1. INTRODUCTION AND EXPLANATORY NOTES

The Shipboard Scientific Party[1]

Glomar Challenger departed from Las Palmas, Gran Canaria, Canary Islands, on 20 March 1976, drilled two holes at Site 397 (Figure 1), and arrived at Vigo, Spain, on 12 April 1976. Graphic summary of the 1453 meters of penetrated sedimentary section is shown in Figure 2.

The major objective of Leg 47A was to decipher the complex Cretaceous and Tertiary history of a flexured passive continental margin, for which the West Saharan segment between the Requibat Uplift (Cape Blanc) and the Canary Islands (Cape Juby) is a good example. The subsiding edge of this margin has experienced major episodes of erosion, non-deposition, and redeposition, especially during two major regressions (mid-Cretaceous and mid-Tertiary). The thick wedge of uppermost continental rise sediments off northwest Africa had never before been penetrated beyond the Neogene (DSDP Site 139). DSDP Site 369, on the continental slope nearby, served as an ideal companion site of our proposed drilling program for rise-slope comparisons. The planned site was expected to allow a better reconstruction of the history of uplift and subsidence, transgressions and regressions, mechanics of deposition, and erosion during the Early Cretaceous to Neogene.

A complete description of the background and objectives are in the Site Report chapter along with information on the biostratigraphic zonations and absolute age scales used in this volume.

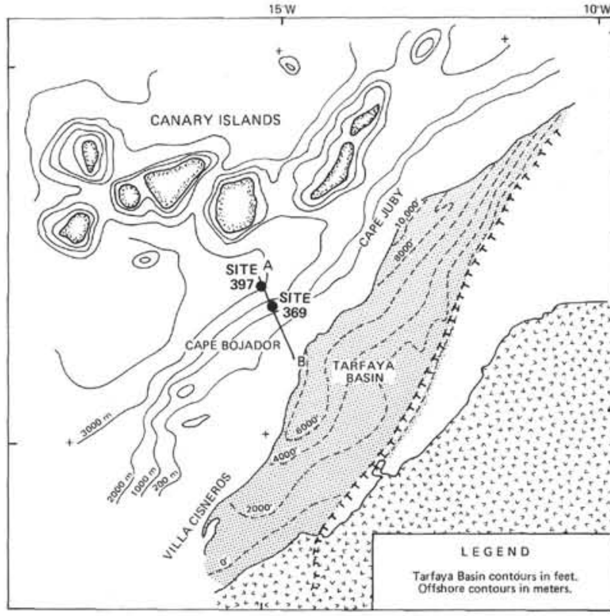

Figure 1. *Topography near Site 397 with sediment isopachs for on-shore portion of Tarfaya Basin.*

EXPLANATORY NOTES

Responsibilities For Authorship

The Site Report chapter in this volume presents the basic shipboard data, and discussion of the general results of drilling obtained during Leg 47A. The authorship of the site chapter is collectively that of the shipboard scientists with ultimate responsibility lying with the Co-Chief Scientists, Ulrich von Rad and William B.F. Ryan. Compilation was by Ulrich von Rad, Michael Arthur, and Oscar Weser with the help of the editors, Fred Laughter and Evelyn Fagerberg. The order and authorship of each section of the Site Report are shown below:

- Site Summary Data
- Background and Objectives (von Rad and Ryan)
- Operations (Weser)
- Lithology (McCoy and Arthur, with input from von Rad, Sarnthein, Lopatin, and Weser; summary chart compiled by McCoy)
- Paleoenvironment and Depositional Processes (Arthur and Cita, with input from Ryan)
- Sedimentation Rates and Hiatuses (Arthur and Ryan)
- Geochemistry (Cornford and Whelan)
- Physical Properties (Mountain)
- Biostratigraphy:
  - Summary (von Rad and Arthur)
  - Nannofossils (Čepek and Wind)
  - Planktonic foraminifers (Cita)
  - Benthic foraminifers (Lutze)
- Paleomagnetism (Hamilton)

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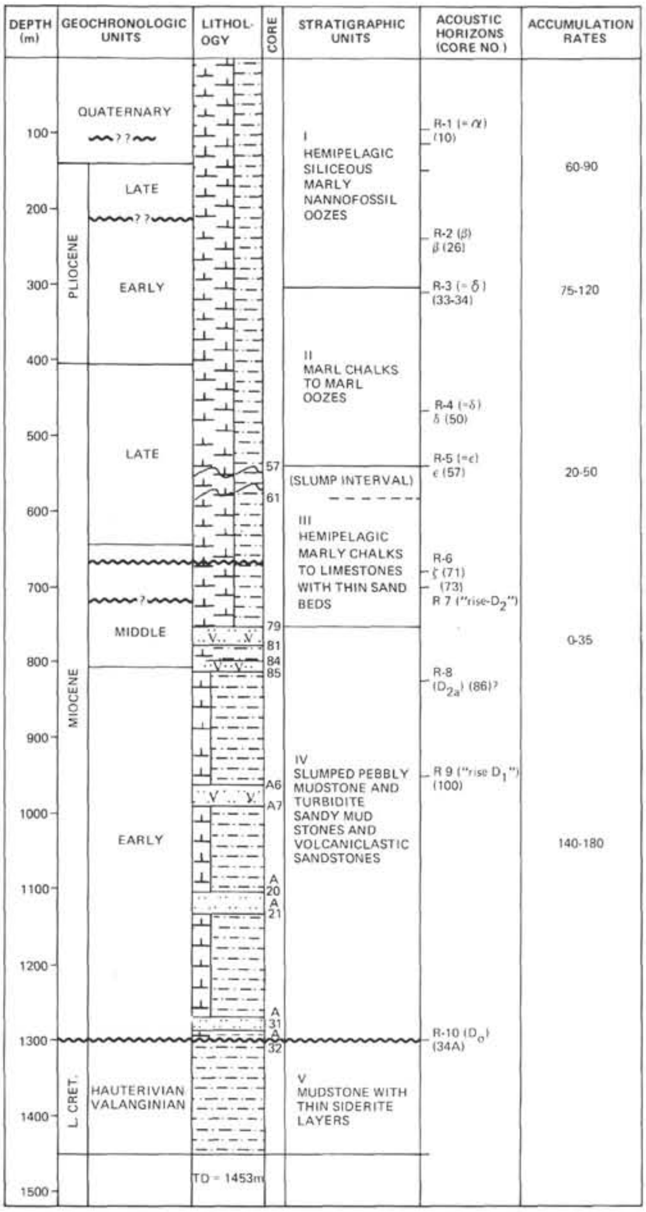

Figure 2. *Litho-bio-acoustostratigraphy at Site 397.*

Temperature Logging (Ryan, with input from Arthur and von Rad)

Correlation of Seismic Reflection Profiles with Drilling Results (von Rad and Ryan)

Summary and Conclusions (von Rad)

We are very grateful to a number of colleagues from the Bundesanstalt für Geowissenschaften und Rolistoffe (B6R, Hannover), Kiel University, and other institutions who allowed us to quote results of their shore-based studies in the Site Chapter or reviewed the contributions of the Shipboard Scientific Party.

Survey and Drilling Data

Surveys

The presite survey data, kindly supplied to the Leg 47A scientific staff by the various organizations and institutions active in the area and on which the site selection was based, is acknowledged in the site chapter.

A shipboard precision echo-sounder together with seismic profiling equipment, was used to determine specific site locations. These data are discussed in the sections dealing with site approach. En route between sites, continuous observations were made of depth, magnetic field intensity, and sub-bottom structure. Underway depths were recorded on a Gifft precision graphic recorder (PGR). The depths were read on the basis of an assumed 800 fathoms/s sounding velocity. The sea depth (in m) was corrected (1) according to the tables of Matthews (1939) and (2) for the depth of the hull transducer, 6 meters below sea level. In addition, any depths referred to the drilling platform have been calculated under the assumption that this level is 10 meters above the water line.

The seismic profiling system aboard *Glomar Challenger* consisted of one Bolt airgun and one 5-l airgun (supplied by the BGR, Hannover), a Scripps-designed hydrophone array, Bolt amplifiers, two band-pass filters, and two EDO recorders, usually recording at two different filter settings.

Drilling Characteristics

The taking of cores in a particular hole was mainly continuous, a few times it was interspersed by drilled, but uncored, intervals of variable length (spot coring).

Due to circulation of water down the hole, drill cuttings are flushed out of the hole onto the sea bed (an "open system") and cannot be examined.

The only information available about sedimentary material between cores, other than from seismic data, is from an examination of the behavior of the drill string as observed on the drill platform. The harder the layer being drilled, the slower and more difficult it is to penetrate. The most prominent of such layers are known as "drill breaks." There are, however, a number of other factors which determine the rate of penetration, so it is not possible to relate this directly to the hardness of the layers. The following parameters are recorded on the drilling recorder, and all influence the rate of penetration.

1) Weight on the bit. This can vary in three steps from zero, when the bit is suspended above the bottom of the hole to 40,000 pounds when two of the three bumper subs are collapsed and the whole bottom assembly bears on the bit. The aim of the driller, is, by reference to the weight indicator, to maintain constant bit weight by lowering the drill string when necessary. However, this is extremely difficult to do in conditions of swell, when the heave of the drill platform may exceed the available extention (6 ft) of the bumper subs.

2) Revolutions per minute. The revolutions per minute (rpm) are related to the torque applied to the top of the drill string, and a direct analysis of the two should give the resistance to drilling. However, the rpm record is not detailed enough to do this. Nevertheless, visual observations of the rate of drill string rotation are useful in assessing bit behavior. In particular, it can be seen that when the drill bit becomes jammed in very resistant

rock; rotation stops, the bit becomes free and the drill string untwists.

Drilling Disturbance

Most cores, when split and examined aboard *Glomar Challenger*, show signs of having been disturbed to a greater or lesser extent by the drilling process. Such signs are the concave downward appearance of many originally horizontal bedding planes, the haphazard mixing of lumps of sediment having differing lithologies, and the near fluid state of some sediments.

Coring disturbance is particularly noticeable in the upper 100 meters or so of soft, unlithified sediments. At the other extreme, well-consolidated sedimentary and igneous rocks can also be reduced to rubble by the coring process. Variations in lithology are not the only factors determining the amount of coring disturbance. Clearly too, some sediment disturbance, and even some fracturing displayed by the cores, may be original predrilling features.

Shipboard Scientific Procedures

Numbering of Sites, Holes, Cores, Samples

Drill site numbers run consecutively from the first site drilled by *Glomar Challenger* in 1968, thus each site number is unique. A site refers to the hole, or holes, drilled while using one acoustic positioning beacon. Several holes may be drilled at a single locality by pulling the drill string above the sea floor ("mud line") and offsetting the ship some distance (usually 100 m or more) from the previous hole. This sometimes becomes necessary where there is insufficient soft sediment at the first location to "spud in" or bury the bottom-hole assembly (BHA).

The first (or only) hole drilled at a site takes the site number. Additional holes at the same site are further distinguished by a letter suffix. The first hole has only the site number; the second has the site number with suffix "A"; the third has the site number with suffix "B"; and so forth. For example, *if* three holes had been drilled at Site 397 they would be referenced as Site 397 (first hole), Hole 397A (second hole), and Hole 397B (third hole). It is important for sampling purposes to distinguish the holes drilled at a site, since recovered sediments or rocks usually do not come from equivalent positions in the stratigraphic column at different holes.

Cores are numbered sequentially from the top down. In the ideal case, they consist of 9 meters of sediment or rock in a 6.6-cm-diameter plastic liner. In addition, a short sample is obtained from the core catcher (a multi-fingered device at the bottom of the core barrel which prevents cored materials from sliding out during core-barrel recovery). This usually amounts to about 20 cm of sediment and is stored separately. This sample, from each core, represents the lowest stratum recovered in the particular cored interval. The core-catcher sample is designated by CC (e.g., 397A-6, CC, is the core-catcher sample of the sixth core taken in the second hole drilled at Hole 397A.

The cored interval is the interval in meters below the sea floor measured from the point at which coring for a particular core was started to the point at which it was terminated. This interval is generally 9.5 meters (nominal length of a core barrel) but may be shorter if conditions dictate. Cores and cored intervals need not be contiguous. In soft sediment, the drill string can be "washed ahead" without recovering core by applying sufficiently high pump pressure to wash sediment out of the way of the bit. In a similar manner, a center bit, which fills the opening in the bit face, can replace the core barrel if drilling ahead without coring is necessary.

When a core is brought aboard *Glomar Challenger*, it is labeled and the plastic liner and core cut into 1.5-meter sections. A full, 9-meter core would thus consist of six sections, numbered from the top down, 1 to 6. (The discrepancy between the 9-meter core and 9.5-meter core interval is discussed below.) Generally, somewhat less than 9 meters is recovered. In this case, the sections are still numbered starting with one at the top, but the number of sections is the number of 1.5-meter intervals needed to accommodate the length of core recovered; this is illustrated in Figure 3.

Thus, as shown, recovery of 3.6 meters of sediment would result in a core with three sections, with a void of 0.9 meter at the top of the first section. By convention, and for convenience in routine data handling at the Deep Sea Drilling Project, if a core contains a length of material less than the length of the cored interval, the sections that recovered material are placed in the top of the cored interval, with the top of Section 1 (not always the top of the sediment) located at the top of the cored interval. This is shown in Figure 4 for the core in the above example.

It was noted above that a discrepancy exists between the usual coring interval of 9.5 meters and the 9-meter length of core recovered. The core liners used are actually 9.28 meters in length, and the core catcher accounts for another 0.2 meter. In cases where the core liner is recovered full to the top, the core is still cut into 1.5-meter sections, measured from the top of the liner.

Samples taken from core sections are designated by the interval in centimeters from the top of the core section from which the sample was extracted; the sample size, in cc (cm^3), is also given. Thus, a full sample designation would consist of the following information:

Leg (Optional)
Site
(Hole, if other than first hole)
Core Number
Section Number
Interval in centimeters from top of section

Sample 397A-1-2, 122-124 cm (10-cm^3) designates a 10-cm^3 sample taken from Section 2 of Core 1 from the

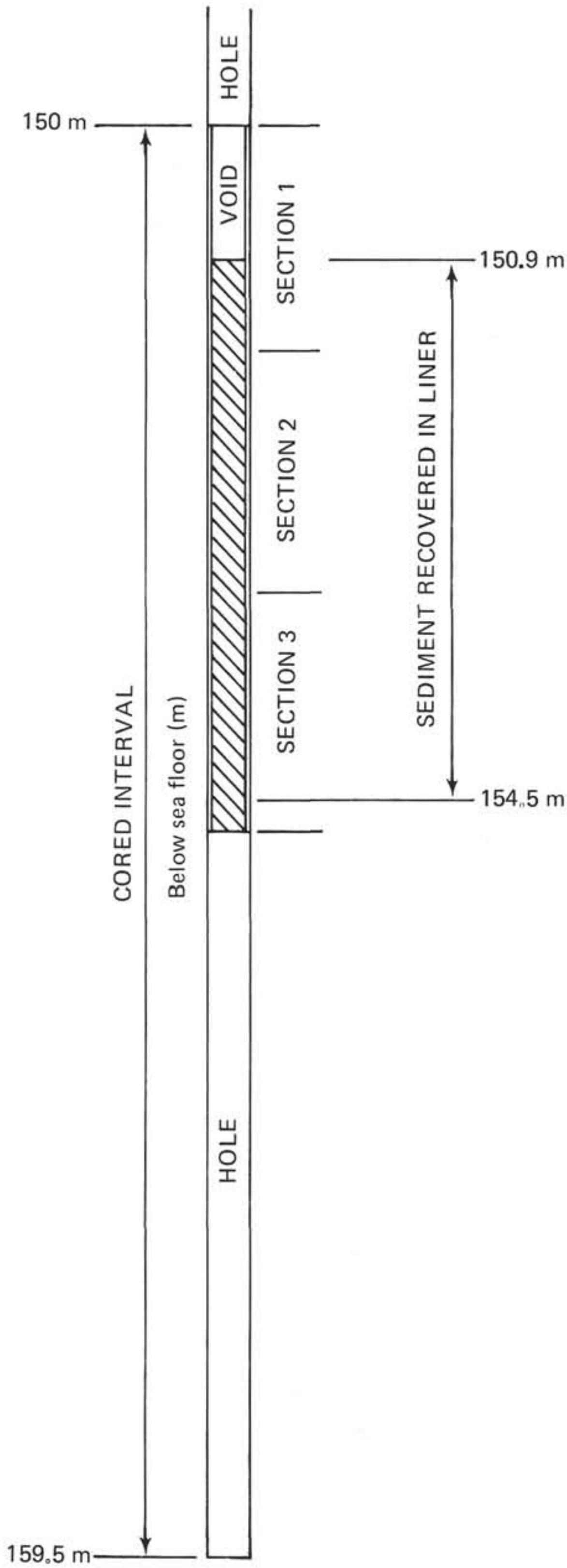

Figure 3. *Position of incomplete sediment recovery within the cored interval.*

second hole drilled at Site 397. The depth below the sea floor for this sample would then be the depth to the top of the cored interval plus 3 meters for Sections 1 and 2, plus 122 cm (depth below the top of Section 3). (Note, however, that subsequent sample requests should refer to a specific interval within a core section [in cm] rather than level [m] below sea floor.)

Handling of Cores

The first analysis of the material recovered by an individual core is the core catcher. Rapid paleontological and lithological analysis of this material from the base of the cored interval is carried out to make decisions as to whether to drill ahead or to take another core.

After a core is brought up to the drill platform, it is cut, sealed, and labeled before beginning its routine progress through the shipboard analytical procedure. Often samples for organic geochemistry are taken at this stage.

In the core laboratory on *Glomar Challenger*, after physical property measurements requiring unsplit cores are made (such as thermal conductivity and density-porosity measurements using gamma ray attenuation techniques) the 1.5-meter sections of sediment core and liner are split lengthwise. One-half is designated the "archive" half, which is sampled by both the shipboard sedimentologists and paleontologists for further shipboard and shore-based analysis.

Sampling

In the core laboratory samples for routine shore-based analysis such as grain size, X-ray mineralogy, and total carbonate content were taken from the working half, labeled, and sealed. Because of the high level of precruise interest in Leg 47A, samples were taken at this stage for numerous shore-based workers, whose contributions can be read in this volume. In addition, samples were regularly taken for immediate shipboard analysis, such as total carbonate by the "carbonate bomb" method. Routine samples were taken for smear slide, carbonate and grain-size analysis. The location of these samples is shown on the core forms in a column using appropriate symbols (see Sample Core Form, Figure 5). The working half was then sent to the paleontology laboratory, where samples for both shipboard and shore-based studies of nannofossils, foraminifers, radiolarians, diatoms, silicoflagellates, and other fossil groups were taken.

Material obtained from core catchers, and not used up in the initial examination, was retained (in freezer boxes) for subsequent work. Sometimes pebbles particularly important to the interpretation of the site were extracted from the core and stored separately in labeled containers as a measure against loss. On occasions where the liners contained only sediment-laden water, the water was usually collected in a bucket, allowed to settle, and the residue was stored in freezer boxes. All samples are deposited in cold storage at the DSDP East Coast Repository at Lamont-Doherty Geological Observatory and are available to investigators.

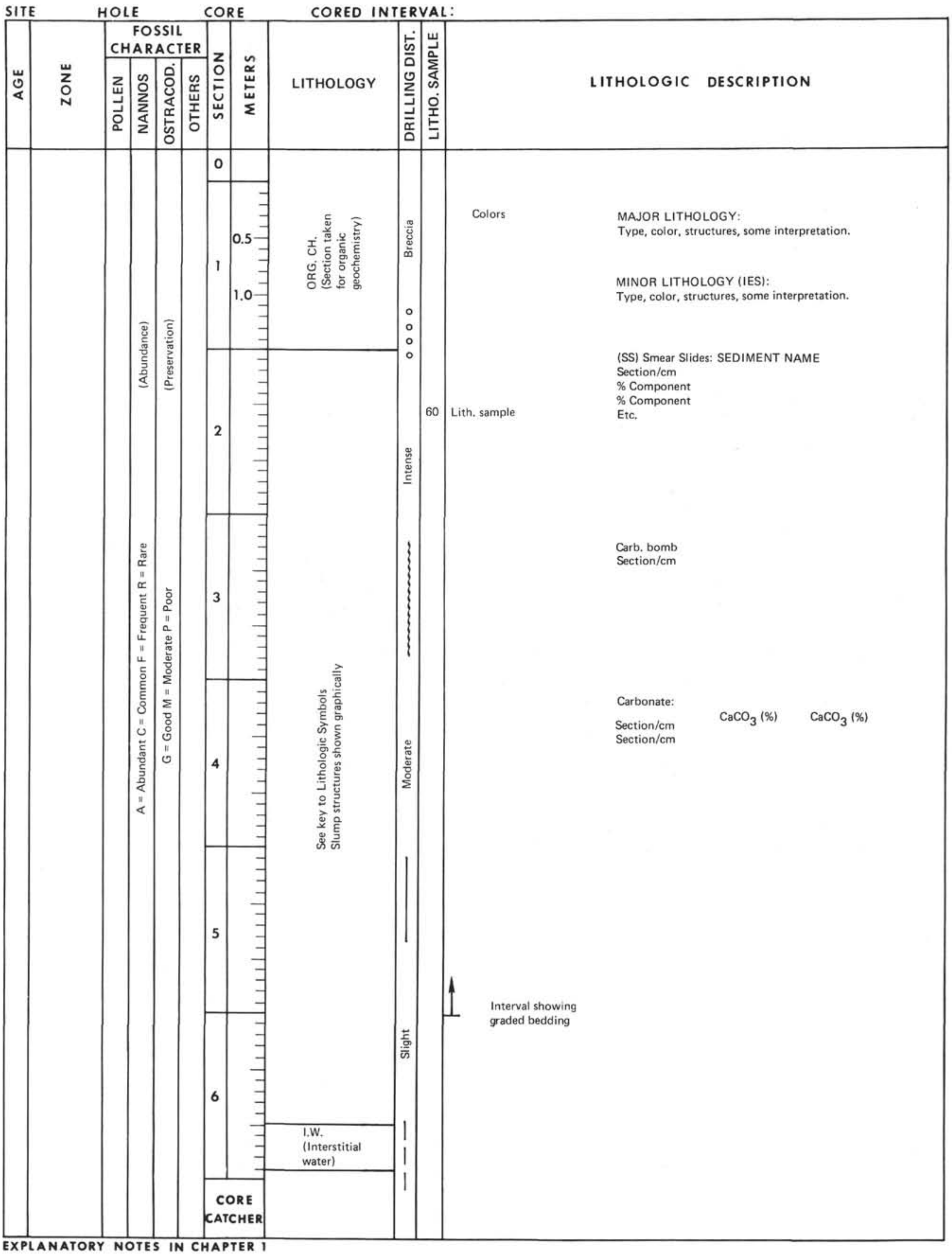

Figure 4. *Sample core form.*

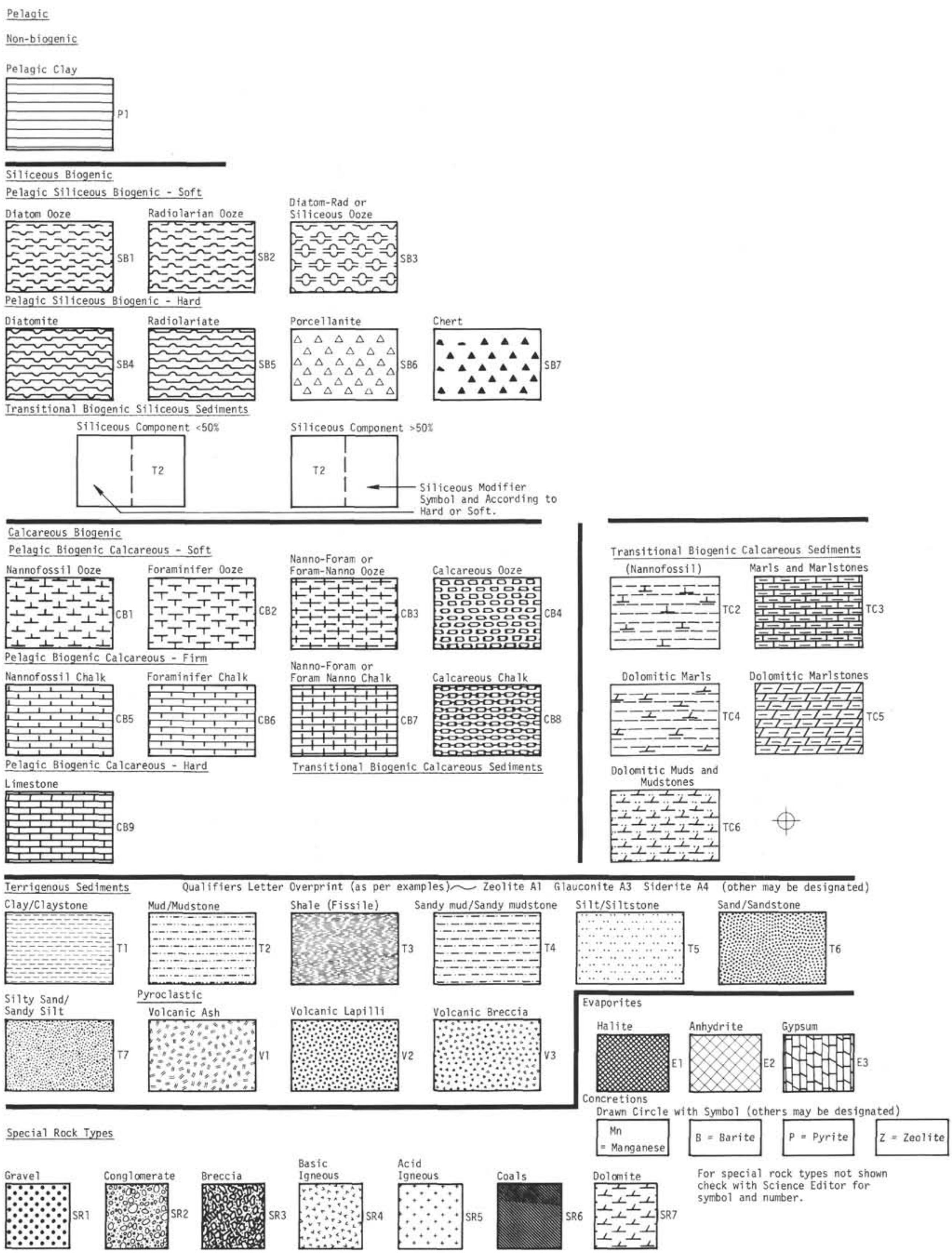

Figure 5. *Graphic symbols to accompany the lithologic classification scheme used on Leg 47A.*

Lithologic Studies

The archive half of the split section is used only for descriptive purposes. The cut surface of each is scraped to emphasize the sedimentary features and the color, texture, structure, and composition of the varying lithologies. Each section is described individually on a Visual Description Form. Smear slides are made and are examined using the shipboard petrographic microscopes. These, in conjunction with the "carbonate bomb" results, provide the basic shipboard information on lithology. The archive half is then photographed.

Core Forms

The basic descriptive data, both lithologic and biostratigraphic, for each section of a particular core are combined to produce the Core Summary Forms, which accompany each site chapter. These are first compiled aboard ship, but are upgraded later using postcruise shore-based data. A sample core form is illustrated in Figure 4. Most data are symbolized, but a short description is provided giving the essential lithologic information in the following order: Sediment or rock name, Sediment disturbance, Color name and Munsell or GSA number, Sedimentary structures and other special features, Composition from smear slides and bulk X-ray analysis, Grain-size and carbonate data. Many cores contain important minor lithologies as well as a basic lithology. The description of the major lithology is so indicated in most cases; however, descriptive information for minor lithologies is included wherever possible.

As noted previously, the rotary drill-coring technique quite often results in disturbance of the cored sediments. This is especially true of the softer unconsolidated sediments. A qualitative estimate of the degree of deformation is given as a symbol on the core logs (see Sample Core Form, Figure 5).

Color names and numbers are derived by reference to the GSA Rock Color Chart (Goddard et al., 1963). The reader is advised that colors recorded in core-barrel summaries were determined during shipboard examination immediately after splitting core sections. Experience with carbonate sediments shows that many of the colors will fade or disappear with time, after opening and storage. Colors particularly susceptible to rapid fading are purple, light and medium tints of blue, light bluish gray, dark greenish black, light tints of green, and pale tints of orange. These colors change to white or yellowish white or pale tan.

Smear-Slide Analysis

Smear slides are prepared from minute amounts (1 or 2 mm^3) of sediment taken with a spatula, puddled and smeared with distilled water on a glass slide, dried, and set under a cover-slip with Caedex. Their examination by petrographic microscope provides a rapid means of mineral identification. They are the basic source of lithologic information used onboard ship, although thin sections are used in studies of basalts and other hard rocks.

Smear-slide estimates of mineral abundances are based on the percentage of the area of the smear-slide covered by each component. Past experience has shown that accuracy may approach a per cent or so for very distinctive minor constituents, but that for major constituents, accuracy of ± 10 per cent is considered very good. The accuracy of this technique aboard ship is much enhanced when employed, as on Leg 47A, in conjunction with numerous carbonate bomb measurements (see below).

"Carbonate Bomb" Data

During Leg 47A, extensive use was made of the "carbonate bomb" device (Müller and Gastner, 1971) as an aid in sediment classification. All total carbonate percentages measured by this method are recorded on the core summary forms, as are levels of sampling (B). Accuracy to within ± 5 per cent total carbonate has been quoted for the device. However, postcruise shore-based studies suggest that it may be somewhat less accurate than this, particularly for high carbonate sediments or for complex mixtures of sedimentary components where carbonate is low (see below). Also the "bomb" device is probably considerably less accurate where dolomitic sediments are encountered.

When CO_2 pressure readings on the carbonate bomb are in the range 0.40 to 0.65, both methods (LECO and bomb) did give comparable values with a maximum difference of ± 5 per cent $CaCO_3$ (weight). With CO_2 pressure readings on the "bomb" in the range 0 to 40, the LECO values were higher, by 7 to 12 per cent $CaCO_3$ (weight) in the lower half of the range and by 1 to 7 per cent (weight) in the upper part. With CO_2 pressure readings on the "bomb" above 0.65 the LECO values are lower, by 1 to 13 per cent $CaCO_3$ (weight).

The LECO method (combustion by inductive heating in an O_2 atmosphere) is considered more reliable than the "carbonate bomb" method.

A scan of the $CaCO_3$ values recorded on the core summary forms for both shipboard "carbonate bomb"and DSDP shore-based LECO measurements reflects the conclusions arrived at above. However, it is important to note that the "carbonate bomb" device is employed aboard *Glomar Challenger* primarily as an aid in the accurate naming of sediments in conjunction with the smear slide observations and that within the bounds of the JOIDES sediment classification, the discrepancies noted would not change the names given to sediments onboard ship.

Sediment Classification

The sediment classification used on Leg 47A was devised by the JOIDES Panel on Sedimentary Petrology and Physical Properties, and adopted for use by the JOIDES Planning Committee in March 1974. It is reproduced in part below.

The only modification found necessary to the JOIDES classification itself was to the "Transitional Biogenic Calcareous Sediments" category; that is, the marls and marlstones (> 30% $CaCO_3$ and > 30% silt and clay). The existing single symbol/category was split into five, taking into account dolomite content, and now includes: marls, marlstones, dolomitic marls, dolomitic marlstones, and dolomitic muds and mudstones.

Lithologic Classification Scheme

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

1) **Compositional Class Boundaries**

a) **$CaCO_3$ content** (determined by carbonate bomb): 30 and 60 per cent. With a 5 per cent 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 per cent. 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 sedimentation (estimated in smear slides); semiquantitative boundary: common 10 per cent. These components are quite conspicuous and a semiquantitative 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 per cent.

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

Description of Sediment Types

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

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

b) **Boundary with siliceous sediments:** 30 per cent identifiable siliceous remains.

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

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

a) Pelagic biogenic siliceous sediments:

soft: Siliceous ooze (radiolarian ooze, diatomaceous ooze, depending on dominant component).

hard: radiolarite, porcelanite, diatomite, chert

(i) Qualifiers:

Radiolarians dominant: radiolarian ooze or radiolarite.

Diatoms dominant: diatom ooze or diatomite.

Where uncertain: siliceous (biogenic) ooze, or chert.

(ii) Qualifiers — In this group numerous qualifiers are possible usually based on minor constituent, for example: glauconitic, pyritic, feldspathic.

In the sand and sandstone category, conventional divisions such as arkose, graywacke, etc. are of course, acceptable, providing the scheme is properly identified. Clays, muds, silts, and sands containing 10 to 30 per cent $CaCO_3$ shall be called *calcareous.*

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

Volcanic breccia	>32 mm
Volcanic lapilli	<32 mm
Volcanic ash (tuff, if indurated)	<4 mm

Compositionally, these pyroclastic rocks are described as vitric (glass), crystal or lithic.

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

Lithologic and Structure Symbols

Figures 5 and 6 display the set of lithological symbols and sedimentary structure symbols which accompany the JOIDES classification, including the modifications employed during Leg 47A. These symbols are used on the Core Summary Forms.

Hole Summary Diagrams

A summary diagram is drawn and accompanies the site chapter. This is primarily a compilation of the lithologic and biostratigraphic data displayed on the core forms. Again these are initially drawn aboard ship and are later modified to take account of shore-based data. Downhole plots of carbonate content and X-ray mineralogical data accompany each diagram. Two sediment summary charts that contain in a graphical format a large amount of biostratigraphical, sedimentological, geophysical, and geochemical data of Site 397 accompanies this volume in the back pocket.

Lithostratigraphic Terminology

Many different lithologies were encountered on Leg 47A. No formal rock stratigraphic units are employed in the site chapters. The sediments are informally divided into units and sub-units. For each site, these unit designations are outlined in a table in the lithology section and also in the appropriate hole summary diagram. Boundaries between specific units and sub-units in cored intervals were both sharp and gradational. If a boundary occurred between cores, it was placed in the middle of the drilled interval unless biostratigraphic evidence deemed otherwise.

Routine Shore-Based Analyses

In a number of cases sediment names have been modified from those given aboard ship to take into account the shore-based data.

Carbon-Carbonate Analyses

Shore-based carbon-carbonate analysis was with a LECO acid-base semi-automatic carbon determinator. Step-by-step procedures used at the DSDP La Jolla Laboratory are reported in Bader et al. (1970), and a discussion of the method, its calibration, and its precision can be found in Boyce and Bode (1972).

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

$$\text{Per cent calcium carbonate } (CaCO_3) = (\%\text{ total C} - \%\text{C after acidification}) \times 8.33.$$

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

Precision of the determination is as follows:

Total carbonate	
(within 1.2 to 12%)	= ±0.3% absolute
Total carbon (within 0 to 1.2%)	= ±0.06% absolute
Organic carbon	= ±0.06% absolute
Calcium carbonate	
(within 10% to 100%)	= ±3% absolute
(within 0 to 10%)	= ±1% absolute

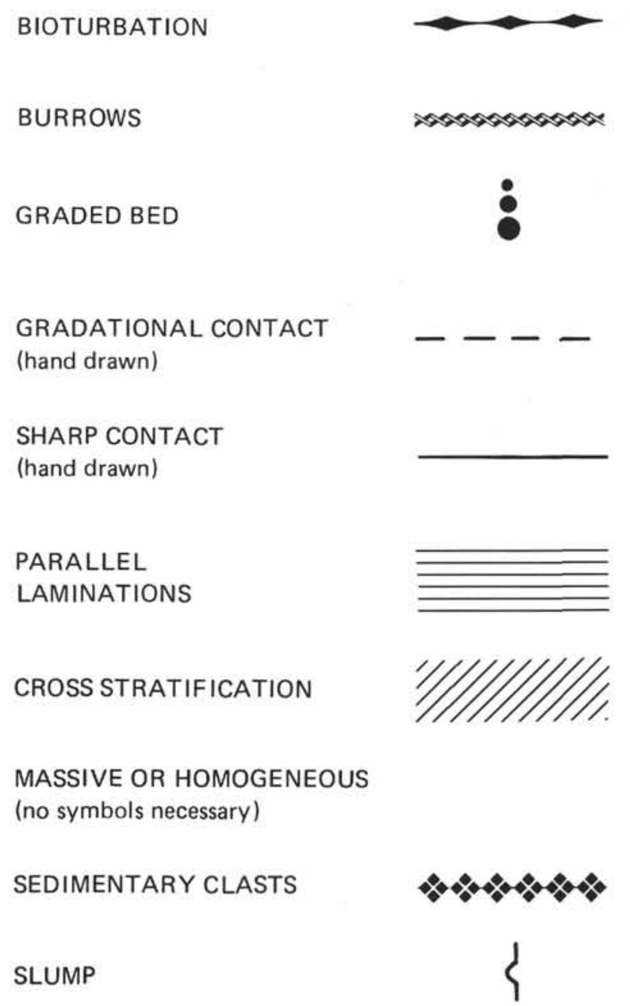

Figure 6. *Sedimentary structure symbols.*

Grain-Size Analyses

The DSDP shore-based grain-size analyses, presented on the Core Summary Forms were derived by standard sieve and pipette techniques, as described in detail in Bader et al. (1970), with modified settling times as in Boyce (1972).

Geochemical Measurements

Shipboard geochemical measurements were routinely made during Leg 47A. The standard DSDP procedures for interstitial water and allied studies were employed. These are adequately described in Waterman (1970) and in Whitmarsh, Weser, Ross, et al. (1974).

Physical Properties

Physical property measurements of bulk wet density, porosity, permeability, water content, compressional velocity, and shear strength were made during Leg 47A.

The measurement techniques and sampling considerations have been carefully described by Boyce (1973) and will only be outlined briefly in the following discussion. Further discussions of the routine physical property measurements, centering principally on certain problems with the techniques and their effects on the quality of the data, can be found in a paper by Bennett and Keller (1973). Anyone intending to draw geologically relevant conclusions based on the physical property data presented in this volume is urged to read both papers. At drill sites where downhole temperature data were obtained, thermal conductivity measurements were made in order to permit calculation of the rate of heat flow through the sea floor.

Sonic Velocity Data

Measurements of compressional wave velocities in sediments were made using the Hamilton Frame apparatus (see Mountain, this volume). All measurements were made at room temperature and pressure after the cores had reached thermal equilibrium with the laboratory, and soon after they were opened. Most of the data are obtained by measuring the length of time required for sound to traverse a path through the sediment and plastic core liner between a 400-kHz acoustic transducer and receiver. This method assumes good acoustic contact between the liner and the sediment, a condition which may not be fulfilled if the sediment does not completely fill the core liner. Corrections must be made to account for the thickness of the liner and the length of time required for the sound to pass through the liner. The corrections routinely applied presuppose liners of constant sound velocity and thickness. The second parameter, thickness, is known to vary widely from shipment to shipment and even within a given section of liner. Thus measurements of sound velocity of material in a split liner are subject to errors not present when measurements are made directly on material consolidated enough to be shaped and put between the transducers.

Where consolidation was sufficient, the ends and sides of chunks of unsplit core were cut or shaped into flat, parallel faces with normals parallel and perpendicular to the long axis of the core, taking care to minimize disturbance to the sample. The velocity was determined directly on these chunks in both directions, and the horizontal and vertical velocities could then be compared in order to detect the presence of seismic anisotropy.

On Leg 47A, a substantial difference was found to exist between horizontal velocities (parallel to bedding) routinely measured through the liner in split cores, and the vertical velocities required to compute the thickness of sedimentary layers from travel time data. Thus it is clear that neglect of acoustic anisotropy can seriously affect realistic interpretation of seismic data from drilling results.

Gravimetric Data

Bulk property measurements were made on sediment samples obtained from the central, presumably undisturbed portion of the sediment cores using small (<1 cm^3) syringe-type samplers and larger ($\cong 20$ cm^3) stainless steel cylinders of known volume. The sediment samples were weighed wet and again after drying at 110°C for 24 hours and computations of bulk wet density, porosity, and water content were made.

The extremely small volume of the syringe sample can result in substantial errors in measuring both weight and volume differences, and the small diameter of the syringe makes representative sampling of coarse-grained, highly porous, and/or well-compacted sediments almost impossible. Comparison of the wet bulk density data taken with the two techniques indicates that the variability of the syringe data is much higher than that of data obtained using the cylinder-sampling technique. Further comparison of the syringe data with densities measured using the larger volume cylinder samples, as well as with densities determined by gamma ray attenuation methods, suggests that the syringe density data may be systematically low. The standard deviation of the syringe data is approximately twice as large as the standard deviations of the density values obtained using the other two measurement methods. Thus bulk properties determined using syringe sampling techniques cannot be used to define any other than the most dramatic changes in sediment physical properties.

The larger volume of the samples obtained using the stainless steel cylinders permits a significant reduction in the errors in the volume and weight measurements. The sampling procedure was to push the sharpened end of a thin-walled cylinder of known weight and volume into the sediment until its lower end made contact with the curved wall of the core liner and its upper end was slightly buried beneath the surface of the freshly split core. Pliers were then used to gently rock the cylinder back and forth in order to break suction between the bottom of the sediment sample and the inside of the core liner. The cylinder was withdrawn with the sediment protruding from both ends and the sediment was carefully shaved and cut back until it was flush with the end of the cylinder. This ensured that the volume of sediment was the same as the previously measured internal volume of the cylinder. The sediment-filled cylinder was then weighed and dried for at least 24 hr at 110°C, after which it was weighed again.

Representative sampling was difficult in coarse-grained sediments due to the tendency for the larger grains to dig into the surface of the sample as the ends were being smoothed. In poorly compacted, plastic sediments the friction of the sediment plug against the inside of the cylinder tended to compress the plug or prevent it from entering the cylinder smoothly, thus causing some mechanical disturbance. In more compact sediments the cylinder tended to fracture the sediment before it had become fully inserted, or to break the plug loose from the remaining sediment in such a way that the ends of the plug did not protrude from, or even reach, the ends of the cylinder. In these cases where the volume was not accurately known the sample was only used to determine water content.

In sediments which could be sampled effectively, plexiglas plates were fastened over the ends of the cylinder to prevent drying, and the attenuation of gamma rays through both the plexiglas and the sample was determined, thus permitting calculation of the wet bulk density, on the basis of gamma ray attenuation data. In this way the bulk-wet density values obtained using both gravimetric and gamma ray attenuation techniques could be compared and the gamma ray attenuation technique could be calibrated using the more direct gravimetric data.

GRAPE Data

Measurement of the attenuation of a pencil-sized beam of gamma rays passing through a known thickness of sediment (or rock) permits calculation of the bulk wet density and porosity of the material. The accuracy of the method as applied to sediment or rock is strongly dependent upon the homogeneity, consistency, and dimensional stability of the sediment as it passes through the gamma ray beam. Because of coring disturbance and the mechanical properties of the sediment, it is common for very soft or very hard sediment to only partially fill the core liner. Often a core of relatively undisturbed sediment or rock will have a variable and smaller diameter than the inner diameter of the core liner. The length of the gamma ray path through both the sediment and through the air, water, or slurry between the sediment core and the walls of the core liner must be known in order to compensate for the effects of the varying geometry. Furthermore, the wet bulk density of the surrounding slurry, if any, must be measured separately using gravimetric techniques in order to correct for the presence of material other than the undisturbed portion of the core itself. All of these variables are difficult to estimate accurately and are time consuming to measure. If neglected, they can produce both highly variable and anomalously low values of wet bulk density and high values of porosity. The most representative wet bulk density values for a particular type of sediment are probably the maximum values recorded. However, it is worth noting that the expulsion of interstitial fluids because of compaction during coring can produce higher wet bulk density values than the actual *in-situ* density. Great care must be taken in drawing geological deductions from data obtained using the gamma ray attenuation technique.

Shear Strength

Measurements of the shear strength of sediment were made. The values were obtained by measuring the torque required to shear the sediment as it was applied to a four-bladed rectangular vane having known width and height. The method is capable of providing meaningful quantitative data for clayey sediments. However, when used for sediment types other than clays the interpretation of the data becomes much more qualitative.

Temperature Measurements

To study the thermal gradient and heat flow in a passive margin setting, *in-situ* downhole temperature and thermal conductivity measurements were obtained at Site 397 with a self-contained downhole temperature instrument designed by A. J. Erickson. The results of the four measurements are briefly discussed in the Site Chapter. For a more detailed discussion of the procedure and interpretation of thermal measurements in DSDP holes, see Erickson et al. (1975). Unfortunately, it was not possible to make downhole logging of the two single-bit holes.

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