1. INTRODUCTION AND EXPLANATORY NOTES[1]

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INTRODUCTION

The Bahama Banks (Fig. 1) represent one of the closest modern analogs of ancient carbonate deposits exposed in mountain belts around the world. The importance of the Bahamas in the interpretation of both the rock record on land and the history of the oceans has long been recognized, specifically regarding facies models, sea-level history, paleogeography, sclerochronology, climatic changes, and vertical tectonics.

Leg 101 of the Ocean Drilling Program (ODP) was an investigation of the last 100 million years of structural and stratigraphic history of the Bahamas carbonate platform. The drilling program was based on the results of seismic studies and a few deep stratigraphic tests as well as extensive work on the Quaternary sediment cover of the Bahamas (see Bathurst, 1971; Paulus, 1972; Schlager and Ginsburg, 1981; Cook et al., 1983; Tator and Hatfield, 1975; and Sheridan et al., 1981; for reviews). Most of the seismic work was fragmented, consisting of proprietary industry surveys on the banks and academic single- and multichannel programs in the intervening deep embayments. With the advent of high-quality multifold seismic profiles, reasonable attempts to develop coherent local seismic stratigraphic frameworks tied to available ground control were made (Sheridan et al., 1981; Schlager et al., 1984; J. Ladd and R. E. Sheridan, unpubl. data), but inadequate regional data density has made long-range correlations difficult.

In 1983, when it became clear that a new scientific ocean drilling program would succeed the Deep Sea Drilling Project (DSDP), the academic community began to examine areas for Atlantic drilling that would combine important scientific results with the logistical advantages of proximity to the United States mainland and favorable meteorological conditions. The Bahamas became an obvious choice, but additional geophysical site surveys were required. Therefore, in response to a request for a proposal (RFP) generated by the Joint Oceanographic Institutions, Inc., a consortium of universities, led by the University of Texas Institute for Geophysics (UTIG), conducted high-resolution (multifold-water-gun) reflection/sonobuoy-refraction surveys in three areas of the Bahamas during April 1984. These surveys aided in the identification of scientific objectives and location of drill sites for Leg 101.

Two major themes regarding the development of the Bahamas carbonate platform were addressed on Leg 101. The deep holes were intended to investigate the origin of the present pattern of platforms and troughs in the Bahamas, whereas the shallow holes, arranged along transects, were to examine the anatomy of carbonate-platform flanks. Within each theme, a number of specific scientific objectives were identified, as follows.

Deep Objectives

1. To date and define the nature of a prominent velocity discontinuity observed on seismic lines in the Bahamas region. This surface separates deeper, discontinuous, hummocky reflections with compressional wave velocities of more than 5.0 km/s from shallower, higher amplitude, more continuous reflectors with compressional wave velocities of 2.5–3.2 km/s. The surface may represent the contact between post–mid-Cretaceous, deep-water apron deposits and mid-Cretaceous shallow-water carbonates. Sampling this horizon was expected to calibrate regional seismic stratigraphy and provide insight into the causes of carbonate-platform drowning.
2. To evaluate the tectonic and environmental controls of carbonate-platform growth.
3. To correlate seismic stratigraphy between the deep Gulf of Mexico and the east coast of North America.
4. To document the history of the Gulf Stream, particularly the role of the Cuban orogeny in the initiation of Gulf Stream flow.
5. To document the history of interplatform basins.

Shallow Objectives

1. To examine the facies patterns of accretionary- and bypass-type slopes, particularly the effects of slope angle and distance from the bank on sedimentation.
2. To document the response of platform flanks to sea-level fluctuations.
3. To study the diagenesis of periplatform ooze, a mixture of platform-derived calcite and bank-derived aragonite and magnesian calcite.
4. To document the Neogene history of interplatform basins.

Leg 101

The *JOIDES Resolution* sailed from Miami, Florida, on 31 January 1985 and returned to Miami on 14 March 1985, completing the first internationally staffed cruise of the Ocean Drilling Program. Nineteen holes were drilled at 11 sites in the Straits of Florida, north of Little Bahama Bank, in the southeastern part of Exuma Sound, and in the Northeast Providence Channel (Table 1).

[1] Austin, J. A., Jr., Schlager, W., Palmer, A. A., et al., 1986. *Proc., Init. Repts. (Pt. A), ODP*, 101.

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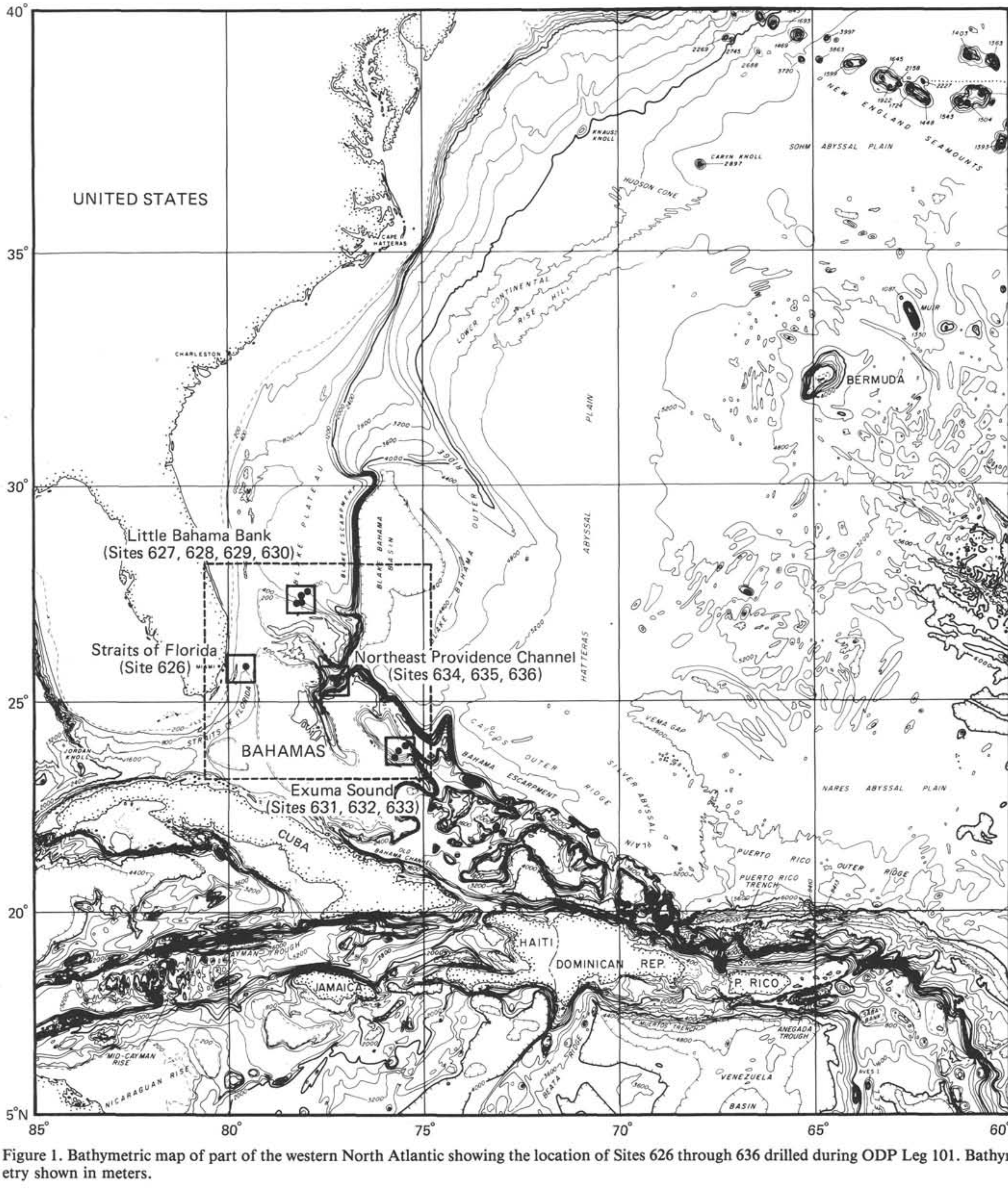


Figure 1. Bathymetric map of part of the western North Atlantic showing the location of Sites 626 through 636 drilled during ODP Leg 101. Bathymetry shown in meters.

The "shallow objectives" of the slope transect sites at Little Bahama Bank (Sites 627, 628, 629, and 630; Fig. 2) and Exuma Sound (Sites 631, 632, and 633) were successful, with good recovery in the upper part of the section.

Although a reentry site had been originally planned for the Straits of Florida, results from a reentry test in this area during the shakedown cruise (Leg 100) indicated that efforts would be unsuccessful. Therefore, all of the "deep-objective" sites on Leg 101 (Sites 626, 627, and 632; Fig. 3) were drilled as single-bit holes. The deep objective was not reached in the four holes attempted at Site 626 in the Straits of Florida because of combined current and substrate problems. A single-bit attempt suc-

Table 1. Summary of Leg 101 drilling.

Hole	Dates (1985)	North latitude	West longitude	Water depth[a] (m)	Penetration (m)	No. of cores	Length cored (m)	Length recovered (m)	Average percentage recovered
626A	31 Jan.-1 Feb.	25°36.00′	79°32.73′	847	12.8	2	11.4	5.0	44
626B	1 Feb.-3 Feb.	25°36.04′	79°33.08′	848	185.5	5	47.5	13.9	29
626C	3 Feb.-4 Feb.	25°36.02′	79°32.80′	844	179.3	19	179.3	66.3	37
626D	4 Feb.-9 Feb.	25°36.02′	79°32.81′	844	456.3	28	276.9	9.4	3
627A	10 Feb.-10 Feb.	27°38.10′	78°17.65′	1030	8.8	1	8.8	9.5	107
627B	10 Feb.-17 Feb.	27°38.10′	78°17.65′	1025	535.8	60	535.6	350.3	65
628A	17 Feb.-19 Feb.	27°31.85′	78°18.95′	966	298.4	32	298.4	216.9	73
629A	19 Feb.-20 Feb.	27°24.39′	78°22.10′	553	16.5	3	16.5	6.2	38
630A	20 Feb.-21 Feb.	27°26.94′	78°20.43′	807	250.3	26	250.3	220.3	88
630B	21 Feb.-21 Feb.	27°26.94′	78°20.43′	807	80.4	9	80.4	79.6	99
630C	21 Feb.-21 Feb.	27°26.94′	78°20.43′	807	9.3	1	9.3	9.3	100
631A	23 Feb.-25 Feb.	23°35.20′	75°44.56′	1081	244.3	25	244.3	159.0	65
632A	25 Feb.-26 Feb.	23°50.44′	75°26.13′	1996	141.0	16	141.0	83.3	59
632B	26 Feb.-1 Mar.	23°50.44′	75°26.13′	1996	283.2	17	162.6	34.8	21
633A	1 Mar.-2 Mar.	23°41.31′	75°37.41′	1681	227.3	24	227.3	110.8	49
634A	3 Mar.-8 Mar.	25°23.02′	77°18.88′	2835	479.4	32	322.5	27.3	9
635A	9 Mar.-9 Mar.	25°25.13′	77°19.92′	3448	20.1	3	20.1	6.2	31
635B	9 Mar.-11 Mar.	25°25.18′	77°19.98′	3470	117.7	14	117.7	31.2	26
636A	11 Mar.-13 Mar.	25°25.11′	77°18.35′	3573	21.0	2	21.0	0.1	0.5

[a] Sea level; corrected m, echo-sounding.

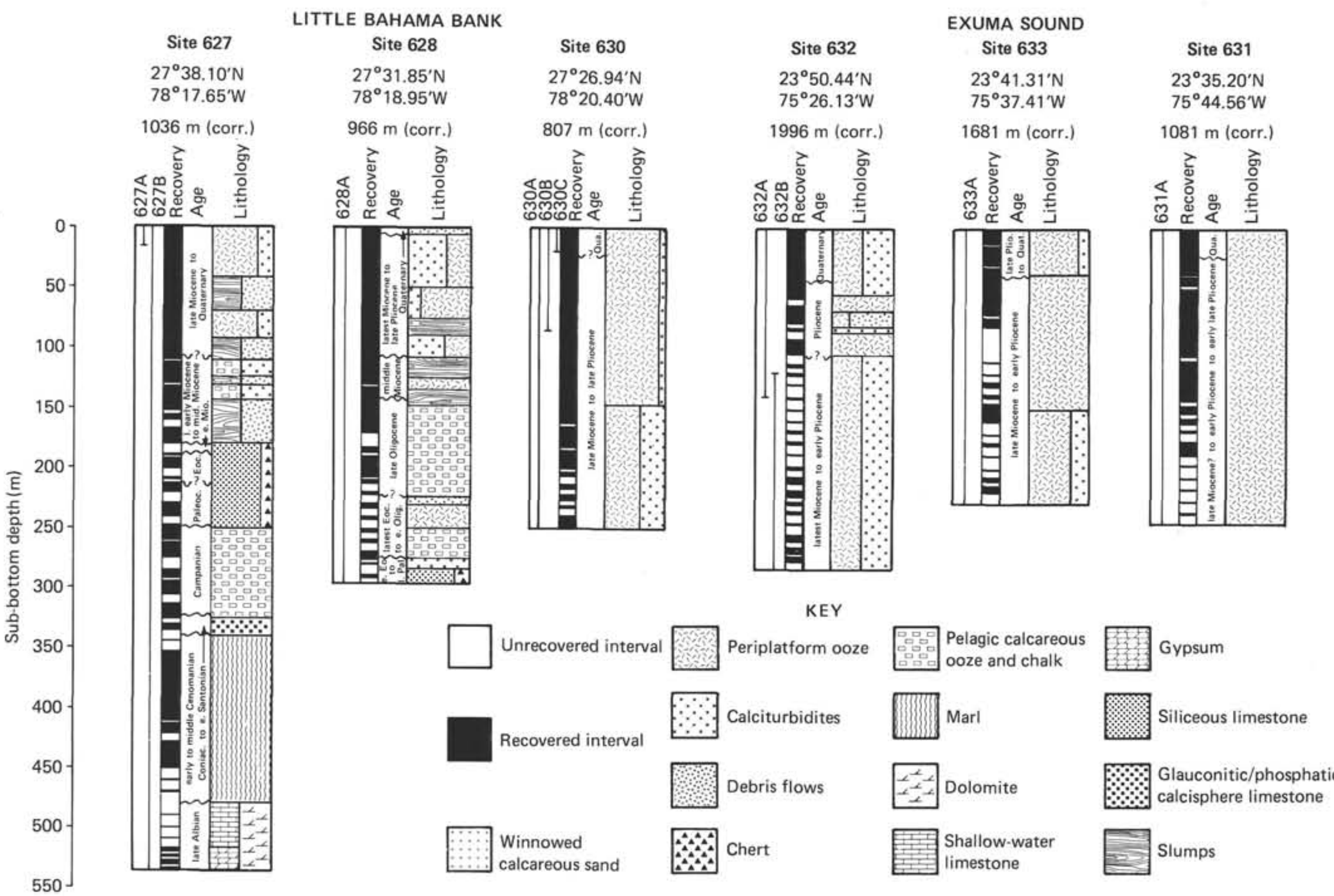


Figure 2. Lithologic sections of "shallow objective" slope transect sites, Leg 101.

ceeded at Site 627 (Little Bahama Bank), where Lower Cretaceous shallow-platform carbonates were recovered. Another deep attempt in Exuma Sound (Site 632) was cut short when hydrocarbons were encountered, forcing the termination of drilling.

The sites in the Northeast Providence Channel were attempts to reach the Lower Cretaceous objective attained at Site 627 but missed at Sites 626 and 632. Originally intended as a reoccupation of DSDP Site 98, a series of operational problems led to the drilling of a total of five holes at Sites 634, 635, and 636 without reaching shallow-platform carbonates. However, Site 635 did provide an important stratigraphic tie with Site 627; Cenomanian marls were recovered at both locations.

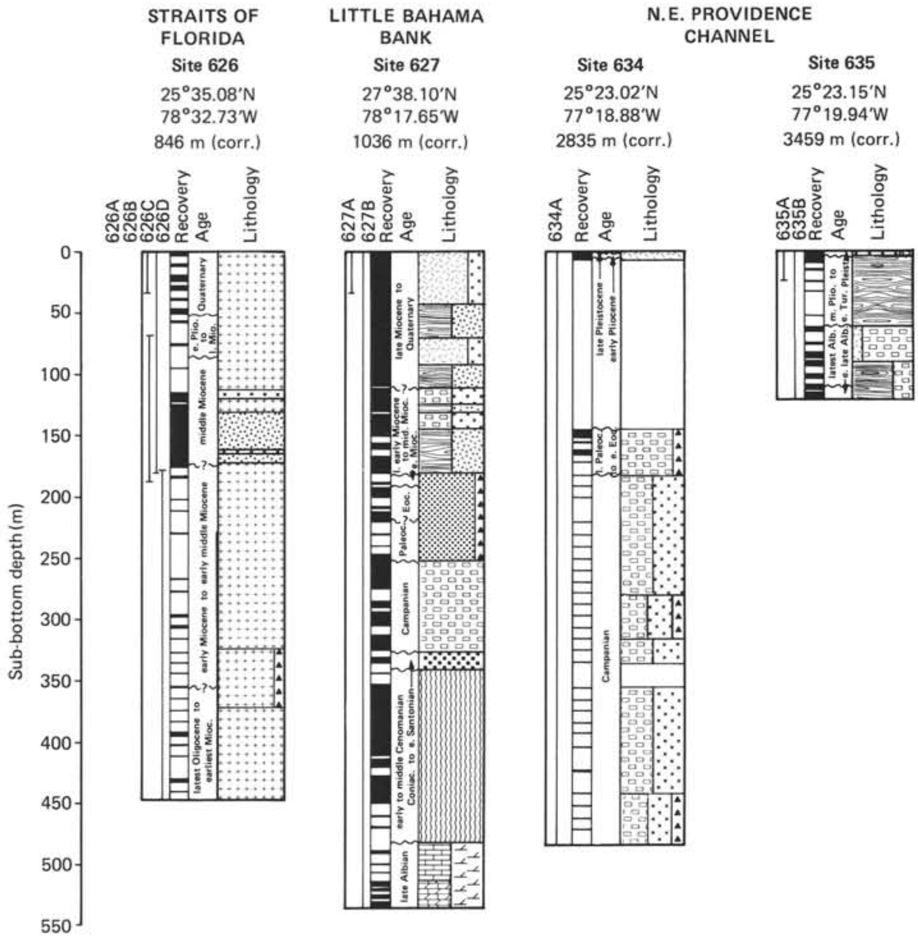


Figure 3. Lithologic sections of "deep objective" sites, Leg 101.

Overall, Leg 101 achieved most of its scientific objectives. The success of this inaugural ODP leg was possible only through the skill and dedication of both the ODP staff and the personnel who operated the SEDCO drilling vessel.

The details and results of the leg are outlined in the site chapters that follow. The results of specialized studies will be published as the *Final Report*, or Part B, of the Leg 101 cruise *Proceedings* volume.

EXPLANATORY NOTES

Standard procedures for both drilling operation and preliminary shipboard analysis of the material recovered have been regularly amended and upgraded since 1968 during DSDP and ODP drilling. In this chapter, we have assembled information to help the reader understand the basis for our preliminary conclusions and to help the interested investigator select samples for further analysis. This information pertains only to shipboard operations and analyses described in the site reports in the *Initial Report*, or Part A, of the Leg 101 *Proceedings of the Ocean Drilling Program*. Methods used by various investigators for further shore-based analysis of Leg 101 data will be detailed in the individual scientific contributions published in the *Final Report*, or Part B, of the volume.

Authorship of Site Reports

Authorship of the site reports was shared among the entire shipboard scientific party, although the two co-chief scientists and the staff scientist edited parts of the material prepared by other individuals. The site chapters are organized as follows (authorship in alphabetical order, with no seniority necessarily implied, in parentheses):

Site Data and Principal Results (Austin, Schlager)
Background and Objectives (Austin, Schlager)
Operations Summary (Austin, Schlager)
Sedimentology (Droxler, Freeman-Lynde, Fulthorpe, Harwood, Kuhn, and Mullins)
Biostratigraphy (Fourcade, Leckie, Melillo, Palmer, Verbeek, Watkins)
Sediment-Accumulation Rates (Leckie, Melillo, Verbeek, Watkins)
Inorganic Geochemistry (Swart)
Organic Geochemistry (Comet, Moore)
Paleomagnetism (Sager)
Physical Properties (Eberli, Lavoie, Ravenne)
Downhole Measurements (Williams)
Seismic Stratigraphy (Austin, Schlager)
Summary and Conclusions (Austin, Schlager)

Following the text in each site chapter are summary graphic lithologic and biostratigraphic figures, core descriptions ("barrel sheets"), and photographs of each core.

Survey and Drilling Data

The survey data used for specific site selections are discussed in each site chapter. All geophysical survey data collected during Leg 101 are presented in the "Underway Geophysics" chapter (this volume).

The seismic-profiling system consisted of either one 400-in.^{3} or two 80-in.^{3} water guns, a hydrophone array designed at Scripps Institution of Oceanography, Bolt amplifiers, two band-pass filters, and two EDO recorders, usually recording at two different filter settings.

Depths were continuously recorded under way on a Gifft precision graphic recorder. The depths were read on the basis of an assumed 1463 m/s sound velocity. The water depth (in meters) at each site was corrected (1) according to the tables of Matthews (1939) and (2) for the depth of the hull transducer (6.8 m) below sea level. In addition, depths referred to the drilling platform level are assumed to be 10.5 m above the water line.

Drilling Characteristics

Because water circulation down the hole is open, cuttings are lost onto the seafloor and cannot be examined. The only available information about sedimentary stratification in uncored or unrecovered intervals, other than from seismic data or wireline logging results, is from an examination of the behavior of the drill string as observed and recorded on the drill platform. The harder a layer, the slower and more difficult it usually is to penetrate. A number of other factors, however, determine the rate of penetration, so it is not always possible to relate drilling time directly to the hardness of the layers. The parameters of bit weight and revolutions per minute are recorded on the drilling recorder and influence the rate of penetration.

Drilling Deformation

When cores are split, many show signs of significant sediment disturbance. Such disturbance includes the concave-downward appearance of originally horizontal bands, the haphazard mixing of lumps of different lithologies (mainly at the tops of cores), and the near-fluid state of some sediments recovered from tens to hundreds of meters below the seafloor. Core deformation probably occurs during one of three different steps at which the core can suffer stresses sufficient to alter its physical characteristics: cutting, retrieval (with accompanying changes in pressure and temperature), and core handling.

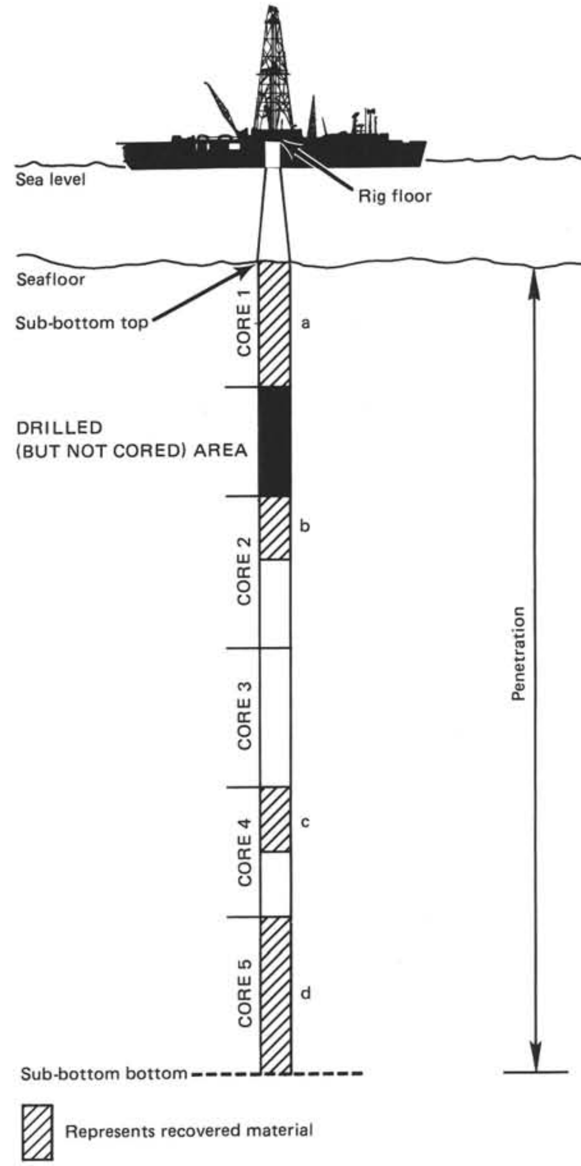
Shipboard Scientific Procedures

Numbering of Sites, Holes, Cores, and Samples

ODP drill sites are numbered consecutively from the first DSDP site drilled by *Glomar Challenger* in 1968. Site numbers are usually slightly different from hole numbers. A site number refers to one or more holes drilled while the ship is positioned over a single acoustic beacon. Several holes can be drilled at a single site by pulling the drill pipe above the seafloor (out of one hole), moving the ship some distance from the previous hole, and then drilling another hole.

For all ODP drill sites, a letter suffix distinguishes each hole drilled at the same site. For example, the first hole takes the site number with the suffix *A*, the second hole takes the site number with the suffix *B*, and so forth. This procedure is different from that used by the Deep Sea Drilling Project (Sites 1 through 624), and prevents ambiguity between site- and hole-number designations.

Figure 4 illustrates various measurements recorded at each drill site. The cored interval is measured in meters below the seafloor. The depth interval of an individual core is measured from the depth below seafloor where the coring operation began to the depth that the coring operation ended. Each coring interval is generally up to 9.7 m long, which is the maximum length of a core barrel (Fig. 5). The coring interval may, however, be shorter. "Cored intervals" are not necessarily adjacent to each other but may be separated by "drilled intervals." In soft sediment, the drill string can be "washed ahead," with the core barrel in



BOTTOM FELT: distance from rig floor to seafloor (number written on white board)

TOTAL DEPTH: distance from rig floor to bottom of hole (sub-bottom bottom)

PENETRATION: distance from seafloor to bottom of hole (sub-bottom bottom)

NUMBER OF CORES: total of all cores recorded, including cores with no recovery

TOAL LENGTH OF CORED SECTION: distance from sub-bottom top to sub-bottom bottom minus drilled (but not cored) areas in between

TOTAL CORE RECOVERED: total from adding a, b, c, and d in diagram

CORE RECOVERY (%): equals TOTAL CORE RECOVERED divided by TOTAL LENGTH OF SECTION times 100

Figure 4. Diagram illustrating terms used in discussion of coring operations and core recovery.

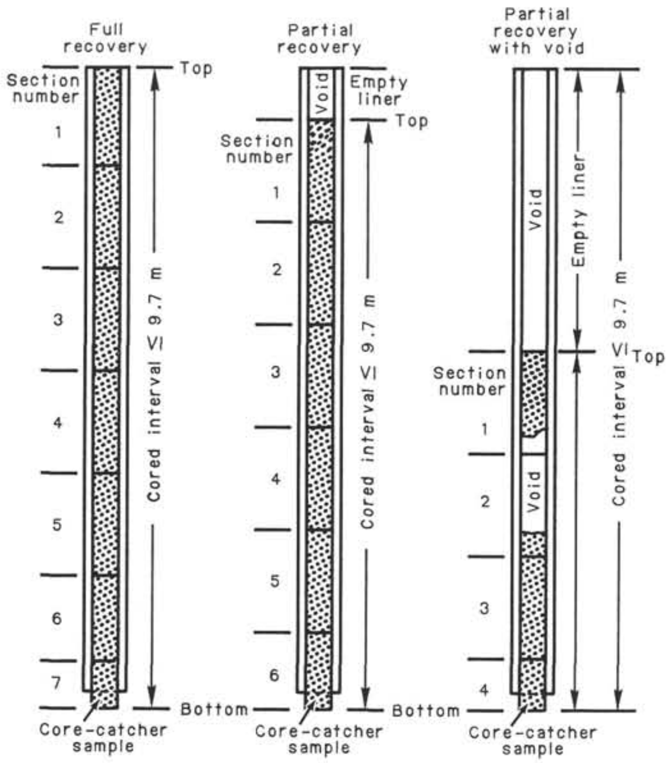


Figure 5. Diagram showing procedure in cutting and labeling of core sections.

place but not recovering sediment, by pumping water down the pipe at high pressure to wash the sediment out of the way of the bit and up the space between the drill pipe and the wall of the hole; however, if thin, hard rock layers are present, it is possible to get "spotty" sampling of these resistant layers within the washed interval.

Cores taken from a hole are numbered serially from the top of the hole downward. Maximum full recovery for a single core is 9.7 m of sediment or rock in a plastic liner (6.6 cm internal diameter), plus a sample approximately 0.2 m long (without a plastic liner) in a core catcher. The core catcher is a device at the bottom of the core barrel that prevents the core from sliding out when the barrel is being retrieved from the hole. The sediment core, which is in the plastic liner, is then cut into 1.5-m-long sections that are numbered serially from the top of the sediment core (Fig. 5). When full recovery is obtained, the sections are numbered from 1 through 7, the last section being shorter than 1.5 m. For sediments and sedimentary rocks, the core-catcher sample is placed below the last section and treated as a separate section.

When recovery is less than 100%, whether or not the recovered material is contiguous, the recovered sediment is placed at the top of the cored interval, and then 1.5-m-long sections are numbered serially, starting with Section 1 at the top. There will be as many sections as needed to accommodate the length of the core recovered (Fig. 5); for example, 3 m of core sample in a plastic liner will be divided into two 1.5-m-long sections. Sections are cut starting at the top of the recovered sediment, and the last section may be shorter than the normal 1.5-m length. If, after the core has been split, fragments that are separated by a void appear to have been contiguous *in situ*, a note is made in the description of the section. All voids, whether real or artificial, are curatorially preserved.

Samples are designated by distances in centimeters from the top of each section to the top and bottom of the sample interval in that section. A full identification number for a sample consists of the following information: (1) leg, (2) site, (3) hole, (4) core number and type (as explained below), (5) section, and (6) interval in centimeters. For example, the sample identification number "101-626A-2R-2, 8-10 cm" means that a sample was taken between 8 and 10 cm from the top of Section 2 of rotary-drilled Core 2, from the first hole drilled at Site 626 during Leg 101. A sample from the core catcher of this core might be designated "101-626A-2R, CC, 7-9 cm."

The depth below the seafloor for a sample numbered, for example, "101-626A-2-2, 8-10 cm" is the sum of the depth to the top of the cored interval for Core 2 (in this example: 1.4 m, equivalent to the length of Core 1), plus the 1.5 m included in Section 1, plus the 8 cm below the top of Section 2. The sample in question is therefore located at 2.98 m sub-bottom, which, in principle, is the sample sub-seafloor depth (however, sample requests should refer to a specific interval within a core section rather than sub-bottom depths in meters).

All ODP core and sample identifiers include core type. The following abbreviations are used: R = rotary barrel; H = hydraulic piston core (HPC); P = pressure core barrel; X = extended core barrel (XCB); B = drill-bit recovery; C = center-bit recovery; I = *in-situ* water sample; S = sidewall sample; W = wash-core recovery; N = Navidrill core barrel (used on Leg 104 and subsequent legs); and M = miscellaneous material.

Core Handling

During Leg 101, as soon as a core was retrieved on deck, a sample was taken from the core catcher and taken to the paleontological laboratory for an initial assessment of the age of the sample.

The core was then placed on a long horizontal rack, and gas samples were taken from any voids observed by piercing the core liner and withdrawing gas into a vacuum-tube sampler. Some of the gas samples were stored for shore-based study, but others were analyzed immediately as part of the shipboard safety and pollution-prevention program. Next, the core was marked into 1.5-m-section lengths, each section was labeled, and the core was cut into sections. Whole-round samples were then taken for interstitial-water (IW) and organic-geochemistry (OG) analysis. Each section was sealed top and bottom by gluing on a plastic cap, blue to identify the top of a section and clear for the bottom. A yellow cap was placed on section ends from which a whole-round core sample had been removed.

The cores then were carried into the laboratory, where the sections were again labeled using an engraver to inscribe the full designation of the section. The length of core in each section and the core-catcher sample were measured to the nearest centimeter, and this information was logged into the shipboard core-log data-base program.

The cores then were allowed to warm to room temperature (approximately 4 hr) before they were split. During this time, the whole-round sections were run through the Gamma Ray Attenuation Porosity Evaluator (GRAPE) for estimating bulk density and porosity (see below; Boyce, 1976), and the pass-through magnetic-susceptibility meter (see below). After the cores had warmed to room temperature, thermal-conductivity measurements were made immediately before the cores were split.

Cores of relatively soft material were split lengthwise into the *working* and *archive halves*. The softer cores were split with a wire or saw, depending on the degree of induration. Harder cores were split with a band saw or diamond saw. Cores split with wire on Leg 101 were split from top to bottom; thus, younger material could possibly be transported downcore on the split face of each section. Therefore, scientists should be aware that the very near-surface part of the split core could be contaminated.

The *working half* was sampled for both shipboard and shore-based laboratory studies. Each extracted sample was logged by location and the name of the investigator receiving the sample in the sampling computer program. Records of all removed samples are kept by the Curator at ODP. The extracted samples were sealed in plastic vials or bags and labeled. Samples were routinely taken for shipboard analysis of sonic velocity by the Hamilton Frame method, for water content by gravimetric analysis, for percentage of calcium carbonate present (carbonate bomb), and for other purposes. Many of these data are reported in the site chapters.

The *archive half* was described visually. Smear slides were made from samples taken from the *archive half* and were supplemented by thin sections taken from the *working half*. The *archive half* was then photographed with both black-and-white and color film, a whole core at a time.

Both halves were then put into labeled plastic tubes, sealed, and transferred to cold-storage space aboard the drilling vessel. Leg 101 cores were transferred from the ship via refrigerated vans to cold storage at the East Coast Repository (Lamont-Doherty Geological Observatory, Palisades, New York).

Core Description Forms ("Barrel Sheets")

The Core Description Forms (Fig. 6), or "barrel sheets," summarize the data obtained during shipboard analysis of each core. The following discussion explains the ODP conventions used in compiling each part of the Core Description Forms and the exceptions to these procedures adopted by Leg 101 scientists.

Core Designation

Cores are designated using site, hole, and core number and type previously discussed (see "Numbering of Sites, Holes, Cores, and Samples," above). In addition, the Cored Interval is specified in terms of meters below sea level (mbsl) and meters below sea floor (mbsf). On Leg 101, these depths were based on the drill-pipe measurement, as reported by the SEDCO coring technician and the ODP operations superintendent.

Age Data

Microfossil abundance, preservation, and zone assignment, as determined by the shipboard paleontologists, appear on the Core Description Form under the heading "Biostrat. Zone/Fossil Character." The geologic age determined from the paleontological results appears in the "Time-Rock Unit" column.

On Leg 101, planktonic foraminifers and calcareous nannofossils provided most age determinations, although radiolarians and larger benthic foraminifers were also used. Detailed information on the zonations and terms used to report abundance and preservation appear below (see "Biostratigraphy").

Paleomagnetic, Physical-Property, and Chemical Data

Columns are provided on the Core Description Form to record paleomagnetic results (not obtained on Leg 101 because the shipboard cryogenic magnetometer had not yet been installed), physical-property values (density, porosity, and velocity), and chemical data (percentage of $CaCO_3$ determined, using the carbonate bomb). Additional information on shipboard procedures appears below (see "Paleomagnetics," "Physical Properties," and "Inorganic Geochemistry").

Graphic Lithology Column

The lithologic-classification scheme presented below (see "Sediment Classification") is represented graphically on the Core Description Forms using the symbols illustrated in Figures 7 and 8. As explained below, we have made some modifications and additions to the graphic-lithology-representation scheme recommended by the JOIDES Sedimentary Petrology and Physical Properties Panel to describe adequately the coarse-grained carbonates encountered on Leg 101 (new symbols introduced for Leg 101 are illustrated in Fig. 8).

The graphic-lithology column illustrates the sediment lithology using a single pattern or group of patterns. The abundance of any component corresponds to the percentage of the width it occupies in the column. For example, the right-hand 80% may show the calcareous pattern, whereas the left-hand 20% may show hemipelagic mud, indicating a lithology containing 80% ooze and 20% mud. The lithological-description text should be referred to for explanation, as in some cases groups of patterns are used to illustrate lithologies intercalated in beds thinner than can be shown at the scale of the barrel sheets.

Sediment Disturbance

The coring technique, which uses a 25-cm-diameter bit with a 6-cm-diameter core opening, may result in extreme disturbance of the recovered core material in both soft and hard sediments. This is illustrated in the "Drilling Disturbance" column on the Core Description Form using the symbols in Figure 9, as explained below.

The following disturbance categories are recognized for soft and firm sediments:

1. Slightly disturbed: bedding contacts are slightly bent.
2. Moderately disturbed: bedding contacts have undergone extreme bowing.
3. Highly disturbed: bedding is completely disturbed, sometimes showing symmetrical diapirlike structure.
4. Soupy: intervals are water saturated and have lost all aspects of original bedding.

The following categories are used to describe the degree of fracturing in hard sediments:

1. Slightly fractured: core pieces in place, with very little drilling slurry or breccia.
2. Moderately fragmented: core pieces in place or partly displaced, but original orientation is preserved or recognizable. Drilling slurry may surround fragments.
3. Highly fragmented: pieces are from the interval cored and probably in correct stratigraphic sequence (although they may not represent the entire section), but original orientation is totally lost. Sometimes drilling "biscuits," rounded pieces of firm sediment, are surrounded by a "drilling paste" formed by abrasion of "biscuits" against one another.
4. Drilling breccia: core pieces have completely lost their original orientation and stratigraphic position. May be completely mixed with drilling slurry. Common at the tops of cores on Leg 101; may in part be downhole contamination.

Sedimentary Structures

In soft and even in some harder sedimentary cores, it is sometimes difficult to distinguish between natural structures and structures created by the coring process. However, where such structures were observed, they are indicated on the "Sedimentary Structure" column of the Core Description Forms. A key to the structural symbols used on Leg 101 is given in Figure 9.

Samples

The position of samples taken from each core for shipboard analysis is indicated in the "Samples" column in the Core Description Form. An asterisk (*) indicates the location of smear slide samples. The symbols *IW*, *OG*, and *PP* designate whole-

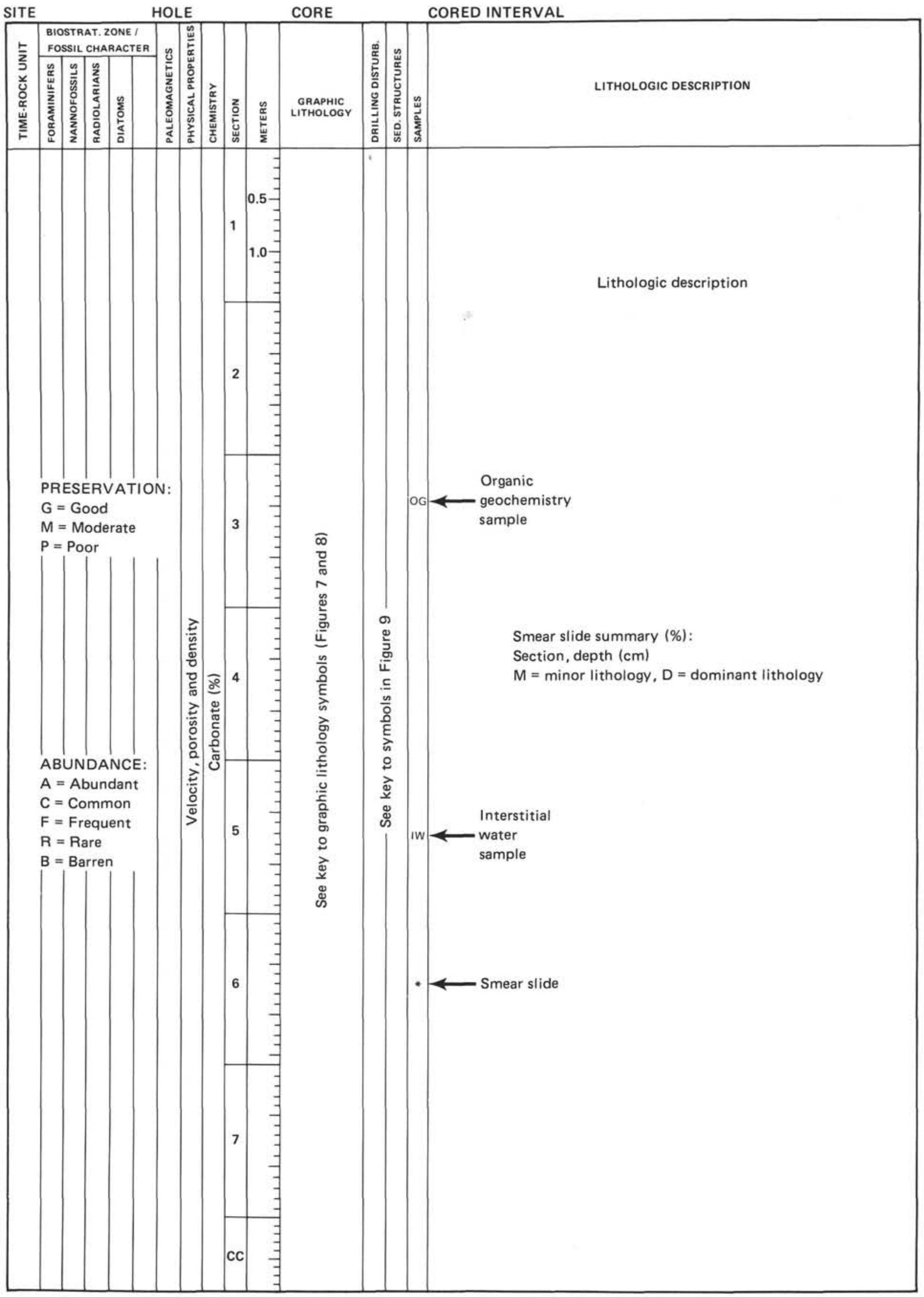


Figure 6. Core Description Form ("barrel sheet") used for sediments and sedimentary rocks.

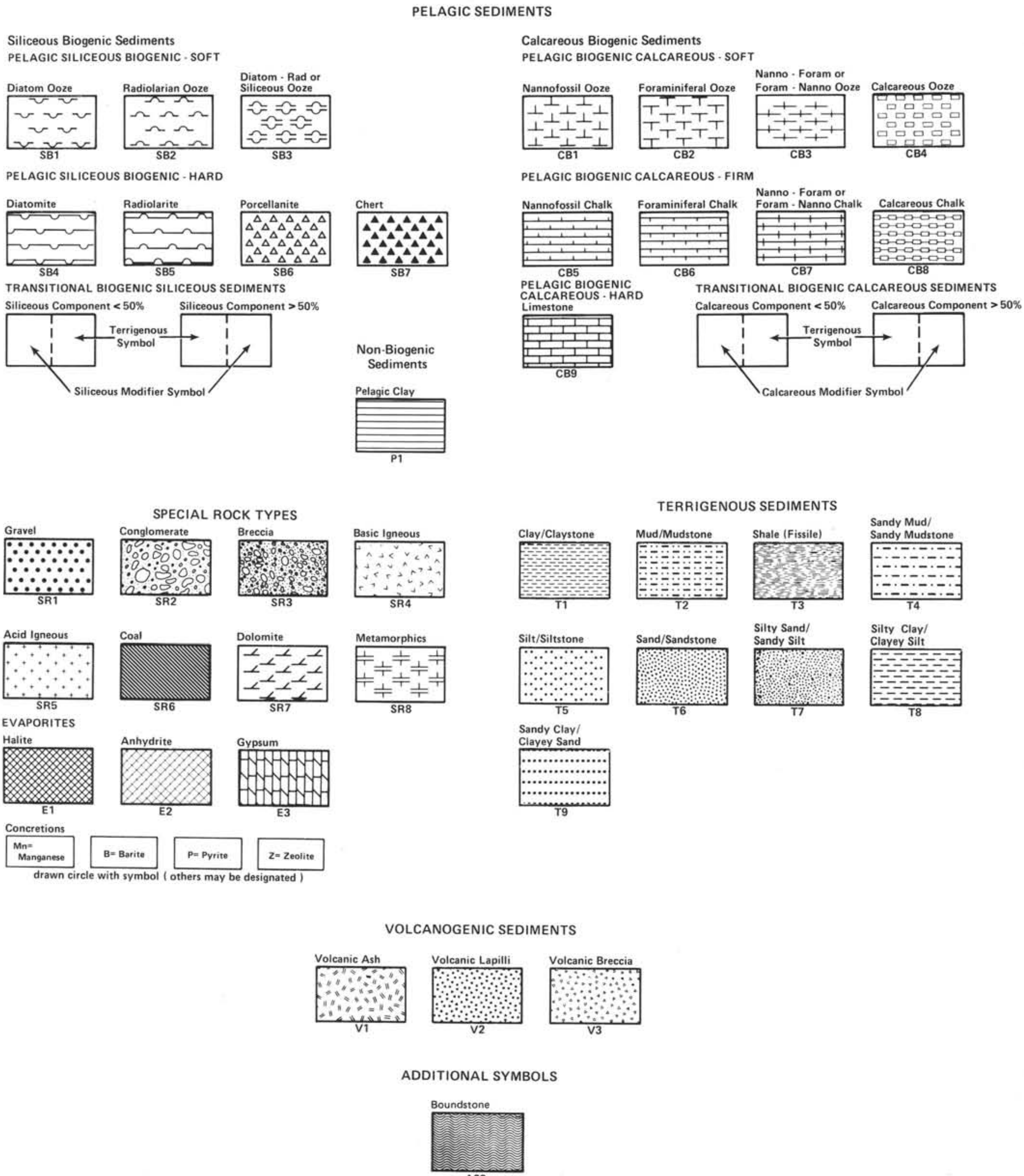


Figure 7. Key to lithologic symbols used in "graphic lithology" column on Core Description Forms (see Fig. 6). Additional symbols are shown in Figure 8.

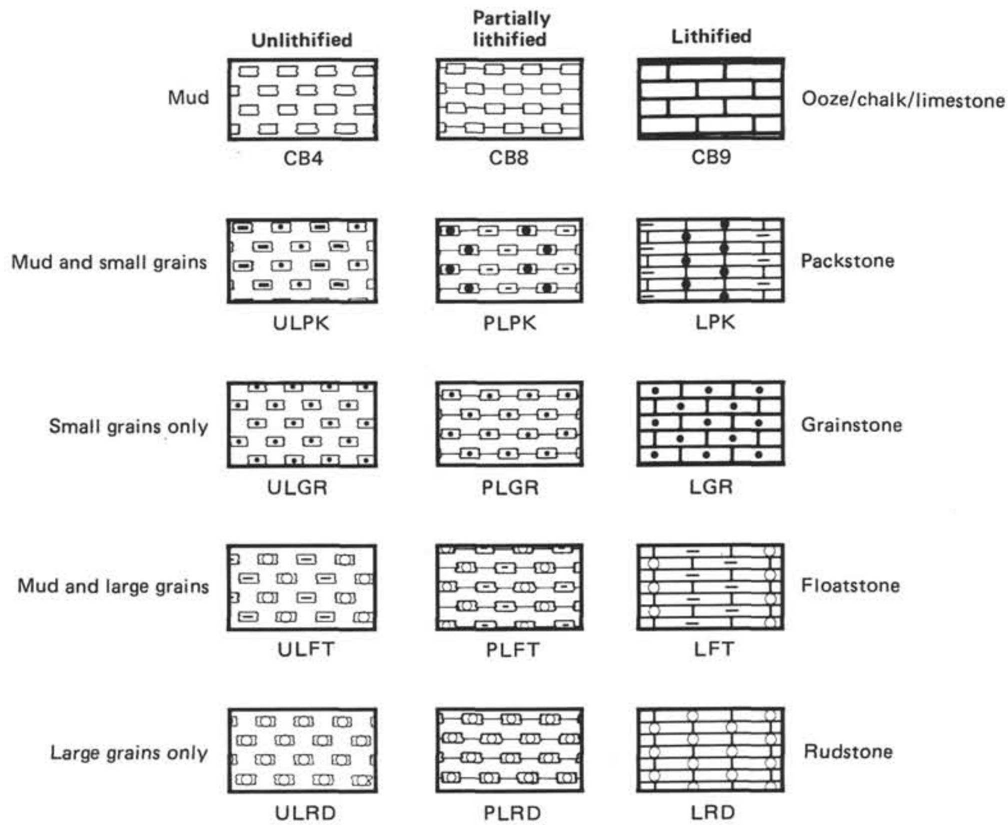


Figure 8. Lithologic symbols adapted for use on Leg 101, based on the Dunham (1962) carbonate classification scheme.

round interstitial water, frozen organic geochemistry, and physical-property samples, respectively.

Although not indicated in the "Samples" column, the position of samples for routine physical-property and carbonate-bomb analyses are indicated by a dot in the "Physical Properties" and "Chemistry" columns (these samples are taken from the working half of the core and generally correspond to smear slide locations in the archive half, although this is not always the case).

Shipboard paleontologists generally base their age determinations on core-catcher samples. Samples from other parts of the core are used mainly to resolve discrepancies and to provide particularly detailed stratigraphy where needed.

Lithologic Description — Text

The lithologic description that appears on each Core Description Form consists of two parts: (1) a brief summary heading that lists all the lithologies (as determined, using the sediment-classification scheme discussed below) observed in a given core in order of importance, with notes as to which may be artificial or displaced (i.e., drilling breccia, downhole contamination), and (2) a detailed list of lithologies, also in order of importance, including data on color, occurrence in the core, and significant features.

Smear Slide Summary

A table summarizing smear slide data, if available, appears on each Core Description Form. The section and interval from which the sample was taken are noted, as well as identification as a dominant (*D*) or minor (*M*) lithology in the core. The percentage of all identified components (intended to total 100%) is listed. As explained below, these data are used to classify the sediment.

Sediment Classification

The sediment-classification system used during Leg 101 is a modification of that devised by the former Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) Panel on Sedimentary Petrology and Physical Properties (SP^4) and adopted for use by the JOIDES Planning Committee in March 1974. Shipboard core descriptions, smear slide descriptions, and carbonate-bomb (percentage of $CaCO_3$) data serve as bases for classification.

Sediment and rock names are defined solely on the basis of composition and texture. Composition is most important for description of those deposits more characteristic of open-marine conditions, with texture becoming more important for the classification of hemipelagic and nearshore facies. These data were primarily determined aboard ship by (1) visual estimates in smear slides and thin sections with the aid of a microscope, (2) visual observation using a hand lens, and (3) unaided visual observation. Calcium carbonate content was estimated in smear slides and by using the carbonate-bomb technique (Müller and Gastner, 1971). Other geologic features determined were color and firmness.

Color

Colors of the recovered material were determined with Munsell soil color charts. Colors were evaluated immediately after the cores were split and while they were still wet. Information on core colors is given in the "Lithologic Description" text on the Core Description Forms.

Firmness

The determination of induration is highly subjective, but the categories used on Leg 101 (after Gealy et al., 1971) are thought

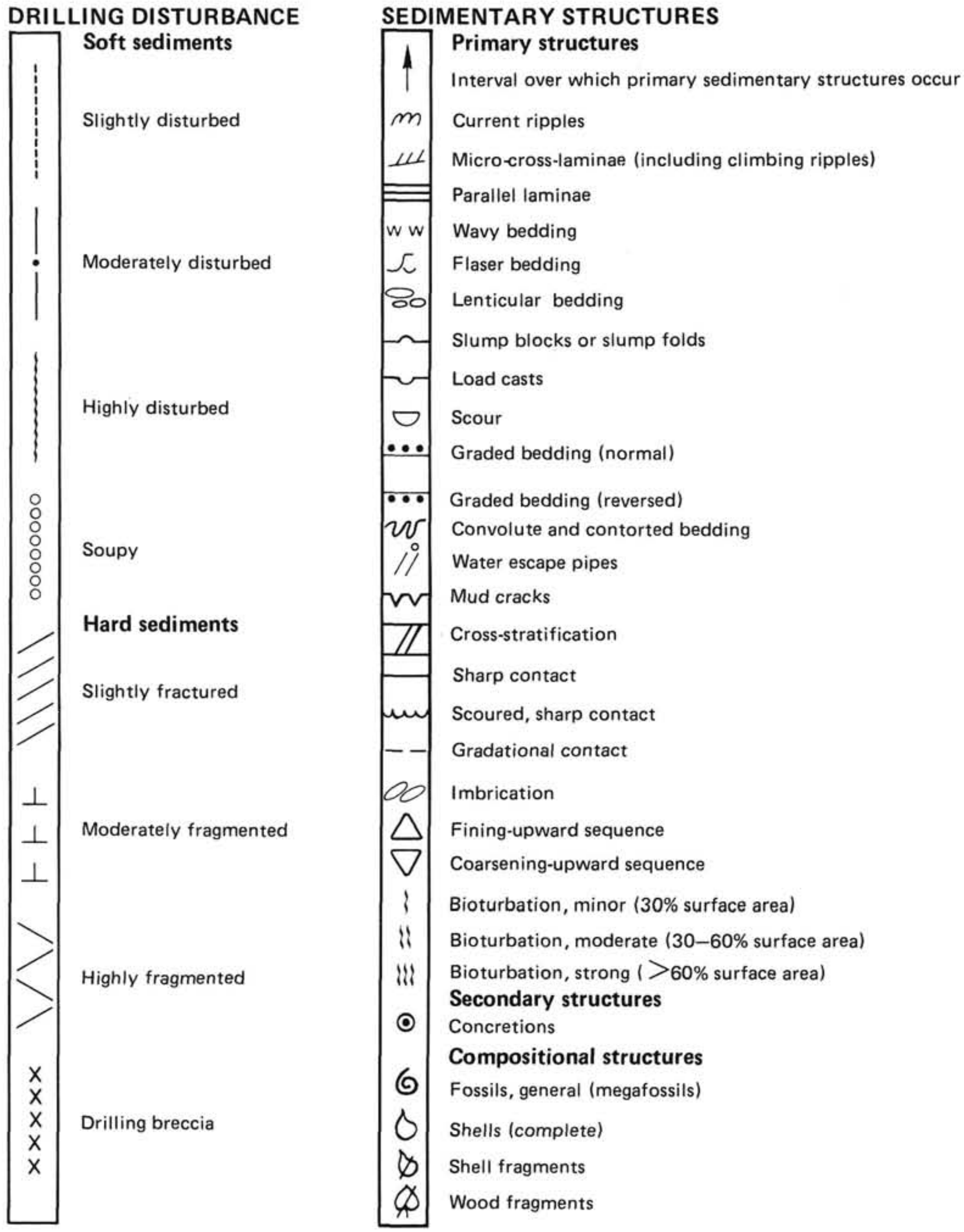


Figure 9. Symbols showing drilling disturbance and sedimentary structures used on Core Description Forms.

to be practical and significant. Three classes of firmness for calcareous sediments were recognized:

1. *Unlithified*: soft sediments that have little strength and are readily deformed under the pressure of a finger or the broad blade of a spatula. This corresponds to the term OOZE for fine-grained carbonates; in coarser grained material the prefix UNLITHIFIED is used (e.g., UNLITHIFIED PACKSTONE).

2. *Partly lithified*: firm or friable sediments that can be scratched with a fingernail or the edge of a spatula blade. This corresponds to the term CHALK for finer grained carbonates; in coarser grained material the prefix PARTLY LITHIFIED is used (e.g., PARTLY LITHIFIED GRAINSTONE).

3. *Lithified*: hard, nonfriable cemented rock, difficult or impossible to scratch with a fingernail or the edge of a spatula. This corresponds to the term LIMESTONE (LITHIFIED OOZE) for finer grained carbonates; in coarser grained material the prefix LITHIFIED is used (e.g., LITHIFIED FLOATSTONE).

There are only two classes of firmness for other sediments:

1. *Soft*: sediment core can be split with a wire cutter. Soft terrigenous sediment, pelagic clay, and transitional calcareous biogenic sediments are termed *sand, silt, clay*, or *mud*.

2. *Hard*: the core is hard (i.e., consolidated or well indurated) if it must be cut with a band saw or diamond saw. For these materials, the suffix *-stone* is added to the soft-sediment name (e.g., *sandstone, siltstone, claystone, mudstone*). Note that this varies from terms used to describe carbonates, in which the suffix "-stone" has no firmness implications (see "Calcareous Biogenic Sediments," below).

Basic Sediment Types

Adapted and modified from the standard DSDP sediment-classification scheme (Supko et al., 1978), the following defines compositional class boundaries and the use of qualifiers in the lithologic-classification scheme used during Leg 101 (Fig. 10):

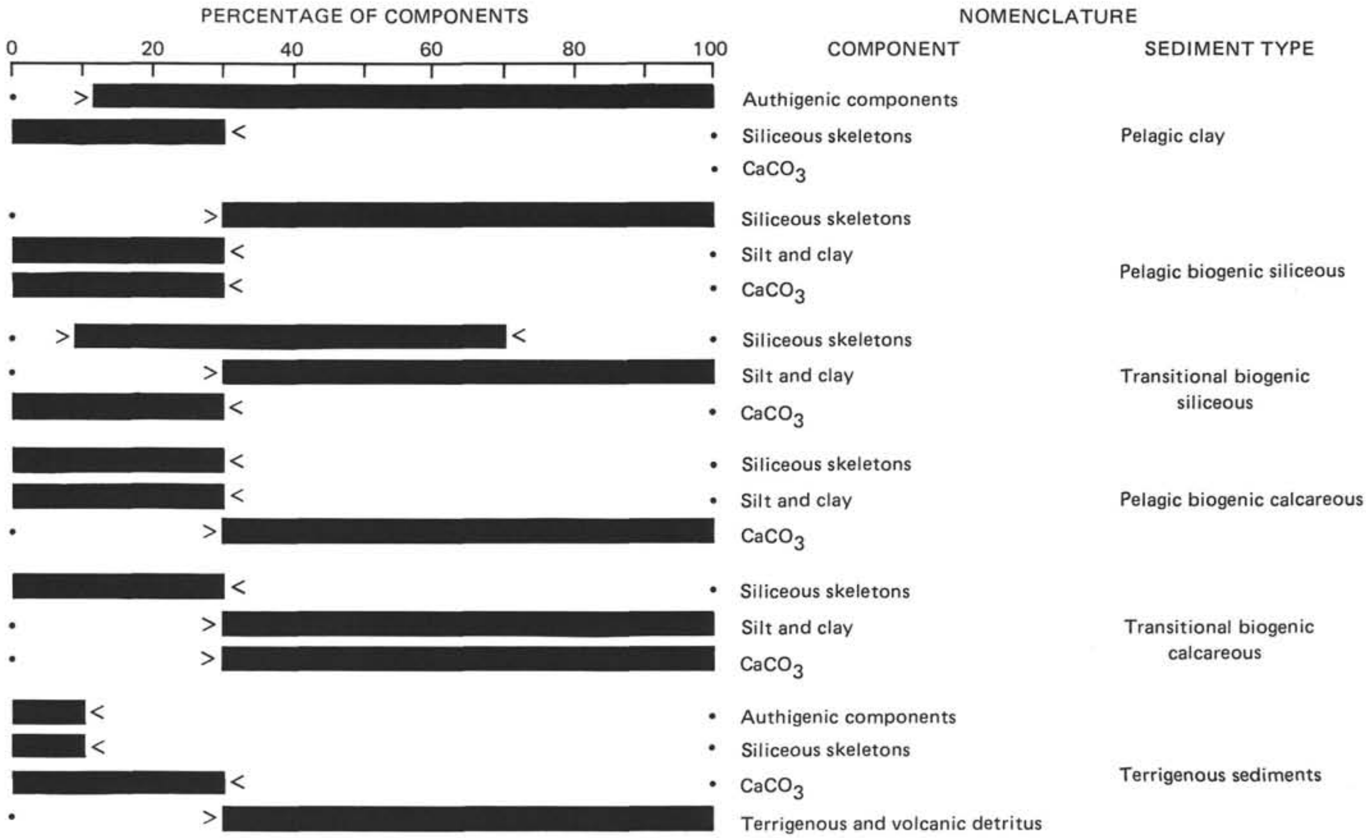


Figure 10. Summary chart for lithologic classification of sediments.

Pelagic Clay

Pelagic clay is principally composed of authigenic pelagic material that accumulated at very slow rates. This type of sediment often has been termed "brown clay" or "red clay." Since all clay-rich sediments cored during Leg 101 show evidence of terrigenous origin, this category was not used.

Siliceous Biogenic Sediments

Siliceous biogenic sediments are distinguished from pelagic clay because they contain common siliceous microfossils, and from the calcareous-biogenic-sediment category by a calcium carbonate content of less than 30%. They are a minor constituent of Leg 101 sediments.

Two categories of siliceous biogenic sediments are detailed below: (1) *pelagic siliceous biogenic sediments* that contain greater than 30% siliceous microfossils and less than 30% silt and clay, and (2) *transitional biogenic siliceous sediments* that contain between 10% and 70% siliceous microfossils and more than 30% silt and clay.

For *pelagic siliceous biogenic sediments*, the following terminology is used:

1. *Soft*: siliceous ooze (radiolarian ooze, diatomaceous ooze, etc., depending on the dominant fossil component).
2. *Hard*: radiolarite, diatomite, chert, or porcellanite.

One or two qualifiers may be used to identify the type of siliceous material in the sediment; for example:

Indeterminate siliceous fossils: siliceous ooze, chert, or porcellanite.
Radiolarians only: radiolarian ooze or radiolarite.
Diatoms only: diatom ooze or diatomite.
Sponge spicules only: spicule ooze or spiculite.
Diatoms < radiolarians: diatom radiolarian ooze or diatom radiolarite.
Diatoms > radiolarians: radiolarian diatom ooze or radiolarian diatomite.

The most dominant component is listed last, and the minor component is listed first.

For *transitional siliceous biogenic sediments*, the following terminology is used:

Diatoms < 50%: diatomaceous mud (soft) or diatomaceous mudstone (hard).
Diatoms > 50%: muddy diatom ooze (soft) or muddy diatomite (hard).

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

A calcareous content of between 10% and 30% in siliceous biogenic sediments carries a qualifier such as "calcareous," "nannofossil," etc.

Calcareous Biogenic Sediments

The standard DSDP/ODP classification scheme (Supko et al., 1978) identifies two classes of calcareous biogenic sediments: (1) *pelagic calcareous biogenic sediments* that contain 65% to 100% biogenic $CaCO_3$ (less than 30% silt and clay), and (2) *transitional calcareous biogenic sediments* that contain 35% to 65% $CaCO_3$ (greater than 30% silt and clay). Lithologic names given these classes of sediment also depend on the degree of sediment consolidation. Sediments belonging to other classification categories but which contain 10% to 35% calcareous components are given the modifier "calcareous" (or "foraminiferal" or "nannofossil," as appropriate). Less than 10% $CaCO_3$ content was ignored.

On Leg 101, however, coarse-grained carbonates with highly varied textures were encountered. To classify these sediment types adequately, the expanded Dunham (1962) textural classification (Embrie and Klovan, 1971) was adopted (Fig. 11). The relative grain-to-mud ratio, grain-vs.-matrix support of the sediment, and grain size were used to adapt the biogenic calcareous categories from the JOIDES sediment classification in Figure 10. Ooze, chalk, and limestone remain the fine-grained end-members; coarser lithologies are classified by using the terms "unlithified," "partly lithified," and "lithified," which are used in conjunction with the textural term ("packstone," "grainstone," "rudstone," or "floatstone"). Sediments containing sand-sized carbonate grains plus carbonate mud are termed "packstones" (which includes the wackestone category of Dunham, 1962), and sediments with grains only (no mud), "grainstones." Sediments with gravel-sized (and larger) grains plus mud are termed "floatstones," and with grains only (no mud), "rudstones." As seen in Figure 8, the standard ooze, chalk, and limestone symbols are adapted for coarse-grained categories with modifications added to represent mud (a dash), sand-sized grains (a dot), and gravel-sized grains (an open circle).

Terrigenous Sediments

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. Coarser terrigenous sediments are classed as conglomerate or breccia, clast-supported or matrix-supported. The size limits for these constituents are those defined by Wentworth (1922) (Fig. 12).

Five major textural groups are recognized on the accompanying triangular diagram (Fig. 13). The terms *clay, mud, silt*, and *sand* are used for unconsolidated sediments that could be cut with a wire in the shipboard core-splitting process. The hard or consolidated equivalents for the same textural groups are *claystone, mudstone, siltstone*, and *sandstone*. Sedimentary rocks falling into the consolidated category include those which generally had to be cut with the bandsaw or diamond saw.

In this sediment category, numerous qualifiers are possible, usually based on minor constituents (for example, "glauconitic," "pyritic," "feldspathic"). Terrigenous sediments and sedimentary rocks containing 10%-35% $CaCO_3$ are qualified by the modifier "calcareous."

Volcanogenic Sediments

Pyroclastic rocks are described according to the textural and compositional scheme of Wentworth and Williams (1932). The textural groups are (1) volcanic breccia (greater than 32 mm in size), (2) volcanic lapilli (4-32 mm in size), and (3) volcanic ash, tuff if indurated (less than 4 mm in size). Compositionally, these pyroclastic rocks are described as vitric (glass), crystal, or lithic. Only a few layers of volcanic ash were encountered on Leg 101.

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

Special Sedimentary-Rock Types

The only special sedimentary-rock types (not included in the coarse-carbonate-classification scheme described previously) that were recovered during Leg 101 are dolomite and gypsum.

Biostratigraphy

Time Scale

Cenozoic planktonic foraminifer, calcareous nannofossil, and radiolarian zones are correlated with the absolute time scale of Berggren et al. (1985), whereas Cretaceous foraminifers and calcareous nannofossils are correlated to the Decade of North American Geology (DNAG) absolute time scale (Palmer, 1983).

Foraminifer Zonation

The planktonic-foraminiferal zonal schemes used for the Cenozoic sediments recovered during Leg 101 are those of Stainforth et al. (1975) and Berggren et al. (1985). Turonian through Maestrichtian planktonic foraminifers are zoned following the schemes of Robaszynski et al. (1979) and Robaszynski et al. (1984). The biostratigraphy for Aptian through Cenomanian is after Leckie (1984).

Foraminifer Abundance and Preservation

The overall abundance of foraminifers contained in sediment samples studied is defined as follows:

<table>
<tr><td colspan="5">Depositional texture recognizable</td><td>Depositional texture not recognizable</td></tr>
<tr><td colspan="4">Original components not bound together during deposition</td><td rowspan="4">Original components were bound together during deposition . . . as shown by intergrown skeletal matter, lamination contrary to gravity, or sediment-floored cavities that are roofed over by organic or questionably organic matter and are too large to be interstices.</td><td rowspan="4">Subdivide according to classifications designed to bear on physical texture or diagenesis.</td></tr>
<tr><td colspan="3">Contains mud (Particles of clay and fine silt size)</td><td>Lacks mud</td></tr>
<tr><td colspan="2">Mud supported</td><td colspan="2">Grain supported</td></tr>
<tr><td>Less than 10% grains</td><td>More than 10% grains</td><td></td><td></td></tr>
<tr><td>Mudstone</td><td>Wackestone</td><td>Packstone</td><td>Grainstone</td><td>Boundstone</td><td>Crystalline carbonate</td></tr>
</table>

Figure 11. Textural classification of limestones (after Dunham, 1962).

MILLIMETERS	MICRONS	PHI (Ø)	WENTWORTH SIZE CLASS	
		-20		
4096		-12	Boulder (-8 to -12 Ø)	
1024		-10		
256		-8		
64		-6	Cobble (-6 to -8 Ø)	
16		-4	Pebble (-2 to -6 Ø)	GRAVEL
4		-2		
3.36		-1.75		
2.83		-1.5	Granule	
2.38		-1.25		
2.00		-1.0		
1.68		-0.75		
1.41		-0.5	Very coarse sand	
1.19		-0.25		
1.00		0.0		
0.84		0.25		
0.71		0.5	Coarse sand	
0.59		0.75		
1/2 — 0.50	500	1.0		
0.42	420	1.25		
0.35	350	1.5	Medium sand	SAND
0.30	300	1.75		
1/4 — 0.25	250	2.0		
0.210	210	2.25		
0.177	177	2.5	Fine sand	
0.149	149	2.75		
1/8 — 0.125	125	3.0		
0.105	105	3.25		
0.088	88	3.5	Very fine sand	
0.074	74	3.75		
1/16 — 0.0625	63	4.0		
0.053	53	4.25		
0.044	44	4.5	Coarse silt	
0.037	37	4.75		
1/32 — 0.031	31	5.0		
1/64 0.0156	15.6	6.0	Medium silt	
1/128 0.0078	7.8	7.0	Fine silt	
1/256 — 0.0039	3.9	8.0	Very fine silt	MUD
0.0020	2.0	9.0		
0.00098	0.98	10.0	Clay	
0.00049	0.49	11.0		
0.00024	0.24	12.0		
0.00012	0.12	13.0		
0.00006	0.06	14.0		

Figure 12. Grain-size categories used for classification of terrigenous sediments (from Wentworth, 1922).

A = abundant (about 2 cm^3 of dry foraminifer residue from a 10-cm^3 sample);
C = common (about 1 cm^3);
F = few (about 0.5 cm^3);
R = rare (0.5 cm^3 or less).

The abundance of particular species in the assemblages in a residue is defined as follows:

A = more than 30% of the population;
C = 10% to 30%;
F = 3% to 10%;
R = less than 3%.

Percentages were estimated by visual examination.

Preservation includes the effects of diagenesis, abrasion, encrustation, and/or (most commonly in deep-sea sediments) dissolution:

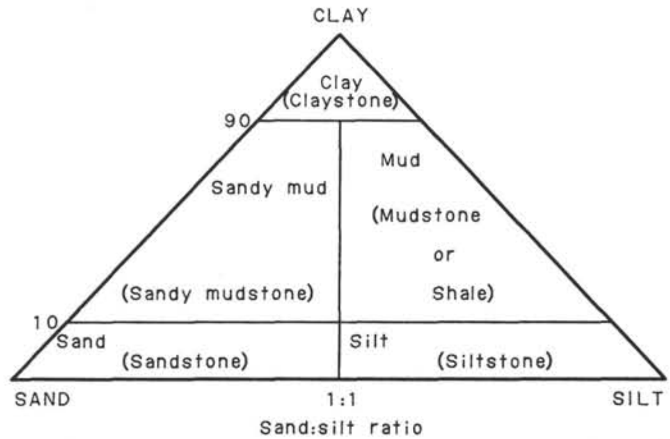


Figure 13. Diagram showing classification scheme used for terrigenous sediments and sedimentary rocks on Leg 101.

G = good (dissolution effects rare and obscure);
M = moderate (specimen dissolution common but minor);
P = poor (specimen identification difficult or impossible).

Nannofossil Zonation

The calcareous-nannofossil biostratigraphic zonation of Martini and Worsley (1970) and Martini (1971) serves as the basis for age determinations of Cenozoic sediments from Leg 101. Calcareous-nannofossil biostratigraphy for the Cretaceous follows the zonation outlined in Watkins and Bowdler (1984). This scheme includes zones and biostratigraphic information based on Sissingh (1977), Manivit et al. (1977), Verbeek (1977), Perch-Nielsen (1979), and Manivit (1981).

Nannofossil Abundance and Preservation

Smear slides were prepared from raw sediment for examination of calcareous nannofossils. The overall abundance of nannofossils was estimated as follows:

A = abundant (1 to 10 specimens per field of view);
C = common (1 specimen per 2 to 10 fields of view);
F = few (1 specimen per 11 to 100 fields of view);
R = rare (1 specimen per 101 to 1000 fields of view).

This system was proposed by Hay (1970) using a magnification of 1000×; a magnification of 1560× was used on Leg 101.

The state of preservation of nannofossils was designated as follows:

G = little or no evidence of overgrowth and/or etching of specimen;
M = some degree of overgrowth and/or etching, but identification generally not impaired;
P = substantial overgrowth and/or etching, identification of specimens difficult but still possible.

Radiolarian Zonation

Radiolarian age determinations were based on the Cenozoic zonation of Riedel and Sanfilippo (1978) and subsequent modification in Saunders et al. (1985).

Radiolarian Abundance and Preservation

Overall radiolarian abundance was determined for the *noncalcareous*, coarse (>63 μm) fraction of the sediment as follows:

A = 10^4 radiolarians per slide;
C = 10^3 radiolarians per slide;

F = 10^2 radiolarians per slide;
R = 10^1 radiolarians per slide;
B = barren of radiolarians.

The abundance of individual specimens was estimated as follows, using modified categories of Westberg and Riedel (1978):

A = >10% of all radiolarians on a slide;
C = 10%–1% of all radiolarians on a slide;
F = 1%–0.1% of all radiolarians on a slide;
R = 0.1%–0.01% of all radiolarians on a slide;
r = <0.01% of all radiolarians on a slide.

The preservation of radiolarians is reported using grades modified from Westberg and Riedel (1978):

G = good preservation (delicate tests and features preserved);
M = moderate preservation;
P = poor preservation (tests corroded, only robust features preserved).

Paleomagnetics

The magnetics laboratory's three-axis pass-through cryogenic magnetometer (built by 2G Enterprises) was not yet on board for Leg 101, so no whole-core alternating-field (AF) demagnetizations were conducted.

Volume magnetic-susceptibility measurements were made on Leg 101 using a Bartington Instruments Model M.S.1 susceptibility meter with a 100-mm sensor coil through which whole cores could be passed. Measurements were taken at 10-cm intervals, from top to bottom, of each 1.5-m core section before it was split. For reference, an empty core liner and one full of seawater were measured. The susceptibility of the empty liner was undetectable, but the seawater displayed a weak diamagnetism (i.e., negative susceptibility). As calcium carbonate has a diamagnetic susceptibility similar to that of water (Collinson, 1983), negative susceptibility values were taken as an indication that the cored material contained very little other than water and carbonate. Conversely, cores giving positive susceptibility readings were assumed to indicate the presence of minute amounts of iron-bearing minerals (e.g., Radhakrishnamurty et al., 1972; Ellwood, 1980).

Organic Geochemistry

CHN Procedure

Shipboard organic-carbon analyses were made using a Perkin-Elmer 240C Elemental Analyzer. Selected sediment samples were treated with concentrated HCl to remove carbonates, washed with deionized water, and dried at 35°C. A Cahn Electrobalance was used to weigh about a 15-mg sample of sediment for analysis of carbon, hydrogen, and nitrogen (CHN) contents. Samples were combusted at 1000°C in the presence of oxygen, and the volumes of the evolved gases determined as measures of the C, H, and N contents of organic matter in the sediments. Concentrations were determined by the Perkin-Elmer 3600 Data Station and compared with those of known shipboard standards. The resulting hydrogen elemental data were untrustworthy because of variable amounts of clay minerals and their hydrates; hence hydrogen values are not reported here. As a result of technical problems, elemental nitrogen values were not reliable. Therefore, they also are not reported. Organic-carbon values were corrected for carbonate content and are reported on a dry-sediment weight basis.

Rock-Eval Procedure

The source character and maturity of organic matter in selected sediment samples were determined with the shipboard Delsi Nermag Rock-Eval II pyrolysis instrument, which uses the process described by Espitalié et al. (1977). About 100 mg of coarsely ground dry sample was heated from 250°C to 550°C at a rate of 25°C/min. Gases released during this heating were carried off in a helium stream, which is split into two parts. One part was directed through a flame ionization detector to monitor hydrocarbons; the other passed through a CO_2 trap from which the total amount of evolved CO_2 is released at the end of the heating program to be measured by a thermal-conductivity detector.

This pyrolysis procedure yielded four parameters that characterize the organic matter in a sample:

1. Area of peak S_1, which corresponds to the quantity of hydrocarbons present in the sample.
2. Area of peak S_2, which corresponds to the quantity of hydrocarbons released by pyrolysis of kerogen up to 550°C, or the "hydrocarbon potential."
3. Temperature, T_{max}, of the top of peak S_2, which is related to the maturity of the organic matter.
4. Area of peak S_3, which corresponds to the CO_2 released from pyrolysis of kerogen.

From S_2, S_3, and the organic-carbon concentration, the hydrogen index (HI) and oxygen index (OI) were calculated and used to determine kerogen-source character and maturity.

Inorganic Geochemistry

Interstitial Waters

Interstitial waters were routinely analyzed for pH, alkalinity, salinity, chlorinity, calcium, and magnesium during Leg 101. The method of obtaining interstitial waters from the sediment, using a stainless-steel press, was described in detail by Manheim and Sayles (1974). IAPSO (International Association of Physical Sciences Organizations) standard seawater is the primary standard for water analyses aboard ship.

Alkalinity and pH were determined using a Metrohm titrator with a Brinkmann combination pH electrode. The pH value of the sample was calibrated with 4.01, 6.86, and 7.41 buffer standards; readings were taken in millivolts and then converted to pH. The pH measurements were made immediately prior to the alkalinity measurements. The 5–10-mL interstitial water sample, after being tested for pH, was titrated with 0.1 NHCl as a potentiometric titration (Gieskes, 1973).

Salinity was determined using a Goldberg optical refractometer, which measures the total dissolved solids. Sayles et al. (1970) found that this "salinity" agreed well with their measured ion sums.

Chlorinity was determined by titrating a 0.1-mL sample diluted with 5 mL of deionized water with silver nitrate. The Mohr titration uses potassium chromate as an indicator.

Calcium content was determined by complexometric titration of a 0.5-mL sample with EGTA, using GHA as an indicator. To enhance the determination of the endpoint, the calcium-GHA complex was extracted into a layer of butanol (Gieskes, 1973). No correction was made for strontium, which is also included in the result.

Magnesium content was determined by EDTA titration for total alkaline earths (Gieskes, 1974). Subsequent subtraction of the calcium value (also includes strontium) yields the magnesium concentration in the interstitial-water sample.

Sulfate analyses were made using a Dionix Ion Chromatograph on samples diluted 1:500. Calibration was via IAPSO, and all samples were further corrected to surface seawater using the relationship

$$SO_4^{2-} = 1.492 \times Cl^-.$$

Calcium Carbonate

The carbonate percentage was determined aboard ship by the carbonate-bomb technique (Müller and Gastner, 1971). The sample was freeze-dried, ground to a powder, and then treated with HCl in a closed cylinder. Any resulting CO_2 pressure is proportional to the percentage of CO_3 of the dried-sediment weight of the sample. The margin of error can be as low as 1% for sediments high in CO_3; the overall accuracy is usually 2% to 5%.

X-Ray Analysis

All samples squeezed for interstitial waters in addition to a limited number of physical-property samples were subjected to x-ray analysis. Samples were analyzed on a Philips APD 3720 instrument using a scan speed of $0.05°s^{-1}$ between 3° and 60° (2 theta) (40 Kv, 35 mA). The percentages of calcite, aragonite, dolomite, and quartz were determined using relative peak heights. The system was calibrated using six artificially prepared samples with known quartz/dolomite/aragonite ratios.

The relationship between relative peak intensity and relative mineral percentage was determined using a least-squares approach. The regression coefficient determined using this method was better than 0.99. Percentages quoted are based on the assumption that these four minerals composed 100% of the sample.

Mol% $MgCO_3$ was determined using the peak-shift method of Goldsmith and Graf (1958).

Standardization of the x-ray was achieved, using eight synthetically mixed standards composed of calcite, aragonite, dolomite, and quartz. As software for determining peak area was not available at the time of the cruise, height was determined at the centroid of the peak. The peaks used are as follows.

Quartz	3.343
Aragonite	3.396
Calcite	3.035
Dolomite	2.890

Ratios of intensities of minor phases were determined relative to a total of calcite + aragonite + dolomite + quartz, and a working line was calculated relative to the same ratio in the standard. These data are shown in Table 2 and in Figures 14 through 16. As may be observed, a good correlation exists between the ratio of intensities and the ratio of concentrations. The exception is ODP 5, which has an extremely high quartz/calcite ratio.

Compositions of most samples fall within the range of the standards analyzed and were determined by assuming that no other minerals were present in the sample.

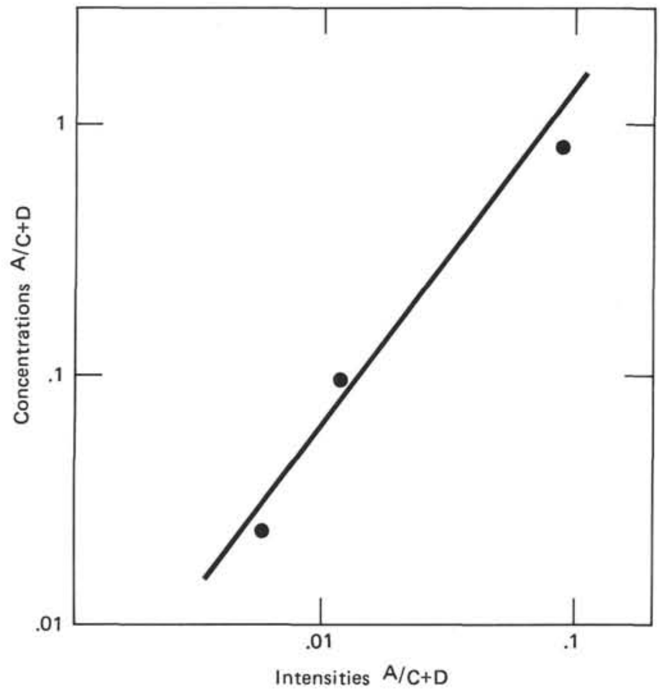


Figure 14. Intensities of aragonite relative to calcite for standards plotted against the concentration ratio.

Physical-Property Procedures

A thorough discussion of physical properties is presented by Boyce (1973, 1976) with respect to equipment, methods, errors, correction factors, and problems related to coring disturbance. Only a brief review of methods employed on Leg 101 is given here.

GRAPE

The Gamma Ray Attenuation Porosity Evaluator (GRAPE), described in detail by Boyce (1976), was used to measure wet-bulk density continuously. From wet-bulk-density analog data, porosity can be estimated by using an assumed or estimated grain density. The calibration of the GRAPE was routinely checked using an aluminum standard before each new core was measured. Factors influencing data quality include pockets of air and water in incompletely filled core sections. A more complete discussion of this technique can be found in Boyce (1976).

Thermal Conductivity

Thermal-conductivity measurements were made on sediments from cores that recovered material soft enough to yield to needle-probe insertion. Measurements were made parallel to bedding. Cores were allowed to warm to room temperature for 4 hr before

Table 2. Intensities of calcite, aragonite, dolomite, and quartz.

	Mineral (%)				Intensities (counts/s)			
Standard	Calcite	Aragonite	Dolomite	Quartz	Calcite	Aragonite	Dolomite	Quartz
ODP 1	91.3	8.7	0	0	9216	100	—	—
ODP 2	92.2	2.4	5.4	0	7174	40	303	—
ODP 3	90.8	0	9.2	0	8245	—	784	—
ODP 4	56.45	43.54	0	0	7310	615	—	—
ODP 5	28.0	0	0	72.0	5685	—	—	6659
ODP 6	66.0	0	0	33.0	7482	—	—	3147
ODP 7	92.7	0	0	7.3	4970	—	—	751
ODP 8	97.6	0	0	2.4	4610	—	—	30

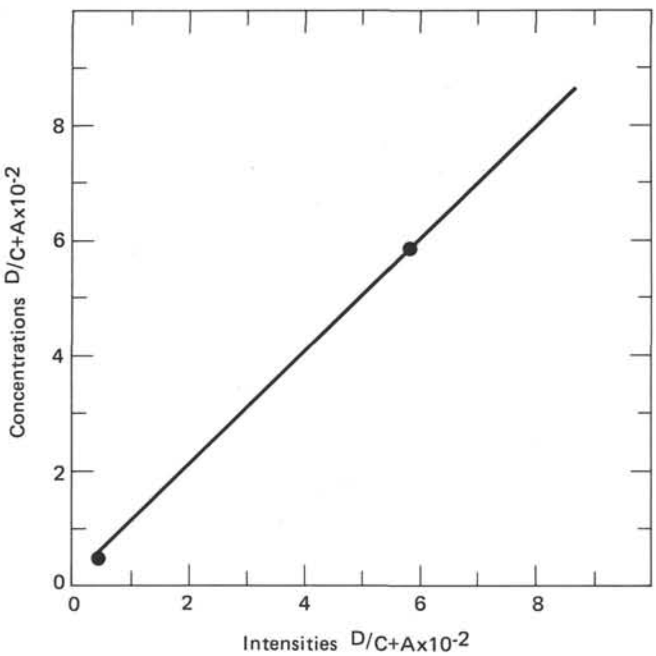


Figure 15. Intensities of dolomite relative to calcite and aragonite plotted against the concentration ratio.

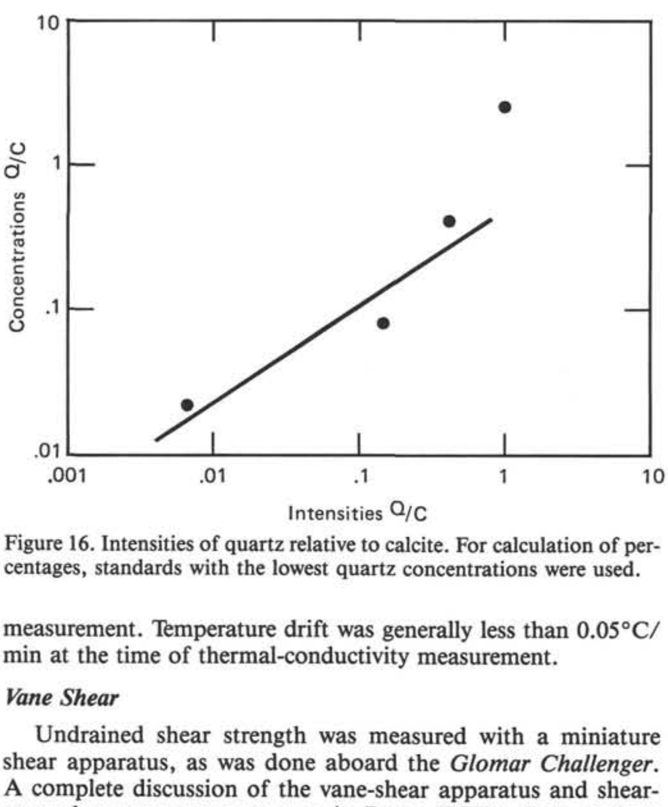


Figure 16. Intensities of quartz relative to calcite. For calculation of percentages, standards with the lowest quartz concentrations were used.

measurement. Temperature drift was generally less than 0.05°C/min at the time of thermal-conductivity measurement.

Vane Shear

Undrained shear strength was measured with a miniature shear apparatus, as was done aboard the *Glomar Challenger*. A complete discussion of the vane-shear apparatus and shear-strength measurement appears in Boyce (1973). Core sections were examined immediately after splitting, and the central interval (at approximately 75 cm) in Sections 2, 4, and 6 of each core was measured. The direction of measurement was normal to the core liner—that is, parallel to bedding. Measurements of vane shear strength were routinely made on sediments with shear strengths less than about 70 kiloPascals (i.e., until the sediment was of sufficient cohesive strength to form drilling "biscuits") or if the sediment appeared to be disturbed.

Velocity

Compressional sound velocity at 400 kHz was measured through sediments and sedimentary rocks with a Hamilton Frame Velocimeter using a Tektronix 5110 oscilloscope and a Tektronix TM5006 Counter/Timer. Sound-velocity correction factors were calculated for each hole on Leg 101 as described in Boyce (1976).

Compressional wave velocity was measured on samples both in and outside of the core liner. Measurements made in the core liner are parallel to bedding planes. Measurements on samples removed from the core liner were made both normal and parallel to the bedding plane where the sample consistency permitted. Efforts were taken to reduce the amount of disturbance resulting from sampling.

Index Properties

Index properties (bulk and grain density, porosity, and water content) were routinely measured gravimetrically on the same samples for which seismic velocity was measured. Samples were placed in pre-weighed and numbered aluminum beakers and weighed in the beakers on a triple-beam balance. The volume of sample and container was then measured on the shipboard Penta-Pycnometer, which first purges the sample chamber of air and then floods the sample chambers with helium gas at a pressure of 19 psi. The volume of sample and container is calculated from the difference between the volume of helium in the empty sample chamber and in the chamber with a sample. Samples were then oven-dried at 105°C, weighed, and their dry volume measured. Index properties were calculated by a computer program in which sample container and volume had been previously entered.

Bulk density, porosity, dry water content (expressed relative to the weight of dry solids), and grain density were corrected for an interstitial salinity of 35‰.

After measurement of dry-sample weight and dry volume, the carbonate content of the samples was measured using the carbonate-bomb method (Müller and Gastner, 1971).

Downhole Measurements

As the first cruise to see implementation of the JOIDES policy to log all holes deeper than 400 m sub-bottom and all holes that penetrate basement rocks, a large suite of logging tools was deployed for Leg 101 by Schlumberger Well Services through a sub-contract with Lamont-Doherty Geological Observatory. What follows is a brief description of the tools used on Leg 101; more details on the principles of measurement utilized by the logging tools can be found by consulting Serra (1984) or any other standard well-logging handbook.

Natural Gamma Ray (GR). This log is used to measure natural gamma radiation in the formation and to aid in depth correlation between logging runs.

Natural Gamma Ray Spectrometry Tool (NGT). The NGT is an extension of the standard natural gamma-ray log. It detects natural gamma radiation in five narrow energy bands, permitting separate quantitative estimates of the concentrations of potassium, uranium, and thorium.

Compensated Neutron Log (CNL). This tool bombards the formation with neutrons and uses counts of those neutrons returning at thermal energy levels to determine the porosity.

Compensated Neutron Tool (CNTG). The CNTG is an improvement on the basic CNL design and measures formation porosity through counts of neutrons at both thermal and epithermal energy levels.

Litho-Density Tool (LDT). The primary purpose of the LDT is to provide a measure of formation bulk density. It also determines the formation photoelectric capture cross section, a quality that is highly lithology-dependent.

Induced Gamma Spectrometry Tool (GST). The GST utilizes a high-energy (14 MeV) neutron accelerator to activate elements in the formation. From analysis of the spectra of the resulting radioactivity, the GST determines concentrations of hydrogen, chlorine, oxygen, carbon, calcium, silicon, iron, and sulfur.

Copies of the logs run during Leg 101 can be obtained from the Director, Log Analysis Center, Borehole Research Group, Lamont-Doherty Geological Observatory, Palisades, NY 10964.

Obtaining Samples

Investigators who want to obtain samples should refer to the ODP–NSF Sample-Distribution Policy. Sample-request forms may be obtained from the Curator, Ocean Drilling Program, 1000 Discovery Drive, College Station, TX 77840. Requests must be as specific as possible: include site, hole, core, section, interval within a section, and volume of sample required.

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