1. INTRODUCTION AND EXPLANATORY NOTES

The Shipboard Scientific Party[1]

And a good south wind sprung up behind;
The Albatross did follow,
And every day, for food or play,
Came to the mariners' hollo!

Samuel Taylor Coleridge

INTRODUCTION

Leg 29, the second Deep Sea Drilling expedition in the Antarctic, began 2 March 1973 when *Glomar Challenger* sailed from Lyttleton, New Zealand, and ended 18 April in Wellington, New Zealand. On this leg 16 holes were drilled at 10 sites (Figure 1) in water from 1068 to 4746 meters deep at latitudes between 40°S and 57°S, south of New Zealand and Australia, and in the Tasman Sea. The site locations span the northern Antarctic, Subantarctic, and cool subtropical (temperate) watermasses. With the general absence of land masses at these latitudes, Leg 29 provided the first opportunity to obtain Cenozoic sedimentary sections in subantarctic areas.

Several aspects of this region are somewhat different geologically and operationally from previous regions drilled by *Glomar Challenger.* Most of the sites are in subantarctic waters, so severe weather was encountered throughout the leg. Despite this, little drilling time was lost and operational feasibility was proved for these high-latitude areas. Distinct oceanographic influences on sedimentation in the area result from the profound effect of the circum-Antarctic current.

The main geological goals on the leg included: (1) determining the history of the separation and relative movement of Australia, Antarctica, and New Zealand; (2) determining the nature of basement rock in the magnetic quiet zone adjacent to Australia; (3) determining the history of development of the circum-Antarctic current and associated bottom-water history, resulting from the northward drifting of Australia from Antarctica and Antarctic glacial history; (4) determining the paleoclimatic and paleoglacial history of the Antarctic area; (5) developing a biostratigraphic zonation in northern Antarctic and subantarctic latitudes for foraminifera, Radiolaria, calcareous nannofossils, diatoms, and other groups; and (6) determining the history of biogenic productivity associated with the Antarctic Convergence and in subantarctic and cool subtropical water masses.

A total of 15 drilling sites of varying importance were originally selected by the JOIDES Antarctic Advisory Panel. Of these, eight were classified as high priority, two of intermediate to high priority, one of intermediate priority; two were secondary sites and two were contingency sites. Of these 15 sites, 10 were drilled during Leg 29, and a new site was added on the Challenger Plateau at the end of the leg. Table 1 summarizes the statistics from these sites.

Tectonic Investigations

Although each site is important in deciphering the overall tectonic pattern, several individual sites are of particular importance for the following tectonic investigations.

Interpretation of magnetic-anomaly patterns south of Australia indicates that Australia began to drift northwards from Antarctica in the middle Eocene (55 m.y.B.P.) (Weissel and Hayes, 1972). Sites 280, 281, and 282 are partly located to study the early rifting history of Australia and Antarctica. Furthermore, Site 282, to the west of Tasmania, is within the magnetic quiet zone, a feature of fundamental significance that occurs here during a period of the earth's magnetic history when reversals were known to have occurred. It was hoped to determine if the original reversals were erased, were never imprinted, or are too scrambled by high-frequency reversals to be recorded at the sea surface.

Site 279 was selected to examine the history of the Macquarie Ridge south of New Zealand. One cannot expect to resolve the complicated motions of the Macquarie triple junction, which is so near the pole of rotation; however, the data will put useful constraints on future speculations. It has also been shown that the Macquarie Ridge has a profound influence on this passage of the circum-Antarctic water mass south of New Zealand. The age of the ridge is thus closely related to the history of changes in the nature of the circum-Antarctic current.

Site 283 was drilled primarily to examine the history of the south-central Tasman Sea. Hayes and Ringis (1973) have suggested from a study of magnetic-anomaly patterns that the Tasman Sea developed earlier than the region between Australia and Antarctica, and that cessation of most spreading in the Tasman

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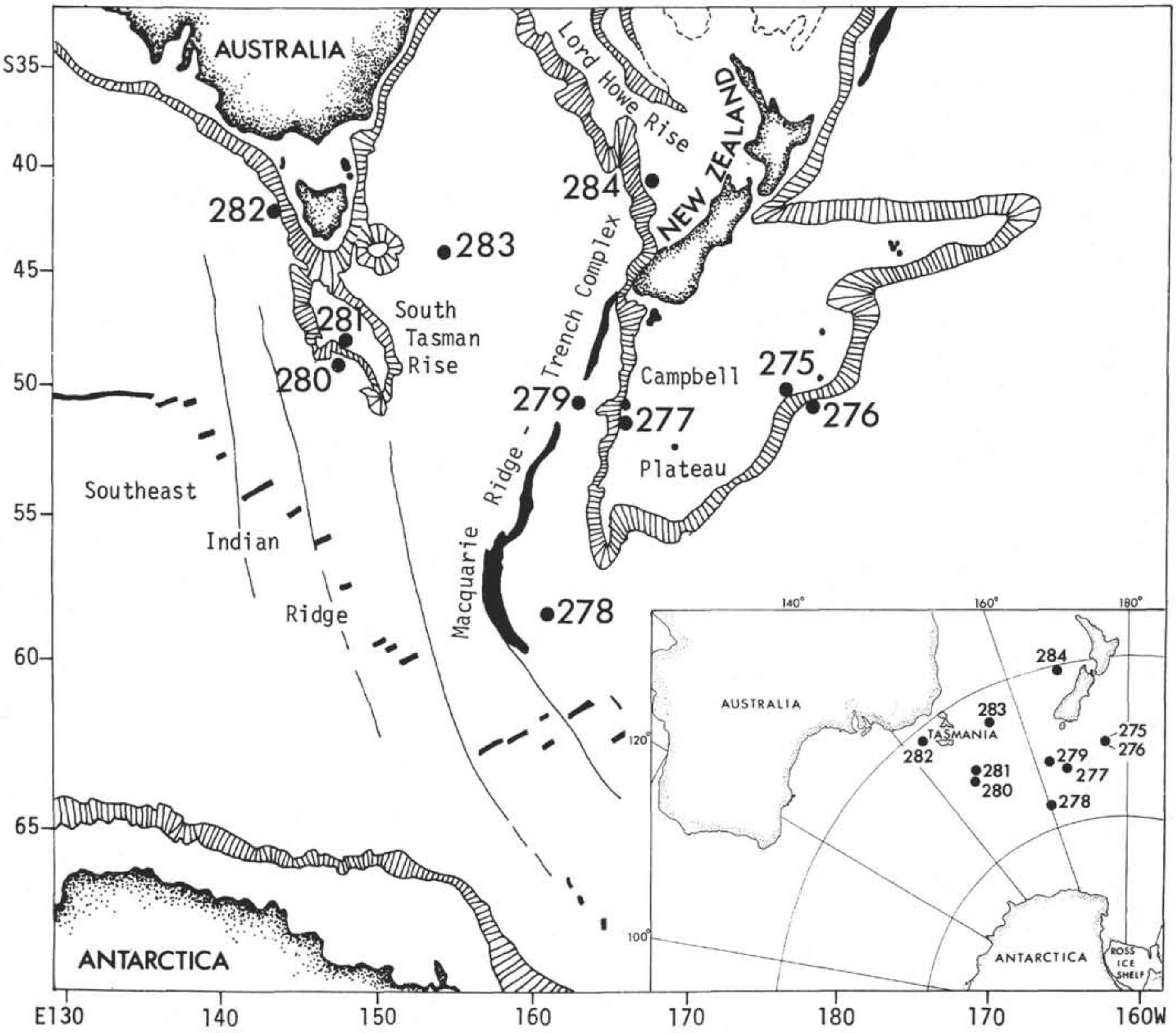

Figure 1. *Site locations, DSDP Leg 29.*

Sea area coincided with initiation of rapid spreading between Australia and Antarctica. Site 283 was drilled to test this theory by examining the sedimentary and paleotectonic record and by determining age of basement.

Paleo-oceanography and Biostratigraphic Investigations

Sometime after the middle Eocene, Australia and Antarctica separated sufficiently to enable the circum-Antarctic current to develop. Patterns of sedimentation, nondeposition, and biogeography revealed by Leg 21 drilling (northern Tasman Sea-Coral Sea) (Kennett et al., 1972), enabled several hypotheses to be formulated on the timing and nature of this major change in paleocirculation during the middle Cenozoic. Drilling at Sites 278-282 has enabled the evolution of marine conditions in the area south of Australia to be determined during the early and middle Cenozoic, and to test such hypotheses. In particular, the nature of lower Cenozoic sedimentation at Sites 280 and 282 has revealed the nature of changing environmental conditions during stages of early rifting from a highly restricted oceanic region to the present-day open-ocean, highly active circulation.

The area in the vicinity of Sites 280 and 282 is one of late Cenozoic deep-sea erosion resulting from high-velocity flow of bottom-water. Deep-sea topography causes the funneling of circum-Antarctic water through this region. Study of disconformities at these and other sites has revealed changes in bottom-water activity throughout the region.

Until now, no Cenozoic fossil zonations exist for the area south of 43°S latitude. Coring during Leg 29 has

TABLE 1
Drilling Summary – Leg 29

Hole	Date (1973)	Latitude (S)	Longitude (E)	Water Depth (m)	Penetration (m)	No. of Cores	Cored (m)	Recovered (m)	Recovery (%)	Maximum Age of Sediment	Nature of Basement
275	4-6 March	50°26.34′	176°18.99′	2800	62.0	5	43.0	17.5	40.6	Late Cretaceous	–
276	7-9 March	50°48.11′	176°48.40′	4671	23.0	1	1.0	0.0	0.0	Paleogene	–
277	11-13 March	52°13.43′	166°11.48′	1214	472.5	46	434.5	258.5	59.6	Mid Paleocene	–
278	14-17 March	56°33.42′	160°04.29′	3675	438.5	35	324.5	277.8	85.0	Mid Oligocene	Pillow basalt
278A	17 March	56°33.42′	160°04.29′	3675	44.0	2	19.0	7.5	39.0		–
279	20-21 March	51°20.14′	162°38.10′	3341	1.0	1	1.0	0.6	60.0	Mid early Miocene	–
279A	21-22 March	51°20.14′	162°38.10′	3341	202.0	13	110.0	79.8	72.5		Basalt
280	26-28 March	48°57.44′	147°14.08′	4176	10.0	1	6.0	5.5	92.0	Early mid Eocene	–
280A	28-31 March	48°57.44′	147°14.08′	4176	524.0	23	201.0	97.2	48.4		Intrusive basalt
281	31 Mar-1 Apr	47°59.84′	147°45.85′	1591	169.0	19	169.0	105.6	62.5	Late Eocene	Paleozoic schist
281A	1-2 April	47°59.84′	147°45.85′	1591	45.5	3	28.5	7.1	24.9		
282	5-8 April	42°14.76′	143°29.18′	4202	310.5	20	167.5	63.7	38.0	Late Eocene	Pillow basalt
283	10-12 April	43°54.60′	154°16.96′	4729	592.0	19	156.0	61.1	39.0	Paleocene	Altered basalt
283A	12-13 April	43°54.60′	154°16.96′	4729	20.0	2	11.0	10.5	92.0		–
284	15-16 April	40°30.48′	167°40.81′	1066	208.0	22	208.0	166.8	80.2	Late Miocene	–
284A	16 April	40°30.48′	167°40.81′	1066	75.0	3	28.5	22.4	78.6		–
Totals					3195.0	215	1908.5	1181.6	61.9		

resulted in the establishment of biostratigraphic zonations (calcareous and siliceous planktonic fossil groups) for the subantarctic and northern Antarctic regions. For this purpose nearly continuous coring was carried out at Sites 277-279, 281, 284, and parts of Sites 280 and 282. This coring has also enabled paleoclimatic studies to be conducted, particularly as they relate to Antarctic glacial history.

Upwelling of nutrient-rich deep waters in the Southern Ocean has caused it to be biogenically the most productive ocean during the late Cenozoic. Studies of biogenic sedimentation rates at Site 278 on the Antarctic convergence has enriched the history of biogenic productivity which is in turn related to the history of the development of the water-mass structures and upwelling.

EXPLANATORY NOTES

The Explanatory Notes section for past Initial Reports volumes has contained information dealing with survey data, drilling characteristics to sediment classification and basis for age determination. Only a few of these subject areas will be discussed in this volume. The reader is referred to other Initial Report volumes for any explanatory notes not covered herein.

The authorship of the site summary chapters (Chapters 2-11) is shared collectively by the shipboard scientific party, the ultimate responsibility lying with the two co-chief scientists. The material in Part I, Site Reports, is arranged in a more or less standardized order as follows (authorship of various sections is indicated in parentheses.

Site Data (Kennett and Houtz)
Background and Objectives (Kennett and Houtz)
Operations (Houtz and Morris)
Lithology (Andrews, Gostin, Hampton, Margolis, and Ovenshine)
Geochemical Measurements (Margolis)
Biostratigraphy (Edwards, Hajos, Jenkins, Kennett, and Perch-Nielsen)
Seismic Data (Houtz)
Sedimentation Rates (Edwards, Hajos, Jenkins, Kennett, and Perch-Nielsen)
Summary and Conclusions (Kennett and Houtz)
References
Appendices

The interpretations of individual authors have been retained in the section for which they were responsible. Therefore, conflicting interpretations are sometimes apparent between a particular section and the summary. Authorship of papers dealing with special topics (Chapters 12-41) and the summary chapters (Chapters 42-44) is cited in the text.[2]

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[2] The chapter written by M. S. Srinivasan and J. P. Kennett entitled "Paleooceanographically controlled ultrastructural variation in *Neogloboquadrina pachyderma* (Ehrenberg) at DSDP Site 284, South Pacific" will be published in Volume 30 of the *Initial Reports of the Deep Sea Drilling Project.*

Shipboard Scientific Procedures

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, at Site 278) was given the number of the site (Hole 278). Second holes drilled by withdrawing from the first hole and redrilling at the same site were labeled "A" holes (Hole 278A).

A core was usually taken by dropping a core barrel down the drill string, and coring for 9 meters as measured by lowering of 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.

On recovery the liner was cut into sections of 1.5 meters measured from the lowest point of sediment within the liner (Figure 2). 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 section (incomplete core) to a figure as high as 6 for the bottom section (complete core), depending on the total length of core recovered. In the event that there were gaps in the core resulting in empty sections, these were still given a number in sequence. Core catcher samples are always considered to have come from the bottom of the cored interval regardless of the depth assigned to the adjacent section above. On occasions, over 9 meters of core were recovered. The small remainder was labeled Section 0 (zero) being above Section 1.

All samples taken from cores were numbered before being processed, according to the system described in the Shipboard Handbook for Leg 29. The label "29-275-3-2, 25 cm" thus refers to Leg 29, Hole 275, Core 3, Section 2, sampled 25 cm from the top of that section. The label "29-275-3, CC" refers to the core catcher sample at the base of Core 3.

The labeling of samples is 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 29-275-3-2, 25 cm is calculated as follows. The top of cored interval of Core 3 is 189 meters. The top of Section 2 is 1.5 meters below top of cored interval, at 190.5 meters. The sample is 25 cm below the top of Section 2, at 190.75 meters.

Handling of Cores

The first assessment of the core material was made rapidly on samples from the core catcher. An age by paleontology enabled rapid decisions to be made on whether to drill ahead, or to take another core.

After a section had been cut, sealed, and labeled, it was brought into the core laboratory for processing. The routine procedure listed below was usually followed:

1) Weighing the section for mean bulk-density measurement.

2) GRAPE analysis for bulk density.

3) Sonic-velocity determinations.

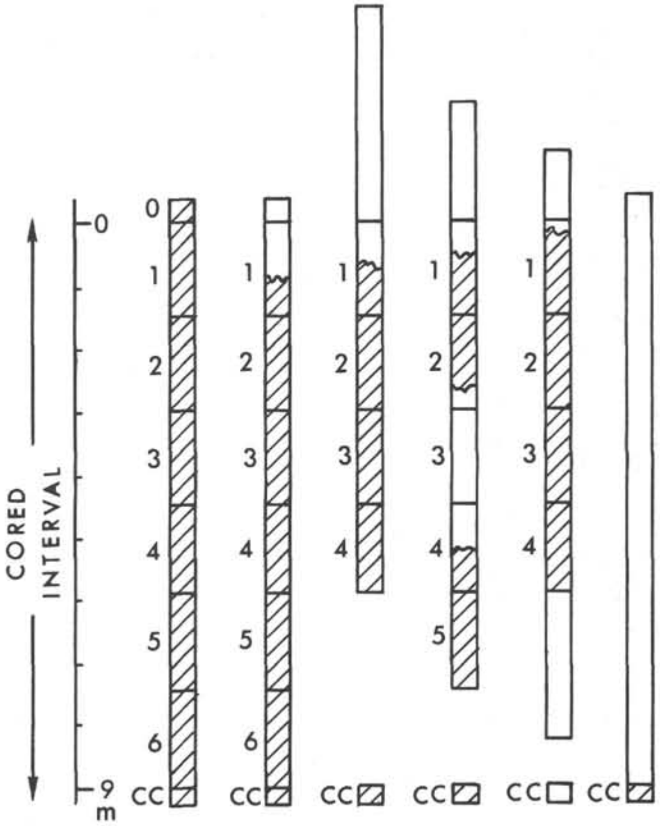


Figure 2. *The method of labeling sections of cores when recovery is complete, incomplete, and divided. The cores have been lined up so that the top of Section 1 is always coincident with the top of the cored interval, according to the method of calculating downhole depth of samples. Core-catcher samples are always considered to have come from the bottom of the cored interval regardless of the depth assigned to the adjacent section above.*

After the physical measurements were made, the core liner was cut by an electric saw, and the end caps by a knife. The core could then be split into halves by 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 hand band saw, machine band saw, or diamond wheel.

One of the split halves was designated a working 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, usually prior to splitting the core. The working half was then sent to the Paleontology Laboratory, where samples for shipboard and shore-based studies of calcareous nannofossils, foraminifera, diatoms, radiolarians, silicoflagellates, and dinoflagellates 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 the sedimentary features more clearly. 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. Smear slides were routinely made from core catcher samples, and from all core sections in which there were visual suggestions of lithologic changes. The smear slides were examined under petrographic microscopes. 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, not used up in the initial examination was retained in freezer boxes for subsequent work.

Cores of basement rocks were obtained at several sites. The fragments were arranged into their original relative orientation where possible and each separate fragment was numbered consecutively from top to bottom in the section with an arrow to indicate orientation. The rocks were described from thin sections and crushed rock-chip smear slides.

All samples are now deposited in cold storage at the East Coast Repository at the Lamont-Doherty Geological Observatory, and are available to investigators.

Procedures Used in Physical, Chemical Properties Measurements, and Sediment Analysis

A thorough discussion is presented in other Initial Report volumes with regard to the equipment, methods, errors, correction factors, presentation, and the coring disturbance relative to the validity of the data.

Core Forms

Lithologies shown in the lithologic column are based on percentage of composition values determined by shipboard smear-slide examinations. Where these values differed from the results of shore-based laboratory studies of grain-size, carbonate, or X-ray mineralogy data, the appropriate correction was made. Entries in the column headed "Litho. Sample" indicate where control on lithologies exists. A sample core form is found on Figure 3 and discussed below:

1) Numerical color designations and names follow the Munsell system as employed in the Geological Society of America Rock Color Chart. Colors recorded in the core-barrel summaries were determined during shipboard examination immediately after the sections were split. 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, yellowish white, or light tan;

2) Written descriptions tell the name of the dominant lithology, followed by pertinent remarks concerning various aspects of the sediments.

Smear-slide descriptions of the dominant lithology are given, followed by similar descriptions of important minor lithologies. The mineralogical abbreviations used in the visual description of cores on the summary core sheets are noted in Figure 3. Smear slides are not point-counted and therefore percentage values initially so derived are usually not too precise. In this sense the numerical values serve more as an approximation of relative constituent amounts rather than as an accurate quantitative guide. To improve the quantitative aspects of the smear slide data, they were updated by the shore-based laboratory data. Consequently, at sample locations where these data were available, many of these values, particularly those reflecting texture, are precise. Numerous compositional estimates, when later compared with shore-based laboratory studies, were found to be closely comparable. The largest error in visual estimation normally occurred where one of the major sediment components was carbonate grains; this error was eliminated by using the shore-based carbon-carbonate data.

3) The remaining portion of the Lithologic Description column contains the results of shore-based laboratory studies on grain-size, X-ray, and carbon carbonate, which were carried out at Scripps Institution of Oceanography, and at the University of California at Riverside. For the X-ray data, only the results from bulk analyses are shown;

4) In the "Fossil Character" columns of the core forms, letters are used to designate the type, abundance, and preservation of the microfossil groups observed and/or studied. The letters are placed in the columns at the sample location (see Figure 3). The letters used to indicate fossil type are the following:

B = Bryozoa
BF = Benthonic Foraminifera
D = Diatoms
F = Planktonic Foraminifera
N = Calcareous Nannofossils
P = Palynomorphs (dinoflagellates, pollen and spores etc.)
R = Radiolaria
S = Sponge spicules
SI = Silicoflagellates

The letters used to indicate fossil abundance are the following:

A = Abundant (high numbers of specimens)
C = Common (many specimens)
F = Few (fairly low numbers of specimens)
R = Rare (low to very low numbers of specimens)

Four letters are used to designate fossil preservation:

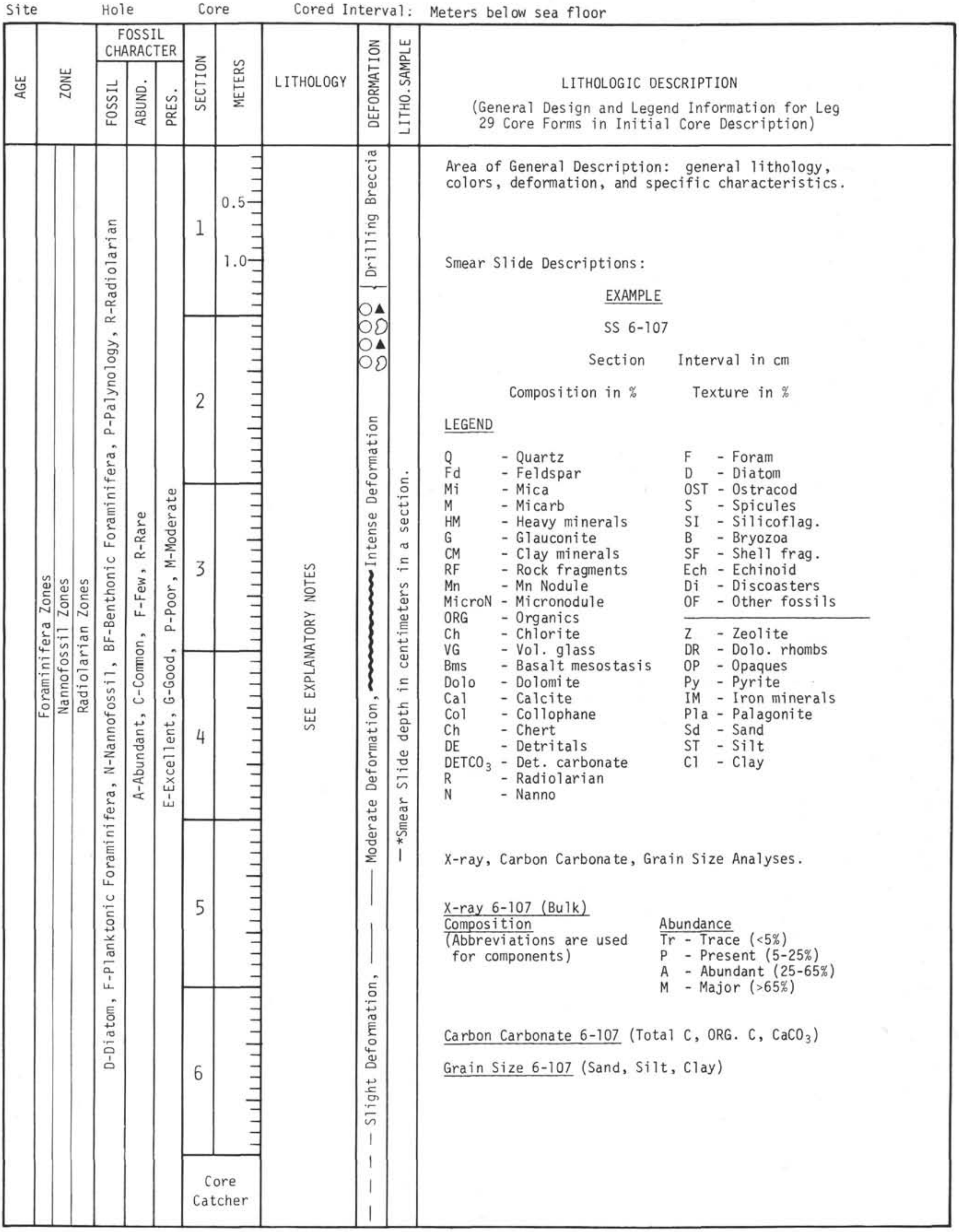
E = Excellent
G = Good (very little dissolution or abrasion
M = Moderate (dissolution and/or abrasion and/or recrystallization noticeable)
P = Poor (substantial to very strong evidence of dissolution and/or abrasion and/or recrystallization)

5) In the "Zone" column, planktonic foraminifera, calcareous nannofossils, and Radiolaria zones are written from left to right.

6) The age column contains ages established as discussed in the basis for Age Determination Section in this chapter. In the deformation column, four degrees of drilling deformation were recognized as follows:

Slightly deformed
Moderately deformed
Intensely deformed
Soupy

The criteria used in defining these degrees of plastic deformation are those in standard use plus those for brittle deformation established during Leg 28 (Figure 4).



LITHOLOGIC DESCRIPTION

(General Design and Legend Information for Leg 29 Core Forms in Initial Core Description)

Area of General Description: general lithology, colors, deformation, and specific characteristics.

Smear Slide Descriptions:

EXAMPLE

SS 6-107

Section Interval in cm

Composition in % Texture in %

LEGEND

Q - Quartz
Fd - Feldspar
Mi - Mica
M - Micarb
HM - Heavy minerals
G - Glauconite
CM - Clay minerals
RF - Rock fragments
Mn - Mn Nodule
MicroN - Micronodule
ORG - Organics
Ch - Chlorite
VG - Vol. glass
Bms - Basalt mesostasis
Dolo - Dolomite
Cal - Calcite
Col - Collophane
Ch - Chert
DE - Detritals
$DETCO_3$ - Det. carbonate
R - Radiolarian
N - Nanno

F - Foram
D - Diatom
OST - Ostracod
S - Spicules
SI - Silicoflag.
B - Bryozoa
SF - Shell frag.
Ech - Echinoid
Di - Discoasters
OF - Other fossils

Z - Zeolite
DR - Dolo. rhombs
OP - Opaques
Py - Pyrite
IM - Iron minerals
Pla - Palagonite
Sd - Sand
ST - Silt
Cl - Clay

X-ray, Carbon Carbonate, Grain Size Analyses.

X-ray 6-107 (Bulk)

Composition (Abbreviations are used for components)

Abundance
Tr - Trace (<5%)
P - Present (5-25%)
A - Abundant (25-65%)
M - Major (>65%)

Carbon Carbonate 6-107 (Total C, ORG. C, $CaCO_3$)

Grain Size 6-107 (Sand, Silt, Clay)

Figure 3. *Sample core form and legend.*

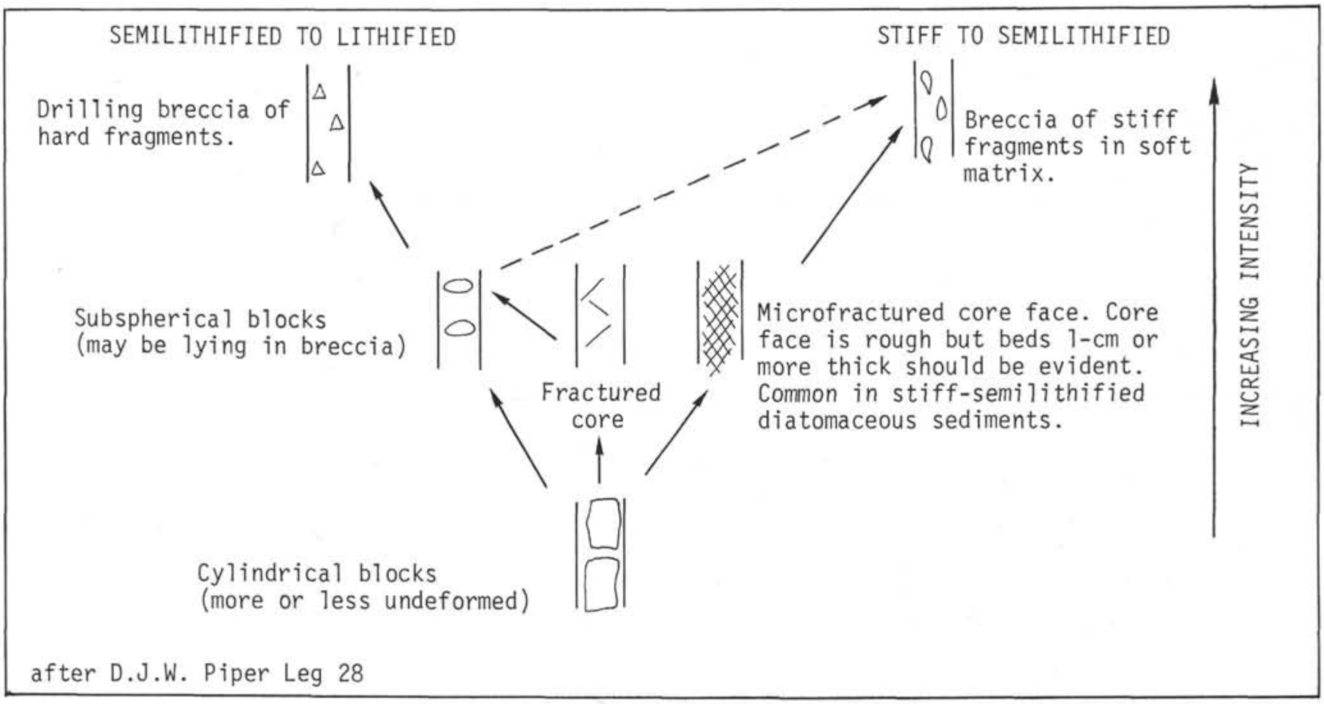


Figure 4. *Graphic examples of brittle deformation with stiff, semilithified, and lithified cores.*

Smear Slide Descriptions

On the core forms the compositional aspect of a sediment name reflects the visual estimation of various sediment constituents as derived from smear-slide examination. The shipboard party tried to be as specific as possible with regard to mineral identifications. Smear-slide listings of mineral abundances were based on estimates of the area of the smear slide covered by each component. Past experience has shown that accuracy may approach several percent or so for very distinctive minor constituents but that for major constituents, accuracy of ±10%-20% is considered very good.

Relative changes in component abundances are probably more accurately reflected in the smear-slide determinations.

Two aspects of smear-slide estimation were noted during Leg 29. First, the percentage of nannofossils in smear slides of foram nannofossil ooze was frequently overestimated. This is probably because the smear slides were made too thin. A demonstration of this error, one recognized on earlier legs, is given by taking a 5-cc sample of ooze with a syringe (the needle tip is cut off), extruding it, screening out the less-than-63-micron fraction, and packing this coarse fraction back into the syringe. The volume of the coarse fraction is read from the graduated scale on the syringe. In many instances smear slide and syringe estimates of foraminifera percentages differed by as much as 70%.

Secondly, the amounts and types of fine silt and clay-size detrital grains in calcareous oozes were difficult to determine under the microscope. Large amounts of fine-grained material commonly occurs in calcareous ooze but is largely unrecognized in the smear slides. For example, a volume comparison of a whole sample, and whole-sample insoluble residue was made for each core catcher sample recovered at Site 279. The results showed that 10%-20% of the sediment consists of fine silt and clay-size material largely unrecognized in the smear slides.

It was found useful to study the sand-size acid residue prepared from each core catcher sample obtained at each site. The procedure used is diagrammed in Figure 5.

Sediment Classification

The sediment classification method used during Leg 29 is the standard DSDP system used since Leg 18. It will be found reproduced in several Initial Report volumes. The classification depends on microscopic examination of smear slides and the identification and visual estimation of areal percentages of the sediment constituents. In naming the sediment, an attempt is made to incorporate the names of all important components.

Lithologic Symbols

Lithologic symbols (Figure 7) have been put on all core and site-summary forms. Where complex lithologies occur, instead of superimposing symbols, each 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 6. It will be noted that the class limits of the vertical bars correspond to some of the percentage

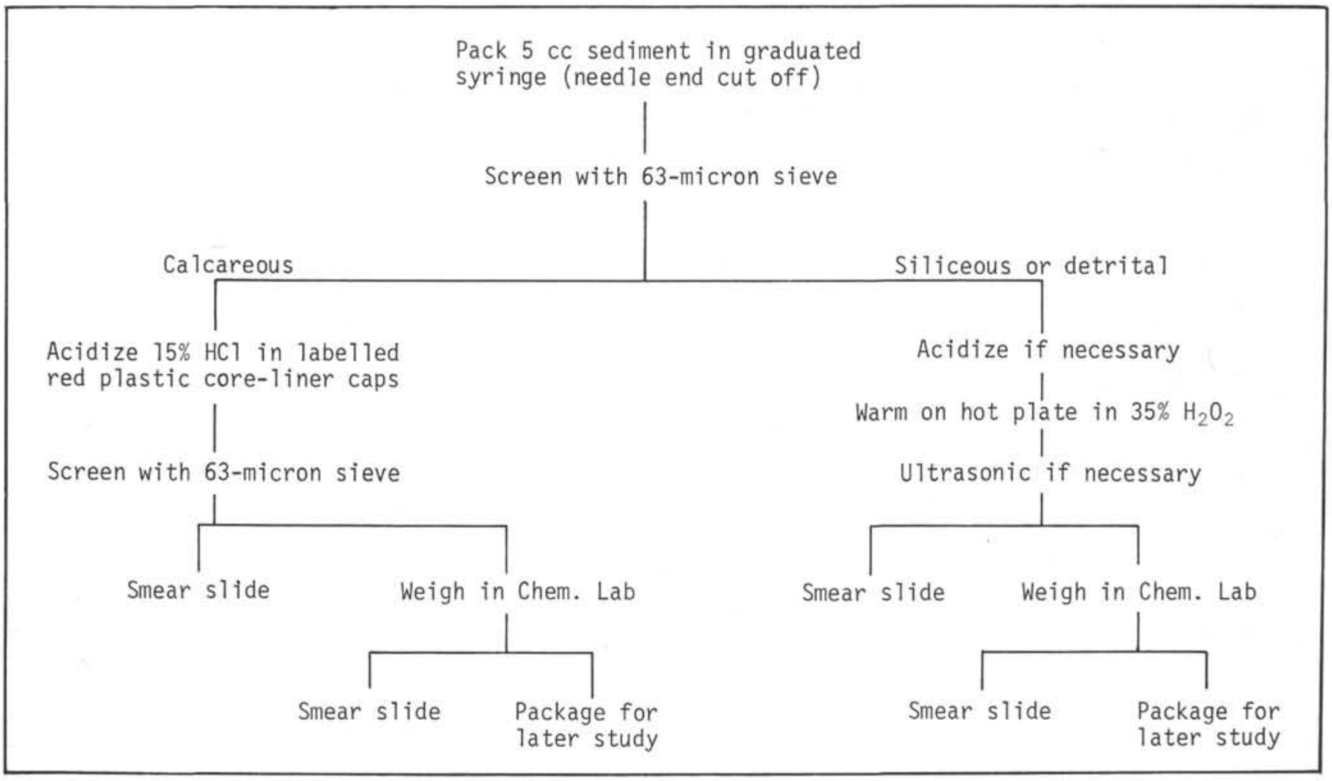


Figure 5. *Diagrammatic procedure for sand-size insoluble residues.*

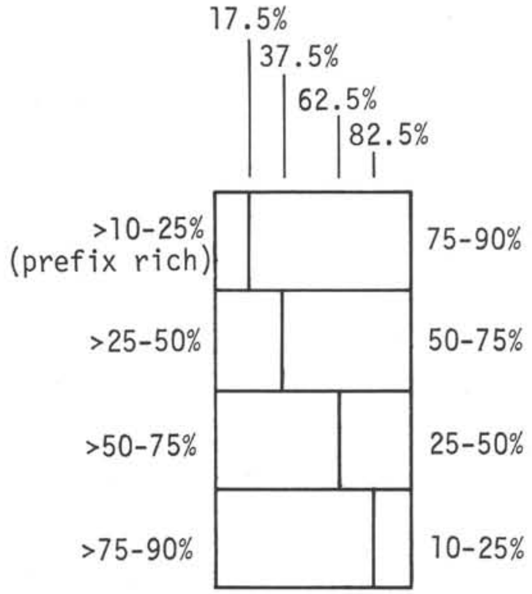


Figure 6. *Vertical bar width representation of class limits.*

categories of the sediment classification: all major components termed "rich" can be shown. The minor components termed "bearing" (2%-10%) are shown by the overprinting of an appropriate letter or symbol. Each letter or symbol corresponds to a specific constituent as shown on Figure 7.

An exception occurs in the case of clastic sediments because both texture and composition cannot be simultaneously represented by symbols. Textural symbols are used when the sediment is of clastic origin, and a compositional symbol is used when the sediment is nonclastic in origin. In instances where it was not obvious whether the sediment was of clastic origin or not, the sediment was represented by a compositional symbol.

Basis for Age Determinations

General

Planktonic and benthonic foraminifera, calcareous nannofossils, diatoms, Radiolaria, palynomorphs, and to a lesser extent, silicoflagellates were employed to determine the age of the sediments encountered on Leg 29. By agreement among the shipboard paleontologists conflicting age assignments were resolved only for biostratigraphic site summary purposes, as shown in Table 2. The most precise age determinations used in this volume are in terms of biostratigraphic zones, as discussed in each of the detailed paleontological reports. Except in certain special cases where there were independent grounds for doubting their chronostratigraphic reliability, these zones are considered equivalent to subdivisions of Cenozoic epochs and Late Cretaceous stages according to the schemes illustrated in Tables 3 to 8. However, in most cases it was deemed inadvisable to use the European Stage Classification because of the difficulty in correlating between the southwest Pacific subantarctic and Europe.

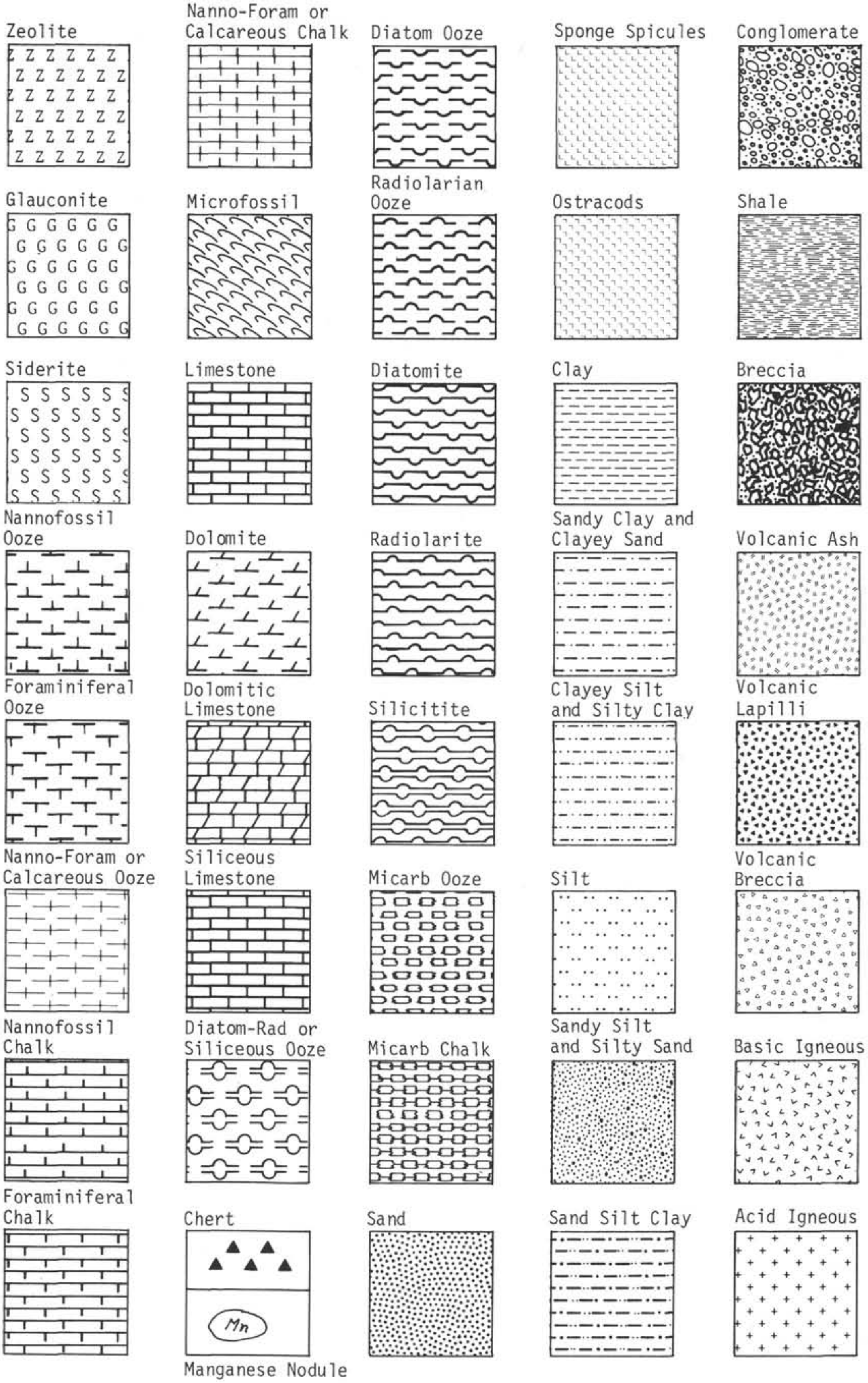


Figure 7. *Lithologic symbols.*

TABLE 2
Biostratigraphic Events Used for Age Assignment in DSDP Leg 29 Sites

Foraminifera and Radiolarians	Series Epoch	Calcareous Nannofossils
	Late Pleistocene	
T *Saturnalus circularis* (Site 278, subantarctic)		T *Pseudoemiliania lacunosa* (not at Site 278)
	Early Pleistocene	
B *Globorotalia truncatulinoides* (Site 284, temperate) T *Eucyrtidium calvertense* (Site 278, subantarctic)	1.8 m.y.	
	Late Pliocene	
		T *Reticulofenestra pseudoumbilica*
	Early Pliocene	
B *Globorotalia puncticulata* (temperate) T *Triceraspyris* sp. (Site 278, subantarctic)	4.3 m.y.	
	Late Miocene	
T *Globorotalia mayeri mayeri*		
	Mid Miocene	
B *Praeorbulina glomerosa curva*		T *Discoaster deflandrei*
	Early Miocene	
	22.5 m.y.	T *Reticulofenestra bisecta*
	Late Mid Oligocene	T *Reticulofenestra placomorpha*
	Early Oligocene	
T *Globigerapsis index*		
	Late Eocene	
		B *Reticulofenestra bisecta*
	Mid Early Eocene	
		T *Discoaster multiradiatus*
	Late Paleocene	
		B *Discoaster multiradiatus*
	Mid Paleocene	
		T *Hornibrookina teuriensis*
	Early Paleocene	
	Late Cretaceous	

Note: Different events define the Plio-Pleistocene and Miocene-Pliocene boundaries in temperate and subantarctic sites. B = first, T = last occurrence of species. Late Cenozoic radiometric ages based on paleomagnetic dating of New Zealand marine sections (Kennett et al., 1972; Kennett and Watkins, 1972). Older ages according to Berggren, 1972.

Both the planktonic foraminiferal and calcareous nannofossil assemblages obtained during Leg 29 can, like those of Leg 21 (Burns, Andrews, et al., 1973), be correlated with their New Zealand equivalents. Accordingly, as an additional aid to interregional correlation, the New Zealand stage classification is reproduced in Table 3.

Planktonic Foraminifera

Age determinations for the Cenozoic using the ranges of planktonic foraminifera was largely based on previously published ranges and zones from southeast Australia (Jenkins, 1960) and New Zealand (Jenkins, 1966, 1967, 1971). The Cenozoic zones and zonal markers used at most sites are shown in Table 4.

Calcareous Nannofossils

Late-Pleistocene to mid-Oligocene nannofloras of Leg 29 Sites 277 to 283 (southernmost subtropical to northernmost Antarctic;=Subantarctic s.l. are zoned in terms of several biostratigraphic events provided by the last occurrences of selected, abundant, dissolution-resistant, and moderately distinctive taxa (Tables 5-8). A slightly amplified version of this scheme can be usefully applied to Tasman Sea subtropical Site 284 (Leg 29) and Sites 206 and 207 of Leg 21 (Table 6).

The early Oligocene to mid-Paleocene assemblages of Leg 29 are zoned in terms of an informally modified version of the scheme proposed by Edwards (1971) for the Paleogene of New Zealand (Table 7). The modifications were necessitated by the obvious failure of several biostratigraphic events useful in New Zealand.

Diatoms, Silicoflagellates, Radiolaria, and Palynomorphs

Age assignments and the basis for age assignments using these fossil groups are discussed in the relevant site report chapters and specific chapters in Part III.

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TABLE 3
The Late Cretaceous and Cenozoic Stage Classification of New Zealand and Their Approximate International Correlatives

International Epoch		New Zealand Stage	Symbol
Pleistocene		Hawera (Series	Q
		Castlecliffian	Wc
		Nukumaruan	Wn
Pliocene		Waitotaran	Ww
		Opoitian	Wo
		Kapitean	Tk
	Late	Tongaporutuan	Tt
		Waiauan	Sw
	Middle	Lillburnian	Sl
		Clifdenian	Sc
		Altonian	Pl
	Early	Otaian	Po
		Waitakian	Lw
Oligocene		Duntroonian	Ld
		Whaingaroan	Lwh
	Late	Runangan	Ar
		Kaiatan	Ak
		Bortonian	Ab
Eocene	Middle	Porangan	Dp
		Heretaungan	Dh
	Early	Mangaorapan	Dm
		Waipawan	Dw
Paleocene		Teurian	Dt
		Haumurian	Mh
		Piripauan	Mp
		Teratan	Rt
Late Cretaceous		Mangaotanean	Rm
		Arowhanan	Ra
		Ngaterian (=Coverian)	Cn
		Moutuan	Cm

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TABLE 4
Planktonic Foraminiferal Zones Used on DSDP Leg 29

International	Planktonic Foraminifera Zones	Foraminifera Boundaries	
Pleistocene	*Globorotalia (G.) truncatulinoides*		
		G. (G.) truncatulinoides	B
	Globorotalia (T.) inflata		
		G. (T.) inflata	B
Pliocene	*Globorotalia (T.) puncticulata*		
		G. (G.) miozea conomiozea	T
	Globorotalia (G.) miozea conomiozea		
		G. (G.) miozea conomiozea	B
	Globorotalia (G.) miotumida miotumida		
		G. (T.) mayeri mayeri	T
	Globorotalia (T.) mayeri mayeri		
		G. (T.) mayeri mayeri	B
	Orbulina suturalis		
		O. suturalis	B
Miocene	*Praeorbulina glomerosa curva*		
		P. glomerosa curva	B
	Globigerinoides trilobus trilobus		
		G. trilobus trilobus	B
	Globigerina (G.) woodi connecta		
		G. woodi connecta	B
	Globigerina (G.) woodi woodi		
		G. woodi woodi	B
	Globoquadrina dehiscens		
		G. dehiscens	B
	Globigerina (G.) euapertura		
		G. (S.) angiporoides angiporoides	T
Oligocene	*Globigerina (S.) angiporoides angiporoides*		
		G. (T.) gemma	T
	Globigerina (G.) brevis		
		G. (T.) gemma	B
	Globigerina (S.) linaperta		
		G. (T.) aculeata	T
	Globorotalia (T.) inconspicua		
		C. cubensis	B
Eocene	*Globigerinatheka (G.) index index*		
		G. (G.) index index	
	Pseudogloboquadrina primitiva		
		G. (M.) crater crater	T
	Globorotalia (M.) crater crater		
		G. (M.) crater crater	B
	Globanomalina wilcoxensis		
		G. wilcoxensis	
Paleocene	*Globigerina (S.) triloculinoides*		

Note: B = first, T = last occurrence of a species.

TABLE 5
Leg 29 Neogene Subantarctic Calcareous Nannofossil Zone: Definition and Adopted Age

Age	Zone	Nannofloral Events	
Pleistocene	*Coccolithus pelagicus*		
		P. lacunosa	T
	Pseudoemiliania lacunosa		
Pliocene		*R. pseudoumbilica*	T
		Ceratolithus amplificus	B
Late Miocene	*Reticulofenestra pseudoumbilica*	*Triquetrorhabdulus rugosus*	T
Middle Miocene		*C. neogammation*	T
	Cyclicargolithus neogammation		
		D. deflandrei	T
Early Miocene	*Discoaster deflandrei*		
		"R." bisecta	T

Note: B = first, T = last occurrence of a species

TABLE 6
Leg 29 Late Neogene Subtropical Calcareous Nannofossil Zones: Definition and Adopted Age

Age	Zone	Nannofloral Events	
Pleistocene	*Coccolithus pelagicus*		
		P. lacunosa	T
	Pseudoemiliania lacunosa		
		D. brouweri	T
Pliocene	*Discoaster brouweri*		
		D. surculus	T
	Discoaster surculus		
		R. pseudoumbilica	T
		Ceratolithus amplificus	B
Late Miocene (part)	*Reticulofenestra pseudoumbilica (part)*		
		Triquetrorhabdulus rugosus	T

Note: B = first, T = last occurrence of a species.

TABLE 7
Leg 29 Late Paleogene Subantarctic Calcareous Nannofossil Zones: Definition and Adopted Age

Age	Zone	Nannofloral Events	
Late Oligocene	*Reticulofenestra bisecta*	*"R." bisecta*	T
Middle Oligocene		*R. placomorpha*	T
Early Oligocene	*Reticulofenestra placomorpha*	*I. recurvus*	T
	Blackites rectus	*D. saipanensis*	T
Late Eocene	*Reticulofenestra oamaruensis*	*R. oamaruensis*	B
	Discoaster saipanensis	*? C. reticulata* *R. hampdenensis*	T T
	Isthmolithus recurvus	*I. recurvus*	B
	Chiasmolithus oamaruensis	*C. oamaruensis*	B
	"Reticulofenestra" bisecta	*"R." bisecta*	B

Note: B = first, T = last occurrence of a species.

TABLE 8
Leg 29 Early Paleogene Subantarctic Calcareous Nannofossil Zones: Definition and Adopted Age

Age	Zone	Nannofloral Events	
Middle Eocene		*"R." bisecta*	B
	Discoaster tani nodifer	*C. reticulatus*	B
	Discoaster distinctus	*C. cristatus*	T
	Reticulofenestra hampdenensis	*R. hampdenensis*	B
	Chiphragmalithus cristatus	*R. placomorpha* *C. cristatus*	B B
	Discoaster elegans	*D. kuepperi*	T
Early Eocene	*Reticulofenestra dictyoda*	*R. dictyoda*	B
	Discoaster lodoensis	*D. lodoensis*	B
	Chiasmolithus grandis	*D. kuepperi* *C. grandis*	B B
	Marthasterites tribrachiatus	*D. multiradiatus*	T
Late Paleocene	*Rhomboaster cuspis*	*R. cuspis*	B
	Discoaster mediosus	*D. mediosus*	B
	Discoaster multiradiatus	*D. multiradiatus*	B
Middle Paleocene	*Unnamed*	*H. kleinpelli*	T
	Heliolithus kleinpelli	*H. kleinpelli*	B
	Not recovered		

Note: B = first, T = last occurrence of a species.