2. EXPLANATORY NOTES

RESPONSIBILITIES FOR AUTHORSHIP

This Initial Report volume is divided into three parts. The first part consists of the various site summaries which, although largely founded upon the work accomplished aboard *Glomar Challenger* during Leg 26, incorporate additional information produced by shore studies following completion of the shipboard work. The second part consists of more detailed discussions of various aspects of the rocks recovered from several or all of the sites occupied during the cruise. The final part of the volume is a summary of the results of Leg 26, putting these results into the broader context of the results of drilling elsewhere in the Indian Ocean.

The authorship of the site summary chapters (Chapters 3-11) is shared collectively by the shipboard scientific party, the ultimate responsibility lying with the two co-chief scientists. Each chapter of Part I follows the same general outline. Sections on background and operations were prepared by T. A. Davies and B. P. Luyendyk; sections on lithology were prepared by G. J. Horvath, D. R. C. Kempe, R. D. Leidy, B. C. McKelvey, and K. S. Rodolfo; sections on physical properties by R. D. Hyndman; sections on the correlation of seismic results with drilling results by B. P. Luyendyk; sections on paleontology and sedimentation rates by E. Boltovskoy, P. Doyle, R. Herb, and H. R. Thierstein; the discussion sections were prepared by T. A. Davies and B. P. Luyendyk in consultation with the other members of the shipboard group. In some chapters specific additional authorship is cited by name. In these cases the contributions of the individually cited colleagues were substantial and warrant more than a simple acknowledgment.

Authorship of the chapters in Parts II and III (Chapters 12-37) is cited by chapter. In general these chapters are more speculative than those of Part I and should be considered interpretations based on information available at the time this Initial Report was submitted for publication. Nevertheless, each chapter from Parts II and III has been subjected to rigorous review by one or more of our colleagues. In many cases the contributions of the reviewers have been substantial and are recognized appropriately in the chapters. In other cases the reviewers are recognized in the collective acknowledgments to this whole volume.

SURVEY DATA

Probably due to the combined facts that the southern Indian Ocean is a remote region and that the weather in this region is particularly disagreeable for significant portions of the year, very little geophysical data were available for scrutiny during planning for Leg 26. No presite surveys were available, and all of our sites were selected on the basis of single geophysical traverses. Geophysical data were obtained from Lamont-Doherty Geological Observatory and the Scripps Institution of Oceanography. Reference data were used as follows: Site 252, R/V *Vema* Cruise 24 and R/V *Conrad* Cruise 14; Site 253, R/V *Argo* CIRCE Expedition, Leg 5; Site 254, R/V *Eltanin* Cruise 48; Site 255, R/V *Conrad* Cruise 11; Site 256, R/V *Conrad* Cruise 9; Site 257, R/V *Conrad* Cruise 11; Site 258, R/V *Conrad* Cruise 8. We had originally planned to drill Sites 248 and 249 off southeast Africa which were drilled instead by Leg 25 due to a last-minute change in program by the Indian Ocean Panel. We therefore selected two other sites in the western basin, Sites 250 and 251. Site 250 was referenced by R/V *Conrad* Cruise 14 data. However, no reference data were on hand aboard ship at the time it was decided to drill Site 251. Site 251 was selected blind on the basis of written recommendations in the preliminary planning notes for Leg 25.

Pre- and postsite surveys were completed by *Glomar Challenger* at several sites (see Chapter 12 for instrumental methods). Presite surveying was conducted at Sites 251 and 255; postsite survey work at Sites 250, 253, and 258. Details of all *Glomar Challenger* surveys are discussed in the Background sections of the site reports.

In addition to pre- and postsite survey work, geophysical data were gathered while steaming to and from sites. These data include precision echo sounding, seismic reflection profiling (airgun), and magnetic profiling. The data and some preliminary observations concerning them are presented in Chapter 12.

BASIS FOR NUMBERING SITES, HOLES, CORES, AND SECTIONS

A site number refers to a single hole or group of holes drilled in essentially the same position using the same acoustic beacon. The first hole at a site (for example, Site 250) was given the number of the site (for example, Hole 250). Second holes drilled by withdrawing from the first hole and redrilling were labeled "A" holes (Hole 250A). Any additional holes drilled under comparable conditions are given succeeding letters, e.g., B, C, etc.

A core was usually taken by dropping a core barrel down the drill string, and coring for 9 meters as measured by lowering of the drill string before recovery. The sediment was retained in a plastic liner 9.28 meters long inside the core barrel and in a 0.20-meter-long core-catcher assembly below the liner. The liner was not normally full.

On recovery, the liner was cut into sections of 1.5 meters measured from the lowest point of sediment within the liner (Figure 1).

In general, the top of the core did not coincide with the top of a section. The sections were labeled from 1 for the top (incomplete) section to a figure as high as 6 for

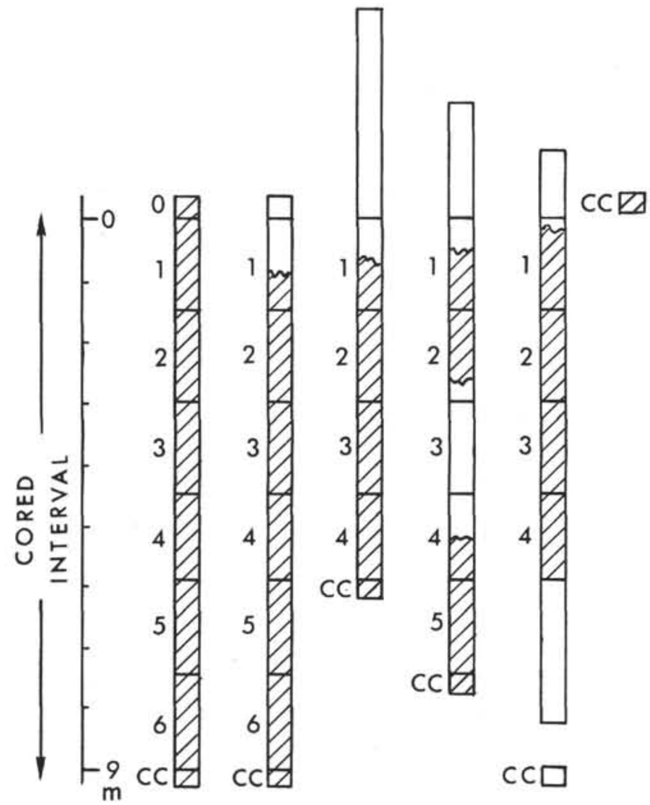

Figure 1. *Method of labeling sections of cores when recovery is complete, incomplete, and divided. The cores have been lined up so that the top of Section 1 is always coincident with the top of the cored interval, according to the method of calculating down-hole depth of samples. Core-catcher samples are always considered to have come from the bottom of the recovered material.*

the bottom (complete) section, depending on the total length of core recovered.

In the event there were gaps in the core resulting in empty sections, these were still given numbers in sequence. In illustrations the core-catcher samples are always considered to come from the bottom of the recovered material, although in interpretation they are often assumed to represent the base of the cored interval.

On occasions, over 9 meters of core were recovered. The small remainder was labeled Section 0 (zero), being above Section 1. On other occasions the sum of the lengths of numbered sections exceeds the total length of core recovered and also the cored interval, resulting in an overlap of nominal depth downhole of the bottom of one core and the top of the core below. In such cases a special note has been made.

In some holes it was found desirable to drill with high water circulation but with a core barrel in place in order to penetrate faster. The drilled interval was often considerably greater than the 9 meters of the core barrel, the principle being that the high water circulation prevented sediments from being recovered. However, some of the harder layers were probably recovered during this procedure. It was difficult, therefore, to assign the correct depth in the hole to these sediments and each case had to be considered on its merits.

All samples taken from cores, before being processed, were numbered according to the system described in the Shipboard Handbook for Leg 26. The label "26-250-3-2, 25 cm" thus refers to Leg 26, Hole 250, Core 3, Section 2, sampled at 25 cm from the top of that section. The label "26-250-3, CC" refers to the core-catcher sample at the base of Core 3.

It is appreciated that with this labeling system, the top of the core material recovered may be located at say, 1.3 meters below the top of Section 1 and the bottom will be at 1.5 meters in, say, Section 2 (if the total recovery is 1.7 m). In relating this to downhole depths, there is an arbitrariness of several meters. However, it is impossible to assess where exactly in the hole the sample came from. Sometimes the core barrel will jam up with a hard sediment after sampling a few meters; this will then really represent the first few meters penetrated. At other times the circulation of water may wash away the upper softer part of a core and recovery will represent the lower part. Separated lengths of core in a core liner may come from the drill bit being lifted away from the bottom of the hole during coring in rough sea conditions. Similarly, there is no guarantee that the core-catcher sample represents the material at the base of the cored interval.

The labeling of samples is therefore rigorously tied to the position of the samples within a section as the position appears when the section is first cut open and as logged in the visual core description sheets. The section labeling system implies that the top of the core is within 1.5 meters of the top of the cored interval. Thus, the downhole depth of "26-250-3-2, 25 cm" is calculated as follows. The top of the cored interval of Core 3 is 55.5 meters. The top of Section 2 is 1.5 meters below the top of the cored interval, that is, at 57.0 meters. The sample is 25 cm below the top of Section 2, that is, 57.25 meters.

For the purposes of presenting the data for the entire hole in the hole summary sheets, where 1 meter is represented by less than 1 mm, the top of the recovered sediment is always drawn at the top of the cored interval. The error involved in this presentation is always less than 1.5 meters compared with depths calculated from the sample label.

Finally, in referring to cores, sections, and samples in the text of this Initial Report, the leg designation is usually omitted. Also, the hole designation is frequently omitted when it is obvious from which hole the referenced sample was taken.

HANDLING OF CORES

The first assessment and age determination of the core material was rapidly made on samples from the core catcher. After a core section had been cut, sealed, and labeled, it was brought into the core laboratory for processing. The core section was first weighed for mean bulk density measurement. Then GRAPE (gamma ray attenuation porosity evaluation) analysis was made for detailed bulk density determination.

After the physical measurements were made, the core liner was cut on a jig using Exacto-type blades, and the end caps cut by knife. The core was then split into halves with a cheese cutter, if the sediment was a soft ooze. At times, when compacted or partially lithified sediments were included, the core had to be split by a machine bandsaw or diamond wheel.

One of the split halves was designated a working half. Sonic velocity determinations using a Hamilton Frame were made on pieces from this half. Samples, including those for grain size, X-ray mineralogy, interstitial water chemistry, and total carbonate content, were taken, labeled, and sealed. Larger samples were taken from suitable cores for organic geochemical analysis.

The working half was then sent to the Paleontology Laboratory. There, samples for shipboard and shore-based studies of nannoplankton, foraminifera, and radiolarians were taken. The other half of a split section was designated an archive half. The cut surface was smoothed with a spatula to bring out more clearly the sedimentary features. The color, texture, structure, and composition of the various lithologic units within a section were described on standard visual core description sheets (one per section) and any unusual features noted. A smear slide was made, usually at 75 cm if the core was uniform. Otherwise, two or more smear slides were made, each for a sediment of distinct lithology. The smear slides were examined microscopically. The archive half of the core section was then photographed. Both halves were sent to cold storage onboard after they had been processed.

Material obtained from core catchers—and not used up in the initial examination—was retained for subsequent work in freezer boxes. Sometimes significant pebbles from the core were extracted and stored separately in labeled containers. On other occasions, the liners would contain only sediment-laden water. This was usually collected in a bucket and allowed to settle, the residue being stored in freezer boxes.

At several sites, hard cores were obtained either of basement or indurated sediment. Each separate core fragment was numbered and labeled consecutively from the top downwards and its orientation indicated by an upward-pointing arrow. Where possible, the fragments were arranged into their original relative orientation, and a few were then sliced longitudinally for examination.

All samples are now deposited in cold storage at the DSDP West Coast Repository at the Scripps Institution of Oceanography, La Jolla, California. These samples may be obtained for further study.

BASIS FOR AGE DETERMINATION

Foraminifera

In the site reports biostratigraphic information is given in three different places: in the Paleontology section, in the core summary sheets, and in the summarized stratigraphic sections (summary and conclusions). Specialized chapters on Neogene and Cretaceous planktonic foraminifera are included in Part II of this volume. The text of the paleontology section in the site reports is therefore generally restricted to information of a more general character, essential for the age determination and for the paleoecologic interpretation. More detailed data are included in those cases where no respective specialized chapter follows in Part II, particularly data concerning some benthonic foraminifera from the sites on Ninetyeast Ridge and Broken Ridge.

In the case of both planktonic foraminifera and nannoplankton, attempts were made to give a correlation with standard biozones. However, planktonic foraminiferal zonations, such as published by Bolli (1966) or Blow (1969), are generally defined in tropical areas. Since all sites of Leg 26 are located in extratropical areas of the southern hemisphere (subtropical, temperate, or cool), the correlation with standard planktonic foraminiferal zones must in many cases remain uncertain, due to the absence of many index species. Consequently, in the stratigraphic sections, many zonal boundaries are indicated with dashed lines or a correlation with an interval of more than one zone had to be indicated.

In the Oligocene-Recent interval the numerical zonal scheme proposed by Blow is used, since its application for nontropical areas may, for the time being, be easier than Bolli's zonation which uses fossil names for designating zones. The latter zonation, however, was used in the Eocene, in which interval Blow's zonation is not satisfactory.

General descriptive terms were used in those cases where no correlation with planktonic zones could be attempted due to the nonpelagic shallow-water character of the assemblages (lower part of the Tertiary at Sites 253, 254, and 255) or due to a paleoclimatically restricted diversity (Cretaceous of the eastern sites).

Regarding abundance and preservation of the fossil assemblages the following abbreviations were used in the core summary sheets:

Abundance:
- A = abundant
- C = common
- F = few
- B = barren

Preservation:
- R = rare
- G = good
- M = medium
- P = poor

Dissolution Effects (where occurring):
- 0 = not affected
- 1 = slightly affected
- 2 = strongly affected
- 3 = partially destroyed
- 4 = totally destroyed

Calcareous Nannoplankton

Data regarding the calcareous nannofossils in the sediments recovered during DSDP Leg 26 are found in different places within this volume. Information concerning the zonation, preservation, taxonomy, and the stratigraphic distribution of species is found in Chapter 28. The extent and correlation of nannofossil zones with foraminiferal zones and with the lithology of the sediments are given in the lithologic and biostratigraphic summary sheets included in each site report (Chapters 3-11). All sediment samples examined for nannofossils are listed in the appropriate positions in the detailed core summary sheets included in each site report (Chapters 3-11) using one or more letters to indicate the abundance and preservation of the respective assemblage, as explained below. The stratigraphic positions of the assemblages studied are indicated in these core descriptions by the zonal numbers as proposed in the "Standard Cenozoic Calcareous Nannoplankton Zonation" by Martini (1970, 1971) and Martini and Worsley (1970).

Biostratigraphy

The numbered Cenozoic calcareous nannofossil standard zonation (Martini, 1970, 1971; Martini and Worsley, 1970) is used in the site reports (Chapters 3 to 11) and is explained, together with the Mesozoic zonation, in Chapter 28.

Abundance and Preservation

The following abbreviations are used in the site reports (Chapters 3-11) and in the range charts (Tables 1-8, Chapter 28):

Abundance of nannofossil assemblages:

A = abundant (more than 1 specimen per field of view)
C = common (1 specimen per 1-3 fields of view)
F = few (total of 4-20 specimens found)
R = rare (total of 1-3 specimens found)
B = barren (of nannofossils)

These indications have only relative value since some of the samples with scarce nannofossils have been centrifuged (Sites 253, 254, and 255).

Preservation of nannofossil assemblages:

G = good (only minor signs of overgrowth or etching observed in the light microscope, no difficulties in species identification)
M = moderate (definite signs of overgrowth or etching, rendered species identification more difficult)
P = poor (delicate species dissolved, strong signs of etching, or of overgrowth, which prevents identification of related species, e.g., discoasters)
E = etched
O = overgrown

The preservation scale used here is similar to the one used in Roth and Thierstein (1972) and Roth (1973) with the exception of the numbers 1, 2, and 3 being replaced by the letters G, M, P.

LITHOLOGIC NOMENCLATURE AND SYMBOLS

The sediment classification scheme used during Leg 26 is based on a series of premises, the most important ones being:

1) It has to be mainly descriptive.

2) The proper sediment name should be determinable with the aid of a petrographic microscope.

3) It should be possible to indicate all major and minor constituents of the sediment in the sediment name.

4) Quantitative class limits should be used.

5) As much as possible, adopted terms should be in common use.

As can be seen from these premises, the emphasis is on practicality.

Classification of Biogenic Sediments

Sediment names are obtained from percentage estimates in smear slides. Admittedly, such estimates vary greatly between individuals, but they are a big improvement over vague terms like "abundant," "common," and "rare." Difficulties are encountered when dealing with sediments containing constituents of greatly different size classes. A good example is a sediment consisting of a mixture of foraminifera and nannofossils. Almost certainly, the nannofossil percentage will tend to be estimated too high.

Percentage limits used in determining the sediment name are 2, 10, and 25. Major constituents present in quantities over 25% provide the sediment name. In order of decreasing abundance, the names of these major constituents are listed progressively further to the left. Minor constituents are those present in quantities under 25%. Their names are added to the sediment name with a suffix, rich for constituents present in percentages between 10% and 25%; bearing for those with percentages between 2% and 10%. They again are listed from right to left in order of decreasing abundance. Constituents present in amounts smaller than 2% may be added with the suffix trace.

Terrigenous and authigenic constituents can be present in biogenic sediments. As long as they do not constitute major components, their names are added in the same way as the biogenic components. For unconsolidated biogenic sediments, the term ooze is added as a suffix to the name. For indurated biogenic sediments, the common terms chalk and limestone are used.

Example: Given an unconsolidated sediment consisting of 35% foraminifera, 30% nannofossils, 20% clay, 8% zeolites, and 7% volcanic glass shards. The name of this sediment would be "glass shard and zeolite-bearing clay-rich nannofossil foraminiferal ooze."

This example highlights a difficulty of which readers should be aware. The total percentage numbers have, of course, to add up to 100. In practice, minor and trace constituent estimates are rounded off to make the total for all constituents 100. Percentage figures like 8 and 7, do not, of course, indicate that estimates can be made within a 1% accuracy. An accuracy of 5% is already considered to be very good.

Abbreviations of names are occasionally employed, for convenience sake. The most common are "foram" for foraminifera, "nanno" for nannoplankton or nannofossil, and "rad" for radiolarians.

Classification of Clastic Sediments

A classification of clastic sediments presents more problems and is likely to provoke more discussion than one for biogenic sediments. But again, practicability has been the underlying principle.

When detrital grains are the only constituents, the sediment is given a simple grain-size name. Detrital in this scheme means clastic grains derived from the erosion of preexisting rocks, except for those of fossil or authigenic origin. Grain-size classes and percentages are again measured and estimated from smear slides. The Wentworth Scale is used for the size-class boundaries, and Shepard's (1954) sand-silt-clay triangle is used to derive textural terms. Percentage limits in this triangle are 20, 50, and 75. When gravel is present, a gravel term may be used as a prefix or suffix. Gravel is used as the only name, when the sediment consists of over 80% gravel. Gravel is used as a suffix for percentages between 30 and 80, while the prefixes gravelly and slightly gravelly are used for percentages between 5 and 30, and below 5, respectively.

When the clastic components are redeposited fossils or fossil fragments, they are also given a grain-size name, like the detrital sediments. However, this name is preceded by the appropriate fossil constituent names, in a fashion similar to that used for the biogenic sediment classification.

It can happen that a sediment consists of a mixture of equal amounts of detrital grains and clastic fossil grains, both of similar size. In that case, the same grain term would have to appear twice at the end of the name. This difficulty can be overcome by adding the prefix detrital. For example, a sediment consisting of equal amounts of reworked foraminiferal tests and detrital grains, both of silt size, would have to be called a "foraminiferal silt silt." In this case, the name becomes "foraminiferal detrital silt."

A sediment can also consist of a mixture of detrital grains and nonreworked (nonclastic) fossil tests. When the detrital grains are a major component, the size term is determined from the textural triangle. The fossil component will not receive a size term, but will be named as in the biogenic sediment classification. A hyphen is placed between the nonclastic and clastic terms.

Example: Given a sediment consisting of 40% nonreworked foraminifera, 20% detrital silt, and 40% clay. The recalculated detrital percentages are 33 and 67. The sediment name will be foraminifera-silty clay.

Classification of Sediments with Volcanic or Authigenic Constituents

For fragmental volcanic constituents, the common particle size classification: volcanic breccia (particles larger than 32 mm), volcanic lapilli (between 32 and 4 mm), and volcanic ash (smaller than 4 mm) has been adopted.

Authigenic constituents are treated in the same way as nonclastic biogenic constituents. An example (zeolite) is already given in the section on the biogenic sediment classification. However, when authigenic constituents are clearly reworked, they are treated in the same way as reworked fossil tests.

A special case is minerals composed of calcium carbonate. During Leg 26, in certain cores, abundant carbonate particles were observed which received the shipboard term micarb. They are generally too small to be determined under an ordinary microscope. Some may be authigenic, others may be fossil debris. It is only with the aid of a scanning electron microscope that such particles can be analyzed. Even then, an estimate of their relative abundance is extremely difficult. The term micarb has, therefore, been retained in the core descriptions for all carbonate particles of unknown origin.

Symbols

The lithologic symbols used in the core and hole summaries of Leg 26 are reproduced in Figure 2.

Comples lithologies have been represented on the core summary forms using a vertical striping system. To do this, the constituents are divided into the following percentage classes: 0-2, 2-10, 10-25, 25-50, 50-75, and 75-100. The lithologic column is subdivided into 5 subcolumns, their boundaries being the midpoints of the percentage classes (Figure 3). Percentages under 10% cannot be represented this way. For constituents between 2% and 10%, a letter or other symbol can be sparsely overprinted on the main symbols. Constituents under 2% are ignored in the lithology columns. They are, however, mentioned in the text, in the smear slide compositions.

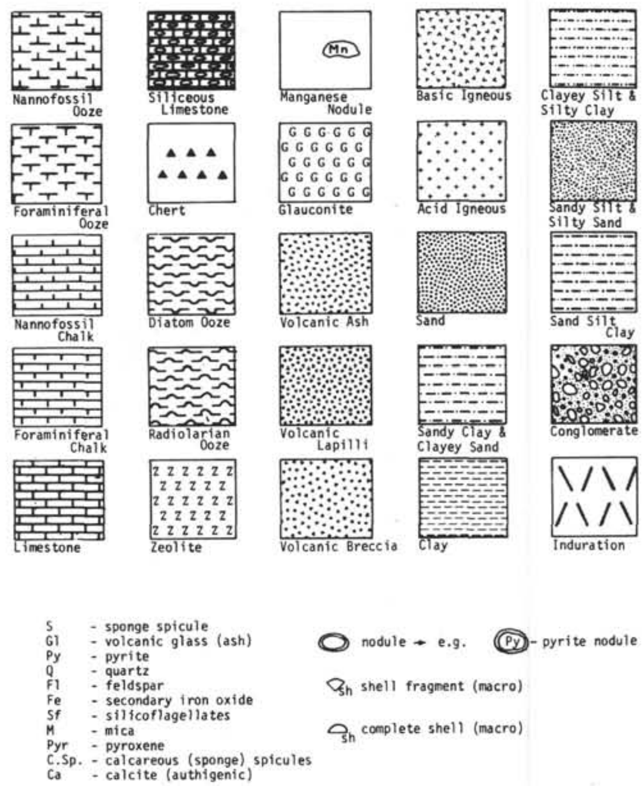

Figure 2. *Standard symbols used to illustrate lithology.*

GRAIN SIZE ANALYSES

Grain size distribution was determined by standard sieving and pipette analysis. The sediment sample was dried, then dispersed in a Calgon solution. If the sediment failed to disaggregate in Calgon, it was dispersed in hydrogen peroxide. The sand-sized fraction was separated by a 62.5μ sieve with the fines being processed by standard pipette analysis following Stokes settling velocity equation (Krumbein and Pettijohn, 1938, p. 95-96), which is discussed in detail in Volume 9

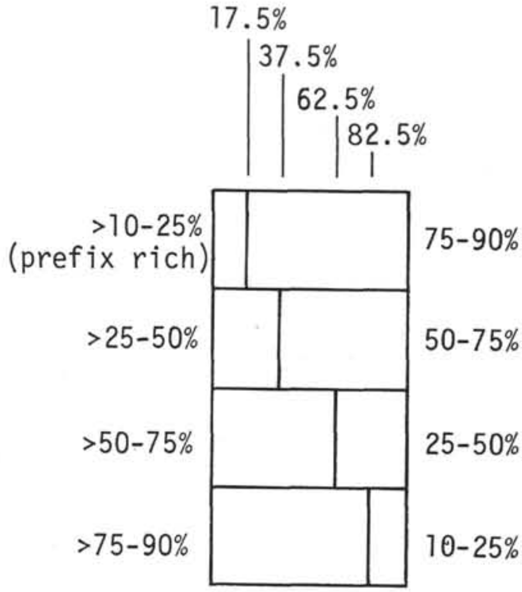

Figure 3. *Vertical bar width representation of class limits.*

of the Initial Reports of the Deep Sea Drilling Project. Step-by-step procedures are in Volume 5. In general, the sand-, silt-, and clay-sized fractions are reproducible within ±2.5% (absolute) with multiple operators over a long period of time. A discussion of this precision is in Volume 9.

CARBON AND CARBONATE ANALYSES

The carbon-carbonate data were determined by a Leco induction furnace combined with a Leco acid-base semiautomatic carbon determinator. Normally, the more precise seventy-second analyzer is used in place of the semiautomatic carbon determinator, but it was not used for these samples because of malfunctions.

The sample was burned at 1600°C, and the liberated gas of carbon dioxide and oxygen was volumetrically measured in a solution of dilute sulfuric acid and methyl red. This gas was then passed through a potassium hydroxide solution, which preferentially absorbs carbon dioxide, and the volume of the gas was measured a second time. The volume of carbon dioxide gas is the difference between the two volumetric measurements. Corrections were made to standard temperature and pressure. Step-by-step procedures are in Volume 4 of the Initial Reports of the Deep Sea Drilling Project and a discussion of the method, calibration, and precision are in Volume 9.

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

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

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 our determinations, all carbonate is assumed to be calcium carbonate.

Precision of the determination is as follows:

Total carbon (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 10-100%)	= ±3% absolute
(within 0-10%)	= ±1% absolute

X-RAY METHODS

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

Treatment of the raw samples was: washing to remove seawater salts, grinding to less than 10μ under butanol, and expansion of montmorillonite with trihexylamine acetate. The sediments were X-rayed as randomized powders. A more complete account of the methods used at Riverside can be found in Appendix III of Volume 4 of the Initial Reports.

The data are tabulated in appendices to the site reports (Chapters 3-11). Columns 1 and 2 contain the core numbers and the depths of the cored intervals (in meters below the mudline). Column 3 gives the depths of single samples. Column 4 contains the percentage of the diffuse scattered X-rays. The amorphous scattering percentage in column 5 is derived from the data of column 4 by a simple conversion based on the ratio of Bragg and diffuse scattering in pure quartz. It is a measure of the proportion of crystalline and amorphous materials in the sample. The remaining columns contain crystalline mineral percentages computed by the method of mutual standards using peak heights.

MEASUREMENT OF PHYSICAL PROPERTIES

The physical properties measured on Leg 26 were bulk density, water content, porosity, sonic velocity, and thermal conductivity. Densities and porosities were determined from the total weight and volume of each core section, by the syringe technique involving weighing and oven drying 0.5-1.0 cm^3 of sediment, and by the gamma ray attenuation (GRAPE) method. The section weight method gives values that are of poor reliability being generally too low, because of incomplete filling of the liner and mixing and disturbance of the sediment. Even well-preserved cores have a thick layer slurry between the core and liner so the densities determined in this way are a lower limit. Densities by the syringe method have less bias, but the amount of material is so small that the results are of low accuracy (Bennett and Keller, 1973, have given a critical discussion of these methods).

The GRAPE technique utilizes the attenuation of gamma ray intensity in a beam passing through a sediment sample. For the 0.30-0.36 Mev Barium^{133} source, Compton electron scattering is the dominant attenuation process. The attenuation thus depends on the electron density in the material, which in turn is approximately proportional to the bulk density for common geological materials (e.g., calcite, quartz, dolomite, and some clays). Aluminum cylinders of different diameters are used for calibration.

A shore-based program is used to correct for variations in electron densities of different core materials, particularly for the seawater component. The method is described by Evans (1965), Harms and Choquette (1965), and, as used on *Glomar Challenger*, by Boyce (1973, 1974). Cores are passed continuously through the gamma beam on a carriage so that a nearly continuous profile of counts per unit time is obtained. The data are averaged over 3-cm-long core length intervals. Cores with significant gaps or voids give an irregular trace. The envelope of the maximum values gives the best estimate of in situ density.

GRAPE densities are computed for 150 points along each core section or every centimeter. These data include many low density points associated with voids, breaks, or disturbances in the core. In order to obtain estimates of the average in situ density in the sea floor these points must be removed. An example is shown in Figure 4. Particularly at the ends of the core sections there are points of apparent low density that represent simply unfilled core liner. We have used a simple truncation procedure to eliminate the spurious points. The procedure must be simple and universally applicable since the large amount of data precludes subjective evaluation.

The program starts by computing the average of the 150 densities in a core section. It then truncates or removes all points that are outside prescribed limits above and below this average (a "window"). Out limits are +10% and ⁻5%. The smaller lower limit is an attempt to compensate for the bias toward too low densities (gaps and voids) rather than too high densities. The remaining points are averaged again. If the new average differs from the first by more than a prescribed factor (we are using 0.5%), a second truncation with the same window is applied and so on until a stable average is reached. Two iterations are usually sufficient. If more than 20% of the data points have been truncated for the final average, we consider the section average to be unreliable and the value is not plotted.

Estimates of average density for each core are presented in this volume. The complete data are available from Deep Sea Drilling Project. The cores giving irregular GRAPE traces probably have many gaps or voids and the computed densities have not been presented. Unfortunately, some data on cores with real, large density variations also are discarded.

Sonic (acoustic, seismic) velocities on cores are needed for the interpretation of seismic reflection and refraction data, particularly for converting seismic reflection times to depths in the sedimentary column. Acoustic impedance, given by the product of the sonic velocity and bulk density, is closely related to reflection coefficients. Thus, rapid changes in acoustic impedance may be associated with seismic reflectors. The velocities were measured by determining the time delay of a high-frequency pulse transmitted through sediment or rock samples using a Hamilton Frame (Hamilton, 1965; Cernock, 1970). The resolution is better than 0.01 km/sec and accuracy about ±0.02. Velocity was measured on at least one sample from each core. In the unconsolidated uppermost cores measurements were measured through the split core and liner, a correction being made for the thickness and travel time of the liner (0.295 cm and 1.36 μsec for the liner used on this leg).

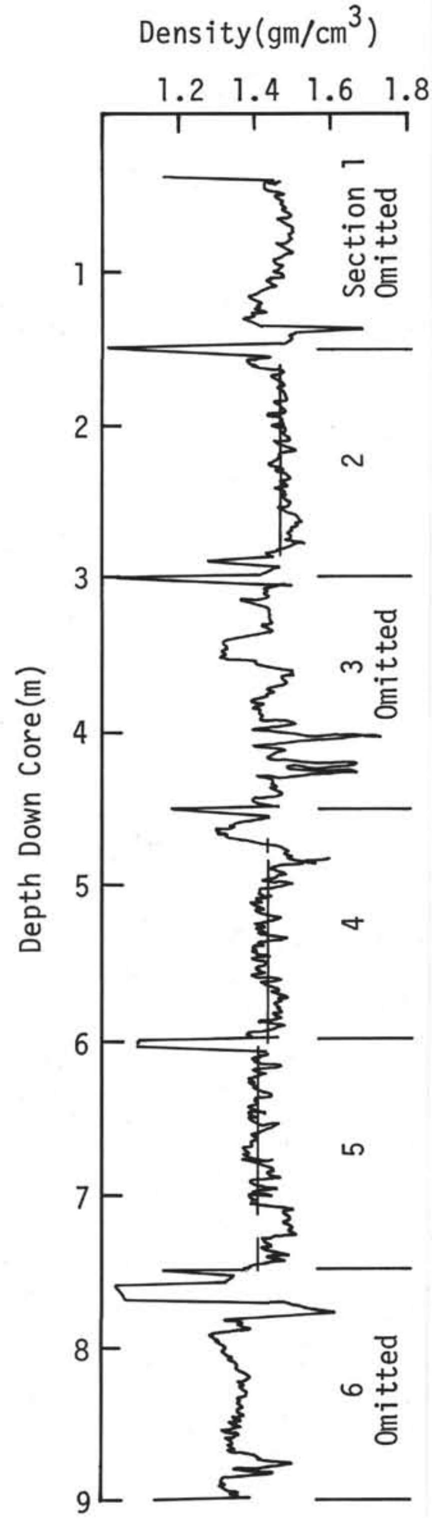

Figure 4. *Example of truncated average densities (Site 68, Core 2).*

Variations in liner thickness were monitored but did not change significantly. Semiconsolidated sediments were measured in and out of the liner. There was a negligible difference in the velocities obtained by the two methods (less than 0.02 km/sec). Velocities of consolidate sediments were measured both parallel (horizontal) and perpendicular to the bedding (vertical). There is significant anisotropy, the parallel velocity usually being higher.

The sonic velocities were all measured at room temperature (20° to 25°C) and 1 atm pressure. The in situ temperatures range from 0° to 35°C with most below 10° and pressures between 0.3 and 0.6 kbar. The data of Schreiber et al. (1972) suggest that the velocities will be 5% to 10% higher at 0.5 kbar. Wilson (1960) finds an increase in velocity for seawater of 5.4% from 1 bar to 0.5 kbar and a decrease of 5.1% from 20° to 0°. Thus, the effects of temperature and pressure approximately cancel for seawater. The effects are likely similar for unconsolidated sediments.

Velocities of basalt cores were determined by cutting and rough polishing parallel faces on each sample. Glycerine was used to make contact with the transducers. The samples had been shelf dried for up to 3 days but were briefly soaked in seawater before measurement. Thus the values may be slightly too low because of incomplete saturation (Christensen, 1973). One atm velocities are generally 0.2 to 0.3 km/sec lower than for 0.5 kbar, so this amount must be added to the shipboard values to obtain estimates of in situ velocities. These results are discussed in the later section on basalt velocities.

Thermal conductivity is an important physical property of sediments. Its relationship to composition, other physical properties, and depth is needed to facilitate conductivity estimates required for the downward extrapolation of temperatures from near-surface heat-flow measurements. Conductivities are required to be combined with downhole temperatures for geothermal heat flux (see section on geothermal measurements). The thermal conductivity was measured at least once on each core of the unconsolidated sediments using the needle probe technique (Von Herzen and Maxwell, 1959) described in detail in Chapter 13.

DATA PRESENTATION

As much of the primary data as possible concerning each site are presented in the site summary chapters (Chapters 3-11). The sections of each site chapter, in general, have the following sequence:

- Background and Objectives
- Operations and List of Cores Cut
- Lithology
- Shipboard Geochemical Measurements
- Physical Properties
- Correlation of Seismic Reflection Profile with Drilling Results
- Paleontology
- Sedimentation Rates
- Summary and Conclusions
- References
- Appendices
  - Grain Size Determinations
  - Carbon-Carbonate Determinations
  - X-Ray Analyses

At the end of each site chapter are graphical summaries of each core showing the age, lithology, composition, and positions of samples and smear slides, followed by photographs of the cores and a graphical summary, at a scale of 200 meters per page, of the overall results of drilling at the site.

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