2. EXPLANATORY NOTES

The Shipboard Scientific Party[1]

RESPONSIBILITIES FOR AUTHORSHIP

This volume is divided into eight parts. The first part is the introductory material and the second part consists of site summaries which include the additional information produced by shore studies along with work done onboard ship. The next five parts (III-VII) consist of topical papers discussing specific aspects of Leg 34; these papers are by shipboard scientists and by other scientists receiving samples from Leg 34. Part VIII is a summary of the results of Leg 34, integrating them into our overall understanding of the oceanic crust in general and the Nazca plate in particular.

Authorship of the site summary chapters (Chapters 3-5) is shared by the shipboard scientific party plus contributions by G. Blechschmidt. Each chapter of Part II follows the same general outline. Sections on background and operations were prepared by R. Yeats and S. Hart; sections on lithology by W. Benson, H. Sachs, and T. Vallier for sediments and M. Bass for basalts; sections on physical properties and correlation of drilling results with seismic profiling by M. Salisbury; section on geochemistry by R. Hart and D. Cameron; sections on paleomagnetism and petrology of opaque minerals by J. Ade-Hall; sections on paleontology and sedimentation rates by P. Quilty, G. Blechschmidt, and H. Sachs; and the discussion and summary sections by R. Yeats (sediments, structure) and S. Hart (basement rocks) in consultation with other members of the shipboard group.

Authorship of chapters in the other parts (Parts III-VIII) is cited by chapter. These are topical studies dealing with one or more of the sites and, in many cases, involving other, related work not done as part of DSDP. In general, these chapters are more interpretative than those in Parts I and II.

NUMBERING OF SITES, HOLES, CORES, SAMPLES

Drill site numbers run consecutively from the first site drilled by *Glomar Challenger* in 1968. The site number is unique; thus, use of a leg number is optional. A site refers to the hole or holes drilled from 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 (for example, Holes 319 and 319A of Site 319). For purposes of compiling the stratigraphy, the lithologic columns for each hole at a Leg 34 site are assumed to be similar or identical. In other areas this has not always proved to be the case, as there can sometimes be large lateral variations in the thickness of stratigraphic units.

Holes drilled at a site take the site number and are 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. 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.

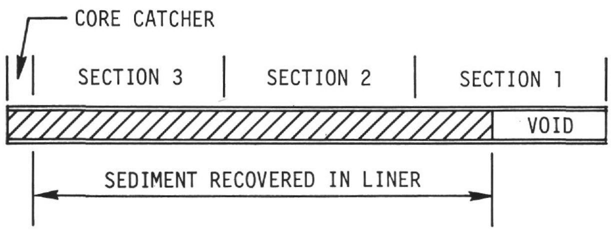
Cores are numbered sequentially from the top down. In the ideal situation, they consist of 9 meters of sediment or rock in a plastic liner of 6.6 cm diameter. In addition, a short sample (as much as 20 cm) is obtained from the core catcher (a multifingered device at the bottom of the core barrel which prevents cored materials from sliding out during core barrel recovery) and sometimes, if sediment completely fills the core liner, a "zero section" may result that can be up to 30 cm in length. It is the sample from each core that represents the lowest stratum recovered in the particular cored interval. The core-catcher sample is designated by CC (e.g., 319A-4, CC = core catcher sample of the fourth core taken in the second hole at Site 319).

The cored interval is the interval in meters below the sea floor, measured from the point at which coring for a particular core was begun 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 sediments, 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 hard rocks, a center bit, which fills the opening in the bit face, can replace the core barrel if drilling ahead without coring is desired.

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-m core and 9.5-m cored interval is discussed below.) Generally, something less than 9 meters is recovered. If this occurs, 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 below. Therefore, recovery of 3.6

[1]Robert S. Yeats, Ohio University, Athens, Ohio (Co-Chief Scientist); Stanley R. Hart, Carnegie Institution of Washington, Washington, D.C. (Co-Chief Scientist); James M. Ade-Hall, Dalhousie University, Halifax, Nova Scotia; Manuel N. Bass, Carnegie Institution of Washington, Washington, D.C.; William E. Benson, National Science Foundation, Washington, D.C.; Roger A. Hart, Physical Research Laboratory, Ahmedabad, India; Patrick G. Quilty, West Australian Petroleum Party Ltd., Perth, West Australia, Harvey M. Sachs, Case Western Reserve University, Cleveland, Ohio; Matthew H. Salisbury, National Science Foundation, Washington, D.C.; T.L. Vallier, University of California at San Diego, La Jolla, California.

meters of sediment would result in a core with three sections and 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 recovered material is placed in the top of the cored interval, with the top of Section 1, rather than the top of the sediment, equal to the top of the cored interval. This is shown below for the core in the above example.



Thus, the depth below the sea floor of the top of the sediment of this hypothetical core would lie at 150.9 meters (not 150.0 m) and the bottom at 154.5 meters (the core-catcher sample is regarded as being dimensionless).

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 six 1.5-meter sections, measured from the bottom of the liner, and the extra 0.28-meter section at the top is designated Section 0, or the "zero section." The zero section is ignored in calculations of depth below the sea floor of cores or levels within cores.

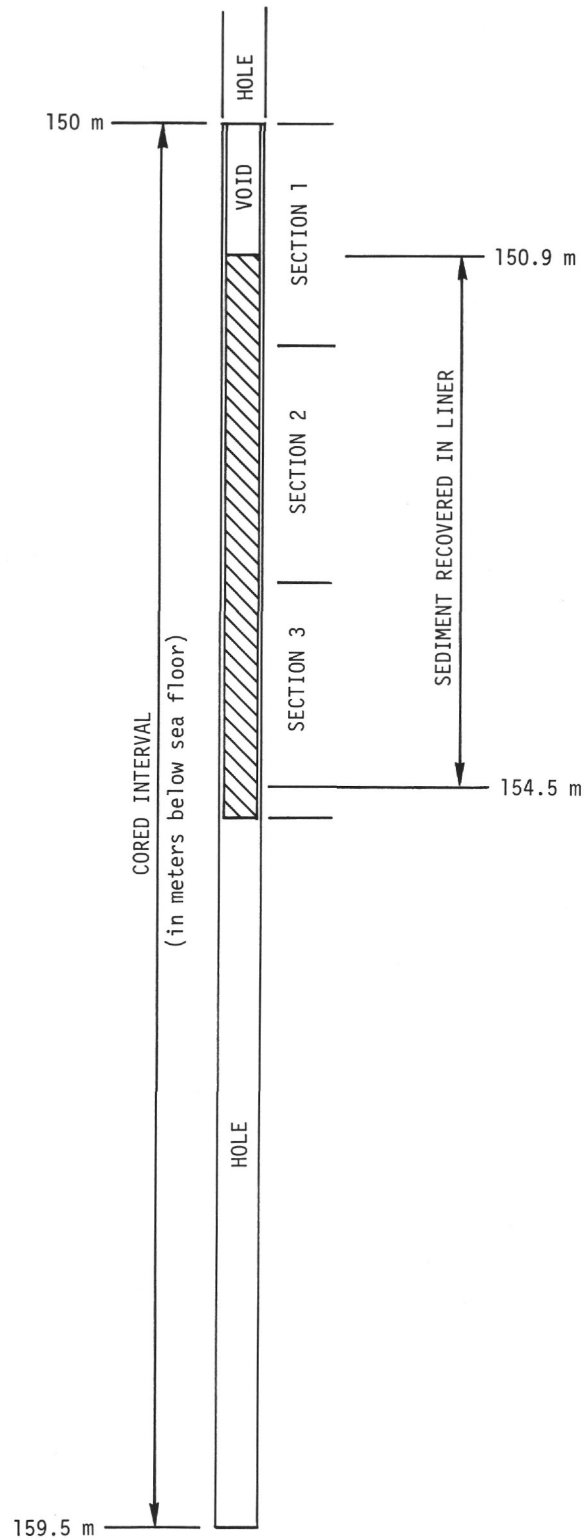
In the core laboratory on *Glomar Challenger*, after some steps of routine processing, the 1.5-meter sections of sediment core and liner are split in half lengthwise. One half is designated the "archive" half, which is described by the shipboard geologists and photographed, and the other is the "working" half, which is sampled by the shipboard sedimentologists and paleontologists for further shipboard and shore-based analysis.

Basalts were not split in this manner. Rather, 2.5-cm-diameter minicores were taken using a drill press and a small diamond-impregnated coring bit. The minicores were subsequently divided for specific sampling needs. For additional details with regard to the shipboard handling of basalt, contact the Curator, Deep Sea Drilling Project.

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; sample size, in cc, 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

319A-4-3, 122-124 cm (10 cc) designates a 10-cc sediment sample taken from Section 3 of Core 4 of the second hole drilled at Site 319. The depth below the sea floor for this sample would then be the depth to the top of the cored interval—assume 150 meters in the example above—plus 3 meters for Sections 1 and 2, plus 122 cm (depth below the top of Section 3), or 154.2 meters. (Note, however, that sample requests should refer to a specific interval within a core section rather than level below sea floor.)



CORE DISTURBANCE

The rotary drill-coring technique quite often results in a high degree of disturbance of the cored sediments. This is especially true of the softer unconsolidated sediments. Core disturbance has been treated at great length in previous volumes of the Initial Reports of the Deep Sea Drilling Project and will not be elaborated upon here. A qualitative estimate of the degree of deformation is given on the core logs.

CARBON-CARBONATE

Sediment samples are analyzed on a Leco 70-second analyzer following procedures outlined in Volumes 9 and 18 of the Initial Reports of the Deep Sea Drilling Project. Accuracy and precision of the results are as follows:

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

X-RAY MINERALOGY

Semiquantitative determinations of the mineral composition of bulk samples are tabulated on the core logs. In each listing the percentage of "amorphous scattering" (noncrystalline, unidentifiable material) is shown along with the crystalline, identified fraction. The percentages of identified minerals sum up to 100%. The analytical methods used are described in Volumes 1 and 2 of the Initial Reports of the Deep Sea Drilling Project and in Appendix III of Volume 4.

GRAIN SIZE ANALYSES

The grain size analyses presented on the core logs are performed by standard sieve and pipette techniques, described in detail in Appendix III of Volume 4 of the Initial Reports (p. 745), with modified settling times as in Volume 9.

SEDIMENT CLASSIFICATION

The sediment classification used here is similar to the one used in Volume 18 of the Initial Reports which was devised by O.E. Weser. Accompanying the sediment classification is a set of lithologic symbols (Figure 1). These symbols have been used on all core and site summary forms. Where complex lithologies occur, each major constituent is represented by a vertical bar. The width of each bar corresponds to the percentage value of the constituent it represents in the manner shown on Figure 2. It will be noted that the class limits of the vertical bars correspond to those of the sediment classification. With this system of graphical representation, the major and minor constituents may be shown.

Smear slides were the basic means of mineral identification for sediments on shipboard although thin sections and mineral grain mounts were used in studies of basaltic rocks. Smear slide estimates of mineral abundances were based on the area of the smear slide covered by each component. Past experience has shown that accuracy may approach a percent or so for very distinctive minor constituents but that, for major constituents, accuracy of 10% to 20% is considered very good. Of more importance than absolute accuracy are relative changes in component abundances.

CLASSIFICATION AND NOMENCLATURE RULES

I. Rules for class limits and sequential listing of constituents in a sediment name
  A. Major constituents
    1. Sediment assumes name of those constituents present in major amounts (major defined as >25%). See example in rule IA3.
    2. Where more than one major constituent is present, the one in greatest abundance is listed farthest to the right. In order of decreasing abundance, the remaining major constituents are listed progressively farther to the left.
    3. Class limits when two or more major constituents are present in a sediment are based on 25% intervals, thusly: 0-25, 25-50, 50-75, 75-100.
    Example illustrating rules IA and IB are the resulting sediment names:

% Clay	% Nannos		
0-25	75-100	=	Nanno ooze
25-50	50-75	=	Clayey nanno ooze
50-75	25-50	=	Nanno clay
75-100	0-25	=	Clay

  B. Minor constituents
    1. At the discretion of the geologist, constituents present in amounts of 10-25% may be prefixed to the sediment name by the term rich.
    Example: 50% nannofossils, 30% radiolarians, 20% zeolites would be called a zeolite-rich rad nanno ooze.
    2. At the discretion of the geologist, constituents present in amounts of 2-10% may be prefixed to the sediment name by the term bearing.
    Example: 50% nannofossils, 40% radiolarians, 10% zeolites would be called a zeolite-bearing rad nanno ooze.
  C. Trace constituents. Constituents present in amounts of <2% may follow the sediment name with addition of the word trace. This again is at the discretion of the geologist.

II. Specific rules for calcareous and siliceous tests
  A. Nannofossil is applied only to the calcareous tests of coccolithophorids, discoasters, etc.
  B. The term calcareous or siliceous, depending on skeletal composition, is applied where no attempt is made to distinguish fossils as to major subgroup. Thus, if no percent estimate is made, a mixture of radiolarians, diatoms, and silicoflagellates would be called siliceous ooze. Where this distinction is made, the appropriate fossil name is used.
  C. Fossil tests are not qualified by a textural term unless very obviously redeposited.
  D. Abbreviations, as nanno for nannofossil, rad for radiolarian, etc., may be used in the sediment name.
  E. The term ooze follows a microfossil taxonomic group whenever it is the dominant sediment constituent.
  F. Usage of the terms marl and chalk to designate amounts of microfossils, 30-60% and >60% respectively, as used by Olausson (1960) and others, is dropped. The term chalk is retained to designate a compacted calcareous ooze.

III. Clastic sediments
  A. Clastic constituents, whether detrital, volcanic, biogenous, or authigenic, are given a textural designation. When detrital[2] grains are the sole clastic constituents of a sediment, a simple textural term suffices for its name. The appropriate term is derived from Shepard's triangle diagram (see Figure 3). The textural term can be preceded by a mineralogical term when this seems warranted. Such mineralogical terms are applied as per rules IA and B.
  B. When the tests of a fossil biocoenosis or authigenic and detrital grains occur together, the fossil or authigenic material is not given a textural designation (as per rule IIC). However, the detrital material is classified texturally by recalculating its size components to 100%. With the presence of other constituents in the sediment, the detrital fraction now requires a compositional term.

---

[2]Detrital = all clastic grains derived from the erosion of preexisting rocks except for those of biogenous, authigenic, or volcanic origin.

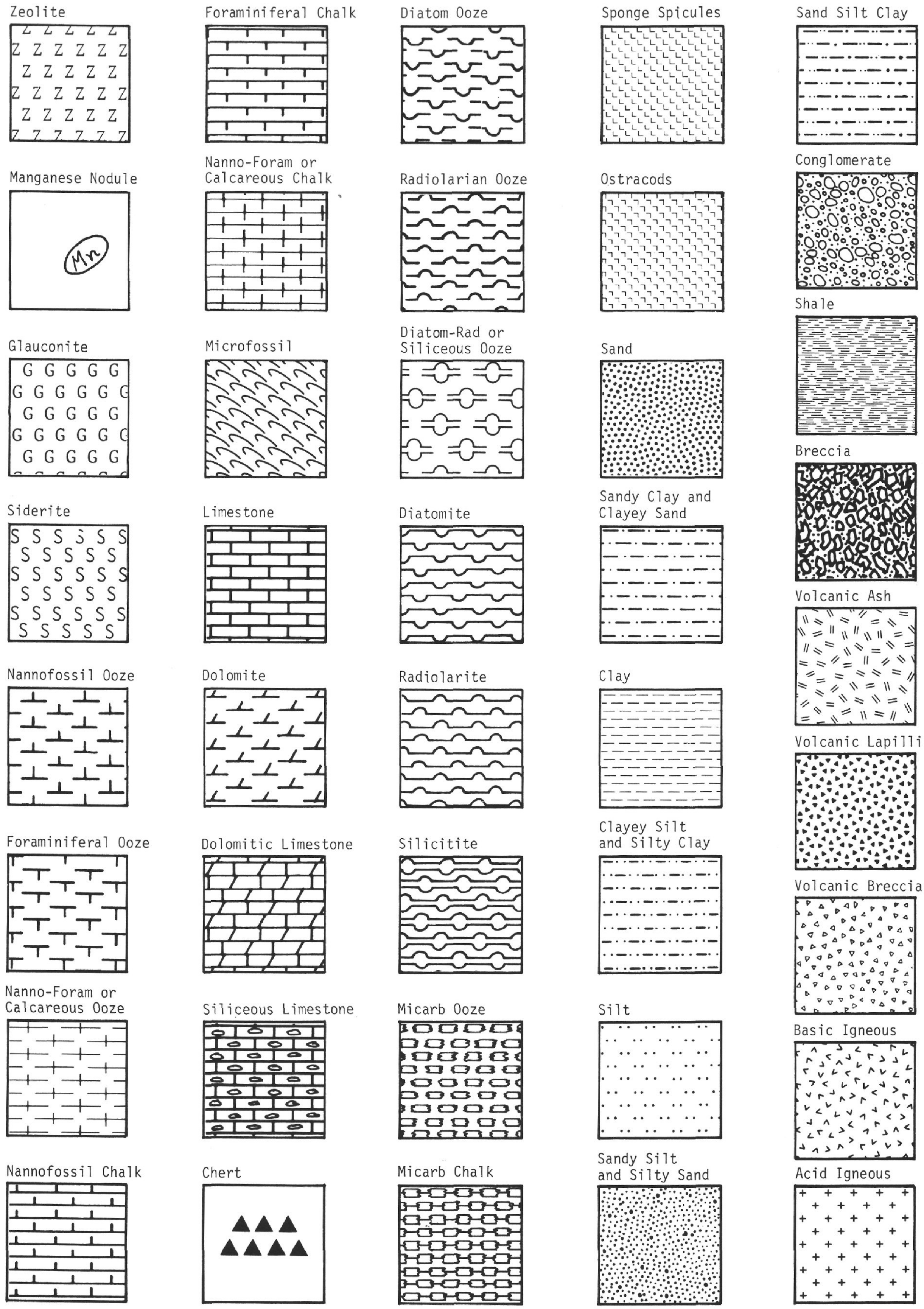


Figure 1. *Lithologic symbols used in Volume 34.*

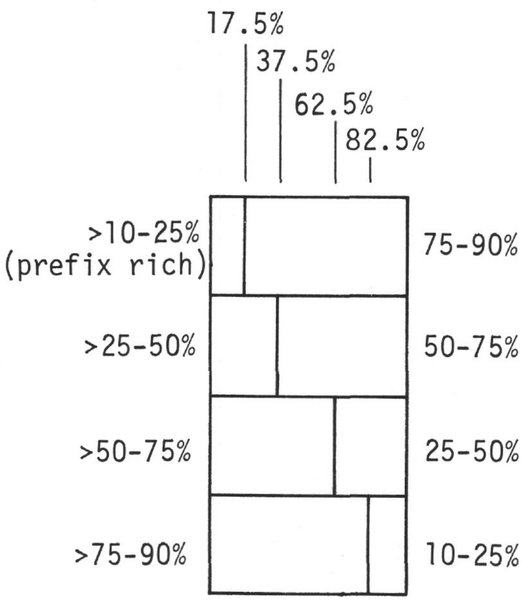


Figure 2. *Vertical bar width representation of class limits.*

C. Clastic volcanics
Redeposited pyroclastics also become a clastic component. They are again recognized by the term volcanic and receive a textural term such as gravel, sand, silt, etc. It is particularly difficult at times to differentiate between volcanic sand (i.e., transported by tractive mechanisms) and crystal ash (i.e., direct outfall resulting from explosion of a volcano).

D. Clastic authigenic constituents
Where authigenic minerals are recognized as being a redeposited constitutent, they are given a textural designation in addition to their mineral names.

IV. Volcanic and authigenic constituents

A. Volcanic constituents
Pyroclastics are given textural designations already established in the literature. Thus, volcanic breccia = >32 mm, volcanic lapilli = <32 mm to >4 mm, and volcanic ash = <4 mm. It is at times useful to further refine the textural designations by using such modifiers as coarse or fine. An ash wholly, or almost wholly, of glass shards is termed vitric ash.

B. Authigenic constituents

1. Authigenic minerals enter the sediment name in a fashion similar to that outlined under rules IA and B. Normally, as with a fossil biocoenosis, the authigenic minerals are not given a textural designation and texture.
2. The terms ooze and chalk are applied to carbonate minerals of all types using the same rules that apply to biogenous constituents.

V. Color

A. Color is not formally part of the sediment name. However, its employment for sediment description is important particularly as it provides one of the criteria used to distinguish pelagic and terrigenous sediments.

B. Common usage dictates that it is no longer expedient to employ the term red for sediments (*usually* pelagic) which are various shades of red, yellow, and brown. The proper color designation should be used.

CORE FORMS

The basic lithologic data are contained on core summary forms. As far as possible, the data are presented in the following order:

Sediment or rock name
Deformation
Color name and Munsell or GSA number

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.

Composition
Grain size, carbon-carbonate, and X-ray data

Many cores contain minor important lithologies as well as a basic lithology. The description of the basic lithology is so indicated in most cases; however, descriptive information for minor lithologies is included wherever possible. X-ray data are those collected by the DSDP X-ray mineralogy laboratory at the University of California, Riverside. Grain size and carbon-carbonate results are from the DSDP laboratory at Scripps.

A sample core form precedes the site-by-site presentation of the cores (Figure 3). On this sample core form is contained all legend and explanatory notes for an understanding of the core forms.

Because of an emphasis on basalt penetration and recovery and the growing interest of petrologists in DSDP basalt, the basaltic rocks are portrayed on a section-by-section basis with a drawing and a photograph to help subsequent sampling.

BIOSTRATIGRAPHY

Planktonic foraminifera zonations follow those used by the Deep Sea Drilling Project in previous volumes of the Initial Reports. For the most part, calcareous nannofossil zonations follow those established by Martini (1971). More specific information about the zonal distribution used may be found in Blechschmidt (this volume).

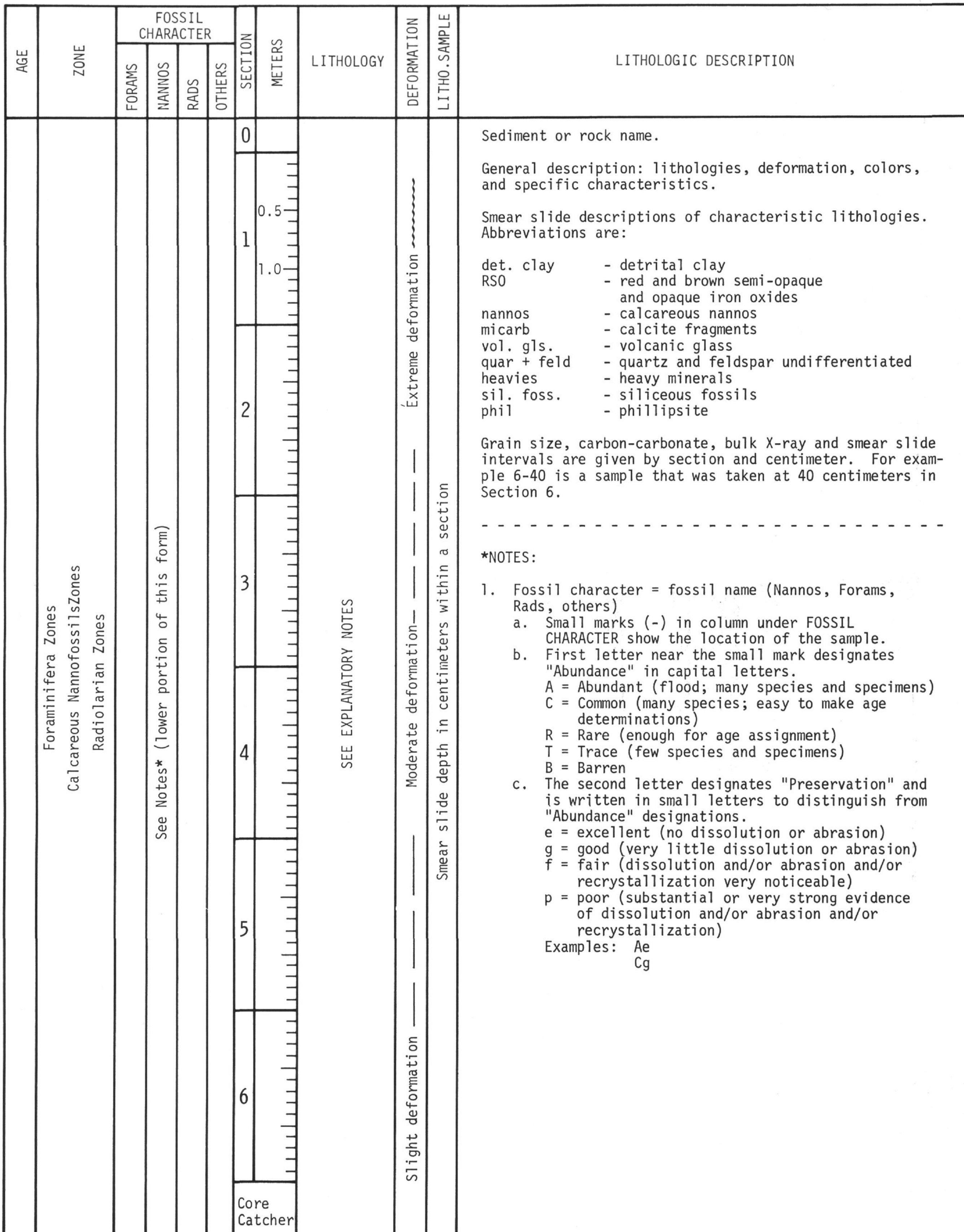
PHYSICAL PROPERTIES

Determinations were made at closely spaced intervals of the wet bulk density, porosity, thermal conductivity, electrical resistivity, and magnetic properties of materials recovered during Leg 34. Compilations of this information, presented with the core descriptions in each site report, will serve as the basis for interpretation of the seismic, magnetic, and thermal structure of each site as determined from pre- and postsite airgun and magnetometer surveys, on-site sonobuoy surveys, and downhole heat-flow measurements.

Two quite different techniques are used onboard *Glomar Challenger* for measurement of sample density and porosity, namely variants of the gravimetric technique and the Gamma Ray Attenuation Porosity Evaluator (GRAPE).

The gravimetric techniques rely upon measurement of sample mass using a simple beam balance. Though sea state obviously affects accuracy, it was found that the mass of known samples could be measured routinely to ±0.05% by mounting the balance knife edge perpendicular to the long axis of the ship and measuring only while the ship was on site and stabilized for drilling. Sample volumes of hard rock were determined from the

Site Hole Core Cored Interval: Meters below sea floor.



AGE | ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADS, OTHERS | SECTION | METERS | LITHOLOGY | DEFORMATION | LITHO. SAMPLE | LITHOLOGIC DESCRIPTION

Foraminifera Zones
Calcareous NannofossilsZones
Radiolarian Zones

See Notes* (lower portion of this form)

0, 1, 2, 3, 4, 5, 6, Core Catcher

0.5, 1.0

SEE EXPLANATORY NOTES

Slight deformation — Moderate deformation— Extreme deformation

Smear slide depth in centimeters within a section

Sediment or rock name.

General description: lithologies, deformation, colors, and specific characteristics.

Smear slide descriptions of characteristic lithologies. Abbreviations are:

det. clay - detrital clay
RSO - red and brown semi-opaque and opaque iron oxides
nannos - calcareous nannos
micarb - calcite fragments
vol. gls. - volcanic glass
quar + feld - quartz and feldspar undifferentiated
heavies - heavy minerals
sil. foss. - siliceous fossils
phil - phillipsite

Grain size, carbon-carbonate, bulk X-ray and smear slide intervals are given by section and centimeter. For example 6-40 is a sample that was taken at 40 centimeters in Section 6.

- -

*NOTES:

1. Fossil character = fossil name (Nannos, Forams, Rads, others)
   a. Small marks (-) in column under FOSSIL CHARACTER show the location of the sample.
   b. First letter near the small mark designates "Abundance" in capital letters.
      A = Abundant (flood; many species and specimens)
      C = Common (many species; easy to make age determinations)
      R = Rare (enough for age assignment)
      T = Trace (few species and specimens)
      B = Barren
   c. The second letter designates "Preservation" and is written in small letters to distinguish from "Abundance" designations.
      e = excellent (no dissolution or abrasion)
      g = good (very little dissolution or abrasion)
      f = fair (dissolution and/or abrasion and/or recrystallization very noticeable)
      p = poor (substantial or very strong evidence of dissolution and/or abrasion and/or recrystallization)
      Examples: Ae
                Cg

Figure 3. *Sample core form and explanation.*

dimensions of machined cores or by immersion, while the volume of sediments was determined from the inside dimensions of the sampling tool (syringe). Since volume distortion of the sediments is likely during both drilling and laboratory sampling, and since considerable errors arise in the measurement of the syringe sample volume (Bennett and Keller, 1973), measured values of sediment wet-bulk density must be regarded as an approximation (±5%) to in situ values. Repeatability of density determinations for basalts is observed to be ±0.5%.

The porosity of the sediments was determined gravimetrically by measuring sample mass loss as a result of heating. As in the measurement of sediment wet-bulk density, measurements of sediment porosity can only be viewed as approximate (±5%) due to the probability of volumetric distortion. Though slight systematic differences (0.01 g/cc) were commonly noted between the wet and dry bulk densities of basalts recovered on Leg 34, these differences lay within the measurement error of shipboard gravimetric equipment, and therefore no quantitative attempt was made to measure basalt porosity.

The second shipboard means of determining bulk density and porosity, namely, GRAPE, relies upon the fact that the attenuation of a gamma ray beam through a sample of known length by Compton scattering is a function of the electron density of the sample, which is in turn a function of its bulk density. Porosity, in turn, can be determined from wet-bulk density if the composition, and thus the grain density, of the sediment can be estimated from thin section or chemical analysis.

Two GRAPE sampling modes are available to the investigator—a continuous mode in which the entire core is scanned, section-by-section, as it is passed through the beam and a static mode in which a single point is scanned for a period of 2 min. Due to poor sampling statistics, density and porosity determination by the continuous mode are very crude (±11%). For this reason, though the entire sediment column was scanned in the continuous mode, no use is made of the data in this report. The incorporation of the data in this volume in graphical form with the core descriptions is meant to serve only as a rough guide to changes in density and porosity with depth in the column.

Sampling statistics for the 2-min static mode, however, are more satisfactory, suggesting an accuracy of ±2% under closely controlled conditions, a figure verified against samples of known density. For this reason, numerical determinations of bulk density and porosity were made only on selected samples using the 2-min GRAPE technique. On the average, one interval per core was selected for examination from the sediment column. Wet bulk densities and porosities were calculated using the procedures outlined by Boyce (1973) with the exception that an empirically derived linear correction factor was incorporated into the attenuation equation, allowing 2-min measurements through unconsolidated sediments contained in a core liner. GRAPE measurements of basalt bulk density were generally made at much closer intervals (5 per m) using the same technique, minus the liner.

At those intervals where either density or porosity have been measured simultaneously by two or more independent techniques, the discrepancy between measurements usually lies within the standard errors of the techniques involved. In the case of sediments this error is systematic; GRAPE determinations of wet bulk density average 5% higher than gravimetric determinations, while GRAPE porosity values average 5% lower. In the case of basalts, no systematic discrepancy is noted between GRAPE and gravimetric bulk density determinations provided that the sample path length is approximately equal to a core diameter. (If this condition is not adhered to, a strong inverse dependence of measured density upon sample length will arise from considerations of beam and sample geometry.)

Measurements of sonic velocity through samples of both sediment and basalt are made routinely aboard *Glomar Challenger* using the Hamilton frame velocimeter. In this technique, oscilloscope delay circuitry is used to measure the time of passage of a compressional wave through a sample of known length held at atmospheric pressure. Though simple in principle, since seismic velocities are, as a rule, strongly dependent upon confining pressure, this technique is limited in application to those instances in which either in situ confining pressures are low (i.e., near-surface conditions) or the effects of high confining pressure upon velocity are small (sediments under high pore pressure or extremely fresh basalts). At the sites examined on Leg 34, the latter conditions apply in the sediments and the underlying basalts, respectively; the sediments invariably exhibit high porosity and thus high pore pressures, while the basalts are unusually dense. Under these circumstances, Hamilton frame velocity measurements may be roughly comparable to in situ velocities.

With these reservations in mind, sonic-velocity measurements were made at intervals of approximately one per core in both the sediments and basalts. ue to the poor rise time characteristics of the equipment, measurement repeatability is ±5%.

Appearing as separate chapters in this volume are studies of the sonic velocities of Leg 34 basalts under hydrostatic confining pressures ranging from 0 to 6.0 kb. In one such study (Salisbury and Christensen), the samples in addition, were water saturated prior to velocity measurement, thus allowing the velocities to be determined for in situ conditions.

Electrical resistivity studies were conducted by Drury (this volume) on basalts from Sites 319 and 321 over a range of temperatures (5°-50°C), pressures (0-2.0 kb), and conditions of water saturation.

REFERENCES

Bennett, R.H. and Keller, G.H., 1973. Physical properties evaluation. *In* van Andel, T.J., Heath, G.R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 16: Washington (U.S. Government Printing Office), p. 513-519.

Boyce, Robert E., 1973. Physical properties-methods. *In* Edgar, N.T., Saunders, J.B., et al., Initial Reports of the Deep Sea Drilling Project, Volume 15: Washington (U.S. Government Printing Office), p. 1115-1127.

Martini, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation: Plankt. Conf. 2nd Proc., Rome 1970, v. 2, p. 739-785.