1. INTRODUCTION AND EXPLANATORY NOTES[1]

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The high-latitude South Atlantic Ocean and the adjacent Antarctic Ocean have throughout Mesozoic and Cenozoic time undergone pronounced geographic alterations that have produced a change from a temperate marine climate in the late Mesozoic and Paleogene to a frigid ocean in the Neogene. This climatic change has been the most significant factor in the history of deep and surface water circulation between the southern and more northern parts of the Atlantic.

DSDP Leg 71 was the first of five legs designed to study late Mesozoic and Cenozoic paleoenvironments in the South Atlantic Ocean; the broad objectives of Leg 71 were to study the history of sedimentation at the eastern end of the Falkland Plateau, the effect of the plateau as a barrier between water masses during the early opening of the South Atlantic, and the evolution of the Antarctic Convergence. In particular, there were four specific objectives:

1) To expand upon the geologic history of the Falkland Plateau from sediment cores and to assess its influence upon oceanic circulation during the Cenozoic. Changes in oceanic circulation are thought to have occurred during this period in response to the initial opening and enlargement of the South Atlantic, the development of bottom water passageways through the ridges and fracture zones in the vicinity of the Falkland Plateau, the opening of Drake Passage, and the climatic evolution of Antarctica and the Southern Ocean.

2) To study the history of bottom water flow through the region during Cenozoic time on the basis of its erosional, transportational, and depositional consequences, of calcium carbonate dissolution, and of the oxygen isotopic record.

3) To provide Cenozoic biostratigraphic sequences for the South Atlantic.

4) To provide, if coring was successful enough, the Mesozoic sedimentary sequences needed to define the paleoceanographic conditions existing during the early opening and development of the Atlantic Ocean.

Five high-priority sites were proposed for Leg 71. Under ideal sea conditions all five sites could have been successfully drilled and the objectives met within the allotted time. Unfortunately Leg 71 suffered periods of adverse seas and weather that prevented us from completing Site 512 and occupying a site in the southeast corner of the Argentine Basin long enough even to spud in at that location.

Locations of the four sites actually drilled are shown on Figure 1. Columnar sections for the units penetrated are given in Figure 2, and Table 1 provides a summary of coring statistics.

PRINCIPAL RESULTS

Falkland Plateau

Hole 511 was drilled to a depth of 632 meters subbottom on the Falkland Plateau. The section drilled consisted of six units:

Unit 1) 3 meters of siliceous ooze and thin foraminiferal oozes of Pliocene to Recent age.

Unit 2) 192 meters of diatomaceous ooze and nannofossil diatomaceous ooze spanning the Paleocene to Early Oligocene.

Unit 3) 14 meters of calcareous ooze and zeolitic foraminiferal ooze of late Campanian–early Maestrichtian age.

Unit 4) 203 meters of zeolitic clay and claystone with intercalations of nannofossil claystone ranging from Turonian to Campanian–early Maestrichtian in age.

Unit 5) 80 meters of claystone, nannofossil claystone, and nannofossil chalk of early Albian to Turonian age.

Unit 6) 134 meters of petroliferous mudstone and nannofossil mudstone of Late Jurassic to earliest Albian age.

Drilling was terminated at the penetration limit imposed by the Safety Panel. Two lowerings of the downhole temperature probe gave a heat flow value of 1.5 HFU. The drilling results confirm the continuity of the chronostratigraphic units of the Ewing Bank into the basin province of the Falkland Plateau. The microfossils in Unit 2 provide temporal control since they can be correlated with lower latitude zonations and the New Zealand stages.

Two holes were drilled at Site 512 on the Falkland Plateau. The first (512) was piston cored to 78 meters sub-bottom while the second (512A) was washed to 78 meters and then rotary-drilled to 90 meters sub-bottom. Two units were recovered in Hole 512:

Unit 1) 930 cm of ice-rafted sand gravel of Plio–Pleistocene age.

[1] Ludwig, W. J., Krasheninnikov, V. A., et al., *Init. Repts. DSDP*, 71: Washington (U.S. Govt. Printing Office).
[2] Present address: Gulf Oil Exploration and Production Company, Houston, Texas 77236.

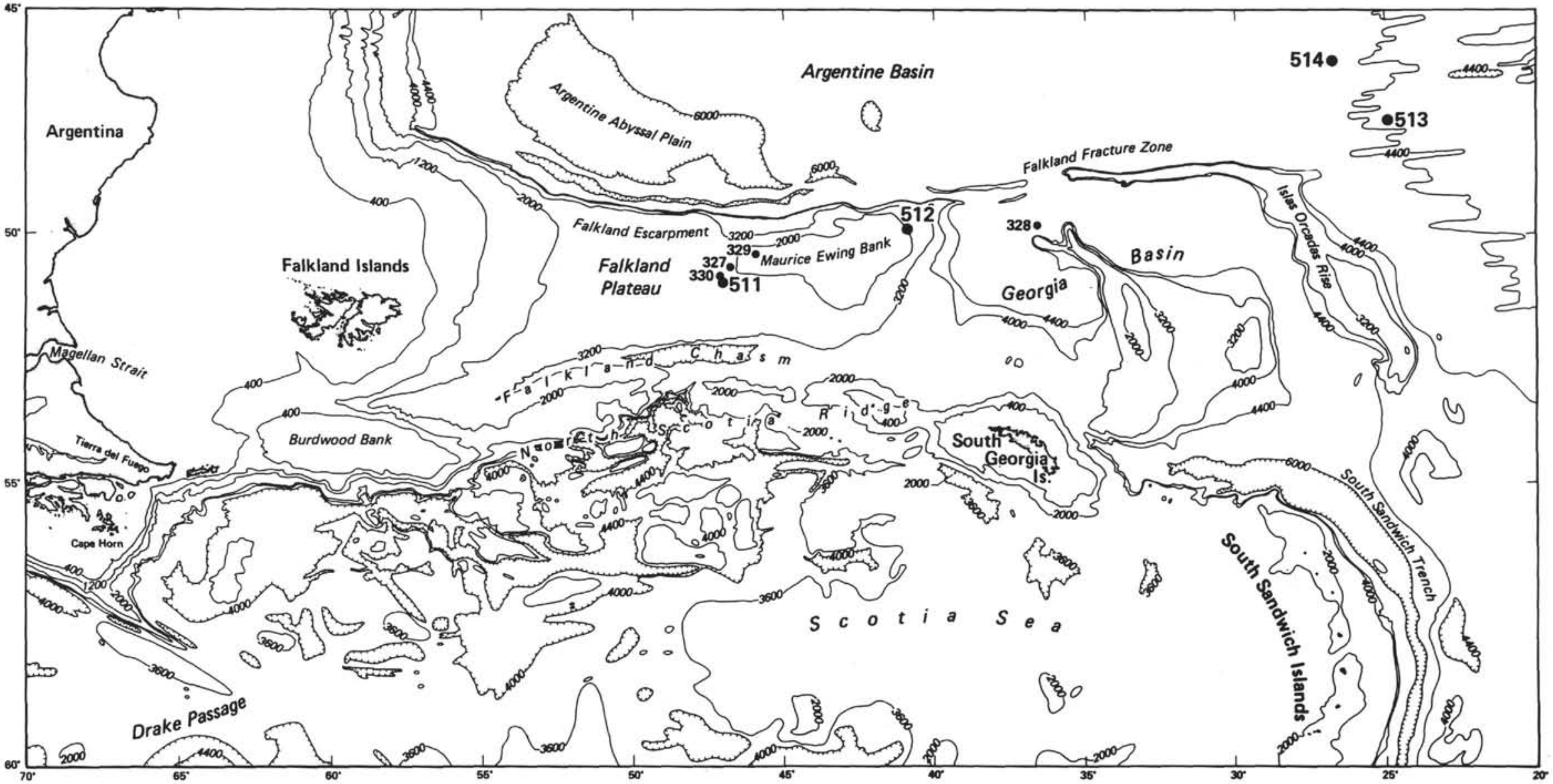

Figure 1. Leg 71 site location map.

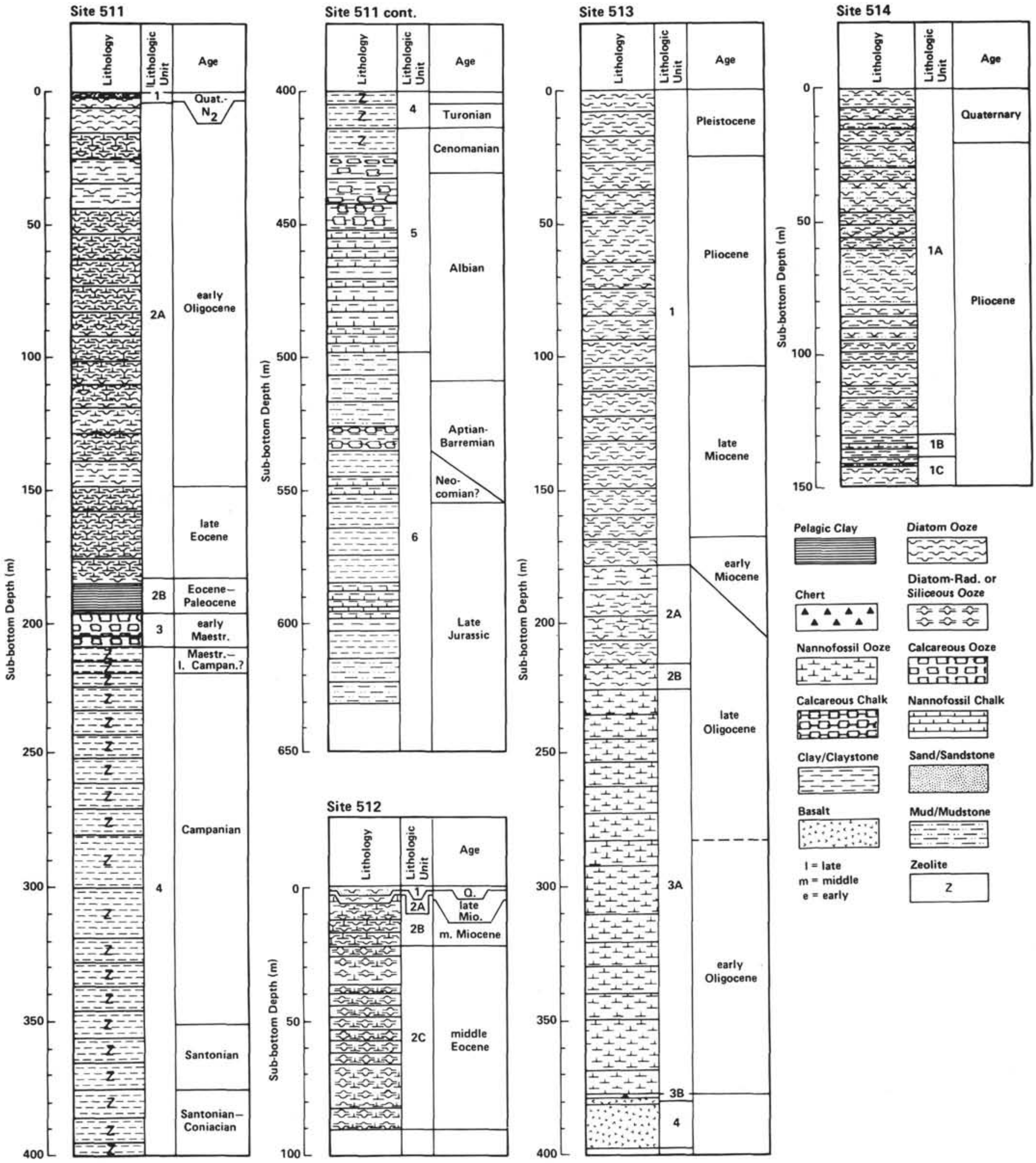

Figure 2. Columnar sections of Sites 511, 512, 513, and 514.

Unit 2) 77 meters of diatomaceous ooze, diatomaceous and siliceous nannofossil ooze, and siliceous nannofossil ooze of middle Eocene to late Miocene age.

Only one core was obtained from Hole 512A and this had the same lithology as the lowermost interval cored in Hole 512. Drilling was terminated in Hole 512A because of sea conditions. The site was abandoned after five days of persistent current and long-period swells which prohibited drilling and a forecast of worsening weather.

Table 1. Leg 71 coring summary.

Hole	Dates (1980)	Latitude	Longitude	Water Depth (m)	Penetration (m)	Number of Cores	Meters Cored	Meters Recovered	Percentage Recovered
511	15-21 January	51°00.28′S	46°58.30′W	2589	632	70	632	385.62	61
512	22-27 January	49°52.19′S	40°50.71′W	1846	78	19	78	68.0	86
512A	22-27 January	49°52.17′S	40°50.71′W	1846	90	2	17	7.8	45
513	2-7 February	47°34.99′S	24°38.40′W	4373	104	11	104	53.8	51
513A	2-7 February	47°34.99′S	24°38.40′W	4373	387	36	321	169.1	52
514	8-13 February	46°02.77′S	26°51.30′W	4318	150.8	35	150.8	139.4	92

Southeast Argentine Basin

Hole 513 was cored to a sub-bottom depth of 104 meters and Hole 513A was cored to basement at a sub-bottom depth of 387 meters. We recovered a total of 47 cores and four lithologic units.

Unit 1) 180 meters of muddy diatomaceous ooze of middle Miocene to Recent age.

Unit 2) 53.9 meters of lower Miocene to upper Oligocene muddy diatomaceous nannofossil ooze and diatomaceous nannofossil ooze.

Unit 3) 145.5 meters of nannofossil ooze ranging from upper to lower Oligocene with a white chert bed at the base.

Unit 4) 6 meters of fine-grained basalt interpreted to be basement.

Siliceous microfossils indicate recovery of a unique Quaternary to late Miocene sequence containing almost all biostratigraphic zones. Middle Miocene is found in only one core, and an apparently continuous early Miocene–early Oligocene sequence is observed in 21 cores.

Data from this site document fluctuations in the position of the Polar Front and provide an excellent opportunity to calibrate zonal schemes of different siliceous groups, to correlate temperate and subtropical zonations, and to investigate climatic changes and oceanic subsidence.

Hole 514 was cored with the hydraulic piston corer to 151 meters sub-bottom through Pliocene to Quaternary diatomaceous clays and oozes. The section recovered constituted one unit, divided into three subunits:

Subunit 1A) 130.3 meters of diatomaceous clay and muddy diatomaceous ooze.

Subunit 1B) 7.3 meters of mud and nannofossil ooze.

Subunit 1C) 13.2 meters of diatomaceous mud.

Siliceous microfossils permit recognition of almost all diatom and radiolarian zones except in one gap in the middle Pliocene. Paleomagnetic measurements detected almost all epochs and events and permit correlation with siliceous fossil zonations. Mixed siliceous and calcareous fossils trace the relative position of the Polar Front and its migration with time.

SUMMARY OF PRINCIPAL RESULTS

As we have just noted, of the four sites drilled on Leg 71, two were on the eastern part (Maurice Ewing Bank) of the Falkland Plateau (Sites 511 and 512) and two on the lower flank of the Mid-Atlantic Ridge east of the Argentine Basin (Sites 513 and 514). The different geologic natures of these two areas, one on continental crust and other on oceanic crust, and their different geographic position in relation to the spreading center of the Mid-Atlantic Ridge are reflected in the nature and age of the sedimentary cover. On Maurice Ewing Bank sites, drilling penetrated sediments from Late Jurassic to Quaternary age; on the Mid-Atlantic Ridge sites, sediments of early Oligocene to Quaternary age were recovered.

Some of the drilling results have regional significance; others deal with major geological problems of the South Atlantic, such as the early history of the breakup of Gondwanaland and late Cenozoic events connected with fluctuations of the Polar Front.

The following are significant scientific results of Leg 71:

1) The early opening of the South Atlantic (Neocomian–Aptian) was marked by the existence of a basin with restricted water mass circulation and anoxic conditions. Bottom life was largely absent; fossils are represented by rare plankton (foraminifers) and necton (belemnites). Under such conditions, shales were deposited with a high content of organic carbon (1.7% to 4.1%), indicating a high potential for generating petroleum. Ratios of gaseous hydrocarbons and pyrolysis–fluorescence analyses suggest a fairly low degree of maturity of the black shales. A geothermal gradient of 7°C/100 m at Site 511 shows that the depth of oil maturation in the black shales could be reached in regions of deeper burial.

2) A comparatively complete section of Cretaceous sediments on Maurice Ewing Bank provides valuable data for this period of time and represents a biostratigraphic reference section for the high latitudes of the Southern Hemisphere. Of special interest are 174 meters of Turonian–Campanian biogenic sediments containing rather rich and diverse planktonic foraminifers and nannofossil assemblages found for the first time in these high latitudes.

3) Biostratigraphic and seismostratigraphic data indicate that a major erosional event took place at or near the Tertiary–Cretaceous boundary, implying that strong bottom currents were in existence and were admitted to the area prior to the opening of the Drake Passage in the Oligocene–middle Miocene.

4) The composite section of middle and upper Eocene and Oligocene sediments of Sites 511, 512, and 513 records the mild climatic conditions that existed at that time, when various groups of calcareous and siliceous microfossils coexisted. Comparison of zonal schemes of

foraminifers, nannofossils, radiolarians, diatoms, and silicoflagellates and correlation with the New Zealand section and possibly with the temperate–subtropical zonations will increase knowledge of the Eocene–Oligocene stratigraphy of the high-latitude belt of the Southern Hemisphere.

5) The long Eocene–lower Oligocene sections from the Falkland Plateau provide an excellent opportunity to study the detailed history of climatic and paleoceanographic change in the vicinity of the Eocene/Pliocene boundary. Stable-isotope studies (Muza, et al., this volume), coupled with assemblage changes among the radiolarians, foraminifers, and dinoflagellates, record a significant drop in paleotemperatures within the earliest Oligocene. This temperature drop is accompanied by a marked divergence in surface and bottom water isotopic temperatures and reflects a major change in circulation and water-mass configuration over the Plateau. This probably reflects the expansion of sub-Antarctic and Antarctic water masses and their migration over the site during the earliest Oligocene.

6) Knowledge of the broader geologic history of the Falkland Plateau has been expanded by Leg 71 drilling, specifically as regards the history of oceanic subsidence, which distinctly accelerated at or near the Lower/Upper Cretaceous boundary. Lithostratigraphic units that originally were continuous across the bank and the basin province of the Plateau have been removed locally by intensive erosion. Periods of exceptionally rapid sediment accumulation (as much as 44 m/m.y. during the late Eocene–early Oligocene) are separated by hiatuses or condensed intervals that seem to be the norm for the plateau.

7) The age of the basal layers above basalts at Site 513 was determined as earliest Oligocene ($\sim$36.5 m.y.), corresponding exactly with the age predicted by magnetic anomalies (between Anomaly 13 and 15; basal Oligocene).

8) Excellent assemblages of siliceous fossils (diatoms, radiolarians, and silicoflagellates) from Neogene and Quaternary sediments at all sites present the opportunity for updating biostratigraphic zonal scales and establishing a unified zonal scheme for the Neogene and Quaternary of high latitudes of the Southern Hemisphere. The continuous paleomagnetic record measured at Site 514 made possible recognition of the Brunhes and Matuyama epochs (with Jaramillo and Olduvai events), Gauss Epoch (with Kaena and Mammoth events), and Gilbert Epoch (with Cochiti Event). The recognition of these events will aid significantly in paleoenvironmental interpretation of this sequence, with its uniquely high sedimentation rate.

9) Siliceous microfossils, planktonic and benthic calcareous microfossils, and lithologic observations reveal pronounced fluctuations of the Polar Front in the Pliocene and Quaternary. The most southerly positions of the Polar Front occurred during the warm late Gilbert and middle Gauss epochs. Between these two intervals, the Polar Front occupied a more northerly position, suggesting cooler climatic conditions during the latest Gilbert–early Gauss epochs. Late Pliocene–Quaternary time is marked by deterioration of climatic conditions, with brief warmings near the Pliocene–Quaternary boundary (late Matuyama) and at the end of the Quaternary (latest Matuyama and late Brunhes). Fluctuations of the Polar Front are reflected partially in sedimentation rates that decreased markedly from the earliest Pliocene to Quaternary. The highest rate (180 m/m.y.) occurred during the early Pliocene (Gilbert Epoch); the lowest rate (2.3 m/m.y.) occurred in the Quaternary (early Brunhes).

In order to put the individual chapters of this volume into a regional context, the reader is referred to the various syntheses contained herein and in the recent literature. Barker et al. (1977) provide a brief summation of the geologic history of the region. Wise et al. (1982) provide a paleontologic and paleoenvironmental synthesis for the Falkland Plateau based on drilling and piston core data that predate Leg 71. Ludwig (this volume) discusses the geologic framework of the Plateau, and Basov et al. (this volume) provide correlations and analyses of the biostratigraphies of all macro- and microfossil groups encountered in Leg 71 cores. Ciesielski and Weaver (this volume) present a synthesis of the Miocene–Holocene history of the southwest Atlantic.

EXPLANATORY NOTES

Organization and Authorship

The organization of this *Initial Report* for Leg 71 is in two parts. Part 1 summarizes the basic findings of each site drilled and contains descriptions of geophysical work and syntheses which deal with the paleoenvironmental history of the southern South Atlantic. Appendices include reports from shore laboratories that analyze DSDP material from every leg.

Part 2 contains the papers describing work done on samples or data from one or more sites. Also included are supplementary data from piston cores and other DSDP drill holes in the South Atlantic or adjacent regions.

The entire shipboard scientific party authored the site chapters. Overall responsibility lies with the co-chief scientists (Ludwig and Krasheninnikov), who also wrote Background and Objectives, and Survey and Operations[3] sections. For each site the senior sedimentologist (Bornhold) wrote the Lithologic Summary. Shipboard lead paleontologists were appointed: Wise (nannofossils), Ciesielski (diatoms), Weaver (radiolaria), and Krasheninnikov (foraminifers). Each paleontologist contributed his subsection to the Paleontology section, but the biostratigraphic summaries were written collectively. Bayer wrote Physical Properties, von der Dick wrote Organic Geochemistry, Salloway wrote Paleomagnetism, and Ludwig wrote the correlation of seismic profiles with lithology. After discussion with the shipboard party, the co-chief scientists wrote the Summary and Conclusions. The DSDP Staff Representative during the cruise was

[3] Mr. Glen Foss, Leg 71 operations manager, contributed significantly to this part of each site chapter.

Usher, who served in that capacity until December, 1980, when his duties were assumed by Wise.

Numbering of Sites, Holes, Cores and Samples

DSDP drill sites are numbered consecutively from the first site drilled by *Glomar Challenger* in 1968. Site numbers are slightly different from hole numbers. A site number refers to one or more holes drilled while the ship was positioned over one acoustic beacon. These holes could be located within a radius as great as 900 meters from the beacon. Several holes may be drilled at a single site by pulling the drill pipe above the seafloor (out of one hole), moving the ship 100 meters or more from the previous hole, and then drilling another hole.

The first (or only) hole drilled at a site takes the site number. A letter suffix distinguishes each additional hole at the same site. The first hole takes only the site number; the second takes the site number with suffix A; the third takes the site number with suffix B, and so forth. It is important, for sampling purposes, to distinguish the holes drilled at a site, since recovered sediments or rocks from different holes usually do not come from equivalent positions in the stratigraphic column.

The cored interval is measured in meters below the seafloor. The depth interval of an individual core is the depth below seafloor that the coring operation began, to the depth that the coring operation ended. Each coring interval is generally 9.5 meters long, which is the nominal length of a core barrel; however, the coring interval may be shorter or longer (rare). "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 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 wall of the hole; however, if thin hard rock layers are present then it is possible to get "spotty" sampling of these resistant layers within the washed interval, and thus have a cored interval greater than 9.5 meters.

Cores taken from a hole are numbered serially from the top of the hole downward. Core numbers and their associated cored interval in meters below the seafloor are normally unique for a hole, but problems may arise if an interval is cored twice. When this situation occurs, the core number is assigned a suffix, such as "S"[4] for supplementary.

Full recovery for a single core is normally 9.28 meters of sediment or rock, which is in a plastic liner (6.6 cm inside diameter), plus about a 0.2 meter-long sample (without a plastic liner) in the core catcher. The core catcher is a device at the bottom of the core barrel which prevents the cored sample 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-meter-long sections and numbered serially from the top of the sediment-core (Fig. 3). When full recovery is obtained, the sections are numbered from 1 through 7 with the last section being shorter than 1.5 meters. The core-catcher sample is placed below the last section when the core is described, and labeled Core-Catcher (CC): it is treated as a separate section[5].

When recovery is less than 100 percent, and if the sediment or rock is contiguous, the recovered sediment is placed in the top[6] of the cored interval, and then 1.5 meter-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. 3); for example, 3 meters of core sample in plastic liners will be divided into two 1.5-meter-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-meter length.

When recovery is less than 100 percent, the sediment's original stratigraphic position in the cored interval is unknown, so we employ the convention assigning the top of the sediment recovered to the top of the cored interval. This is done for convenience in data handling, and consistency. Also, if recovery is less than 100 percent and core fragments are separated, and if shipboard scientists believe the sediment was not contiguous, then sections are numbered serially and the intervening sections are noted as void, whether they are contiguous or not. The core-catcher sample is described in the initial core description beneath the lowest section.

Samples are designated by centimeter distances from the top of each section to the top and bottom of the sample in that section. A full identification number for a sample consists of the following information.

Leg
Site
Hole
Core Number
Interval, in centimeters from the top of section

For example, a sample identification number of "71-511-9-3, 12-14 cm" is interpreted as follows: 12 to 14 cm designates a sample taken at 12 to 14 cm from the top of Section 3 of Core 9, from the hole drilled at Site 511 during Leg 71. A sample from the core catcher of this core is designated as "71-511-9,CC."

The depth below the seafloor for a sample numbered "71-511-9-3, 12-14 cm", is the summation of the following: (1) the depth to the top of the cored interval for Core 9, which is 71.5 meters; (2) plus 3 meters for Sections 1 and 2 (each 1.5 meters long) plus the 12 cm depth below the top of Section 3. All of these variables add up to 74.62 meters[7], which theoretically is the sample depth below the seafloor.

Handling of Cores

A core is normally cut into 1.5 meter sections, sealed, and labeled; the sections are then brought into the core laboratory for processing. The following determina-

[4] Note that this designation has been used on previous legs as a prefix to the core number for sidewall core samples.

[5] This procedure is followed for sediments only. For basalts, the core-catcher sample is incorporated into and given the number of the last section.

[6] This technique differs from the labeling systems used on Legs 1 through 45, which had a designation called "zero section," but did not have a "number 7 section".

[7] Sample requests should refer to a specific interval within a core-section, rather than the level below the seafloor.

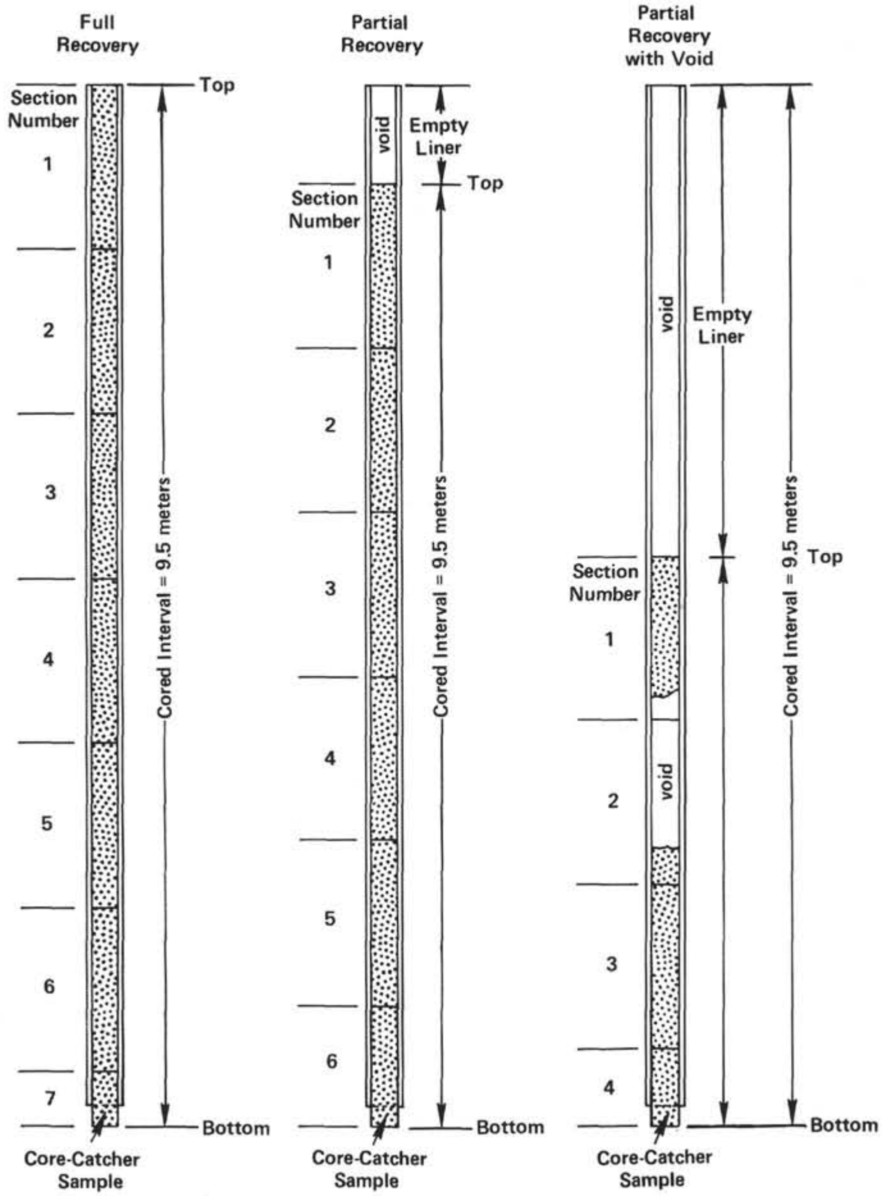

Figure 3. Labeling of sections for various kinds of recovery.

tions normally are made before the sections are split: gas analysis, thermal conductivity analysis (soft sediment only), and continuous wet-bulk density determinations using the Gamma Ray Attenuation Porosity Evaluation (GRAPE).

The cores are then split longitudinally into "working" and "archive" halves. The archive half is described and photographed, but not sampled. Samples are extracted from the "working" half, including those for determination of grain-size distribution, mineralogy by X-ray diffraction, sonic velocity by the Hamilton Frame method, wet-bulk density by a static GRAPE technique, water content by gravimetric analysis, carbon/carbonate analysis, percentage of calcium carbonate (Carbonate Bomb), geochemical analysis, paleontological studies, and magnetic studies. Smear slides from each major lithology and most minor lithologies are prepared and examined microscopically. Physical disturbance by the drill bit, color, texture (for uncemented lithologies), sedimentary structures and composition ($\pm 20\%$) of the various lithologies are recorded on Core Description Forms (Fig. 4).

After the cores are sampled and described, they are maintained in cold storage aboard *Glomar Challenger* until they can be transferred to a DSDP repository. Core sections removed for organic geochemistry study are frozen immediately aboard ship and kept frozen. All Leg 71 cores and frozen cores are presently stored at the DSDP East Coast Repository (Lamont–Doherty Geological Observatory, Palisades, N.Y.).

Descriptions of cores, smear slides, and thin-sections, and determinations of $CaCO_3$ (Carbonate Bomb), physical properties, and rock magnetism were made for Leg 71 aboard ship. Following the cruise, at shore-based laboratories, grain-size analyses and carbon/carbonate determinations (DSDP sedimentology laboratory) pro-

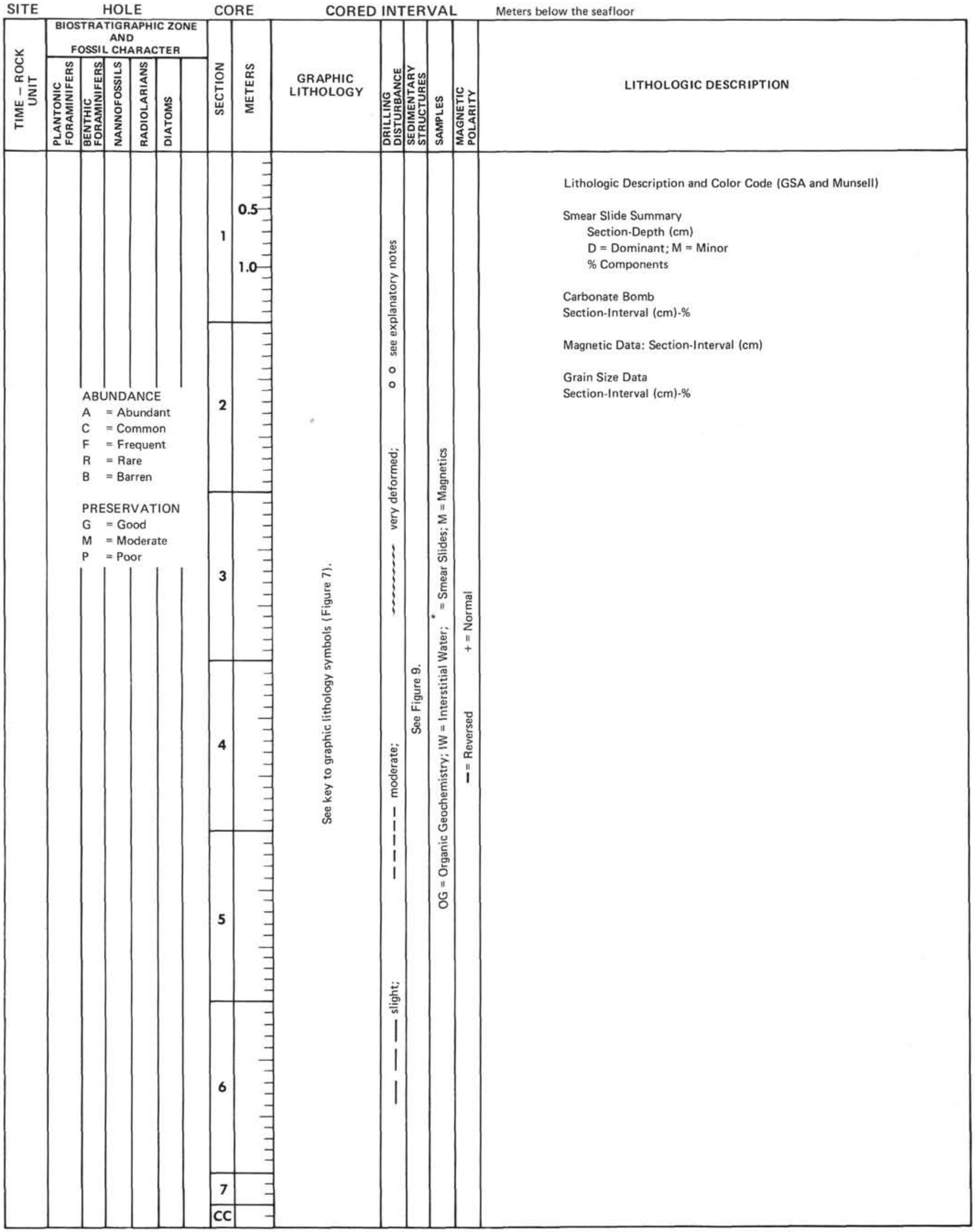

Figure 4. Core description form (sediments).

vided data for the Core Descriptions in this volume. These samples, and their location in the cores, are coded on the core description forms; the key to these codes is shown in Figures 4 and 5.

HPC Cores

HPC cores are distinguished from conventional cores by the designation HPC following the word CORE in the heading and by an expanded vertical scale only 3 sections long (maximum) to allow space for more detailed descriptions.

SEDIMENT DESCRIPTION CONVENTIONS

Sediment Disturbance

Recovered rocks, and particularly the soft sediments, may be extremely disturbed. This mechanical disturbance is the result of the coring technique, which uses a large 25-cm diameter bit with a small 6.0-cm diameter opening for the core sample. The disturbance categories used for soft and firm sediment are indicated in a column on the Core Description Form by coded patterns to which the key is shown in Figure 4. The categories are as follows:

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

Sedimentary Structures

In soft and even in some harder sedimentary cores, it may be extremely difficult to distinguish between natural structures and structures created by the coring process. A column on the Core Description Form (Fig. 4) may have patterns (coded symbols) to indicate typical structures. A set of structure symbol codes recommended by an ad hoc committee of the JOIDES Sedimentary Petrology and Physical Properties Panel is shown in Figure 6.

Color

Colors of the geologic material are determined with a Munsell or Geological Society of America Rock-Color Chart. Colors were determined immediately after the cores were split and while they were still wet.

Graphic Lithology Column

The graphic lithologic column is constructed on the basis of the lithologic classification scheme that follows. The lithologies and their corresponding symbols are shown in Figure 7. A single lithology will be represented by a single pattern. Some lithologies are represented by a grouping of two or more symbols. The symbols in this grouping may correspond to end-member sediment constituents, such as clay and nannofossil ooze. The percentage of one component to another may be represented in the graphic column by the symbols being presented in proportion to their percentages. For example, 20% of the column may have a clay symbol where 80% of the column may have a nannofossil ooze symbol. This would mean that the sample was approximately 80% nannofossils and 20% clay. The vertical lines which separate the symbols are shown at the top of Figure 7 with their corresponding percentages and positions in the column.

Text of Core Description

Format, style, and terminology of the descriptive portion of the Core Description Forms (Fig. 4) are not controlled by the "Mandatory Graphic Lithologic Column Scheme," beyond the minimal name assignment, which is derived from the lithologic classification (below). Any additional information or observations are normally included in the text portion of the core description.

LITHOLOGIC CLASSIFICATION

The basic classification system used here was devised by the JOIDES Panel on Sedimentary Petrology and Physical Properties (SPPP) and adopted for use by the JOIDES Planning Committee in March 1974.

General Principles

This classification is not comprehensive. Therefore, a category of "Special Rock Types" creates additional definitions and terminology of rock types not covered. The classification is descriptive and genetic implications are not intended. These divisions are, of course, artificial, and the proposed classification is only a rough grouping of what we really find in nature. The classification, as used in this volume, uses data which were primarily estimated or measured aboard the ship.

I) General rules for class limits and order of components in a sediment name.
   A) Sediment assumes the names of those components present only in quantities greater than 15%.
   B) Where more than one component is present, the component in greatest abundance is listed farthest to the right, and other components are listed progressively to the left in order of decreasing abundance.
   C) The class limits are based on percentage intervals given below for various sediment types.

II) Composition class boundaries
   A) $CaCO_3$ content (determined by Carbonate Bomb)
      Boundaries of 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-micronodules, etc., fish bones, and other indicators of very slow sedi-

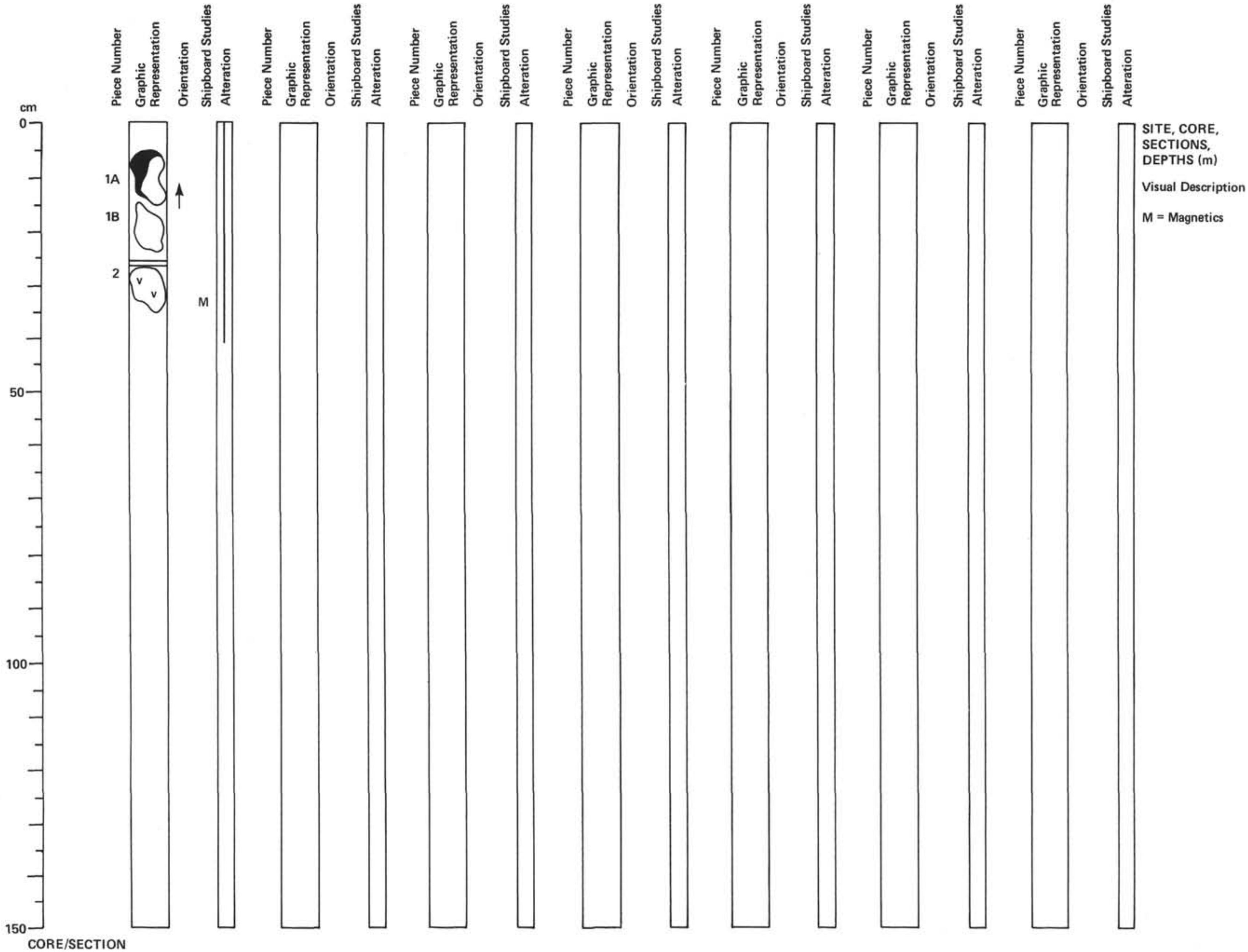

Figure 5. Visual core description form (igneous).

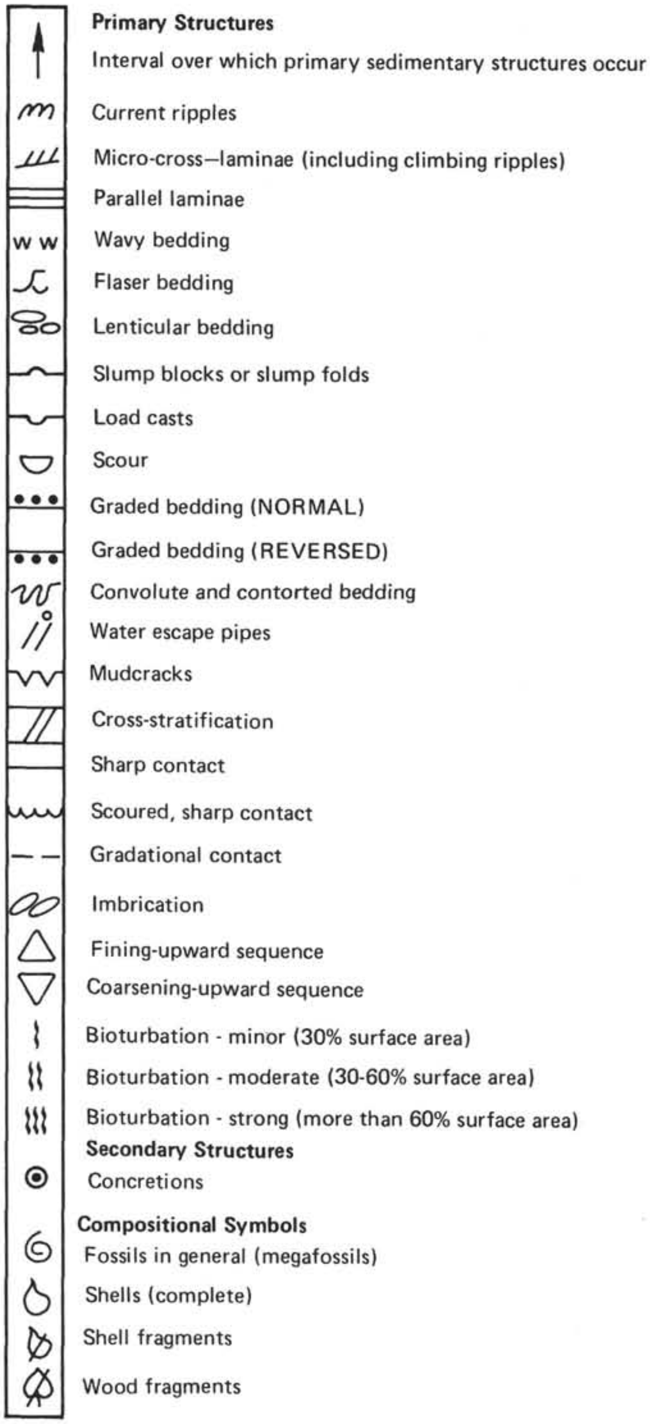

Figure 6. Structure symbol codes.

mentation (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 option should be used freely. However, components of less than 5% (in smear slide) should not be used as a qualifier except in special cases.

Descriptive Data

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 are primarily determined aboard the ship by visual estimates in smear slides, using a microscope.

Smear Slides

The lithologic classification of sediments is based on visual estimates of texture and composition in smear slides made aboard ship. These estimates are of areal abundances on the slide and may differ somewhat from the more accurate laboratory analyses of grain size, carbonate content, and mineralogy. Experience has shown that distinctive minor components can be accurately estimated (~1 or 2%), but that an accuracy of ~10% for major constituents is rarely attained. Carbonate content is especially difficult to estimate in smear slides, as is the amount of clay present. The locations of smear slides made are given on the Core Description Forms.

Sediment Induration

The determination of induration is highly subjective, but field geologists have successfully made similar distinctions for many years. The criteria of Gealy (1971) are used for calcareous deposits; subjective estimate or behavior in core cutting is used for others.

1) Calcareous sediments
   Soft: oozes have little strength and are readily deformed under the finger or the broad blade of a spatula.
   Firm: chalks are partly indurated oozes; they are friable limestones that are readily deformed under the fingernail or the edge of a spatula blade.
   Hard: cemented rocks are termed limestones.
2) The following criteria are used for other sediments:
   If the material is soft enough for the core to be split with a wire cutter, the sediment name only is used (e.g., silty clay, sand).
   If the core must be cut on the band saw or diamond saw, the suffix "stone" is used (e.g., silty claystone, sandstone).

Description of Sediment Types (Fig. 7)

A. Pelagic clay

Principally authigenic pelagic deposits that accumulate at very slow rates. The class is often termed brown

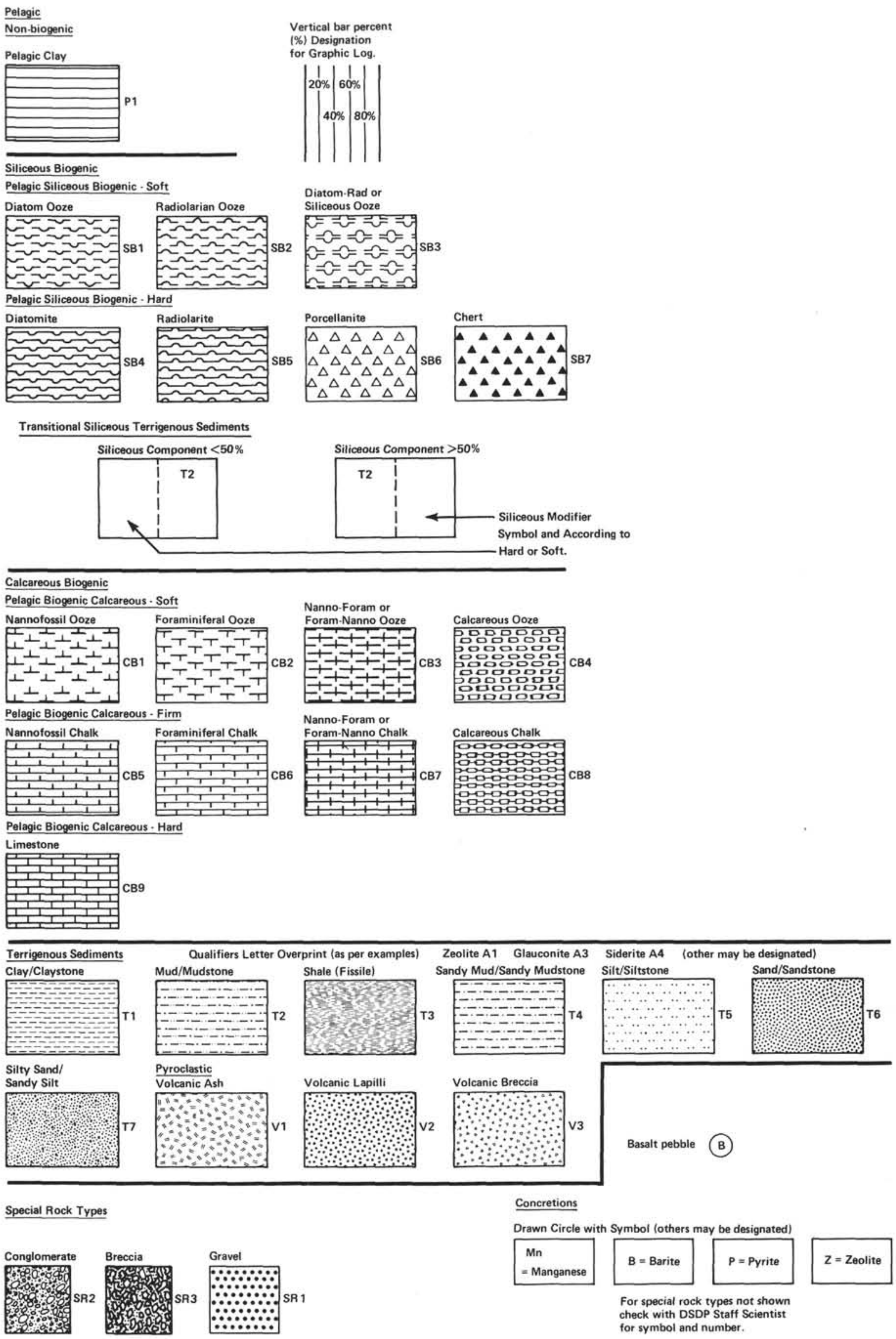

Figure 7. Graphic symbols to accompany the lithologic classification scheme.

clay, or red clay, but since these terms are confusing, they are not recommended.

1. Boundary with terrigenous sediments

Boundary of pelagic clay with terrigenous sediments is where authigenic components (Fe/Mn-micronodules, zeolites), fish debris, etc., become common (>10%) in smear slides indicating pelagic clay. The accumulation rates of pelagic clay and terrigenous sediments are very different; therefore, transitional deposits are exceptional.

2. Boundary with siliceous biogenic sediments

<30% identifiable siliceous remains.

3. 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 ship. These sediments are placed in the "Special Rock" category, but care should be taken to distinguish them from ordinary pelagic clays.

B. 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).

1. Pelagic biogenic siliceous sediments

a. Soft: siliceous ooze (radiolarian ooze, diatomaceous ooze, depending on dominant component).
b. Hard: radiolarite, porcellanite, diatomite, and chert.
c. Qualifiers:
   Radiolaria dominant—radiolarian ooze or radiolarite.
   Diatoms dominant—diatom ooze or diatomite.

Where uncertain—siliceous (biogenic) ooze, chert, or porcellanite; when containing >10% $CaCO_3$, qualifiers are as follows:

Indeterminate carbonate: calcareous.
Nannofossils only: nannofossil.
Foraminifers only: foraminiferal.
Nannofossil-foraminiferal } depending on dominant
Foraminiferal-nannofossil } component

2. 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.

C. 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).

1. Pelagic biogenic calcareous sediments

a. Soft: calcareous ooze.
b. Firm: chalk.
c. Hard: indurated chalk.

The term limestone should preferably be restricted to cemented rocks.

d. Composition 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-foraminiferal ooze.
>50	Foraminiferal ooze.

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

2. Transitional biogenic calcareous sediments

a. $CaCO_3$ 30–60%: marly calcareous pelagic sediments.
   Soft: marly calcareous (or nannofossil, foraminiferal, etc.) ooze.
   Firm: marly chalk.
   Hard: marly limestone.
b. $CaCO_3$ >60%: calcareous pelagic sediments.
   Soft: calcareous (or nannofossil, foraminiferal, etc.) ooze.
   Firm: chalk.
   Hard: limestone.

Note that 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.

D. Terrigenous sediments

Terrigenous sediments are distinguished by a terrigenous component in excess of 30% and siliceous and authigenic components each less than 10%.

Sediments in this category are subdivided into textural groups by smear slide estimation or grain-size analysis on the basis of the relative proportions of sand, silt, and clay. The size limits are those defined by Wentworth (1922). Textural classification follows the triangular diagram of Shepard (1954).

The transition between pelagic and terrigenous sediments is termed hemipelagic.

Qualifiers

In general, sediments containing various constituents in the 10–30% range may be identified in the name of the sediment—for instance, vitric diatomaceous mud or vitric muddy diatomaceous ooze. If more than one such qualifier is used, they are listed in order of increasing abundance in the sediment.

SPECIAL STUDIES

Carbonate Bomb

The percentage of $CaCO_3$ was also determined aboard ship by the Carbonate Bomb technique (Müller and Gastner, 1971). In this simple procedure, a sample is powdered and treated with HCl in a closed cylinder. Any resulting CO_2 pressure is proportional to the $CaCO_3$ content of the sample. Application of the calibration factor to the manometer reading ($\times$ 100) yields % $CaCO_3$. The percentage of error can be as low as 1% for sediments high in $CaCO_3$, and in general an accuracy of ~2 to 5% can be obtained.

These data are presented on the Core Description Forms. The sample interval is designated by two numbers: the section number, followed by the top of the sample interval; for example, a sample from Section 2 from 14 to 15 cm with 52% calcium carbonate will be present on the core form as follows:

CARBONATE BOMB:
2, 14–15 (52)

Carbon/Carbonate Analysis

Following the cruise, sediment samples were analyzed at the DSDP sediment laboratory on a LECO WR-12 Carbon Analyzer. Sample preparation procedures are identical to those used with the old LECO 70 Analyzer as outlined in Boyce and Bode (1972) and Bode (1973); discussion of the LECO WR-12 Analyzer is in Bode (1973). Accuracy and precision of the results are as follows:

Total carbon	=	±0.3% (absolute)
Organic carbon	=	±0.06% (absolute)
$CaCO_3$	=	±3% (absolute)

The carbon/carbonate data are presented on the Core Description Forms. The sample interval is designated by two numbers, the section number, followed by the top of the sample interval. For example: a sample from Section 2 from 11 to 12 cm with 90% total carbon, 0.1% organic carbon, and 74% calcium carbonate will be presented on the core forms as follows:

CARBON/CARBONATE:
2-11 (90, 0.1, 74)

Grain-Size Analysis

Distribution of sand-size, silt-size, and clay-size particles was determined from 10 cm³ sediment samples at the DSDP sediment laboratory by standard sieve and pipette methods (Appendix III, in Bader, R. D., Gerard, R. G., et al., *Init. Repts. DSDP*, 4, p. 745 with modified settling times as in Boyce, 1972). Textures use Shepard's (1954) sediment classification. The sand, silt, and clay boundaries are based on the Wentworth (1922) scale. Thus the particle size of the sand, silt, and clay fraction ranges from 2000 to 62.5 μm, and less than 3.91 μm, respectively.

Grain size data are presented on the Core Description Forms. On the core forms the sample interval is designated by two numbers, the section number and the top of the sample interval within that section. For example, a sample from Section 2 from 11 to 13 cm with a grain-size distribution of 20% sand-size, 30% silt-size, and 50% clay-size will be presented on the core form as follows:

GRAIN SIZE:
2-11 (20, 30, 50)

Paleomagnetics

Inclination, declination, and intensity of natural remnant magnetization were determined aboard ship from 10 cm³ samples using a Digico spinner magnetometer. The data are presented on the Core Description Forms as follows:

Magnetic Data:
Inclination
Declination
Intensity (emu/cc)

At Site 514 polarity, determined from magnetic inclination, was used to construct a magnetostratigraphy. Polarity is presented in an additional column entitled Magnetic Polarity.

Biostratigraphy

Microfossil assemblages recovered on Leg 71 are high-latitude. Low-latitude biostratigraphic zonations are not applicable for most groups other than calcareous nannofossils of Mesozoic and Paleogene age. Zonal schemes used are as follows:

1) Planktonic foraminifers: Cenozoic—Jenkins, 1971.
2) Calcareous nannofossils: Cenozoic—Bukry, 1973; Okada and Bukry, 1980; Edwards, 1971; Wise, this volume. Mesozoic—Thierstein, 1973; Roth, 1978; Medd, in press; Wise, this volume.
3) Radiolarians: Chen, 1975; Weaver, 1976.
4) Diatoms: McCollum, 1975; Schrader, 1976; Gombos, 1981; Weaver and Gombos, 1981; Gombos and Ciesielski, this volume; Ciesielski, this volume.
5) Silicoflagellates: Ciesielski, 1975; Perch-Nielsen, 1975; Bukry, 1975; Busen and Wise, 1977; Shaw and Ciesielski, this volume.

Igneous Rock Description Conventions

Visual Core Description Forms

Visual Core Description Forms for igneous and metamorphic rocks are not the same as those used for sediment. Igneous rock representation on core forms comparable to those for sediments is too compressed to provide adequate information for rock sampling. Consequently, Visual Core Description Forms shown in Figure 5 are assigned to permit more complete graphic representation. Each of these forms covers one 1.5 meter section. All chemical, physical property, and magnetic data, as well as summary hand-specimen and thin-section descriptions, are presented for each section.

Using a rock saw, basalt cores are split into archive and working halves. The latter are described and sampled aboard ship. On the core forms, the left box is a visual representation of the working half. Two closely spaced horizontal lines in this column indicate the location of styrofoam spacers taped between basalt pieces inside the liner. Each piece is numbered sequentially from the top of each section, beginning with the number 1. Pieces are labeled on the rounded, not the sawed surface. Pieces which could be fit together before splitting are given the same number, but are separately consecutively lettered, as 1A, 1B, 1C, etc. Spacers were placed between pieces with different numbers, but not between those with different letters and the same number. In general, addition of spacers represents a drilling gap (no recovery). All pieces which are cylindrical and longer than the liner diameter have orientation arrows pointing up, both on the archive and working halves. Special procedures are adopted to ensure that orientation is preserved through every step of the sawing and labeling process. All orientable pieces are indicated by upward-pointing arrows to the right of the graphic representation on the description forms. Because the pieces become rotated during drilling it is not possible to sample for declination studies.

Samples are taken for various measurements aboard ship and later ashore. The type of measurement and approximate location are indicated in the column headed "Shipboard Studies" using the following codes:

M = magnetics measurement

The state of alteration (see Fig. 5 for symbols) is shown in the column labeled "Alteration."

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