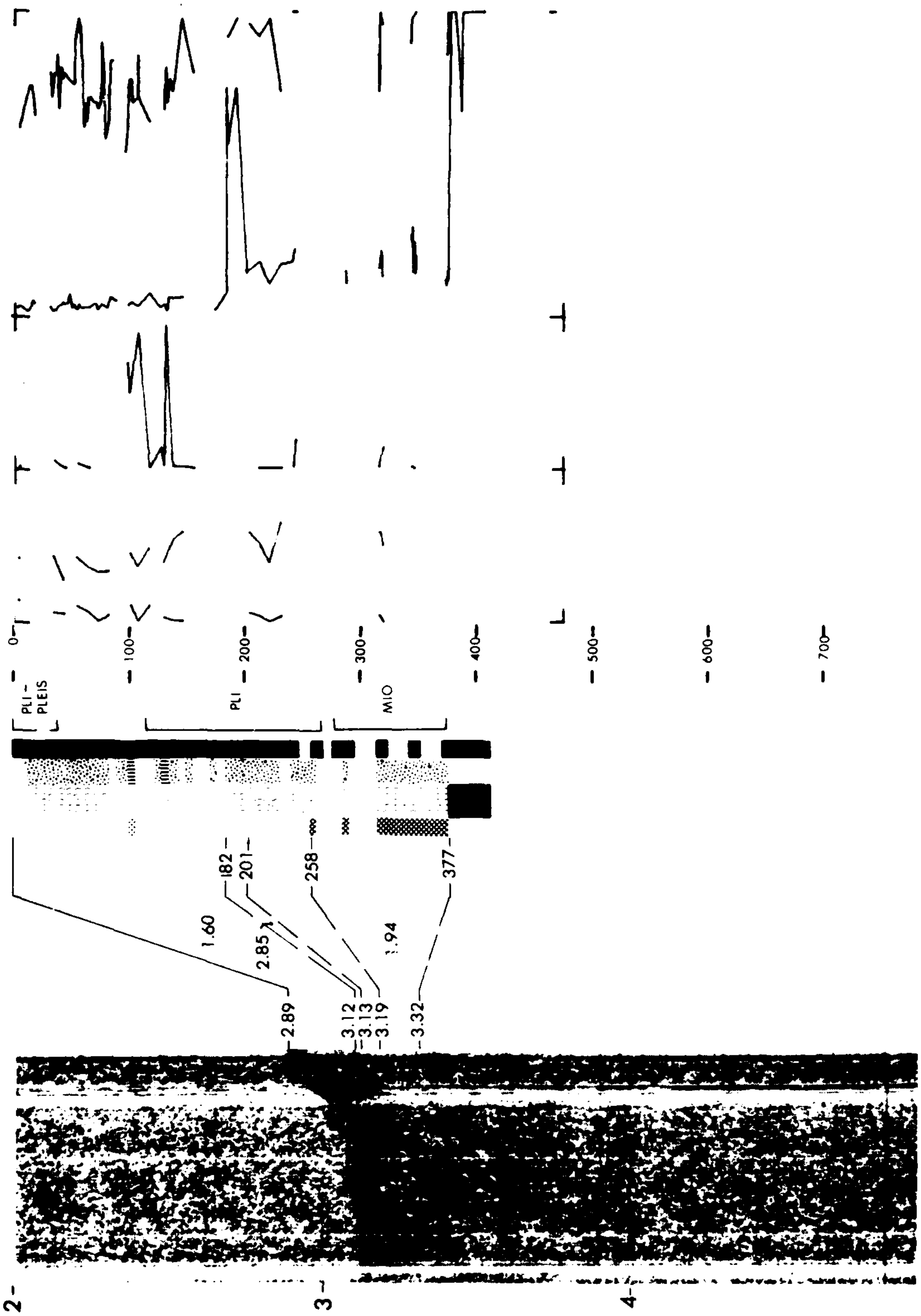
Penetration:
Drilled-- 76 meters
Cored---- 338 meters
Total---- 414 meters
Recovery:
Basement- 4 cores
19 meters
Total---- 37 cores
140 meters

The following history of sediment accumulation is suggested: deposition commenced with the turbidites (?) of Subunit 3B, above the basalt. This basalt may represent a sill, which is indicated by the baked nature of the foraminifera as well as by the relatively coarse grained texture of the igneous rock. These "distal" turbidites (?) may have been initiated under periglacial conditions, because the immediately overlying Subunit 3A contains pebbles which may have been ice rafted. The nature of the finer (than granule size) sediments in Unit 3, and in the entire sediment column, does not furnish positive proof for the above assumption. Neither the sediments described here nor most other glacial-marine sediments are identical to sediments carried in floating icebergs. The bulk of this sediment may have been settled out from suspensoids, which were introduced into the marine environment if not under glacial, at least under periglacial (?) conditions. The variable sediments of Unit 1 are interpreted as being deposited during a changing glacial regime. Therefore, the sediments in Subunit A may perhaps reflect the existence of waxing and waning major continental ice sheets.





SITE 344 LEG 38



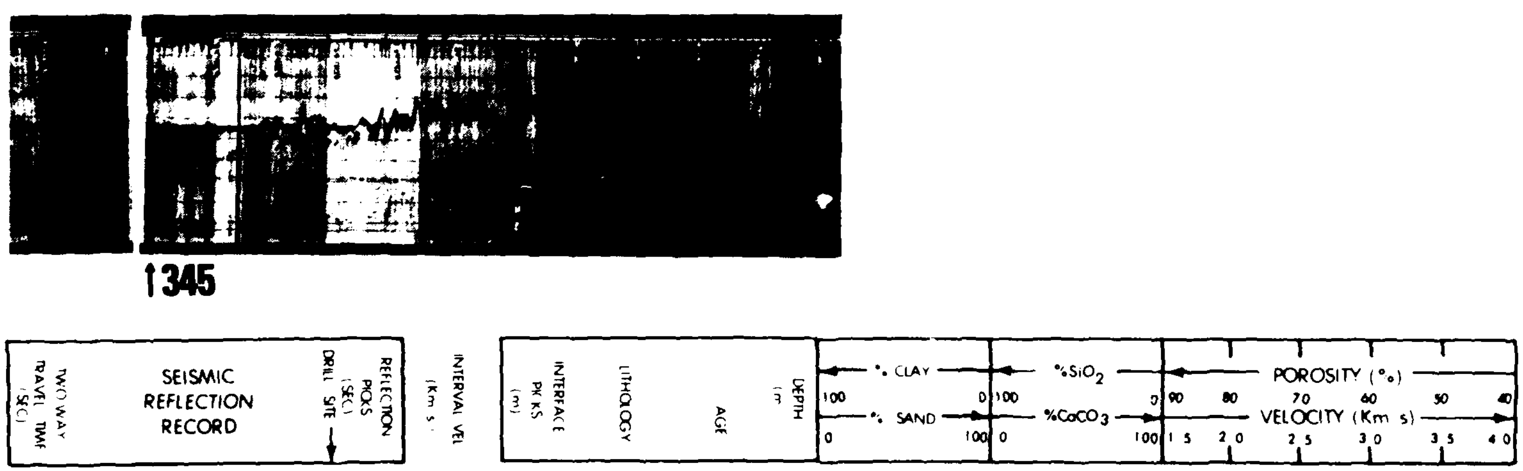
SITE DATA

Position:
Latitude 69°50.2' N
Longitude 1°14.3' W
Date: 09/01/74
Time: 0818Z
Water depth: 3195 meters
Location: Base of Mohns Ridge

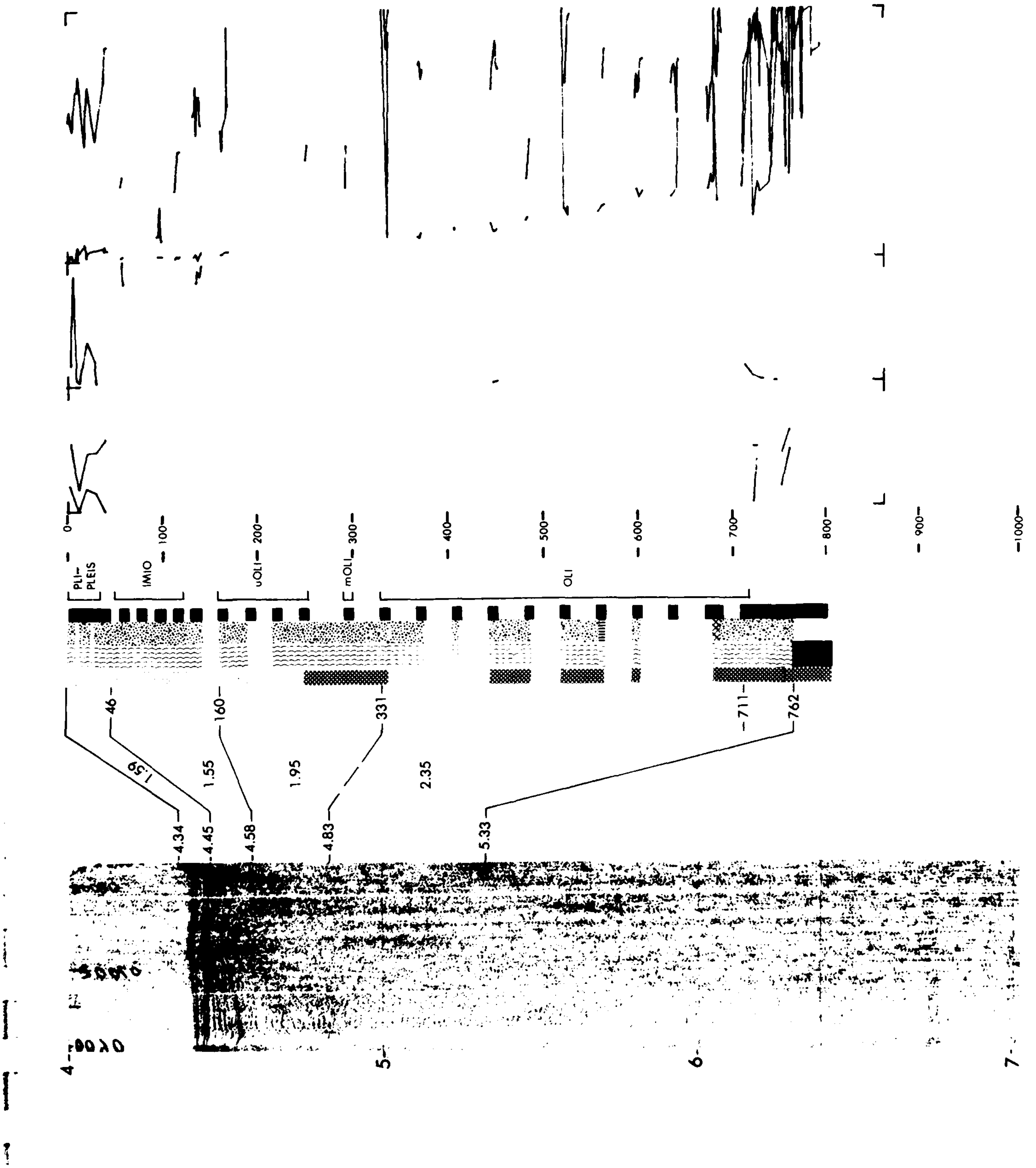
CORE DATA

Penetration:
Drilled-- 466 meters
Cored---- 336 meters
Total---- 802 meters
Recovery:
Basement- 4 cores
9 meters
Total---- 36 cores
189 meters

The reddish-brownish pebbly mudstones and diamictites above the basaltic basement are interpreted as slump or similar deposits, transported and deposited mainly by gravity. These pebbly mudstones and diamictites are overlain by a series of turbidites, indicating either increasing water depth, increased distance from the source, reduced transport energy, or a combination of these parameters. Extensive bioturbation in the fine-grained rocks above each turbidite unit indicates quiet water conditions between the occurrences of turbidity currents. The number of total thicknesses of turbidites apparently disminshes from Subunit 3B into the upper portions of Subunit 3A. Volcanic ash contributed to the sediment make-up through "Unit 3 time." The trend to quiet-water conditions continued into Unit 2 time. Subunit 2a, of lower Miocene age or upper Oligocene age shows a continuation of quiet water conditions. Clays predominate; volcanic ash is also present. Unit 1 is an accumulation of glacial-marine sediments, of Holocene to Plio-Pleistocene age. The base of this unit (Core 5) is of early Miocene age thus perhaps signaling the initiation of glacial-marine sedimentation during the Miocene, i.e., prior to about 5 m.y. ago.



SITE 345 LEG 38



SITE DATA

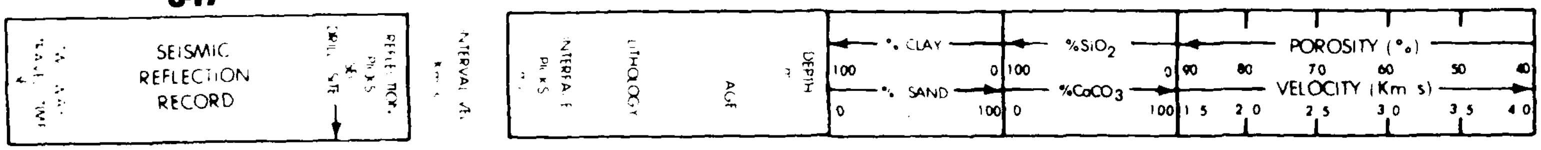
Position:
Latitude 69°53.3' N
Longitude 8°41.1' W
Date: 09/06/74
Time: 0450 Z
Water depth: 732 meters
Location: Jan Mayen Ridge

CORE DATA

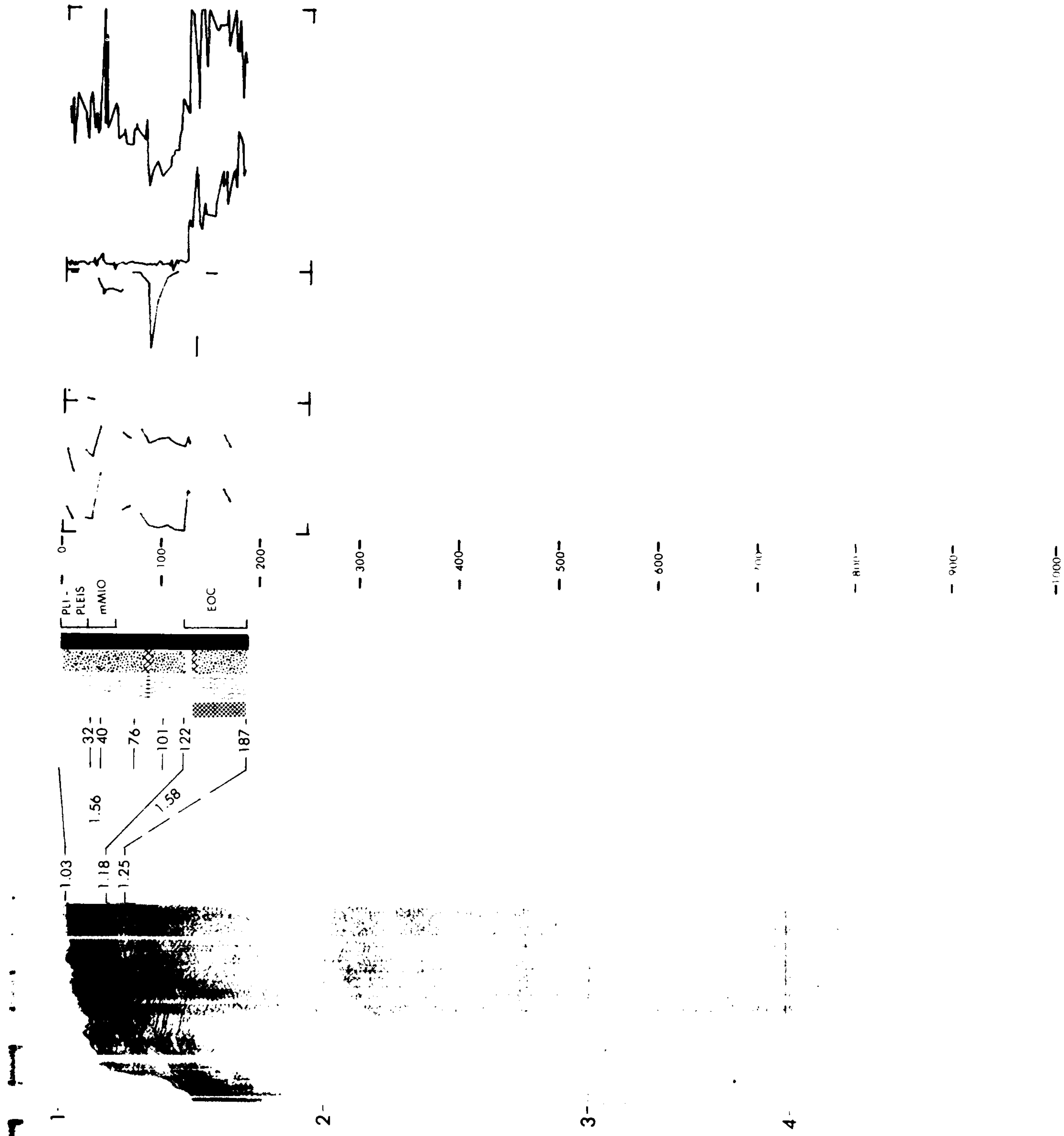
Penetration:
Drilled-- 0 meters
Cored---- 187 meters
Total---- 187 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 20 cores
120 meters

The Plio-Pleistocene sandy mud and mud of Subunit 1A are presumably of glacial-marine origin, but include minor contributions from pelagic organisms such as calcareous nannoplankton and foraminifera, bottom-dwelling organisms such as sponges, diagenetic mineral alteration products such as glauconite, and volcanic ash. Local mottling of the sediments suggests the presence of bioturbation. Glauconitic sediments may represent either a hiatus in sedimentation, or an unconformity, inasmuch as this unit appears to separate Quaternary (Plio-Pleistocene) sediments above, from Miocene sediments below. The abundance of sponge remains may be related to cold marine waters, a suitable growth environment, or conditions that were unattractive to other fauna. The sediments are locally intensely mottled, indicating abundant organic reworking and probably accumulated in a relatively shallow environment. Unit 3 is generally similar to Subunit 2B, but does not contain sponge spicules or other biogenic material. It is lithified, and the boundary between it and Subunit 2B may represent an unconformity. The increasing abundance of graded beds downward within Unit 3 may suggest deposition at deeper marine environments.

↑346
347



SITE 346 LEG 38



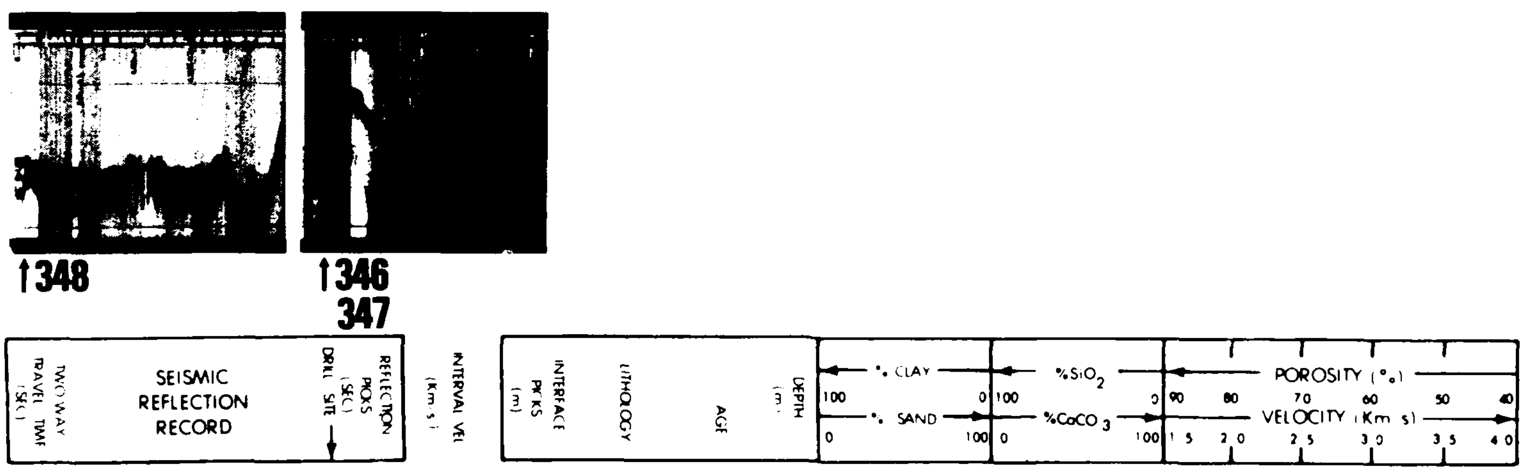
SITE DATA

Position:
Latitude 69°52.3' N
Longitude 8°41.8' W
Date: 09/07/74
Time: 1802Z
Water depth: 745 meters
Location: Jan Mayen Ridge

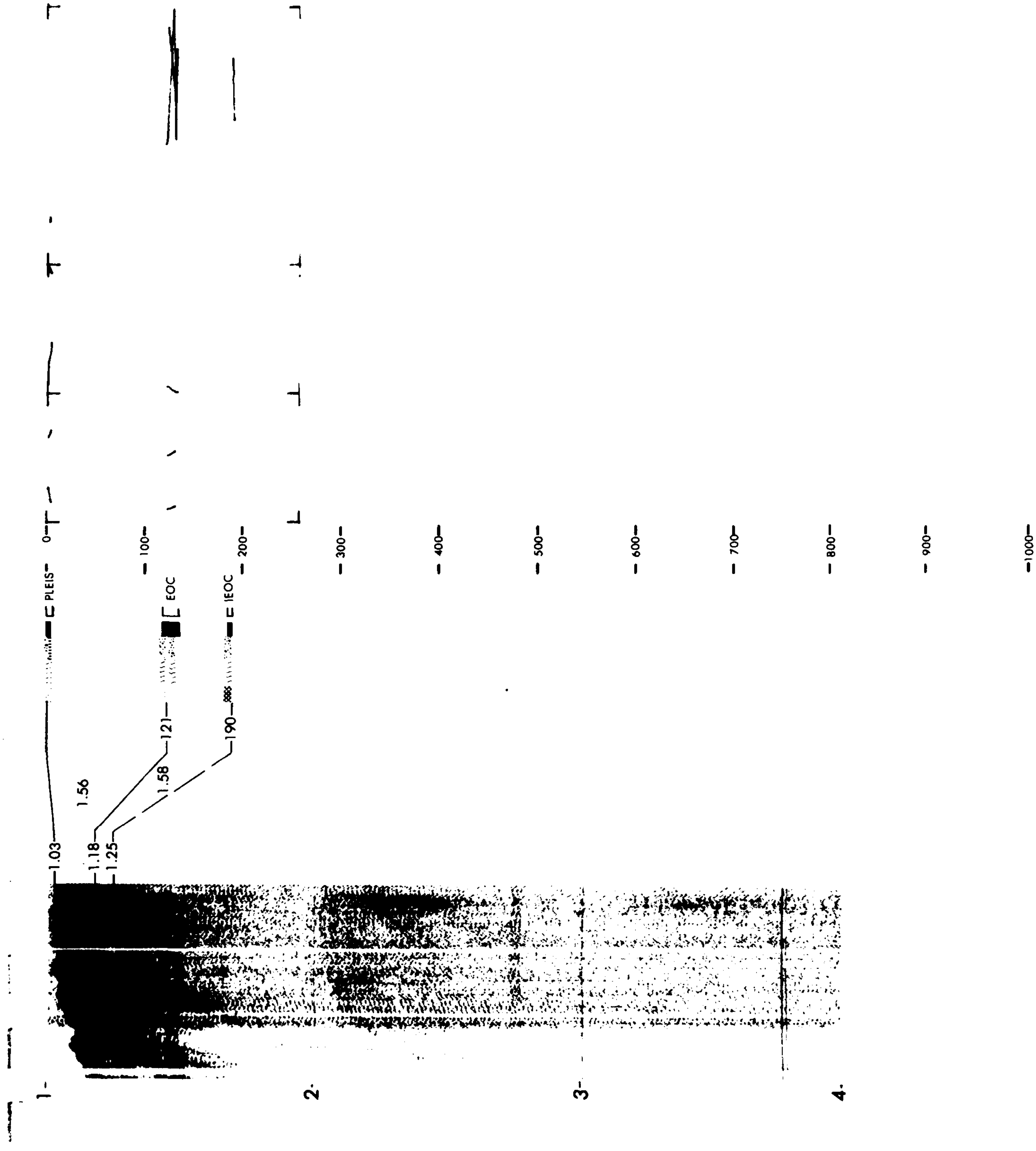
CORE DATA

Penetration:
Drilled-- 66 meters
Cored---- 24 meters
Total---- 190 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
1[illegible] meters

Unit 1 appears to represent Quaternary sedimentation on top of the Jan Mayen Plateau. The muds may represent glacial-marine ice-rafted sedimentation or glacial-marine sediments reworked by current activity or deposit-feeding organisms on top of the plateau. The underlying transitional biogenic siliceous oozes of Unit 1 may represent hemipelagic sedimentation between episodes of glacial-marine sedimentation. The reasons for the presence of the transitional biogenic calcareous nannofossil ooze in the upper few meters of this site, as opposed to its absence at Site 346, is not known. Unit 2 consists of an apparently thick sequence of massive mudstones and sandy mudstones that are very comparable to similar strata in Unit 3 at Site 346. The extensive bioturbation of Unit 3 may suggest a slow sedimentation rate, and the possible presence of a turbidite unit may indicate deposition in relatively deep water. However, the source and direction of transport of the sands and fine rounded lithic pebbles are not known.



SITE 347 LEG 38



SITE DATA

Position:
- Latitude 68°30.2' N
- Longitude 12°27.7' W

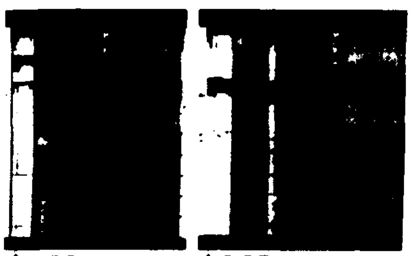
Date: 09/09/74
Time: 1221Z
Water depth: 1763 meters
Location: Icelandic Plateau

CORE DATA

Penetration:
- Drilled-- 228 meters
- Cored---- 316 meters
- Total---- 544 meters

Recovery:
- Basement- 3 cores, 8 meters
- Total---- 34 cores, 214 meters

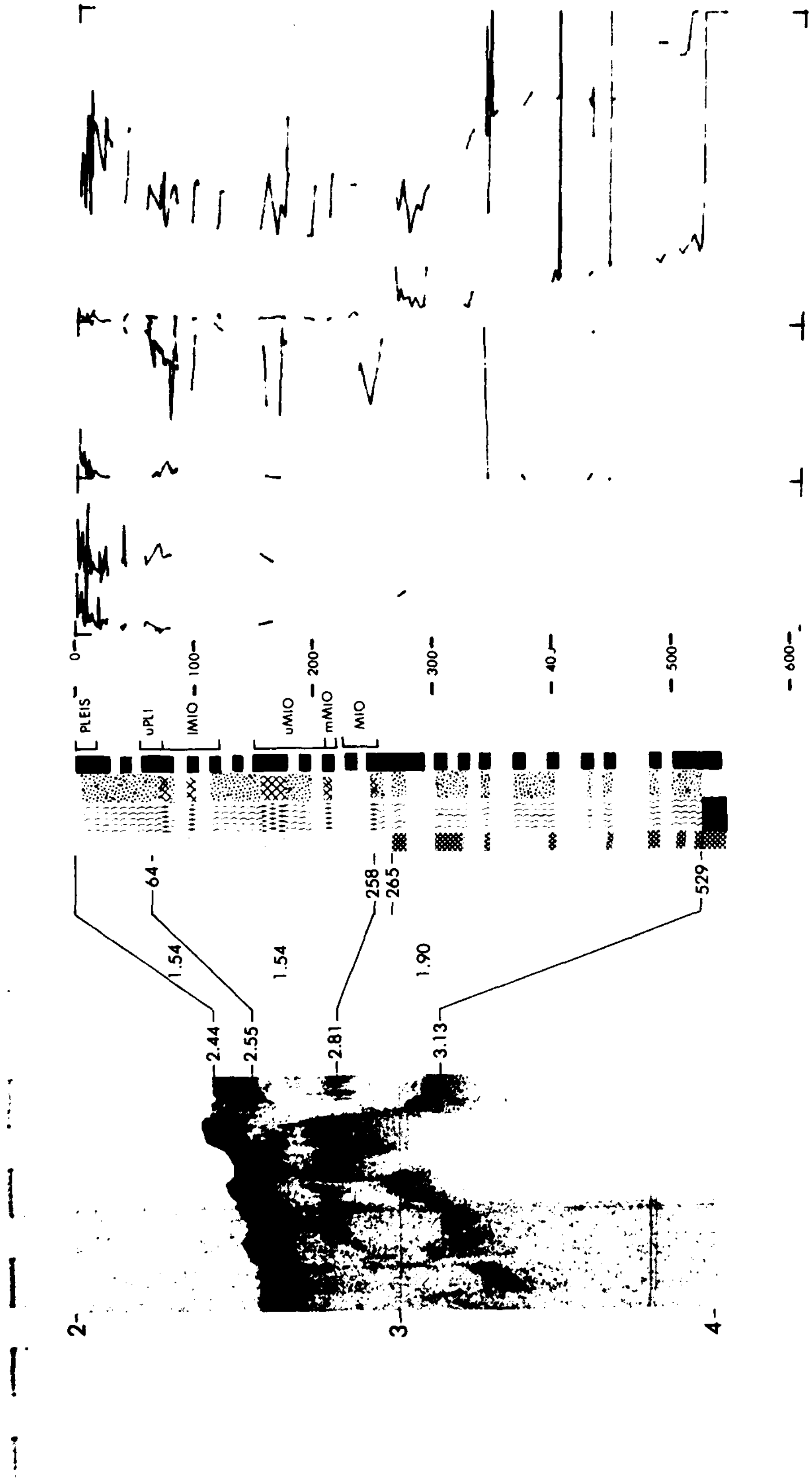
The glacial-marine and pelagic sediments of Unit 1 probably record both glacial, interglacial, and postglacial sedimentation. Because of the extensive core deformation in these uppermost soft sediments, and the unknown extent of biogenic reworking, the sedimentary history as indicated by the cores is not too reliable. Coarse clastic detritus, presumably ice-rafted volcanic material, could have been derived from Iceland or adjacent suboceanic volcanos. The progressive downward fining in average grain size indicates gradation into underlying Unit 2. Unit 2 represents a long history of probably slow hemipelagic sedimentation with persistant contributions of volcanic materials. Siliceous organisms are numerically dominant over calcareous ones, except for some thin nannofossil oozes in the upper part. Unit 3 represents deposition of terrigenous sediments at probably relatively slow rates of sedimentation and reasonably deep water, although the lack of sedimentary structures and stratification severely restricts the interpretation of depositional processes, environments, and bathymetry. Extensive bioturbation, worm tubes, and pyrite nodules suggest slow rates of sedimentation under reducing conditions.



↑349 ↑348

TWO-WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE →	INTERVAL VEL (Km/s)	INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	% CLAY 100–0 / % SAND 0–100	% SiO_2 100–0 / % $CaCO_3$ 0–100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 348 LEG 38



SITE DATA

Position:
- Latitude 69°12.4' N
- Longitude 8°05.8' W

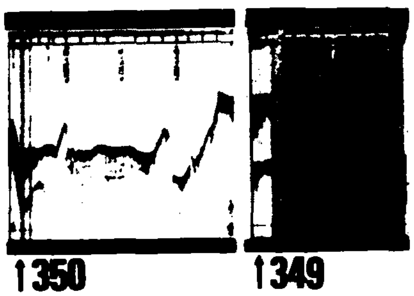
Date: 09/13/74
Time: 0950Z
Water depth: 915 meters
Location: Jan Mayen Ridge

CORE DATA

Penetration:
- Drilled-- 199 meters
- Cored---- 120 meters
- Total---- 319 meters

Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 13 cores
- 81 meters

Unit 1 presumably represents glacial-marine sedimentation during the late Cenozoic, but may include postglacial Holocene sediments. The transition downward to Unit 2 is marked by the presence of abundant volcanic ash, the first appearance of significant amounts of glauconite, color change from yellowish-brown to greenish-gray, relatively abundant sponge spicules, changing amounts and types of biogenic constituents, and sharp changes in cohesiveness and other physical properties. The boundary appears to be adjacent to an unconformity separating Pleistocene and Oligocene sediments. The lack of sorting and current-formed structures probably indicates the absence of strong current activity. Presumably, hemipelagic sedimentation and reworking, as well as erosion of older strata may have supplied most of the detritus. The boundary between Units 2 and 3 is marked by a basal conglomerate that separates older lithified strata from younger unconsolidated sediments. There is no indication of subaerial weathering or erosion. Unit 3 represents a complex sedimentary facies, including pebbly mudstones, sandstones, turbidites, and hemipelagic sediments.

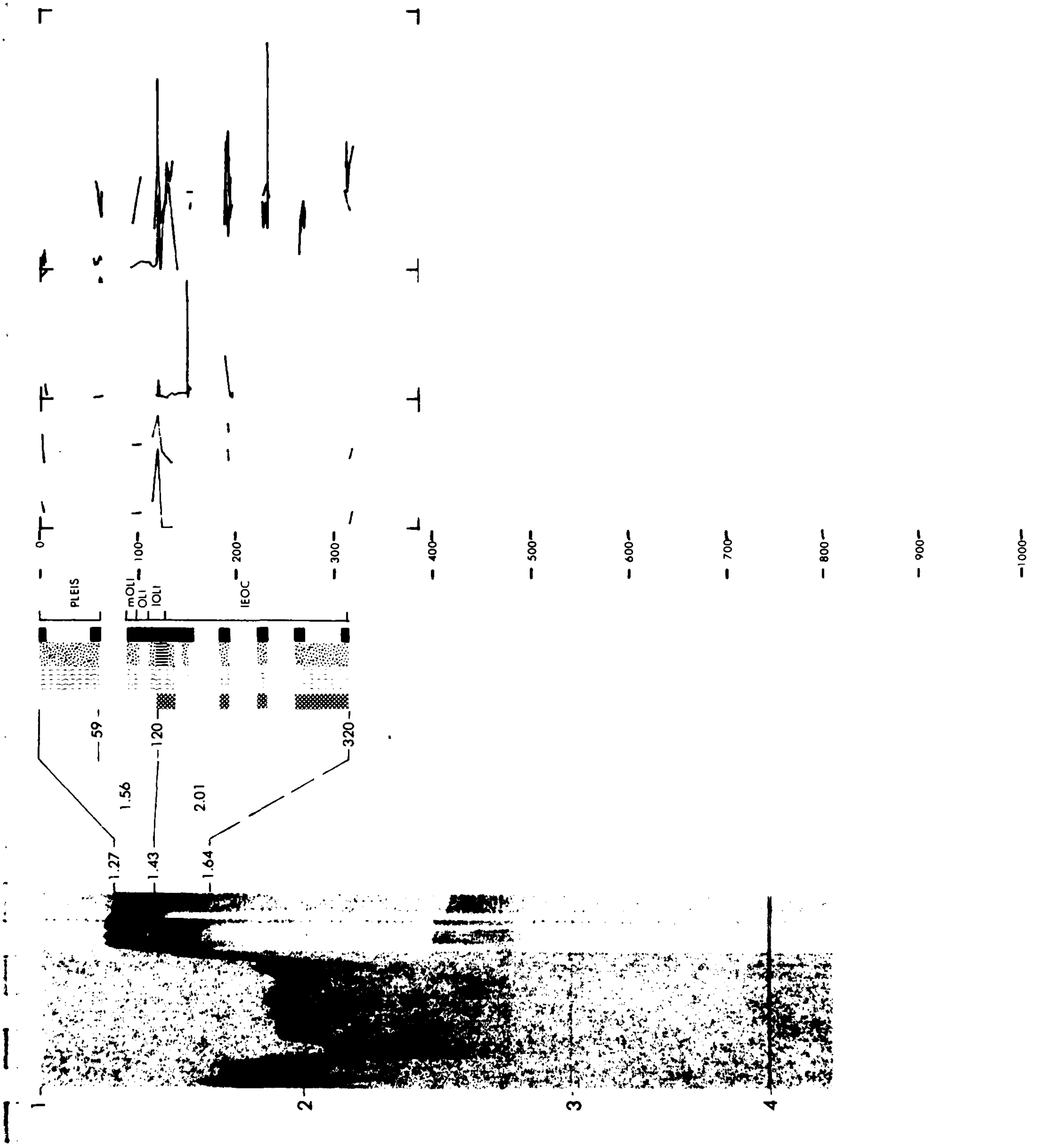


SEISMIC REFLECTION RECORD

INTERVAL VEL Km/s

INTERFACE PICKS | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100–0 / % SAND 0–100 | %SiO$_2$ 100–0 / %CaCO$_3$ 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 349 LEG 38



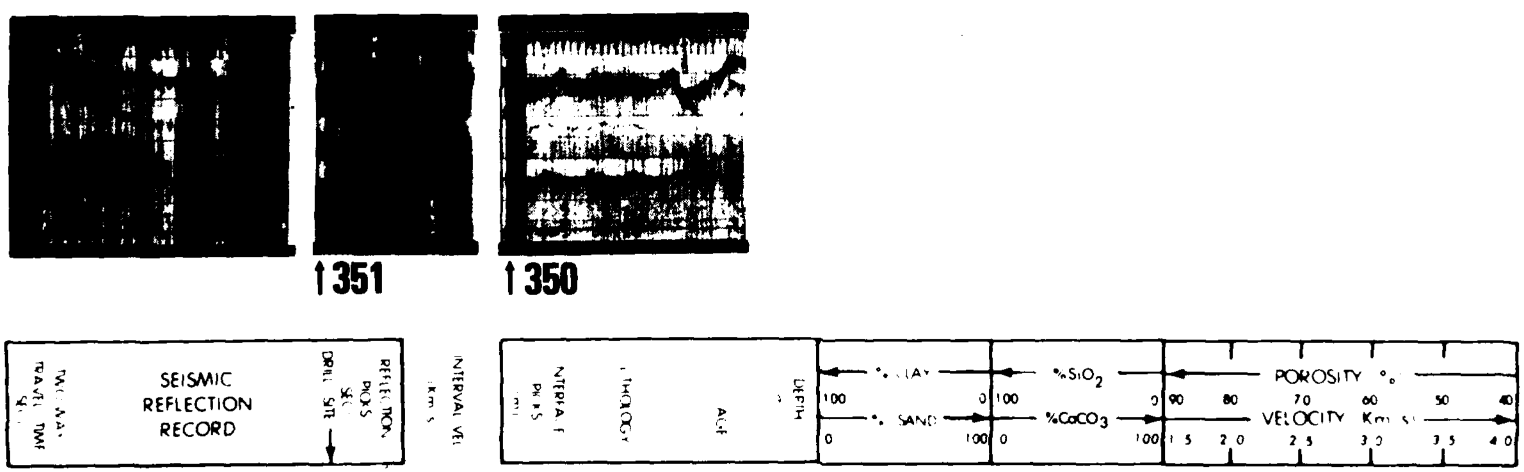
SITE DATA

Position:
    Latitude $67^{o}03.3'$ N
    Longitude $8^{o}17.7'$ W
Date: 09/15/74
Time: 1153Z
Water depth: 1275 meters
Location: Ridge south of Jan Mayen Ridge

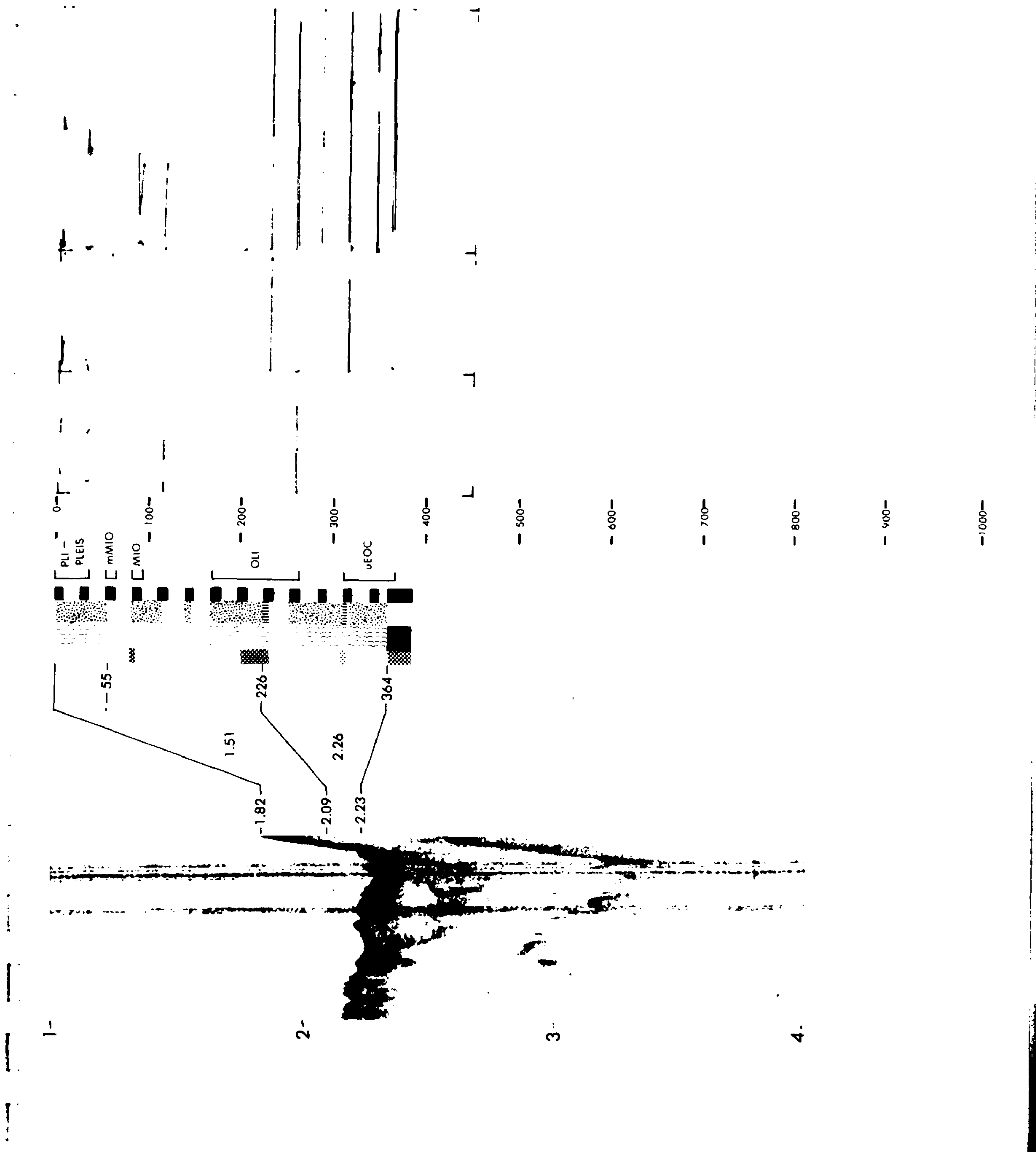
CORE DATA

Penetration:
    Drilled-- 230 meters
    Cored---- 150 meters
    Total---- 388 meters
Recovery:
    Basement- 2 cores, 4 meters
    Total---- 16 cores, 49 meters

The sequence begins in the Eocene with breccias above the basalt, interpreted as slump deposits to be succeeded by "proximal" turbidites, "grain-boundary-flow" deposits, and similar sediments of Unit 3, all of which indicate a relative proximity to the sediment source. The environment of deposition is interpreted to have been a steep submarine slope, perhaps in the vicinity of a submarine canyon. Limestones in this sequence are perhaps oozes, originally deposited on the upper parts of a "continental" slope, above the CCD, redeposited by turbidity currents, broken during transport, and recrystallized after deposition. In Oligocene time terrigenous sediments continued to be deposited, but turbidity currents became *less frequent and changed in character* to "distal" deposits. Bioturbation indicates that quiet-water conditions prevailed, and unbiquitous pyritization suggests that reducing conditions existed below the life zone of the burrowing organisms. The influx of terrigenous materials in Unit 1 was strong because of continental-glacial conditions which prevailed through much of this time on the surrounding land masses. Volcanism played an important role as sediment contributor, and continued to do so up to the present time.



SITE 350 LEG 38



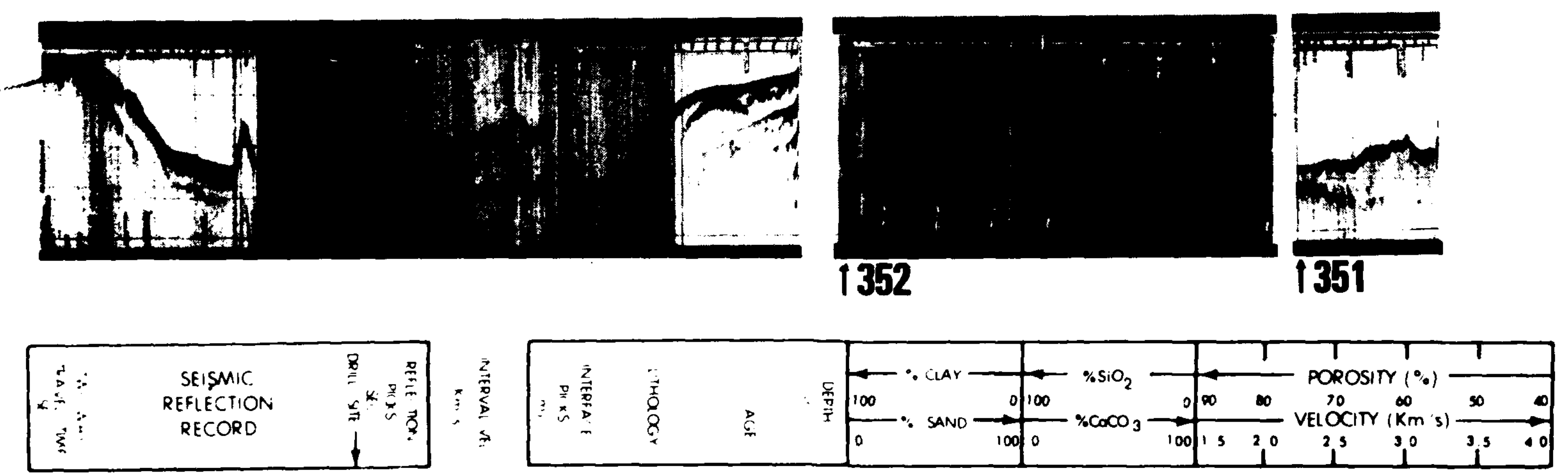
SITE DATA

Position:
Latitude 67°47.3' N
Longitude 11°18.3' W
Date: 09/17/74
Time: 0738Z
Water depth: 1844 meters
Location: Icelandic Plateau

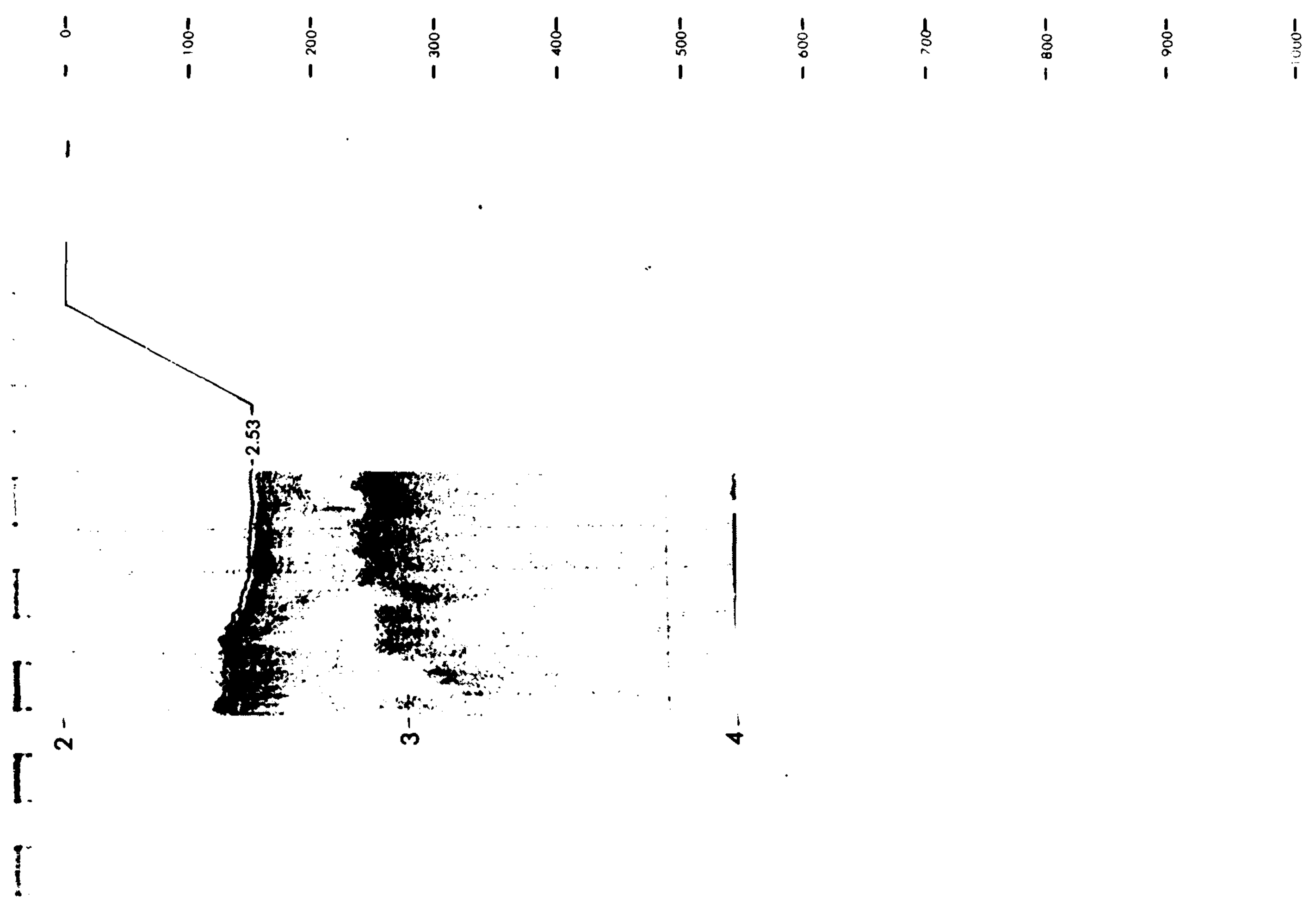
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 0 meters
Total---- 0 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 0 cores
0 meters

Site 351 was occupied for 5.5 hr on 17 September 1974. However, continuing and deteriorating weather conditions prevented the hole from being drilled.



SITE 351 LEG 38



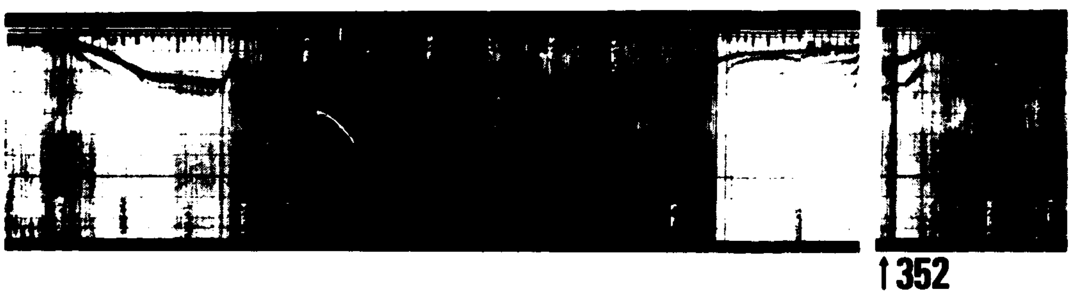
SITE DATA

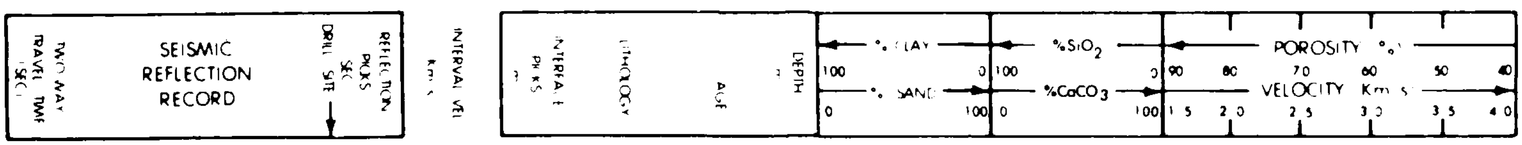
Position:
Latitude 63°39.0'N
Longitude 12°28.3'W
Date: 09/19/74
Time: 0330Z
Water depth: 990 meters
Location: Iceland-Faeroe Ridge

CORE DATA

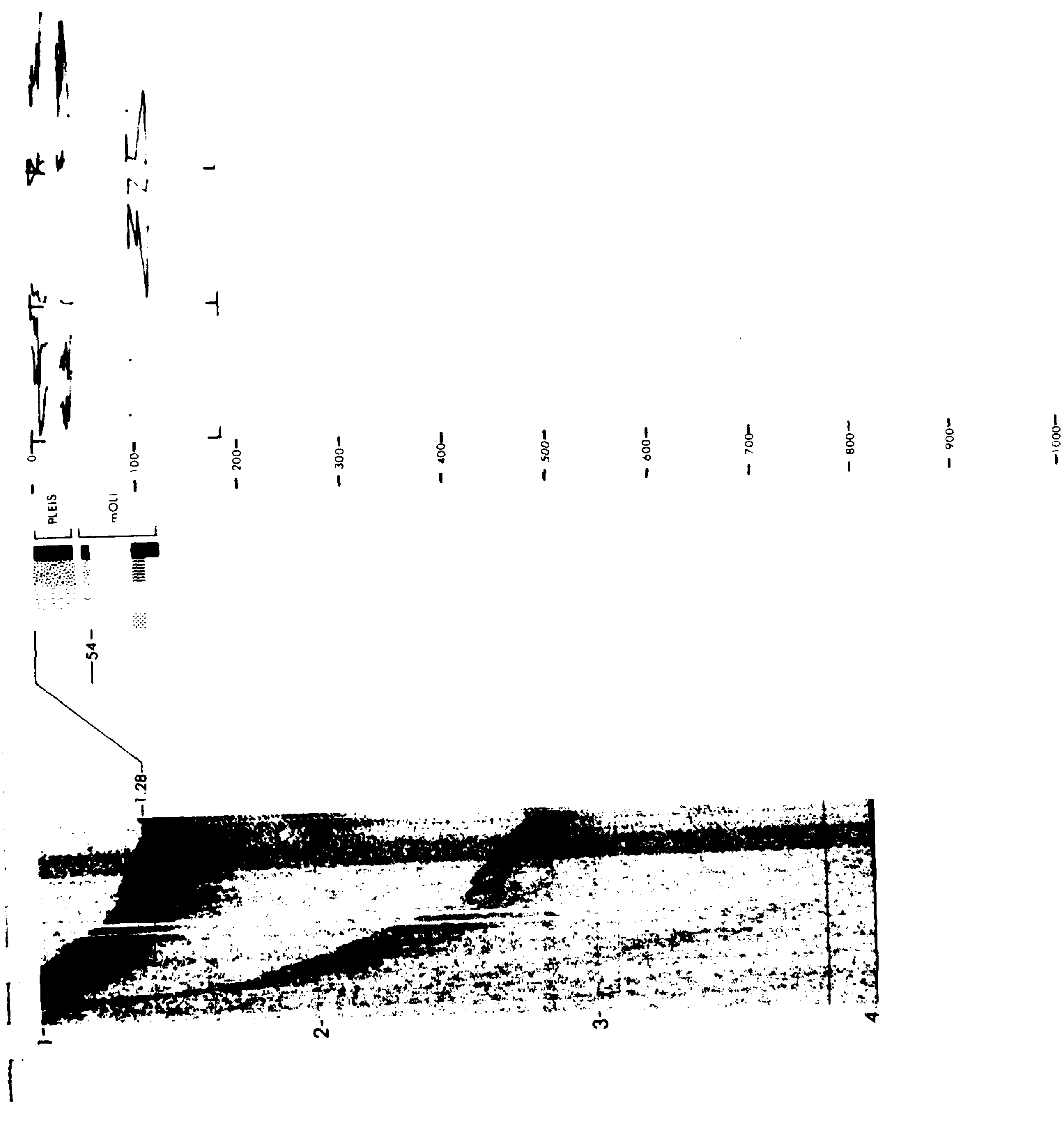
Penetration:	352	352A	
Drilled--	57	94	meters
Cored----	46	28	meters
Total----	103	122	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	6	3	cores
	26	5	meters

The nannofossil ooze (Unit 2) indicates dominant biogenic pelagic sedimentation during middle-late (?) Oligocene time. Associated foraminifera indicate bathyal depths. A short period of volcanic activity in the area (Iceland) is indicated by the ash and palagonite of Core 3, Section 2. Extensive bioturbation in Core 3, Section 2, and to some degree in Core 3, Section 1 indicates a bottom environment and a sedimentation rate conducive to bottom dwelling organisms. A probable late (?) Oligocene to Pleistocene hiatus is indicated. Unit 1, the dominant sandy muds and muds, admixed with coarse pebbles represents pelagic sedimentation of terrigenous components, with contributions from ice rafting. This unit is a great deal thinner (38[?]m) than a corresponding unit found at Site 336 (168.5 m). However, it may be that bottom currents or other transfer mechanisms were more effective on the southern flank of the ridge (352) during Miocene or Pliocene and subsequently removed a large part of section or prevented deposition. The author suggests that the Iceland-Faeroe Ridge acted as a barrier against the mixing of North Atlantic and Norwegian Sea surface waters at least as late as the middle Oligocene.





SITE 352 LEG 38



SITE DATA

Position:
- Latitude 10°54.9' N
- Longitude 44°02.2' W

Date: 10/21/74
Time: 1055Z
Water Depth: 5165 meters
Location: Vema Fracture Zone

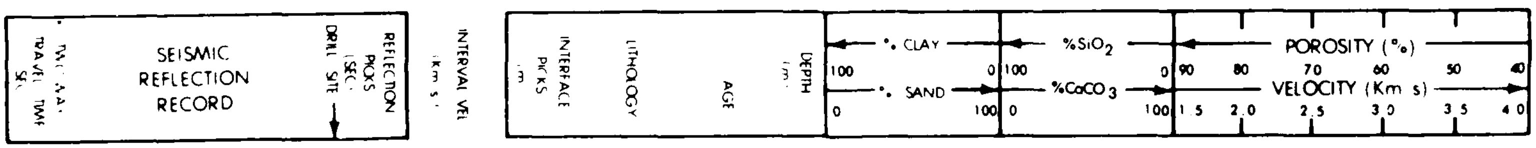
CORE DATA

	353	353A	353B	
Penetration:				
Drilled--	361			meters
Cored----	23			meters
Total----	384			meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	3	1	1	cores
	5	3	1	meters

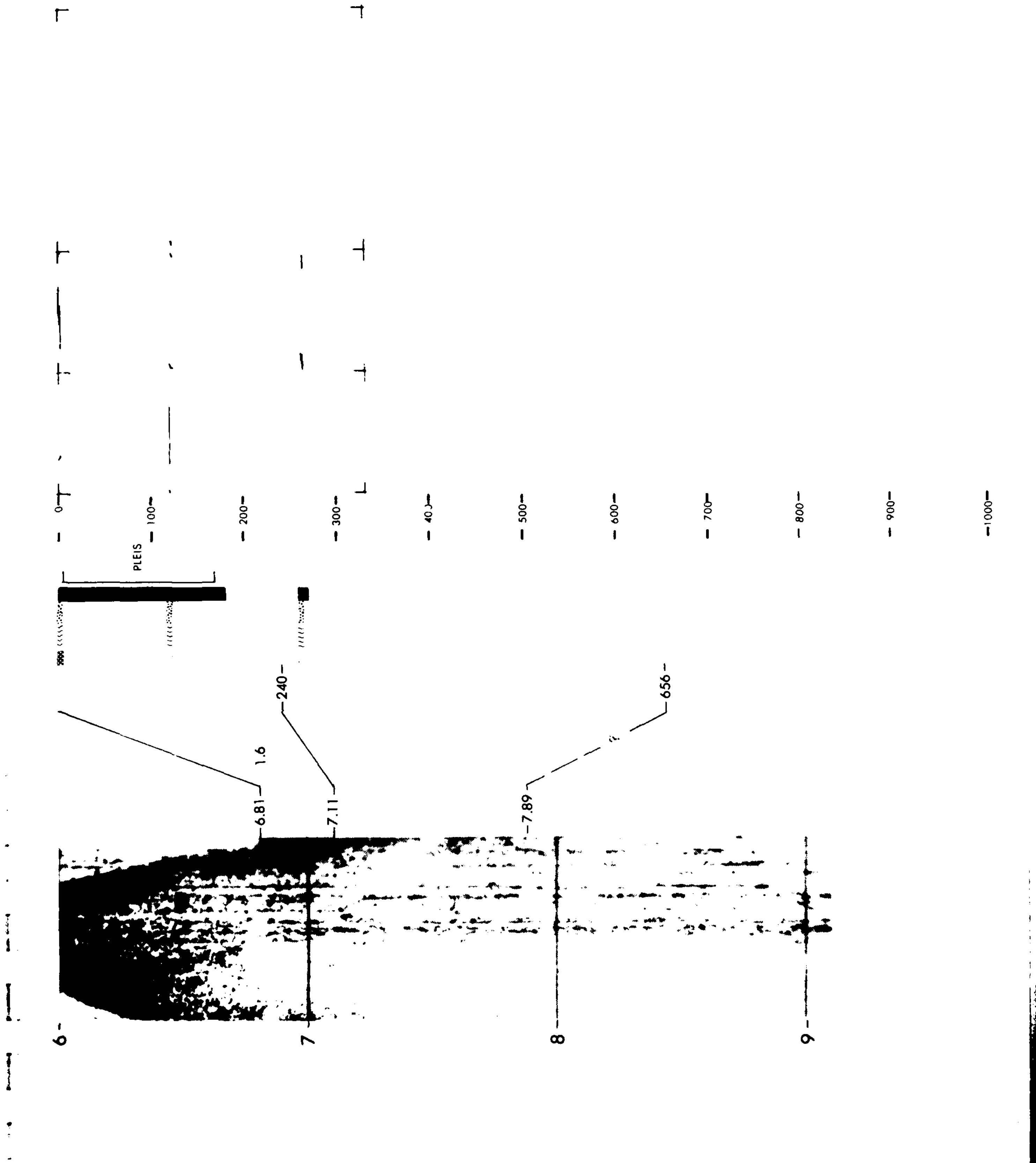
The basalt cobbles probably represent talus material, which originated from the basalt flows constituting the upper kilometer or so of the exposed crustal section on the northern wall of the fracture zone. Dredge hauls collected from the slopes of the northern wall in the vicinity of the site indicate that serpentinized periotites are exposed on the wall. It is surprising that no fragments of serpentinite or other plutonic rocks were found in the talus material drilled at Site 353. A possible explanation is that the talus from the upper basaltic portion of the northern wall is fed preferentially to the transverse valley along south-facing shallow channels or "canyons." The Vema transverse valley contains a thick sequence of Pleistocene turbidites. The assemblage shows signs of redeposition and dissolution. The mineralogy of the clastics suggests the Amazon Cone, some 500 km away, as the source of the turbidites. The presence of a mineral such as olivine and grains of basaltic glass in sediments from Site 353 indicates that a minor but significant fraction of the sediment derived locally from the walls of the Vema transverse valley.

Interbedded calcareous and detrital sediments. Calcareous sediment; nannofossil rich.

353



SITE 353 LEG 39



SITE DATA

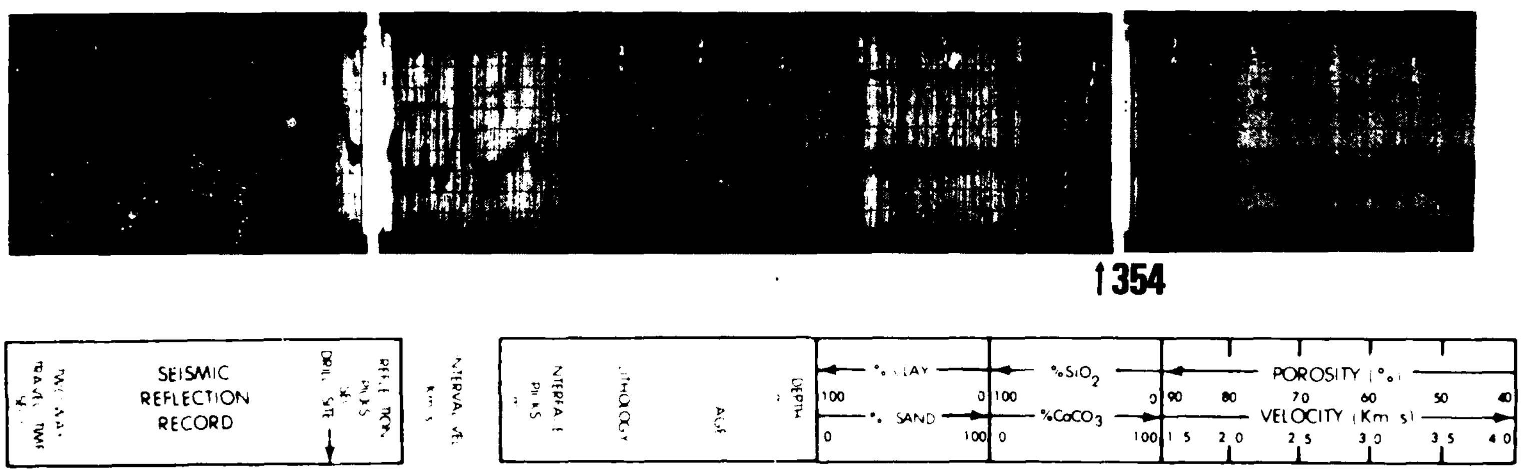
Position:
Latitude 5°53.9' N
Longitude 44°11.8' W
Date: 10/26/74
Time: 1250Z
Water depth: 4045 meters
Location: Cleara Rise

CORE DATA

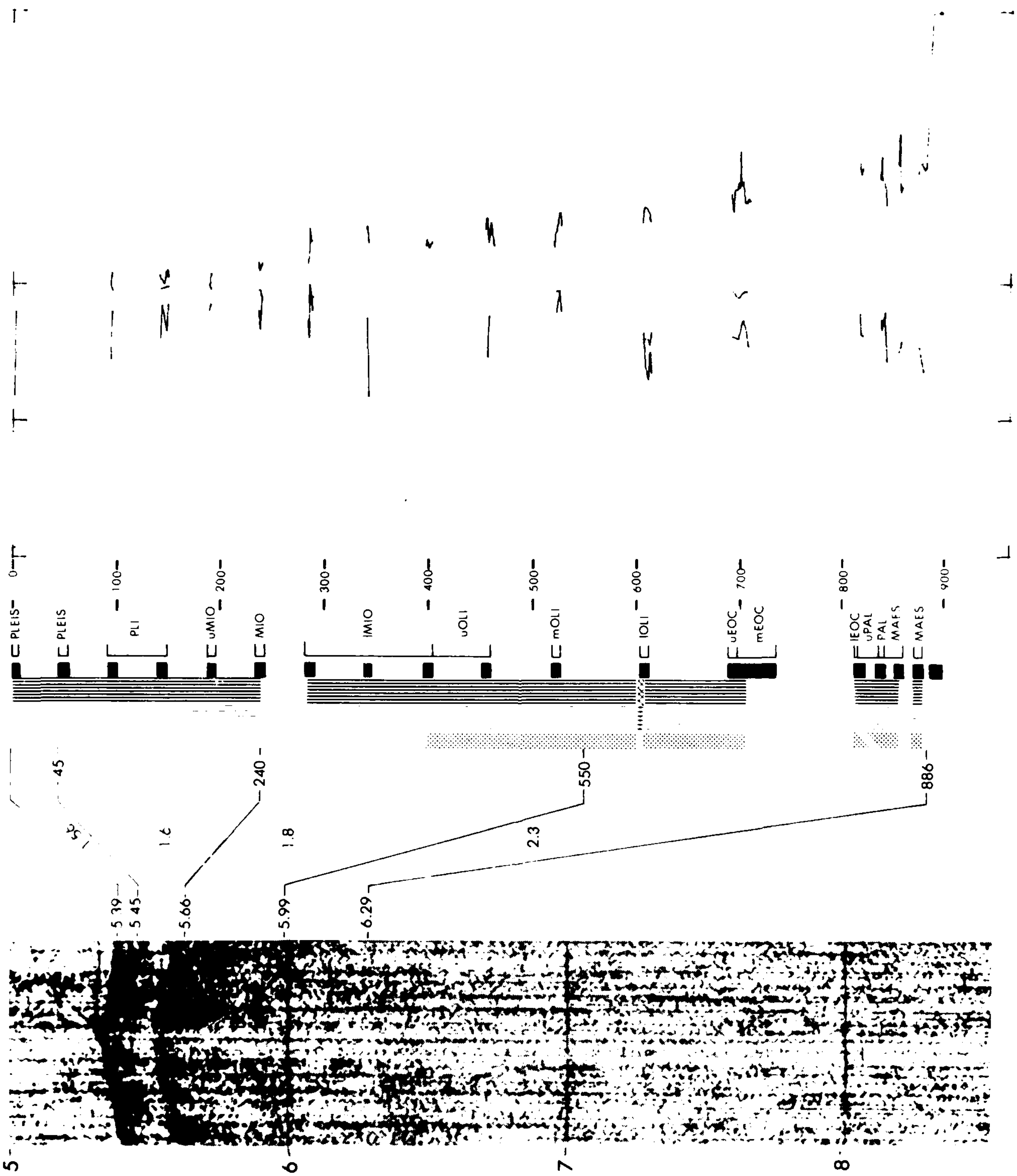
Penetration:
Drilled-- 689 meters
Cored---- 211 meters
Total---- 900 meters
Recovery:
Basement- 1 cores
8 meters
Total---- 19 cores
119 meters

The basement cored at Site 354 is a diabasic basalt, the relative coarseness of which may indicate the slow cooling of a sill. Anaerobic bottom conditions existed north and south of the equatorial fracture zone area (Vema, Romanche, etc.) during the Late Cretaceous. Pelagic deposition of nannofossils and foraminifers prevailed from the middle Paleocene through the early Miocene. Periods of slow sediment accumulation, or perhaps hiatuses, are represented in the upper Maestrichtian-lower Paleocene and at the Eocene-Oligocene boundary. A short hiatus occurs in the middle Miocene. The Ceará Rise and the similar Sierra Leone Rise in the eastern Atlantic were probably formed at the Mid-Atlantic Ridge as voluminous outpourings of basaltic magma about 80 m.y.B.P. The basalt mound, after being rapidly formed rifted in two; the Ceará Rise moved west and the Sierra Leone Rise moved east, and they subsided as they moved away from the ridge. The terrigenous silt and clay represent Amazon River sediment, since the Amazon River began draining into the Atlantic Ocean in the Miocene.

Calcareous sediment, either nannofossil or foraminifera rich. One thin layer of siliceous sediment, diatom rich, occurs in lower Oligocene time.



SITE 354 LEG 39



SITE DATA

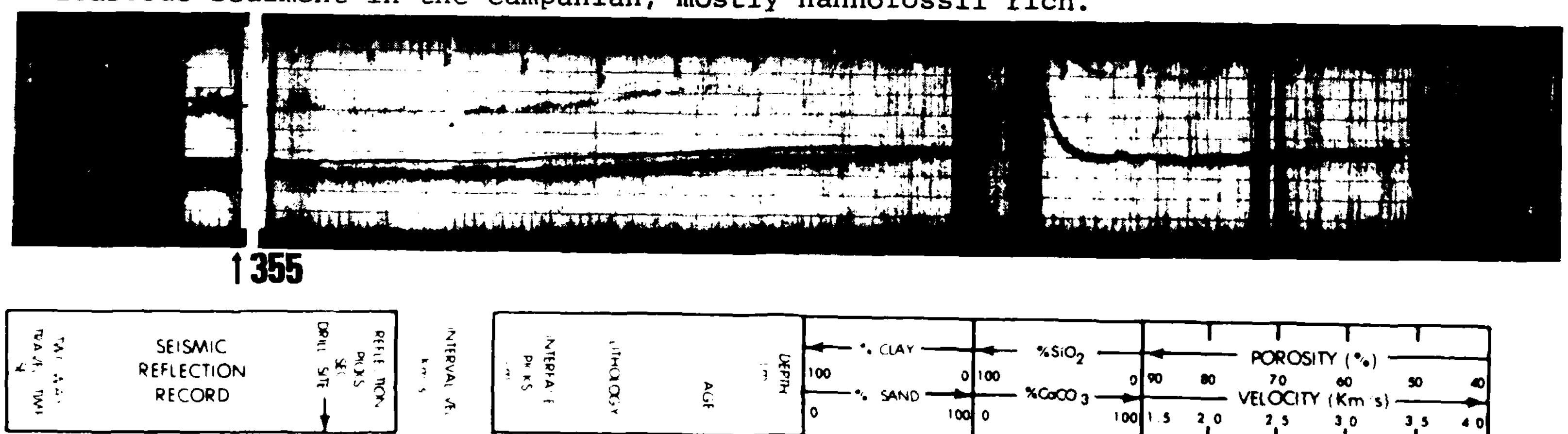
Position:
Latitude 15°42.6' S
Longitude 30°36.0' W
Date: 11/08/74
Time: 1900z
Water depth: 4901 meters
Location: Brazil Basin

CORE DATA

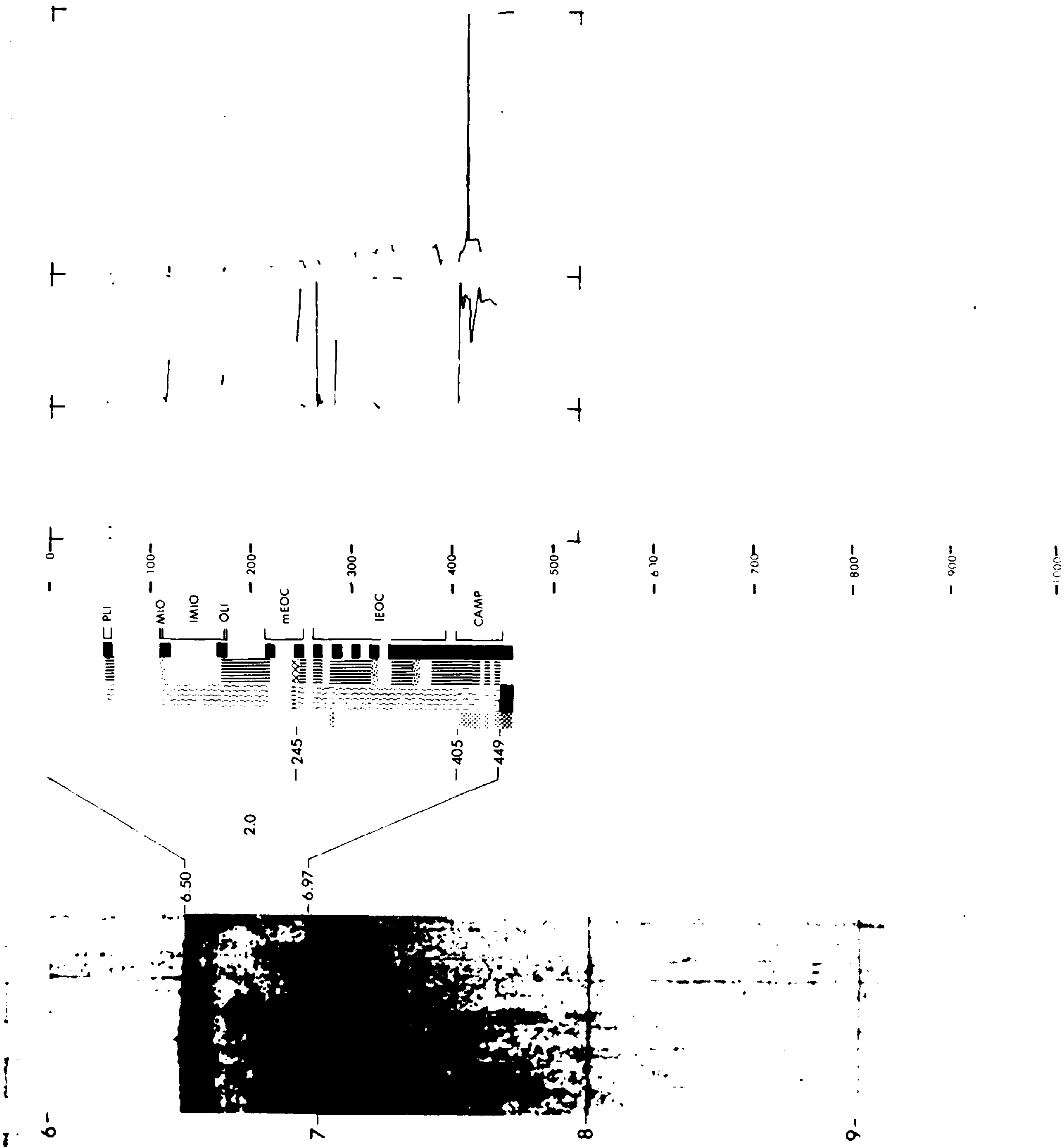
Penetration:
Drilled-- 253 meters
Cored---- 207 meters
Total---- 460 meters
Recovery:
Basement- 2 cores
3 meters
Total---- 22 cores
118 meters

The basalt cored at Site 355 is a typical ocean-ridge tholeiite. It is assumed to be a surface flow, so its age is representative of the age of ocean crust at this distance from the present mid-ocean ridge. Unconsolidated Campanian to lower Maestrichtian nannofossil ooze forms the basal sediment sequence, and numerous veins of calcite (satin spar) occur within the ooze. The veins are presumably the product of a diagenetic process associated with hydrothermal solutions which acted upon the sediments when the site was still within the region influenced by crustal generation. The lower Eocene sediments contain numerous laminae of sand and silt, which indicate a period when turbidity currents were contributing detritus. The laminae contain abundant zeolites, presumably authigenic. Siliceous organism remains occur in significant quantity in the middle Eocene. Bioclastic carbonate debris was introduced by turbidity currents in the Miocene. A mid-Miocene hiatus occurs in Core 2, a middle Eocene hiatus is probable between Cores 3 and 4, and a middle Maestrichtian-lowermost Eocene hiatus or interval of very slow sediment accumulation exists between Cores 15 and 17.

One thin layer of siliceous sediment; radiolaria rich, occurs in middle Eocene time and two thin layers of calcareous sediment, oolite rich occurs in lower Eocene time. Calcareous sediment in the Campanian; mostly nannofossil rich.



SITE 355 LEG 39



SITE DATA

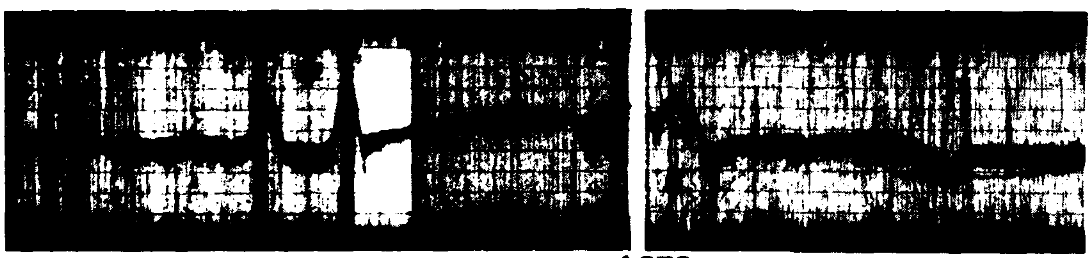
Position:
Latitude 28°17.2' S
Longitude 41°05.3' W
Date: 11/16/74
Time: 1318Z
Water depth: 3175 meters
Location: São Paulo Plateau

CORE DATA

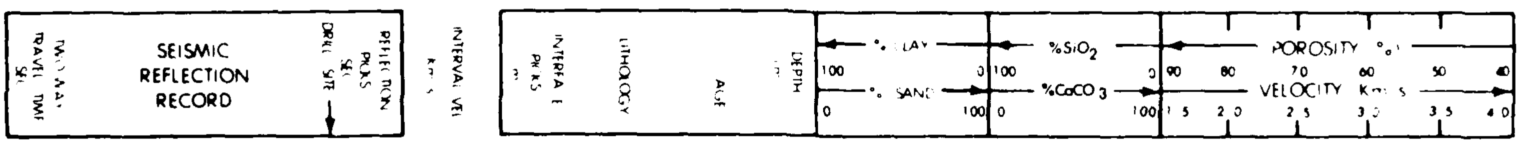
Penetration:	356	356A	
Drilled--	323	722	meters
Cored----	418	19	meters
Total----	741	741	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	44	2	cores
	316	18	meters

The marly dolomitic linestones of Unit 7 were deposited in an open marine environment. The coarse sand-sized graded layers of Unit 7 probably represent turbidites which originated at the Brazilian margin. Cores 39, 40, and 41 contain repeating sequences of black carbonaceous mudstones and gray layers of nannofossil marl. The black layers indicate reducing conditions, whereas the light gray layers were deposited under aerobic conditions. Oxidizing conditions existed in the basin during deposition of the Santonian to Maestrichtian marly chalks (Unit 5). The Cretaceous/Tertiary boundary is represented by continuous deposition. The Eocene was a time of incursion of cooler waters and of important contributions of siliceous fossil tests to the sediment. Because the transition from Unit 2 to Unit 3 is very sharp, it is probable that silica was remobilized as cement by chemical changes in the pore water. Major hiatuses cover the time span from late middle Eocene through Oligocene and late early Miocene through Pliocene. The Neogene sediments of Unit 1 are almost entirely pelagic; hence terrigenous material has not reached this site since the early Miocene.

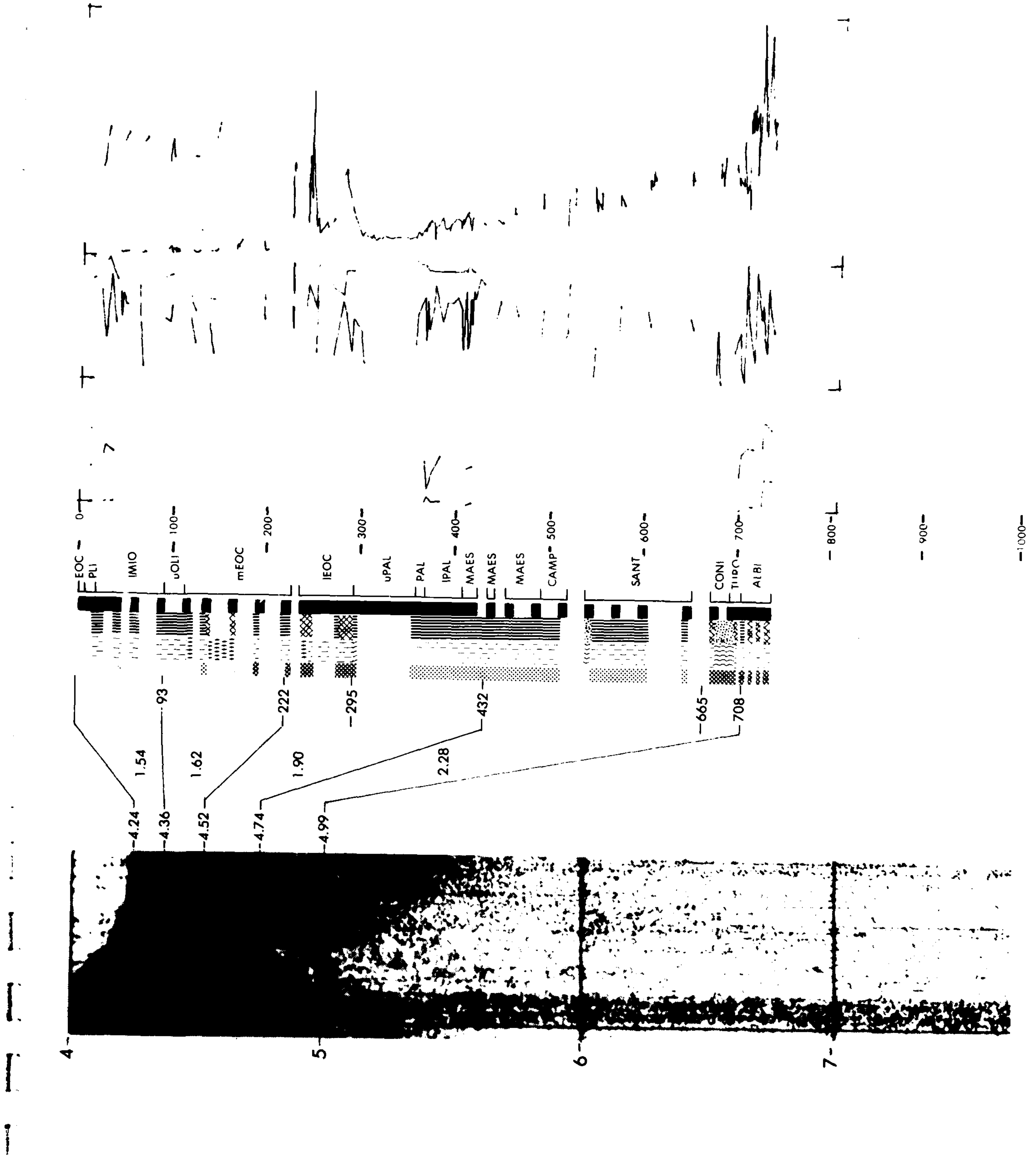
Calcareous sediment; occasionally nannofossil rich, rarely foraminifera rich, interbedded with detrital and siliceous sediments.



356



SITE 356 LEG 39



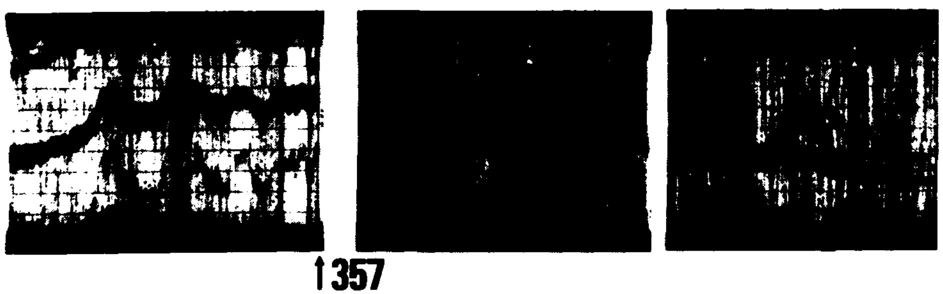
SITE DATA

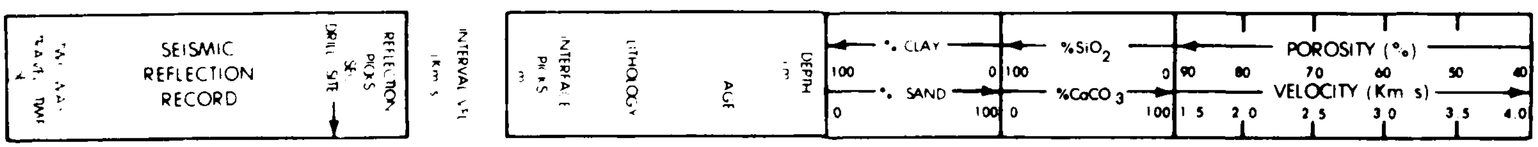
Position:
Latitude 30°00.2' S
Longitude 35°33.6' W
Date: 11/23/74
Time: 0823Z
Water depth: 2086 meters
Location: Rio Grande Rise

CORE DATA

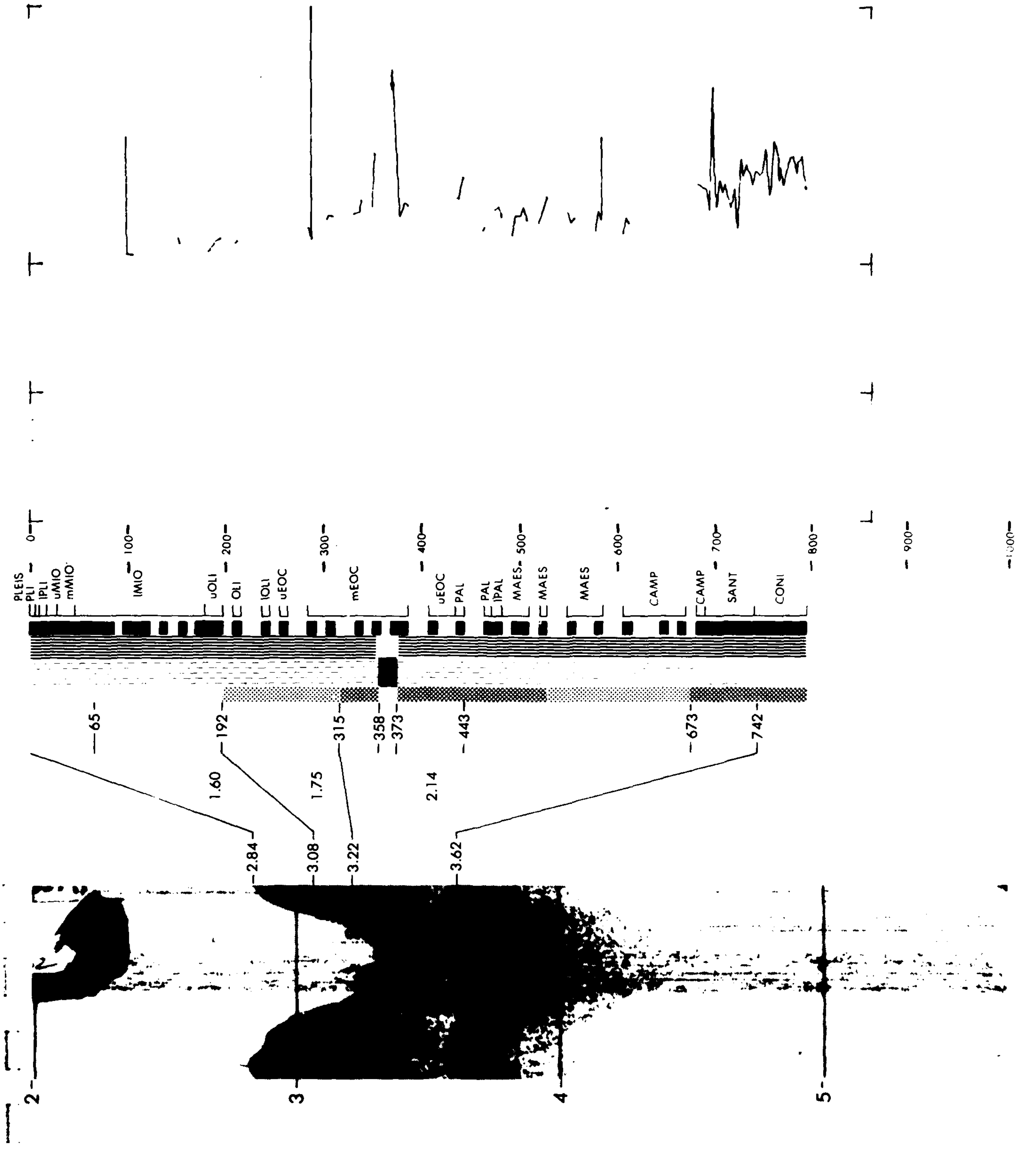
Penetration:
Drilled-- 323 meters
Cored---- 473 meters
Total---- 796 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 51 cores
345 meters

The lowermost part of Unit 5 (Cores 49-51) is marly limestone and chalk, laminated throughout, and deposited under reducing conditions that prevented almost all benthic life. In Core 49 and those above, oxidizing conditions become evident, but layers reflecting oxidizing and reducing conditions alternate. The cause of this alteration between grayish reduced sediment and brownish burrowed oxidized sediment could be variation in the rate of input of terrigenous and organic material from outside the deposition area, or fluctuation of an oxygen boundary. Unit 3 consists mainly of volcanic breccia, graded in size, but relatively homogenous in composition. Since its grain size decreases gradually upward through the whole unit, this breccia probably represents only one short depositional event. The dolostone below and above the volcanic breccia seems genetically related to deposition of the volcanic components. Unit 2 is made up of limestone, chalk, and oozes; the degree of consolidation and/or recrystallization increases down the unit, from almost-soupy ooze to limestone. The sediments of Unit 1 represent pure calcareous pelagic deposits in a subtropical ocean.





SITE 357 LEG 39



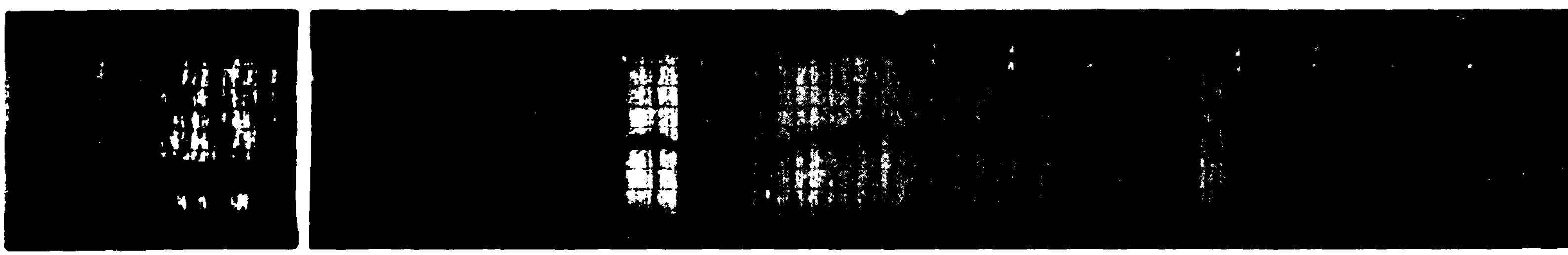
SITE DATA

Position:
Latitude $37^{\circ}39.3'$ S
Longitude $35^{\circ}37.8'$ W
Date: 11/30/74
Time: 0702Z
Water depth: 4962 meters
Location: Argentine Basin

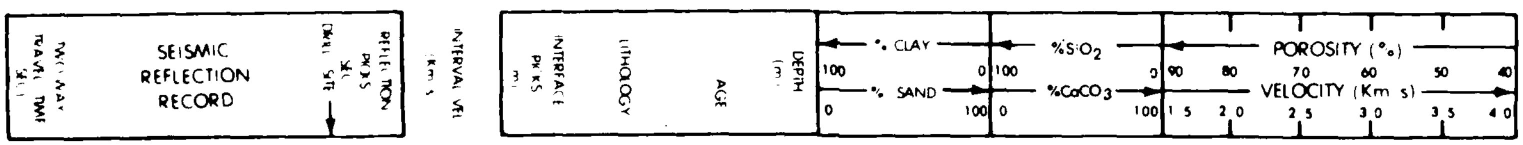
CORE DATA

Penetration:
Drilled-- 690 meters
Cored---- 152 meters
Total---- 842 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 16 cores
89 meters

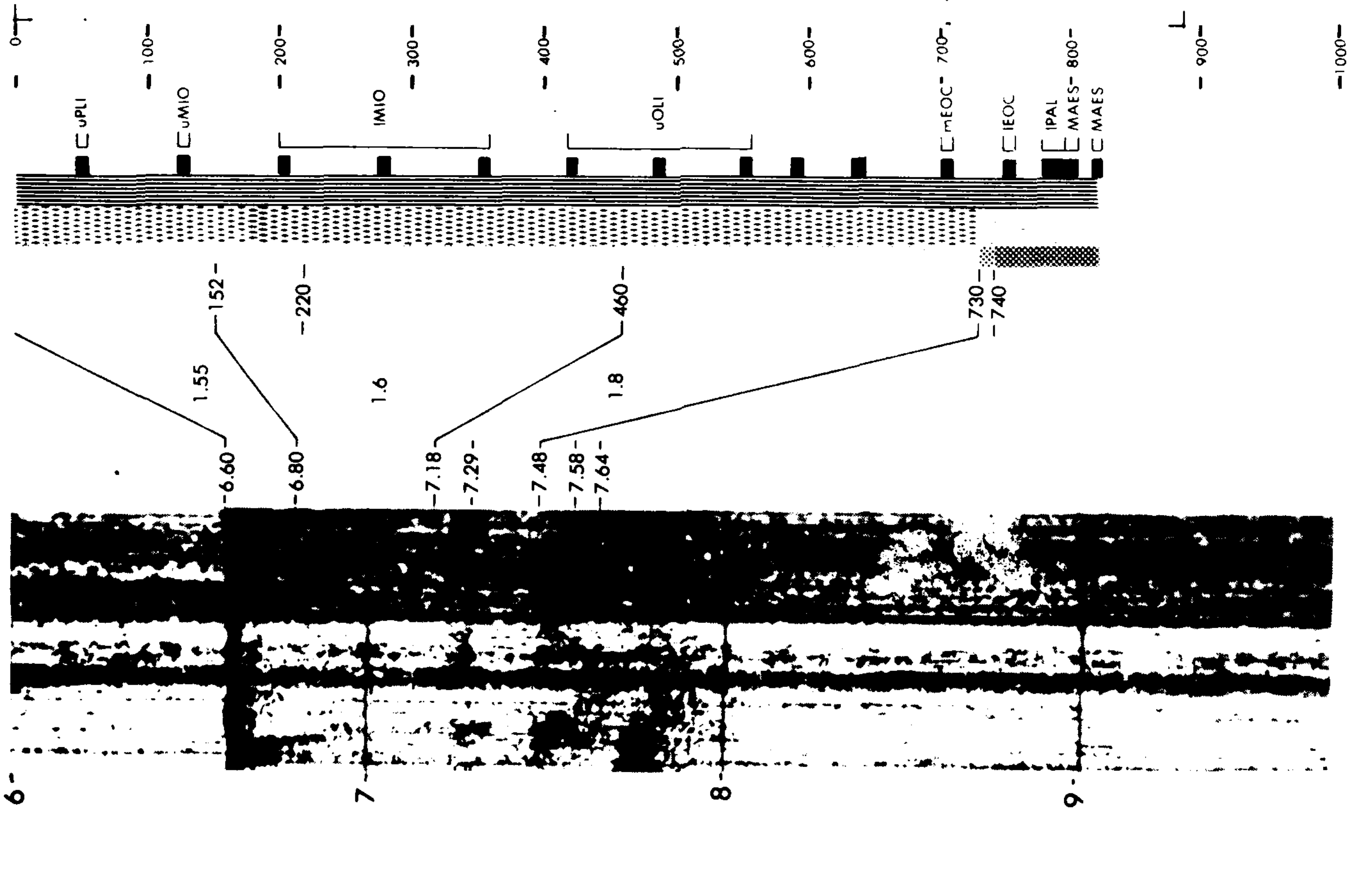
The lowermost sediments (chalks and mudstones) seem to be intimately interbedded and mixed. They are predominantly reddish brown in the lower portion; indistinct blue-green areas and bands become more prevalent in the upper portion. The alternating sequence of chalks and mudstones in Unit 2 implies a depositional surface approximately coincident with the CCD. Occasional fluctuations of the CCD are represented by alternating carbonate-rich or -poor sediments. The slow rate of accumulation suggests a basin with weak circulation and with increasingly open marine conditions as the basin developed. The siliceous and biogenic siliceous mudstones of Unit 1 represent deposition below the CCD. The relatively high rates of accumulation imply that they are not pure dissolution facies, but rather the result of high productivity of siliceous organisms and perhaps introduction of terrigenous components by currents. The Unit 1 sediments show no current structures and are fine grained. This is as expected, since the site is in the eastern part of the Argentine Basin, an area presently under the weak eastern arm (south-flowing) of the Argentine Bottom Gyre where fine-grain deposition from nepheloid layers is occurring.



358



SITE 358 LEG 39



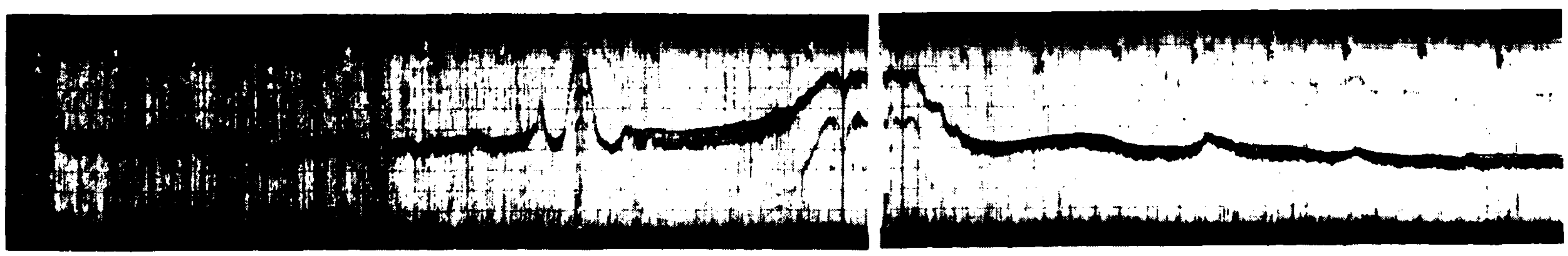
SITE DATA

Position:
Latitude $34^{o}59.1'$ S
Longitude $4^{o}29.8'$ W
Date: 12/10/74
Time: 1520 z
Water depth: 1655 meters
Location: Walvis Ridge Seamount

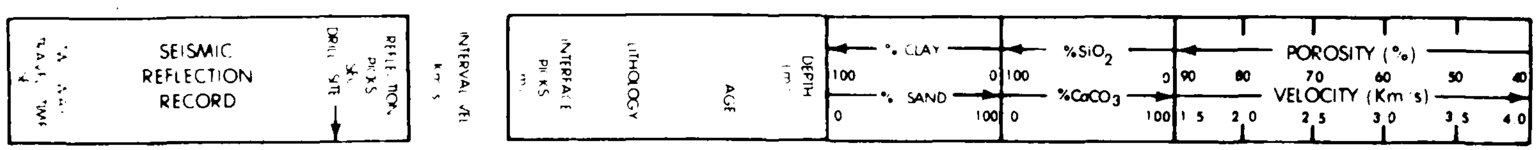
CORE DATA

Penetration:
Drilled-- 57 meters
Cored---- 50 meters
Total---- 107 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 8 cores
27 meters

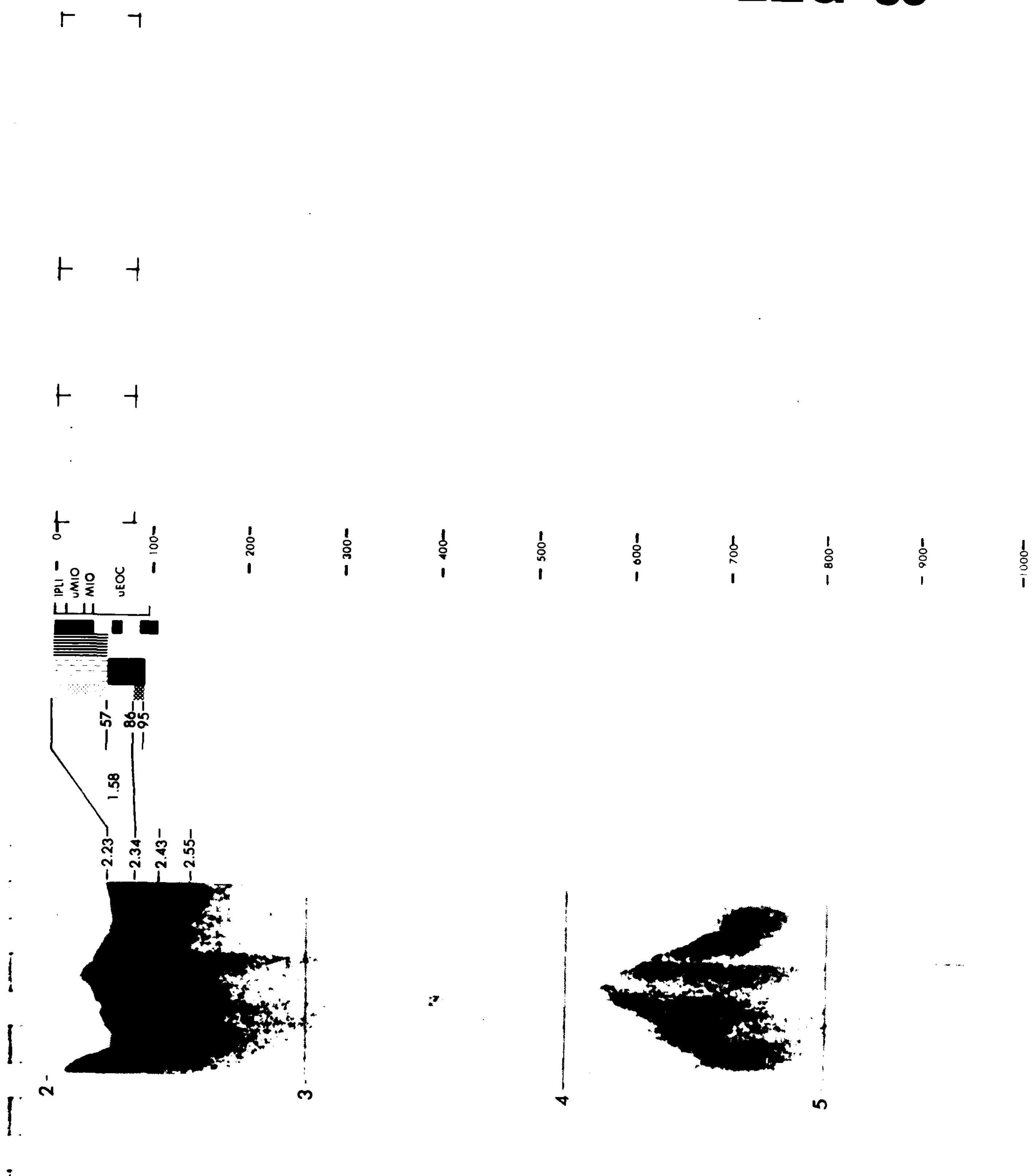
Site 359 ash flow may have been subaerially emplaced. This, if so, would imply either that any sediments underlying the tuff are nonmarine or that the seamount was tectonically raised above sea level between deposition of such sediments and deposition of the tuff. The tuff is overlain by calcareous volcanic mud of roughly the same age (late Eocene). Overlying upper Eocene biogenic oozes contain no volcaniclastic components; this indicates that volcanic activity ceased before the end of the Eocene. At a spreading rate of 2 cm/yr, the seamount would have moved laterally away from the spreading center a distance of 200-300 km before volcanic activity ceased; this implies that an active magma chamber was entrained beneath the seamount for at least 10 m.y. The major upper Eocene-middle Eocene hiatus within the pelagic ooze sequences may be a consequence of nondeposition, erosion by currents, or slumping. It is of local importance only. The uppermost nannofossil and foraminifer oozes have been intensively winnowed. Heavy overgrowth on both foraminifers and nannofossils are qualitative indicators of high $CaCO_3$ mobility in the interstitial waters of these sediments.



359



SITE 359 LEG 39



SITE DATA

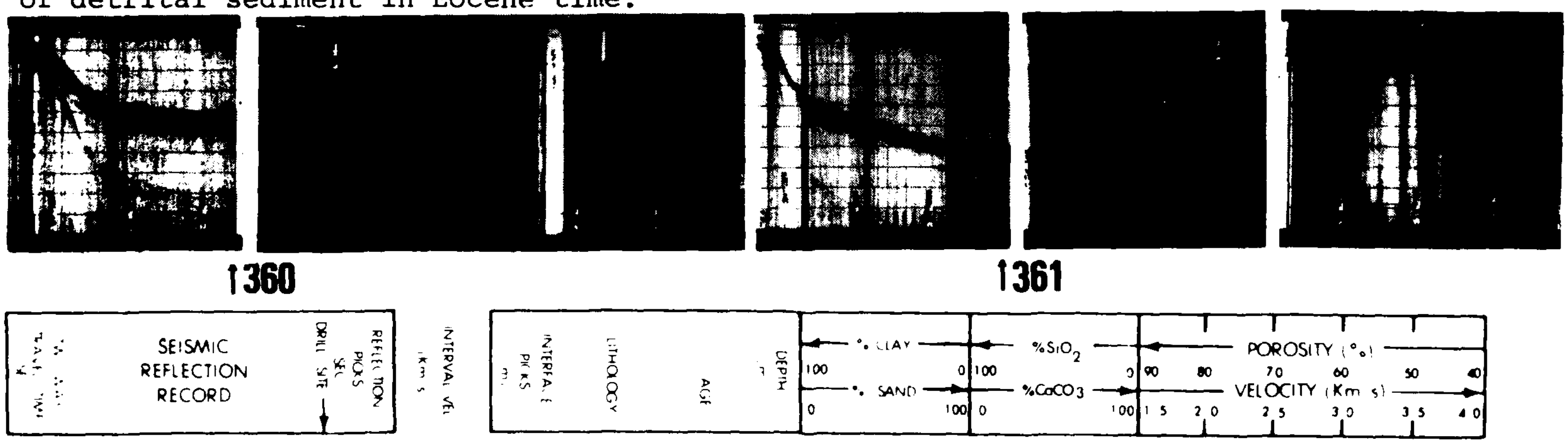
Position:
Latitude 35 °50.7' S
Longitude 18 °05.8' E
Date: 12 /20/74
Time: 21.35 Z
Water depth: 2949 meters
Location: Cape Basin
Continental Rise

CORE DATA

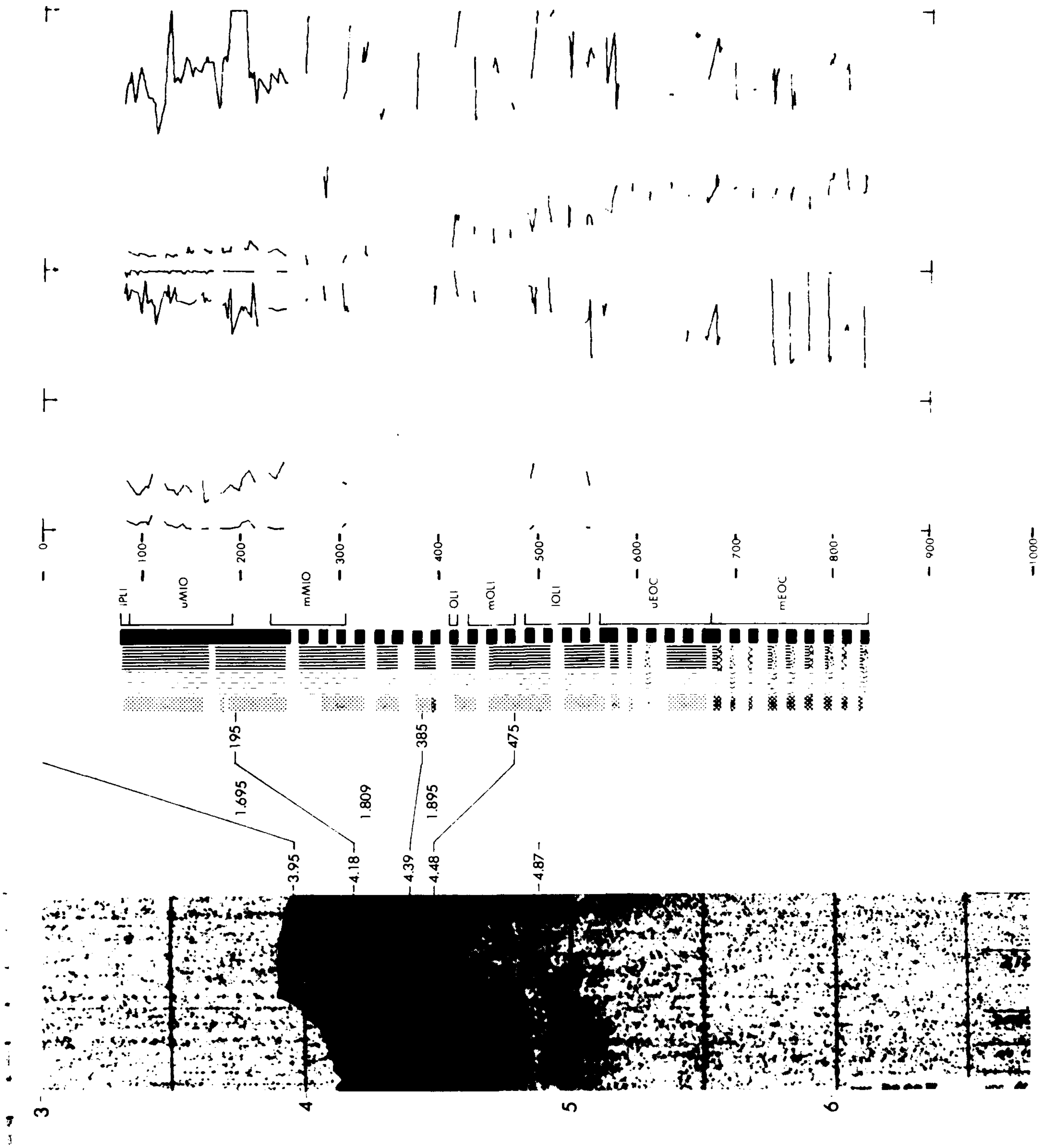
Penetration:
Drilled-- 364 meters
Cored---- 475 meters
Total---- 839 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 50 cores
278 meters

A continuous section was penetrated from the Pliocene into the middle Eocene, consisting predominantly of biogenic oozes, chalks, and marly chalks. The disposition is sharply pelagic in nature with episodes of especially high productivity during the late Miocene, middle Miocene, early Miocene and early Oligocene. The planktonic foraminifers are for the most part of the cool-temperate type characteristic of the Austral. New Zeland biogeographic province. The earliest major cooling was initiated in the middle part of the late Eocene. Selective carbonate dissolution occurred within the late and middle Miocene and again in the Eocene. An acoustic unit consisting of what may be long-wavelength apparent upslope-migrating sediment dunes correlates to the significantly more marly Eocene section containing thin silty and sandy beds which have been highly bioturbated. The influence of bottom currents on this sediment unit was apparently very subtle, for there are no detectable stratigraphic gaps. The currents promoted the dilution of the biogenic sediments more by accelerating the in- of terrigenous mud than by the erosional removal of sediment or the condensation of lithologic column by winnowing.

Calcareous sediment; mostly nannofossil rich, interbedded with a few thin layers of detrital sediment in Eocene time.



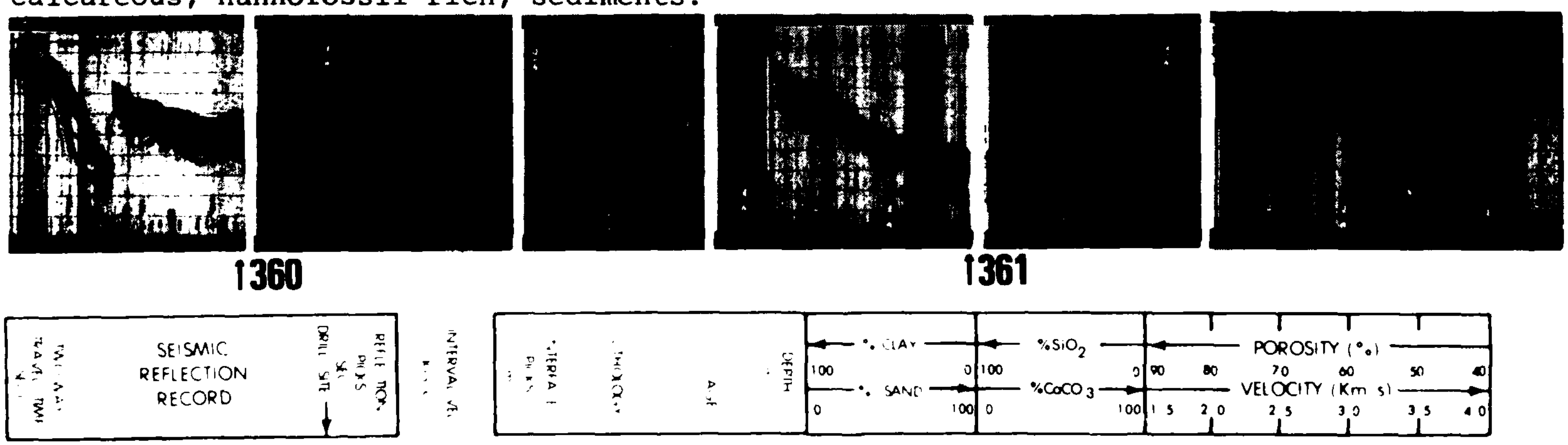
SITE 360 LEG 40



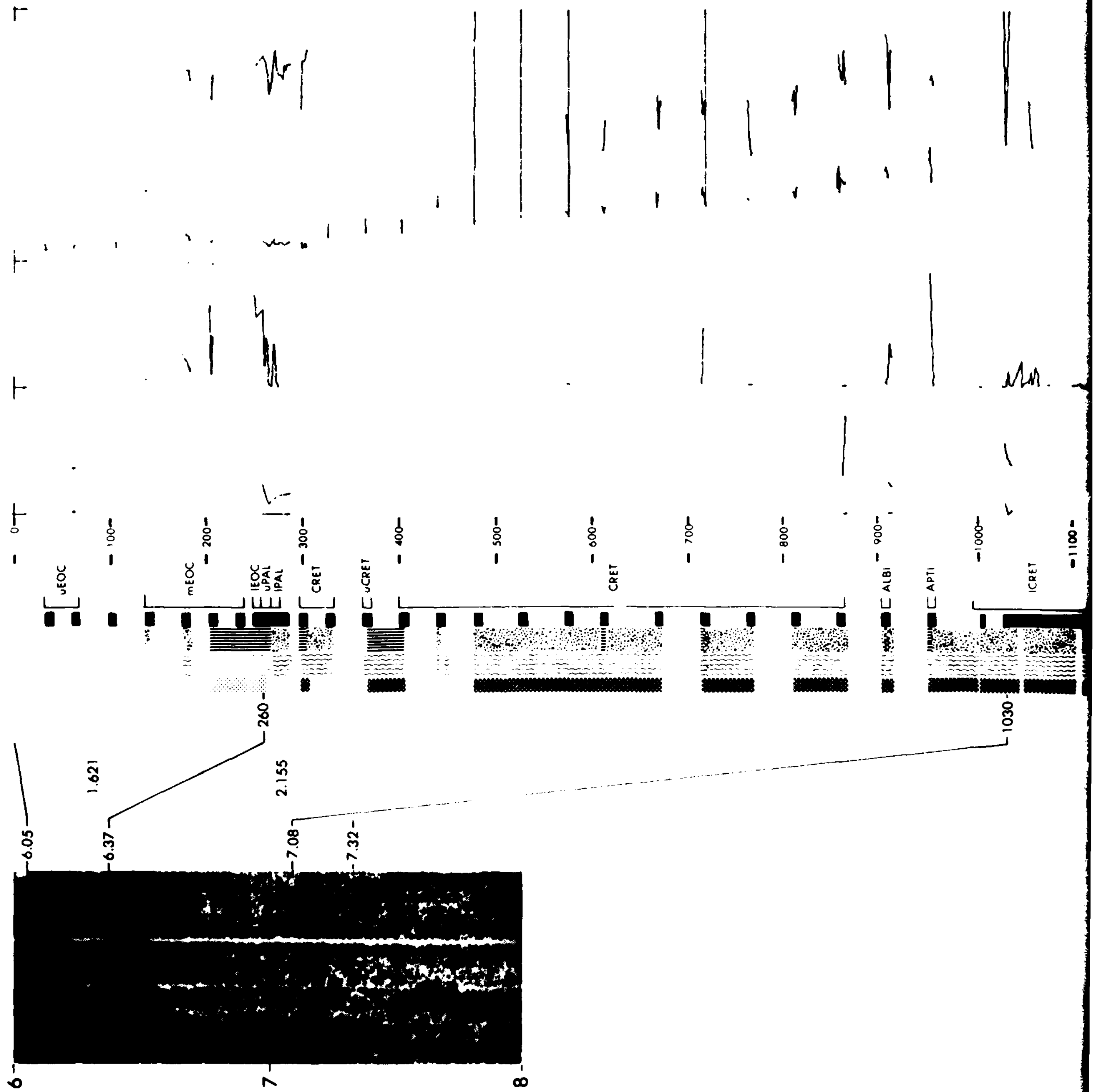
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	35°39.7' S	Drilled--	849 meters
Longitude	15°26.9' E	Cored----	465 meters
Date: 01/05/75		Total----	1314 meters
Time: 0010 Z		Recovery:	
Water depth: 4549 meters		Basement-	0 cores
Location: Cape Basin			0 meters
Continental Rise		Total----	49 cores
			222 meters

The hole was abandoned following the destruction of the drill bit some 50-100 meters from acoustic basement. Extrapolation of sediment accumulation rates would give this basement a Barremian age. Surficial Eocene mud, calcareous mud, marly nannofossil ooze, and chalk directly overlie Paleocene pelagic clay. The abrupt contact between the carbonate-rich and carbonate-poor strata corresponds to Reflector D. The Maestrichtian through Albian interval is comprised of non-carbonate terrigenous shale with intercalated sandy mudstones and siltstones interpreted as a distal fan turbidite facies deposited in its entirety beneath the carbonate compensation depth. The Aptian interval is considerably more sandy and highly carbonaceous. Thick clastic beds are interpreted as moderately deep proximal fan to fan-valley environment sterile to indigenous benthic life. Many of the massive sands are calcite cemented. These Aptian-age sandstones correlate with Reflector AII of Emery et al. (1975). Calibration of the Cape Basin magnetic lineations confirms an initial opening of the South Atlantic during the late Valanginian to early Hauterivian stage of the Early Cretaceous.

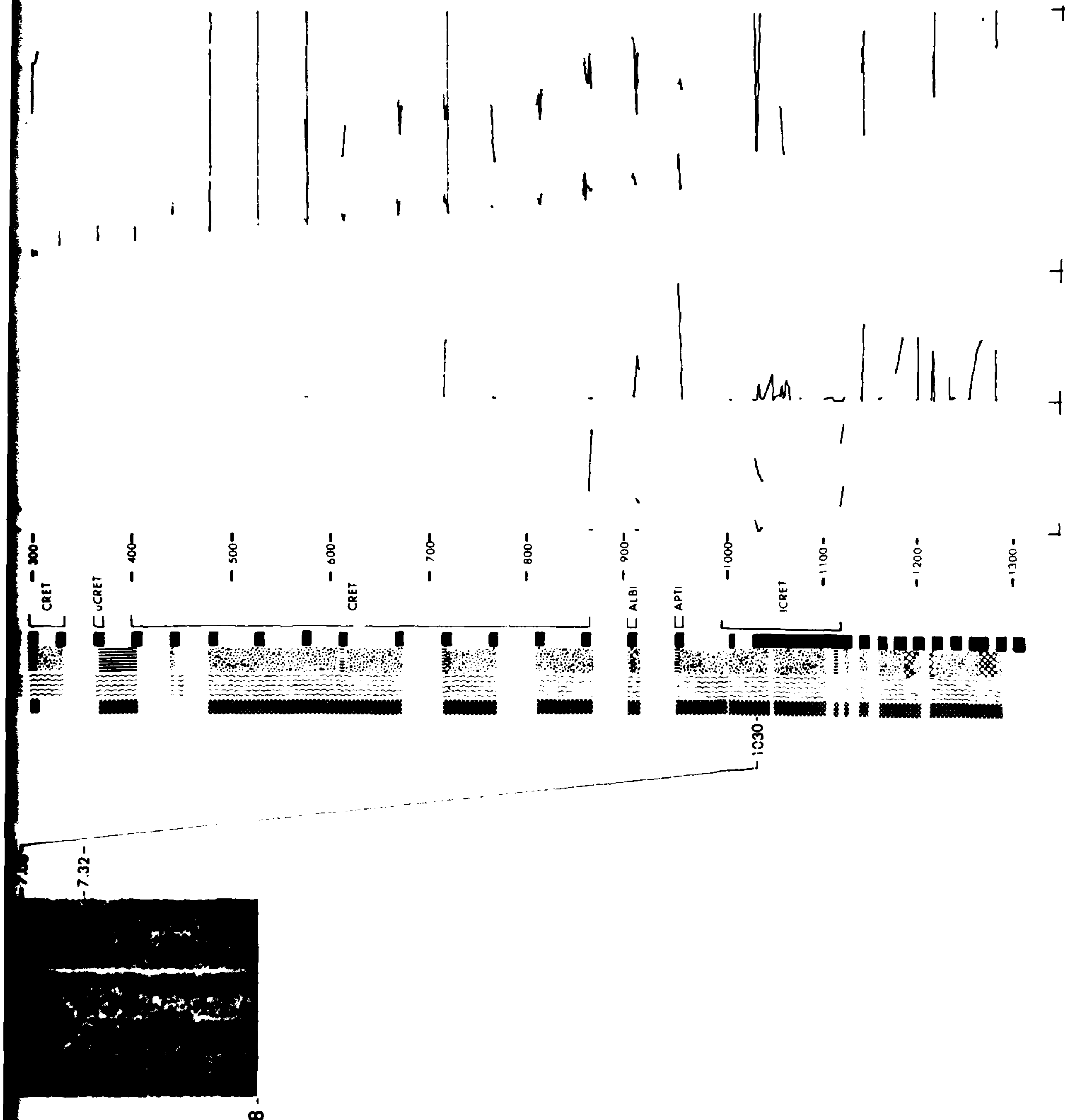
Detrital, occasionally phosphate rich, sediment interbedded with thin layers of **calcareous, nannofossil rich, sediments.**



SITE 361 LEG 40



SITE 361 LEG 40



SITE DATA

Position:
Latitude 19°45.4' S
Longitude 10°31.9' E
Date: 01/17/75
Time: 1740Z
Water depth: 1325 meters
Location: Walvis Ridge

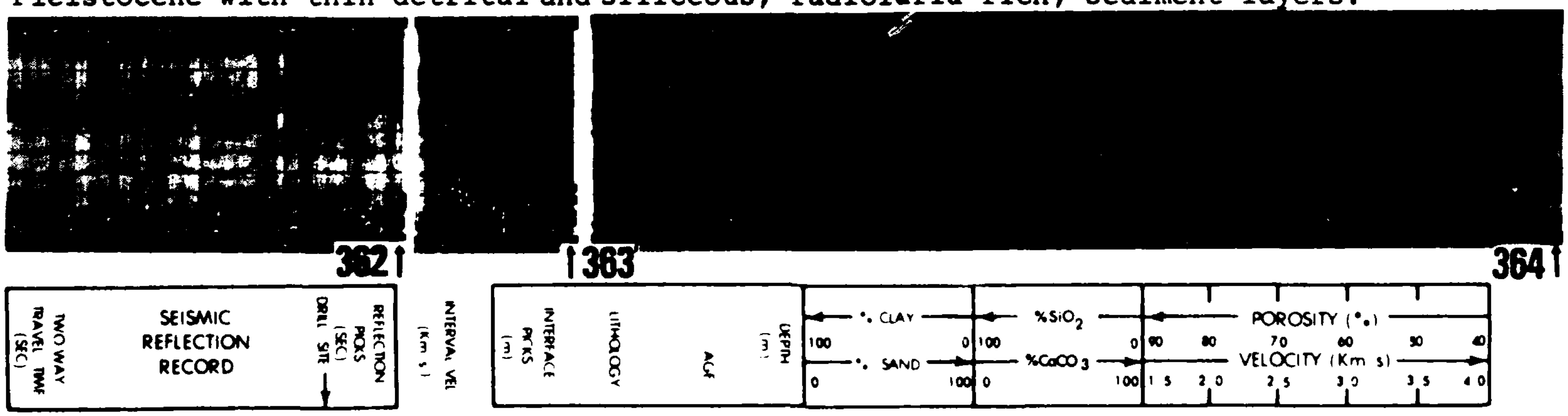
CORE DATA

	362	362A	
Penetration:			
Drilled--	387	972	meters
Cored----	418	109	meters
Total----	805	1081	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	44	12	cores
	367	77	meters

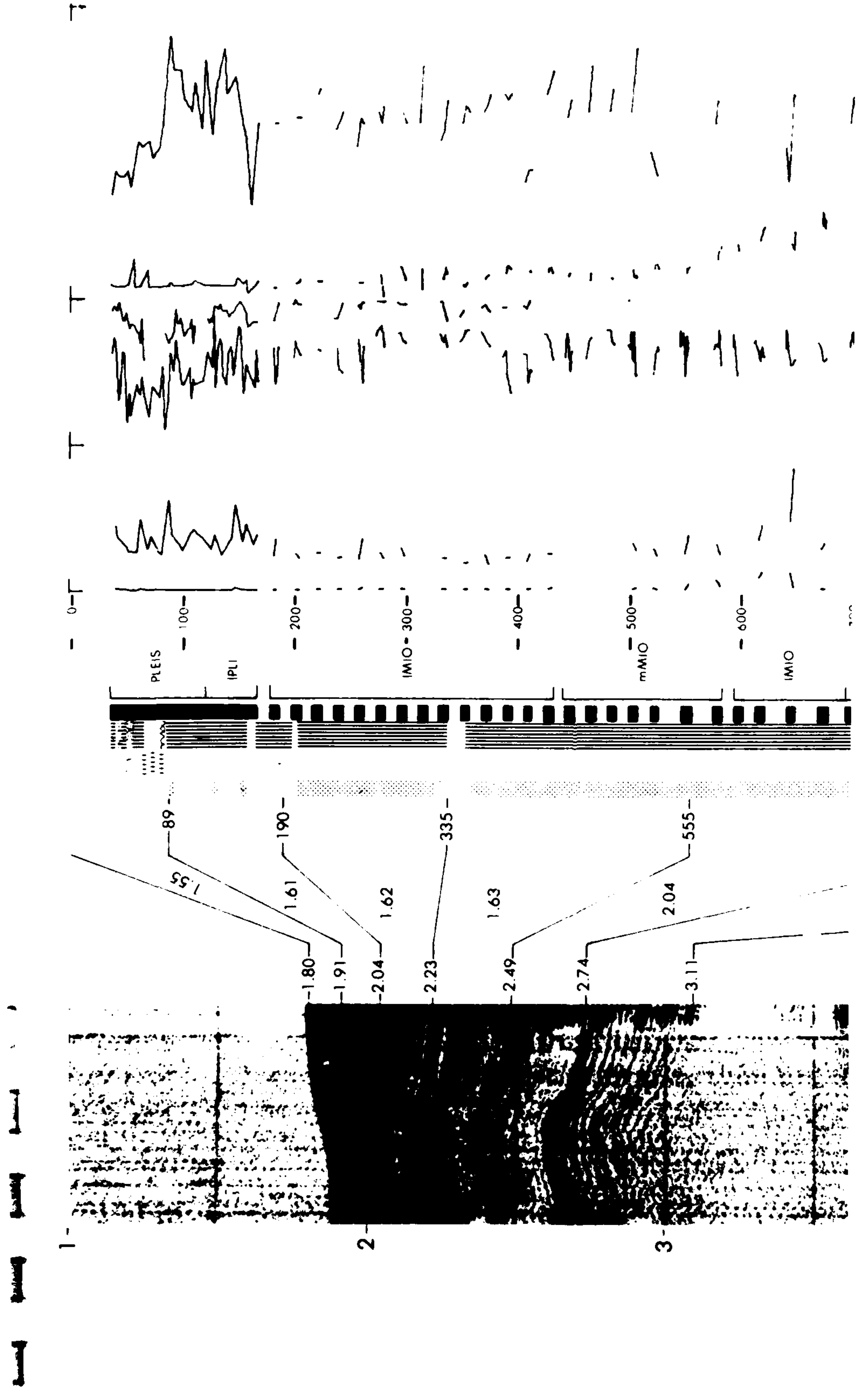
Four lithologic units are recognized. Unit 1 is a Pleistocene to upper Miocene diatomaceous marly nannofossil ooze and chalk bearing radiolarians and silicoflagellates. A strong erosional and regressive cycle occurs in the upper Miocene. Unit 2 is an upper Miocene to uppermost Oligocene foraminifer-bearing nannofossil chalk, well-bedded with cyclic intercalations of marly material and containing a strong dissolution cycle in the middle Miocene Globorotalia fohsi fohsi and G. fohsi lobata zones. Unit 3 is an Oligocene-age Braarudosphaera chalk, with intercalations of marly nannofossil chalk showing evidence of dissolution and winnowing between pure white beds totally dominated by the Braarudosphaera. Unit 4 is an upper to lower Eocene marly nannofossil chalk and limestone, with an appreciable diagenetic recalcification and cementation which eventually caused the destruction of the bearings in the core bit.

A strong, regionally widespread reflector at 0.94 seconds correlates with the top of the Braarudosphaera chalk unit. This acoustic horizon can be traced all the way to Site 360 in the southern Cape Basin. Lithologic Unit 1 is confined to progradational foreset beds along the African slope and is absent from the shelf in the Abutment Plateau area.

Calcareous, nannofossil (once aragonite) rich, sediment interbedded in the Pleistocene with thin detrital and siliceous, radiolaria rich, sediment layers.

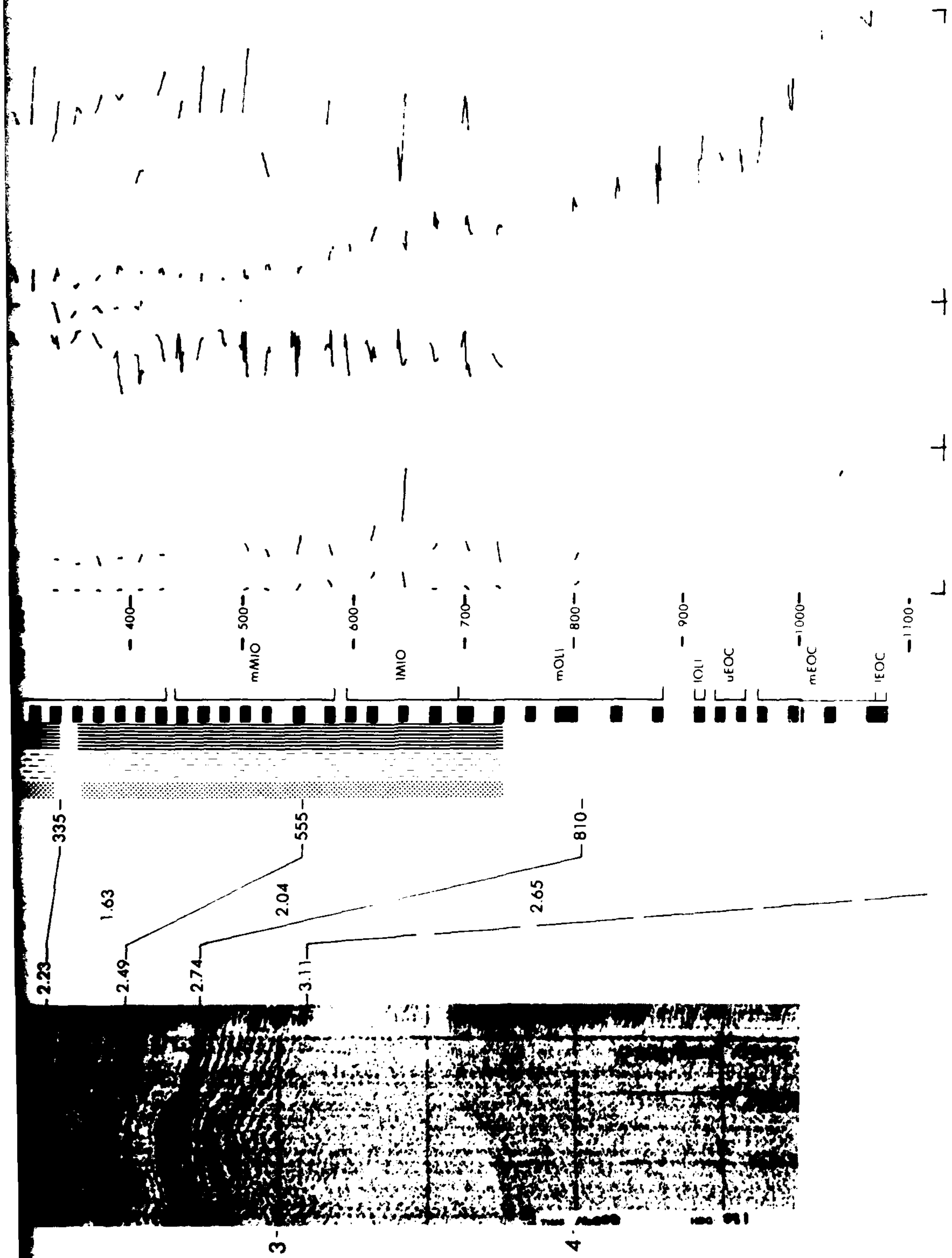


SITE 362



0
100
200
300
400
500
600
PLEIS
lPLI
lMIO
mMIO
lMIO
89
190
335
555
1.55
1.61
1.62
1.63
2.04
1.80
1.91
2.04
2.23
2.49
2.74
3.11
1
2
3

SITE 362 LEG 40



SITE DATA

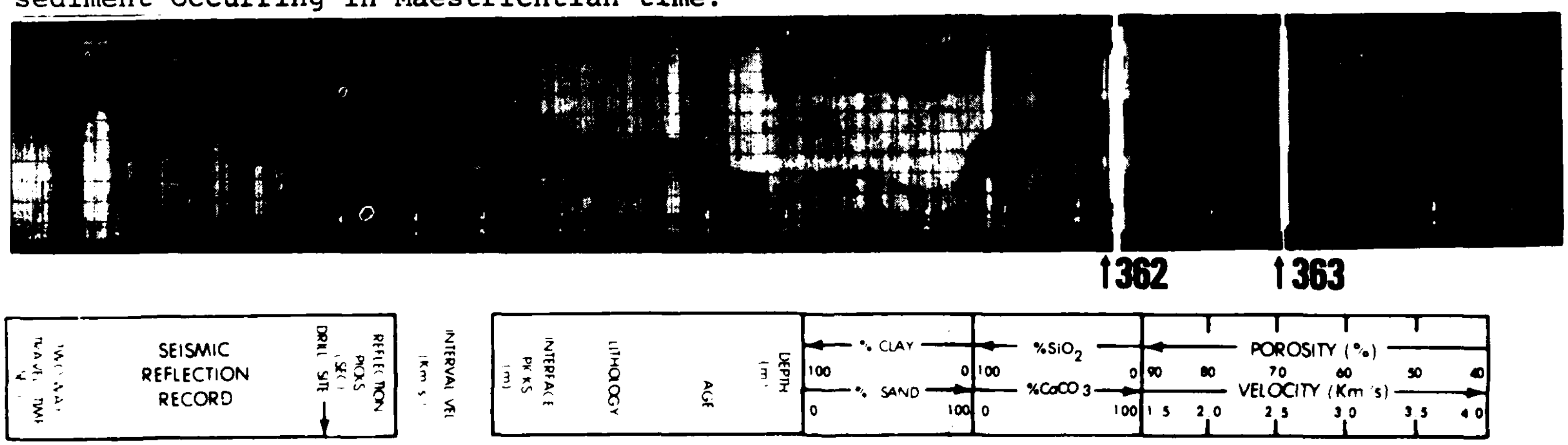
Position:
Latitude 19°38.7' S
Longitude 9°02.8' E
Date: 01/24/75
Time: 0344Z
Water depth: 2248 meters
Location: Walvis Ridge

CORE DATA

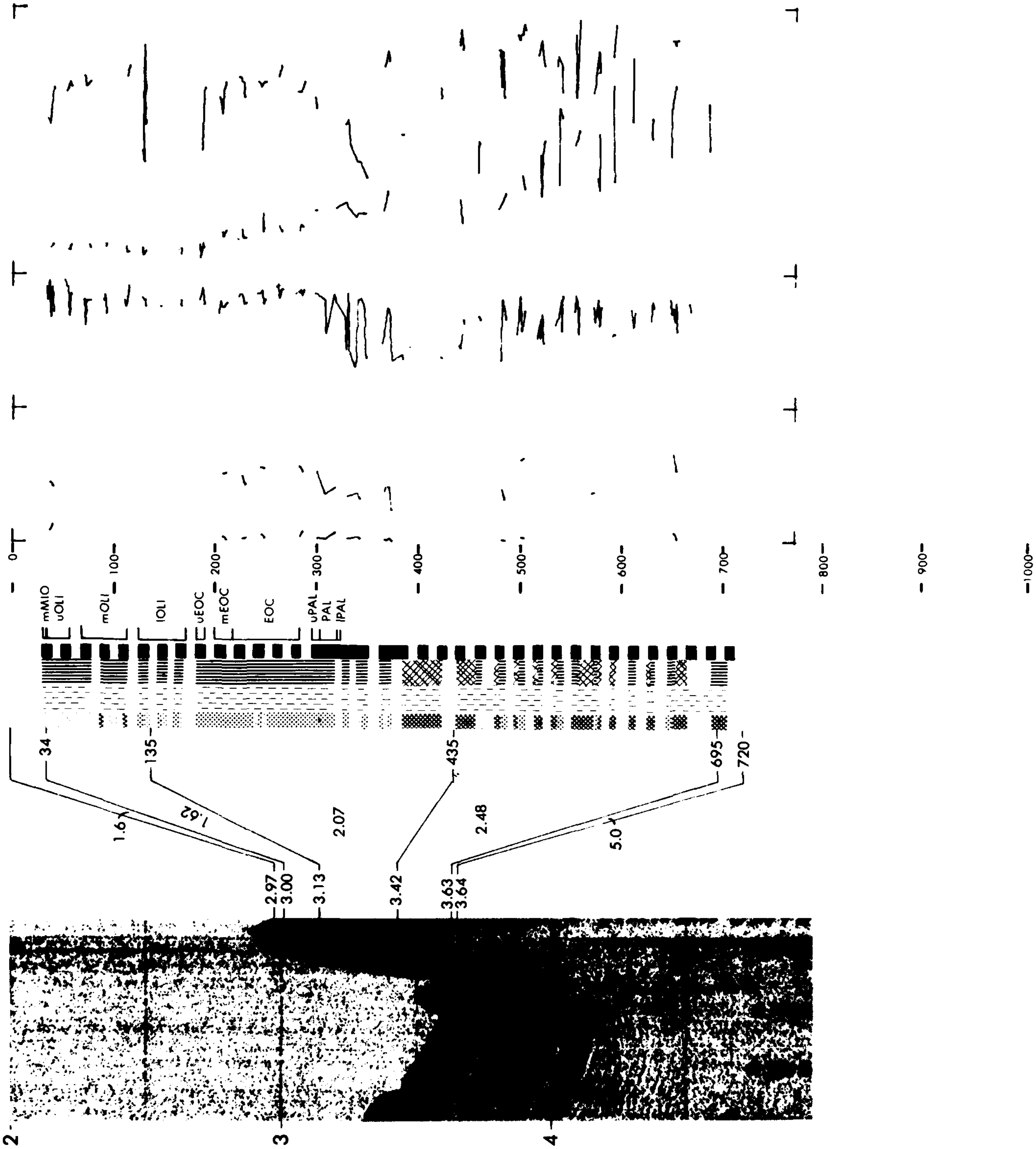
Penetration:
Drilled-- 335 meters
Cored---- 380 meters
Total---- 715 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 40 cores
227 meters

The section has one prominent erosional gap between the Recent and the upper Miocene. Another gap occurs between the Coniacian and the uppermost Albian, but may partly reflect ecologic conditions which prevented North Atlantic Cenomanian-Santonian marker fossils from reaching the South Atlantic. Three lithologic units are recognized. Unit 1 is an upper Miocene to lower Maestrichtian nannofossil ooze and chalk containing white Braarudosphaera ooze layers in the Oligocene. Unit 2 is a Campanian to lower Aptian nannofossil marl. There is considerable evidence of condensation of the section by winnowing along thin, numerous erosional contacts. The Albian has dark layers characterized by disseminated pyrite, suggesting at least localized reducing conditions. The input of terrigenous clays in the marls of this unit is strongly cyclic and perhaps climatically controlled. Recrystallization including dolomitization is extensive in the Aptian. Pore fluids show the influence of underlying volcanic basement (Sotelo and Gieskes, this volume). Unit 3 consists of lower Aptian limestone, interlayered with calcarenites containing fragments of lamillibranchs and calcareous algae, suggesting a high-energy, near-shore environment.

Calcareous, mostly nannofossil rich, sediment with one thin layer of detrital sediment occurring in Maestrichtian time.



SITE 363 LEG 40



SITE DATA

Position:
Latitude 11° 34.3' S
Longitude 11° 58.3' E
Date: 01/30/75
Time: 0442Z
Water depth: 2448 meters
Location: Angola Continental Margin

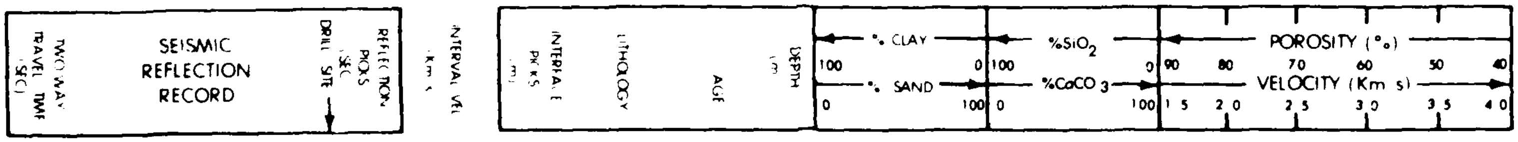
CORE DATA

Penetration:
Drilled-- 659 meters
Cored---- 427 meters
Total----1086 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 46 cores
296 meters

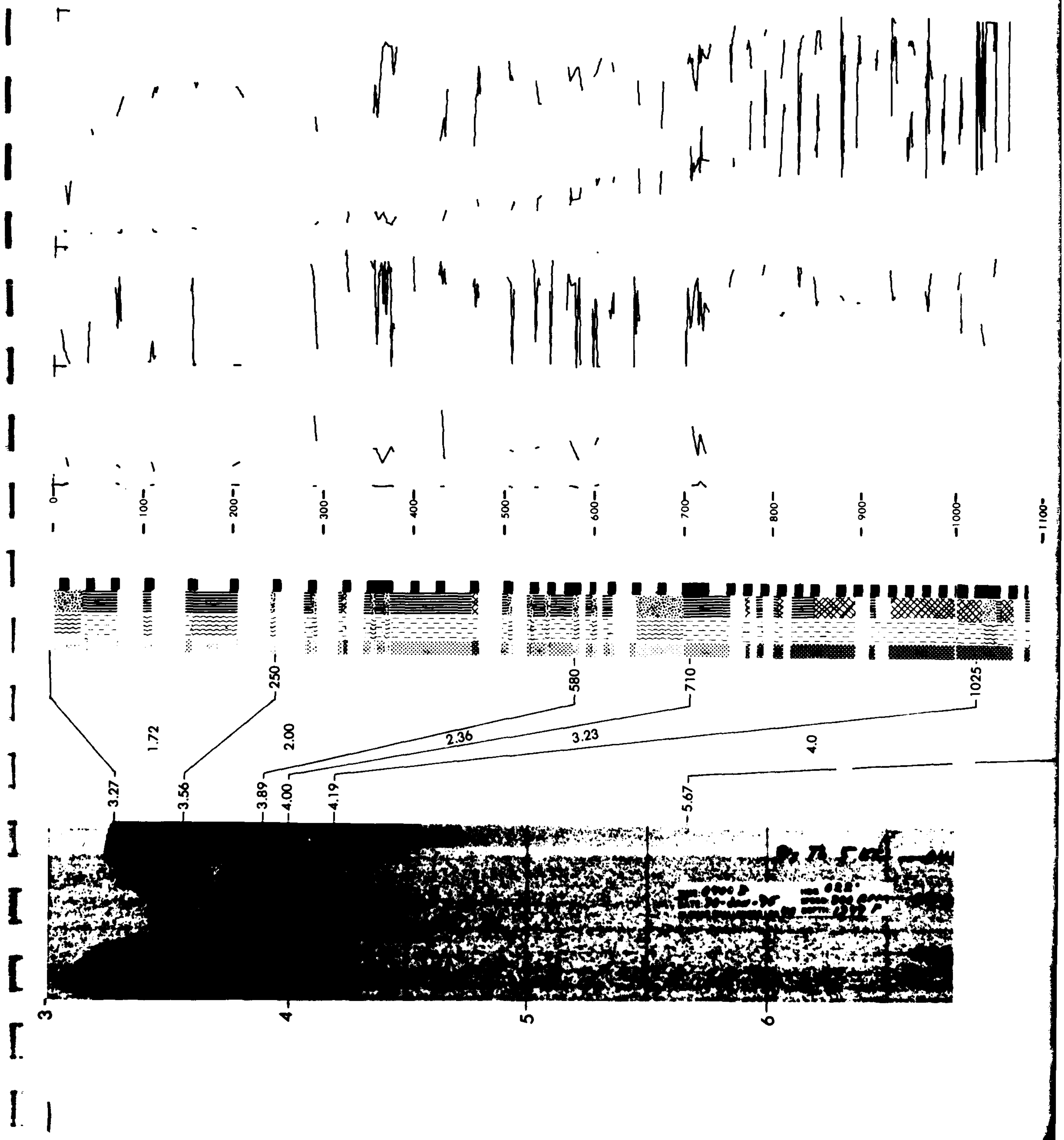
A sequence from the Pleistocene down into the upper Aptian was penetrated containing a major erosional disconformity corresponding to most of the Oligocene and the upper Eocene. The drilling terminated with a worn-out bit in dolomitic limestones with very high interstitial salinities just above the Aptian evaporite and salt formations. The Paleogene and Upper Cretaceous series is for the most part pelagic in nature, and contains tropical to sub-tropical faunas deposited in generally tranquil deep-water environments. The Lower Cretaceous faunas include ammonites and Inoceramus and characteristically indicate non-tropical environments and an initial immigration of marine life into the Angola Basin from the south following the termination of the Aptian salinity crisis. There is no evidence of shallow littoral or intertidal sedimentation, even for the deposits directly overlying the evaporites. Sapropels and sapropelic limestones occur in the upper Coniacian to Cenomanian interval and in the lower Albian and upper Aptian. Albian marly chalks and limestones contain pressure-solution stylolites, steeply dipping bedding contacts, overturned folds, and interformational breccias probably linked to salt diapirism.

Calcareous, occasionally nannofossil rich and oolite rich at the bottom of the cored interval, sediments interbedded with detrital sediments, sometimes in thin layers.

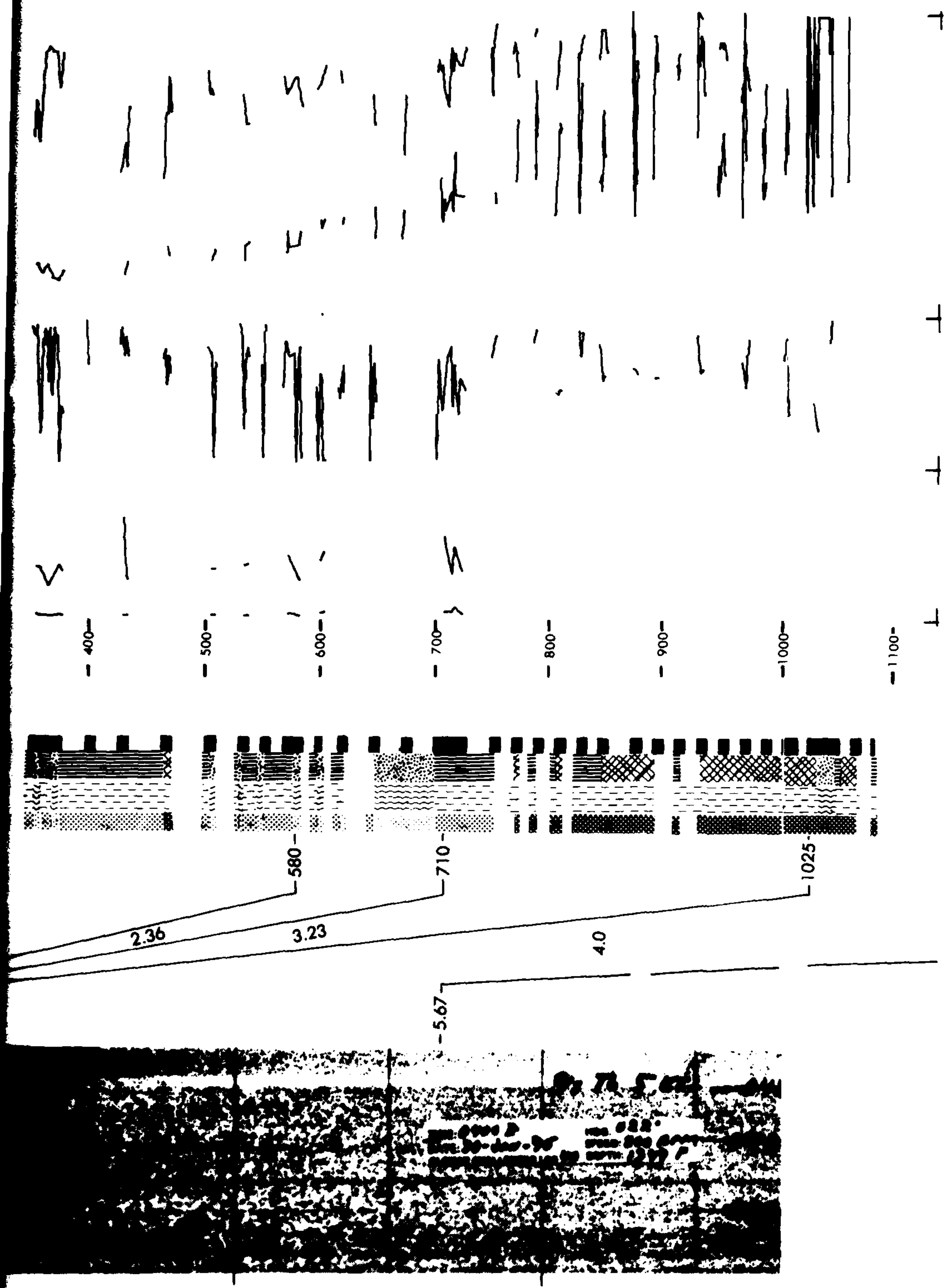
364



SITE 364 LEG 40



TE 364 LEG 40



2

SITE DATA

Position:
Latitude 11°39.1' S
Longitude 11°53.7' E
Date: 02/08/75
Time: 1740Z
Water depth: 3018 meters
Location: Angola Continental Margin

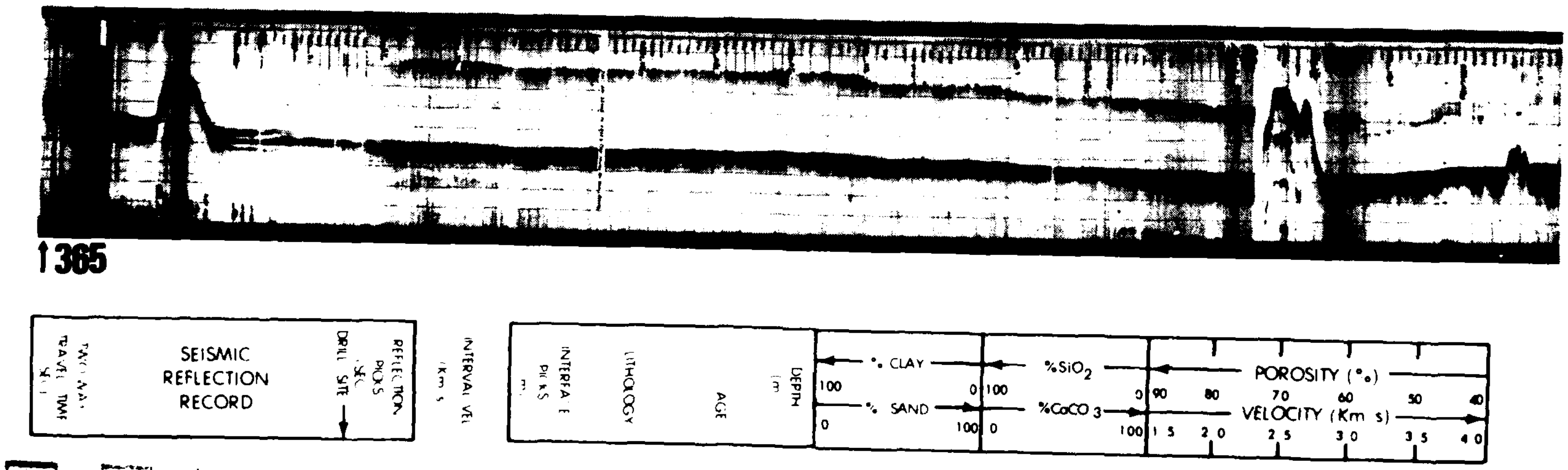
CORE DATA

Penetration:
Drilled-- 624 meters
Cored---- 63 meters
Total---- 687 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 7 cores
35 meters

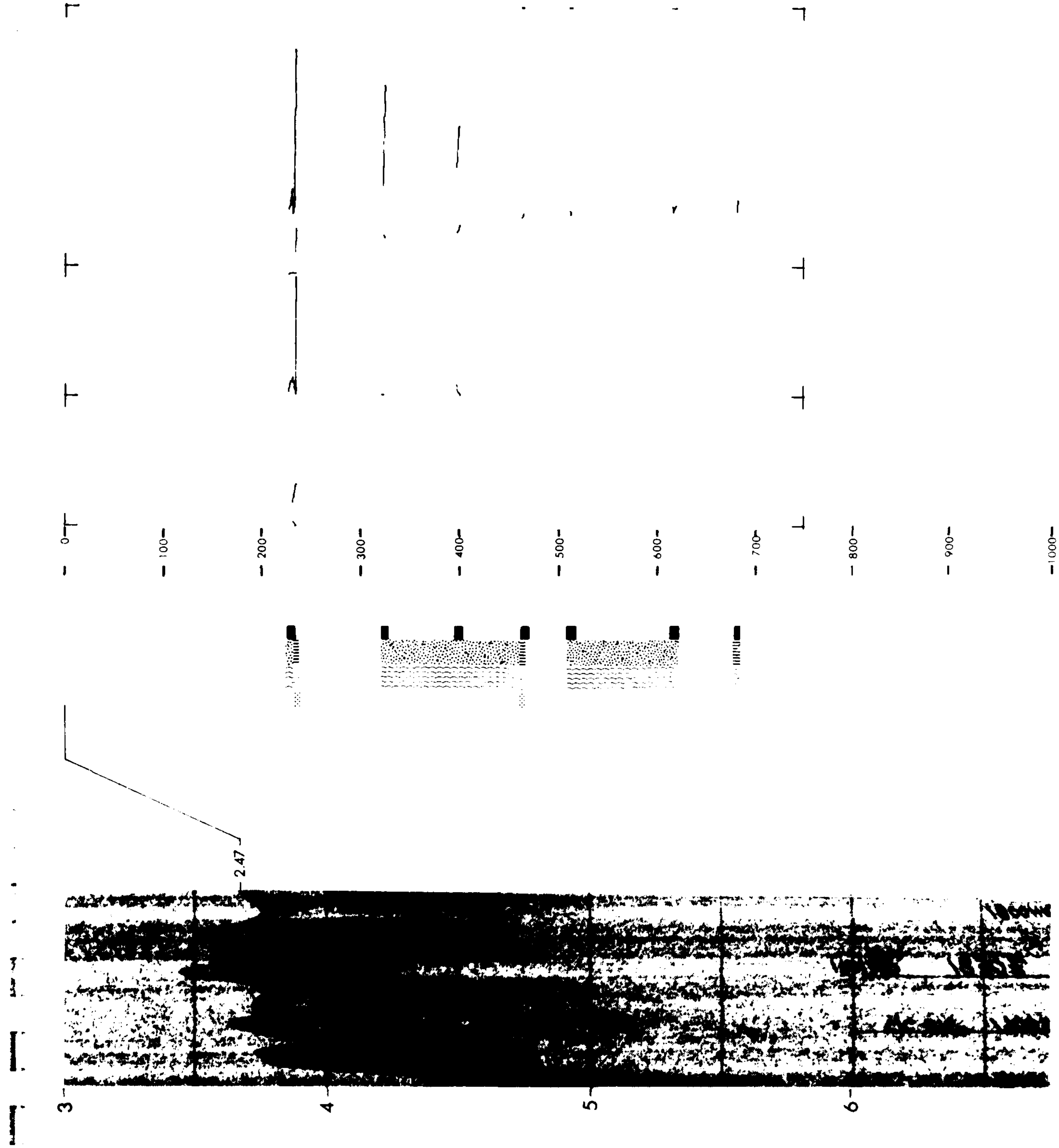
Site 365 was drilled rapidly with very intermittent coring in an unsuccessful desperate attempt to reach the Aptian evaporite and salt formation before time ran out at the end of the leg. Interstitial salinities in the last sediment core at 687 meters sub-bottom exceeded those at the base of Site 364, indicating that the salt was not far below.

The canyon fill consists primarily of Neogene-age terrigenous muds and mudstones containing primitive arenaceous benthic foraminifers, fish teeth, and palynomorphs, along with allochthonous blocks of Coniacian-Santonian nannofossil ooze and Cenomanian to upper Albian sapropelic mudstone reworked from the canyon wall. The Mesozoic strata indicated their displaced nature by extremely steep bedding inclinations ranging up to 70° from the horizontal and by mixed assemblages spanning a broad stratigraphic interval. The depositional environment was continuously deep, well oxygenated, and, during the interval of the Miocene and Oligocene recorded in the cores, below the calcium compensation depth.

Detrital sediments interbedded with two thin calcareous layers.



SITE 365   LEG 40



SITE DATA

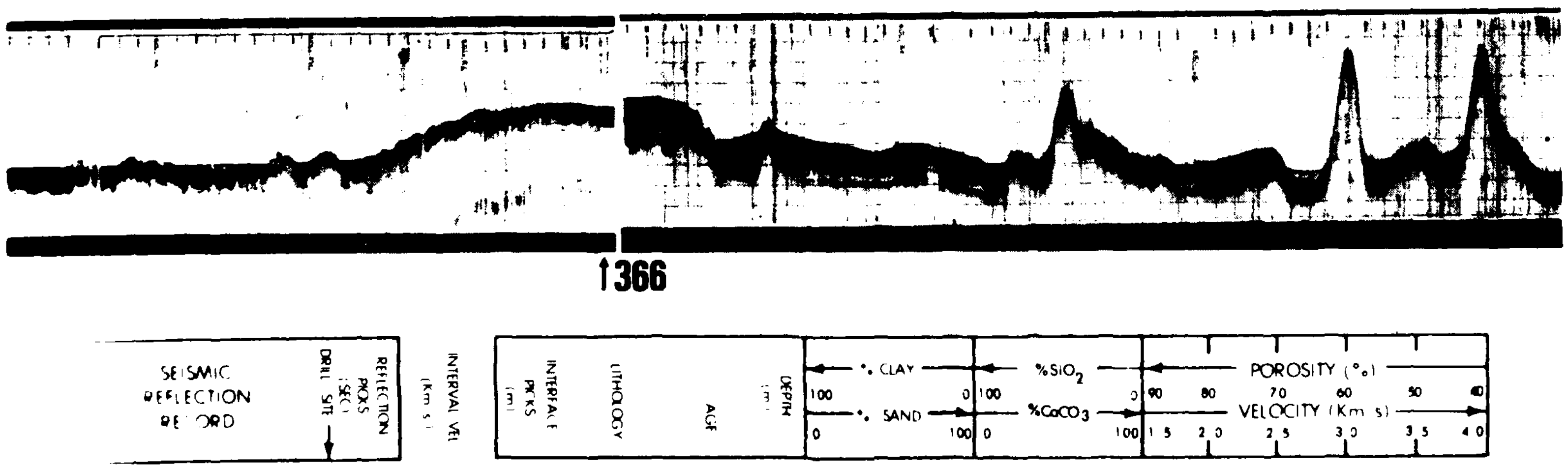
Position:
Latitude 5°40.7' N
Longitude 19°51.1' W
Date: 02/22/75
Time: 1150Z
Water depth: 2853 meters
Location: Sierra Leone Rise

CORE DATA

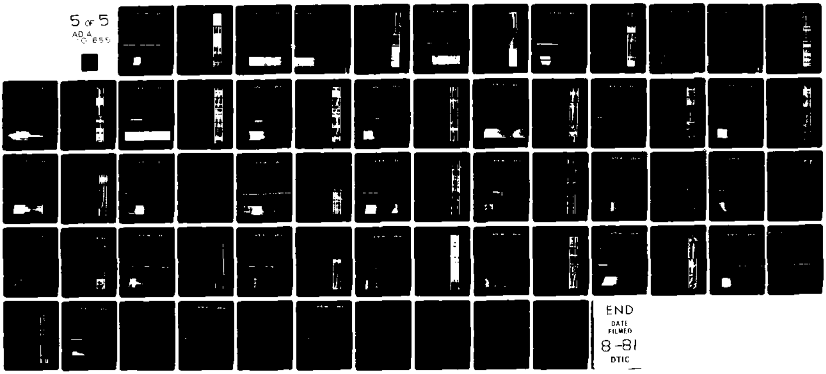
Penetration:	366	366A	
Drilled--	332	0	meters
Cored----	518	367	meters
Total----	850	367	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	55	39	cores
	304	278	meters

The site was drilled in the upper part of the Sierra Leone Rise in a region where the seismic reflection profiles suggest the sedimentary section may be complete and undisturbed. A nearly complete section of the Cenozoic was obtained. It represents a typical pelagic record for an oceanic rise and can be compared with the record obtained on similar elevated oceanic areas. This record appears to provide an ideal reference section for the low-latitude Atlantic Cenozoic record. Two characteristics make this record particularly useful; (1) the section is nearly complete and only very minor stratigraphic hiatuses are present; and (2) the presence of abundant planktonic foraminifers, nannoflora, radiolarians, and, to some *extent diatoms*, provides an excellent opportunity to correlate zonal boundaries obtained from these different microfossil groups in the tropical-subtropical environment.

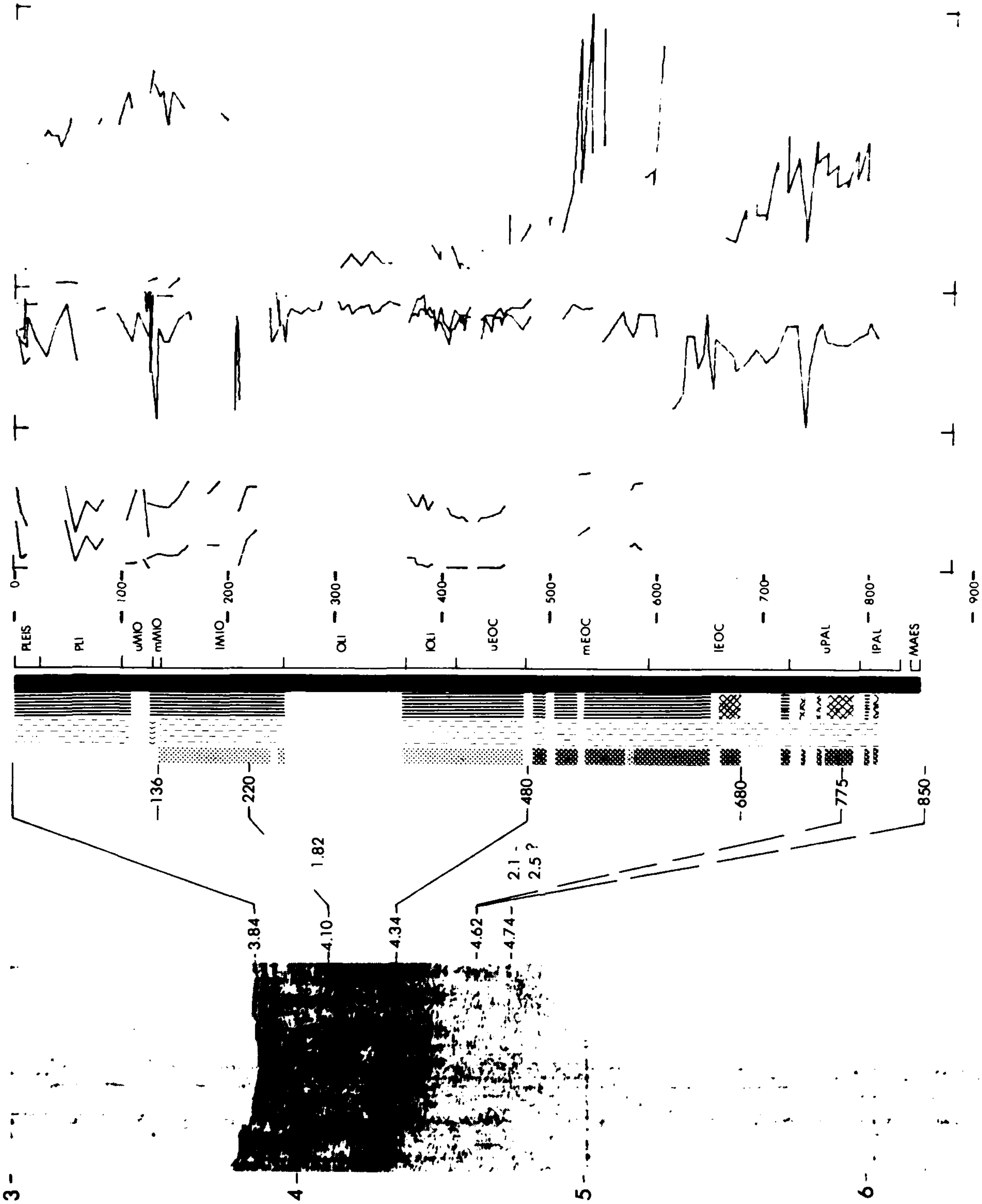
Calcareous sediments nannofossil rich.



AD-A101 655 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 20/1
A SUMMARY OF SELECTED DATA: DSDP LEGS 20-44,(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL



SITE 366 LEG 41



SITE DATA

Position:
- Latitude 12°29.2' N
- Longitude 20°02.8' W

Date: 03/03/75
Time: 1730Z
Water depth: 4748 meters
Location: Cape Verde Basin

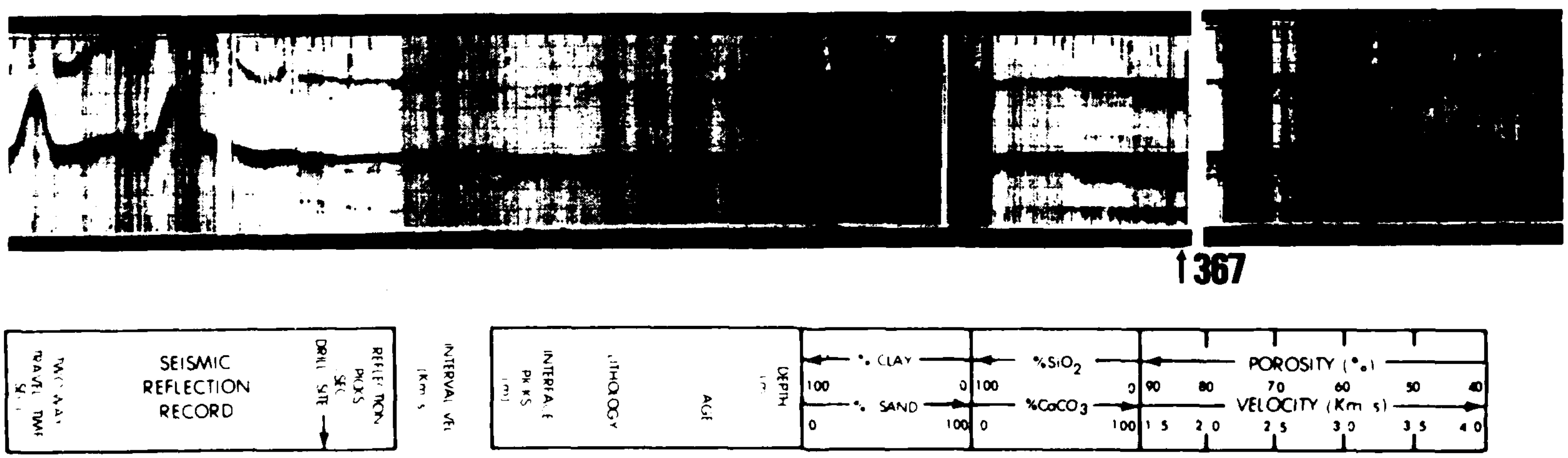
CORE DATA

Penetration:
- Drilled-- 806 meters
- Cored---- 347 meters
- Total----1153 meters

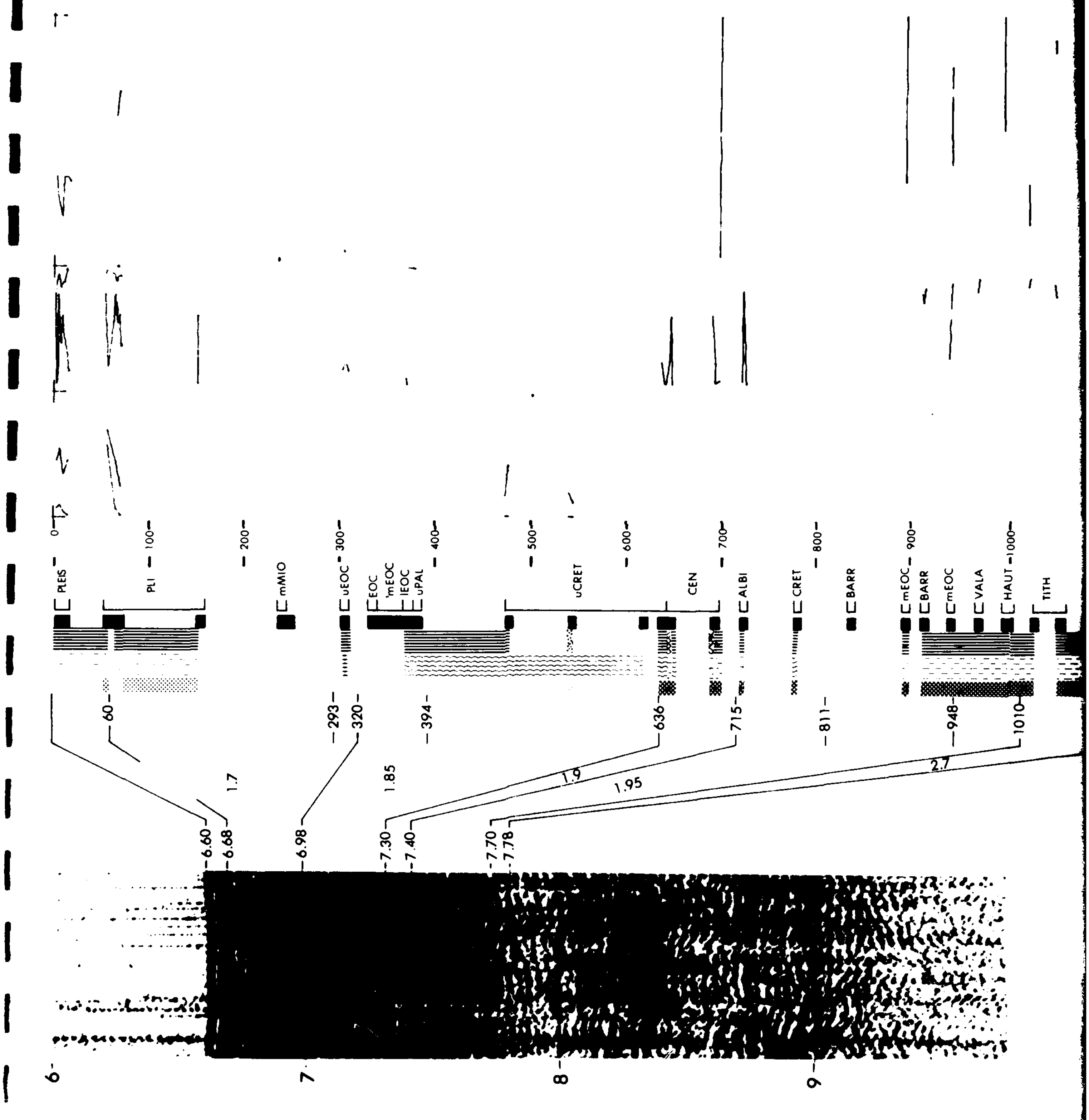
Recovery:
- Basement- 3 cores, 6.6 meters
- Total---- 40 cores, 174 meters

The most impressive result obtained is the striking similarity between the succession of Mesozoic facies sampled at the site and those described in the western North Atlantic (Hollister, Ewing, et al., 1972; Lancelot et al., 1972). This confirms the symmetrical evolution of both sides of the North Atlantic during the Mesozoic, prior to the major changes caused by wide communication with other oceanic basins and onset of vigorous thermohaline circulation sometime during the early Tertiary. This evolution started with the deposition of deep-water carbonates which became covered by clays when continuous subsidence—caused by the regularly increasing distance from the Mid-Atlantic Ridge—brought basins below the level of the CCD. The schematic picture simply derived from the sea floor spreading concepts is complicated by the occurrence of black shales above the carbonate sequence.

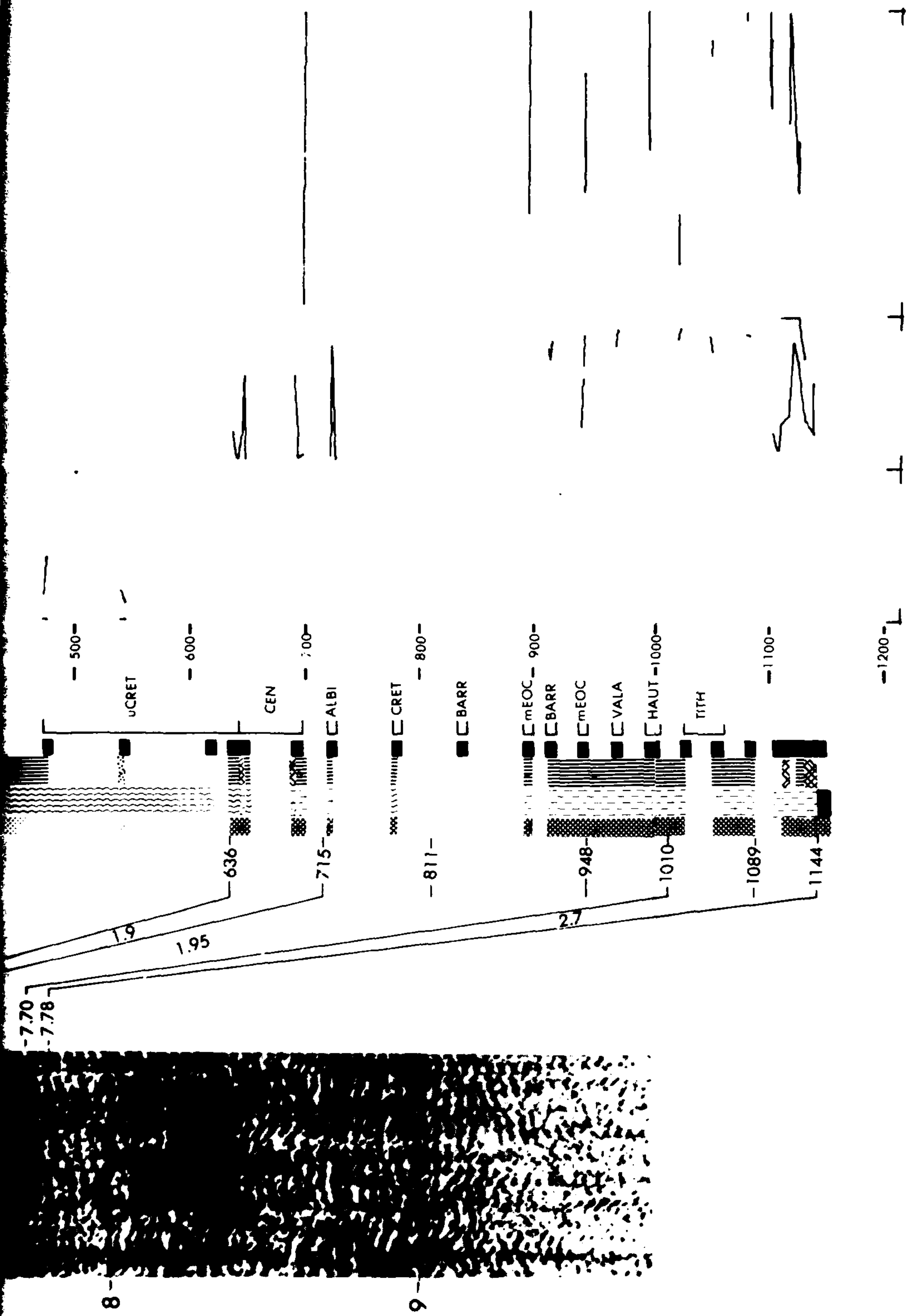
Calcareous sediment; occasionally nannofossil rich, once in Cenomanian time, oolite rich and once in Jurassic time, foraminifera rich. Siliceous sediment; radiolaria rich.



SITE 367 LEG 41



367 LEG 41


500
600
700
800
900
1000
1100
1200
uCRET
CEN
ALBI
CRET
BARR
mEOC
BARR
mEOC
VALA
HAUT
TITH
636
715
811
948
1010
1089
1144
1.9
1.95
2.7
7.70
7.78
8
9

SITE DATA

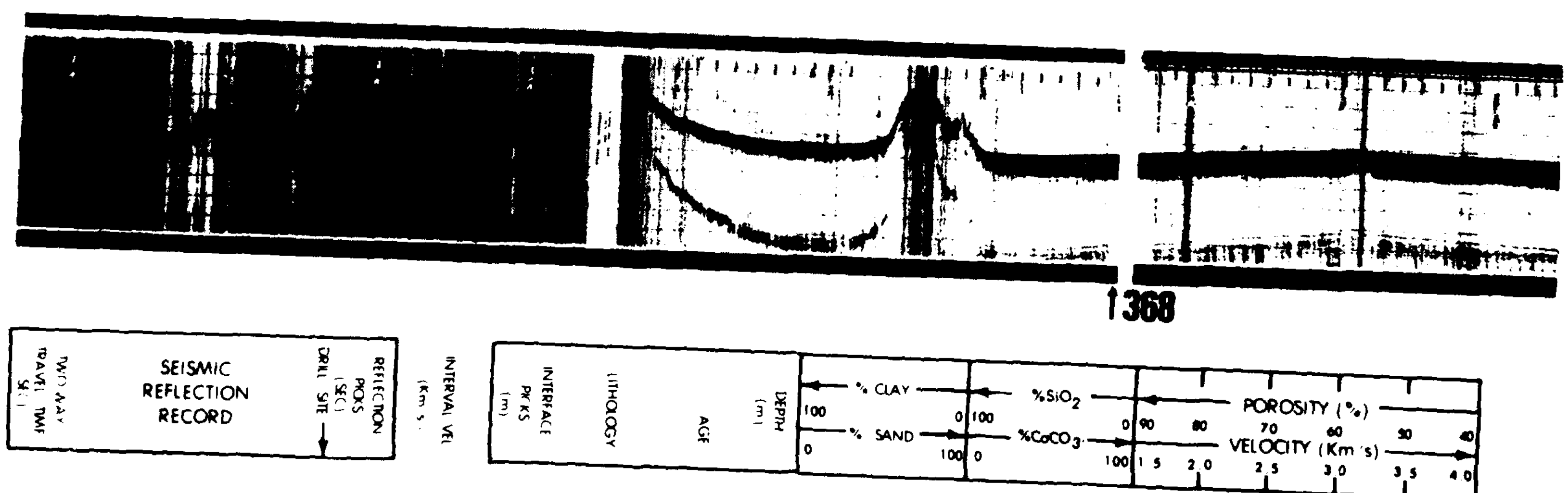
Position:
Latitude 17° 30.4' N
Longitude 21° 21.2' W
Date: 03/13/75
Time: 0755Z
Water depth: 3366 meters
Location: Cape Verde Rise

CORE DATA

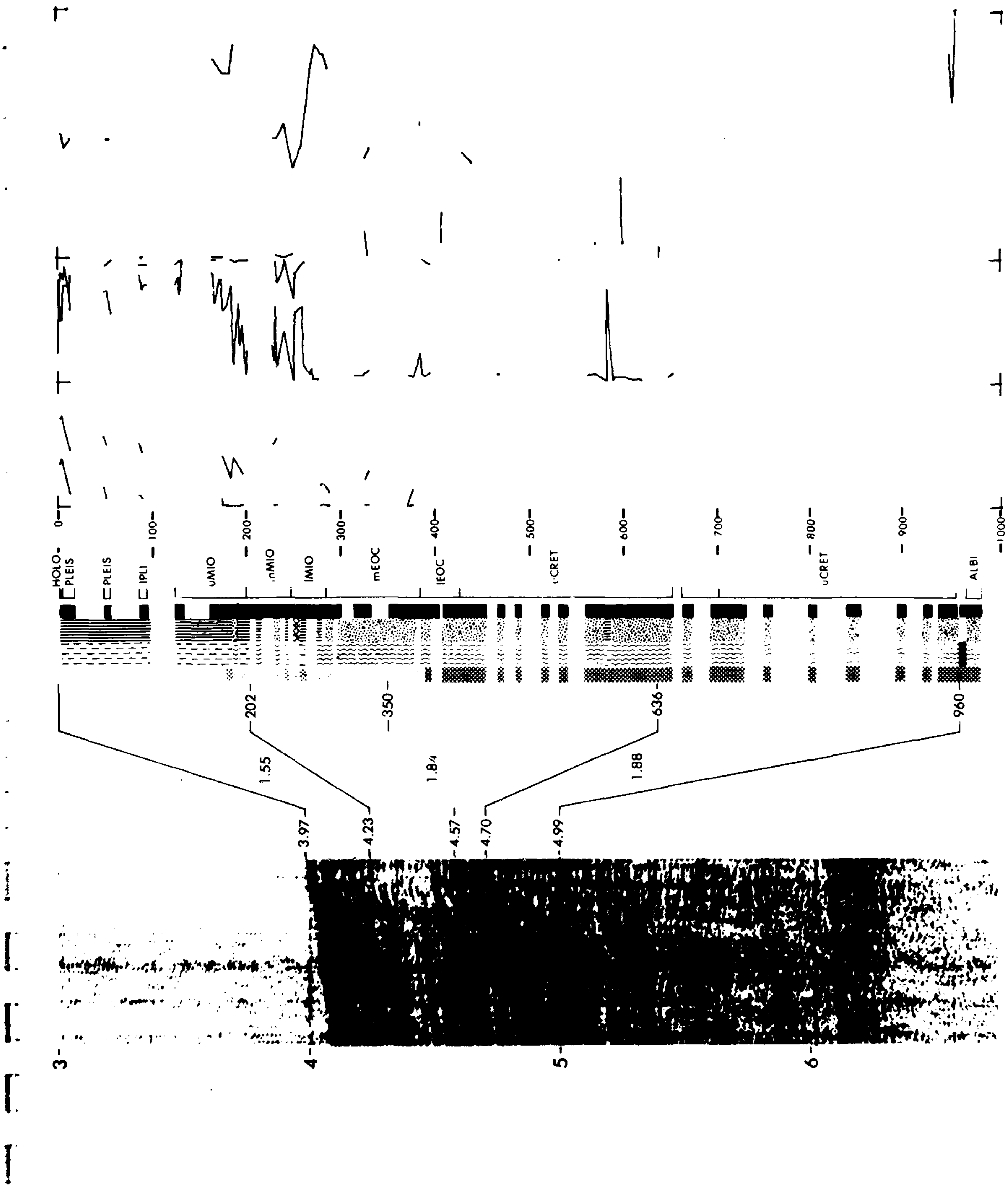
Penetration:
Drilled-- 402 meters
Cored---- 582 meters
Total---- 984 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 63 cores
328 meters

The Cape Verde Islands area is undoubtedly underlain by oceanic crust because this volcanic mass lies in an area of rather well-defined Mesozoic magnetic anomalies. Data obtained at the site strongly suggest that the rise is a result of a broad uplift of more than 1000 meters, probably related to and contemporaneous with the early Neogene volcanic activity that built the Cape Verde Islands and is also recorded in the region of Dakar. This volcano-tectonic origin of the rise is supported by three different observations: (1) Absence of carbonates between the Turonian-Albian and the middle Miocene, (2) Occurrence of a series of turbidites in most of the terrigenous section, (3) Presence of diabase sills at the base of the section, indicative of volcanic activity beneath the rise after the emplacement of the oceanic basement.

Calcareous, mostly nannofossil rich, sediments interbedded with thin detrital layers of Miocene Epoch and one thin layer of siliceous sediment.



SITE 368 LEG 41



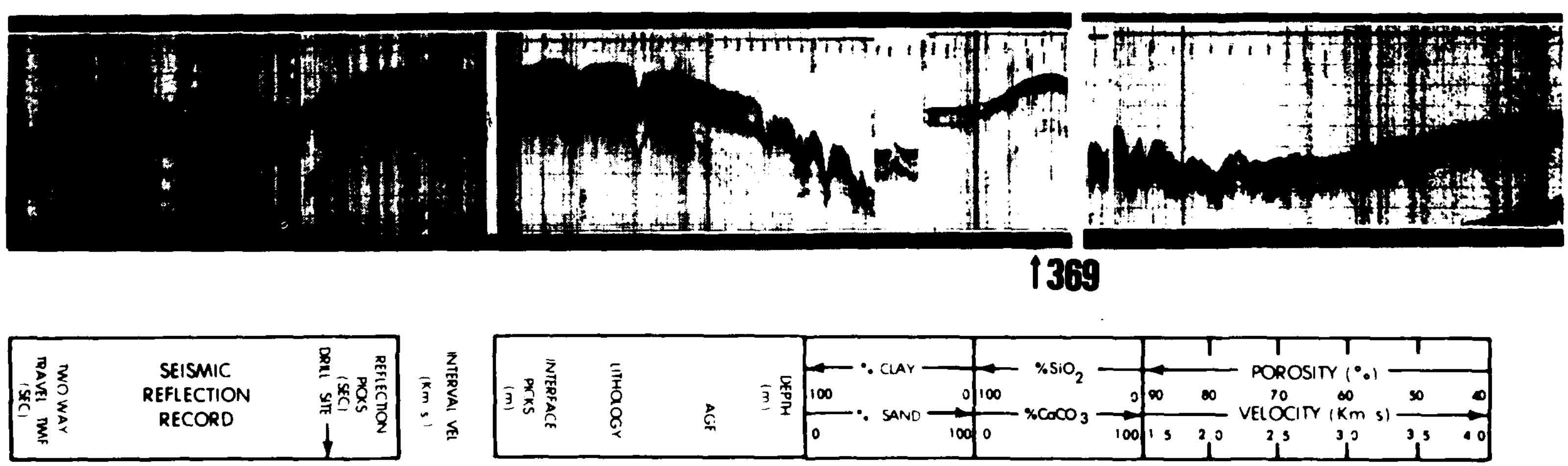
SITE DATA

Position:
Latitude $26^\circ 35.6'$ N
Longitude $15^\circ 00.0'$ W
Date: 03/23/75
Time: 2275Z
Water depth: 1752 meters
Location: Continental slope off Cape Bojador, Spanish Sahara

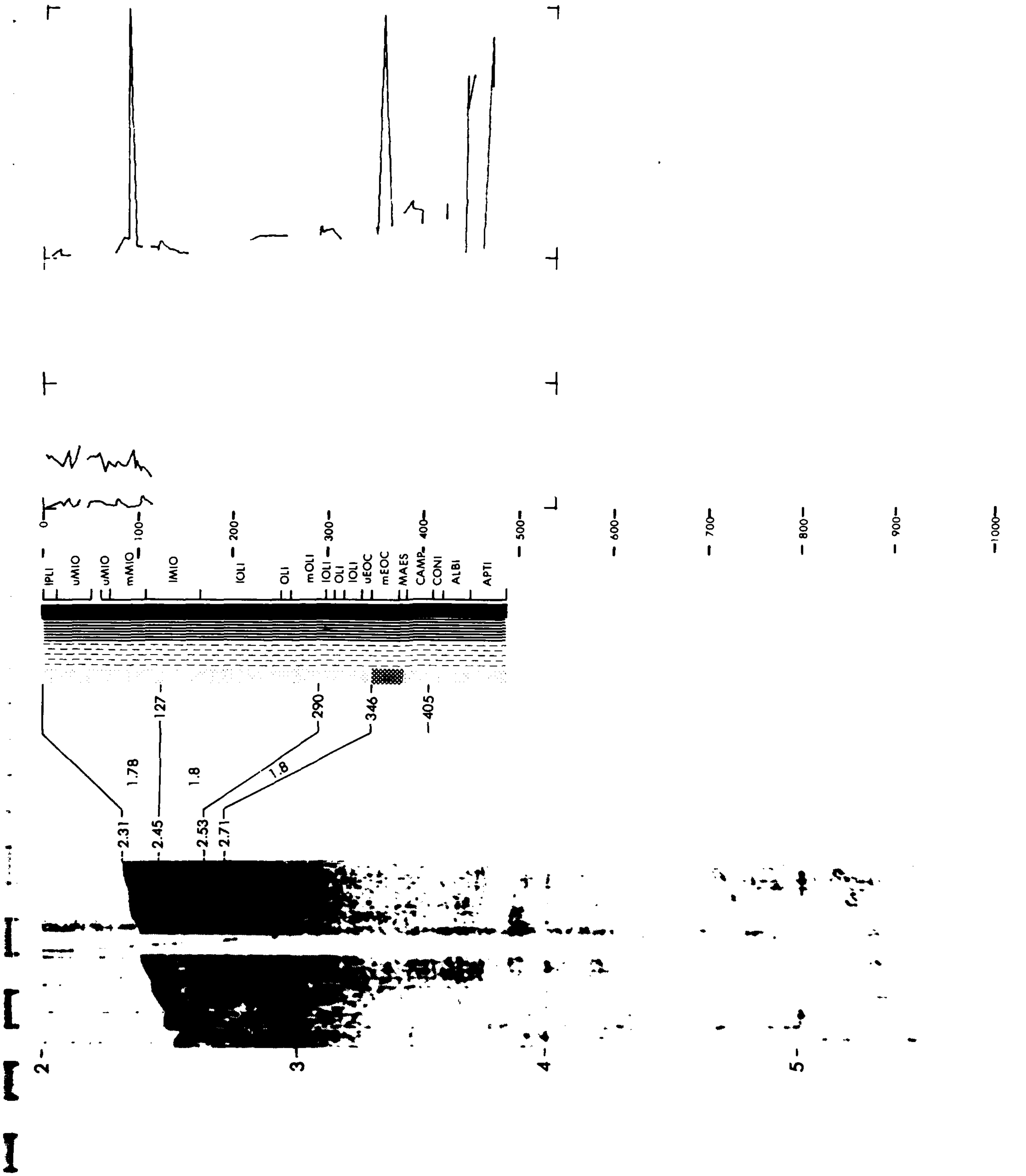
CORE DATA

Penetration:	369	369A	
Drilled--	0	42	meters
Cored----	42	446	meters
Total----	42	488	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	5	47	cores
	36	350	meters

The most striking aspect of the nature of the sediments recovered from the continental slope is the predominance of the pelagic facies over the hemipelagic facies. The biogenous contributing to the sediments is much more important than the terrigenous one. Biogenous contribution is reflected by the carbonate content of the sediments (40% to 80%, upper Cretaceous and Neogene). Because no detrital carbonates were observed, these values give an overall image of the minimum biogenous contribution.



SITE 369 LEG 41



SITE DATA

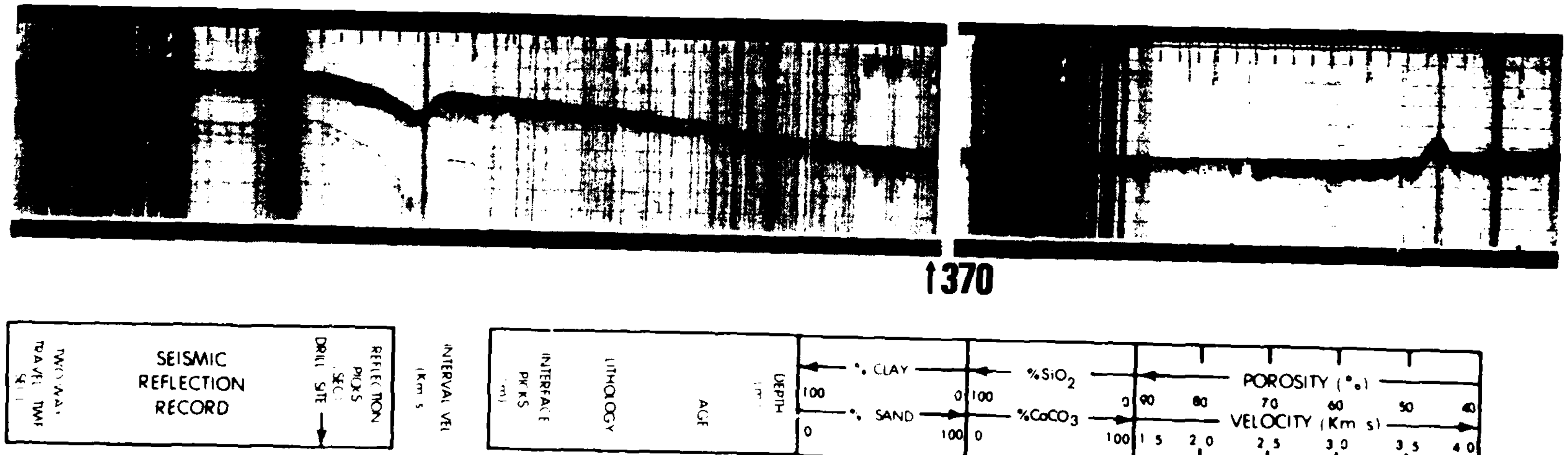
Position:
Latitude 32°50.2' N
Longitude 10°46.6' W
Date: 03/29/75
Time: 0006Z
Water depth: 4214 meters
Location: Deep basin off Morocco

CORE DATA

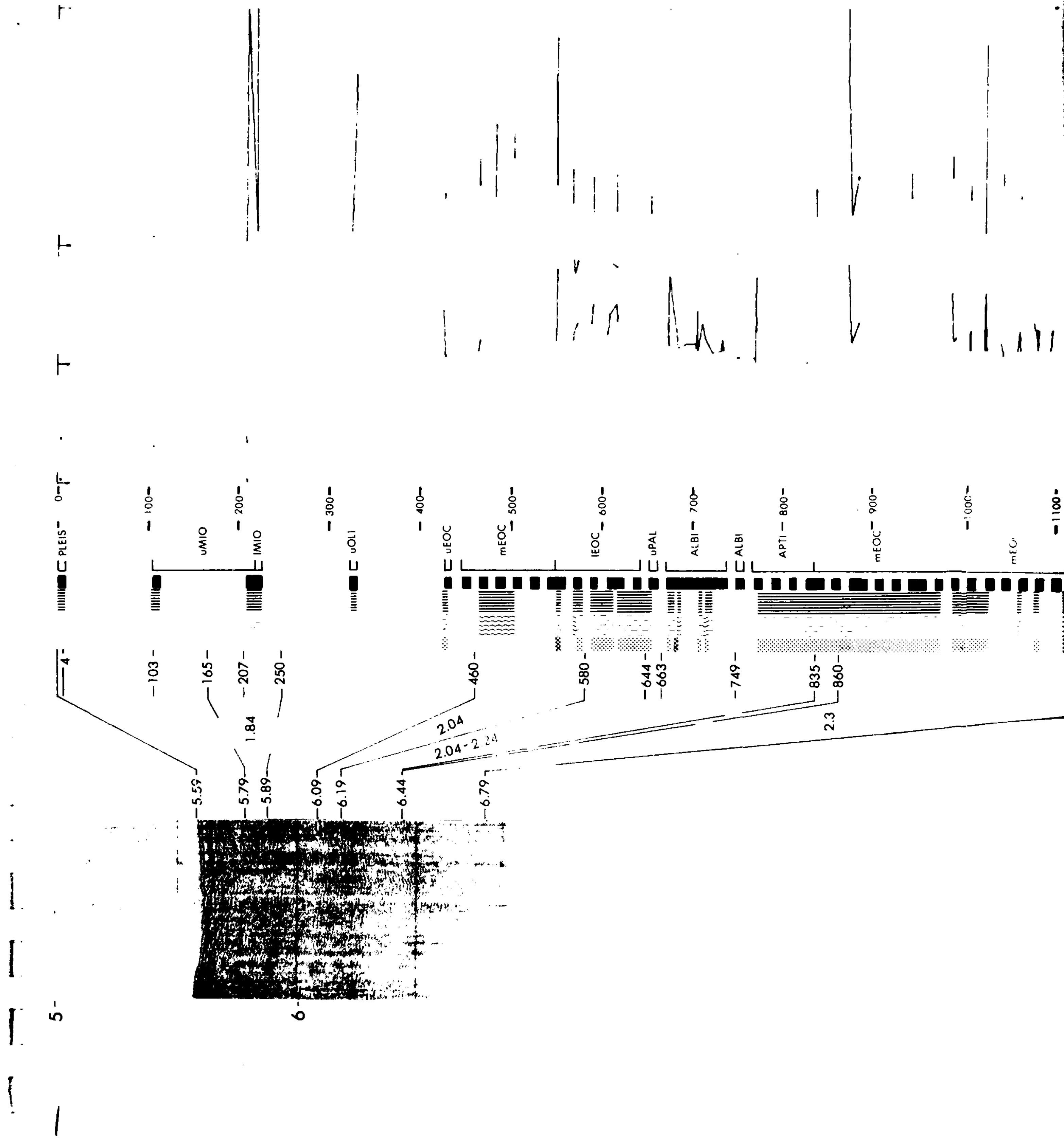
Penetration:
Drilled-- 693 meters
Cored---- 483 meters
Total----1176 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 51 cores
203 meters

The sediments display regular successions of turbidite sequences occasionally separated by pelagic intervals. Other redeposition features probably of more proximal character, are flow and current structures, convoluted silt and sand beds, "floating" pebbles in fine-grained slumped sediments, and current ripples. All these structures suggest deposition on a deep-sea fan and are typical of lower continental rise environments.

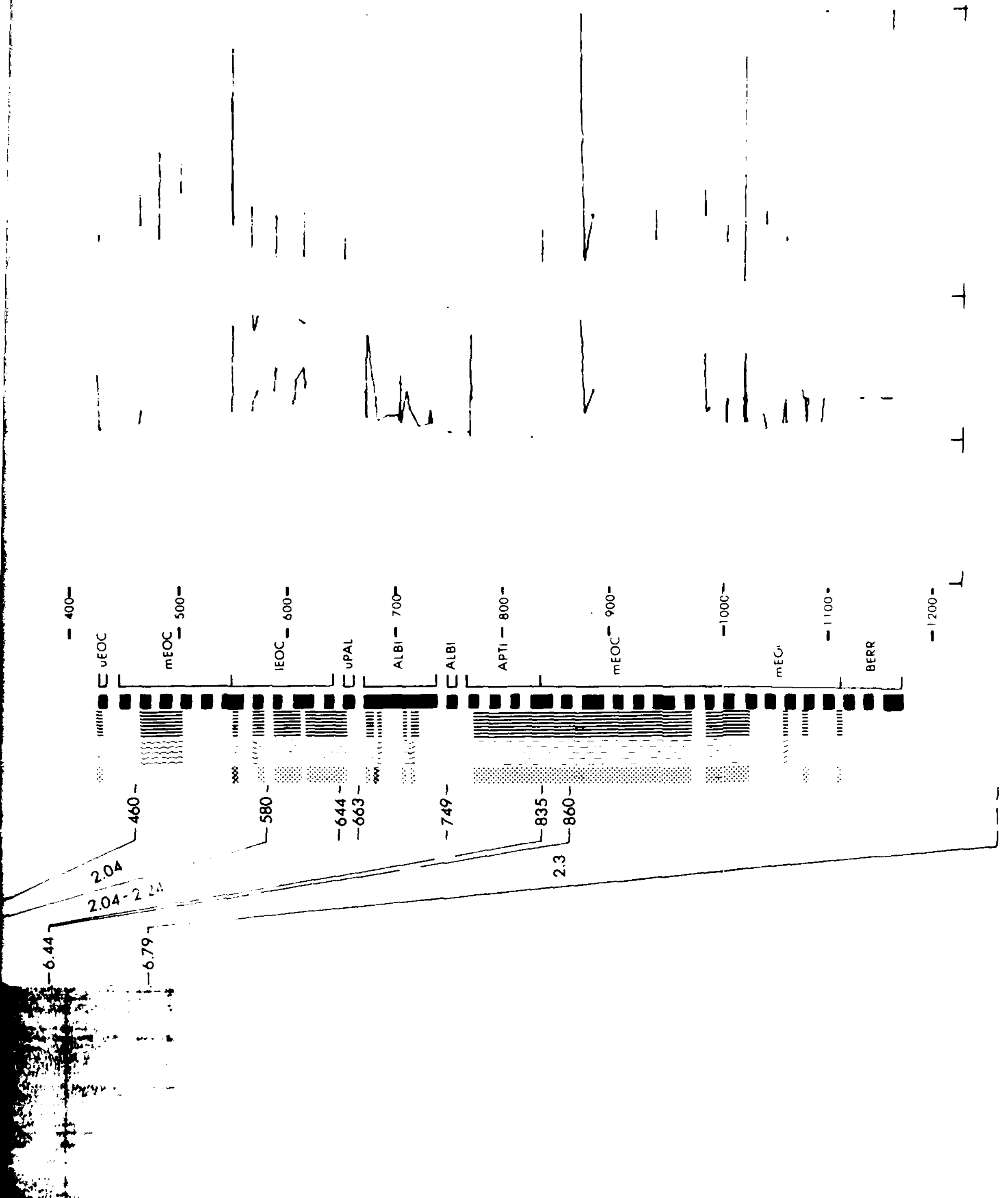
The composition of the terrigenous components does not seem constant throughout the section. During the Cretaceous and during the Neogene, siltstones and sandstones are mainly composed of quartz, possibly reflecting very active erosion on land. During the Eocene the composition of the coarse-grained sandstones and conglomerates is different and consists mainly of redeposited clay and mud pebbles, porcellanite fragments, detrital biogenic material and very abundant glauconite. The origin of this material is not clear. A hiatus of 35 m.y. is observed between the late Cenomanian and the middle Paleocene so that most of the Late Cretaceous is missing.



SITE 370 LEG 41



TE 370 LEG 41



400
500
600
700
800
900
1000
1100
1200
uEOC
mEOC
lEOC
uPAL
ALBI
ALBI
APTI
mEOC
BERR
460
580
644
663
749
835
860
2.04
2.3
6.44
6.79

SITE DATA

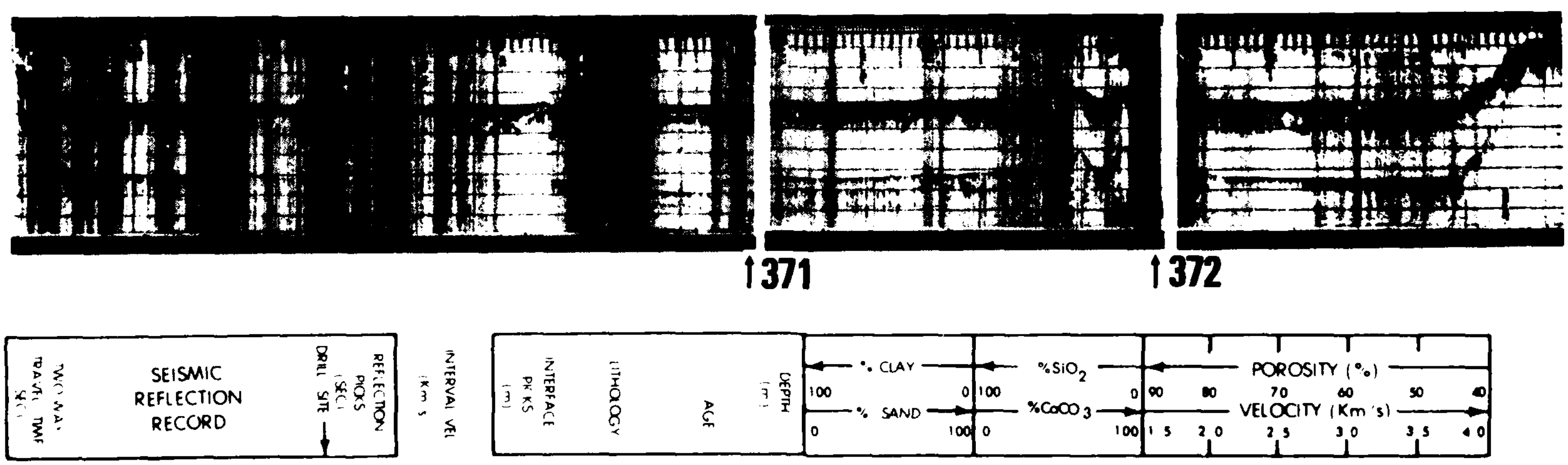
Position:
Latitude $37^{\circ} 35.9'$ N
Longitude $5^{\circ} 15.5'$ E
Date: 04/16/75
Time: 0854Z
Water depth: 2792 meters
Location: South Balearic Basin

CORE DATA

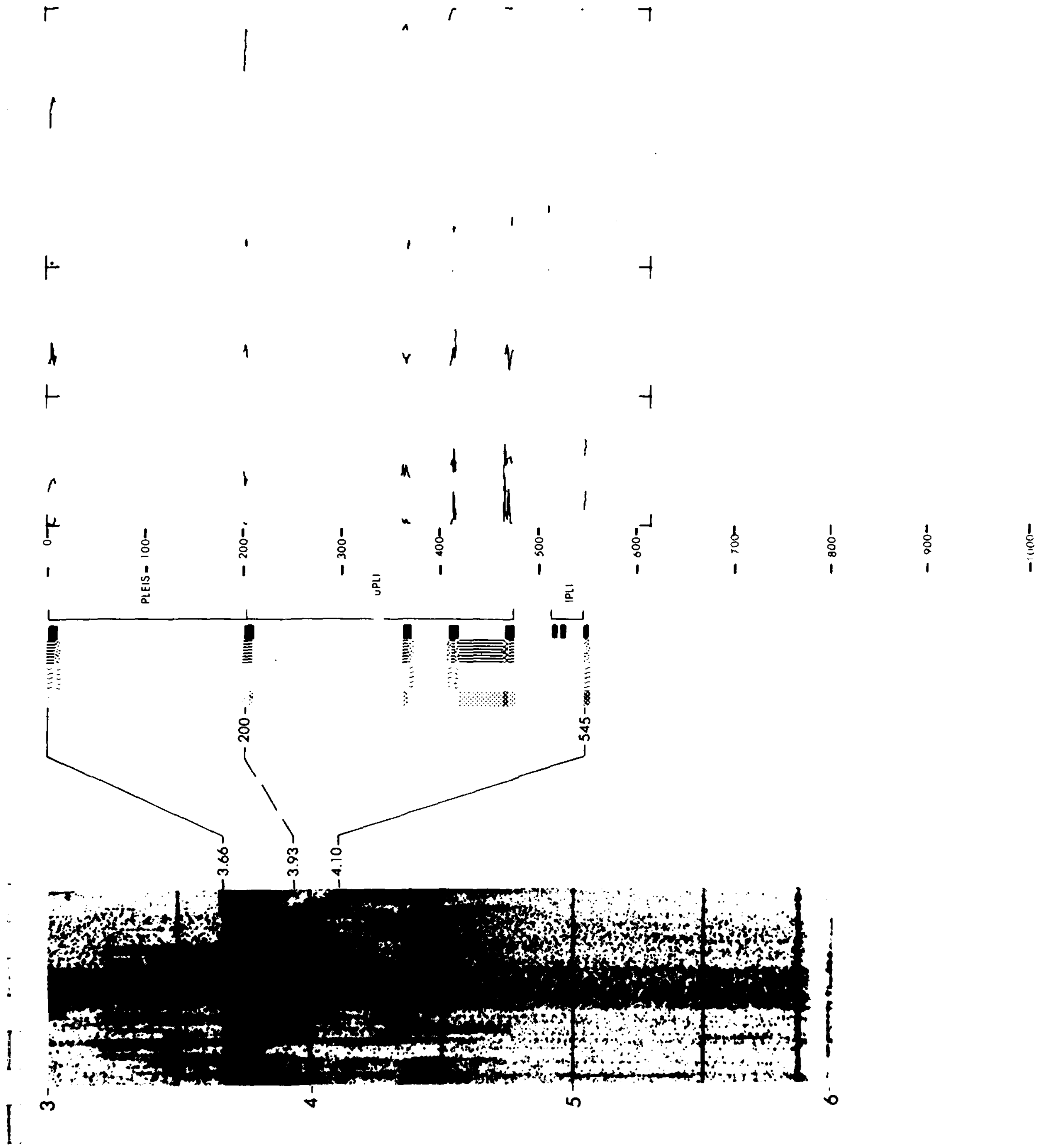
Penetration:
Drilled-- 489 meters
Cored---- 62 meters
Total---- 551 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 8 cores
43 meters

Unfortunately, a thin veneer of evaporite was present above basement, and the hole was terminated in accordance with a ruling of the JOIDES Safety Panel. Two major stratigraphic units were penetrated: a Plio-Quaternary sequence of calcareous muds and mudstones with sandy intercalations overlies the late Miocene evaporites. The muds and mudstones appear to have been deposited on a knoll which has stood slightly above the surrounding abyssal plain since the early Pliocene. The intercalated sands are distal turbidites and deposits reworked by contour currents. The depositional environment has remained in at least the upper to mid-mesobathyal (1000-2500 m) depth range from the early Pliocene to Holocene. The lowest Pliocene is absent on the paleotopographic high. The Messinian probably includes a sand deposit at its top, which is underlain by nodular anhydrite, containing stromotilitic seams and dolomitic sandy mud. This upper Miocene sequence is interpreted as indicative of a subaerial to shallow subaqueous evaporitic environment analogous to present-day salt pans.

Calcareous, one thin layer nannofossil rich, interbedded with thin detrital layers.



SITE 371 LEG 42



SITE DATA

Position:
Latitude 40°04.8' N
Longitude 4°47.8' E
Date: 04/19/75
Time: 0342Z
Water depth: 2699 meters
Location: East Menorca Rise

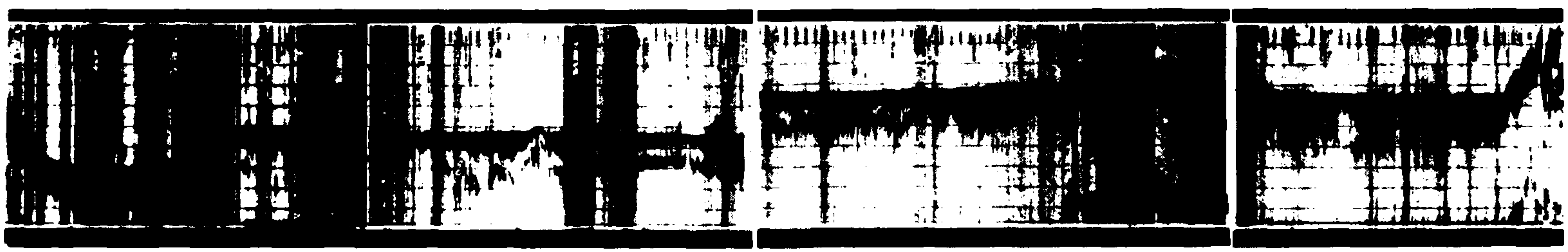
CORE DATA

Penetration:	372	372A	
Drilled--	454		meters
Cored----	431		meters
Total----	885	154	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	46	0	cores
	316	0	meters

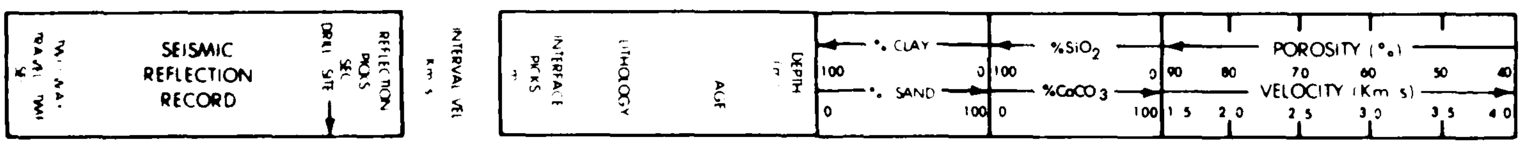
Unit I, Plio-Quaternary marls; Unit II, late Miocene gypsum and dolomitic marls; Unit III, early to middle Miocene marlstones to marls; Unit IV, early Miocene mudstones.

Although basement was not reached, extrapolation on the basis of sedimentation rates suggests that the earliest sediments deposited on the Menorca Rise should be earliest Miocene to Oligocene in age. The mudstones and marls of Units I, III, and IV are marine. A remarkable faunal change from normal marine mesobathyal (> 1500 m depth) to shallow lagoonal benthic faunas (300-500 m depth) occurs at the base of Unit II. The evaporites were deposited in subaerial to restricted subaqueous environments. Conditions returned to normal marine mesobathal (> 1500 m depth) in the early Pliocene Unit I. The structural history of the Menorca Rise is envisioned to have been somewhat similar to that established for stable continental margins in different parts of the world. Previous suggestions that the Baleric Basin owed its origin to Plio-Quaternary subsidence are discounted.

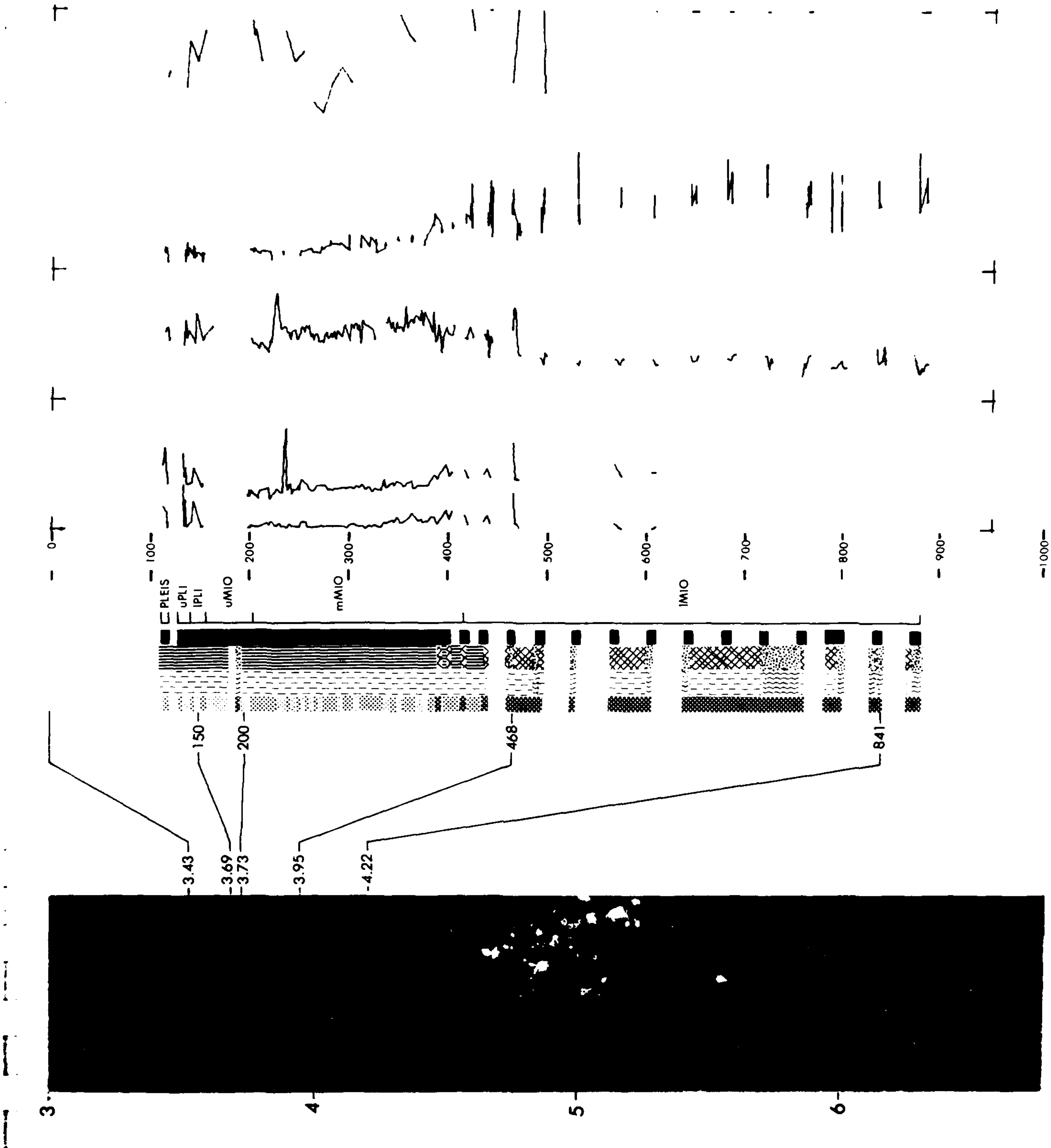
Calcareous, nannofossil rich, sediment interbedded with detrital sediments.



↑371 ↑372



SITE 372 LEG 42



SITE DATA

Position:
- Latitude 39° 43.7' N
- Longitude 12° 59.6' E

Date: 04/27/75
Time: 0419Z
Water depth: 3517 meters
Location: Tyrrhenian Abyssal Plain

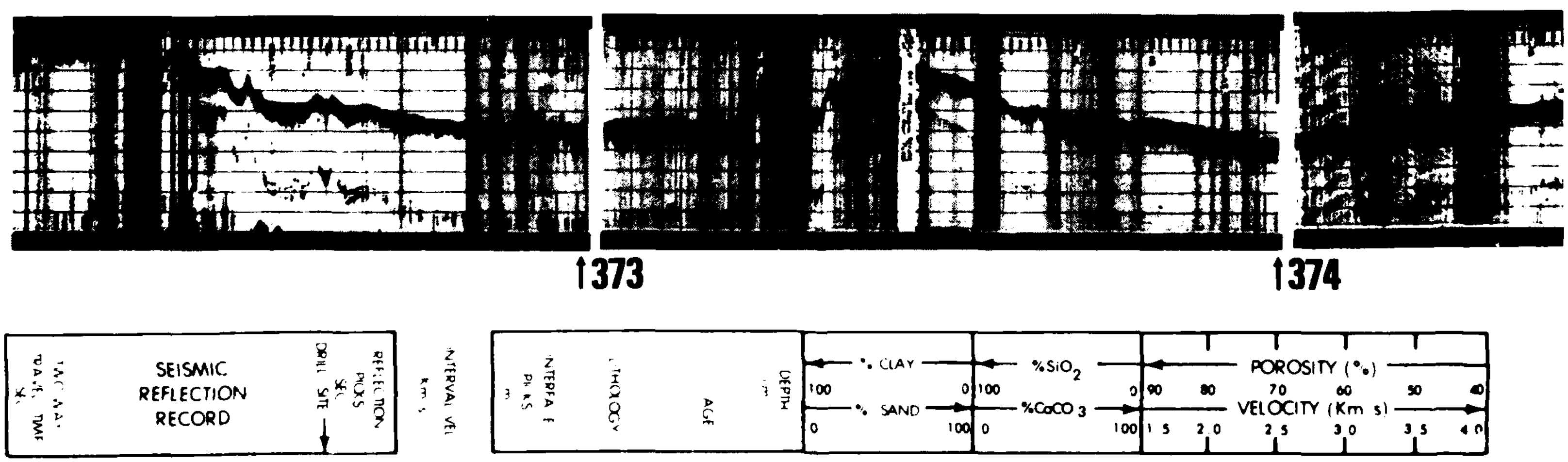
CORE DATA

Penetration:
- Drilled-- 343 meters
- Cored---- 114 meters
- Total---- 457 meters

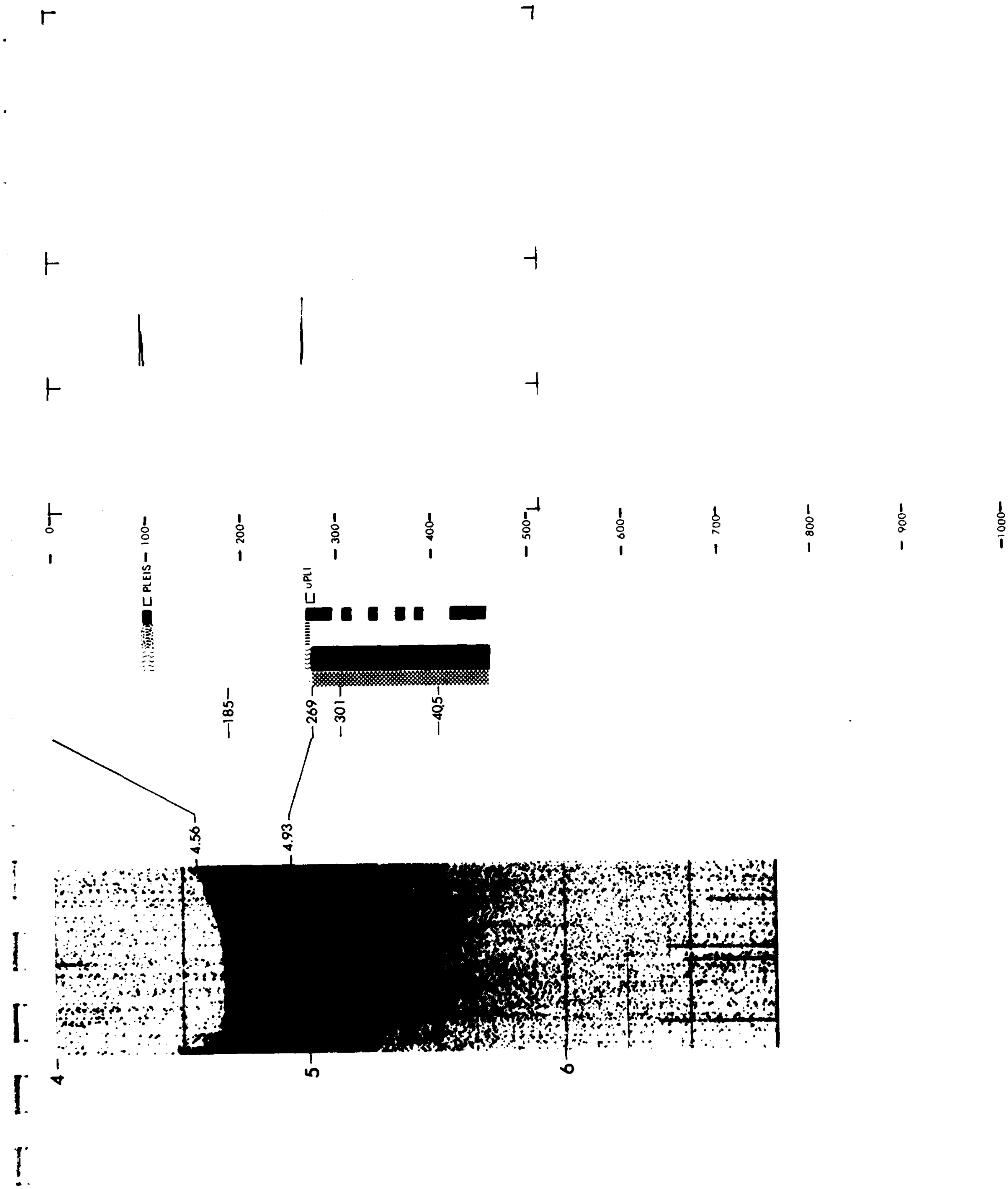
Recovery:
- Basement- 2 cores, 22 meters
- Total---- 12 cores, 27 meters

Site 373 was located on the flank of a seamount in the central Tyrrhenian Abyssal Plain and its prime objective was to sample the basement. The original hole was positioned too high on the flank and the bottom-hole assembly could not be stabilized. Hole 373A was an 800-meter offset to the west, where acoustic basement was encountered at 270 meters, and the hole was terminated in basalt at 457.5 meters. A Plio-Quaternary sequence of nannofossil marls, zeolite marls, and volcanic ashes and sands overlies a basaltic basement complex of calcareously cemented basalt breccias and flow basalts. The limestone matrix of the basaltic breccias contained foraminifers dated as not older than middle Miocene and is probably early Miocene. The flow basalts were extensively altered despite a penetration almost 200 meters beyond the top of basement. This basement complex bears a general resemblance to that encountered in drilling on the Mid-Atlantic Ridge. Basalt volcanism undoubtedly played a role in the genesis of the Tyrrhenian Basin.

Sediments in thin layers, detrital and calcareous, nannofossil rich. Surface sediment detrital, phosphate rich.



SITE 373 LEG 42



SITE DATA

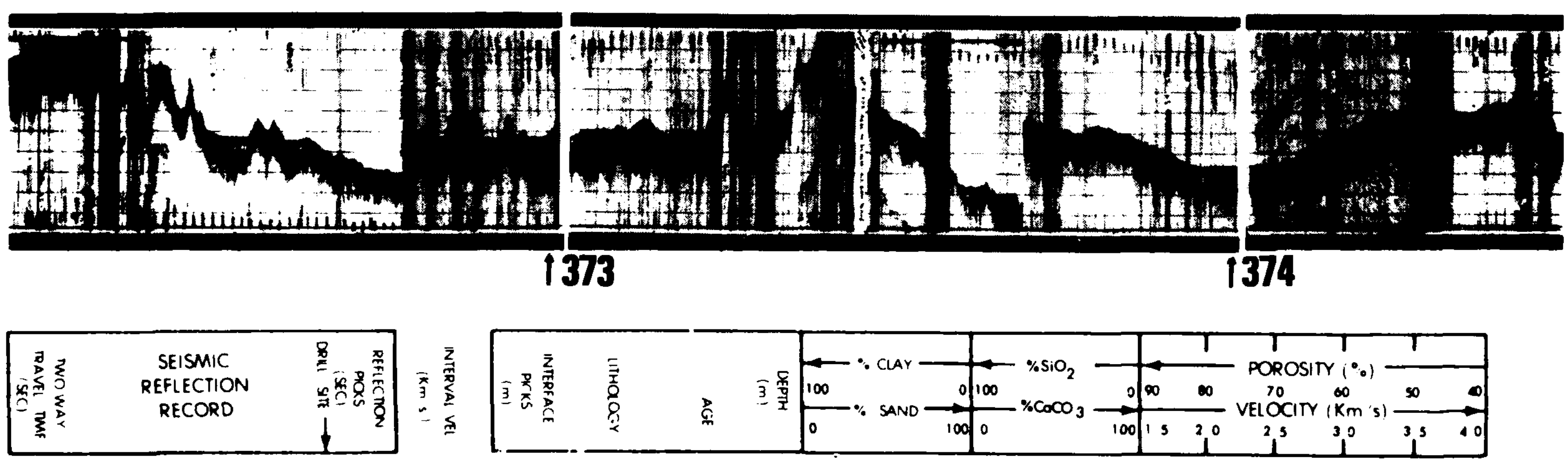
Position:
Latitude $35^{\circ}50.9'$ N
Longitude $18^{\circ}11.8'$ E
Date: 05/01/75
Time: 0244Z
Water depth: 4078 meters
Location: Central Messina Abyssal Plain

CORE DATA

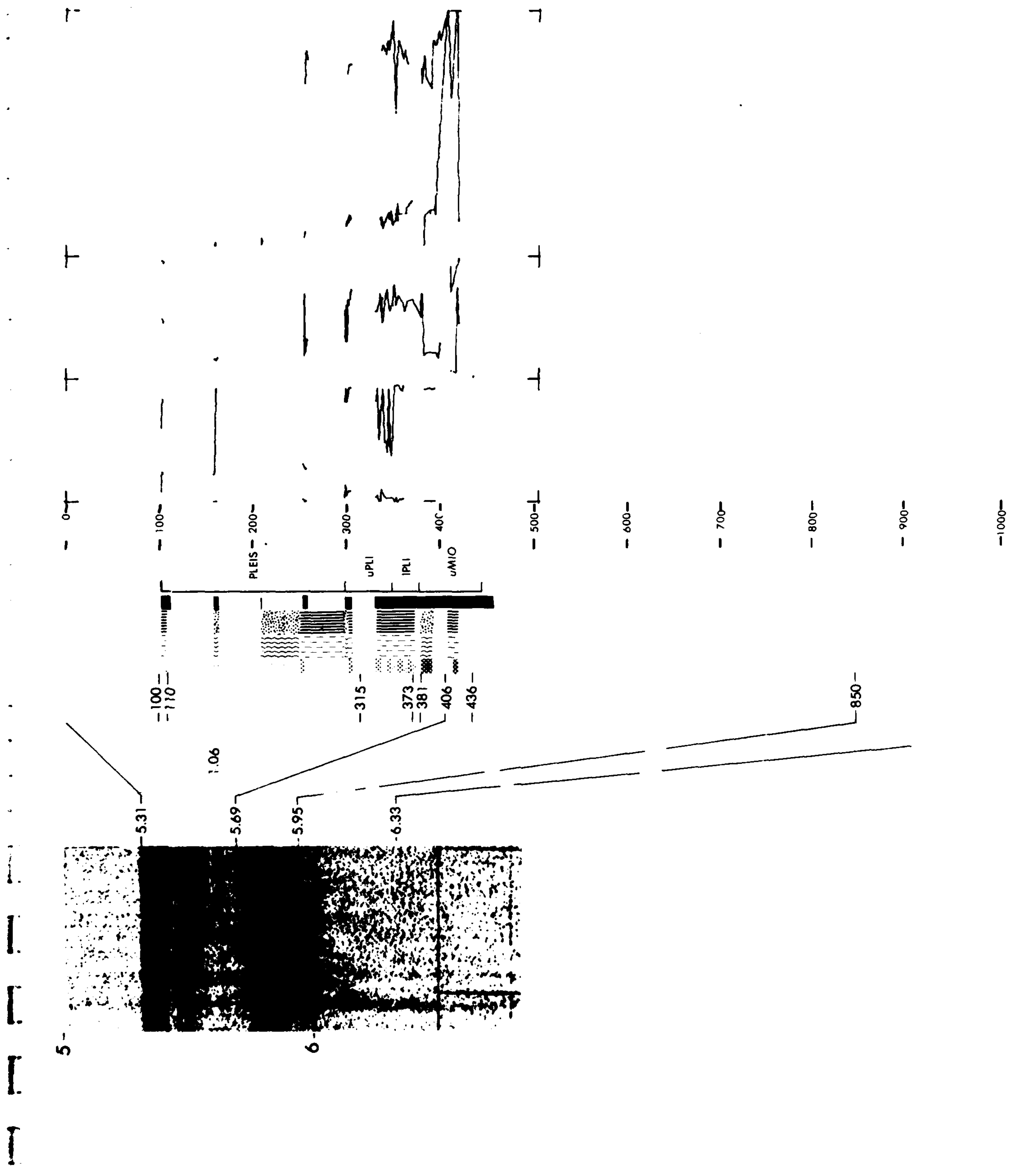
Penetration:
Drilled-- 304 meters
Cored---- 153 meters
Total---- 457 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 24 cores
77 meters

The Plio-Quaternary sequence, which overlies the late Miocene (Messinian) evaporites, is of hemipelagic nannofossil muds, marls, and oozes interspersed with sapropels and sapropelic marls, which were deposited when the basin was stagnant. An upward increase in the frequency of sand and silt layers, a decrease in carbonate content and an increase in sedimentation rate, together show a trend towards more terrigenous influx to the basin in the late Quaternary. The site has remained at mesobathyal depths since the early Pliocene. Repopulation of benthic faunas after the Messinian salinity crisis probably took place gradually. This suggests the existence of a shallow sill between the eastern and western Mediterranean in the earliest Pliocene. The late Miocene evaporites drilled, by reference to seismic profiles, must belong to the "upper Evaporite" member of the Mediterranean Evaporite formation. Dolomitic mudstones overlie a sequence of mudstone-gypsum cycles and these in turn overlie anhydrite and halite.

Calcareous, mostly nannofossil rich, oolite rich in upper Miocene, sediment interbedded with detrital sediment, occasionally serpentine rich.



SITE 374 LEG 42



SITE DATA

Position:
- Latitude $34^{\circ} 45.7'$ N
- Longitude $31^{\circ} 45.6'$ E

Date: 05/07/75
Time: 1258Z
Water depth: 1900 meters
Location: Florence Rise, west of Cyprus

CORE DATA

Penetration:
- Drilled-- 748 meters
- Cored---- 73 meters
- Total---- 821 meters

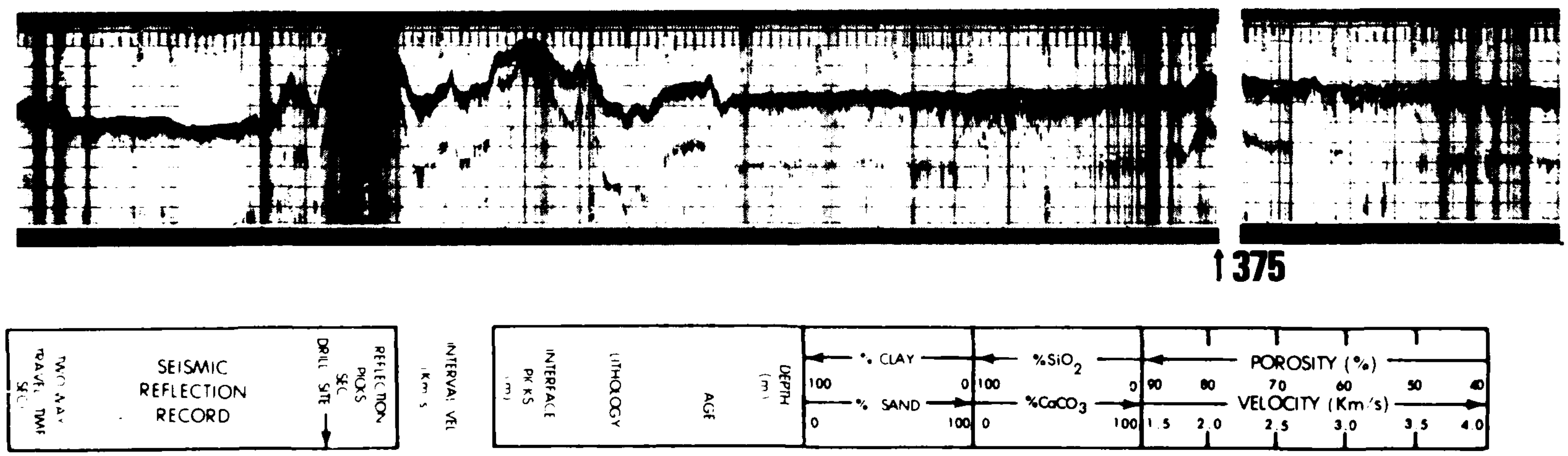
Recovery:
- Basement- 0 cores
  0 meters
- Total---- 13 cores
  67 meters

Sites 375 and 376 are discussed together.

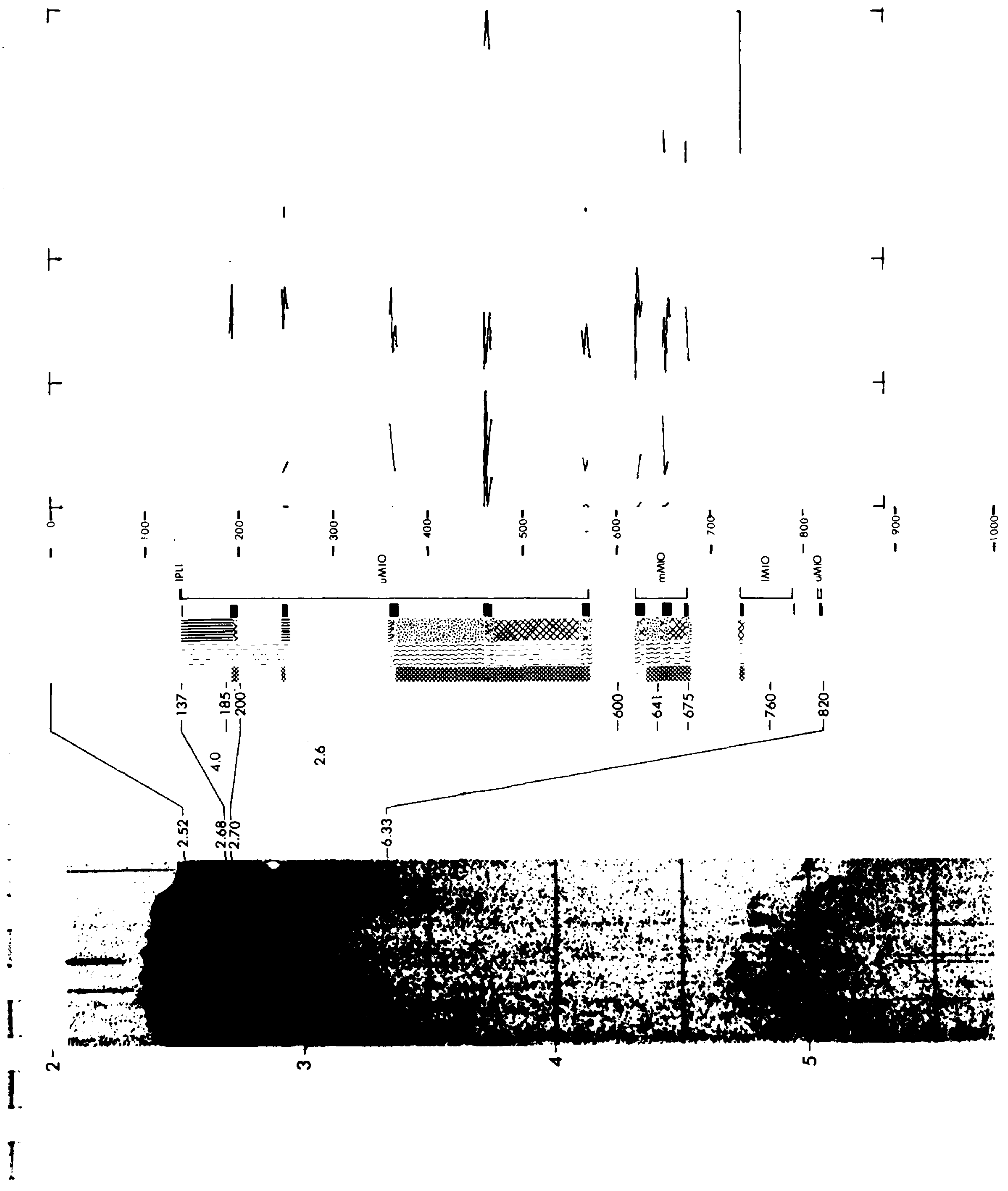
Site 375, near the top of the rise intermittently cored a sediment sequence, Burdigalian to Quaternary in age. Site 376, on the Antalaya basin flank of the rise, almost continuously cored a Messinian to Holocene sequence. The sites complement each other and combined, provide a standard section for correlation with sequences described on land in Cyprus.

The Quaternary nannofossil marls contain tephra and sapropelic layers, indicative of volcanic events and periods of basin stagnation, respectively. The Pliocene nannofossil marls, also containing sapropelic layers, have extremely low sedimentation rates, due to numerous hiatuses, and are complicated by sediment slumping. (Continued on Site 376.)

Calcareous, occasionally nannofossil rich, rarely oolite rich, sediment interbedded with thin layers of detrital, rarely mica or serpentine rich, sediment.



SITE 375 LEG 42



SITE DATA

Position:
Latitude $34^{\circ}52.3'$ N
Longitude $31^{\circ}48.4'$ E
Date:
Time:
Water depth: 2101 meters
Location: Florence Rise, west of Cyprus

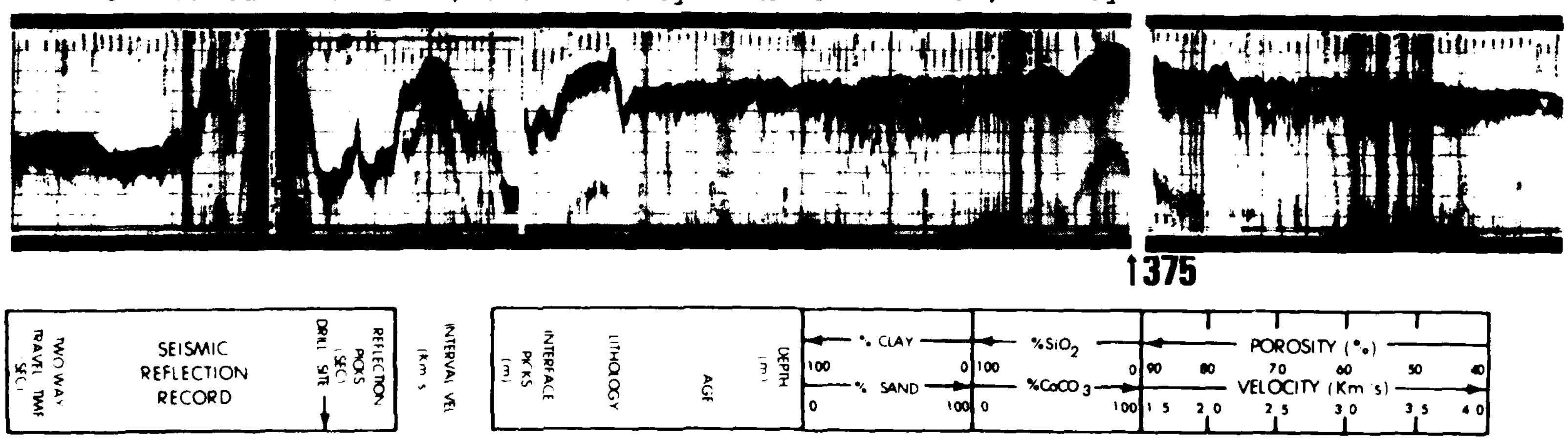
CORE DATA

Penetration:
Drilled-- 14 meters
Cored---- 202 meters
Total---- 216 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 23 cores
76 meters

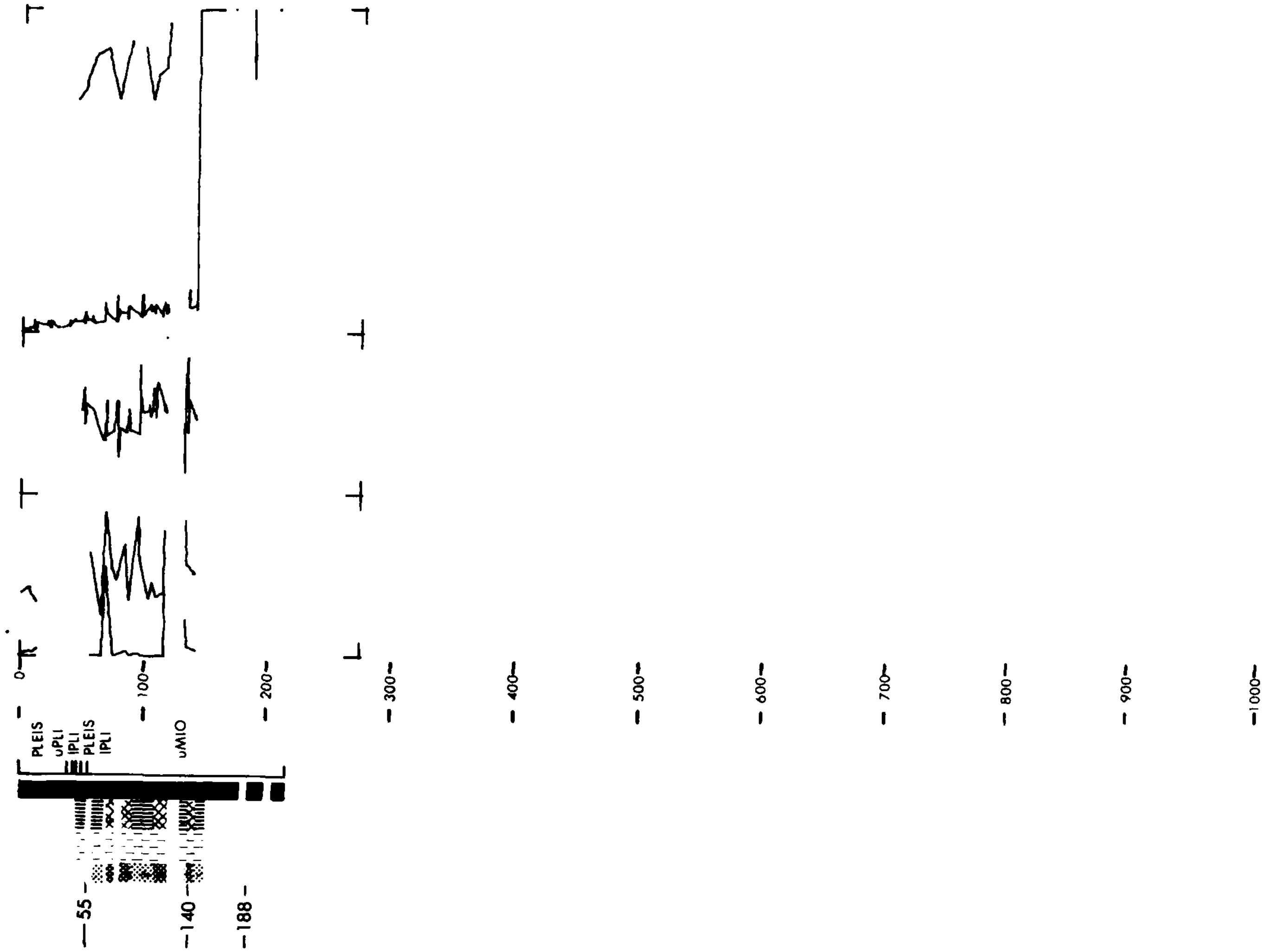
Sites 375 and 376 are discussed together, and the discussion is continued from Site 375.

Nannofossil marlstones and dolomitic marlstones of latest Miocene age overlie a gypsum with marlstone evaporite sequence. Siltstones and sandstones within this upper marl and marlstone unit are interpreted as turbidites. Faunas believed to be autochthonous, contain Ammonia beccari and Cyprideis pannonica indicative of a brackish euryhaline "Lago Mare" environment. Horizons with marine microfossils show that there was occasional influx of marine waters into this "Lago Mare." The gypsum with marlstone evaporites, which are interpreted as deposits of a shallow subaqueous environment, are followed downwards by anhydrite and halite at Site 376 and are collectively recognized as the upper part of the Mediterranean Evaporite Formation. The pre-evaporite sequence of Site 375 comprises 400 meters of flysch-like sediments, including sapropelic layers which overlie more than 200 meters of hemipelagic marlstones with distal turbidites, having at their base intercalated limestones which constitute an acoustic reflector. Analyses of benthic foraminifers suggest that this pre-Messinian sequence was deposited in a basin with water depths throughout in excess of 1000 meters.

Calcareous sediments; occasionally nannofossil rich, rarely foraminifera rich.



SITE 376 LEG 42



SITE DATA

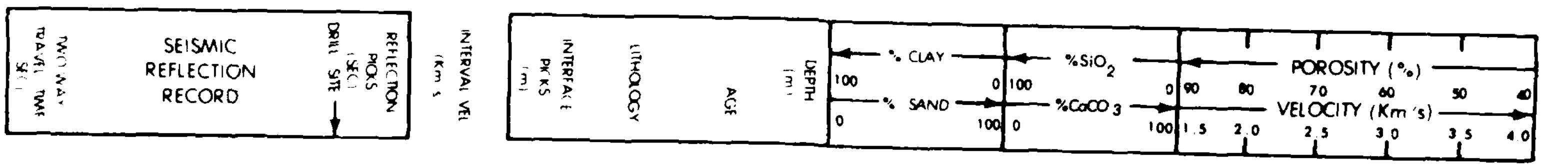
Position:
Latitude 35° 09.7′ N
Longitude 21° 25.9′ E
Date: 05/15/75
Time: 0745Z
Water depth: 3718 meters
Location: Mediterranean Ridge

CORE DATA

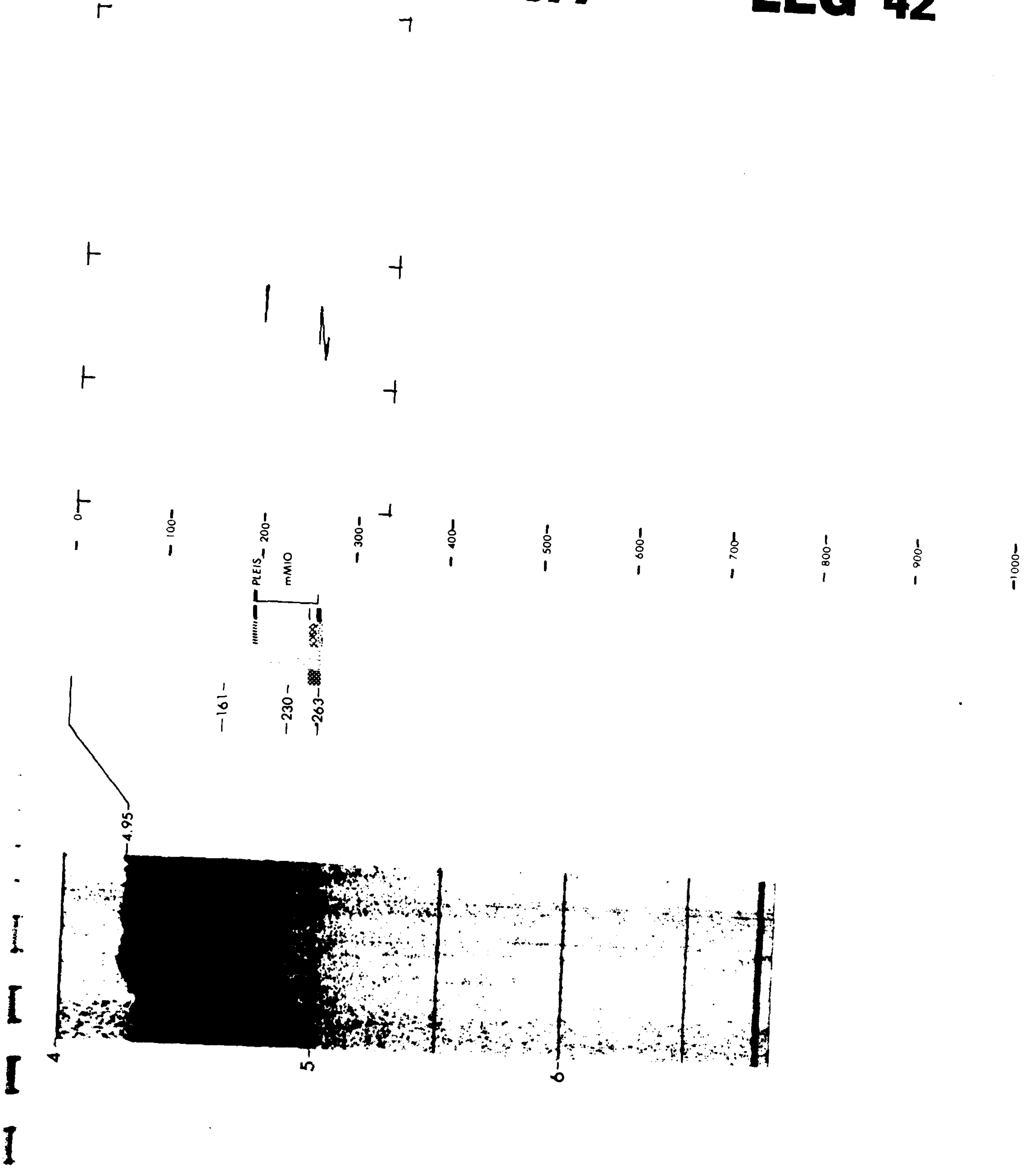
Penetration:
Drilled-- 253 meters
Cored---- 10 meters
Total---- 263 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
6 meters

Site 377 was located in a cleft on the Mediterranean Ridge, previously drilled by Leg 13 (Site 126). Its objective was to penetrate further a pre-Messinian section known to be present beneath the Quaternary valley-fill. The hole penetrated 100 meters into the pre-Messinian, but was terminated at 263 meters subbottom because of an unproductive drilling rate. In this hole a middle Miocene marl was encountered underlain by a flysch-like terrigenous sequence of siltstones, sandstones, and dark gray mudstones. These sediments were deposited on a continental rise or in a basinal setting, prior to their uplift by pre-Quaternary tectonic deformation. The poorly preserved benthic faunas were nevertheless, sufficient to demonstrate a bathyal depth here in the middle Miocene.

One thin layer of detrital sediment occurs in cored interval.



SITE 377 LEG 42



SITE DATA

Position:
- Latitude 35°55.7' N
- Longitude 25°07.0' E

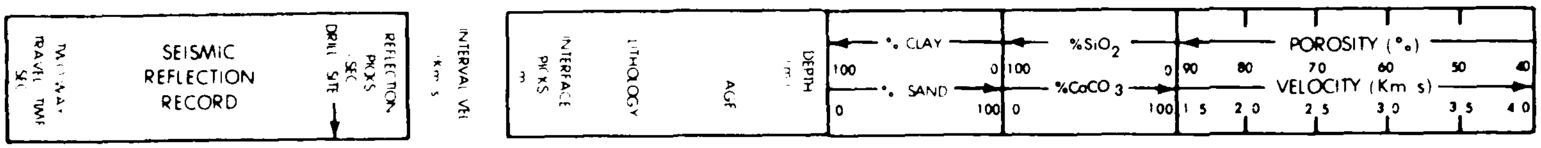
Date: 05/17/75
Time: 1444Z
Water depth: 1835 meters
Location: North Cretan Basin

CORE DATA

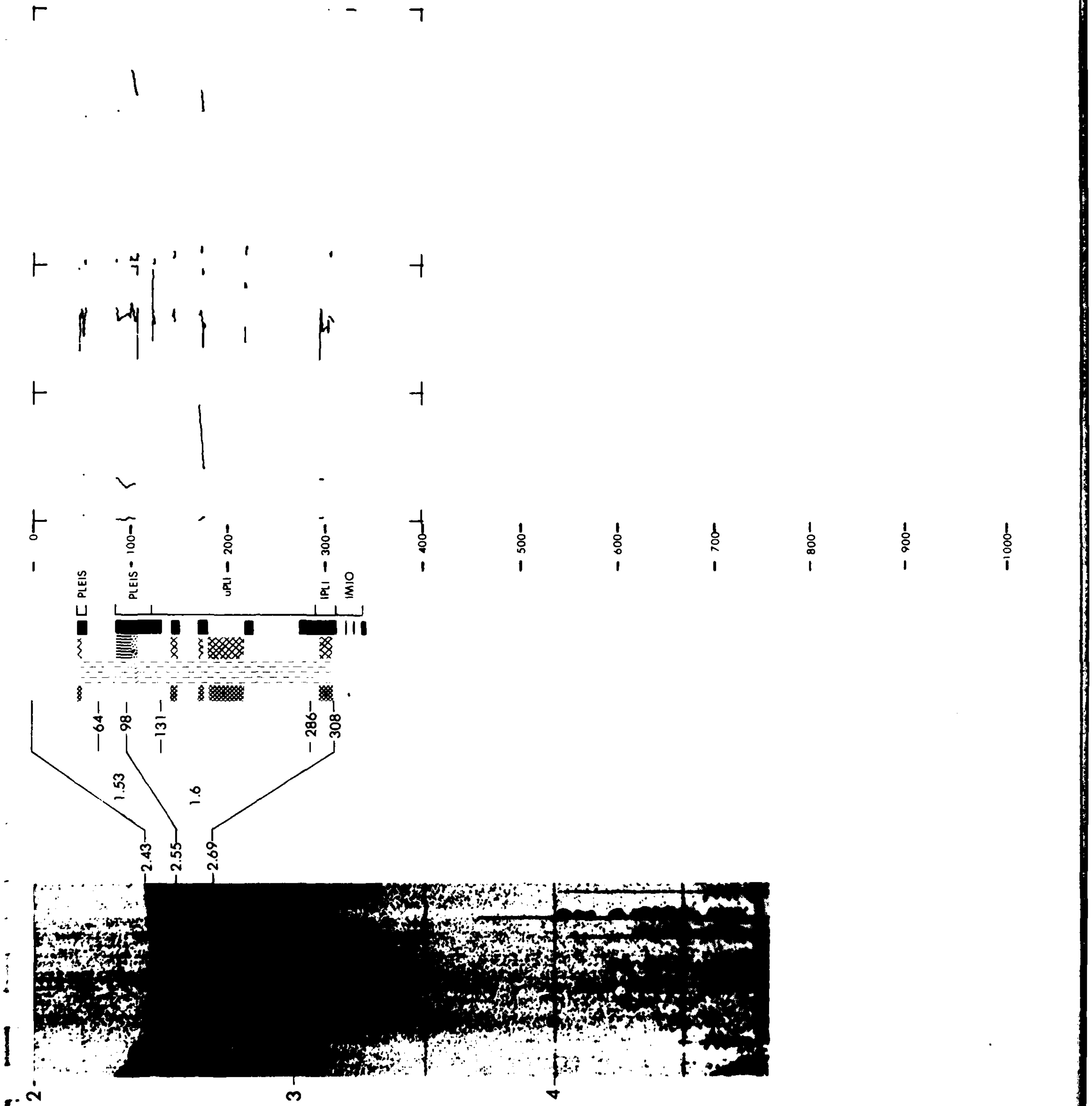
Penetration:	378	378A	
Drilled--	228	297	meters
Cored----	84	46	meters
Total----	312	343	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	11	9	cores
	39	20	meters

The Quaternary sequence of nannofossil marls and ooze with numerous sapropels and sapropelic layers was deposited at a high sedimentation rate (up to 200m/m.y.). The more compacted and slightly cemented Pliocene nannofossil marlstones contained numerous sapropels and burrows. The Plio-Pleistocene sapropels and sapropelic layers display numerous burrows and current structures. At the base of the Pliocene sequence, the sedimentation rate decreases sharply to about 9m/m.y. The late Miocene evaporites are represented mainly by coarse selenitic overlain by a brecciated dolomitic gypsum limestone. These are interpreted as having been deposited in a shallow subaqueous environment with occasional subaerial diagenesis. The "Lago Mare" facies of dolomitic marls, which was found at the other eastern Mediterranean sites, is absent here. The most recent major deformation event in the Cretan Basin was probably in the early to middle Quaternary. Heat-flow studies support geophysical interpretations of the area as a recently created back-arc basin, which is presently being underthrust by the eastern Mediterranean sea floor.

Calcareous, mostly nannofossil rich, once foraminifera rich, sediment interbedded with only one thin layer of detrital sediment (Pleistocene).



SITE 378 LEG 42



SITE DATA

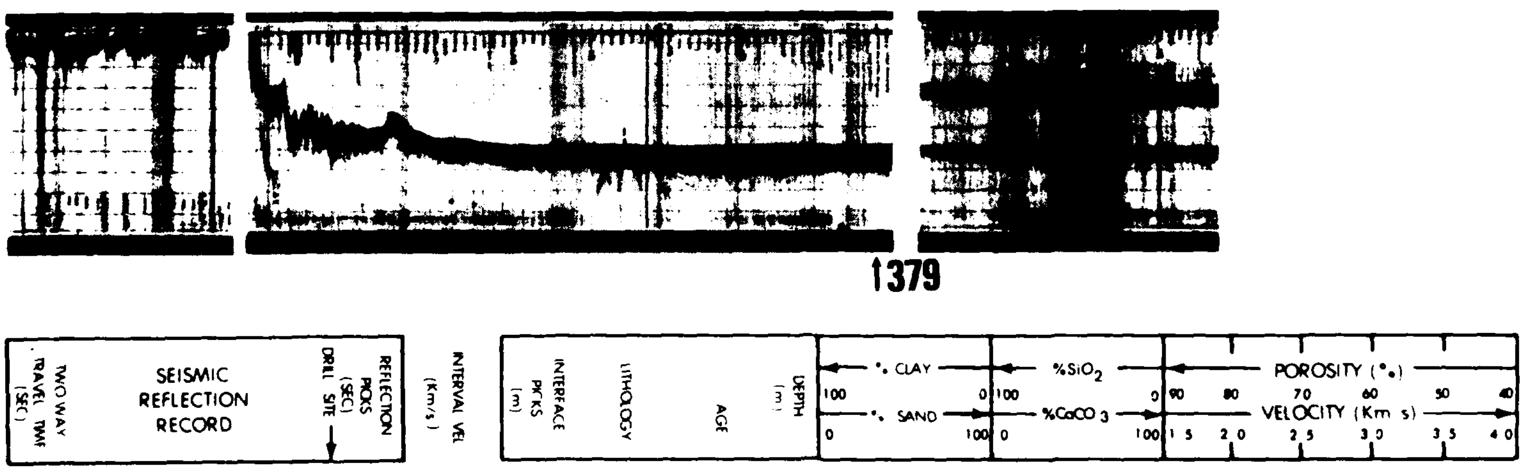
Position:
Latitude 43°00.3' N
Longitude 36°00.7' E
Date: 05/28/75
Time: 0730Z
Water Depth: 2165 meters
Location: Central Black Sea

CORE DATA

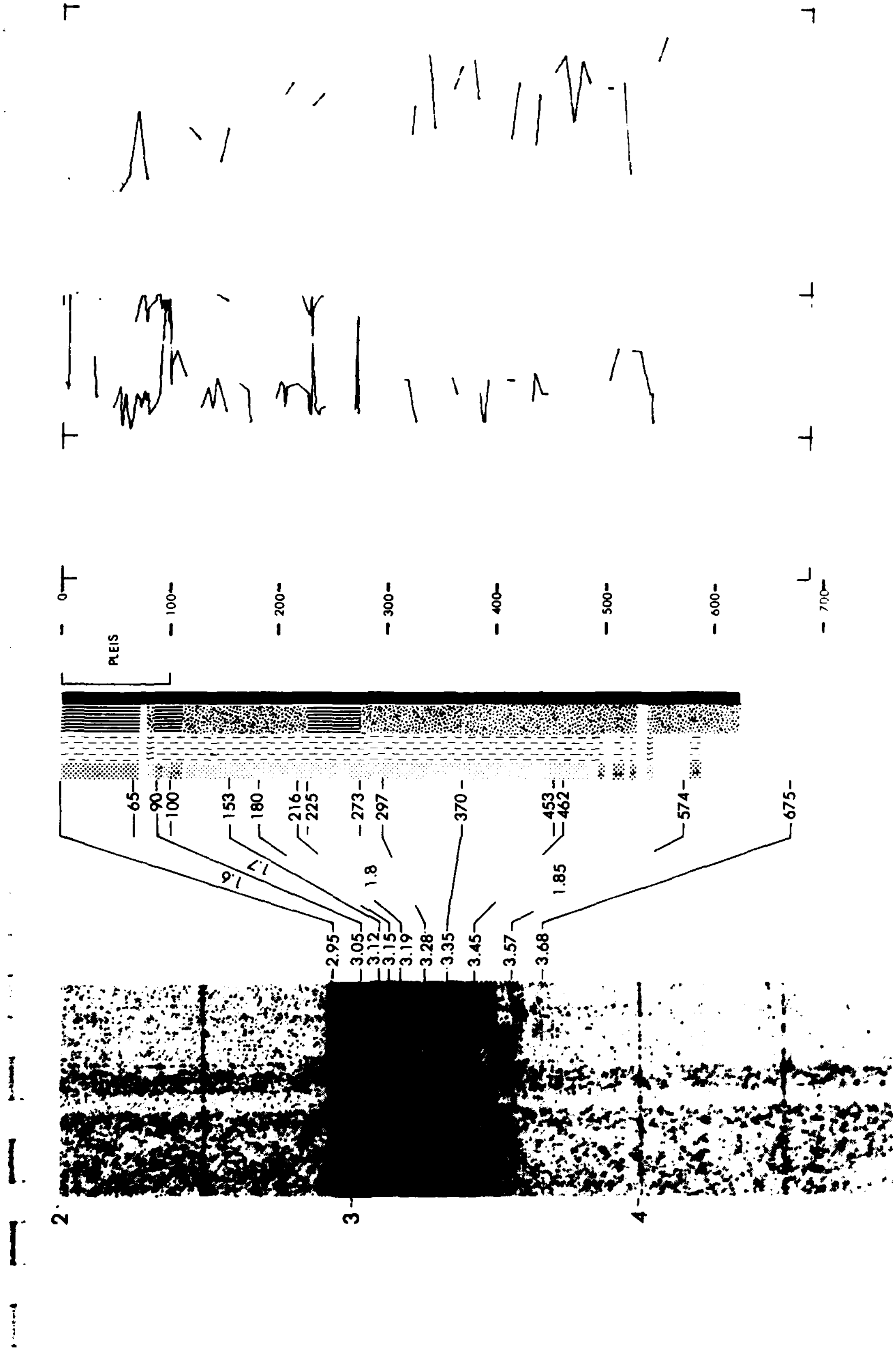
Penetration:	379	379A	379B	
Drilled--	0	2.5	78	meters
Cored----	7	622	81	meters
Total----	7	624	159	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	68	9	cores
	4	381	29	meters

The sediment section can be divided into nine subunits, but in general are of terrigenous origin. Sediments are mainly a dark greenish-gray to dark gray terrigenous mud, with occasional interbeds of silts, sandy silts, and sands. Some of the coarse beds are graded, suggesting that they were deposited from turbidity currents. Based on micro-palentological, stratigraphic, and other studies, it seems clear that the entire section is Pleistocene in age. The fauna and flora from this site occasionally indicated (when present) environmental changes. Periods of fresh or brackish water conditions were common in the past. Spores and pollen were especially useful, in particular using ratios of typical Steppe to Forest forms. These ratios indicate three cool or Steppe periods (called Alpha, Beta, and Gamma) and three warmer or Forest periods (called Celia, Betty, and Anna) which, besides being of environmental importance, permit some degree of correlation with Site 380.

Calcareous, rarely nannofossil, aragonite, or oolite rich sediment interbedded with detrital, rarely mica rich, sediment.



SITE 379 LEG 42



SITE DATA

Position:
Latitude 42°05.9'N
Longitude 29°36.8'E
Date: 05/29/75
Time: 2030Z
Water depth: 2107 meters
Location: Black Sea; basin apron

CORE DATA

Penetration:	380	380A	
Drilled--	0	339	meters
Cored----	370	734	meters
Total----	370	1073	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	40	79	cores
	169	421	meters

The upper part of the section is of terrigenous origin whereas chemical sediments are more typical of the lower 600 or 700 meters. Sedimentation rates in the range of 30-40 cm/1000 yr. appear likely for the Quaternary section (assuming a 1.5 to 2 m.y. age for the beginning of the Pleistocene glaciation).

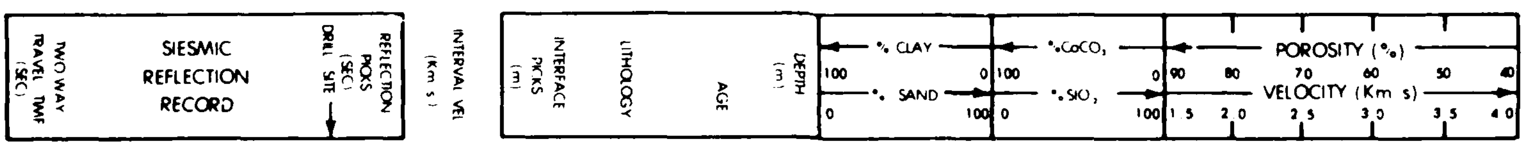
Sediments having high amounts of carbonate intercalations were common in the lower and middle parts of the section. It appears that late Miocene was the oldest age reached by drilling at this site.

The sediment section, as at *Sites 379 and 381, was* not very rich in fauna and flora (with the general exception of spores and pollen), thus age determination was difficult.

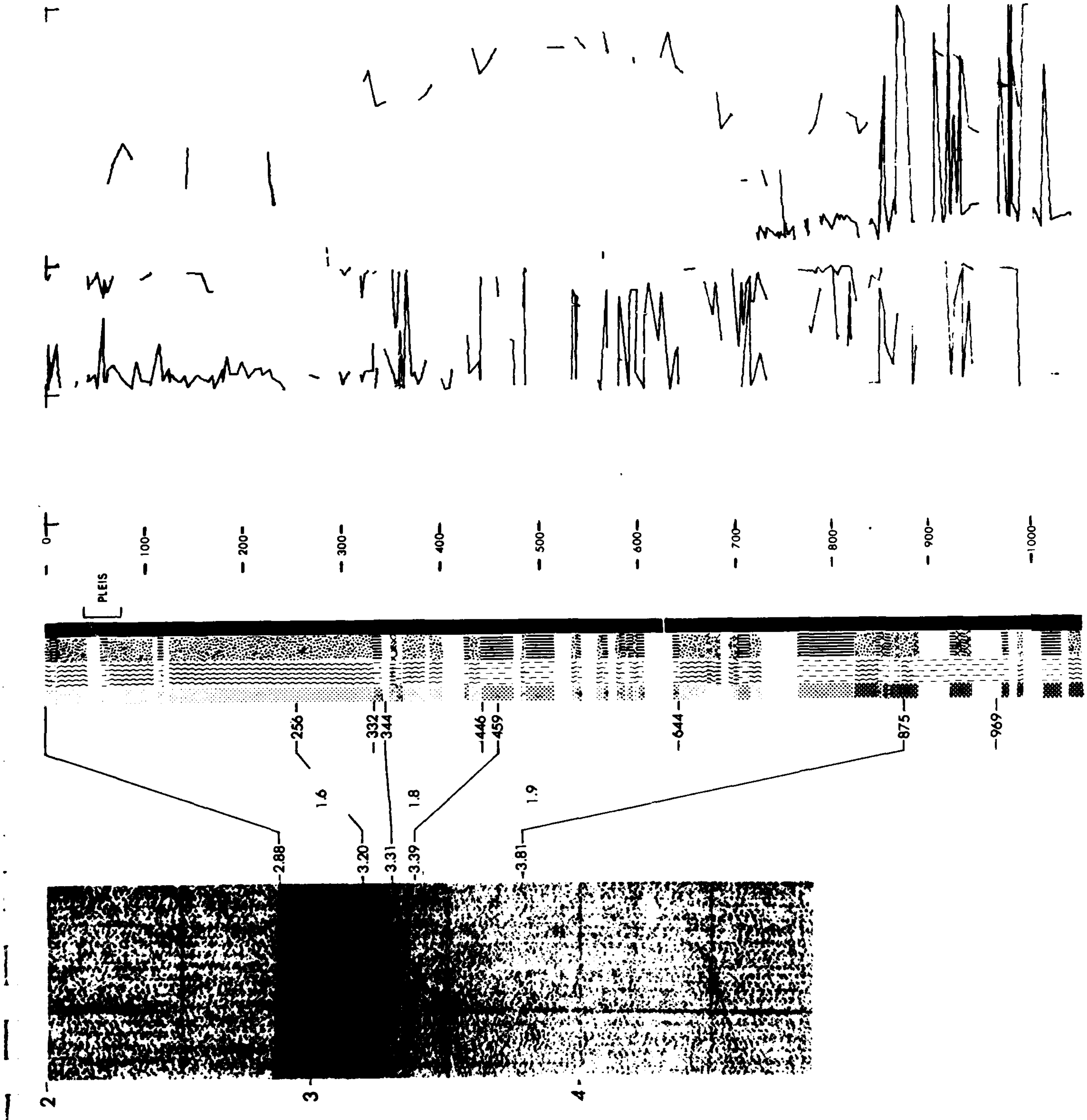
The cores were generally very gassy, but methane/ethane ratios stayed within a safe range. Interstitial salinities slowly increased with depth reaching a maximum of 98°/oo. Five of eight heat flow values are considered to be representative of in situ conditions and show a geothermal gradient of 35°C/km.

The most important microfossil group appears to be the pollen and spores. As with Site 379 three major steppe peaks and four cooler dryer periods were observed. These can be used for correlation between sites.

Interbedded calcareous and detrital sediments. Calcareous; rarely oolite rich, only once aragonite rich, and once lamellibranch rich. Three thin layers of siliceous, diatom rich sediment occur at approximately 700 meters subbottom.



SITE 380 LEG 42



SITE DATA

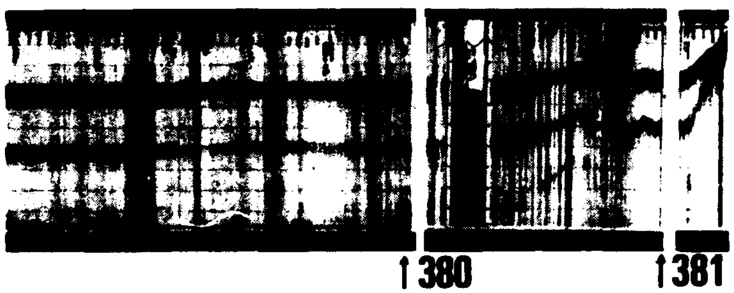
Position:
Latitude 41° 40.2' N
Longitude 29° 25.0' E
Date: 06/07/75
Time: 1530Z
Water depth: 1728 meters
Location: Black Sea

CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 503 meters
Total---- 503 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 54 cores
269 meters

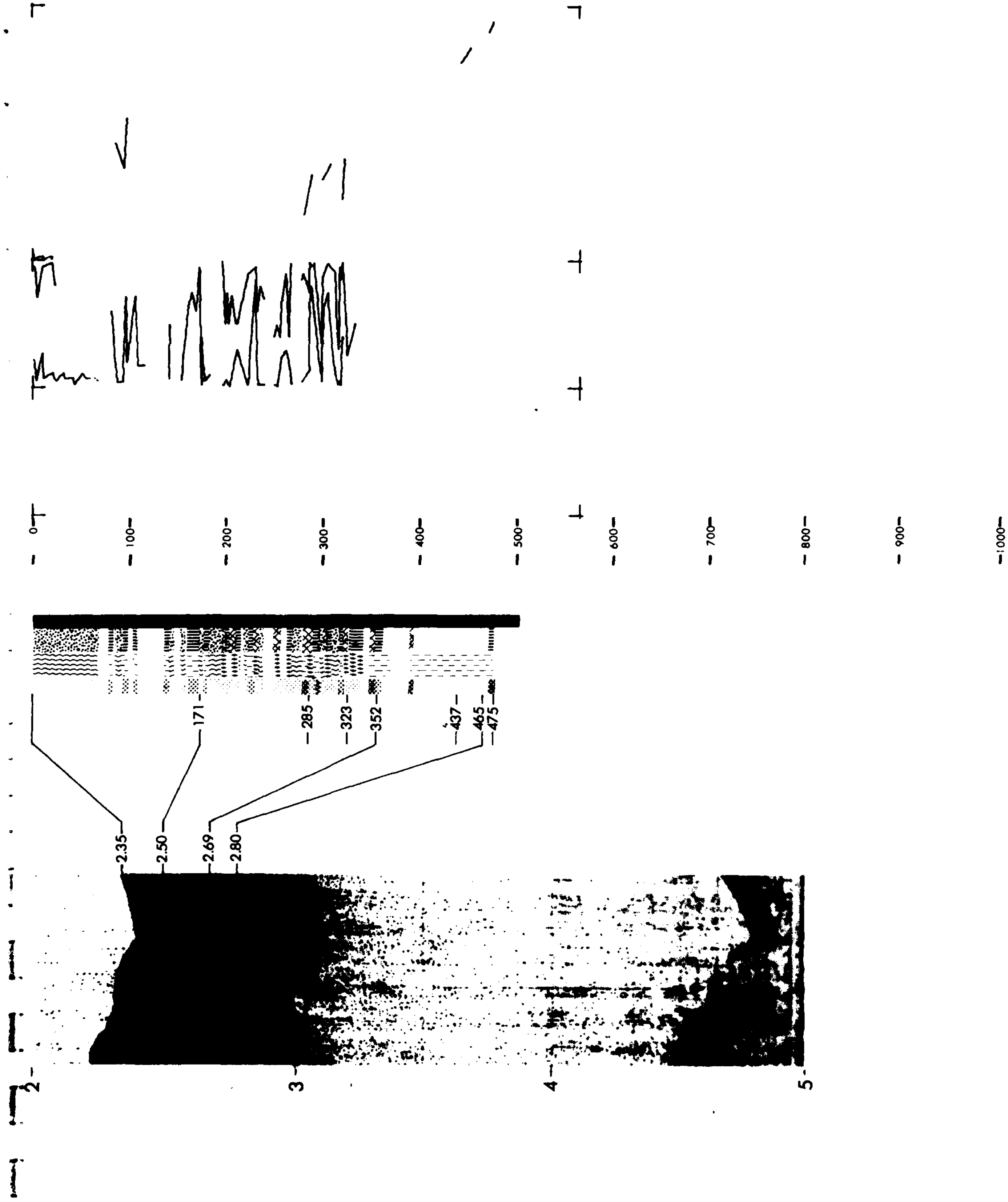
Nine sedimentary units were described from this site terrigenous muds and chemical sediments are common as at other sites, while the fauna and flora are likewise not very useful. The presence of breccia, shellhash and some fauna indicates extremely shallow water conditions during deposition of some of the sedimentary units, subareal exposure is possible. The faunal record, especially the spores and pollen are not as complete as at Sites 379 and 380; the cool period Beta appears to be absent and Alpha is somewhat reduced—these data are useful but not conclusive in establishing correlation with the other two sites. Pore fluids did not show the fresh-water sequences common in the other sites— salinity decreased below 360 meters which is also different than that of the other sites. It could be concluded that some of the sedimentary section is missing—a point also possibly indicated by some stratigraphic evidence.

Interbedded calcareous, siliceous, and detrital sediments in thin layers. Siliceous; diatom rich.



TWO WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE	INTERVAL VEL (Km/s)	INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	100 ← % CLAY 0 / 0 % SAND → 100	100 ← %SiO$_2$ 0 / 0 %CaCO$_3$ → 100	90 80 70 60 50 40 ← POROSITY (%) / 1.5 2.0 2.5 3.0 3.5 4.0 VELOCITY (Km/s) →

SITE 381 LEG 42



SITE DATA

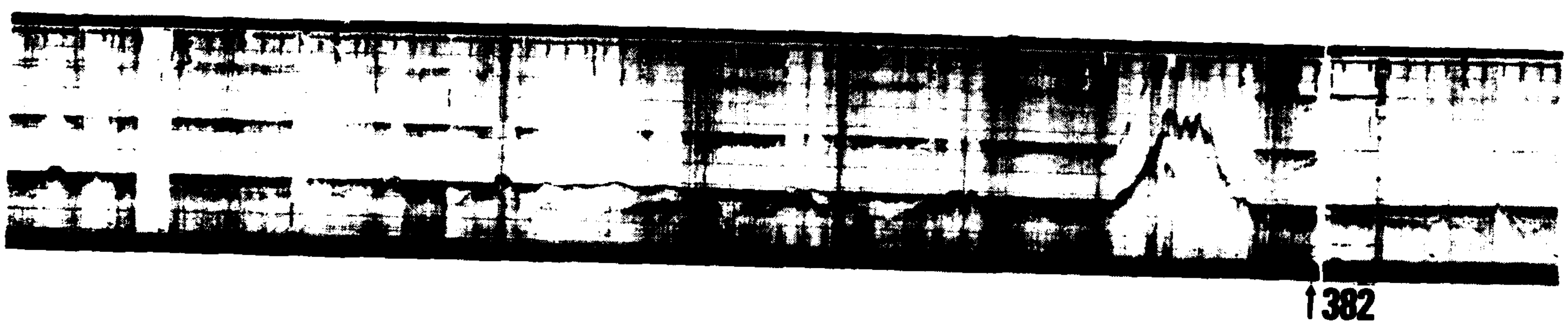
Position:
Latitude 34°25.0′ N
Longitude 56°32.2′ W
Date: 07/05/75
Time: 1359Z
Water depth: 5526 meters
Location: East of Nashville Seamount

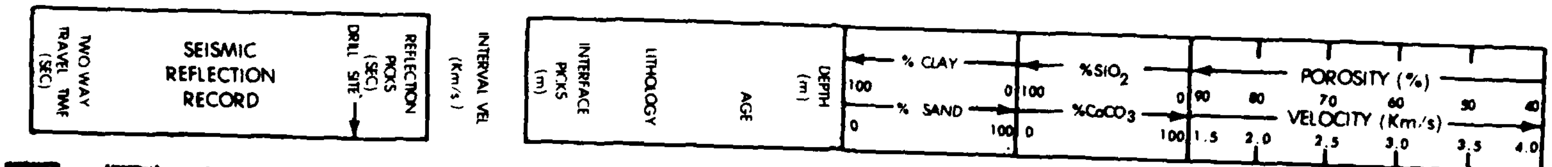
CORE DATA

Penetration:
Drilled-- 288 meters
Cored---- 232 meters
Total---- 520 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 25 cores
162 meters

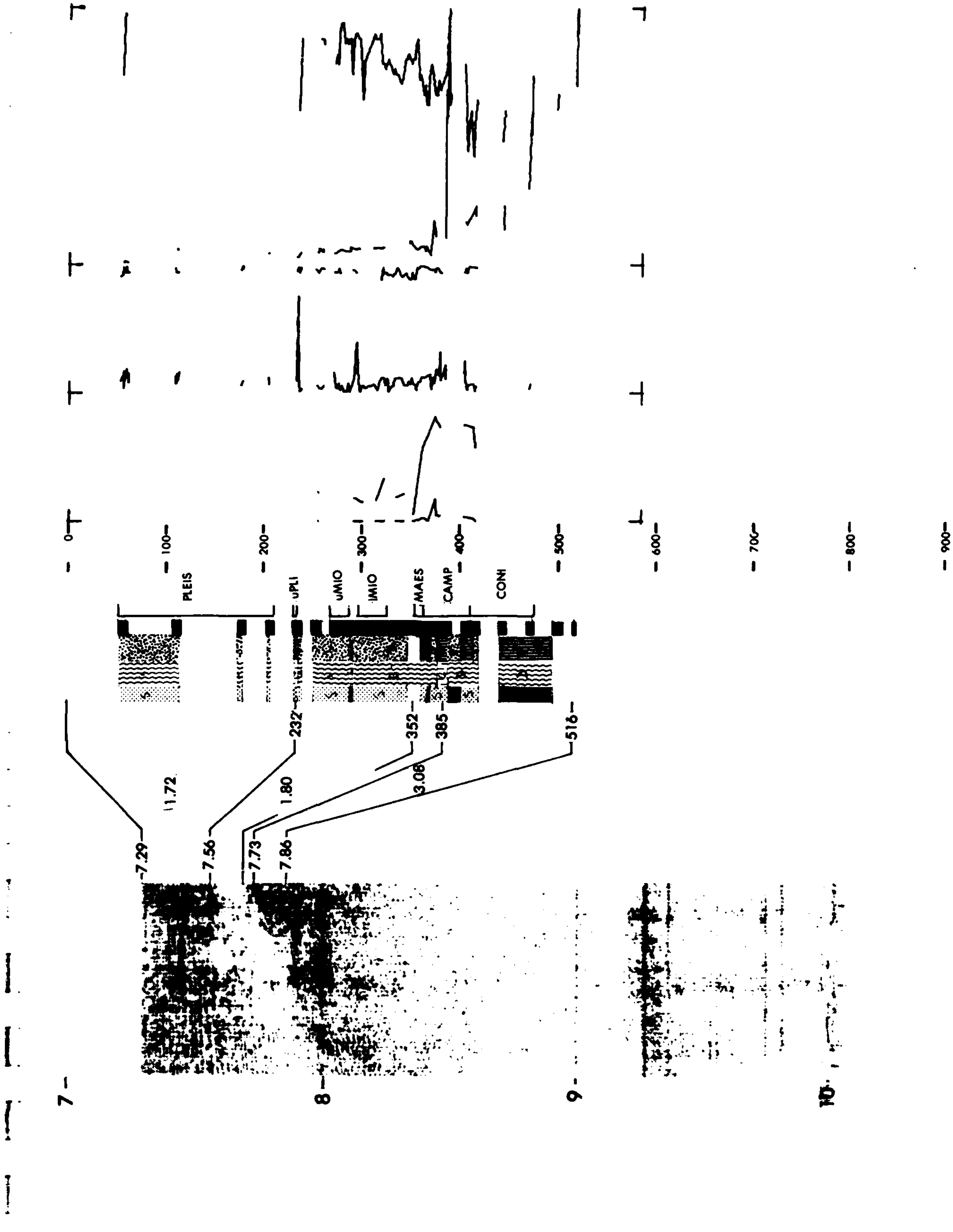
The shallowest lithofacies is distal turbidites which date initial development of the Sohm Abyssal Plain in this area as early Pliocene. Underlying Miocene-Pliocene hemipelagic clays, apparently current-deposited, can be traced seismically throughout much of the northeastern part of the basin, wherethey comprise the bulk of the sedimentary record. A hiatus of about 45 million years separates the Miocene section from Maestrichtian and older volcanogenic detritus, and it may be caused by either slumping or early Tertiary erosion by bottom currents.

Detrital sediment interbedded with thin layers of calcareous sediment.





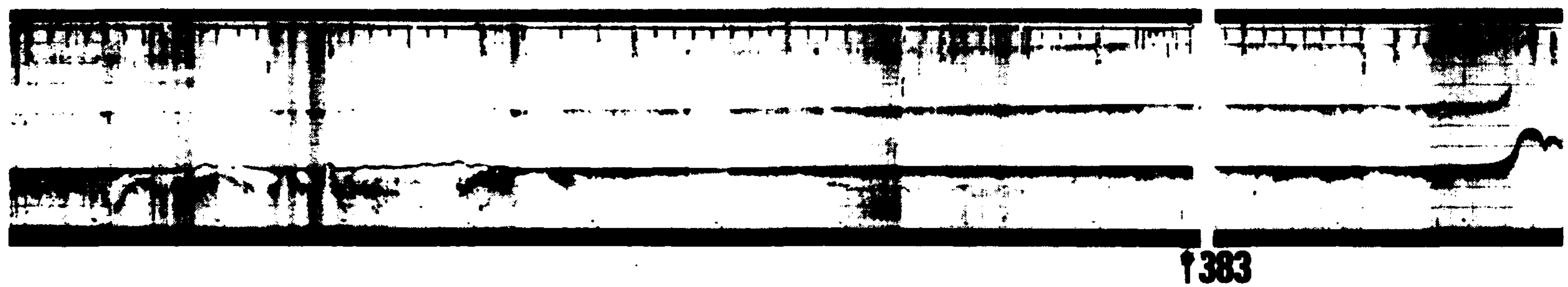
SITE 382 LEG 43

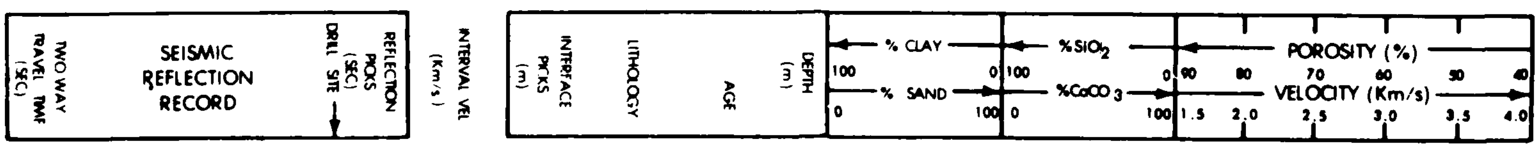


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	39°14.9' N	Drilled--	101 meters
Longitude	53°21.2' W	Cored----	19 meters
Date: 07/10/75		Total----	120 meters
Time: 2228Z		Recovery:	
Water depth: 5283 meters		Basement-	0 cores
Location: Sohm Abyssal Plain			0 meters
		Total----	2 cores
			4.9 meters

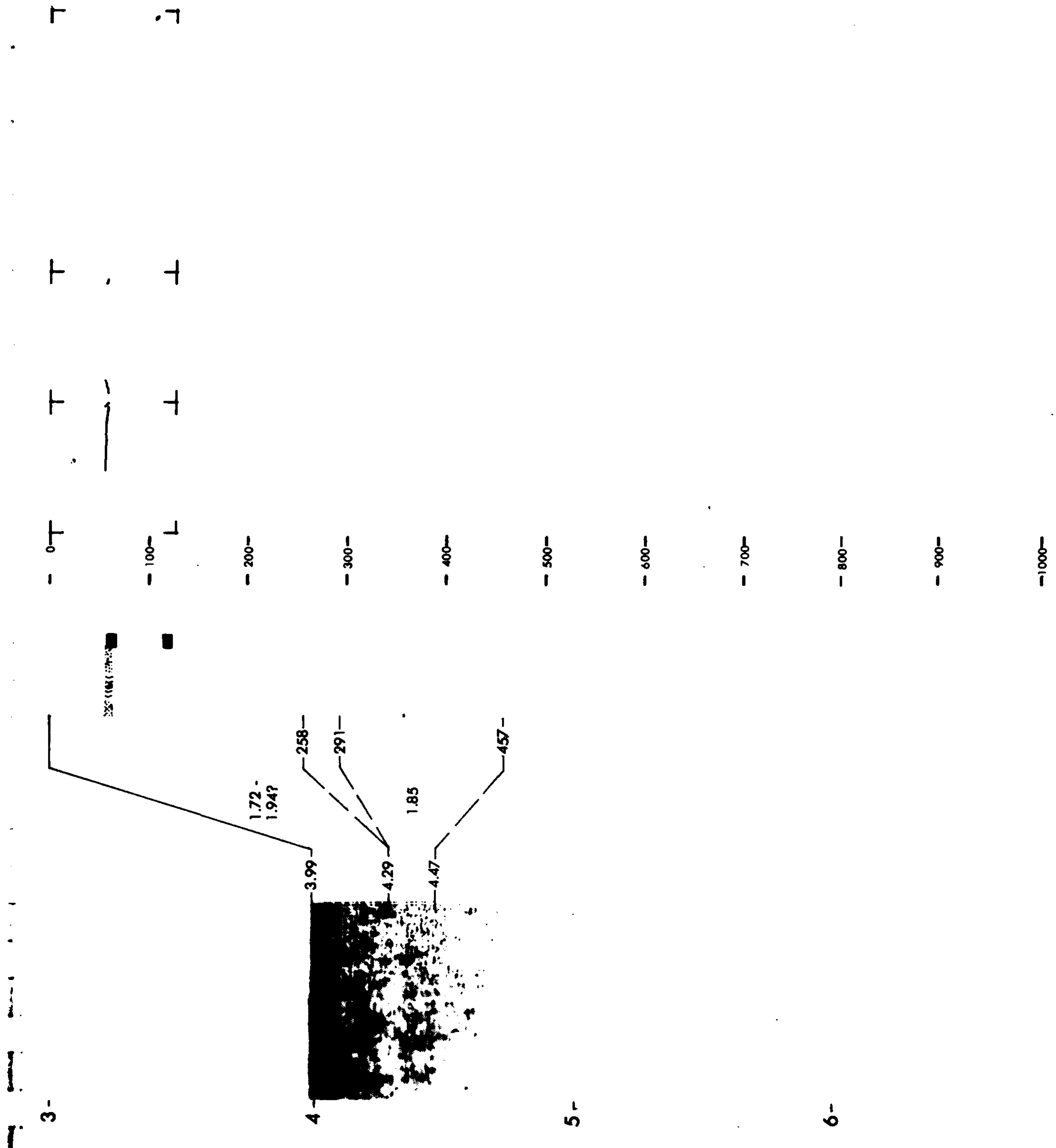
Site 383 was abandoned before reaching basement because of severe hole-stability problems in coarse unconsolidated Pleistocene sands.

Detrital sediment; mica or serpentine rich.





SITE 383 LEG 43



SITE DATA

Position:
Latitude $40^{\circ}21.6'$ N
Longitude $51^{\circ}39.8'$ W
Date: 07/12/75
Time: 2237Z
Water depth: 3909 meters
Location: J-Anomaly Ridge; Grand Banks Continental Rise

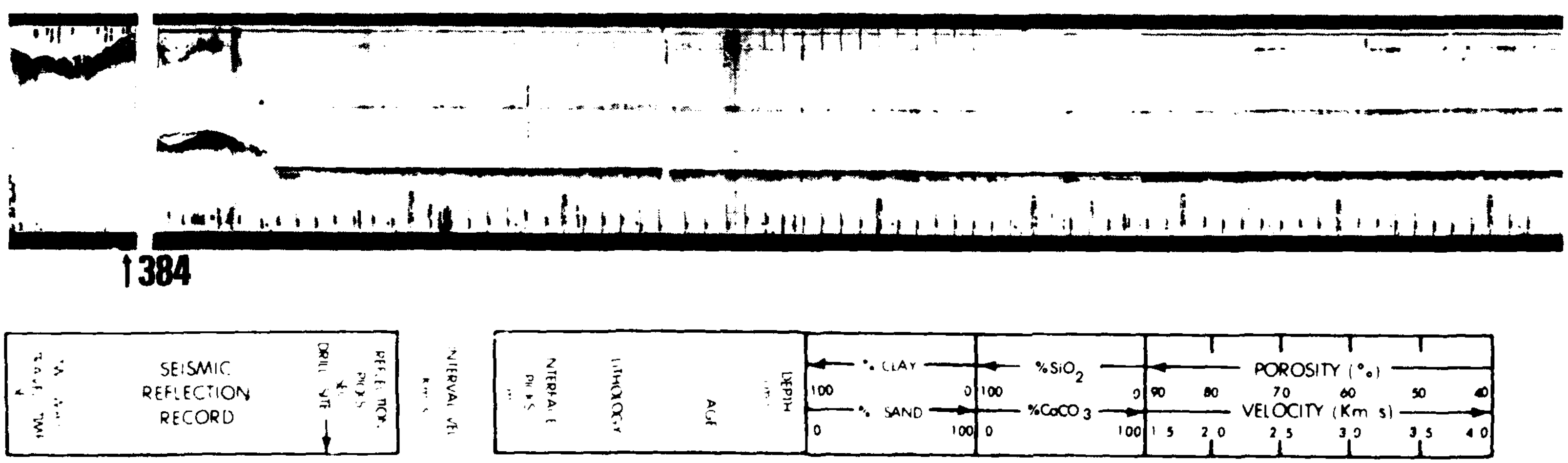
CORE DATA

Penetration:
Drilled-- 136 meters
Cored---- 194 meters
Total---- 330 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 22 cores
110 meters

A pelagic nanno-foram ooze section was cored continuously from 51 m subbottom (middle Eocene) to the lower Maestrichtian at 193 m. A hiatus of about 4 million years, probably caused by early Eocene current erosion, occurs between the upper Paleocene and the upper lower Eocene where cherts and silicified limestones mark Horizon A. Only 10 m (uncored) separates the pelagic ooze from the underlying reefal material of apparent Aptian age. Small fragments of nanno marl of Coniacian-Santonian (?) age were recovered at the top of the reef facies. There appears to be a major hiatus associated with the change from a reef to a pelagic depositional environment. The hiatus presumably represents the time the ridge was too deep for reef growth but too shallow for tranquil pelagic sedimentation.

Basalt was penetrated at 325 m. A plugged bit and severe bending of the drill string by deep currents precluded drilling an offset hole at this site to core the upper 50 m of the sediment column and recore the Cretaceous-Tertiary boundary.

Calcareous sediment; nannofossil rich.



SITE 384 LEG 43

SITE DATA

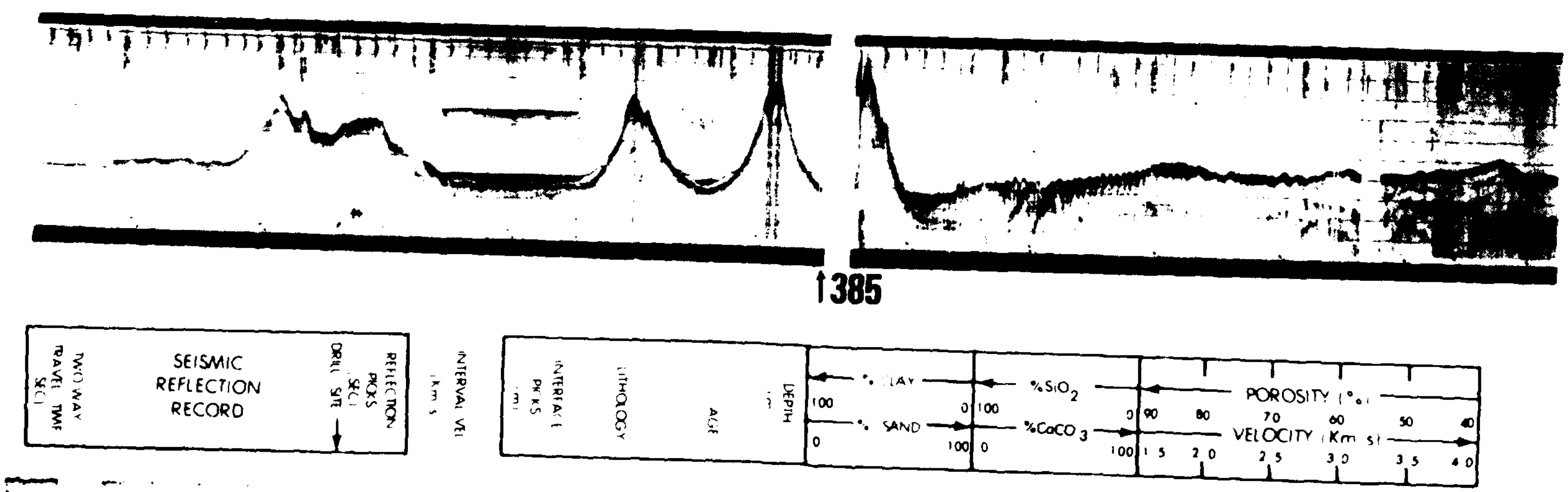
Position:
  Latitude $37^{\circ}22.2'$ N
  Longitude $60^{\circ}09.4'$ W
Date: 07/18/75
Time: 0620Z
Water depth: 4936 meters
Location: Vogel Seamount

CORE DATA

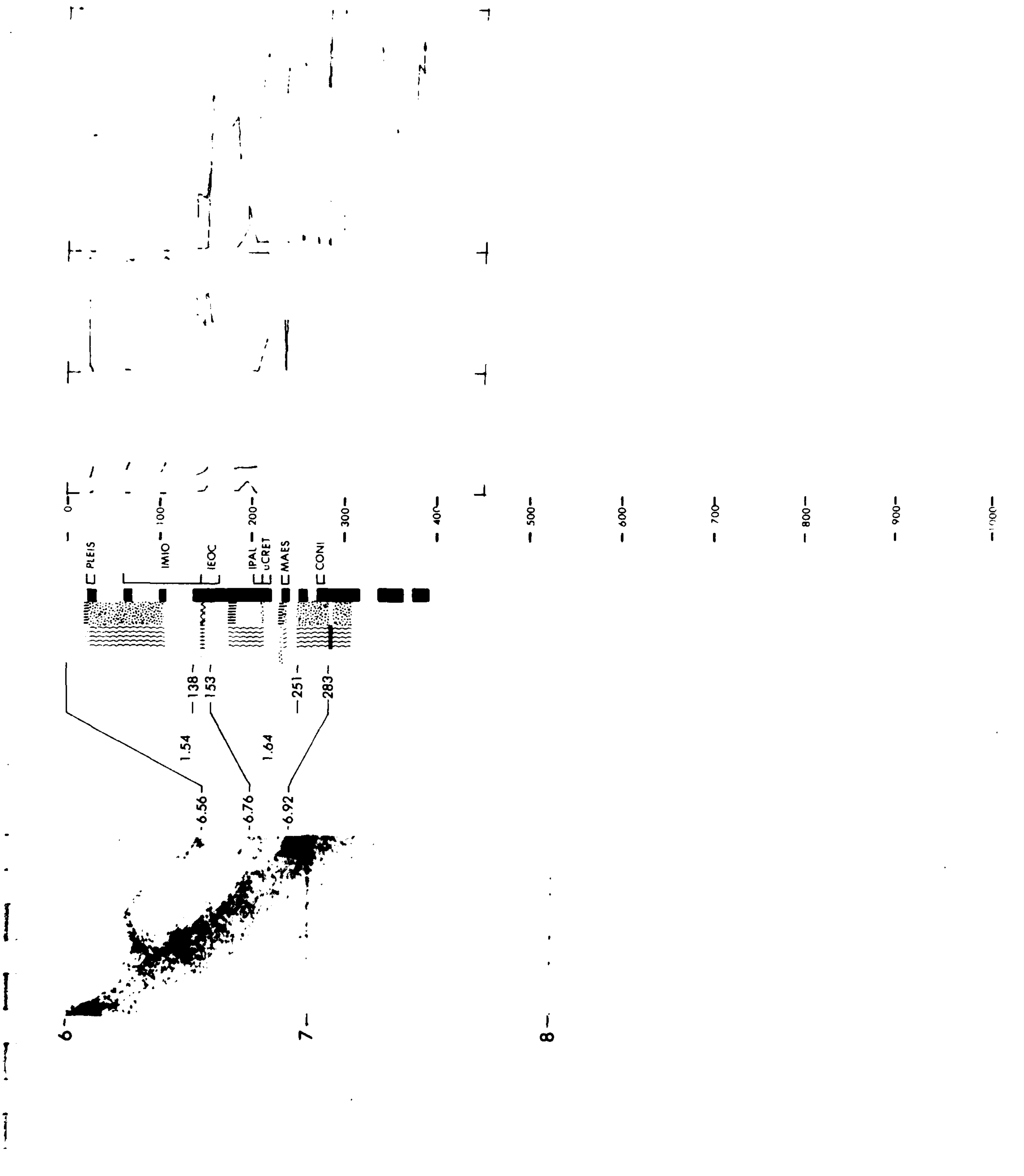
Penetration:
  Drilled-- 165 meters
  Cored---- 228 meters
  Total---- 393 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 24 cores
  63 meters

We drilled 278 m through acoustically non-laminated sediment on the deep flank of the seamount and penetrated 115 m into the volcaniclastic apron. Neogene clays overlie Paleogene radiolarian and zeolitic clays. The upper-lower and lower-middle Eocene section contains a rich and well-preserved radiolarian fauna as well as interbeds of chert, which correlate with Horizon A in the profiler record. Marly nanno ooze spans the Cretaceous-Tertiary boundary and overlies the Upper Cretaceous volcanogenic detritus, which comprises the acoustically opaque apron of the seamount. Disconformities between middle Eocene and lower Miocene sediments, and lower Miocene and Quaternary deposits appear to be related to erosion by abyssal currents.

Detrital sediment, rarely serpentine rich, interbedded with few thin layers of calcareous, nannofossil rich, or siliceous, radiolaria rich, sediments.



SITE 385 LEG 43



SITE DATA

Position:
Latitude $31^{\circ}11.2'$ N
Longitude $64^{\circ}14.9'$ W
Date: 07/24/75
Time: 2202Z
Water depth: 4792 meters
Location: Central Bermuda Rise

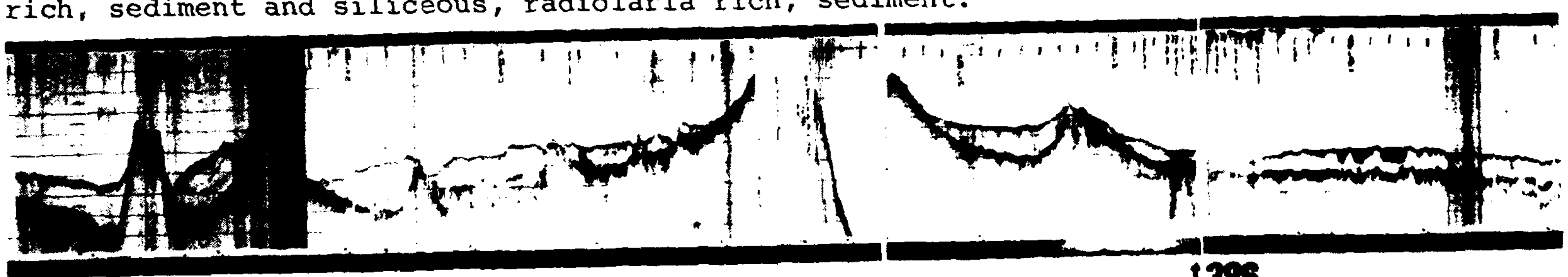
CORE DATA

Penetration:
Drilled-- 347 meters
Cored---- 627 meters
Total---- 974 meters
Recovery:
Basement- 1 cores
7.6 meters
Total---- 66 cores
439 meters

Deposition was predominantly continuous although highly variable in rate. Short hiatuses are indicated in the middle to upper Oligocene and possibly the upper Eocene. High rates characterize the Cretaceous black claystones (18 m per million years), upper Paleocene to middle Eocene siliceous claystones and turbidites (40), and Oligocene volcanogenic turbidites (19). Miocene zeolitic clays and Late Cretaceous variegated clays accumulated slowly (less than 6 m per million years). Because the drill site was in a deep valley, material shed from adjacent peaks must have increased accumulation rates, especially during periods of high productivity.

Moderately chloritized basalt (1.9 m) was recovered at the bottom of the hole. The absence of olivine, the presence of pigeonitic augite, and enrichment in groundmass iron as indicated by late-crystallized magnetite suggest a nearly saturated or over-saturated subalkaline basalt. The basalt is comparable to that found previously at Site 100 and typifies present-day ridges. The basalt core is cut by a hydrothermal vein 0.7 m thick.

Detrital sediments interbedded with thin layers of calcareous, rarely nannofossil rich, sediment and siliceous, radiolaria rich, sediment.

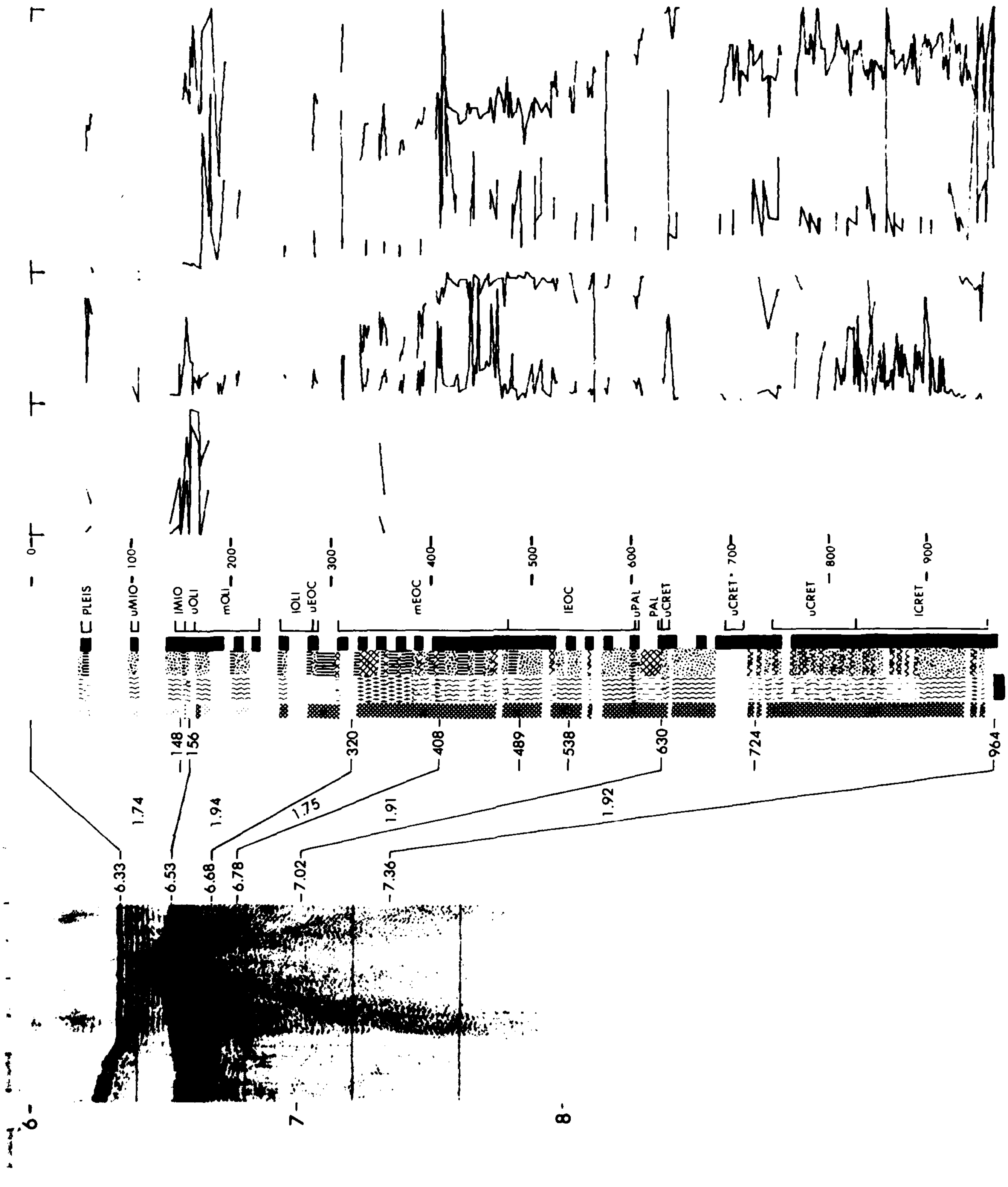


TWO WAY TRAVEL TIME (SEC) | SEISMIC REFLECTION RECORD | REFLECTION PICKS (SEC) DRILL SITE

INTERVAL VEL (Km/s)

INTERFACE PICKS (m) | LITHOLOGY | AGE | DEPTH (m) | % CLAY 100 0 / % SAND 0 100 | % SiO_2 100 0 / % $CaCO_3$ 0 100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 386 LEG 43



SITE DATA

Position:
Latitude 32°19.2' N
Longitude 67°40.0' W
Date: 08/01/75
Time: 1719Z
Water depth: 5117 meters
Location: Western Bermuda Rise

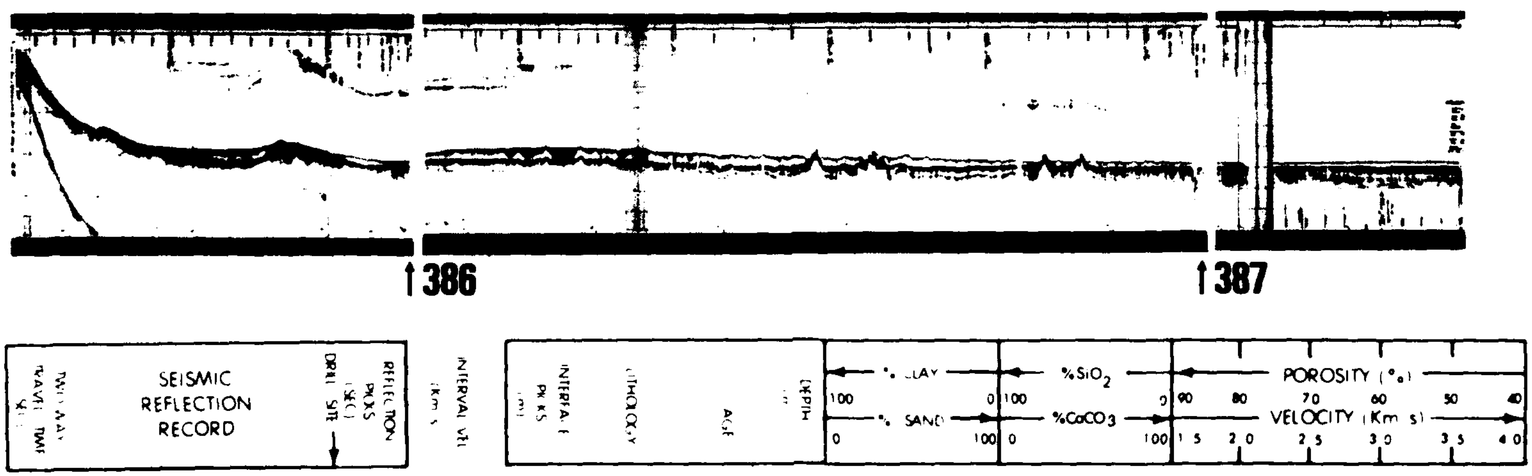
CORE DATA

Penetration:
Drilled-- 326 meters
Cored---- 468 meters
Total---- 794 meters
Recovery:
Basement- 1 cores
2.9 meters
Total---- 50 cores
177 meters

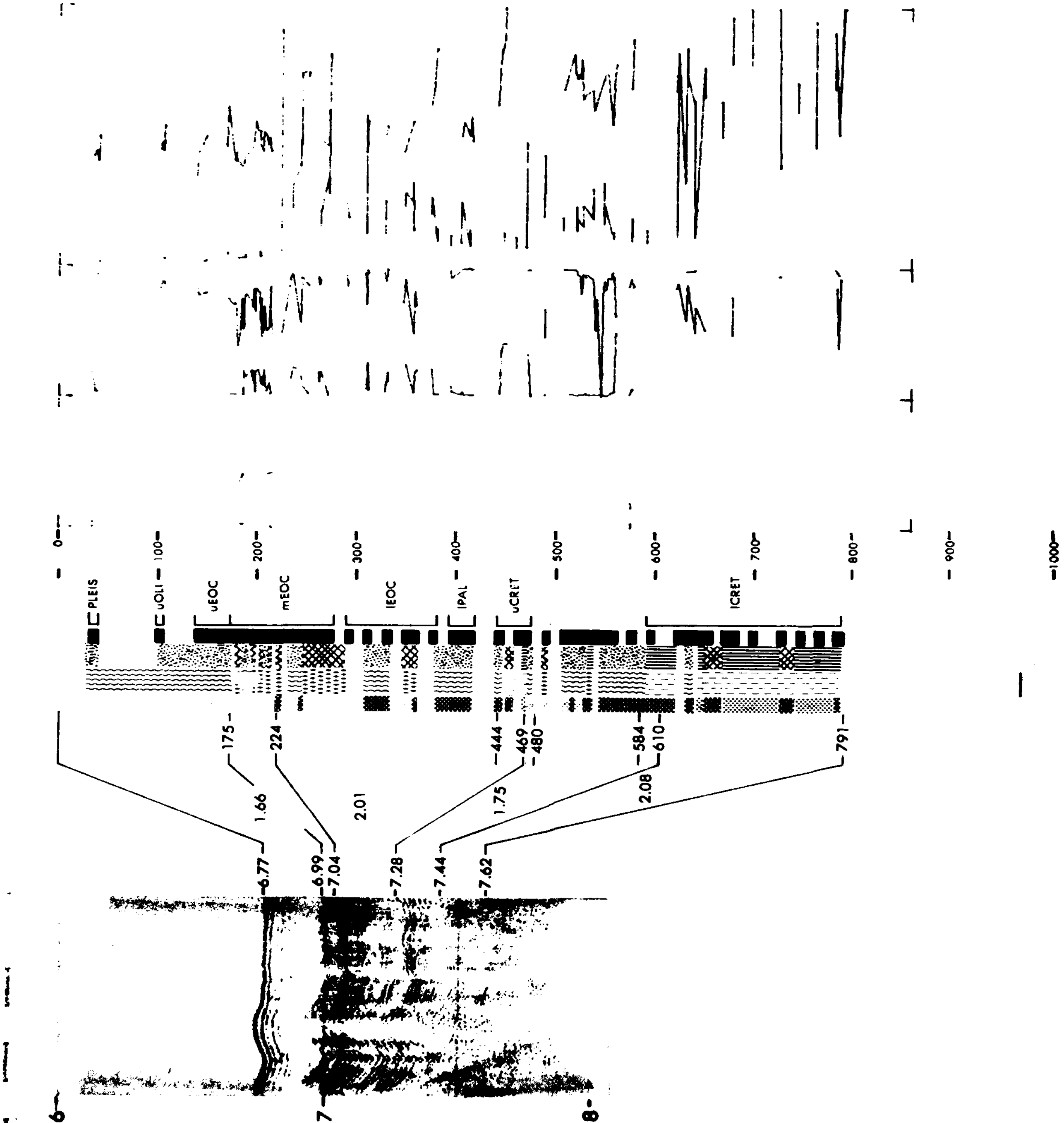
The Oligocene-Neogene section in this 795-m hole is only half as thick as that at Site 386 because the massive Oligocene turbidites derived from Bermuda volcanics did not reach Site 387. However, the Paleocene-Eocene radiolarian mudstones with interbedded cherts have nearly identical thicknesses at both sites. A hiatus separates middle and upper Eocene sediments at Site 387. Sediment accumulation was very rapid in the upper-lower and lower-middle Eocene (110 m per million years), and surprisingly low rates of about 5 m per million years characterize the Paleocene siliceous claystones, Upper Cretaceous variegated claystones, and Lower to Upper Cretaceous black claystones.

Below the limestones of Horizon Beta we recovered 3 m of fine-grained basalt compositionally similar to basalt at Site 386. The basalt is commonly cut by vein calcite and contains enclosures of calcareous claystone. Gradation to a coarser interior, low vesicularity, and lack of glassy surfaces suggest that the basalt is structurally a sill.

Detrital sediments interbedded with thin layers of siliceous, radiolaria rich, sediments.



SITE 387 LEG 43



SITE DATA

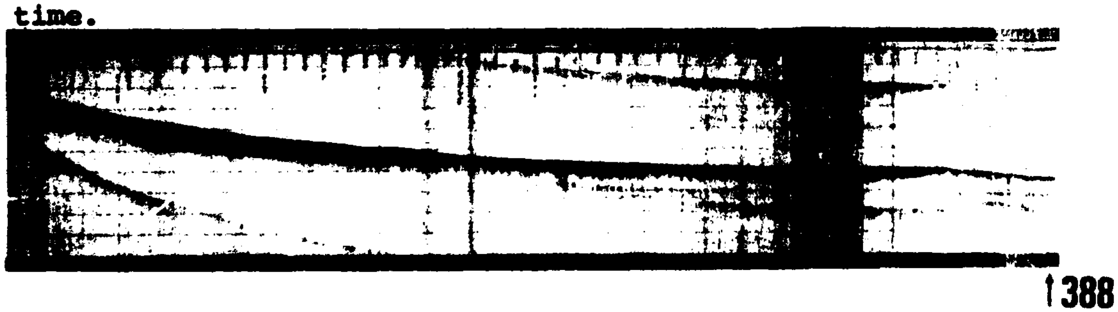
Position:
Lati de 35° 31.3′ N
Longi de 69° 23.8′ W
Date: 08/ /75
Time: 0705Z
Water depth: 4919 meters
Location: Lower Continental Rise Hills

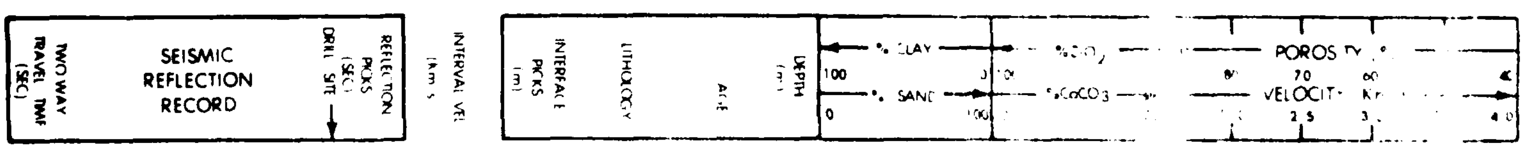
CORE DATA

Penetration:	388	388A	
Drilled--	0	242	meters
Cored----	0	98	meters
Total----	0	341	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	11	cores
	0	43	meters

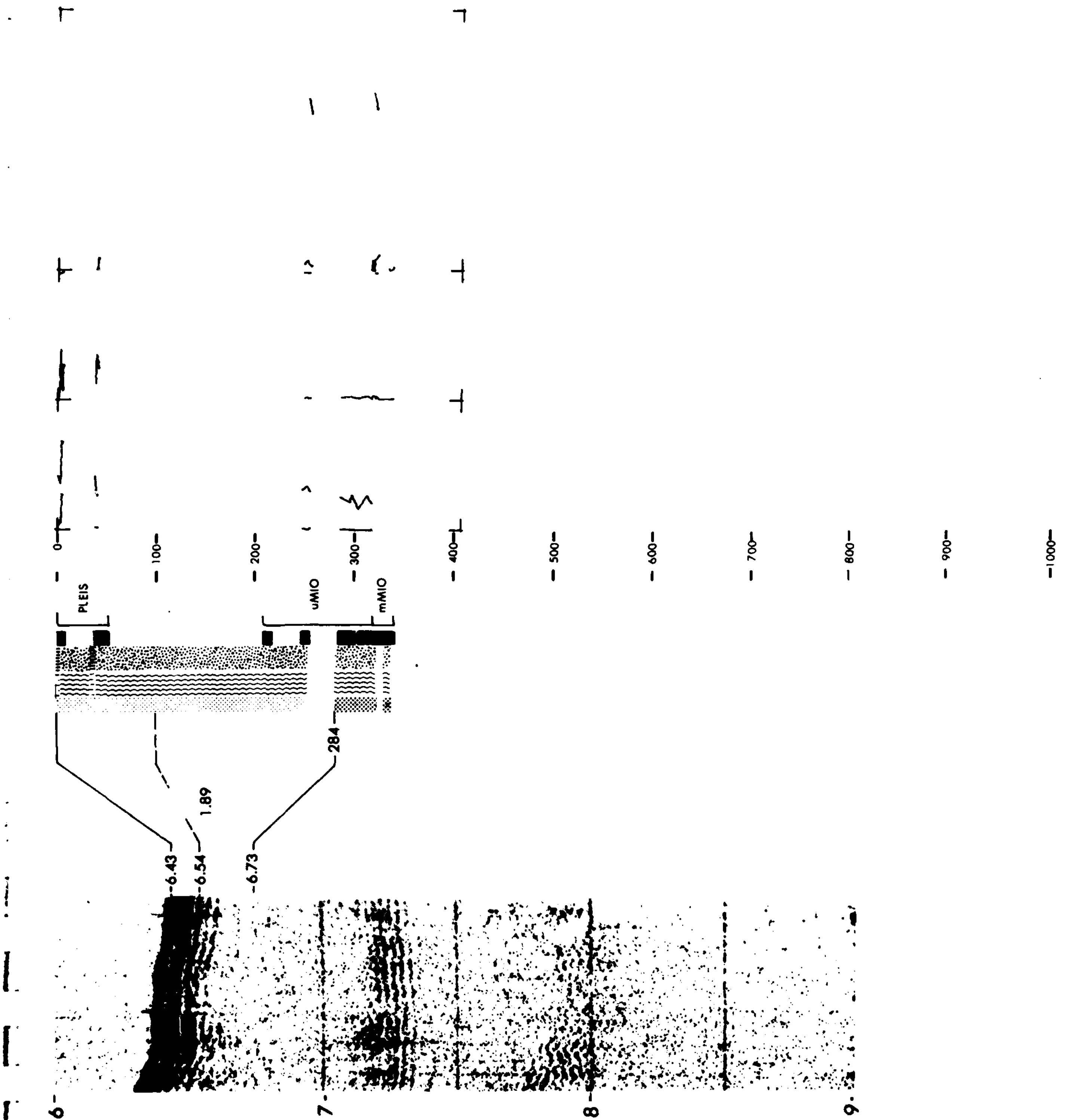
Gas is present in the Miocene hemipelagic clay at about 300 meters sub-bottom. We detected methane and ethane in ratios expectable in pelagic sediments, however, two attempts to take pressurized samples of the gas (which theoretically could have been in a clathrate form) failed when the ball valve of the pressure core barrel failed to close. The upper beds are apparently conformable with topography which virtually eliminates erosion as a possible origin for these features. Pliocene and late Miocene bedding structures are inclined under the ridges and swales whereas an upper-Mioc e reflecting horizon is essentially planar. Cores taken across this horizon contai delicate bedding and burrow structures indicating that the reflector is not a surface above which beds were folded as would be the case if the continental rise hills were formed at the toe of a large regional slump. The seismic profile shows synclinal bedding under some of the ridges. This is compatible with the hypothesis that contour currents built the lower continental rise hills as constructional m waves or "dunes" with dipping axial planes. Within the resolution of the seismic da , however, the features could also have been produced by local slumping.

Two thin layers of calcareous, nannofossil rich, sediment occ in Pleistocene time.





SITE 388 LEG 44



SITE DATA

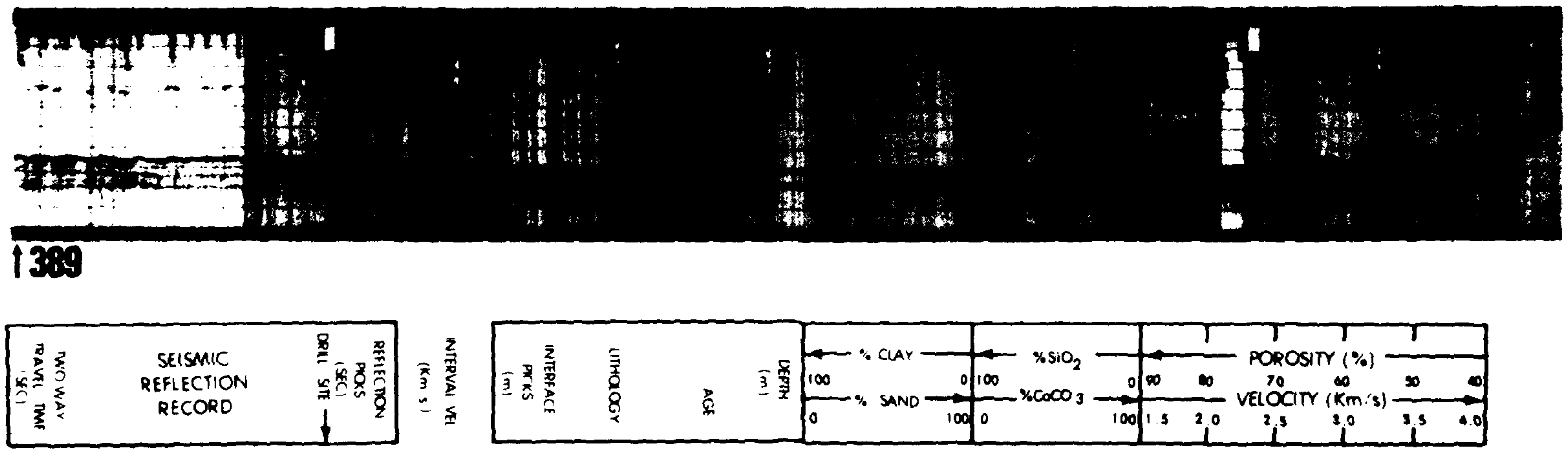
Position:
Latitude 30°08.5'N
Longitude 76°05.6'W
Date: 06/26/75
Time: 0745Z
Water depth: 2724 meters
Location: North Rim of Blake Nose

CORE DATA

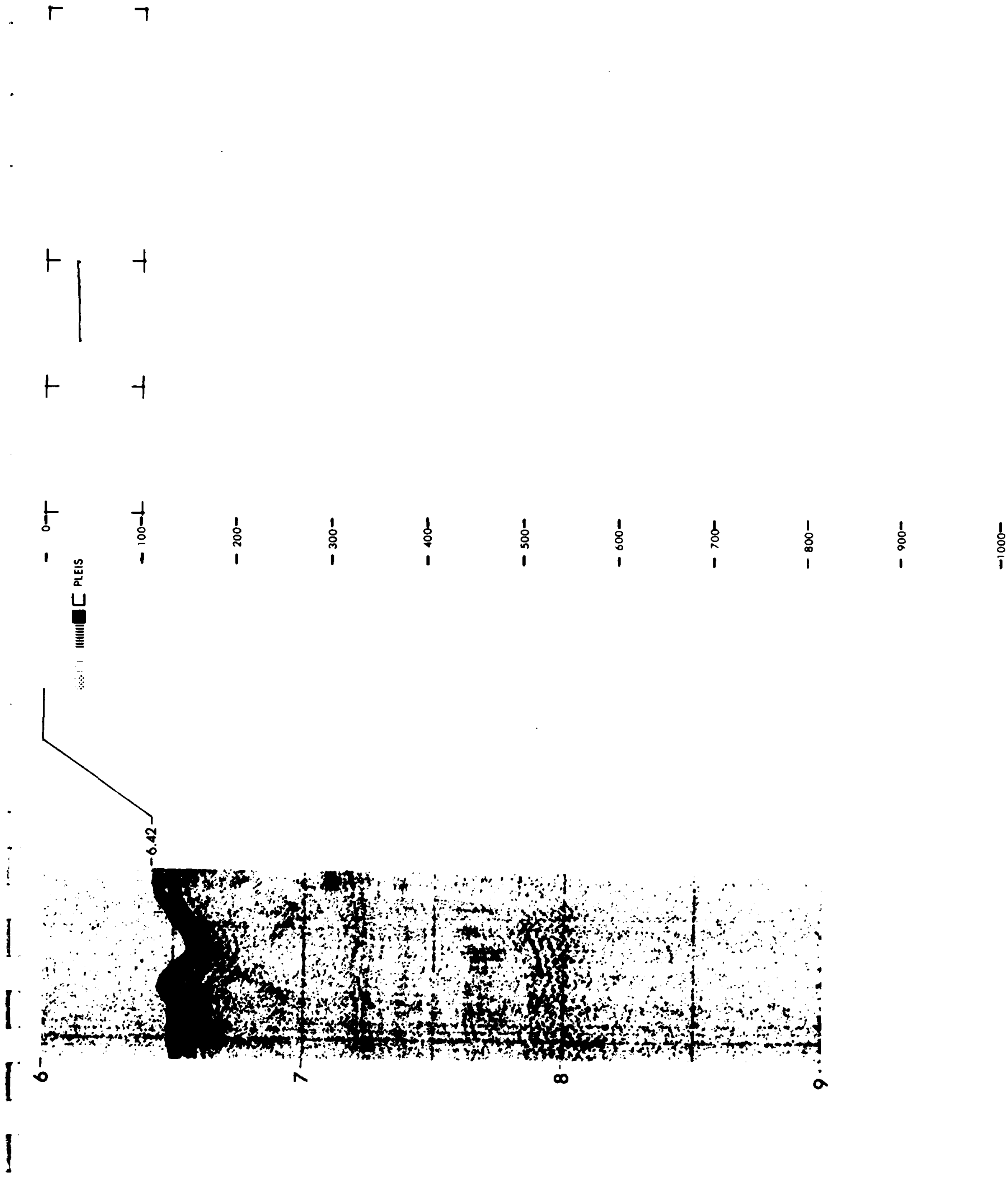
Penetration:
Drilled-- 30 meters
Cored---- 10 meters
Total---- 40 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 1 core
3.5 meter

An abortive attempt to spud in technically constitutes Site 389. Here we recovered a single core containing manganese nodules, sand, foraminifers, and shell fragments. Although the pipe we supposedly washed in 30.5 meters before attempting to take the first core, the bit apparently skidded across a surface patch of hard lag gravel and scooped about 3.5 meters of surface sediment into the core barrel. The bumper sub was bent as the bit deflected across the hard surface and drilling at the site was abandoned.

Calcareous sediment; foraminifera rich.



SITE 389 LEG 44



SITE DATA

Position:
- Latitude 30°08.5' N
- Longitude 76°06.7' W

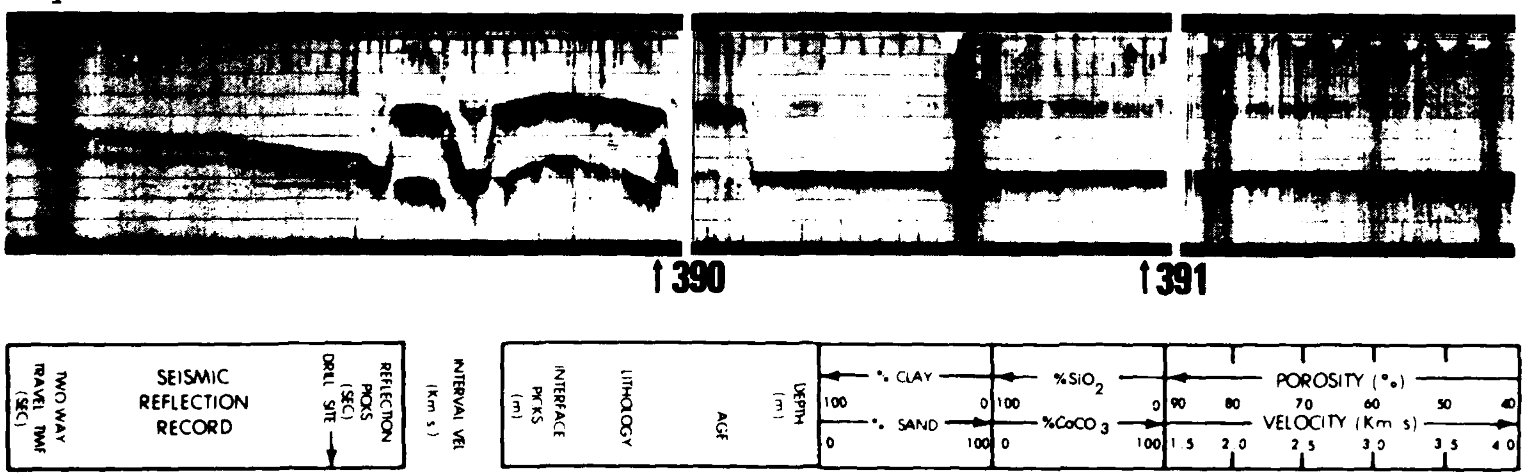
Date: 08/28/75
Time: 1714Z
Water depth: 2670 meters
Location: North Rim of Blake Nose

CORE DATA

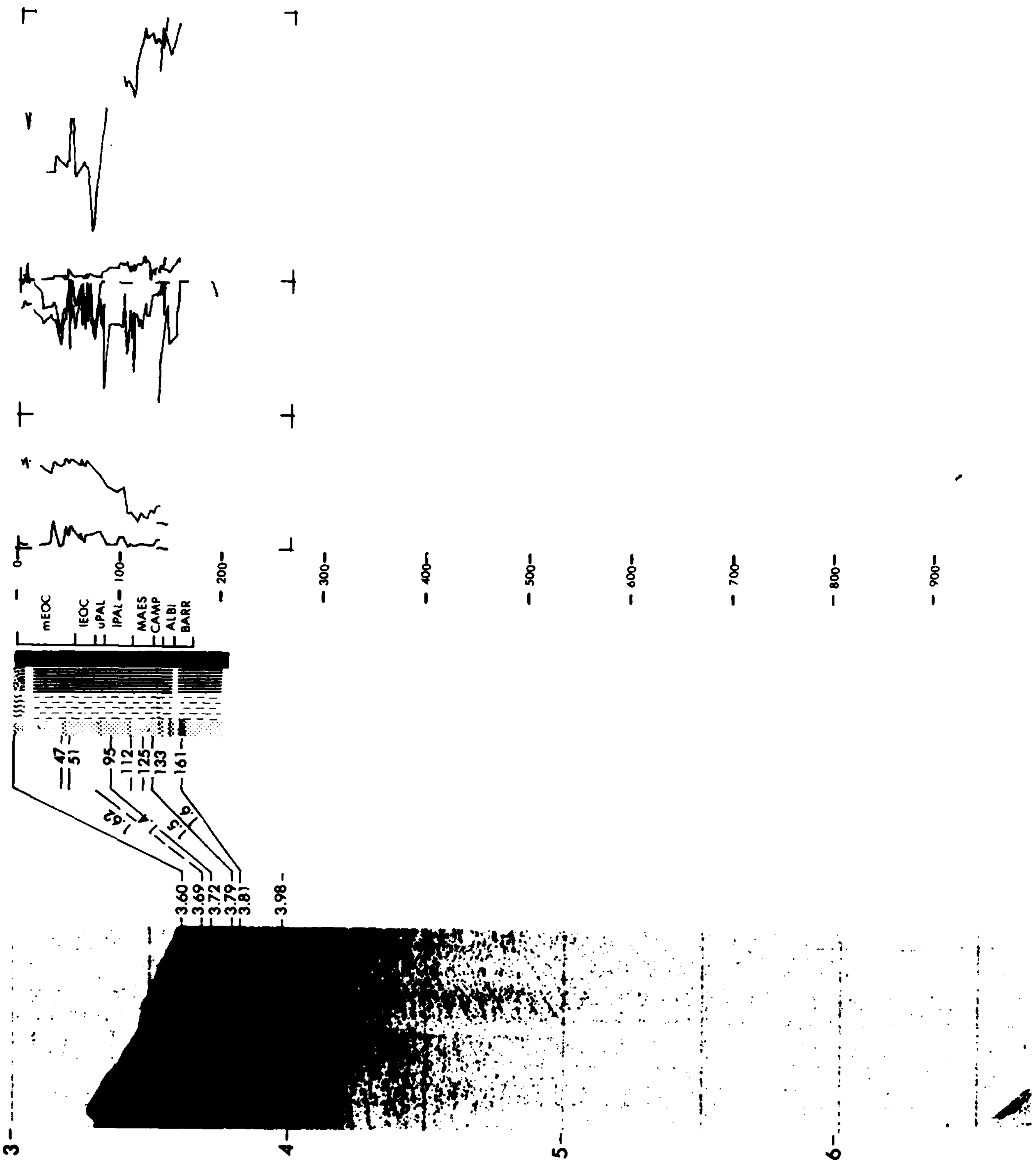
Penetration:	390	390A	
Drilled--	114	9	meters
Cored----	92	133	meters
Total----	206	142	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	10	14	cores
	27	87	meters

Continuous coring through Eocene, Paleocene, and Maestrichtian sediments provided an outstanding stratigraphic sequence. We identified two prominent seismic reflectors which correspond to: (1) lower Eocene and upper Paleocene cherty-limestone and (2) a major hiatus between Campanian and Albian nannofossil ooze. To the west of the site, the hiatus forms a major angular unconformity below which at least three regional reflectors are truncated. At Site 390 the unconformity represents about a 30-m.y. hiatus (Campanian and Albian) and represents progressively less time toward the west. The contact between shallow-water Barremian limestone and pelagic Aptian-Albian nannofossil ooze was cored in Hole 390. Although the transition zone is very narrow in the cored sediment, it represents an increase in water depth (estimated from fossil evidence), of from less than 100 meters to more than 500 meters (about 7 cm/1000 yr), unusual for the Early Cretaceous in the Blake-Bahama area. Submarine bottom currents apparently eroded the area during the Santonian (?) to produce the Campanian-Albian hiatus The related change in environment may have helped end reef building on the Blake Nose.

Calcareous sediment, occasionally nannofossil rich, interbedded with three thin layers of detrital sediment.



SITE 390 LEG 44



SITE DATA

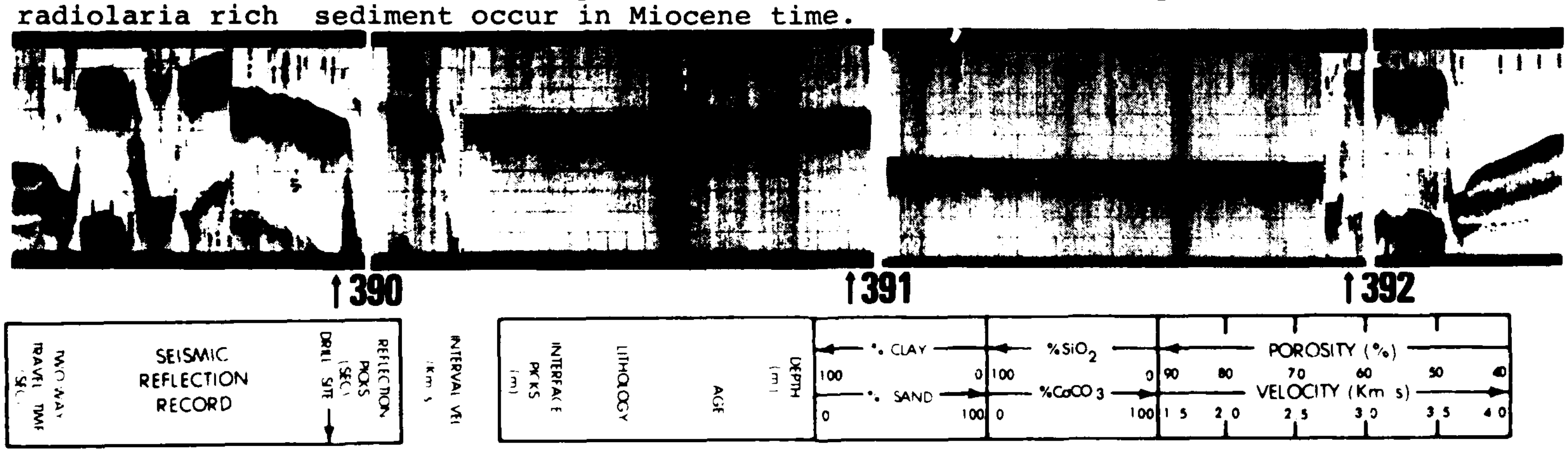
Position:
Latitude 28°13.7' N
Longitude 75°36.8' W
Date: 09/02/75
Time: 0820Z
Water depth: 4974 meters
Location: Blake-Bahama Basin

CORE DATA

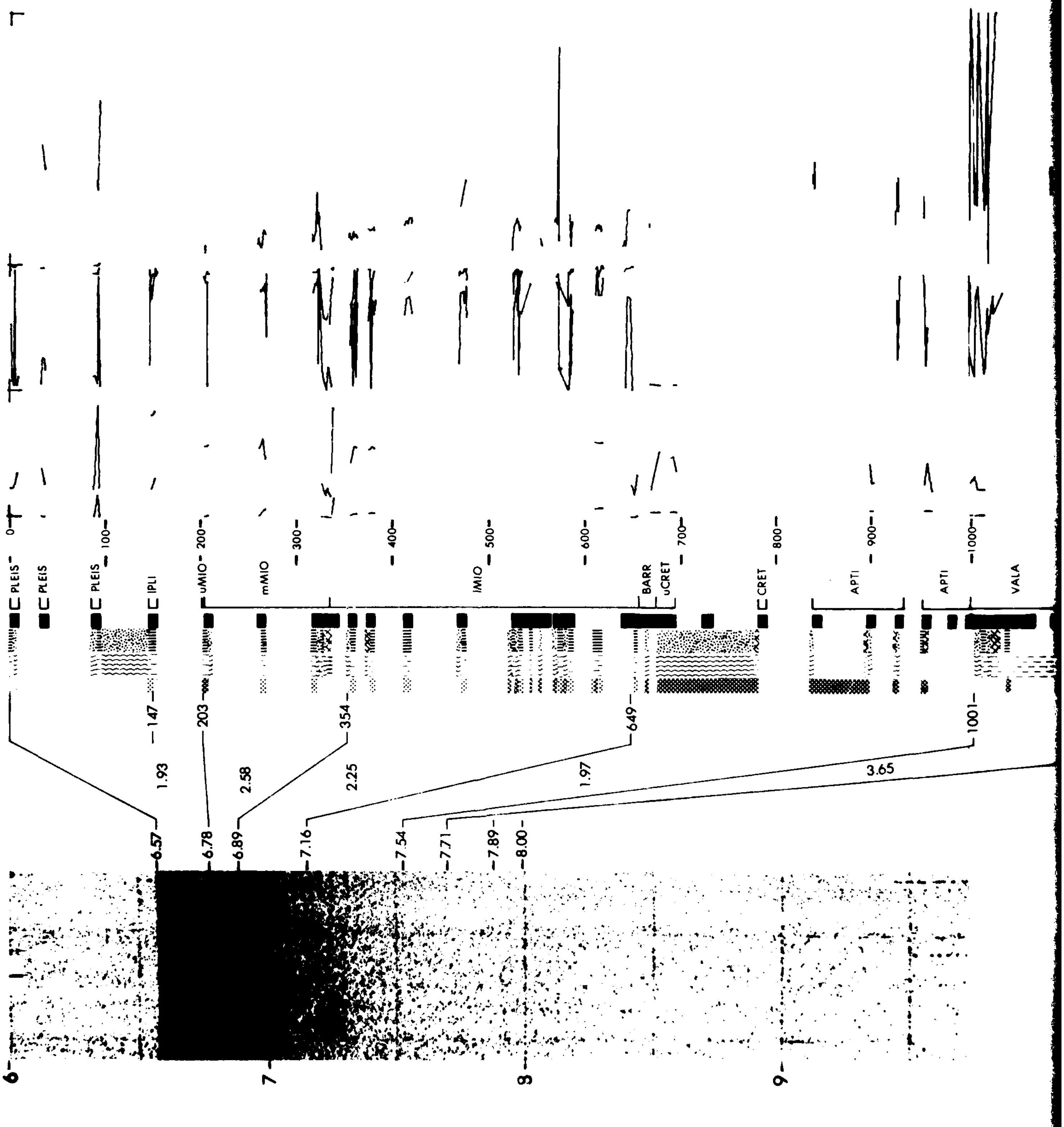
Penetration:	391	391A	391B	391C	
Drilled--	79	523	0	911	meters
Cored----	5	199	9.5	501	meters
Total----	84	722	9.5	1412	meters
Recovery:					
Basement-	0	0	0	0	cores
	0	0	0	0	meters
Total----	1	21	1	54	cores
	2.3	130	9.3	216	meters

The Cenozoic section consists entirely of Quaternary hemipelagic clay and reworked Miocene carbonates. The Pliocene, entire lower Tertiary, and probably uppermost Cretaceous sediments are missing. The Miocene sediments comprise 500 meters of carbonate turbidites and intraclastic chalk breccias. These reworked carbonates were probably derived from the Bahama Bank and the Blake Plateau and transported to the basin by debris flows and turbidity currents. Middle Cretaceous black clay directly underlies the Miocene chalk breccias. Below this we continuously cored a complete section of Neocomian limestone which is perhaps the best documented Lower Cretaceous biostratigraphic section yet recovered in the deep sea. The Cretaceous/Jurassic boundary is transitional and well documented at Site 391. We identified four of six prominent sub-bottom reflectors and correlated them with lithology. We did not penetrate the bottom two reflectors. Horizon A is a Miocene-Cretaceous unconformity and horizon β is the transition between clay and limestone at the base of the Aptian through the top of Neocomian. The top of Tithonian red clayey limestones marks another widespread reflector, horizon C.

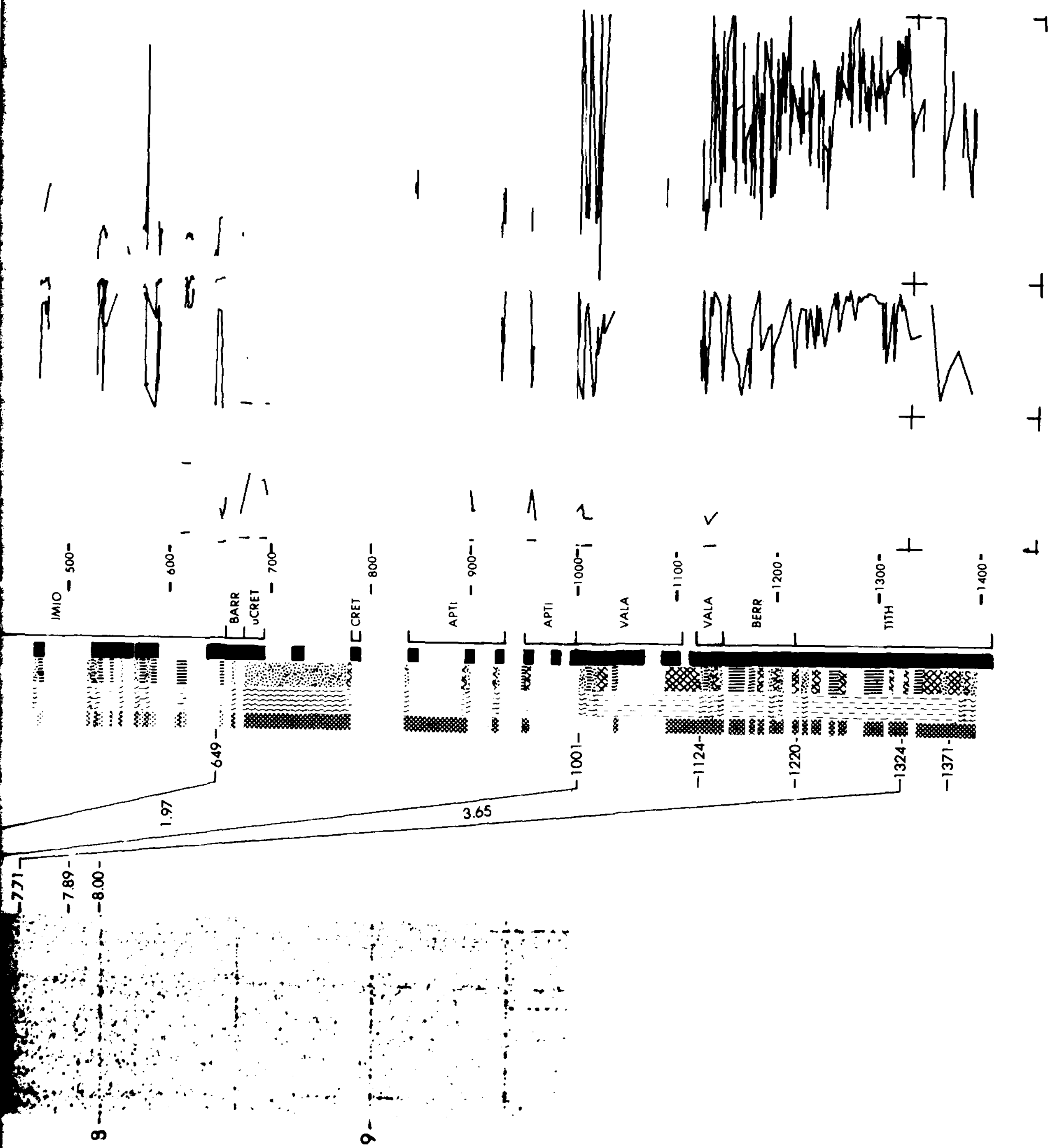
Calcareous sediment interbedded with detrital sediment, sometimes thin layered. Calcareous sediment; occasionally nannofossil rich. Three thin layers of siliceous, radiolaria rich sediment occur in Miocene time.



SITE 391 LEG 44



391 LEG 44


IMIO
BARR
uCRET
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APTI
APTI
VALA
VALA
BERR
TITH
500
600
700
800
900
1000
1100
1200
1300
1400
649
1001
1124
1220
1324
1371
1.97
3.65
7.71
7.89
8.00

2

SITE DATA

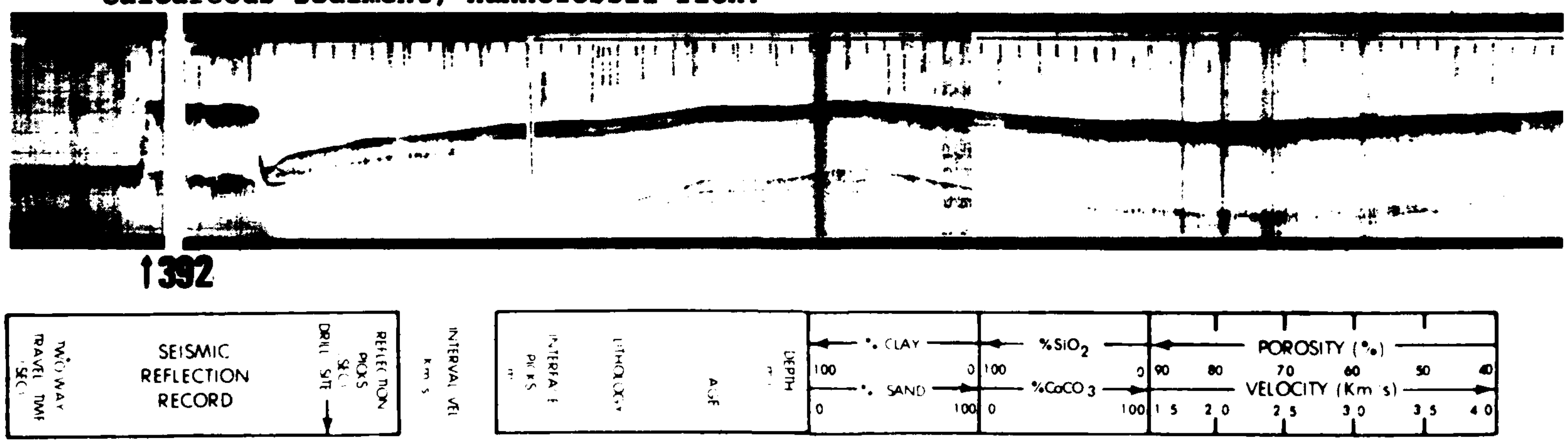
Position:
Latitude 29°54.6' N
Longitude 76°10.7' W
Date: 09/23/75
Time: 1010Z
Water depth: 2607 meters
Location: South Rim of Blake Nose

CORE DATA

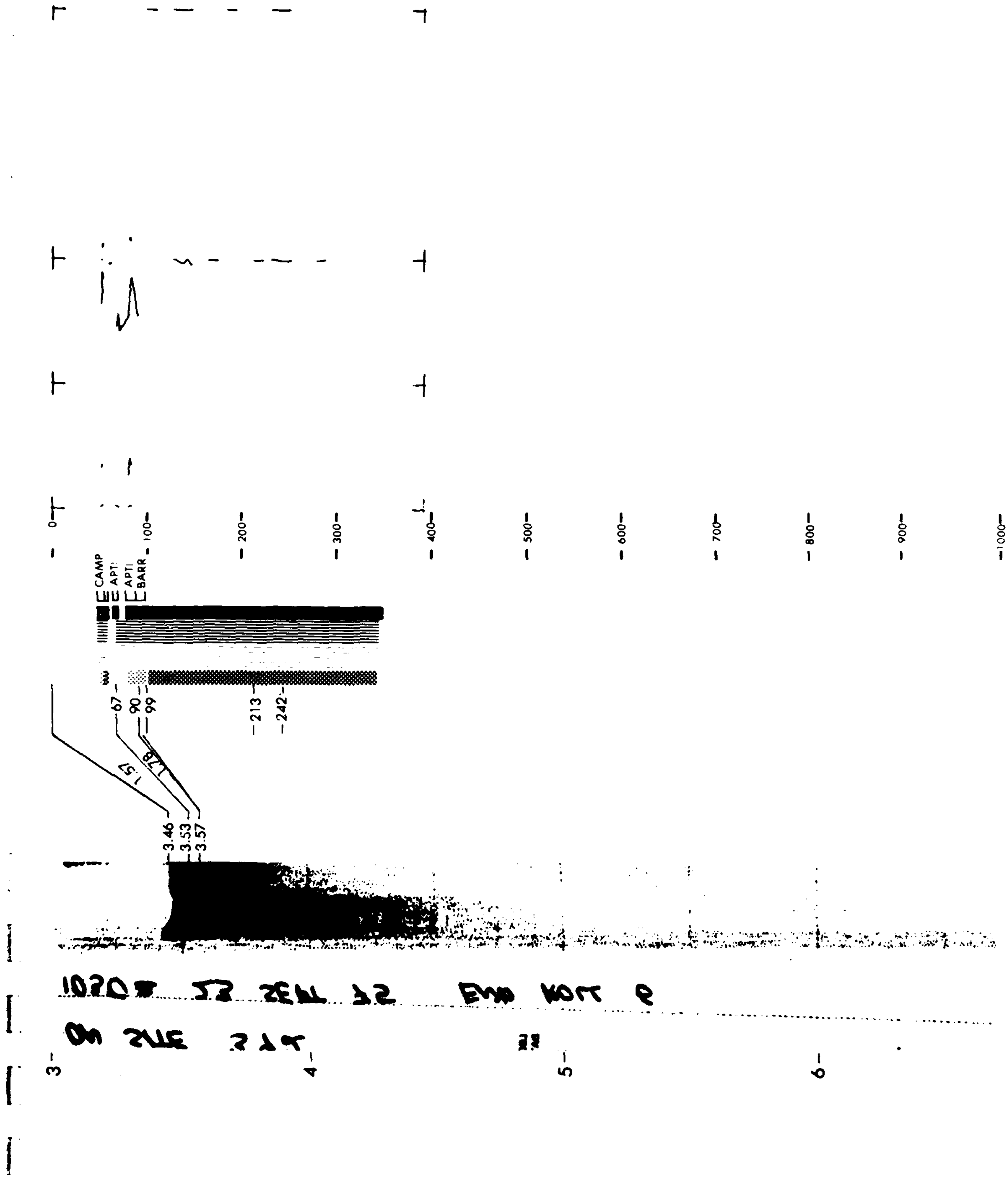
Penetration:	392	392A	
Drilled--	47	66	meters
Cored----	12	282	meters
Total----	60	349	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	33	cores
	3.2	25	meters

Coring began at 50.5 meters sub-bottom in pale brown ooze and continued in mostly soft sediment to 99 meters where hard "reef" limestone was encountered. The hard "reef" limestone was cored continuously until the bit was destroyed at 349 meters sub-bottom. The sedimentary sequence at Site 392 is essentially the same as that at Site 390. The Campanian/Albian unconformity present at Site 390 is also present at Site 392 indicating its persistence along the edge of the Blake Nose. Upper Campanian ooze directly overlies Aptian-Albian ooze and the lower half of the Upper Cretaceous is missing. A thin interval of Barremian ooze overlies hard shallow-water limestone. The top of the limestone is brecciated, stained and cemented with limonite, and contains limonite ooids. Below this the limestone is of the three general types: (1) fenestral limestone, (2) oolite, and (3) a skeletal moldic limestone. Fossils are all shallow-water types. All the limestone has been recrystallized and some of the diagenesis must have occurred above the water table. Shallow-water limestone accreted during the Early Cretaceous, but accumulation ceased by late Neocomian or certainly by early Barremian time, after which accretion did not keep pace with subsidence and only pelagic oozes accumulated.

Calcareous sediment; nannofossil rich.



SITE 392 LEG 44



SITE DATA

Position:
Latitude 28°11.8' N
Longitude 75°35.9' W
Date: 11/11/75
Time: 1047 Z
Water Depth: 4951 meters
Location: Blake-Bahama Basin

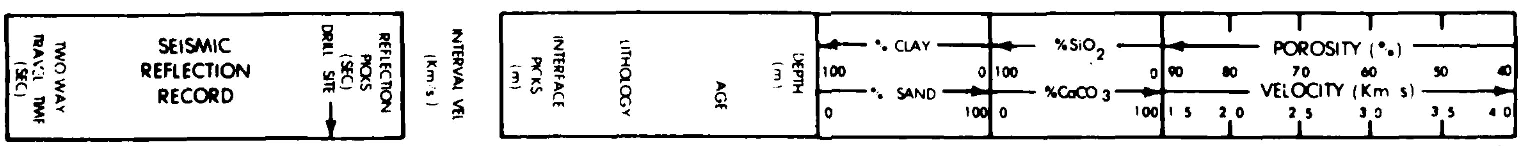
CORE DATA

Penetration:	393	393A	393B	
Drilled--	47	50	56	meters
Cored----	8	9	0	meters
Total----	55	59	56	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	1	0	cores
	4.3	9.5	0	meters

Site 393 was a re-occupation of Site 391 in the Blake-Bahama Basin. It was selected for the engineering trials because the soft bottom would provide a good test for the new type re-entry cone and because of the scientific importance of coring the older sediments and basement in the Blake-Bahama Basin.

Several technical failures resulted in poor recovery and the site was ultimately abandoned when the beacon failed. We recovered only 58.5 meters of Quaternary calcareous clays.

Interbedded thin layers of calcareous and detrital sediments.



SITE 393 LEG 44

0 100 200 300 400 500 600 700 800 900 1000

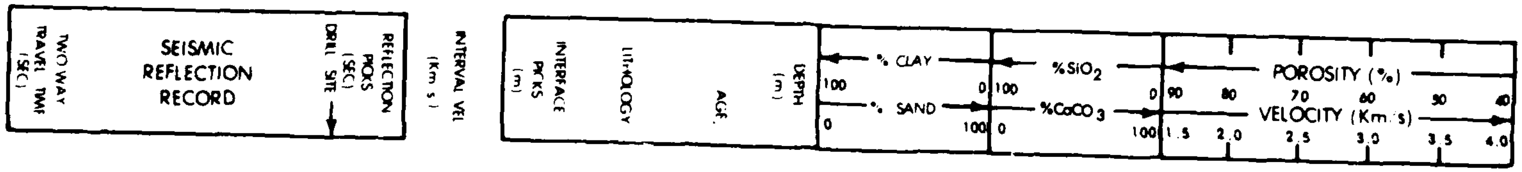
SITE DATA

Position:
Latitude 28°11.7'N
Longitude 75°35.8'W
Date: 11/22/75
Time: 1440
Water depth: 4957 meters
Location: Blake-Bahama Basin

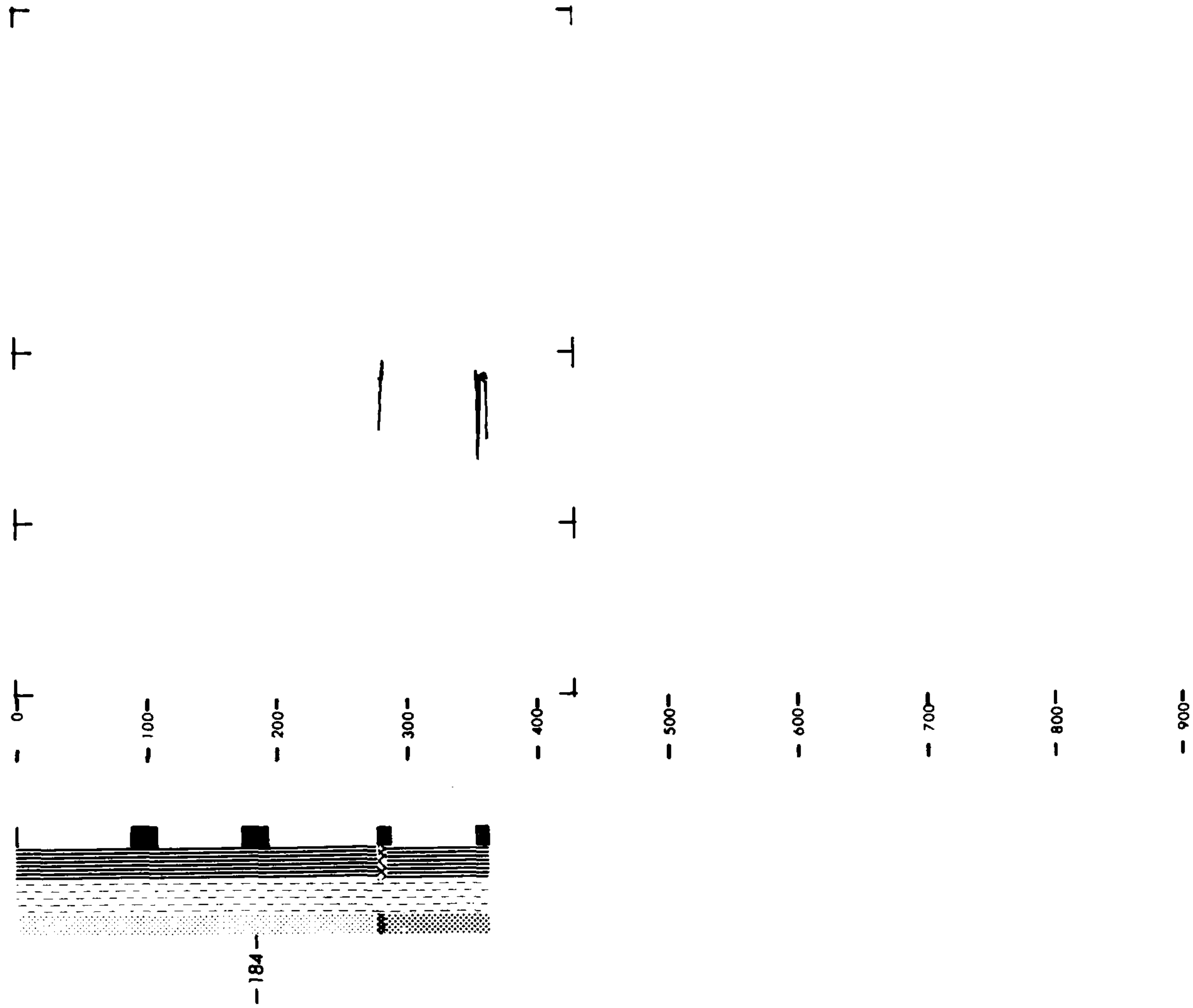
CORE DATA

	394	394A	
Penetration:			
Drilled--	84	307	meters
Cored----	0	57	meters
Total----	84	364	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	0	6	cores
	0	17	meters

Site 394 was drilled about 1000 feet southeast of Site 393. We had only sufficient time to accomplish the higher priority technical objectives and took only six cores to fill gaps in the Site 391 sedimentary record. Cores 4, 5, and 6 were recovered from intervals previously unsampled at Site 391. They contain Miocene carbonate gravity deposits as was expected on the basis of previous drilling.



SITE 394 LEG 44



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DSDP
Geoacoustic properties
Physical properties

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Deep ocean sediment cores recovered by the drill ship D/V GLOMAR CHALLENGER have provided invaluable "boundary conditions" for the interpretation of marine seismic reflection and refraction data. In combination, these data provide much of the basis for constructing geoacoustic models in support of low-frequency acoustic propagation in the deep ocean. This report provides a concise, graphic correlation between vertical reflection seismic records across the drill holes, and lithologic-physical property data measured from

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the drilled cores. This correlation and condensation in a standardized format is the first step in producing a synthesis of the data, which will provide insight into the correlation between lithologic and acoustic properties of marine sediments. As stated, this data presentation is only the first step of a synthesis, and interpretation has been minimized. The material is being published at this time in the belief that the condensed data presentation is of immediate value to many people independent of the authors' ultimate objective. A detailed discussion of terminology and measurement technique is provided for users from outside the geoscience discipline.