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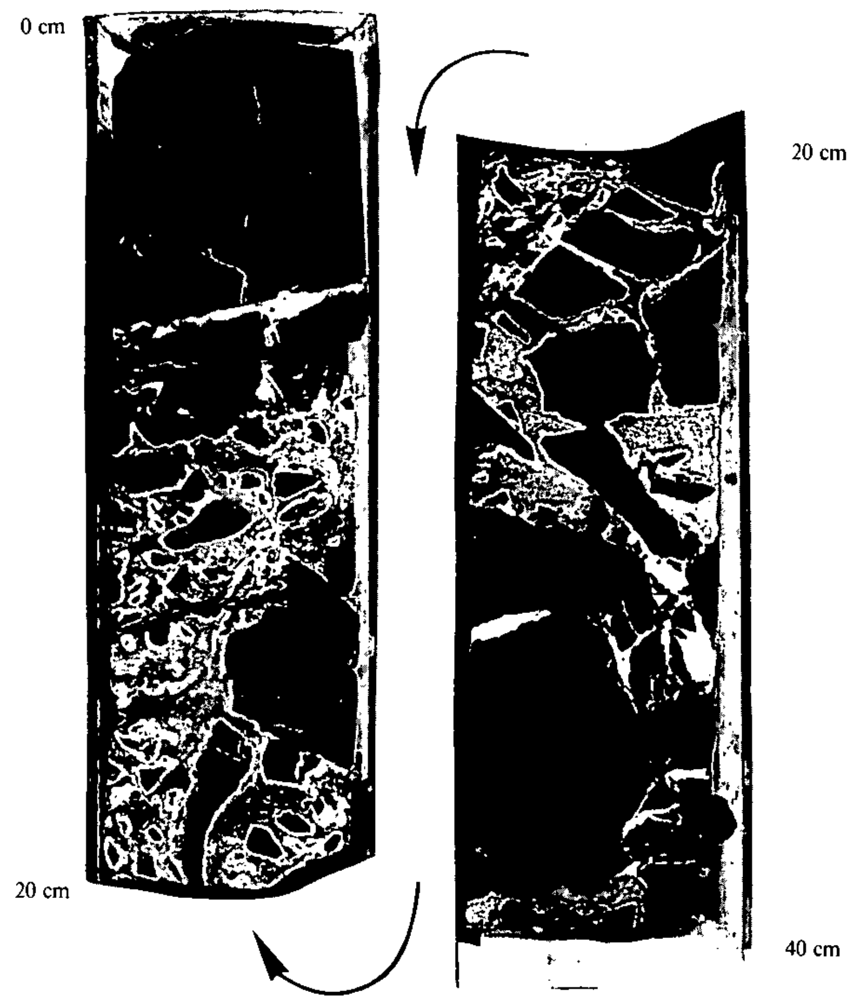
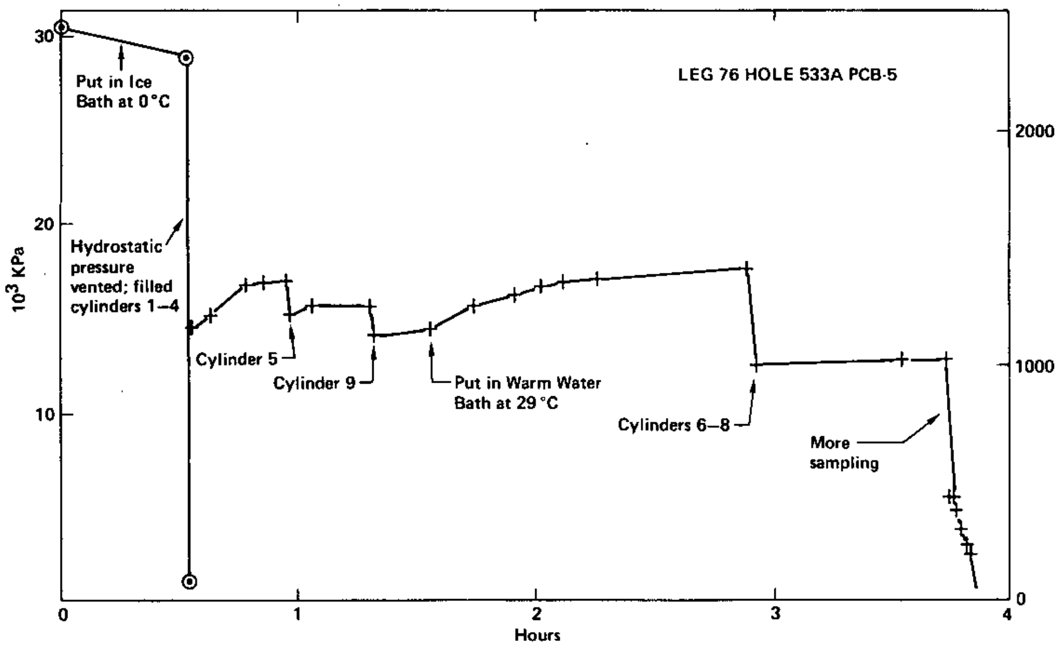
Vol. VII No. 1 Feb. 1981



Cemented basalt breccia from Hole 534A, Leg 76.



Graphic evidence for gas hydrates in the Blake-Bahama Outer Ridge. The distinctive saw-tooth pattern of pressure changes recorded in a pressure-core-barrel from Hole 533A is typical of gas hydrates decomposing under increasing temperature and decreasing pressure. (See also Leg 76 cruise summary.)

Cover: Lower Callovian(?) fractured and recemented basalt from beneath the oldest sediments cored in the Blake-Bahama Basin (Core 534-A-129-2, 0-40 cm). This basalt, recovered during Leg 76, probably formed on the outer glassy rind of lava pillows. Upon cooling, the pillows fractured and fragments fell into spaces. Later hydrothermal fluids deposited calcite, and quartz to heal the rubbly basalt and transform it into a massive rock. This basalt provides additional evidence of the processes that alter newly created fresh oceanic basalt.

TABLE OF CONTENTS

VOL. VII, NO. 1, FEBRUARY 1981

TENTATIVE *GLOMAR CHALLENGER* SCHEDULE, LEGS 76 (EXTENSION) TO 82

Leg	Departs	Departure Date	Total	Days Opers.	Steaming	Terminates at	Arrival Data	Port Days	Re-entry	Purpose
76 Ext.	Ft. Lauderdale	5 Dec 80	12	8	4	Ft. Lauderdale	21 Dec 80	5	Yes	Complete Site 534 Blake-Bahama Basin
77	Ft. Lauderdale	27 Dec 80	37	30	7	San Juan	1 Feb 81	5	No	Florida Straits
78A	San Juan	6 Feb 81	32	27	5	San Juan	10 Mar 81	2	No	Barbados Ridge
78B	San Juan	12 Mar 81	29	15	14	Las Palmas	10 Apr 81	5	Yes	Downhole experiments, Site 395
79	Las Palmas	15 Apr 81	46	38	8	Brest	31 May 81	5	No	West Africa
80	Brest	5 Jun 81	45	41	4	Southampton	20 Jul 81	5	Yes	Bay of Biscay
81	Southampton	25 Jul 81	52	41	11	St. Johns	15 Sep 81	3	Yes	Rockall Bank
82	St. Johns	18 Sep 81	42	34	8	Norfolk			Yes	East Coast U.S.

Compiled 14 January 1981

SHIPBOARD SCIENTIFIC PARTIES

Leg 77

R. Buffler	Co-chief scientist	USA - UTMSI
W. Schlager	Co-chief scientist	USA - RSMAS
O. Ayello-Suarez	Sedimentologist	Cuba
K. Pisciotto	DSDP representative/ Sedimentologist	USA - SIO
P. Cotillon	Sedimentologist	France - Univ. Claude Bernard
R. Halley	Sedimentologist	USA - USGS
R. Tyson	Sedimentologist	UK - Open Univ.
L. Magoon	Petroleum geologist	USA - USGS
J. Patton	Organic geochemist	USA - Marathon Oil
C. McNulty	Paleontologist (foraminifers)	USA - Univ. of Texas
I. Premoli-Silva	Paleontologist (foraminifers)	Italy - Univ. di Milano
J. Bowdler	Paleontologist (nannofossils)	USA - Union Oil
D. Watkins	Paleontologist (nannofossils)	USA - Fla. State Univ.
M. Testarmata	Paleomagnetist	USA - Univ. of Texas
H. Kinoshita	Physical properties specialist	Japan - Chiba Univ.

Leg 78A

B. Biju-Duval	Co-chief scientist	France - Inst.France du Petrole
C. Moore	Co-chief scientist	USA - UCSC
J. Natland	DSDP Representative/ Igneous Petrologist	USA - SIO
D. Cowan	Sedimentologist	USA - Univ. of Washington
C. Pudsey	Sedimentologist	UK - Oxford
M. Tardy	Sedimentologist	France - Univ. Pierre et Marie Curie
A. Wright	Sedimentologist	USA - UCSC
C. Hemleben	Sedimentologist/ Paleontologist (foraminifers)	FRG - Univ. Tübingen
R. Guerra	Paleontologist (foraminifers)	USA - Mobile
J. Bergen	Paleontologist (nannofossils)	USA - Florida State
N. Killmar	Paleontologist (radiolarians)	USA - SIO
D. Wilson	Paleomagnetist	HIG
G. Claypool	Organic geochemist	USA - USGS
M. Marlow	Physical properties specialist	USA - USGS
M. Willis	Log analyst	USA - MIT

Leg 78B

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M. Salisbury	Co-chief scientist	USA - SIO
M. Langseth	Geophysicist (hydro-fracture and heat flows)	USA - LDGO
S. Hickman	Hydrofracture specialist)	USA - USGS
J. Svitek	Televiewer technician	USA - USGS
V. Nechoroshkov	Geophysicist (downhole magnetometer experiment)	USSR - Inst. of Geophysics
V. Ponomarex	Geophysicist (downhole magnetometer experiment)	USSR - Inst. of Geophysics
K. Becker	Geophysicist (large-scale resis-tivity experiment)	USA - SIO
M. Mathews	Log analyst	USA - UC, Los Alamos
(To be determined)	Geophysicist (downhole seismic experiment)	
A. Ballard	Geophyysicist (Program Manager - DARPA)	USA - NORDA
R. Wallerstadt	Project engineer (DARPA)	USA - GMDI
E. Kaiser	Superintendent (DARPA)	USA - GMDI
S. Dye	Technician (DARPA)	USA - GMDI
C. Mulchay	Electrical engineer (DARPA)	USA - Teledyne
W. Grosskopf	Electronics technician (DARPA)	USA - Teledyne
C. Coker	Electronics technician (DARPA)	USA - Teledyne
R. Jocobsen	Geophysicist (U.S.S. *Bartlett*)	USA - NORDA
D. McGowan	Geophysicist (U.S.S. *Bartlett*)	USA - Univ. Texas
P. Donahoe	Electrical engineer (U.S.S. *Bartlett*)	USA - Univ. Texas

Leg 79

K. Hinz	Co-chief scientist	FRG - Bund. für Geowissen.

(Second co-chief scientist to be determined).

Leg 80

P. de Graciansky	Co-chief scientist	France - Ecole des Mines
C. Poag	Co-chief scientist	USA - USGS

GLOMAR CHALLENGER OPERATIONS

CRUISE SUMMARIES

Leg 74[1]
Walvis Ridge

Leg 74 began on 6 June 1980 in Cape Town, South Africa and ended in Walvis Bay, 24 July 1980. Eleven holes were drilled at five closely spaced sites across the aseismic Walvis Ridge from the Cape Basin into the Angola Basin (Table 74-1). The transect extends a little over two degrees of latitude (200 km) and reaches from the crest of the ridge, at approximately 1000 meters water depth, to the Angola Basin with 4437 meters water depth.

[1]Abridged from a preliminary Leg 74 report prepared by Theodore C. Moore Jr., Philip D. Rabinowitz (co-chief scientists), Anne Boersma, Peter E. Borella, Alan D. Chave, Gerard Duee, Dieter Füterer, Ming-Jung Jiang, Helene Manivit, Suzanne O'Connell, Stephen H. Richardson, and Nicholas J. Shackleton.

Introduction

The Walvis Ridge consists of offset NNW-trending crustal blocks connected by ENE-trending blocks. Together these blocks form a roughly linear ridge which extends to the northeast and joins the continental margin of Africa near 20°S latitude. Within the area of study (Figure 74-1), the structural blocks tend to slope steeply into the Cape Basin and slope gradually westward into the Angola Basin. Magnetic anomaly 32 (lower Maestrichtian) is identified here, near the ridge crest; younger anomalies are identified to the west.

All sites drilled during Leg 74 lie beneath surface currents in the eastern part of the central subtropical gyre. They are approximately 800 km off the coast of Africa — well outside the main flow of the eastern boundary current (Benguela Current) and the associated regions of high productivity. Surface oceanographic conditions are today rather uniform over the

Table 1. Leg 74 Coring Summary

Hole	Dates (1980)	Latitude	Longitude	Water Depth[1] (m)	Sub-bottom Penetration (m)	No. of Cores	Meters Cored	Meters Recovered	Per Cent Recovery
525	10 June	29°04.24'S	02°59.12'E	2467	3.6	1	3.6	3.6	100
525A	10-15 June	29°04.24'S	02°59.12'E	2467	678.1	63	555.1	406.7	73
525B	15-19 June	29°04.24'S	02°59.12'E	2467	285.6	53	227.0	181.7	80
526	14 July	30°07.36'S	03°08.28'E	1054	6.3	2	6.3	3.6	57
526A	14-16 July	30°07.36'S	03°08.28'E	1054	228.8	46	200.8	206.6	100+
526B	16 July	30°07.36'S	03°08.28'E	1054	28.3	5	22.0	13.5	61
526C	16-17 July	30°07.36'S	03°08.28'E	1054	356.0	21	185.0	70.9	38
527	28 June-4 July	28°02.49'S	01°45.80'E	4428	384.5	44	384.5	243.9	63
528	4-10 July	28°31.49'S	02°19.44'E	3800	555.0	47	441.0	272.8	62
528A	10-13 July	28°31.16'S	02°18.97'E	3815	130.5	30	130.5	116.5	89
529	18-20 July	28°55.83'S	02°46.08'E	3035	417.0	44	417.0	309.7	74
						356	2572.8	1829.5	71

[1]Water depths from sea level.

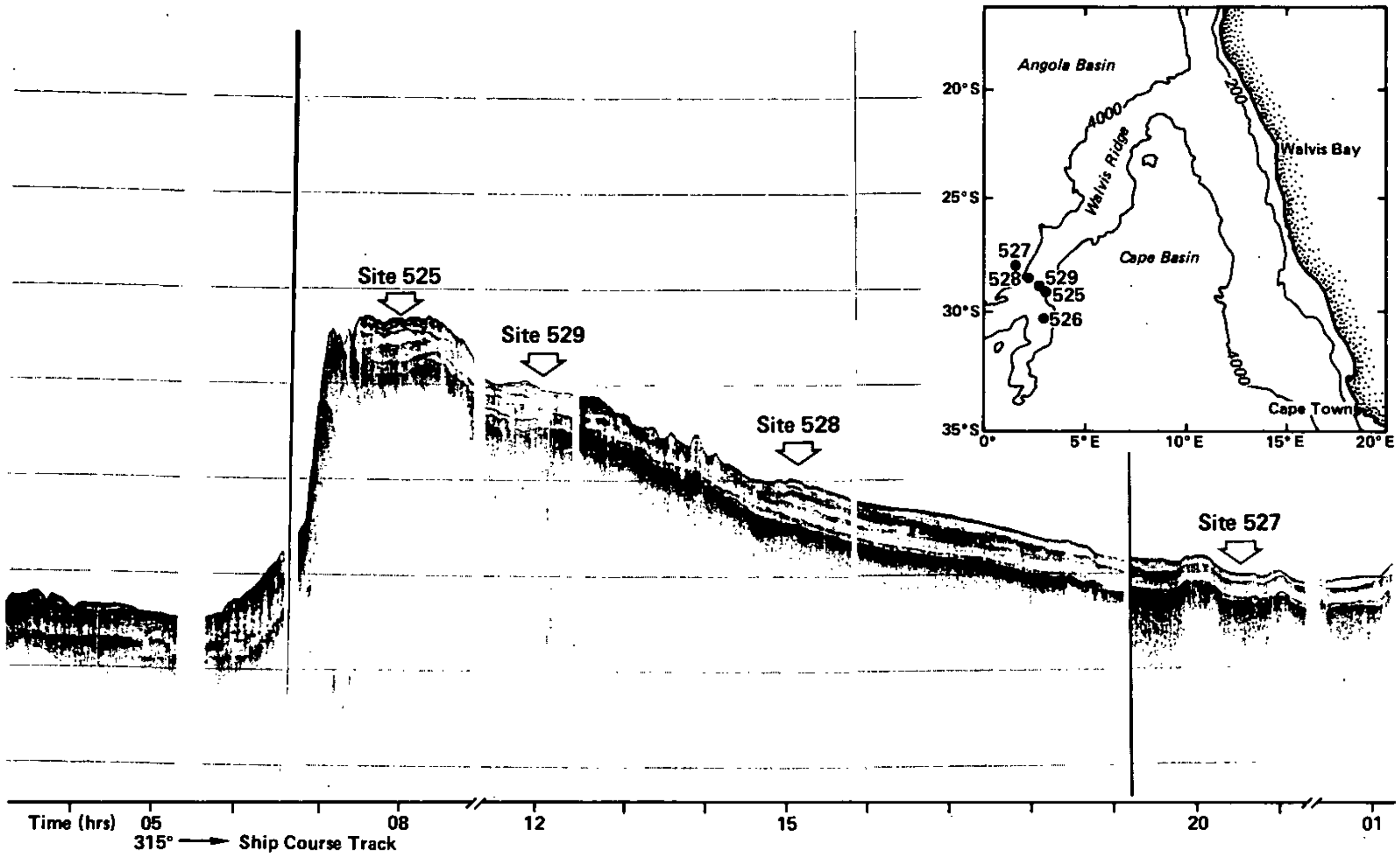

Figure 74-1. Site localities and index map.

study area and we assume them to have been so in the past. Thus, even though near-surface currents may have changed slightly in the past, at any given time all sites probably received a uniform supply of biogenic and detrital material.

The shallowest site (Site 526, SA-II-7) lies within the depth interval now occupied by Antarctic Intermediate Waters. The remaining, deeper sites are located on what appears to be a separate structural block of the Walvis Ridge. They all lie within the depth interval occupied by North Atlantic Deep Water which dominates the deep and bottom waters of the Angola Basin.

The Leg 74 drilling was planned to address three main scientific problems: (1) the history of the deep waters and the changes in their vertical oceanographic gradients; (2) the nature and tectonic evolution of the Walvis Ridge; and (3) the biostratigraphy and magnetic stratigraphy of the eastern South Atlantic.

This suite of closely spaced sites is ideally suited for studies of the deep waters. Not only have the sites lain within different water masses and thus can provide samples suitable for benthic faunal studies, but they also have lain (and presently lie) at different depths, providing a profile of sites, all of which receive approximately the same pelagic debris. Thus, any differences in average accumulation rates for a given interval of time should be the result of differences within two processes: dissolution rates as a function of depth, and winnowing and/or erosion. Detailed stratigraphic studies and the analysis of the accumulation rates for different sized components will aid in distinguishing these two processes.

Our results should help stratigraphers establish a regional biostratigraphic framework tied to magnetic stratigraphy. The recovery of several stratigraphic sections within a relatively small geographic area enhances the usefulness of the material. This assures nearly complete

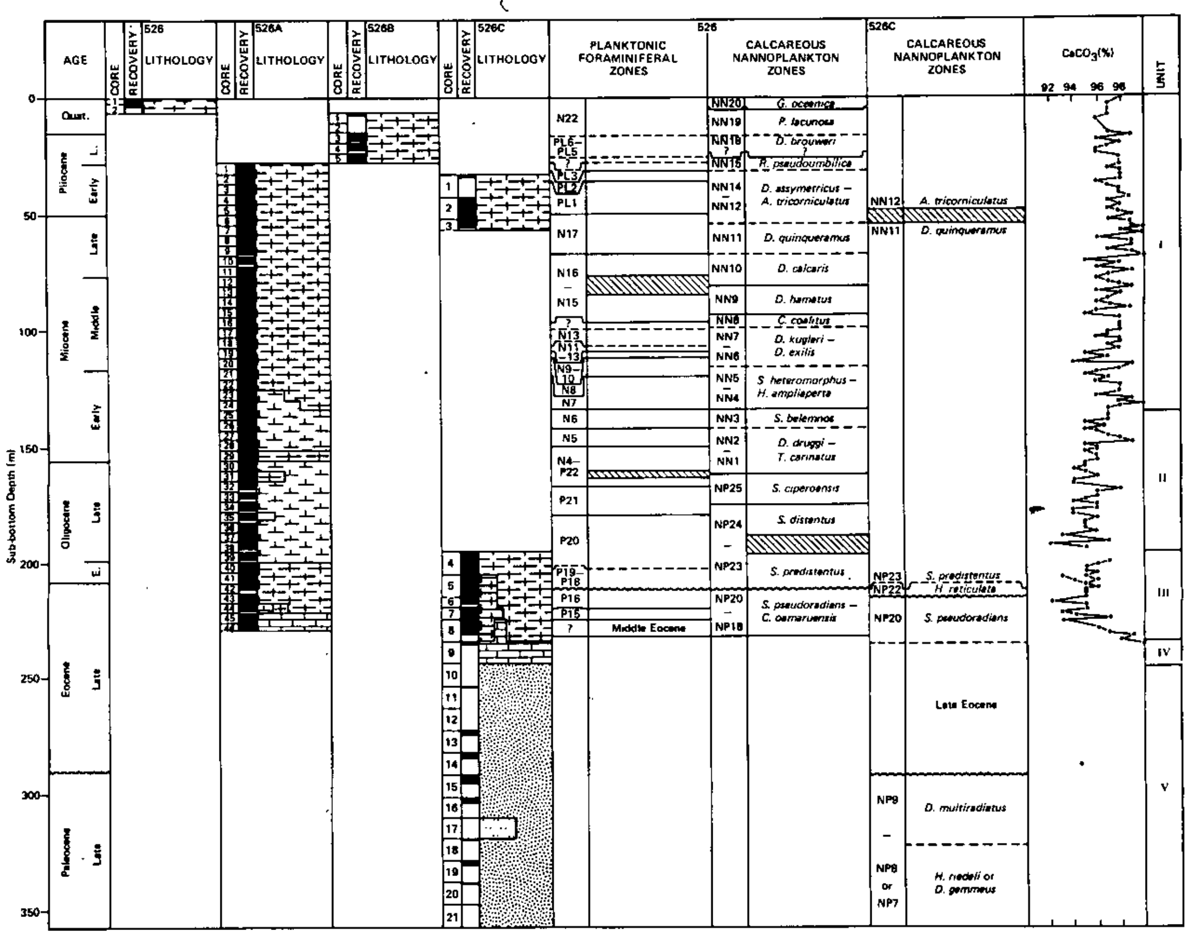

Figure 74-2. Site 526 stratigraphic summary.

... biostratigraphic sequence and optimal preservation of both the older parts of the section (in deeper sites with less overburden and diagenesis) and the younger parts (in shallower sites with less dissolution).

The study of aseismic ridges in general, and the Walvis Ridge in particular, allows us to verify our hypotheses concerning the age and subsidence history of the ridge, and also provides samples of the upper basement complex. These samples allow us to study the magnetic character, petrology, and chemical composition of the crustal rocks as well as the mode of emplacement of the basaltic basement complex.

In the following paragraphs the sediment and basement lithologies are summarized *in order of water depth of site along the transect* (shallowest to deepest).

Site 526

Site 526 (SA-II-7) on crust the age of magnetic anomalies 31-32, is the shallowest site (drilled in the shallowest water) drilled during the Walvis Ridge transect. Drilling yielded a relatively complete and well preserved Neogene and upper Paleogene calcareous sedimentary section (Figure 74-2). The hole was piston cored to a sub-bottom depth of 229 meters (recovery rate of 98%), then rotary cored to 356 meters sub-bottom (recovery rate averaged 38%). We terminated the hole when drilling encountered a thick sand formation creating unstable hole conditions.

We recognized five major lithologic units shown graphically on Figure 74-2.

Unit I, from the mud line to about 130 meters sub-bottom is a very homogeneous lower Miocene white foraminifer and foraminifer-nannofossil ooze (carbonate content is 97%). Ichnofossils are poorly preserved.

Unit II, from 130 meters to about 195 meters is a homogeneous very pale orange to pinkish gray, lower Oligocene nannofossil ooze with a few chalk layers. Carbonate preservation is moderate and bioturbation is slight. Carbonates comprise about 92 per cent of the sediment.

Unit III, from 195 meters to about 225 meters is a homogeneous pinkish gray, upper Eocene, foraminifer-nannofossil ooze, devoid of trace fossils. Carbonates comprise about 92 per cent of the sediment.

Unit IV, is a thin, white limestone layer with rhcoliths.

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Unit V, from about 242 to 356 meters,iplex calcareous sand with debris of bryozoans, . fragments of lamellibranchs, and echin The shell fragment debris indicates its dep tion in very shallow water.

We did not penetrate the basement compl at this site.

Site 525

Site 525 (SA-II-1) on crust of magnetic anomaly 32 age, is on a broad, relatively flat crest of a NNW-SSE trending block of the Walvis Ridge. We drilled three holes (Figures 74-3 and 74-4) which sampled a complete section

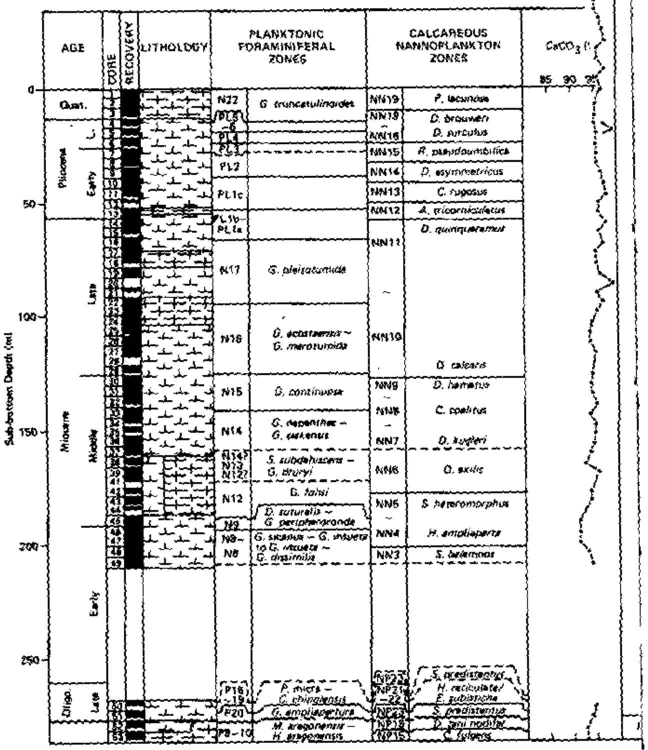

Figure 74-4. Hole 525B stratigraphic summary.

from the sea floor to the top of a basement complex (at 574 meters sub-bottom) and penetrated an additional 103 meters into the basement complex.

We recognized three major sedimentary lithologic units at Site 525. The top of **Unit I** **(Ia)** consists of a very homogeneous nannofossil and foraminifer-nannofossil ooze. The base

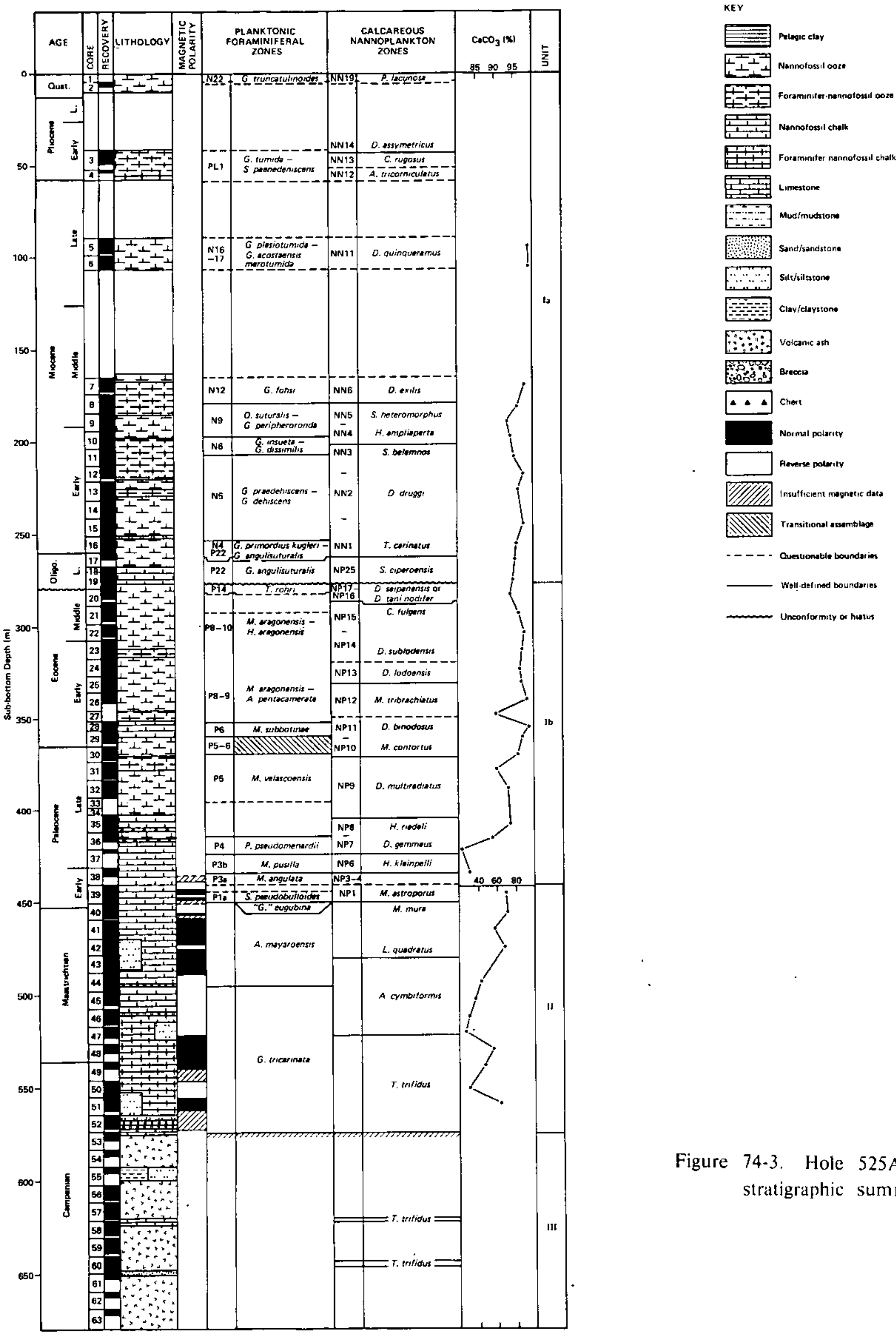

Figure 74-3. Hole 525A stratigraphic summary

of Unit Ia coincides with a color change and major hiatus between upper Oligocene and middle Eocene sediments at 270 meters sub-bottom. The bottom of **Unit I (Ib)** consists of nannofossil and foraminifer-nannofossil ooze and chalk which terminates near the well preserved Cretaceous/Tertiary boundary at 452 meters. Chert fragments were found near the base of Unit Ib. The carbonate content in Unit I is more than 90 per cent except near its base where the carbonate is somewhat less.

Unit II sediments extend from near the Cretaceous/Tertiary boundary at 452 meters to the basement complex at 574 meters and consist of cyclical nannofossil marly chalk and siltstone/sandstone of turbidite and/or slump origin. The oldest sediments are upper Maestrichtian to upper Campanian. The carbonate content of this unit is generally less than 50 per cent. Beautifully preserved biogenic sedimentary structures are present throughout the section. A spectacular 6-meter thick turbidite sequence occurs at the base of Unit II and overlies the basement complex.

Unit III consists of 0.2- to 2.0-meter sections of bioturbated marly limestone and volcanogenic sediment interlayered within the basaltic basement rocks.

We drilled 103 meters of this basement complex. The upper 20 meters is highly altered greenish gray aphyric vesicular basalt; the remainder is gray to black, moderately altered, predominantly aphyric, vesicular flow and pillow basalt with glassy margins and numerous calcite veins. Most of the large vesicles are filled with calcite and small amounts of pyrite. The groundmass is predominantly plagioclase and clinopyroxene (augite) and has some alteration products. The shipboard biostratigraphic and paleomagnetic results corroborate crustal formation at Site 528 at about the time of magnetic anomaly 32.

Site 529

Site 529 (SA-II-2) on crust the age of magnetic anomalies 31-32, is located near the upper part of the slope on the Walvis Ridge transect. We drilled here to sample those parts of the section missed at other sites on the transect. The hole was continuously cored to a sub-bottom depth of 417.0 meters and was terminated when we had to return to port.

We recognized three major lithologic units at Site 529 which are shown on Figure 74-5. **Unit I**, consisting of a very homogeneous white to pinkish gray lower Oligocene foraminifer-nannofossil ooze, extends from the mud line to about 160 meters sub-bottom. The sedimentary structures are poorly preserved. Carbonates comprise about 95 per cent of the sediment. A hiatus occurs between the lower Pliocene to middle Miocene, and most probably within the middle Miocene sediments. The sediments record slumps or mass movements occurring in the early Pleistocene and late to early Miocene (Figure 74-5).

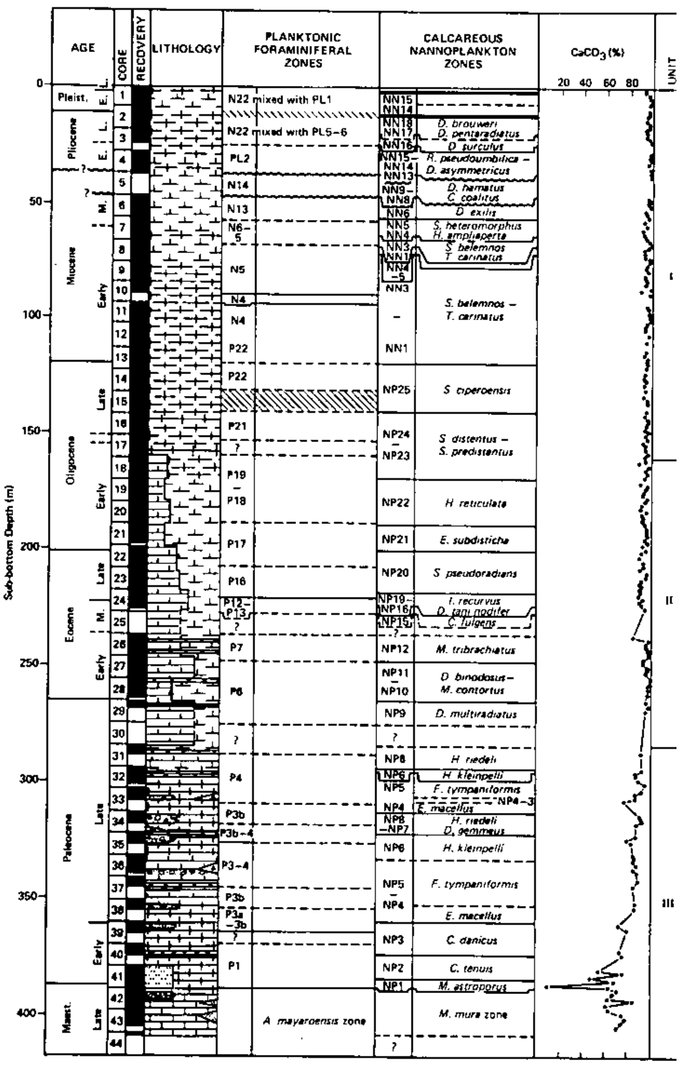

Figure 74-5. Site 529 stratigraphic summary.

Unit II from 160 to about 284 meters sub-bottom (upper Paleocene), consists of pink nannofossil ooze and chalk (with chalk increasing with depth) and a few diagenetic chert layers in the bottom half. Bioturbation is slight to moderate and carbonates comprise 90 per cent of the sediment.

Unit III extending from 284 to 417 meters (the bottom of the core is upper Maestrichtian) consists of light to olive gray foraminifer-nannofossil chalk containing 85 per cent carbonate. Chert layers occur in the upper half of the unit. Biogenic sedimentary structures are excellently preserved. A large slump structure occurs in the upper Paleocene; other smaller slump structures — one near the very well preserved Cretaceous/Tertiary boundary — also occur. Volcaniclastic sediments are abundant in the lower part of the unit.

We did not reach the basement complex at this site.

Site 528

Site 528 (SA-II-3), on crust of age between magnetic anomalies 31 and 32, is midway up the western flank of the Walvis Ridge. The two holes drilled here give a complete sedimentary section from the sea floor to the top of a basement complex at 474 meters sub-bottom, (Figure 74-6). Drilling also penetrated an additional 80 meters into the basement complex. We obtained a good sonic velocity log in that hole.

Unit I, from the sea floor to 160 meters sub-bottom (lower Miocene to upper Oligocene) consists mainly of white nannofossil and foraminifer-nannofossil ooze; the sediment contain 90 per cent calcium carbonate.

Unit II, from 160 to 383 meters consists of lower Paleocene pinkish gray nannofossil ooze and chalk (with chalk increasing at depth); chert fragments occur near the base. The sediments contain 85 to 90 per cent calcium carbonate.

Unit III, from 383 meters (early Paleocene, near the Cretaceous/Tertiary boundary) to the basement complex at 474 meters sub-bottom, consists of an alternating sequence of light gray to reddish brown nannofossil chalk and greenish gray volcanogenic sandstone to mudstone. Turbidites occur near the base of the unit. The carbonate content varies from 30 to 90 per cent.

Unit IV comprises 0.5- to 5.0-meter thick beds of nannofossil chalk, calcareous mudstone and volcanogenic sediment interbedded within the basement complex. The nannofossils from the oldest sediments both above and within the basement complex indicate they fall within the *A. cymbiformis* Zone (Maestrichtian).

We drilled 80 meters into the basement complex and recognized seven units, from between 3 to 17 meters thick, each separated by sediment of Unit IV, above. The seven units are of two basic types: a medium- to fine-grained slightly to moderately altered, highly plagioclase-phyric, massive, flow basalt which is somewhat similar to material found at Site 527, and an aphyric to sparsely plagioclase-phyric, vesicular, moderately altered flow basalt. The few vesicles seen in the first type are generally filled with green clay minerals; both types have subophitic textures.

The shipboard biostratigraphic and paleomagnetic results (Figure 74-6) corroborate the crustal formation at Site 528 during the time between magnetic anomalies 31 and 32.

Site 527

Site 527 (SA-II-5), on crust of magnetic anomaly 31 age, is the deepest site on the western flank of the Walvis Ridge. A single rotary-drilled hole penetrated the complete sedimentary section to the top of basement (at 341 meters sub-bottom) and an additional 44 meters into the basement complex. A density log was run before the hole caved in.

We recognized five major sedimentary units (shown on Figure 74-7).

Unit I, from 0 to 102 meters sub-bottom, consists of Pleistocene to upper Miocene very homogeneous, white nannofossil and foraminifer-nannofossil ooze comprising 95 per cent carbonate.

Unit II, from 102 to 142 meters is an upper Miocene to upper Eocene brown marly nannofossil ooze to nannofossil clay (upper Miocene to upper Eocene) showing some cyclic sedimentation patterns. The carbonate content ranges from 20 to 95 per cent. A major decrease in sedimentation rate, or a hiatus, is recorded between mid-Miocene to lower Oligocene sediments.

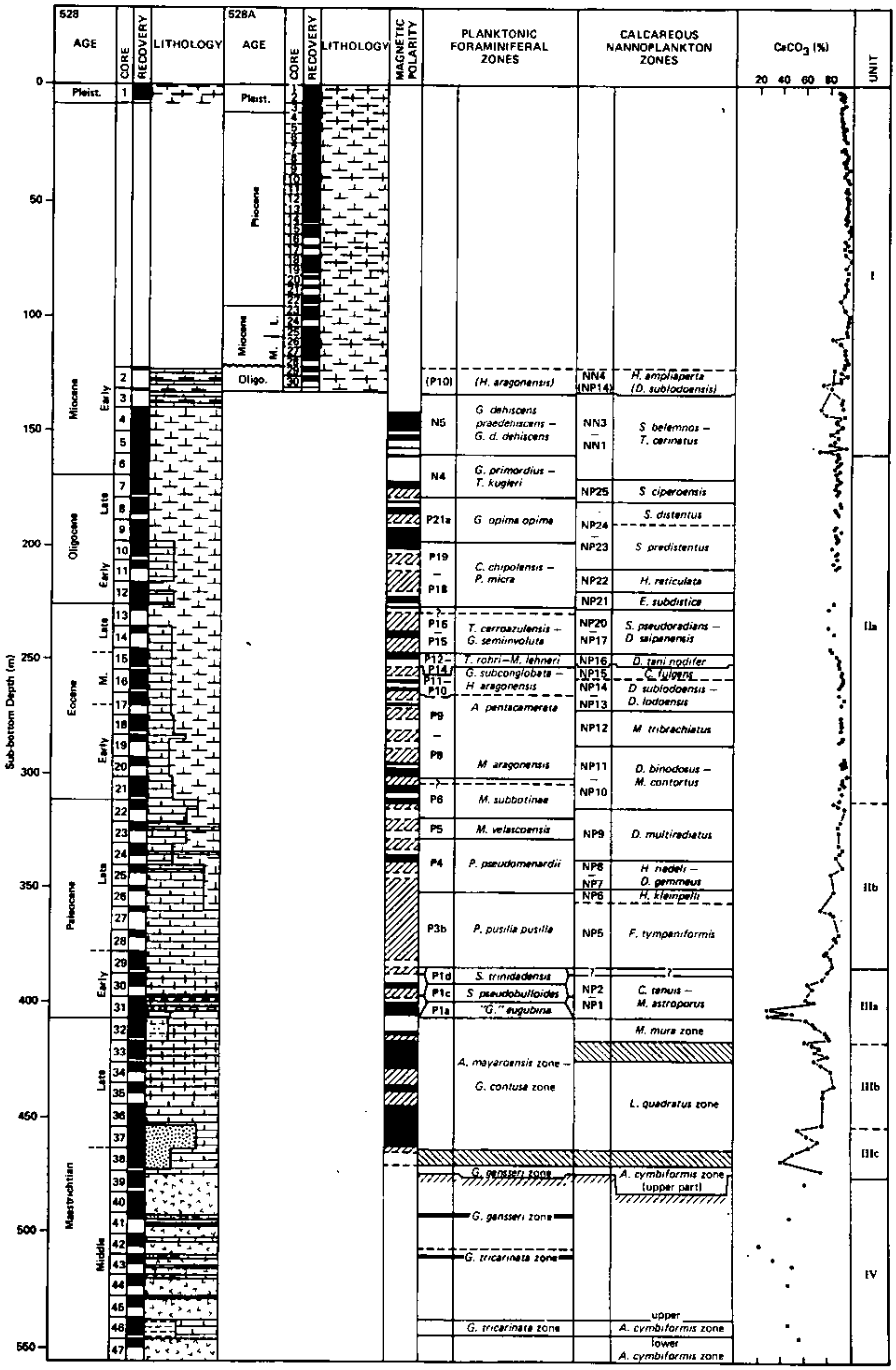

Figure 74-6. Site 528 stratigraphic summary.

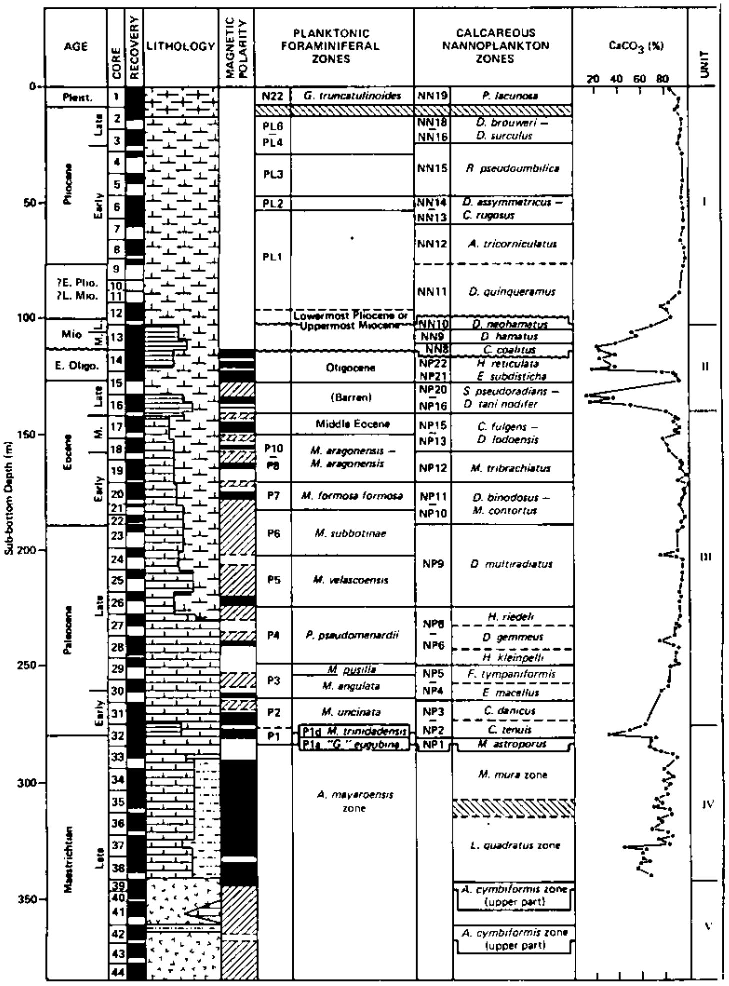

Figure 74-7. Site 527 stratigraphic summary.

Unit III, from 142 to 275 meters, consists of alternating beds of nannofossil chalk and ooze with chalk increasing with depth. The carbonate content is 85 per cent.

Unit IV, a reddish brown muddy nannofossil chalk, extends from near the well preserved Tertiary/Cretaceous boundary at about 275 meters to the top of the basement complex at 341 meters sub-bottom. The non-calcareous components are mainly volcanogenic sediment.

Unit V comprises 0.02-, 0.06- and 3.50-meter beds of nannofossil limestone and carbonate mudstone interbedded within the basaltic basement complex. A very sharp increase in calcium, and decrease in magnesium, occurs within the pore fluids here. The oldest sediment from both above and within the basement complex is mid-upper Maestrichtian.

We cored 44 meters into massive flow basalts and recognized two different types. The upper flow is altered, medium-grained, plagioclase olivine, clinopyroxene, phyric, basalt with large plagioclase, and mainly altered olivine, phenocrysts. The lower part is more altered and is a much finer-grained plagioclase, olivine clinopyroxene, phyric basalt. A few vesicles are filled with clay minerals.

The shipboard biostratigraphic and paleomagnetic results corroborate the crustal formation at Site 527 at the time of magnetic anomaly 31.

Lithologic Summary

We drilled five closely spaced sites in water depths ranging from 1035 to 4437 meters. Although we noted some obvious differences between sites in the shallowest and deepest water, the sediments are generally uniform from site to site. In general, from top to bottom, nannofossil and/or foraminifer nannofossil ooze grade into ooze and chalk sequences with a decreasing ratio of ooze to chalk and increasing volcaniclastic sediment with depth. Interbedded nannofossil chalk and limestone and volcaniclastic sediment occur within the basaltic basement complex. The carbonate content is high (>90%) throughout most of the sequences, but it tends to drop near their bases. Preservation of biogenic and primary sedimentary structures is generally poor to non-existent near the tops of the sections but tends to improve with depth. Graded turbidite sediments are found near the bottoms of the columns.

Basalt flows and lesser pillow basalts with intercalated sediment occur in the basement complex of all sites. The basalts range from aphyric to plagioclase-olivine-clinopyroxene phyric basalt. Although basalts with alkaline affinities have previously been dredged from near the Walvis Ridge, the suite recovered during Leg 74 has none of the mineralogical characteristics often associated with alkali basalts (pleochroic titan-augite, alkali feldspar abundant apatite). We therefore tentatively assume, pending shore-based geochemical study, that these are tholeiitic basalts.

Sediment Accumulation Rates

One of the Leg 74 objectives was to obtain information on the history of the carbonate dissolution profile through the water column. We were able to reconstruct approximate accumulation rates on board ship for three broadly defined sediment components: the coarse fraction composed chiefly of foraminifers, the fine carbonate fraction composed chiefly of coccoliths, and the non-carbonate fraction composed chiefly of volcanogenic material in the lower part, and mainly of clay, in the upper part of the section.

Figure 74-8 summarizes accumulation rates, in $g/cm^2/10^3y$, for each of these components over the past 70 million years. Ages were estimated using the time scale compiled by Vincent (1975)[1] for the Neogene, and by Hardenbol and Berggren (1978)[2] for the Paleogene. We also used shipboard magnetic measurements which were particularly helpful in our estimates of late Cretaceous sedimentation rates.

Overall accumulation rates reflect variations both in the production and in the dissolution of carbonate; only in the Late Cretaceous and the early Paleocene do volcanogenic sediments significantly contribute to the overall accumulation. They add 0.7, 0.8, and 1.0 $g/cm^2/10^3y$ to the three upper Cretaceous sections and about half that amount to the lower Paleocene section. Carbonate production averaged about 1 $g/cm^2/10^3y$ during the past three million years. The rate was probably about the same during the early Miocene, the mid-to-early Eocene and the Paleocene. Carbonate was being produced at over twice this rate during the Pliocene, and the latter part of the middle Miocene and at about half this rate during the late Miocene and much of the Oligocene. At the times of maximum carbonate production, the ratio of foraminifer to nannofossil production was highest, supporting the inference that this broad-scale variation reflects the history of regional fertility.

Superimposed upon this temporal pattern, we detect some variation in the vertical dissolution gradient. This is on the basis of foraminifer data in the shallowest part, and coccolith data,

[1]Vincent, E., 1975. Neogene planktonic foraminifera from the Central North Pacific, Leg 32, Deep Sea Drilling Project. *In* Larson, R. L., Moberly, R. *et al.*, 1975. Initial Reports of the Deep Sea Drilling Project, Volume 32, Washington (U.S. Government Printing Office), p. 765-791.

[2]Hardenbol, J. and Berggren, W. W., 1978. A new Paleogene numerical time scale. AAPG Studies in Geology No. 6, p. 213-234.

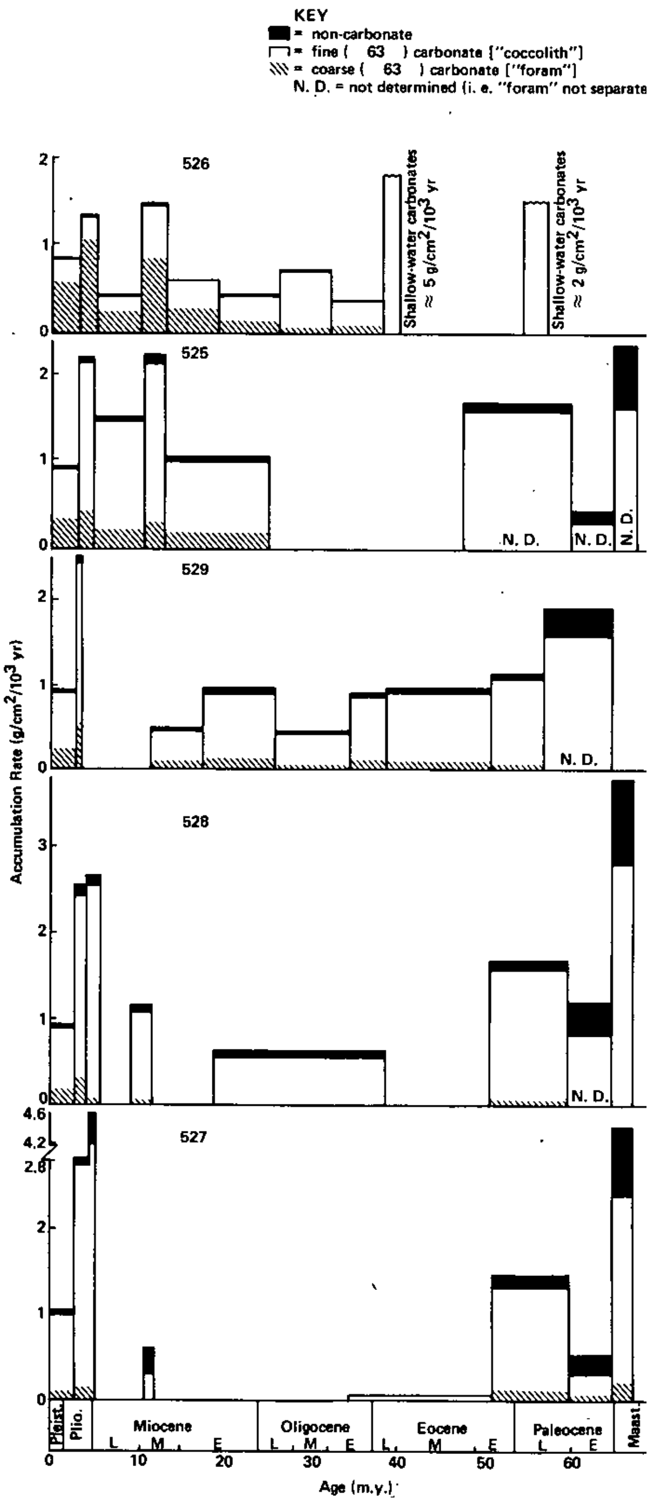

Figure 74-8. Sediment accumulation rates.

in the deeper part of our traverse). Pleistocene, Pliocene, and Paleocene, foraminifers occur even in the deepest site, Site 527; foraminifers accumulated at Site 528 except during the Oligocene. (Oligocene foraminifers are present but accumulated at a negligible — 0.007 $g/cm^2/10^3y$ — rate. No foraminifer-free sediment accumulated at the shallower three sites).

The degree of undersaturation of the upper part of the water column was considerably greater during the times of high carbonate production. If the carbonate dissolution rate at 2500 meters water depth had been as high in the late Miocene and Oligocene as it was during the last 3 million years or during the mid-Miocene, no foraminifers would have survived, yet we see that the Oligocene foraminiferal accumulation at 2500 meters (Site 525) was not much less than at 1000 meters (Site 526).

We did not have sufficient time to estimate the foraminiferal accumulation rates in the more indurated parts of the sections. These will be complicated by diagenetic effects.

We noted a second surprising phenomenon; the coccolith accumulation rate systematically increases downslope, showing that winnowing is not confined to the shallow part of the ridge. The accumulation rate of non-carbonate sediments varies in a similar manner in the upper part of the section where this component comprises fine-grain clay. Over the past five million years, coccoliths accumulated fastest in the deepest site at 4400 meters (Site 527). At other times when the CCD was shallower, coccoliths were dissolved from the deepest site. During the Oligocene, for example, coccolith accumulation was greatest at 3000 meters (Site 529), decreasing at shallower depths owing to winnowing, and in deeper water owing to dissolution.

Biostratigraphy and Evolution of Walvis Ridge Floras and Faunas

Within the Leg 74 area, sedimentation began upon the Walvis Ridge during the early Maestrichtian. The benthic faunas and the ratio of planktonic to benthic foraminifer sediments deposited in the forming basalt layers at both the shallower and deeper sites confirm the approximate depth of basalt formation predicted by their present-day depths and standard back-tracking techniques. Shallow-water faunas and turbidites from shallow pinacles near our sites, contain abundant *Inoceramus* fragments. Maestrichtian nannoplankton and planktonic foraminifers are typical of middle latitudes. Preservation, however, varies among the sites and appears to be strongly affected by the amount of sedimentary overburden. Nannofossils are moderately well preserved throughout, but foraminifers are poorly preserved at both Sites 525 and 529; the best preserved faunas are found at the deeper Site 527.

We cored the Cretaceous/Tertiary boundary in four continuous sedimentary sequences which contain diverse nannofossil and foraminiferal biotas. The sediments contain substantial amounts of volcanic material below the boundary at all sites, and up into the Paleocene at Site 525. A short zone of blue-gray sediment just below the boundary contains a warmer-water fauna, suggesting that slightly warmer surface waters moved into this area just before the end of the Cretaceous. All sediments contain calcareous ooze and moderately well preserved nannofossils, but rather poorly preserved foraminifers.

In the basal Paleocene, the volcanic contribution has altered the sediments to rich hues of brown and green at several sites; fossils are nontheless well preserved at all but Site 529. Here the sediments are strongly lithified, presumably owing to overburden. The basal Tertiary *G. eugubina* Zone was recovered, attesting to the relative stability of conditions. The Paleocene faunas are typical of those often found in the middle latitudes and floras contain temperate water mass indicators. The shallowest site probably lay close to sea level at this time and contained a carbonate shelf fauna subjected to large influxes of volcanic material. Sedimentation during the Paleocene was more continuous at the deeper, than at the shallower, sites; e.g., hiatuses were greater at Sites 525 and 529 at the end of the early Paleocene (Figure 74-9). Some of the best preserved nannofossils are found in the upper Paleocene of Site 529 despite the large overburden at this site.

Early Eocene faunas are relatively well preserved at all sites and indicate deposition at intermediate depths. The faunas contain sufficient warmer-water elements to indicate warmed surface waters in this area. Above this level, preservation worsens markedly and the South Atlantic episode of poorly preserved middle Eocene sediments is evidenced on the

Walvis Ridge. Hiatuses further interrupt this sequence and we found little continuity from the middle into upper Eocene suggesting intensified erosion. By the late Eocene, Site 527 was approachng the CCD and most of the foraminifers were dissolved. Nevertheless, the *nannoflora* was useful for zonation in this interval. Little of the late Eocene is revovered at any of the other sites; faunas contain typical middle latitude species and sediments are nearly all carbonate oozes. At this time, the shallowest site, Site 526, lay near the shelf/slope intercept as evidenced by the large amounts of redeposited shallower-water sediments and fossils.

The Eocene/Oligocene transition is preserved only at Site 529 where we recovered a thick transitional sequence containing well preserved biotas. A regression occurred at the shallowest site, Site 526, and consequently sediment was removed during this time. At the deeper sites,

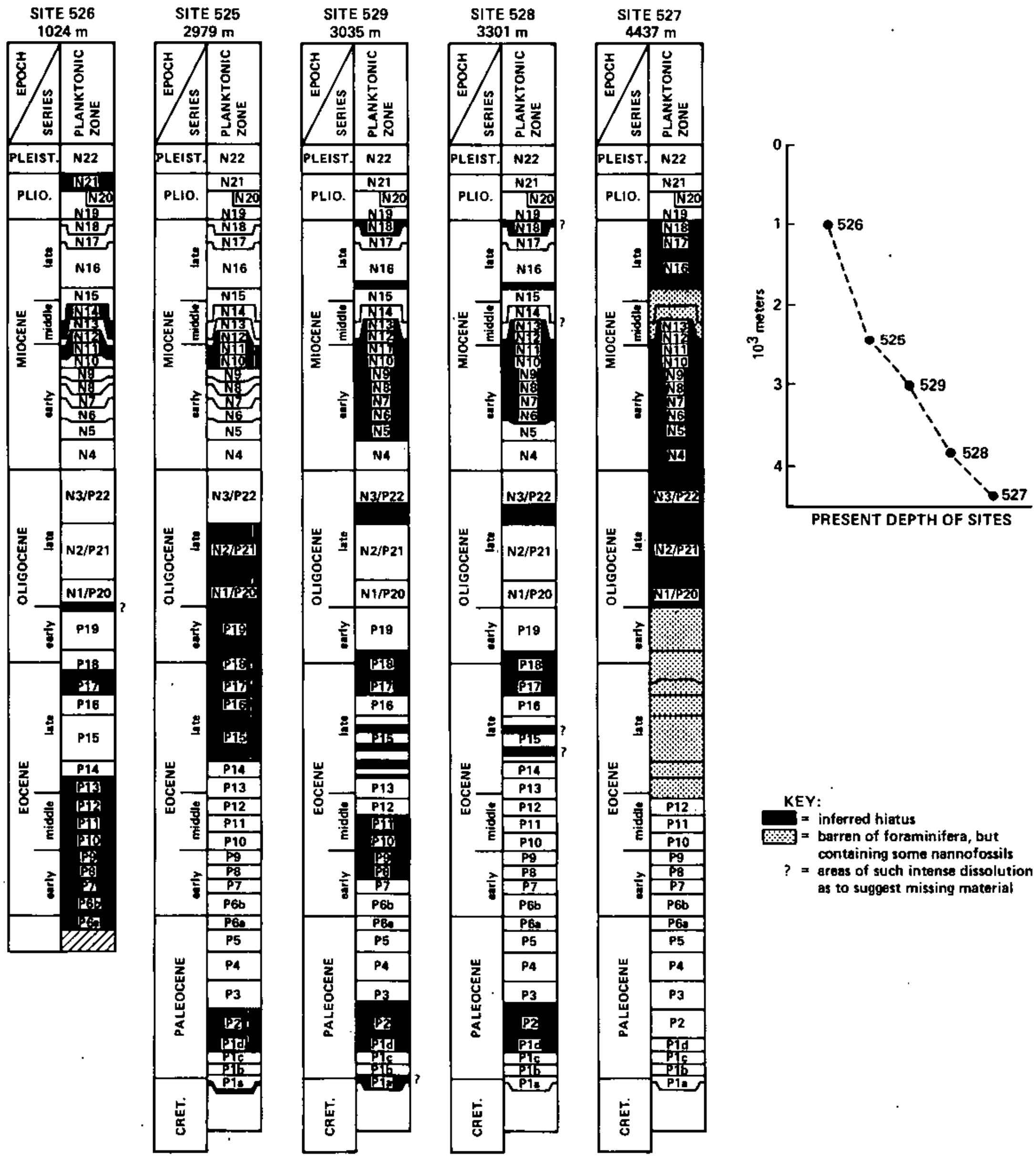

Figure 74-9. Tertiary hiatuses.

hiatuses vary in duration from less than a million years, to the entire early Oligocene. Site 529 was apparently in an area of active sediment slumping and removal, but was not itself subjected to sediment erosion.

The only continuous Oligocene sequence was recovered at Site 529. It contains temperate fossils which include several moderately well preserved boreal species. Drilling at the shallower site, Site 526, penetrated a nearly complete Oligocene section which must have lain at depths greater than 500 meters, although continuing to receive shallow-water materials. The effect of a middle Oligocene regression is marked by increased sediment erosion at the shallower site and by the presence of benthic foraminifers that suggest shoaling water depths. The other sites, however, apparently lay too deep to record the effects of the regression. Site 527 lay below the CCD for foraminifers throughout the Oligocene; only at Site 526 did we detect an interval of abundant *Braarudosphaera*.

The lower Miocene sequence contains hiatuses in the lower part at Site 528 and in the upper part at Site 529. The sedimentation rates were generally high at all sites. Above the base of the Miocene, which contains some warmer-water fossils, we found many boreal species. Foraminifer and nannofossils were well preserved except adjacent to the hiatuses. The sediment was nearly all intermediate-depth carbonate ooze, except at Site 527 which was a red clay.

Middle Miocene sediments are marked by hiatuses (Figure 9), redeposition, and higher water contents, as well as by core disturbance. We were unable to subdivide these intervals owing to the lack of tropical index fossils. The buildup of the Antarctic ice sheet, at this time, is evidenced by the lack of warmer-water fossils and erosional disruption of sedimentation producing somewhat longer hiatuses at the deeper sites.

The late Miocene carbonate ooze contained relatively well preserved middle latitude and temperate water biota in a relatively complete stratigraphic section. A change in benthic foraminifers at this time may correlate with the post Messinian high productivity episode in the Atlantic.

We recovered four very well preserved and apparently complete Pliocene sections containing boreal and temperate planktonic species. The deepest site, Site 527, emerged above the CCD at the beginning of the Pliocene and the fossils here are well enough preserved to allow detailed climatic studies. This site may have lain in a slightly different surface watermass (relative to the other sites) from the Pliocene onwards. A marked decrease in boreal species and their replacement by a typical middle latitude fauna appears to have occurred in the mid-Pliocene coincident with the extrapolated base of the Gauss interval. Pliocene sediments were recovered at Site 529, but active slumping throughout the Neogene renders the sequence here somewhat suspect.

Portions of the lower upper Pleistocene sediments contained well preserved temperate floras and faunas in coarse-grained foraminifer nannofossil ooze. Active slumping continued during the Pleistocene at Site 529.

Conclusions

- As suggested by crustal magnetic anomaly patterns, this part of the Walvis Ridge was formed at a mid-ocean-ridge spreading center. The age of the basement is approximately 69-71 million years (magnetic anomaly 31 to 32) with the sites in deeper water slightly younger than the upslope sites.
- The basement is composed of basaltic flows intercalated with nannofossil chalk and limestone containing a significant volcanogenic component. The basalts do not appear to have an alkalic composition, but shore-based geochemical studies are required to more accurately evaluate the type of basalt recovered.
- The sections are dominated by carbonate ooze and chalk. Dissolution apparently had a marked effect on accumulation in the deeper sites, particularly during the late Miocene, Oligocene, and late Eocene.
- Volcanogenic material is common in the Maestrichtian and lower Paleocene sediments and is probably derived from sources on or near the Walvis Ridge.
- Accumulation rates in the shallowest site drilled suggest that there were two peaks in carbonate supply to the sea floor: one during the early Pliocene, the other in the late middle Miocene. Carbonate production averaged 1 $gm/cm^2/10^3y$ during much of the rest of the Cenozoic.

- The rates of dissolution as a function of depth, calculated by combining data from all the sites, indicate that the upper part of the water column was more undersaturated with respect to carbonate during times of high carbonate production.

- The effects of winnowing on the sediments are shown by a systematic downslope increase in the clay (non-carbonate fraction) and coccolith (<63 μm size fraction) accumulation rates. The coccolith accumulation rate is lowered in the deepest site only during intervals of intense dissolution when the CCD and lysocline shoaled.

- Standard zonations for the foraminifer and calcareous nannofossils could be used through much of the section. The relative abundances of some species commonly used in tropical zonations, however, are low in this area, and the stratigraphic range of source species appear to be different. Our results indicate that the upper Maestrichtian foraminifer zones need to be revised. Careful correlation with the magnetic stratigraphies will help in establishing the possible diachronism of species datum planes.

- The Walvis Ridge faunas and floras are temperate; the uppermost Maestrichtian and early Eocene faunas appear to be warmest and the middle Miocene and lower Pliocene faunas appear to be cooler-water types. The boreal elements of the lower Pliocene fauna are replaced by more temperate forms in the mid-Pliocene.

- The Cretaceous/Tertiary boundary, spanned by sediments containing well preserved nannofossils, was recovered in four of the five sites. The basal Tertiary *G. eugubina* Zone was also recovered.

- The shallowest site (526) did not sink below sea level until the late Paleocene. Here, benthic faunas are distinctly different from those of the deeper sites and from sites on continental slopes at similar depths.

- The effect of a middle Oligocene regression is recorded by the benthic foraminifers of Site 526 which indicates that water depths rapidly shoaled and then deepened. Other sites were too deep to record a change in the benthic fauna.

Leg 75[1]
Walvis Ridge

Leg 75 began in Walvis Bay, South Africa on 26 July and ended in Recife, Brazil on 6 September 1980. Eight holes were drilled at three sites on the Walvis Ridge.

Introduction

Legs 71 through 75 were devoted to the study of late Mesozoic and Cenozoic paleoenvironments in the South Atlantic Ocean. Leg 75 was planned to study, in particular, the development of anaerobic conditions in ancient oceans and the effect of the Walvis Ridge as a barrier to oceanic circulation in the South Atlantic.

Anaerobic sediments indicative of deposition in a reducing environment are not extensive in the modern open ocean; the location and the extent, however, of such depositional environments are of exceptional interest because high concentrations of organic carbon can accumulate and be preserved under such conditions. Today such environments are restricted either to isolated basins whose bottom waters are not, or are only very slowly, renewed, or to substrates beneath the oceanic mid-water oxygen minimum developed under highly fertile and productive surface-water masses along continental margins. Prime examples of the first case, euxinic conditions, are the Black Sea and the Cariaco Trench. Examples of the second case are known from the continental margins off west India, southwest Africa, and from the Gulf of California. The two types of depositional environments are similar because laminated anaerobic sediments with a high organic carbon content occur in both, but they can be distinguished by reconstruction of their paleogeographic and paleobathymetric setting and by analyses of the fossil contents of their sediments.

Conditions favorable to the development of black shales in the deep ocean occurred several times during the Cretaceous when anaerobic sediments were laid down over wide regions in several ocean basins.

[1]From a Leg 75 preliminary report prepared by William W. Hay, Jean-Claude Sibuet (co-chief scientists), Eric J. Barron, Robert E. Boyce, Simon Brassell, Walter E. Dean, Barbara H. Keating, Charles L. McNulty, Philip A. Meyers, Masato Nohara, Roger E. Schallreuter, John C. Steinmetz, Dorrik Stow, and Herbert Stradner.

Results from Leg 40 have shown that at Site 361 in the Cape Basin (4549 meters water depth), the lowermost 313 meters are alternating upper Albian to lower Aptian black shale, sandy mudstone, and sandstone. The shale showed little variation in composition and the organic carbon content averaged 3 per cent (by weight).

At Site 363 on the Walvis Ridge (2248 meters water depth) we found no black shale, but encountered 2- to 4- cm thick beds of organic carbon-rich black pyritic mudstone in upper Albian strata, suggesting that at least localized reducing conditions existed.

At Site 364 on the continental margin off Angola (2439 meters water depth) we found black shale and organic carbon-rich limestone in the lower Santonian-upper Albian and in the lower Albian-upper Aptian; organic carbon content of individual beds reaches up to 26 per cent.

The main scientific objective of Leg 75 was to investigate the environmental history of the South Atlantic and to determine whether the Cretaceous black shale was deposited in the bottom of a barren, anoxic basin or at mid-depths within the oxygen minimum layer of a quasi-normal oceanic basin, and whether the anoxia was a result of an abnormally high influx of organic matter, or was caused by salinity or temperature-induced stratification.

Another objective, linked to this primary question, was to study the oceanographic effects of the subsidence of a continuous aseismic ridge attached to a passive continental margin. Unlike the Rio Grande Rise, the Walvis Ridge has no deep passages to permit northward flow of bottom waters and it was important to determine the extent to which the Walvis Ridge has served as a dam to circulation and to current-transported sediments.

Table 75-1 summarizes occupation at the three Leg 75 sites; their locations are shown on Figure 75-1. We devoted most of the drilling time to three holes at one site, Site 530, in the Angola Basin. Drilling at Site 531 was attempted on a guyot-like feature on the Walvis Ridge but could not be spudded in. We devoted the remainder of the time to hydraulic piston coring at Site 532, near the Leg 40 Site 362, to obtain a detailed record of the Benguela upwelling system.

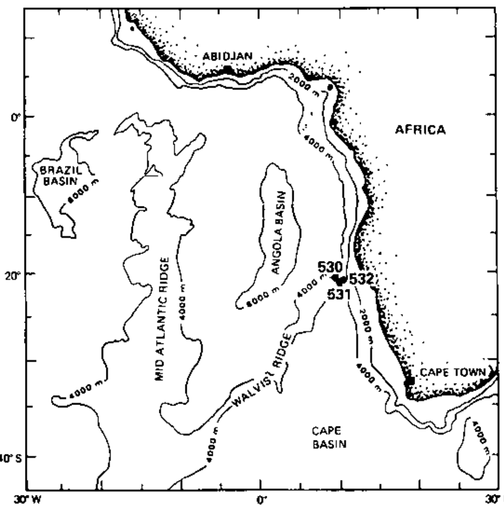

Figure 75-1. Location map of Sites 530, 531, and 532.

Site 530

Site 530 is in the southeastern corner of the Angola Basin, about 20 km north of the Walvis escarpment, near the eastern end of the Walvis Ridge. It lies on the abyssal floor of the Angola Basin and exhibits a seismic stratigraphic sequence typical for the entire deep part of the basin.

Magnetic lineations of the basement are not distinct at Site 530. The M sequence (M0 to M11) has been clearly identified in the Cape Basin south of the Walvis Ridge by Rabinowitz (1976)[1]. Cande and Rabinowitz (1978)[2] have published an interpretation of the Angola Basin anomalies in which they suggest that a ridge jump occurred approximately at the time of Anomaly M0 or later, so that the basement at Site 530 would be lower Aptian or younger. One of the objectives of drilling at this site was to determine the basement age and establish whether the hypothesis of a ridge jump in the southern Angola Basin is correct.

[1]Rabinowitz, P. D., 1976. A geophysical study of the continental margins of Southern Africa. Geol. Soc. Amer. Bull., v. 27, p. 1643-1653.

[2]Cande, S., and Rabinowitz, P. D., 1978. Mesozoic seafloor spreading bordering conjugate continental margins of Angola and Brazil. Proc. of Offshore Technical Conference, Rep. OTC 3268, Houston, 1869-1876.

Table 2. Leg 75 Coring Summary

Hole	Dates (1980)	Latitude	Longitude	Water Depth[1] (m)	Sub-bottom Penetration (m)	No. of Cores	Meters Cored	Meters Recovered	Per Cent Recovery
530	29-30 July	19°11.26′S	9°23.15′E	4629	125	2	11.0	9.2	83.6
530A	30 July-15 August	19°11.26′S	9°23.15′E	4629	1121.0	108	996.0	619.46	62.2
530B	15-18 August	19°11.26′S	9°23.15′E	4629	180.6	48	180.6	155.08	85.9
531	19 August	19°38.44′S	9°35.31′E	1267	1	1	1	0.02	2
531A	19 August	19°38.44′S	9°35.47′E	1267	1	1	1	0.27	27
532	20-21 August	19°44.61′S	10°31.13′E	1331	250.8	61	250.8	232.44	92.7
532A	21-23 August	19°44.64′S	10°31.13′E	1331	199.6	47	199.6	161.15	80.7
532B	23-25 August	19°44.66′S	10°31.13′E	1331	291.3	74	291.3	267.0	91.7
						342	1859.3	1444.62	78.0

[1]Water depths from sea level.

Extensive multi-channel seismic surveys of the area had been carried out by the University of Texas Marine Science Institute and the Bundesanstalt für Geowissenschaften und Rohstoffe. Correlating the results of drilling at DSDP Sites 362 and 363 with the processed multi-channel seismic profile (BGR-36) allowed us to identify three main sequences bounded by discontinuities on the adjacent Walvis Ridge. The lowest surface of discontinuity was thought to be a paraconformity where the Cenomanian and much or all of the Turonian would be missing, as at Site 363; the middle discontinuity was expected to be early Oligocene, the top of the *Braarudosphaera* chalk as noted at Sites 362 and 363; the upper discontinuity was expected to be middle Miocene corresponding to strata which had been drilled at Site 362. Because of the water depth difference and probable differences in sedimentary facies, we could not with certainty extend this seismic stratigraphy to the deep Angola Basin — except for the lowest discontinuity which can be recognized throughout the area. This discontinuity is thought to correspond to a Cenomanian-Turonian hiatus also known to occur near the base of the upper black shale sequence at Site 364. Prior to drilling the interpretation of seismic stratigraphy was limited to tracing the lower discontinuity and to studying the basal onlap of the sequence above it. We recovered only two cores from Hole 530 before a dropped heat-flow tool plugged the drillstring and forced us to abandon the hole.

We washed Hole 530A to 125 meters sub-bottom, then continuously cored it to basalt at about 1103 meters sub-bottom. We recovered three basalt cores before slow drilling progress forced us to terminate the hole.

Although we attempted to measure the water temperature (heat probe) near the bottom of the hole at two intermediate levels and at the mud line the results were unsatisfactory. Following some operational difficulties, however, we successfully ran the gamma-ray log, sonic log, induction log, laterolog, neutron log and temperature log in the bottom part of the hole.

We continuously cored Hole 530B with the hydraulic piston coring to a sub-bottom depth of 180.6 meters, taking 48 cores.

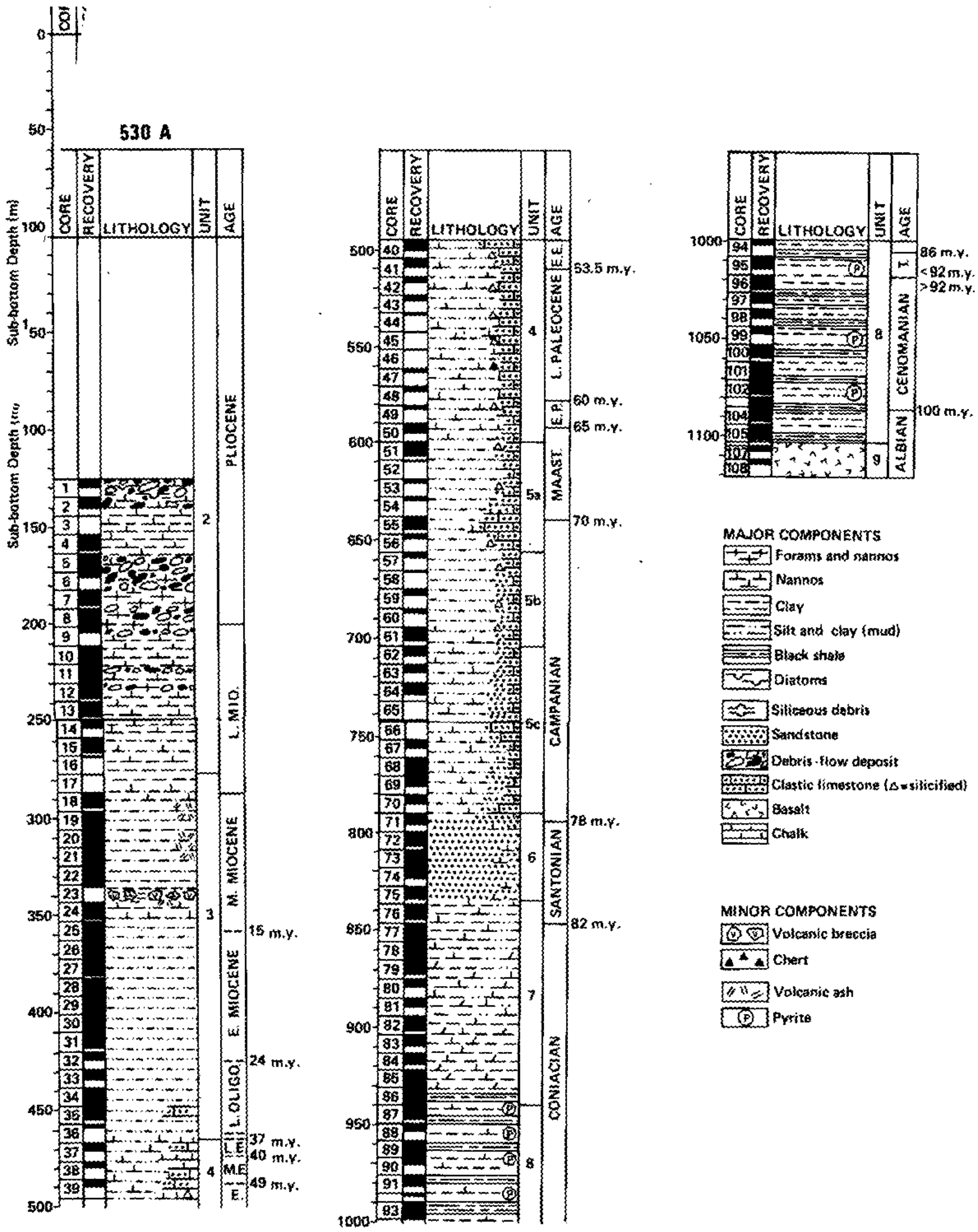

Figure 75-2. Stratigraphic column for Hole 530A.

Figures 75-2 and 75-3 summarize the stratigraphic sequences at Hole 530A, and 530B.

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Nine lithologic units, eight sedimentary and one basalt, were recognized at Site 530 in the southern Angola Basin (Table 75-2).

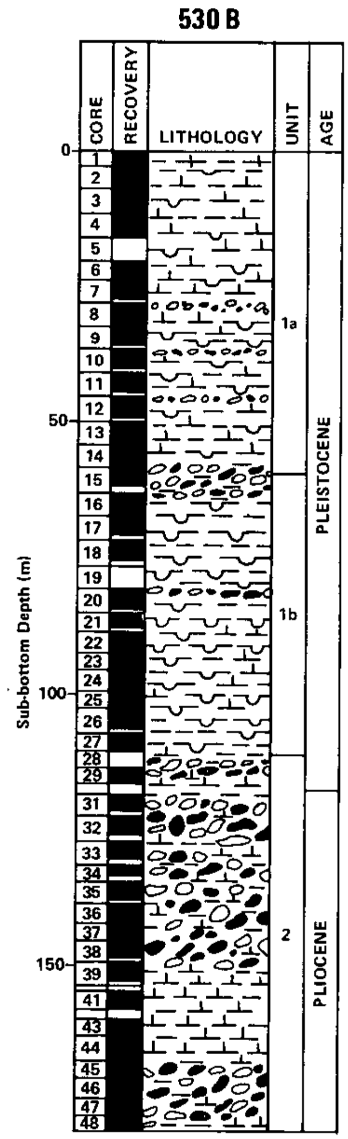


Figure 75-3. Stratigraphic column for Hole 530B. (See Figure 75-2 for legend to lithologic symbols.)

Unit 1: Nannofossil marl and ooze, diatom ooze, and debris-flow deposits (0 to 110 meters sub-bottom; Pleistocene, 0-1.7 m.y.B.P.)

Unit 1 sediments contain mixtures of nannofossils, diatoms, and clay, in roughly that order of abundance. The debris-flow deposits and turbidites are superimposed on these background pelagic sediments at a number of horizons within the unit. The unit is subdivided into two sub-units on the basis of relative abundance of diatoms and nannofossils.

More abundant nannofossils and foraminifers in **Sub-unit 1a** records a deepening CCD during the Pleistocene and Holocene. Numbers of diatoms increase in the older Pleistocene and Pliocene sediments. The Pleistocene and Holocene sediments, rich in both diatoms and calcareous microfossils, are interbedded with debris-flow deposits and diatom-rich mud turbidites.

Maximum diatom productivity occurred during the Pliocene, and is probably associated with the maximum extent of upwelling conditions off the coast of southwest Africa. Shoaling of the CCD, as indicated by low to nil concentrations of carbonate, and high diatom productivity resulted in the accumulation of diatom-rich, carbonate-poor sediments interbedded with debris-flow deposits to form **Sub-unit 1b**.

The debris-flow deposits are present at several horizons within Unit 1 and are thicker toward the base of the unit to a maximum thickness of about 6 meters. The clasts of this debris-flow deposit comprise at least 7 or 8 different lithologies found in overlying and underlying sequences, and include calcareous and siliceous marl, mud, and a few sandy clasts and shell fragments. Sizes of clasts vary, and range from about 5 mm to at least 40 cm in maximum dimension. Most clasts are elongate and are subrounded to well rounded. Stages of clast disintegration vary from those with sharp, well defined outlines, to those with completely smeared-out multicolored streaks and mottles. Some clasts are in contact with each other but most are supported in a dominantly diatom-nannofossil ooze matrix.

The clasts within the debris-flow deposits probably came from sediments deposited at approximately the same time on the Walvis Ridge. The larger flows can be interpreted from seismic reflection profiles to have moved down slope 15 to 20 km. Thick (20-100 cm)

Table 75-2 Composition, cores, and depths of occurrence, thickness, age, and sedimentation rates of lithologic units cored at Site 530, southern Angola Basin

Unit	Lithology	Cores	Sub-bottom Depth (m)	Thickness (m)	Age	Sedimentation Rate (m/m.y.)
1a	Diatom nannofossil marl and ooze and deposits	530B, 1-14	0-58	58	Holocene to Pleistocene	?
1b	Diatom ooze and debris-flow deposits	530B, 15-27	58-110	52	Pleistocene	
2	Nannofossil clay marl, and ooze and debris-flow deposits	530B, 28-48; 530A, 1-16	110-277	167	Pleistocene to upper Miocene (1.7-10 m.y.b.p.)	20
3	Red and green mud	530A, 17-36	277-467	190	Lower Miocene to Oligocene (10-37 m.y.b.p.)	9
4	Multicolored mud-stone, marlstone, chalk, and clastic limestone	530A, 37-50	467-600	133	Eocene to Maestrichtian (37-66 m.y.b.p.)	5
5a	Dark green mud-stone, marlstone and clastic limestone	530A, 50-55	600-647.5	47.5	Maestrichtian (66-69 m.y.b.p.)	16
5b	Dark green mud-stone, marlstone, clastic limestone, and siliciclastic sandstone	530A, 56-61	600.5-704.5	57	Maestrichtian to middle Campanian (69-70.5 m.y.b.p.)	38
5c	Dark green mud-stone, marlstone, and calcareous siliciclastic sandstone	530A, 62-70	704.5-790	85.5	Middle-lower Campanian (70.5-77.5 m.y.b.p.)	11
6	Glauconitic sandstone	530A, 71-75 Sect. 1 & 2	790-831	41	Upper-middle Santonian (77.5-80.5 m.y.b.p.)	
7	Variegated red and green clay-stone, siltstone, and sandstone	530A, 75, Sect. 3-86	831-940	109	Lower Santonian to Coniacian (80.5-84 m.y.b.p.)	31
8	Red and green claystone and marlstone with interbedded black shale	530A, 87-105	940-1103	163	Coniacian to Albian (84-102.5 m.y.b.p.)	9
9	Basalt	530A, 105, CC-108	1103-1121	19		

clay-diatom turbidites are approximately equal in abundance to pelagic ooze and marl in subunit 1a. The turbidites may also have come from the Walvis Ridge where similar materials of the same age were recovered at Sites 362 and 532.

Unit 2: Nannofossil marl, clay, and ooze and debris-flow deposits (110 to 277 meters sub-bottom; Pliocene and upper Miocene, 1.7-10 m.y.B.P.).

Unit 2 comprises mainly calcareous biogenic sediments interbedded with thick debris-flow deposits and thin mud turbidites. Sediments are light greenish gray to olive to olive gray; the darker colors reflect an increasing clay content. The biogenic sediments are composed mainly of nannofossils, with variable contents of foraminifers, clay, and source siliceous material. The marked increase in carbonate as nannofossil marl and ooze, beginning in the late Miocene probably resulted from a combination of rapid deepening of the CCD and increased productivity as the Benguela upwelling system came into being. Turbidity currents supplied fine-grained clastic sediments that formed clay-marl-ooze cycles in Unit 2 but most of the sediment that accumulated was pelagic nannofossil debris. The oldest evidence of sediment supply from the Walvis Ridge is recorded by the debris-flow deposits that began to accumulate during the late Miocene. The thickness of the largest debris flow deposit near the top of Unit 2 is at least 32 meters. As in Unit 1, the clasts include 7 or 8 multicolored mud, marl, and ooze lithologies, as well as a few basalt pebbles. Here they range up to 60 cm in diameter. The base of this unit coincides with a change in sonic velocity and density of the sediment.

Unit 3: Green and red mud (277 to 467 meters sub-bottom; basal Miocene through upper Oligocene, 10-30 m.y.B.P.)

Unit 3 comprises very thinly bedded basinal turbidite, pelagic clay, and volcanogenic-palagonitic silt. The sediments were deposited from the late Oligocene to the late Miocene following a period of much reduced sedimentation during middle Eocene through early Oligocene. Seismic reflection profiles show that the equivalent of this unit extends over much of the Angola Basin and was dominated by sediment contribution from the African continental margin.

The lower Oligocene may be represented at the base of the unit by a condensed section with hiatuses. The base of Unit 3 corresponds to the widespread lower seismic discontinuity — the anticipated Cenomanian-Turonian hiatus.

Unit 4: Multicolored mudstone, marlstone, chalk, and clastic limestone (467 to 600 meters sub-bottom; Eocene, Paleocene, and upper Maestrichtian, 50-66 m.y.B.P.).

Unit 4 comprises small amounts of red and dominantly green mudstone, calcareous mudstone, and marlstone, with numerous interbeds of nannofossil chalk and clastic limestone. The colors vary with the proportions of carbonate present: white and bluish white limestone, yellowish gray chalk, greenish and olive-gray mudstone, dark greenish gray mudstone, pale yellow marlstone, brownish gray mudstone.

The clastic limestone beds contain mainly shallow water carbonate debris, including benthic reef foraminifers, shell debris, and fragments of calcareous algae and bryozoans, mixed with volcanic rock fragments, quartz, feldspar, glauconite and heavy minerals. The carbonate and mud tend to occur as turbidites with sharp, scoured, and loaded bases, and with more gradational, bioturbated tops.

The Cretaceous/Tertiary boundary (65 m.y.B.P.) is well represented in this unit, and is documented by, moderately to well preserved, nannofossils in Core 50, Section 2 (593.0 meters). Study of nannofossils on board ship revealed that the boundary lies between 14 cm and 53 cm in Core 50 in Section 2. The boundry is not a sharp break between Maestrichtian and Paleocene assemblages and some interlayering or mixing may be present. Paleomagnetic studies show a shift in polarity just below the paleontologic boundary that is normal above and reversed below 63 cm. Further shore-based studies of additional samples should reveal the precise location and nature of the boundary on the basis of first occurrences of Tertiary nannoplankton.

Unit 5: Mudstone, marlstone, clastic limestone, and siliciclastic sandstone (600 to 790 meters sub-bottom; lower Maestrichtian and Campanian; 66.7-77.5 m.y.B.P.).

Unit 5 contains no chalk beds, and interbeds of clastic limestone are less common downward. The carbonate clastic debris is replaced by dark-colored siliciclastic sandstone down section and by glauconitic sandstone near the base of the unit.

Partly silicified fragments of the large mollusk *Inoceramus* are present in many of the cores. The fragments consisting of slabs 0.5 to 1.0 cm thick fibrous calcite (the prismatic layer of the mollusk shell), are usually oriented parallel to bedding, and often occur as continuous or partly broken layers. Most *Inoceramus* fragments have a broken gray outer rim of varying thickness in which the calcite has been replaced by silica.

Several irregular sequences of thickening and thinning turbidites in Unit 4 and 5 suggest that these sediments may have been deposited on fan lobes and in small channels.

The base of Unit 5 is marked by an increase in sonic velocity and a decrease in density reflecting the relatively high velocity but a low density of the glauconitic sandstone of Unit 6.

Unit 6: Glauconitic sandstone (790 to 831 meters sub-bottom; Campanian-Santonian, 77.5-80.5 m.y.B.P.).

The dominant lithology is carbonate-cemented, greenish black, glauconitic sandstone with limonitic ooids which were probably altered from glauconite or chamosite. The sand occurs as thin (5-10 cm) to thick (1-3 meters) graded turbidites. Many of the turbidites show complete Bouma sequences.

We initially thought that these coarse materials were derived from the top of the Walvis Ridge. By back-tracking the bathymetry of the ridge, however, we inferred that most of the ridge crest was already deeply submerged (about 1 km) by the time the first coarse glauconitic sands were deposited during the Santonian (about 81 m.y.B.P.). Possibly one or more volcanic islands or seamounts with shallow water platforms were present, but we have no bathymetric evidence to suggest that these features existed. We conclude, therefore, that the source of the coarse clastic was probably the African continental margin, channeled into the basin down submarine canyons.

Unit 7: Variegated red, green and purple claystone, siltstone, and sandstone (831 to 940 meters sub-bottom; lower Santonian and upper Coniacian, 80.5-84 m.y.B.P.).

Unit 7 comprises red claystone with interbeds of green, red, and purple siltstone and claystone, and green sandstone forming numerous repeated turbidite sequences.

Unit 8: Red and green claystone and marlstone with interbedded black shale (940 to 1103 meters sub-bottom; lower Coniacian, lower Turonian, Cenomanian and upper Albian, 85-102.5 m.y.B.P.).

Unit 8 is dominantly red and green claystone with some black shale beds. Faint horizontal laminae and low-angle cross-laminae suggest that the greenish gray and grayish red claystone beds are probably fine-grained turbidites interbedded with basinal pelagic sediments.

The black shale beds average 5 per core and are commonly between 2 and 15 cm thick; they are interbedded with green claystone. The black shale beds may contain very low-amplitude ripples, as well as fine horizontal lamination and bioturbation structures. They are commonly fissile and, more rarely, massive.

A hiatus representing the late Turonian (86-90 m.y.B.P.) occurs within this unit, but does not have any pronounced physical expression.

The sediments in Units 8 through 6 comprise a classic progradational submarine fan sequence grading from basinal (Unit 8) and lower-fan deposits (Unit 7), through middle fan lobe and channel sediments (Unit 7), to a thick upper-fan channel sandstone (Unit 6). These are overlain by a thinning- and fining-upward channel fill sequence (Unit 5c). We do not yet have direct evidence for the source of these basinal and fan sediments, but the shape of the sedimentary wedge on seismic reflection profiles suggests that all of these sediments were derived from the African continental margin. The coarse-clastic turbidites consist mostly of shallow-water debris, which is particularly evidenced by the oolitic glauconitic sand and shallow-water carbonate sand. These different materials, first glauconitic sand, then siliciclastic sand, and finally carbonate sand, were progressively supplied to Site 530 either by change in sediment type in the same general source area, or by contributions from several different sources. The fact that we commonly saw massive or interlaminated mixtures of two coarse-clastic types suggests that the different materials were supplied from the same general area either by exposure, by erosion of different types of sediment or, more likely, by progressive formation and accumulation of different sediment types in the same general source area.

The green color in Unit 8 is the result of diagenetic reduction of iron in red clay around layers rich in organic matter that subsequently formed the black shales. We suggest the following sequence of events for the interbedded red, green, and black clay lithologies observed in Unit 8.

a. The red clay matrix containing low concentrations of organic matter was deposited by pelagic and turbiditic processes. Deposition of this background sediment was interrupted periodically by the deposition of clay containing high concentrations of organic matter, also deposited as distal turbidites. Both clay types were deposited in an oxygenated bottom-water environment.

b. The high biological and chemical oxygen demand of the clay layers rich in organic matter produced reducing conditions within the sediments, and perhaps also in the bottom waters overlying the sediments.

c. H_2S was produced in the sediments by sulfate reducing bacteria and may have accumulated, at least for a short distance in the overlying bottom-waters, if the H_2S was supplied at a rate greater than O_2 and/or if O_2 was removed at rates greater than that of H_2S by bottom currents. The accumulation of H_2S in the bottom waters for some distance above the sediment/water interface would be aided by reduced bottom-water circulation, but the primary cause of anoxic conditions was the high biological and chemical oxygen demand within the sediments. We have no evidence that reducing bottom waters existed for any extensive period of time after deposition of the organic carbon-rich clays. The dominant regime during the deposition of Unit 8 (and overlying Unit 7) was one that permitted the accumulation of oxidized organic carbon-poor red clay.

d. The organic carbon-rich clay layers became anoxic almost immediately after deposition because of the high oxygen demand within the sediments. Reducing conditions extended for a short distance into the underlying red clay and into overlying clay layers as they were deposited until oxidizing conditions could be re-established. This sequence of events would produce a sequence of red clay with a black clay layer sandwiched between two green clay layers that were produced by reduction of the red clay. If another organic carbon-rich layer was deposited before oxidizing conditions were re-established the resulting sequence would be alternating green (reduced red clay) and black clay beds.

e. We believe that the color of the organic carbon-rich clay layers is black owing mainly to organic matter and presence of FeS. The reduction of iron in the clay adjacent to the black clay would result in the green color of these adjacent beds. It would also cause the migration of iron and sulfate ions toward the organic carbon-rich beds to produce localized concentrations of FeS at the boundary between the black organic carbon-rich bed and underlying organic carbon-poor bed. In time the FeS was converted to FeS_2 which resulted in the pyryte concentrations commonly found at the contact between a black shale and underlying green claystone.

In the South Atlantic, black shales were formed during two distinct periods: the Aptian-early Albian and the late Albian-Coniacian. The earlier event was widespread; it is recorded in sediments of the Angola Basin (Site 364), the Cape Basin (Site 361) and the Falkland Plateau (Sites 327, 330 and 511). The later event was a more limited occurrence being previously detected only from the Angola Basin (Sites 363 and 364) and the northern slope of the Rio Grande Rise (Site 516). Black shales, however, were also formed during the late Albian-Coniacian in the southern North Atlantic (e.g. Cape Verde Basin, Site 367).

At Site 530, upper-Albian to Coniacian the black shale contains up to 16.5 per cent organic carbon and is comparable with that of a similar age from Site 364. Shipboard analyses show that the organic matter in the black shale is mainly derived from marine organisms, but a few samples also contain terrestrially derived organic matter. If shore-based studies corroborate these preliminary findings, then the formation of black shale at Site 530 may be very similar to that at Site 364 where the upper Albian-Coniacian black shale contain organic matter either of marine origin or of mixed marine/terrestrial origins with up to 8 per cent plant debris. In contrast, the organic matter of the earlier Aptian-Albian black shale at Site 364 was derived wholly from marine sources.

At Site 530, all the organic matter within the black shale is immature as shown by its low production index, the temperature of the maximum hydrocarbon production recorded during Rock-Evaluation pyrolysis, and by the absence of significant levels of gaseous hydrocarbons formed by diagenetic processes.

The upper Miocene-Pleistocene biogenic ooze recovered with the hydraulic piston corer is high in organic carbon (up to 6%), although it shows evidence of extensive bioturbation. The organic matter is predominately of marine origin, and is certainly related to the high productivity of the Benguela upwelling system.

A calculation of the mass of organic carbon in Cretaceous Unit 8 gives 0.37 kg/cm for the lower 240 meters of the sediment column. The Pleistocene and Pliocene sediments contain more than 0.40 kg/cm in the upper 200 meters of sediment. The porosity is about 60 per cent in the upper sediments and about 35 per cent in the basal sediments thus the Pleistocene-Pliocene accumulation was actually much greater than the Cretaceous accumulation.

Unit 9: Basalt (1103-1121 meters sub-bottom).

We cored 19 meters of medium gray, fine-grained basalt containing veins and vugs filled with calcite. The contact between the basalt and red mudstone of Unit 8 occurs in the core-catcher sample of Core 530A-105. Here the basalt is light gray with a thin, white, altered glassy layer immediately below the mudstone. White veins and veinlets of calcite extend from the basalt into the overlying reddish mudstone for a distance of about 5 cm. The meter of mudstone above the basalt appears to be hydrothermally altered or baked.

The oldest sediment at Site 530 is upper Albian. Using van Hinte's (1976) time scale and extrapolating the previous sedimentation rate, we infer its age to be 102.5 m.y.B.P. Assuming a constant sea-floor spreading rate for the creation of the oceanic crust older than anomaly 34 (79 m.y.B.P.), we predict that the oldest oceanic crust at the ocean-continent boundary is 106 to 108 m.y.B.P. (i.e., early Albian). This supports the hypothesis of a ridge crest jump in latest Aptian as proposed by Cande and Rabinowitz (1978) just after the salt deposition. This ridge jump explains both the lack of salt deposits in the southeastern Angola Basin and the relative eastward shift of the Anomaly 34 lineation with respect to the axis of symmetry of the South Atlantic.

Site 531

Marine geologists need to understand the subsidence history of the Walvis Ridge in order to interpret the paleoceanography of the southwest Atlantic. The best calibration points for subsidence of the ridge are the moments when particular topographic features subsided below sea level.

The BGR-36 processed seismic profile shows a flat-topped platform at this site. As this guyot-like structure is at a water depth of only 1300 meters we suspected that it had subsided below sea level more recently than other deeper parts of the ridge. Preliminary estimates suggested that the platform subsided below sea level about 20 million years ago — after the formation of the adjacent ocean crust — and would provide precise calibration for the ridge subsidence curve.

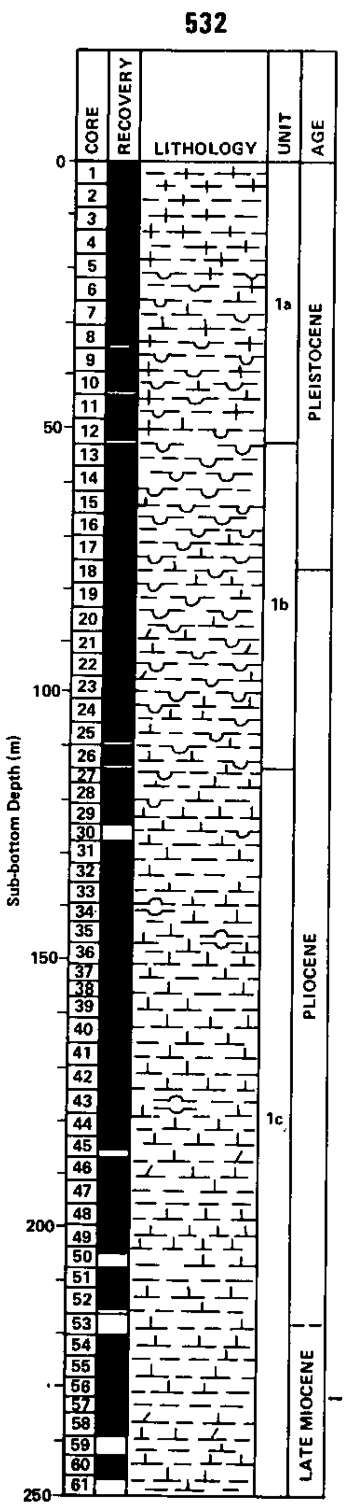
A very hard bottom foiled, two attempts to spud in at Site 531 but two cores were recovered which contain a small amount of Pleistocene-Holocene foraminifer ooze. The second core, taken at Hole 531A, contains a single small rock fragment about 1 centimeter across. The rock fragments consist dominantly of rounded to subrounded, coarse, sand-size fragments of volcanic rock, red coralline algae, mollusks, and possibly coral cemented by calcite. Red coralline algal fragments form about 70 per cent of the total. Much of the biogenic material is replaced by cryptocrystalline calcite, although the cellular structure of the red algae is well preserved. The sediment is well sorted and the rock is grain-supported with sparry calcite cement in the intergrain spaces.

The shallow-water indicators found at this site are considerably better preserved than the recrystallized, rounded grains collected at Site 362. The virtual absence of younger sediments suggests that at least the edges of the plateau have been swept clean by currents. This reef-like accumulation extends the maximum extent of the Cretaceous carbonates in the southern hemisphere by 4 to 5° poleward.

Site 532

Site 532, located on the eastern part of the Walvis Ridge, is in a trough filled with relatively thick sediment accumulations. It is about 1.1 nautical miles from Leg 40 Site 362. Our results generally agree with those from the earlier drilling, although we recovered 235 meters of Pleistocene and Plioene sediments, as opposed to 169 meters recovered at Site 362.

We chose to drill this relatively shallow site with the hydraulic piston corer to best use the limited time available. Operations at Site 530 had yielded the unexpected result that the Pliocene and Pleistocene sediments were rich in diatoms and organic carbon and reflected the Benguela upwelling system. The stratigraphic record, however, had been obscured by turbidite and debris flows, so that no details of the history of upwelling could be ascertained.



The upper part of Site 362 had been continuously cored by rotary drilling during Leg 40 but all of the cores taken above 200 meters sub-bottom were badly disturbed. The Site 362 cores are rich in diatoms and calcareous plankton, and also have a high percentage of organic carbon. The earlier workers recognized that the sediments were a product of the Benguela upwelling system which started in the Miocene.

We penetrated to a sub-bottom depth of 250.8 meters at Hole 532 and recovered 61 hydraulic piston cores (Figure 75-4).

Hole 532A was offset southwest and continuously cored with the hydraulic piston corer to a depth of 199.6 meters. The set of 47 cores from Hole 532A will be used for special sedimentary petrology and physical properties studies; only the core-catcher samples were examined aboard ship.

We continuously cored Hole 532B to a depth of 291.3 meters, recovering 74 cores. Cores 1-56 were frozen on board ship to be used later for geochemical studies. We studed the remainder of the cores in the usual manner.

Recovery with the hydraulic piston corer was generally good to excellent, however, the top 50-150 cm of nearly all of the cores (that we opened) from the upper 100 meters was badly disturbed. The disturbance was less below 100 meters, although parts of cores were gas-cracked.

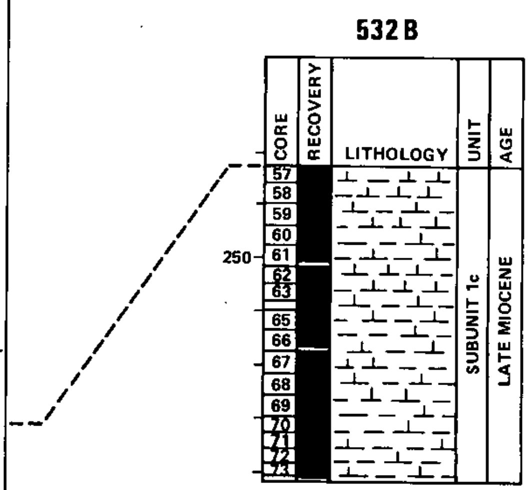


Figure 75-4. Stratigraphic column for Holes 532 and 532B. (See Figure 75-2 for legend to lithologic symbols.)

The sediments are calcareous and siliceous biogenic open-marine pelagic deposits. They comprise variable amounts of terrigenous clay and a high percentage of organic carbon. They accumulated rapidly at rates of between 25 and 60 m/m.y. We recognized a single lithologic unit with variations summarized as follows:

Color: light olive in uppermost Pleistocene, dark layers increasing in intensity and frequency in the mid-Pleistocene; color is lighter into the upper Miocene.

Foraminifers: common in the Pleistocene, but generally less than 10 per cent in the early Pleistocene and older sediments.

Nannofossils: generally 20-50 per cent, fewer in the upper Pliocene.

Diatoms: only become significant (10%-40%) in the upper Pliocene.

Carbonate: decreases from the Pleistocene to upper Pliocene (60%-70% to 20%-40%); increases into the upper Miocene.

Organic Carbon: about 3 per cent-4 per cent in the Pleistocene, 3 per cent-6 per cent in the upper Pliocene, and 1 per cent-2 per cent in the upper Miocene.

Clay: Pleistocene (10%-20%) to upper Miocene (50%-60%).

Interstitial water chemistry: salinity, chlorinity, Ca^{++} and Mg^{++} decrease with depth; pH and alkalinity increase with depth.

Sedimentation rates: Pleistocene (40 m/m.y.), Pliocene (up to 62 m/m.y.), latest Miocene (25 m/m.y.).

We interpret these general features in terms of (1) biotic productivity, (2) terrigenous input, and (3) early diagenesis within the sediment.

Changes in the biogenic component record the development of the upwelling system. Productivity appears to have increased from the late Miocene to a maximum in the late Pliocene with a slight subsequent decrease. This is clearly reflected by the sediment color, organic carbon content, and siliceous biogenic component, but the total accumulation rate for biogenic sediment increases only by about 25 per cent. The increase in pH and alkalinity with depth reflect sulfate reduction in the sediments accumulating beneath the high productivity area. The increase in productivity may be related to climatic cooling (and associated effects) through the Pliocene and/or the northward drift of Site 532, either of which caused an increased or expanded upwelling in the area.

We noted several diagenetic effects in the sediments. The sharp decrease in numbers of planktonic foraminifers in the older Pleistocene sediments and the occurrence of broken tests throughout the older part of the sequence may be a function of either selective carbonate dissolution or exclusion of the planktonic foraminifers from the upwelling area. The carbonate content of the sediment remains high and generally increases with depth through the Pliocene. The nannofossils appear to be somewhat recrystallized in the upper Miocene sediments. We detected authigenic dolomite at irregular intervals below 100 meters while apatite or carbonate-apatite(?) and pyrite occur throughout, suggesting that the sediments beneath the upwelling system may be a significant sink for phosphorous. The formation of these minerals is in part correlated with the loss of Mg and Ca cations from the interstitial water.

In addition to the trends noted above, clearly defined light and dark sediment fluctuations within 1-3 meter intervals represent an average time span of 30,000-50,000 years. The dark layers are richer in organic carbon, clay minerals, and pyrite. One explanation for this cyclicity might be the periodic increase in productivity leading to the relative increase of planktonic species (without preservable skeletons) that ingest clay and organic matter causing their rapid deposition as fecal pellets, and eventual preservation as the darker sediment layers. The increased non-biogenic component of the dark layers may be, in part, owing to an increased terrestrial (wind-borne) influx of clay-size material. We see little evidence that the light-dark cycles were caused by carbonate dissolution within the sediment.

• • •

Our main achievement on Leg 75 was to explore two modes of accumulation of sediments rich in organic carbon. The mode seen in the Cretaceous sediments does not involve long periods of anoxia; the organic carbon appears to be concentrated as a thin turbidite component within a thicker sequence almost devoid of organic carbon. The mode recorded in Pliocene-Pleistocene sediments involves deposition beneath an upwelling system causing organic matter to be dispersed throughout the sediment, although cycles may also be superimposed. The Pliocene-Pleistocene sediments are thoroughly bioturbated and we see no evidence for persisting anoxia in the overlying water in spite of the sediment's high organic carbon content. These two different modes have resulted in significant concentration of organic carbon, but the Pliocene-Pleistocene sediments contain the greater mass of organic carbon per unit volume of the solid phase.

Leg 76[1]

Western North Atlantic Ocean

Leg 76 began on 11 October in Norfolk, Virginia and ended 21 December in Ft. Lauderdale, Florida. Four holes were drilled at two sites (533 and 534). Coring at Site 533 yielded 41 hydraulic piston cores, 24 rotary cores and four pressure-core-barrel cores. Drilling at Site 534, occupied for a total of 44 days, yielded 131 cores, and penetrated to basement at 1635 meters sub-bottom. Drilling recovered the oldest sediment sampled to date from an ocean basin.

Background and Objectives

Our two principal objectives of drilling in the western North Atlantic Ocean were (1) to recover samples at *in situ* pressures using the pressure core barrel to document the presence of gas hydrates in the Upper Tertiary sediments above the bottom-simulating-seismic reflector in the Blake-Bahama Outer Ridge (Site 533), and (2) to continuously core in Upper and Middle Jurassic strata to reach, for the first time, ocean-crust-type basement in the M-28 marine magnetic anomaly zone in the Blake-Bahama Basin (Site 534).

The North American Basin, off the eastern seaboard of the United States, adjoins one of the oldest passive continental margins of the modern oceans. The history of this ocean basin spans in excess of 160 million years. Earlier *Challenger* drilling (Legs 1, 2, 11, 43, and 44) has provided fundamental knowledge of sea floor spreading, sedimentary, and paleoceanographic processes occurring in this basin over the last 145 million years. The absence of samples from older sedimentary strata deposited shortly after opening of the North Atlantic Ocean, however, led JOIDES to plan another site in the Blake-Bahama Basin. Most of Leg 76 was devoted to accomplishing this objective at Site 534 where basement was thought to be as shallow as 1800 meters sub-bottom in 4970 meters of water. The Leg 76 and other western North Atlantic sites are shown in Figure 76-1.

Site 533

We drilled two holes at Site 533 (ENA-7) without geographic offset on the Blake-Bahama

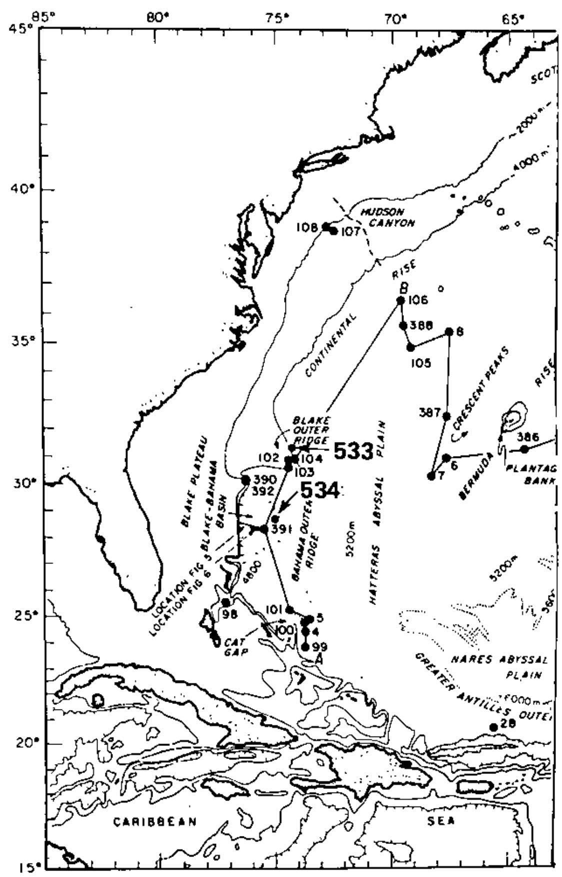


Figure 76-1. Location of Sites 533 and 534. Earlier DSDP drill site are also shown. (After Jansa et al., 1979).

[1]From a Leg 76 preliminary report prepared by Leg 76 and Leg 76 Extension scientists: Felix M. Gradstein, Robert E. Sheridan (co-chief scientists), Leo A. Barnard, Deborah M. Bliefnick, Jay L. Bowdler, Pierre H. Cotillon, Daniel Habib, Robert B. Halley, Peter D. Jenden, Hideo Kagami, Hajimu Kinoshita, Everly M. Keenan, John A. Kostecki, Keith A. Kvenvolden, Michael Moullade, James Ogg, James W. Patton, Kenneth A. Pisciotto, Isabella Premoli-Silva, Alastair H. F. Robertson, Peter H. Roth, Thomas H. Shipley, Margaret M. Testarmata, Richard V. Tyson, David K. Watkins, and Larry Wells.

Outer Ridge. Drilling yielded 41 hydraulic piston cores (0-167.5 meters), 24 rotary cores, and four pressure-core-barrel (PCB) cores (141.5-399.0 meters). We also successfully completed three heat probe measurements to total depth, but were unable to log Site 533 because the bit failed to release. A summary of drilling results is given on Table 76-1.

The continuous coring to a depth of 400 meters at Site 533 accomplished all of the planned scientific objectives except for the logging. We were able to conduct, for the first time, a quantitative geochemical experiment on gas-hydrates in the marine environment.

Lithology

We identified two lithologic units at Site 533 (Table 76-2). The oldest, **Unit 2**, is middle upper Pliocene, dark greenish gray, calcareous clay and mud. It generally lacks bedding structures and was deposited at a high rate during the middle Pliocene and at a decreased during the late Pliocene. A very low sedimentation rate during latest Pliocene to earliest Pleistocene indicates that sediment was eroded from or transported over the site. This would corroborate the interpretation of a hiatus between Units 1 and 2 made on the basis of seismic data. This hiatus, which dates back to 2.0-1.8 million years, may be related to the rapid escalation of northern hemisphere glaciation during the mid-Pliocene (around 3.5 m.y.B.P.). Enhanced deep circulation during this time could have caused the deep basin erosion.

Unit 1 is Pleistocene through Holocene light gray green and rose, nannofossil clay and mud. The unit is interpreted to have been deposited by contour-following currents at relatively high rates. Its striking variations in microfossil assemblages, calcium carbonate content, and color are associated with the climatic variations during the Pleistocene. We infer from unexpectedly few reworked nannofossils that the clastics came from predominantly Quaternary sources, such as those found along the continental slopes to the north. The continuous sequence of cores and the position of Site 533 make it ideal for detailed investigations of the Quaternary deep ocean.

Many marine geologists suppose that the Blake-Bahama Outer Ridge is being formed by sediment transported by geostrophic contour currents. Although considerable evidence from geomorphologic and seismic data supports this conclusion, the lack of obvious current-derived structures in the Site 533 cores led the shipboard scientists to reconsider the depositional processes which produced these sediments, and their relationship to the genetic term "contourite." On the basis of our observation of the Site 533 cores, we suggest that new criteria be developed for the classification of fine-grained (mud) contourites. These criteria may require the application of other than visual inspection, such as x-radiography, clay mineralogy, and detailed size analyses of the silt- and clay-size fractions to establish sorting characteristics. At the very least, the criterion of "ubiquitous laminae" must be discarded as a necessary requirement.

Acoustic Properties and Seismic Stratigraphy

Measurements with well-positioned sonobuoys made by *Glomar Challenger* at Site 533 yielded compressional wave velocities of approximately 2.3 km/sec above the bottom-simulating reflector (BSR). These relatively high velocities contrast with the more normal sediment velocities, approximately 1.8 km/sec, measured for the interval below the BSR. We attribute the higher velocities above the BSR to the presence of thin layers of gas hydrates interlayered with normal sediments. The spatial distribution and actual thickness of the gas hydrate beds is still enigmatic, as is the amount of gas hydrate needed to cause these higher seismic velocities.

The seismic stratigraphy at Site 533 is well documented by the *Challenger* profile and the reference *Conrad* multichannel profile MC87. The Pleistocene through Holocene sequence is a well stratified unit which onlaps an angular unconformity at the site.

Temperature

We documented temperatures at Site 533 by three well-equilibrated measurements at different depths. These measurements revealed temperatures as high as 19°C at 400 meters, and near linear temperature gradients of 3.9°C/100 meters near the bottom of the hole. By extrapolating these temperature measurements to the depth of the BSR, at approximately 600 meters, we infer that the temperatures would be in the range where methane gas hydrate would decompose. The temperature measurements support the interpretation that the BSR is a phase change

Table 76.1. Leg 76 Coring Summary

Hole	Dates (1980)	Latitude	Longitude	Water Depth[1] (m)	Penetration (m)	No. of Cores	Total Meters Cored	Total Meters Recovered	Percentage Recovered
533	13-16 Oct.	31°15.60′N	74°52.19′W	3191	167.6	41 HPC	167.6	146.0	87
533A	16-19 Oct.	31°15.60′N	74°52.19′W	3191	399.0	24 RC 5 PCB	259.2	203.5	79
534	22-21 Oct	28°20.63′N	75°22.89′W	4973	87.5	RC	2.8	2.8	100
534A	29 Oct.-29 Nov. 6 Dec.-19 Dec.	28°20.63′N	75°22.89′W	4971	1666.5	130 RC	1130.2	629.8	56
						201	1559.8	982.1	63

[1]Corrected echo sounding.

Table 76-2. Stratigraphic Summary and Presence of Gas Hydrates at Site 533, Blake-Bahama Outer Ridge.

Unit	Lithology	Cores	Sub-bottom Depth and Thickness in Meters	Age	Sedimentation Rate (cm/10³Y)	Gas Hydrate
1	Light gray green and rose foraminifer-nannofossil clay and interbedded nannofossil silty clay and marl	533; 1-38 (HPC) 533A; 1-3 (RC; PCB)	0-158; 158	Upper Pliocene to Quaternary	8.3 (Cores 1-35) 1 (Cores 35-38)	---
2	Dark greenish gray, fissile, hydrocarbon rich silty nannofossil clay	3-29 24 RC 5 PCB	158-399; 241	Middle-upper Pliocene	8.5 (Cores 3-11) 21.3 (Cores 12-29)	Seen in Core 13

boundary between gas hydrated sediments and normal sediments.

Geochemical Measurements

Pore water measurements show the variations of salinity, chlorinity, and alkalinity in the drilled section at Site 533. A notable anomaly in these data is the pronounced negative alkalinity gradient across the unconformity at the base of the Pleistocene sediments. This might be caused by lack of diffusion and closure at this contact, and in any case, it further supports the identification and depth determination of this unconformity. Also, the chlorinity values fluctuated near the depths where the gas hydrates were evident. Possibly, the hydrates are excluding chlorides which take up residence in other nonhydrated interlayers.

We conducted conventional gas sampling in cores from Site 533. We also quantitatively measured pressure and volume on gas hydrates with pressure containers and the pressure core barrel (PCB). The most significant result of the quantitative organic geochemical measurements was the documentation of the presence of gas hydrates. Four successful PCB samplings maintained sediments under high pressure, at about 4500 psi, and permitted us to experimentally measure gas pressure as a function of temperature and time. On two of the PCB cores the pressure/time curves follow the saw tooth pattern expected for gas hydrates decomposing under increases in temperature and decreases in pressure (see figure, inside front cover). Volumetric expansion of a gas hydrate sample was found to be as high as 13:1 indicating abnormally high volumes of methane — higher than could be in solution with normal pore water. More importantly, the composition of the gas hydrate excluded the higher hydrocarbons (normal butane and higher, $> C_4$), which do not fit in the hydrate cage structure. This is the first experimental evidence that gas hydrates in a marine environment follow the predicted behavior.

We cannot estimate the volume of gas hydrate in the sediments of Site 533. We saw several thin icy and fizzy layers in Core 13, but do not know how much hydrate, which is perhaps finely distributed in the 6-meter pressurized section, produced the pressure effects. Gas hydrates may only be present in thin (cm or mm) layers which decompose rapidly upon release of pressure.

Site 534

We occupied the deep, multiple re-entry, site (Site 534) a total of 44 days. Operations were interrupted twice while *Challenger* returned to port for engine repairs and to change crews. In order to accomplish the multiple re-entry, a record 531 meters of casing was placed in the hole. Using six drill bits, we successfully drilled Hole 534A to a depth of 1666 meters, and continuously cored from 536 meters to 1666 meters sub-bottom.

Stratigraphy

We readily identified the lithological units penetrated at Site 534 between 0 and 1496 meters sub-bottom as previously defined formations[1] in the North American Basin (Figure 76-2). The dark colored claystone, olive gray limestone and radiolarian claystone between 1496 meters and 1635 meters on M-28 age oceanic basement, however, is older than, and quite different from, the oldest unit (Cat Gap) so far defined from either the northwestern or the eastern Atlantic. This unnamed unit will be the subject of a separate stratigraphic study.

In descending stratigraphic order, these formations and their broad chronostratigraphic assignments are:

- 0-28 meters, Core 534-1: 2.8 meters of Quaternary, gray, nannofossil ooze and silty clay (Blake Ridge Formation).
- 545-696 meters, Cores 534A, 1-18: 165.5 meters of middle and upper Miocene chalk and intraclastic chalk and dark green mudstone (Great Abaco member of the Blake Ridge Formation).
- 696-741 meters, Cores 534A, 19-23: 45 meters of upper Eocene interbedded zeolitic and siliceous, variegated mudstone, graded sandstone and porcellanite (Bermuda Rise Formation).
- 741-764 meters, Cores 534A, 24-36: 23 meters upper Maestrichtian variegated claystone (Plantagenet Formation).

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[1]The formation names used by the Leg 76 co-chief scientists are defined and described in, Jansa, L. F., and others, 1979, Mesozoic-Cenozoic sedimentary formations of the North American Basin; western North Atlantic, in *Deep Sea Drilling Results in the Atlantic Ocean: Continental Margins and paleoenvironment*, Eds. M. Talwani, W. Hay, and W. B. F. Ryan, American Geophysical Union, Maurice Ewing Series 3, Washington, D. C.

- 764-950 meters, Cores 534A, 27-46: 186 meters of Cenomanian through lower Aptian black to green carbonaceous claystone (Hatteras Formation).
- 950-1342 meters, Cores 534A, 47-91: 392 meters of Barremian through lower Berriasian bioturbated and laminated radiolrian-rich nannofossil limestone and chalk. The sequence grades upward into calcareous claystone and carbonaceous claystone (Blake-Bahama Formation).
- 1342-1496 meters, Cores 534A, 92-111: 154 meters of Tithonian through Oxfordian, grayish red, calcareous claystone underlain by dark greenish gray claystone with limestone interbeds. Note that although red claystone intercalations are present in the type section at Site 105, the lower limestone bearing parts of the unit at Site 534 has no lithological equivalent at the type sections. The sediments, however, are approximately the same age as the Cat Gap Formation and so we assign it to that formation.

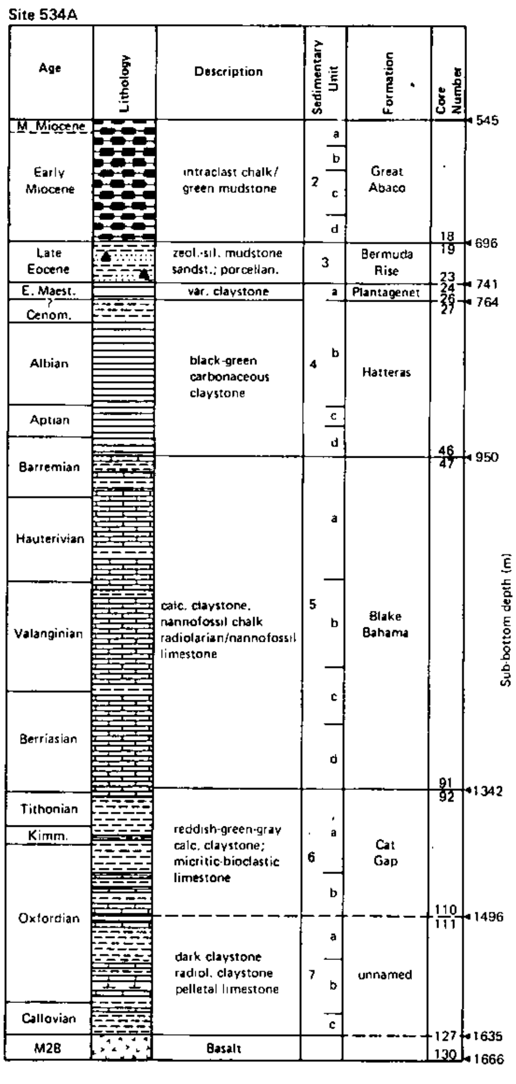

Figure 76-2. Stratigraphic summary of Hole 534A.

- 1496-1653 meters, Cores 534A, 112-117: 139 meters of dark variegated claystone underlain by olive gray pelletal limestone and radiolrian claystone, and then by greenish black to brown nannofossil claystone. This unnamed lithostratigraphic unit comprises lower-middle Callovian through lower-middle Oxfordian sediments.
- 1635-1666.5 meters, Cores 534A, 127-130: 31 meters of dark gray aphyric to sparsely microporphyritic basalt, green claystone, and reddish brown siliceous limestone with filaments filling some of the thin, 1-5 cm, fractures.

Our biostratigraphy of the Jurassic, Cretaceous, and lower Tertiary sedimentary section is preliminary; the abyssal depths at which the hemipelagic sediments were deposited and the intermittent and generally very low sedimentation rates (0.5-3 cm/10^3 yr) just above or below the CCD for foraminifers has resulted in a patchy and often much impoverished foraminiferal assemblage. The sequence contained virtually no planktonic forms, owing to its extensive dissolution.

We could not ascertain the magnetostratigraphy of the sedimentary column on board ship. We assigned the basal beds to the lower-middle Callovian *S. hexum* nannofossil zone which suggests the basement was formed no earlier than anomaly M-28.

Physical Properties and Seismic Stratigraphy

The correlation among the seismic reflectors, the laboratory velocity measurements, the *in situ* impedance calculations, and the lithologies of, and hiatuses in, the cores is excellent.

The laboratory measurements, corrected to *in situ* values, gave generally higher values for limestone and cherty layers, 2.4-4.0 km/sec, and generally lower values for shale and claystone, 2.0-2.9 km/sec, as expected. The measured velocities and densities generally increase with depth for each lithology: claystone, chalk, and limestone.

The *in situ* corrected velocities and densities, while generally increasing with depth clearly showed, in five cases, strong and abrupt inversions at depths as great as 1600 meters. The acoustic inversions caused slight inaccuracies of the sonobuoy velocities which failed to account for the inversions and led to 40 to 50-meter discrepancies between predicted and drilled depths.

We made preliminary seismic stratigraphic correlations with bedding impedance contrasts for Horizons A^c (upper Eocene cherts), β (Barremian limestone), C (Tithonian red shaly limestone), and D (lower Oxfordian limestone). Other reflections were attributed to possible unconformities, such as Horizon A^u (lower Miocene/upper Eocene), β' (lower Albian/upper Aptian), C' (upper Berriasian/lower Berriasian), and D' (middle to upper Oxfordian/lower to middle Oxfordian).

Depositional History

Deposition at Site 534 from the Jurassic to the Quaternary was continuous but slow (0.1 cm/10^3 year or less). During much of that time the site rested between the CCD for foraminifers and nannofossils. The hemipelagic mud deposited under these conditions forms the "background" sediment at the site. Periodically turbidity flows or currents deposited large amounts of slope or shelf carbonate and carbonaceous claystone at rates as high as 4 cm/10^3 years.

Three quarters of this sediment (decompacted thickness) was deposited during the first 50 million years after the site appeared on the mid-ocean ridge; the overlying Miocene and younger sediments were formed during the last 20 million years. Most of the carbonate was redeposited during the early part of the early-Cretaceous and during the Miocene; carbonaceous claystone deposits filled the basin during mid-Cretaceous time. Little sand and silt was redeposited owing to its general absence on the carbonate platform to the west and southwest and to the site's great distance from the source.

During the middle and late Jurassic, hemipelagic deposition, recorded by brown and greenish-black radiolarian claystone and redeposited limestone, was interrupted by tubidite flows. The slope- and shelf-derived turbidite debris was deposited alternately under oxidizing and reducing conditions. Conditions become continuously more oxidizing during the latter part of the Jurassic.

Limited bottom circulation in the middle Jurassic Atlantic Ocean Basin led to deposition of the alternating beds of organic carbon-rich and more oxidized sediments as occurred later during the middle late Cretaceous.

Evidence for bottom currents detected in the Oxfordian sediments, may indicate that normal oceanic circulation was re-established by Oxfordian time. The Jurassic ocean surface waters sustained radiolarian faunas and nannofloras indicating a continuous open-marine connection to Tethys, and probably to the Pacific as well. Such a connection is also shown by the presence of primitive Oxfordian planktonic foraminifers — some of the oldest known. Their occurrence corresponds to a peak in their abundance in sediments along the margins of the Mediterranean basin.

The basal beds cored above oceanic basement at Site 534 may have been deposited below the CCD for foraminifers at a depth, on the basis of back-tracking, of 2.8-3.0 km. Aragonite and calcareous claystone is more abundant in the Upper Jurassic part of the section suggesting that the CCD and lysocline shifted downward more than the ocean basin subsided during the Late Jurassic.

Organic carbon- and phosphate-rich sediments were formed during Callovian time, and organic carbon-rich sediments also formed briefly during Kimmeridgian-Tithonian time. The alternation of oxidized and reduced sediment is significant because it demonstrates the delicate balance in the Jurassic Ocean between the terrestrial contribution (organic carbon) and oxygen depletion as a function of weak bottom circulation and, probably, a wet climate.

The massive influx of both redeposited and pelagic carbonate in the earliest Cretaceous (Berriasian to Barremian) is gradually replaced by carbonaceous clay accumulation during Aptian-Cenomanian time. The CCD shoalled sharply during Barremian through Aptian time leaving a carbonate-depleted sediment. The carbonaceous clay was deposited by turbidites; the organic matter is mostly terrigenous and less marine in origin, reflecting deposition in a wet climate. The content of organic carbon is great enough to form petroleum, but the carbon is not sufficiently mature. Marine and terrestrial clay minerals occur in distinct cycles and organic carbon contents form distinct peaks. A peak in organic carbon in the Cenomanian sediments correlates to similar peaks in sediments from other Atlantic sites. The variegated and oxidized mid-Aptian sequences contain a few silt layers and resistant clay minerals, and were apparently deposited in a markedly different environment, i.e. one of improved bottom circulation and slower accumulation or greater winnowing.

We were surprised to find Maestrichtian and upper Eocene sediments where we expected a Miocene/Cenomanian disconformity (penetrated at Site 391). We may need to revise previous estimates that up to 800 meters of (mostly Oligocene) sediment were removed by erosion. Rather, we prefer to conclude that the Late Cretaceous and Paleogene Blake-Bahama Basin was sediment starved.

One of the lower Miocene debris flows comprising over 30 meters of continuously graded beds, may have been deposited from the same slumping event recorded in the Site 391 sediments — 22 km southeastward. Rather similar and coeval deposits were previously found during DSDP cruises off Morocco suggesting a common cause(s) for their formation. We are not sure if oversteepening of the shelf terrace owing to the Oligocene eustatic sea level fall, or if Alpine tectonic activity (in the Atlas Mountains and Cuba-Antilles) caused the Miocene slumping.

Sea Floor Spreading

The North Atlantic Ocean is generally thought to have rifted during Triassic to early Jurassic time, and to have significantly opened not later than late early Jurrasic. This estimate of the opening is largely derived from estimates for early spreading of ± 2 cm/yr. Our finding Callovian sediments on M-28 anomaly basement, however, indicates a spreading rate almost twice that fast.

Extrapolation of the 3.76 cm/yr spreading rate dates the Blake Spur magnetic anomaly as basal Callovian, which is about 20 million years younger than at one time thought. This means that the major spreading center shift causing the beginning of the modern North Atlantic occurred much later than originally supposed.

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SITE SUMMARIES

Leg 77
Florida Straits

Co-chief scientists: Richard T. Buffler ; Wolfgang Schlager

Site 535 (near ENA-12B)

Latitude: 23°42.43'N
Longitude: 84°30.97'W
Water Depth: 3455.5 meters
Penetration: 714.0 meters

We continuously cored Site 535 through Quaternary mud (0-154 m) and through lower Cretaceous (Berriasian to middle Albian) limestone and carbonaceous marl (154-714 m). Subdivisions of the Cretaceous sequence on the basis of lithology and physical properties correspond well with seismic stratigraphic units in the area. Rapidly deposited (35 meters per m.y.) hemipelagic Albian limestone with neritic carbonate sand (154-388 m) correspond to an upper seismic unit of hummocky, discontinuous reflectors that thins eastward. Pelagic Aptian to Barremian limestone and black marl (388-469 m) was deposited at 5 meters per million years and represents the distal part of a wedge-shaped seismic unit that thins away from the foot of the Florida platform. Well bedded Berriasian-Hauterivian limestone with thinner interbeds of dark marl (469-714 m) closely resembles the Blake-Bahama formation[1] and was deposited at 14 meters per million years The limestone appears seismically as a transparent unit. The hole bottomed in 10 meters of Berriasian cephalopod limestone (with hard grounds) that produces a sharp and continuous seismic reflector.

Interbeds of dark marl and marly limestone in the Berriasian to Aptian section are, in part, rich but immature source beds. Tar-filled fractures in the Valanginian-Hauterivian sediments suggest possible upward migration from more abundant but still immature source beds deeper in the section, or downdip from the drill site. We continuously evaluated and monitored the cores aboard ship and saw no indications for mature hydrocarbons. The tar posed no threat to our operations because we lacked evidence for mature hydrocarbons, the lack of structure, and because drilling was conducted only in levels sub-cropping in a nearby erosional channel.

[1]See Leg 76 summary for reference.

Rhythmic alternation of bioturbated limestone and laminated dark limestone and marl are common throughout the Valanginian to Aptian part of the section and indicate intermittent anoxia, probably coupled with fluctuations of surface productivity. Good preservation of calcareous biota, including preservation of numerous ammonites, suggests very low rates of carbonate dissolution. Terrigenous material is conspicuously absent throughout the Cretaceous section except for a minor background of clay. We interpreted a few bentonite bands in the Valanginian to be ash layers. The stratigraphy at Site 535 is difficult to reconcile with that at Site 97. Early Cenomanian fauna was recovered from the bottom of Hole 97 whereas the topmost beds at Site 535 are middle or upper Albian. Seismic profiles show that the bottom of Hole 97 and the top of Hole 535 are separated by at least 500 meters of section with one distinct unconformity. Our present data allow only 3 million years to deposit this section. We hope to solve this problem at Site ENA-12E.

Site 536 (ENA-14C)

Latitude: 23°29.29′N
Longitude: 85°12.58′W
Water depth: 2808.5 meters
Penetration: 213 meters

We continuously cored Site 536 through Quaternary to upper Cretaceous (Maestrichtian) foraminifer-nannofossil ooze to chalk (0-80 m), lower Cretaceous (Aptian-Albian) diaclastic limestone (80-184 m) and barren dolomite (184-213 m). This sequence of Tertiary carbonate ooze on a topographic high is interrupted by long hiatuses in sedimentation, but contains a complete record of the Cretaceous to Tertiary boundary, with 80 cm of the *Micula mura* zone overlain by the *Globigerina eugubina* zone. We interpret the lower Cretaceous limestone as a debris apron at the foot of the Campeche Scarp. It consists of sand and rubble-size fragments of rudists, algae, and corals with interlayers of pelagic chalk containing abundant radiolarians and pelagic foraminifers. We did not recover the boundary with the underlying dolomite. The dolomite contains possible algal laminations and poorly preserved bioclastic layers, suggesting that it was deposited in very shallow, restricted conditions. The low porosity and high sonic velocity of the dolomite indicate its diagenesis while deeply buried, and contrasts sharply with the lithology of the overlying Cretaceous limestones. Thus, the dolomite may be older Mesozoic or Paleozoic. Extensive caving of the Cretaceous limestone forced us to abandon the hole.

Site 537 (ENA-14B)

Latitude: 23°56.01′N
Longitude: 85°27.62′W
Water depth: 3148 meters
Penetration: 216 meters

We spot cored Site 537 to 88 meters subbottom, then cored continuously to a total depth of 216 meters where severe caving forced us to abandon the hole. Because chert and hard ash layers were encountered at shallow depths, and because nearby Site 536 had been cored continuously, we decided not to take piston cores at the site.

In spite of the limited penetration and poor recovery (10%), drilling at this site yielded very interesting results. The sequence consists of Quaternary to Paleocene nannofossil ooze (0-92 m) containing chert and a high percentage of radiolarians in the Eocene, and ash layers and oxide-coated hard grounds in the Paleocene sediments. A 60-cm interval of ooze and chalk yielded upper Cretaceous and Aptian fossils. From 92.5 to 149.5 meters, we recovered limestone with Valanginian to upper Jurassic shallow-water detritus. These sediments represent either a talus apron at the foot of a platform, similar to, but older, than the one at Site 536, or an autochthonous shallow-water limestone cap on top of a fault block. The carbonates are underlain by gray sandstone, marl, and dolomite with coral fragments, marine ostracods, bivalves and a few foraminifers (150-168.5 m). The gray sandstone passes downward into red arkose comprising possible ash layers and a variety of igneous rock fragments. The igneous rock fragments include acid volcanic and basic rocks (168.5-197 m). A varicolored phyllite with distinct cleavage and beds dipping 10 to 20 degrees underlies the clastics and is interpreted as pre-Mesozoic basement (197-216.5 m).

Drilling at Sites 536 and 537 was characterized by poor recovery and difficult hole conditions. The results are still inconclusive in several respects. We did not core the contacts between basement, clastics, shallow-water carbonates, and pelagic caps and recovered very little material. The timing of block faulting thus remains uncertain within wide limits (Valanginian to Paleocene) and the nature of the shallow-water limestone at Site 537 remains open. We plan to pursue these questions by drilling to basement at Site ENA-14A on Catoche Knoll.

Site 538 (ENA-14A)

	Hole 538	Hole 538A
Latitude:	23°50.98'N	23°50.95'N
Longitude:	85°27.62'W	85°09.23'W
Water depth:	3148 meters	2801 meters

Site 538 is on the north flank of Catoche Knoll. In Hole 538, we took one core in upper Oligocene ooze but found the sediments too stiff to continue drilling. We then offset upslope and spudded Hole 538A into a softer upper Pliocene ooze at a site located along Line SF-2 at the peak of the knoll. Drilling penetrated through 183.5 meters of mainly Pliocene to Paleocene nannofossil ooze and chalk. We interpret a 7.8-meter section of Paleocene chalk found sandwiched between middle and lower Eocene sediments to be a slump. The lower Eocene sediments lie directly on a 5.1-meter section of upper Cretaceous (Maestrichtian) chalk (183.5-188.6 m). A fault separates this chalk from a 22.9-meter section of upper Albian deep-water chalk, limestone, claystone and chert (188.6-211.5 m). Pieces of shallow-water bioclastic limestone (possible upper Albian-lower Berriasian) occur between 211.5 and 268.5 meters and overlie basement. These rocks are either from a shallow-water platform or from redeposited platform talus. A thin film of Berriasian chalk, lying directly on the basement, suggests that deeper water conditions existed prior to deposition of the bioclastic limestone. The data from this hole may indicate the times of uplift and later drowning of Catoche Knoll. We also drilled 64 meters of basement consisting of an older metamorphic complex composed of gneiss and amphibolite intruded by younger diabase and basaltic rocks. These rocks are highly sheared and in places are altered to serpentinite. They may be good examples of injected transitional crust.

Site 539 (ENA-12J)

	Hole 539	Hole 539A
Latitude:	23°47.34'N	23°47.20'N
Longitude:	85°25.19'W	85°25.29'W
Water depth:	3106 meters	3099 meters

Site 539 is located along Line SF-15 in an area of irregular topography. The two attempts to spud-in at this site were unsuccessful. Drilling at the first hole (539) recovered two cores of Pleistocene, to possibly upper Pliocene, terrigenous mud and nannofossil ooze. We drilled to a total depth of seven meters before encountering rocks too hard to drill. The hard rocks were not recovered.

Drilling at the second hole (5 penetrated only 7.5 meters, sampling upper gocene ooze and chalk before the bit enc tered rocks too hard to drill.

PLANNED *CHALLENGER* DRILLIN

Leg 78A

Caribbean

San Juan to San Juan, Puerto Rico, 6 February to 10 March 1980. Co-chief scientists: Bernard Biju-Duval and Casey Moore.

The basins of the Caribbean Sea remain an enigma in proposed reconstructions of the opening of the equatorial Atlantic. We ask whether the basement of the Caribbean plate consists of older segments of Pacific or of Atlantic crust. Did the Caribbean originate by interarc spreading? Is it best thought of as a plate or as a boundary zone between plates? Drilling in the Caribbean will not only address these tectonic questions, but recovery of the sedimentary record will help define the history of communication of Atlantic and Pacific water masses. Finally, we hope that by drilling the Lesser Antilles forearc we can completely penetrate the toe of an accretionary prism, a goal yet to be achieved at any active margin.

Lesser Antilles Arc (CAR-1 and CAR-2)

The Lesser Antillean Island Arc lies between the Atlantic and Venezuelan Basins. It comprises physiographic elements from east to west: (1) the Barbados Slope, (2) the Barbados Ridge (a complex outer high), (3) the Tobago Trough (a forearc basin), (4) the Lesser Antilles volcanic belt, (5) the Grenada Basin (a back arc basin), and (6) the Aves Ridge (a possible remnant arc).

Drilling at CAR-1 and CAR-2 is planned to calibrate two seismically well defined areas, one at the toe of the accretionary prism (Barbados Ridge) and the other on the flank between the back arc basin (Grenada Basin) and the "remnant" arc (Aves Ridge).

Data from drilling, when incorporated with other data from the region, (i.e., extensive refraction, reflection, gravity and magnetic data, drilling and geological maps of Barbados, maps and radiometric age dates from many of the volcanic islands) should improve our understanding of the various elements of island arcs and their genesis.

Front of the Barbados Ridge, CAR-1 Sites. The Tobago Trough is a forearc basin located east of the presently active Lesser Antilles Arc. It is filled with up to 4000 meters of horizontally bedded turbidites(?) and is flanked by the Barbados Ridge to the east. This major high is 300 km wide and is underlain by up to 20 km of accreted sediments which were sheared off the oceanic basement of the western Atlantic and piled up as the crust moved westward toward a flat to gently west-dipping subduction zone.

The Barbados Ridge sediments are exposed on the island of Barbados. The Paleogene part of the section may have been derived in large part from the South American continent. The thickness of sediment underthrusting the Barbados Ridge progressively diminishes northward owing to its increasing distance from the source and damming by transverse ridges (for example, the Tiburon Rise and the Barracuda Rise). Seaward of the southern part of the Barbados Ridge, the sediments on the Atlantic abyssal plain are more than 4000 meters thick; the depth to oceanic crust is at least 9.5 km below sea level. In this region, multichannel seismic data show that the oceanic crust and some overlying sediments extend several tens of kilometers westward from the toe of the ridge whereas the overlying, upper part of the section appears to be progressively more folded with reverse faulting.

To the north, between the Tiburon Rise and the Barracuda Rise and near the CAR-1 sites, the oceanic crust of the Atlantic is covered by a thin sequence (0.2 to 0.5 sec) of pelagic sediments (DSDP Site 27). Here the oceanic crust and a part of its thin sediment cover extend for about 20 km under the toe of the trench slope. The overlying, apparently offscraped deposits are probably highly deformed, although little can be resolved in the seismic reflection profiles.

A site survey made by IFP-CNEXO indicates that a single-bit hole, CAR-1A (or CAR-1, CAR-1B or CAR-1C), can penetrate through the toe of the presumed offscraped sequence and into the undisturbed selectively subducted sediments and subjacent Atlantic oceanic crust. Total penetration would be 900 to 1300 meters at a water depth of around 5000 meters. The objectives of the CAR-1, -A, -B or -C hole would be to document the tectonic character of the front of the accretionary prism. Aspects of particular interest include differences in age, physical properties and structural features across any dêcollement between the presumably offscraped and subducted sedimentary sequences. Calibration of these differences requires sampling of an undisturbed section, hence the proposal for CAR-1D, the oceanic reference site. Landward of the CAR-1, -A, -B and -C sites, Sites CAR-1E and -1F are designed to test for lateral variations in age and physical properties of the accretionary prism as well as to document its vertical tectonics. In addition to studying the section at each site by coring, we plan to log each of the major holes and to emplace the H.I.G. downhole seismometer package in one hole (CAR-1A) to monitor current seismicity.

Grenada Trough-Aves Ridge, CAR-2 Sites. The Grenada Trough is a well developed back arc basin between the Lesser Antillean Island Arc (active since the Eocene) and the Aves Ridge. Upper Cretaceous and Paleocene diabases and granodiorites have been dredged from the Aves Ridge and seismic reflection profiles show large volcanoes with flanking deposits containing interbedded sediments. The sedimentary infilling of the Grenada Basin decreases significantly from South to North, culminating in the merging of the Aves Ridge, the Grenada Trough, and the Lesser Antillean Island Arc into a single broad platform. Marine geologists consider the Aves Ridge to be a remnant Cretaceous-early Tertiary arc that was rifted from the Lesser Antillean Arc during the Cenozoic.

If time allows, we plan to drill a single-bit site (CAR-2B or -2A) on the eastern flank of the Grenada Basin. This site should document the age and lithology of the sediment cover and basement of the Aves Ridge. Coring the sequence at CAR-2B or -2A (in relatively shallow water) will also provide an important paleontologic reference scale as well as document the vertical tectonics of the Aves Ridge. Finally, drilling Site CAR-2 should provide data on the evolution of the western edge of the Grenada Trough. Any new knowledge of the tectonic history of the Aves Ridge and Grenada Trough will allow a substantive comparison with the land geology in northern Venezuela.

Age and Nature of the Caribbean Crust, CAR-3

One of the most striking geologic features in the Caribbean is a series of seismic reflectors found throughout large areas of the basin. Horizon B″, for example, occurs over an area of 1 million km in the Venezuelan Basin alone. Drilling during DSDP Leg 15 reached B″, recovering dolerites and basalts with velocities of 4.4 to 5.3 km/sec. The sediments immediately above B″ are upper Turonian (Sites 146, 149 and 150).

The sedimentary section above B″ includes another reflector, A″. At Site 146 this reflector is dated as lower-middle Eocene and is correlated with an impedance contrast between oozes and underlying lithified cherty sediments. The numerous multichannel seismic lines made by UTMSI, IFP-CNEXO, CEPM, L-DGO, and Gulf Oil demonstrate that important changes in the thickness and seismic character of the basin fill occur, especially to the south and east. These thickness variations raise questions concerning the value of the reflectors above B″ as time lines.

Horizon B″ is generally a smooth strong reflector, although it becomes rougher in the southeastern, deeper part of the basin. Throughout the central, northern and western parts of the basin, multichannel profiles below the smooth B″ horizon show horizontal or gently dipping reflectors to a depth of several kilometers with velocities of 4.5-5.3 km/sec. These results suggest that the rocks below B″ are either solely igneous in composition or they are igneous rocks intercalated with high velocity sedimentary rocks. .Nevertheless, stratified sediments with lower velocities could lie below B″. In the Aruba Gap (DSDP Site 153) drilling recovered basalt at the level of B″ which, according to the multichannel seismic data, lies above sediments having velocities of 3.9 km/sec. This layer could possibly be equivalent to pre-B″ horizons elsewhere, but having fewer intercalated volcanic rocks.

The extra crustal thickness in the central part of the Venezuelan Basin might be a result of pre-Turonian flood basalts superimposed on oceanic crust that was otherwise of normal thickness. In the southeast portion of the basin the crust could be more similar to normal oceanic crust.

To resolve the question of the age of the basement in the Venezuelan Basin and the relationship of B″ to basement, we plan a multiple re-entry hole in the Venezuelan Basin (CAR-3) if CAR-1 cannot be occupied or has to be abandoned early.. Drilling at CAR-3 is planned to sample layer 2 where it has a rough surface (equivalent to B″) in the southeastern part of the basin. This site will provide evidence of the age of the crust in an area of more or less typical layer 2. Crustal ages obtained previously were all from the top of reflector B″ where it is smooth and are therefore anomalous. In addition to dating the crust, we hope that drilling the sedimentary sequence above B″ will provide information on the development of the active margin of northern Venezuela. (*DSDP Leg 78 Prospectus*)

Leg 78B

Downhole Experiments, North Atlantic

San Juan, Puerto Rico to Las Palmas, Canary Islands; 12 March to 10 April 1981. Co-chief scientists: Roy Hyndman and Matthew Salisbury.

Introduction

DSDP Leg 78B will be devoted primarily to conducting downhole measurements and experiments in holes previously drilled by DSDP on the mid-Atlantic ridge. On Legs 45 and 46, two holes, 395A and 396B, were drilled into the crust on opposite sides of the mid-Atlantic spreading center south of the Kane fracture zone (near 23°N). Re-entry cones are in place over the holes which should permit re-entry for the downhole measurements. Hole 395A penetrated 571 meters into the basaltic crust — one of DSDP's deepest crustal penetrations — and we will focus our efforts here. We will use Hole 396B (266 meters into the crust), however, if Hole 395A cannot be re-entered. No downhole measurements have been made in Hole 395A, although standard logs and downhole temperature measurements have been made in Hole 396B.

The Leg 78B shipboard party will first take a complete suite of downhole logs, then conduct a series of downhole experiments, and finally, test emplacement of a long-term downhole recording seismograph package. The latter experiment will be carried out by, and the required ship's time funded through, the Defense Advanced Research Projects Agency (DARPA) and the Naval Oceanic Research Development Activity (NORDA).

Plans call for 2-1/2 days logging, 4-1/2 days of downhole experiments and 6 days for the DARPA seismograph-emplacement experiments.

Scientific Objectives

Our primary scientific objective on Leg 78B is to study the geophysical and hyydrogeologic properties of the upper oceanic crust through logging and other downhole experiments. Data from the downhole measurements will complement the regional and geophysical data collected for the area, as well as the laboratory data previously collected from core samples.

The logging will provide a wide range of physical properties data under *in situ* conditions

... the order of a few meters. ...oratory measurements allow calibration of the downhole logs, but because of the small size of the samples, biases in core recovery, and the difficulty of simulating *in situ* conditions, they do not usually give results which are representative of the formation. The differences between the core-sample results and logging results, and between logging results and regional features determined from geophysical surveys give important information on the nature and extent of cracks, fissures, and other forms of large-scale porosity. DSDP plans to include a professional well-log analyst, in addition to a logging engineer, on board ship to ensure that highest quality logs are obtained, and to facilitate their interpretation.

Downhole Measurements

In addition to logging, four special tools will be tested: the Uyeda heat flow tool, a borehole televiewer, the Russian downhole magnetometer and a special long-spaced velocity tool.

The proposed downhole experiments include a large-scale resistivity experiment, and a packer experiment to test for hydrofractures, estimate permeability, and to sample large-volume water. The resistivity experiment and part of the packer experiment will be an attempt to measure physical properties on a scale of a few tens of meters to a few hundreds of meters, that is on a scale intermediate between downhole logging (meter-scale) and large-scale marine geophysical measurements (kilometer-scale). The fractures and other forms of large-scale porosity that facilitate and control hydrothermal circulation in the crust, probably occur mainly within such intermediate-scale spacing; the experiments should thus provide information on the size, character, spacing, orientation, and distribution of such fractures and large-scale porosity. The packer experiment is particularly important in permitting estimation of large-scale permeability, *in situ* pore pressure and, if fracturing is successful, of *in situ* stress in the crust.

DARPA Experiment

The DARPA seismometer-emplacement ...periment will test techniques to emplace a ...ng period seismograph deep in the ocean ...st. If the test is successful a similar device ... be placed in a hole in the north Pacific in ... During Leg 78B operations a second ... the *Bartlett*, will accompany the *Chal-* ... exp... to assist in the deployment and serve as long ... crust

... a shooting ship after laying an ar... around the site. Thus, an active sei... iment similar to the oblique seismic ... will be conducted as part of the D... and as a complement to the other ex... planned for the leg. (*M. Salisbury ... Hyndman*)

Leg 79

Mazagan Plateau

Las Palmas to Brest, 15 April to 31 May 19... Co-chief scientist: Karl Hinz. (The second co-ch... scientist is to be determined.)

The region of the Mazagan Plateau (Figure 79-1) offers unique access for *Glomar Challenger* to document the Jurassic environment of rifting and the early subsidence history of a segment of passive margin bordering the proto-Atlantic. The edge of the Upper Jurassic carbonate platform bulges seaward here from its normal position beneath the present Moroccan continental shelf, and is truncated by a spectacular escarpment (Figure 79-2) that falls more than 2 km to the abyssal sea floor. The escarpment reveals a thick section (possibly faulted) of Mesozoic strata, near the base of which Oxfordian algal limestone has been dredged. With a series of holes drilled stepwise down the escarpment, we should be able to piece together a composite section that records the sequence of depositional environments and subsidence history of this thick carbonate platform, including the timing of platform drowning and the installation of pelagic conditions. The results should bear strongly on the early evolution of the deeply buried conjugate margin on the North American side.

A sequence of three drill holes is planned on the Mazagan Escarpment and Plateau (Figure 79-3): Sites MAZ-4 (alternate MAZ-5) and MAZ-6 (alternate MAZ-7) are on the Mazagan Escarpment itself, at places where the older Mesozoic strata are blanketed by a thin wedge of Cenozoic slope sediments. At MAZ-4, the drill could reach Triassic strata or Paleozoic basement at about 1400 meters depth. Site MAZ-8 is near the deep seaward edge of the Mazagan Plateau, and drilling here will explore the Cretaceous platform carbonates to a depth of 500 meters.

Seaward of the escarpment is a band about 50 km wide where diapirs punch upward into a pile of sediments about 5 km thick (Figure 79-1). Dredges and cores on the slopes of th...

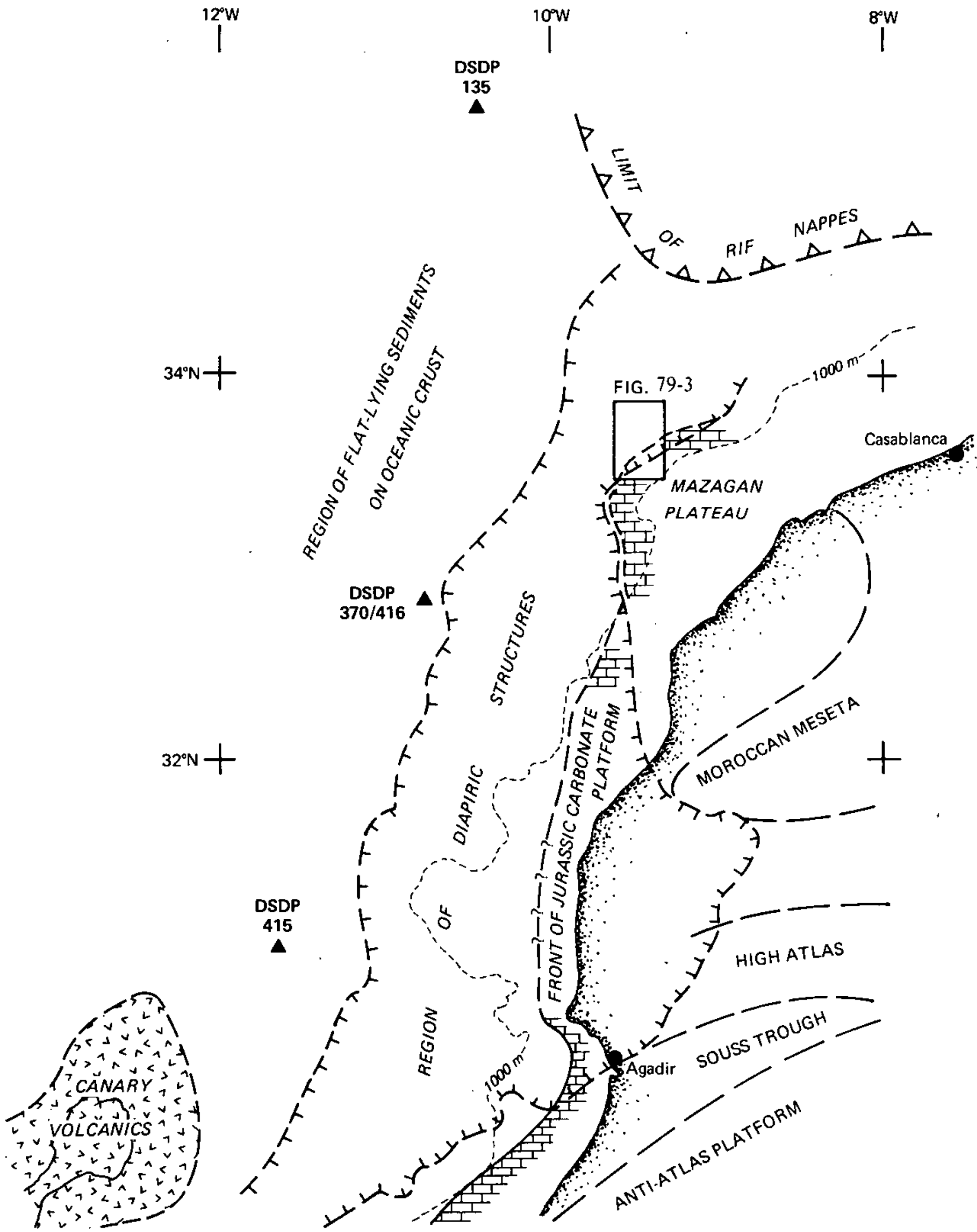

Figure 79-1. Map showing the regional setting of the Mazagan Plateau.

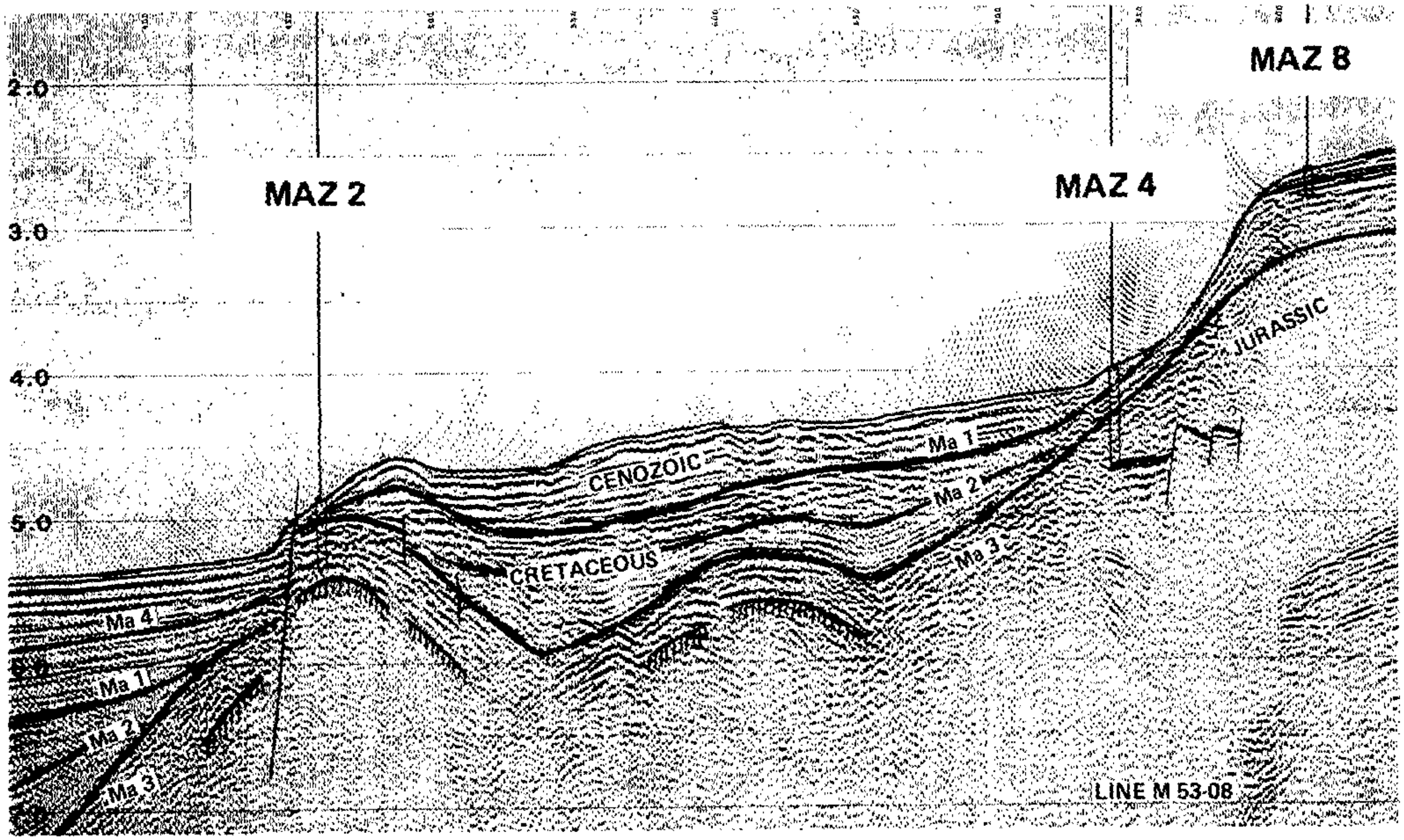

Figure 79-2. Seismic reflection profile (Meteor 53-08) across the Mazagan Escarpment showing proposed drill sites for Leg 79 (See Figure 79-3 for location).

first of these structures just 10 km from the foot of the escarpment (Figure 79-3) recovered fragments of sheared granite. This structure may thus bring close to the sea floor very old sediments, dating to the earliest stage of Atlantic evolution, in the early Jurassic or late Triassic. The dredged fragments of granite open the possibility that this particular structure is not a salt diapir but a Hercynian basement high, overlain by "syn-rift" to early "post-rift" clastic and restricted (evaporitic or carbonaceous) sediments. The formation of the evaporites that appear in the diapir province (Figure 79-1) is an important unsolved problem, and clues as to whether they formed in a deep or shallow basin are badly needed. Drilling on this particular structure has been approved by the Safety and Pollution Prevention Panel, and will be done in a sequence, and at sites located, so as to avoid the possibility of encountering hydrocarbons.

Three sites are planned on this structure: MAZ-9, located down plunge near the northeast end of the structure, will be drilled first in order to establish the nature of the formations and their potential risk for hydrocarbons. If no such dangers appear, then MAZ-2 (alternate MAZ-1) would be drilled, high on the structure and along its northeast flank, where much of the section probably cropped out prior to Cenozoic times. The site is close to the localities where the granite fragments occur on the sea floor. (*K. Hinz and E. L. Winterer*)

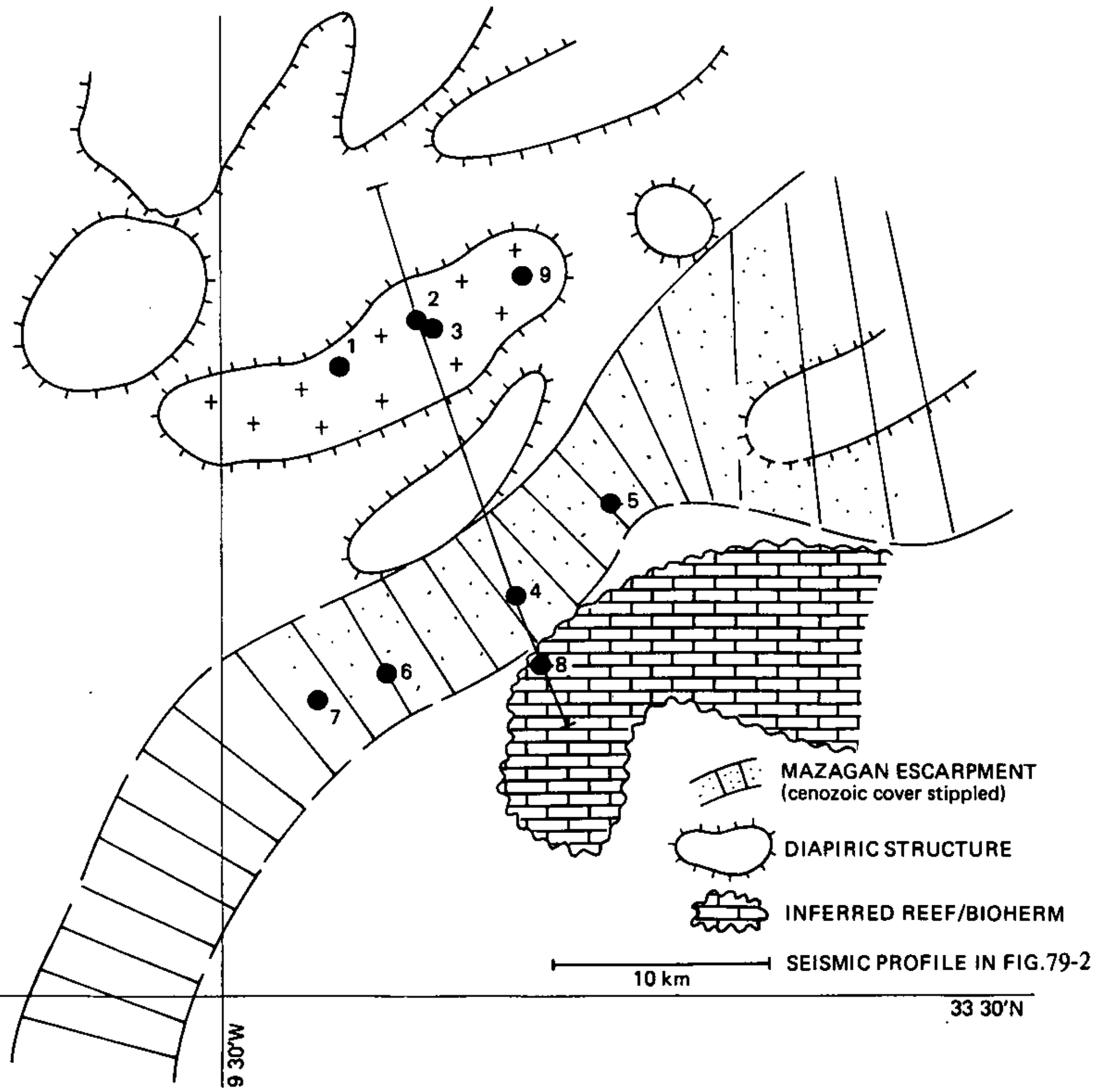

Figure 79-3. Map of Mazagan Escarpment area, showing proposed drill sites for Leg 79 and major geologic features.

DEEP SEA DRILLING PROJECT

Program Plan for FY 1981

The National Science Foundation has approved the DSDP FY 1981 budget following budgetary revisions made early in January. The $19.6 million budgeted is about 6 per cent above the FY 1980 allocation, but is effectively 6 per cent less in view of a 12 per cent inflation rate.

Dramatic increases in fuel and air-travel costs and a recent increase in the *Glomar Challenger* day rate further aggrevates the problem. NSF is examining a request, submitted last fall, for additional funds to cover these major increases in operating costs.

DSDP granted Leg 76 a 2-week extension to allow realization of the scientific objectives at Site 534 (ENA-1) — penetration through oldest Atlantic Basin sediments to basement — and to compensate for time lost owing to ship's repair. The revised drilling schedule appears above.

The time allocated for Legs 77 through 81 remains tentatively unchanged, but Leg 82 would consequently be shortened. We hope that inasmuch as drilling is now assured we can combine the scientific objectives of Legs 82 and 83 to ar a coherent 3-month program along the eastern margin of the United States.

Planning for Legs 78A, 78B and 79 is now well underway. The Safety Panel has approved drilling most of the proposed Moroccan margin sites so that drilling on the Galicia Bank becomes only a contingency plan. The Passive Margin Panel will submit its final program for Legs 79-82 to the Planning Committee in February 1981. The Safety Panel is scheduled to review proposed Legs 80 and 81 sites in early March. (*Y. Lancelot*)

Shipboard Facilities

DSDP intends to purchase a **shipboard mini-computer** that can quickly analyze the results of the gas chromatograph. The computer is particularly needed to better monitor gas-rich sediments on board ship. In addition, it will be able to process (enhance) single-channel seismic profiler data and to process, digitize, integrate, and/or or chart

- underway data (bathymetry, navigation, magnetometer).
- scientist-generated shipboard data (physical properties, smear-slide, inorganic geochemistry, paleomagnetic, and sediment thickness data). (GRAPE data could be integrated later.)
- certain data from previous cruises.

DSDP would like to acquire the mini-computer in June and have it aboard ship by the end of October.

Engineering Developments

Variable-Length Hydraulic Piston Corer

The development of the new variable-length hydraulic piston corer is proceeding satisfactorily. Operators will be able to adjust the length of cores taken from 3.0 meters to 9.5 meters with this tool to better sample sediments of varying thickness **without round tripping the drill string**. We plan to test the system early spring 1981 at SIO.

Pressure Core Barrel

The pressure core barrel (PCB) performed beyond expectations during Leg 76. Four of five coring attempts resulted in full recovery under pressure. The tool is now considered operational and no further development work is planned for the near future.

Extended Core Barrel

DSDP has designed the extended core barrel (XCB) for use following piston coring of the upper sediments without necessitating a trip of the drill pipe. Operators should be able to core entire sedimentary sequences with a single trip of the drill pipe. We have designed the core liner of the XCB to be non-rotating in order to overcome the core disturbance encountered in the past. We have completed the shore-based drilling tests and are now fabricating prototype units. Additional drilling tests are planned in Salt Lake City this spring.

Drill String Fatigue Studies

DSDP is currently taking drill-string-fatigue measurements on board *Glomar Challenger* to validate the analytical work previously completed. The program consists of measuring ship's motion (roll, pitch, heave) and concurrently the stress/strain on the top of the drill string and the motion at the bottom.

Wire-Line Re-Entry

We continue to review various concepts for making re-entry without drill pipe. (*Swede Larson, DSDP Engineering and Development*)

Information Handling Group

The DSDP Information Handling Group has amassed a large collection of geologic data which it makes available to qualified scientists (Table DSDP-1). In addition to processing data the group has also developed various tools (both automated and manual) to assist researchers in locating and displaying data relevant to their studies.

Paleontologic Data Base

We have made a large effort to code, check, and process the paleontologic data compiled on the *Challenger* cruises. Data is currently available from thirty-eight legs (340 sites), representing about 85 per cent of the Tertiary paleontologic data for Legs 1-44. The glossary for the paleontologic data base contains approximately 9200 elements from 25 fossil groups. The data files are arranged by fossil group and then by DSDP leg number so that we can present research results as either formated listings or as range charts.

Hard Rock Major-Element Chemical Analyses

Major-element chemical analyses of igneous and metamorphic rocks and a small number of sedimentary rocks composed of volcanic material comprise the hard rock data base. Analytical data, alteration data, analytical methods and related information are included in the records. The analyses are manually encoded from shipboard descriptions and lists, provided by shore-based studies, hole summary volumes, Initial Core Descriptions, and the Initial Reports.

GRAPE Processing

The shipboard GRAPE (Gamma Ray Attenuation Porosity Evaluator) system has recently been modified so that cores may be processed in 40 per cent less time. In the past the time required to process a core (several hours) both delayed other shipboard analyses and restricted the number of cores which could be tested. The modified GRAPE system will allow shipboard technicians to process many more cores and thus considerably broaden the GRAPE record. Although fewer discrete measurements are made along the length of a core section, the effective resolution determined by a calculated average of successive measurements remains essentially unchanged so that the new data is compatible with data previously disseminated. The B7800 GRAPE software has also been modified to reduce the time and cost of producing data for the archive files.

Data Window

We have added a new feature to our retrieval program, DATAWINDOW. The output now includes stratigraphic, geographic, lithologic, and physical property data by via search on the sample designator (leg, core, site, interval) among the coordinated files.

Data Distribution Policy

The DSDP/NSF Sample Distribution Policy restricts the release of most scientific data gathered aboard *Glomar Challenger* to members of the respective shipboard scientific party until two months after publication of the Initial Core Descriptions. The preliminary report on underway data, containing only track charts and data indexes, however, are immediately available to any interested scientist. (A reimbursement charge will be assessed for handling and reproduction if costs exceed $50.00.)

Address your requests for information or data to:

Information Handling Group
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

(DSDP Data Handling Group)

Core Repositories

Samples Available

Samples from DSDP Legs 1-67, 70 and 71 are available to qualified researchers for study resulting in published papers. We encourage potential investigators wishing samples to obtain first a statement of the DSDP/NSF sample distribution policy and sample request forms from the DSDP curator. (The sample distribution policy also appears in the Initial Report volumes and the Initial Core Descriptions.) We ask that requests for samples be made as specifically as possible, i.e., note hole, core, section, interval within a section, and volume required. Refer to the graphic core descriptions appearing in the Initial Reports and/or Initial Core Descriptions (ICDs) for core details. In order to ensure that all requests for highly desirable but limited samples can be considered, we will not approve requests and/or distribute samples until two months after publication of the ICDs. The ICDs are generally published within 10 months following each cruise and are on file at various institutions throughout the world.

The DSDP curator can approve many standard requests in office, but requests for material of particularly high interest (e.g. certain hydraulic piston cores, key stratigraphic

...) or those for large volumes of material will be reviewed by the NSF Sample Distribution Panel. We urge potential investigators to be judicial in making their sample selection.

Cores from the Pacific and Indian oceans and the Red Sea (Legs 5-9, 16-27, 30-34, 54-70) are at the West Coast Repository at Scripps Institution of Oceanography. Those from the Atlantic and Southern oceans and the Mediterranean and Caribbean seas are at the East Coast Repository at Lamont-Doherty Geological Observatory. All frozen cores — collected specifically for geochemical analyses — are maintained at the West Coast Repository. Interested scientists may view the cores, core photographs, or other associated data at either repository upon making prior arrangements with the appropriate curatorial staff.

Microfossil Reference Repositories

In addition to the DSDP core repositories, plans are underway to establish microfossil reference repositories. The Natural History Museum in Basel, Switzerland, houses a reference collection of DSDP foraminifer slides (John B. Saunders, Curator). Although the slide collection is still being prepared, J. Saunders estimates that it will be completed during the second half of 1981.

The Basel collection is only one of several reference centers being planned to house paleontologic materials (foraminifers, calcareous nannofossils, radiolarians, and diatoms). JOIDES hopes to establish such collections at other suitable sites in North America, western Europe, the USSR, Japan, and the Australian-New Zealand region.

Curatorial Charge

The DSDP curatorial staff is charged with the responsibility to (1) store, preserve, and conserve DSDP cores and related material, (2) distribute samples as required to contributors of the Initial Reports, (3) supply qualified investigators with core samples and related data, and (4) supply samples to the paleontologic reference centers. We encourage your interest in the DSDP materials.

Please address your questions or sample requests to: The Curator, A-031
Deep Sea Drilling Project
Scripps Institution of Oceanography
La Jolla, California 92093

(*L. Garifal, DSDP Assistant Curator*)

to

VOLUME PRODUCTION

Initial Reports

The Initial Reports of the Deep Sea Drilling Project 1-59 are now published. We plan to submit the camera-ready-copy for volumes 60, 61, 62, and 63 to the Government Printing Office (G.P.O.) in June, March, May, and April 1981, respectively. The G.P.O. usually requires about three months, following receipt of camera-ready-copy, to print a volume; Volumes 60, 61, 62, and 63 should then be available in September, June, August, and July 1981, respectively.

Contact the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 for price lists, order forms, or other information regarding purchase of the Initial Reports series. (DSDP does not handle Initial Reports sales.)

Initial Core Descriptions

We have completed Initial Core Descriptions (ICD's) for Legs 27-68, 70-71 and 73, and are currently preparing those for Legs 69, 72, and 74. We expect to complete the Leg 69 ICD by March 1981.

The Initial Core Descriptions, containing graphic core descriptions and primary site data (latitude, longitude, water depth), are prepared primarily for scientists wishing to request sample material from DSDP cores before publication of the more comprehensive Initial Report volumes. We distribute hard copies and microfiche of the ICD's to institutions and libraries throughout the world for ready reference. (DSDP samples are available — after publication of the appropriate ICD, usually within one year following a particular cruise. The Initial Reports usually appear two to three years following the cruise.) (*DSDP Publications Dept.*)

Personnel Briefs

John L. Usher, formerly Associate Chief Scientist for Science Services retired 5 January 1981.

William Coulbourn, Staff Scientist will take a year's leave of absence beginning 26 January 1981 to continue his work on reconstructions of paleoenvironments in Kiel, Federal Republic of Germany.

Deep Sea Drilling is presently accepting applications for the position vacated by John Usher, and also plans to hire one (possibly two) additional sea-going staff scientist(s) and/or a log analyst.

Table DSDP-1. DSDP Data Base Status

Generic Data File	Complete Through Leg	Storage Medium	Comments
SITE SUMMARY DATA Summary of coring and operational data.	74	T	
VISUAL CORE DESCRIPTIONS (Shipboard observations)	44	FT	
SMEAR SLIDE DESCRIPTION (Shipboard observations)	44	FT	
CARBON CARBONATE (DSDP shore lab.)	67	FT	No carbonate data for Leg 46. Carbonate samples for Legs 60 and 62 are being reburned.
CHEMISTRY Water content (Shipboard lab.)	75	FT	No chemistry for Leg 41
Hard rock major element analyses (Shipboard and shore lab.data)	65	FT	No hard rock data for Legs 1-12,20,21,31,40,43,44, 47,48,50,56,57. Legs 62-64 not completed.
DEPTHS (From underway recordings)	75	FT	
GRAIN SIZE %Sand-silt-clay (DSDP shore lab.)	71	FT	No grain-size data for Leg 16. Legs 64-65 grain-size data are not yet processed.
GRAPE (Gamma Ray Attenuation Porosity Evaluator points taken onboard. Data processed and edited onshore.)	65	FT	GRAPE data were not collected on Leg 46. Leg 45 GRAPE is not complete. Legs 53, 55,60,62 are not yet completed.
PALEONTOLOGY (Onshore lab. studies)	44	T	Not completed: 12, 23-28, 38-40, 42.
SCREEN (output from JOIDESSCREEN) Computer-generated lithological classifications. Includes basic composition data, average density, and geologic age of layer.	44	T	
SONIC VELOCITY (Shipboard Hamilton Frame)	75	FT	No sonic data for Legs 1-2. Leg 71 data not yet processed.

UNDERWAY DATA: Recorded onboard between drilling sites.

Bathymetry	Legs 7-9, 13-56,61-72	FT	Navigation	Legs 3-75	FT
Magnetics	Legs 7-9 12-75	FT	Seismic	Leg 73	F

T = magnetic tape F = microfilm

JOINT OCEANOGRAPHIC INSTITUTIONS

At 1980 elec 198

JOI, Inc. Report

sonnel Briefs

At its meeting in Atlanta on November 17, 80, the JOI, Inc. Board of Governors ected the following officers to serve until 982.

Chairman: James D. Baker
Vice Chairman: Charles E. Helsley
Secretary/Treasurer: Arthur E. Maxwell
President: William W. Hay
Vice President: John H. Clotworthy

Ocean Margin Drilling Program — Status

Ten U.S. oil companies have signed agreements with the NSF to participate in funding the Ocean Margin Drilling Program (OMDP) through September 1981. The companies are Atlantic Richfield, Cities Service, Continental Oil, EXXON Production Research, Mobile Oil, Penzoil Exploration and Production, Phillips Petroleum, Standard of California, Sunmark Exploation, and Union Oil.

At its 16-17 September meeting, the Science Advisory Committee (SAC) elected Arthur Maxwell (Woods Hole Oceanographic Institution) to serve as chairman for two years, and Arthur Green (EXXON) to serve as vice-chairman for one year.

To assist in planning of the scientific program, SAC is appointing a number of area and technical Planning Advisory Committees (PACs). At the present time five area PACs have been established to consider the outstanding scientific problems and necessary studies on the U.S. east coast, Gulf of Mexico, west coast of the Americas, Mid-Atlantic Ridge, East Pacific Rise, and Weddell Sea, respectively. A variety of technical PACs will be formed over the coming months as the need for guidance on specific technical aspects of the program develops.

An OMDP directory, including the names and affiliations of the members of the SAC and PACs, will be available from JOI, Inc. in the near future.

The primary **scientific task** until Fall 1981 will be the synthesis of existing geological and geophysical data in eleven geographic regions targeted as candidate drilling areas by the SAC. These regional syntheses are to provide comprehensive documentation of the present state of knowledge of areas considered to be among the most representative and best known examples of active and passive continental margins and the mid-ocean ridge, and the paleoenvironmentally critical Weddell Sea. They will consist of a series of charts showing bathymetry, magnetics, gravity, depth to basement, depth to selected seismic reflectors, isopachs between the seismic reflectors, tectonics, geologic hazards, lithofacies and paleogeography, and heat flow. The charts will be accompanied by cross sections calibrated by existing wells, and each chart will have an overlay showing the data points or lines from which the synthesis was produced. Contracts for regional syntheses have been awarded to eleven groups representing some 84 investigators from 25 institutions. First drafts of the syntheses are to be availble for planning purposes in early Summer 1981.

The regional syntheses will form the basis for further development of the science program by the PACs and SAC. If the program is deemed satisfactory, additional studies to define the location of prospective drill sites, and to continue the scientific program planning and preparation of experiments will be initiated in late 1981. The first drilling would be planned for 1984. (*T. Davies, JOI, Inc.*)

IPOD SITE-SURVEY DATA BANK

The IPOD Site-Survey Data Bank at Lamont-Doherty Geological Observatory has recently (September 1980-December 1980) received the following data.

- *Fred H. Moore* multichannel seismic profiles, CAR-31 through CAR-42C (Leg 78) and navigation and bathymetry of the Leg 77 area, from the University of Texas Marine Science Institute (UTMSI).
- Corrected bathymetric map, Leg 77 site-survey area, from R. Buffler (UTMSI).
- Computer tape of navigation of *Fred H. Moore* (Cruise 3, Leg 1, western Straits of Florida and southeast Gulf of Mexico), from R. Buffler, UTMSI.
- Multichannel seismic profiles from the Caribbean sites CAR-7, CAR72-A,B,C,D, and CAR 71-B,C, and D, from the UTMSI.
- Multichannel seismic profiles from western South Atlantic sites WSA-1,4,5,7,8,10,11,13, and 20, from the UTMSI.
- Prospectus for Leg 77, from R. Buffler, UTMSI.

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- Leg 79 safety package for Mazagan sites, from K. Hinz, Bundesanstalt für Geowissenschaften und Rohstoffe, Abt Geophysik (BGR).
- Leg 79 safety package for Galicia sites, from L. Montadert, Institut Francais de Petrole.
- Microfilms of seismic data from R/V *Fay* of the U.S. east coast and Blake areas, and from M/V *L'olonnois*, Atlantic margin (AMCOR), from National Geophysical and Solar, Terrestrial Data Center (N.G.S.D.C.), Colorado.
- Computer tape of navigation and magnetics over the U.S.A. Project Magnet, from N.G.S.D.C., Colorado.
- Multichannel seismic profiler records and navigation for U.S. east coast lines 14 through 32 and well log data for COST G-1 and G-2, from N.G.S.D.C., Colorado.
- Microfilms of *Glomar Challenger* seismics, bathymetry, and magnetics for Legs 71-74, bathymetric map for Leg 75, and computer tapes of Legs 71-74 navigation, from U. Albright, Deep Sea Drilling Project (DSDP).
- DSDP sample records and sample sub-bottom depths (on microfiche), from DSDP.
- The Data Bank also reports that its data folio for the central Atlantic is now complete.

JOI SITE SURVEY PLANNING COMMITTEE

LeRoy M. Dorman, Chairman

The JOI Site Survey Planning Committee met 18 December 1980 at Lamont-Doherty Geological Observatory to review the present site survey program and to prepare a Request for Proposal (RFP) for surveys relevant to the 1981-1983 *Challenger* drilling program. The following summarizes items from that meeting.

North Atlantic Drilling (Leg 82)

ENA-8 and -11 Surveys

B. Ludwig, P. Stoffa and D. Hayes reviewed the status of the L-DGO contract to survey sites ENA-8 and -11. The execution of this contract has been delayed by ship scheduling problems and is in danger of affecting the drilling program through inability to complete the safety review in time. L-DGO plans to do the 700 or so nautical miles of trackline critical to the safety review just after the LASE experiment, using *Conrad.* This first cruise would return to port in mid-July. Single-channel monitor records would be available immediately and the 36-fold would require an additional 6 weeks. The *Challenger* gets underway on 4 September and is scheduled to drill ENA-3 first. In order to obtain safety approval before sailing, the review would perforce be based on the monitor records. Even so, the scheduling is so close that minor delays in the *Conrad* overhaul or the LASE experiment would jeopardize the site review.

An alternative vessel to *Conrad* is the *Fred Moore*, which will be available before LASE but the survey would have to be done in April (bad weather).

The committee concluded that **the L-DGO site survey plan is feasible only if the Safety Panel can conduct its review between mid-July and 4 September, using single-channel records. If the Safety Panel cannot work on this basis the drilling will need to be rescheduled.**

ENA-3 and -4 Surveys

D. Greever presented samples of the processing done at WHOI on the reflection data for ENA-3 and -4. The goal of the reflection work is the mapping of reflector J_1, just above basement. The WHOI seismologists suggest that the most reasonable processing strategy is to deconvolve one channel of the 12-channel data and to stack only the data near the targets. The panel concurred.

1981-83 Drilling Program

L. Dorman announced that NSF had reportedly agreed to fund the first year of the '81-83 drilling program and appeared likely to fund the second. The most productive plan is then to plan for the 24-month program put forth by the PCOM at their 15-17 October, 1980 meeting.

The most evident need for surveying is in connection with Leg 84 (hydrogeology), Leg 86 (old Pacific), Leg 89 (equatorial Pacific) and Leg 95 (North Atlantic crust). The committee drafted RFPs for these surveys which are in part summarized as follows:

East Pacific Rise - Hydrogeology

M. Leinen and M. Bender of URI presented the proposed hydrogeology program and R. Anderson of L-DGO provided additional consultation.

The objective of DSDP Leg 84 is to study hydrothermal circulation in the oceanic crust.

enrichment of transition metals in many basal sediments recovered by the drilling program suggests that a process of precipitation from hydrothermal solutions is occurring. The hydraulic piston corer (HPC) will be used to sample a complete sedimentary section of ridge flank deposits. This will allow a thorough examination of the hydrothermal flux as the plate segment moves away from the ridge.

The area proposed for drilling consists of the seafloor on the western flank of the East Pacific Rise out to anomaly 7 between 15 and 20°S. Smooth bathymetry and low biogenic productivity have delineated this area as the most likely to achieve the scientific objectives.

The salient problem in this work is logistical because of the nearness of the drilling date. At present, there is no ship available to do the survey work. The most likely candidate is the *Lee*. Site proponents and L. Dorman will pursue solutions to the problem.

Old Pacific

The committee reviewed a proposal survey plan submitted by S. Schlanger of HIG to R. Douglas, Ocean Paleoenvironment Panel chairman. The RFP generated by the panel embodies many elements of the plan.

Drilling is planned to sample Jurassic sediments and crust in the Western Pacific. Sediments deposited during this time are thought to have been representative of open ocean sedimentation in contrast to those deposited in the more restricted Jurassic Atlantic basin. The elemental and magnetic properties of Jurassic igneous basement will also be investigated. Recent drilling results (DSDP Leg 61) have shown that the Western Pacific is characterized by extensive Cretaceous mid-plate volcanism producing sill/flow complexes which are time-consuming to drill. Surveys are required to find areas where these units are absent to allow drilling Jurassic basement. The situation is complicated by the presence of chert layers which, on the basis of siesmic data, are difficult to distinguish from volcanic sills.

Equatorial Pacific

The site proponents assert that detailed bathymetric coverage is necessary to determine the local depositional/erosional environent of the HP core and we agree that this is highly desirable, at least for some of the sites. Such detail can be obtained through use of multi-beam bathymetric soundings or by use of a deeply towed sensor.

We will request proposals for site-spec surveys in support of hydraulic piston coring the eastern equatorial Pacific to be carried o during Leg 82 (September-November, 1982 Detailed stratigraphic sampling of this part c the Pacific is necessary to address the followin scientific questions:

a. What is the history of Quaternary carbonate dissolution cycles? How are changes in carbonate preservation linked to indicators of surface water (planktonic microfossils) and deep water (benthonic microfossil) conditions?

b. What changes in productivity and upwelling have taken place during the past 10 million years? Can these changes be correlated with major climatic/tectonic events in other parts of the world?

c. How closely can highly resolved paleoceanographic oscillations in the Tertiary be correlated (using paleomagnetic and biostratigraphic techniques) with Tertiary sections which have been or will be sampled in other parts of the world's oceans?

North Atlantic Crust

The study of trace elements in oceanic basalts has revealed significant variations in the composition of the upper mantle beneath the North Atlantic. It is clear from recent surveys that a major geochemical transition occurs near the Hayes Fracture Zone at 34°N. A study of the nature of this transition forms an important objective for the next phase of *Glomar Challenger* drilling. A series of holes between 10°N and 40°N is planned to examine the configuration of the geochemical boundary. This will require a detailed knowledge of topography, magnetics and sediment distribution at the position of anomaly 33-34, so that normal (slow spreading) Atlantic crust — free of tectonized basement associated with fracture zones — can be selected for drilling.

The Ocean Crust Panel has recommended five holes along magnetic anomaly 33-34 (60-70 m.y.) to examine the extent of mantle heterogeneity in the vicinity of the Hayes Fracture Zone. We are currently investigating whether British and French workers are prepared to run *Gloria*, *Seabeam* and magnetic traverses in the study area. (*L. M. Dorman*)

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JOI Inc. reports that the resulting Request for Proposal will be mailed in the first week of February 1981.

LETTER TO THE JOIDES COMMUNITY FROM THE PLANNING COMMITTEE CHAIRMAN

Results of the U.S. National Board Review of our 1981-83 Drilling Proposal

The resolution of the U.S. National Science Board (NSB) deliberations on the proposal for *Challenger* drilling in 1981-83 is as follows:

RESOLVED, that the National Science Board approves the general plans for the 2-year scientific program for Deep Sea Drilling Project, International Phase of Ocean Drilling as presented in *NSB-80-467 Revised*.

Further, that the National Science Board approves the making by the Director at his discretion of grants, contracts, or other arrangements to the University of California, San Diego, and the Joint Oceanographic Institutions Incorporated in an amount not to exceed $26,000,000, of which *$10,000,000 is being provided by International Phase of Ocean Drilling partner countries and $2,000,000 is being provided by Defense Advanced Research Project Agency and the United States Geological Survey*, for the fiscal year 1982 with the understanding that the National Science Board approval of the program for fiscal year 1983 is contingent upon the Director seeking approval of the National Science Board for fiscal year 1983 funding.

I am told that the NSB received our scientific proposal very warmly, and that they deemed the advent of hydraulic piston coring as putting us on the threshold of important new discoveries. They expect us to accompany our request for funding for the second year (FY 83) with documentation of some of the actual scientific results of HPC work done on very recent drilling legs and on legs over the coming months. We should be ready to present these results to NSB early next fall.

Personally, I am very heartened by this result. The Board appears to like our scientific proposals, and to be ready to continue funding if we show them results. I believe we are in a strong position and not only can deliver on our promises, but can also now begin to work together to develop a long-term plan for *Challenger* drilling, (see below).

Conference on Scientific Ocean Drilling (COSOD)

During its meeting in Atlanta on 18-19 November the Executive Committee acted upon the recommendation of the PCOM that,

n for the 'to review scientific

in light of the need to integrate prese[ommittee] ceived ocean and other related scientifi[ow such] programs, to most effectively utilize [ocussed,] tools and to develop a coherent plan [ould be] decade ahead, there be a conference "to and reassess goals and directions of sc[xamine] ocean drilling." An interim steering com[*drilling*] of EXCOM, charged with examining how[*anized*] a conference should be organized and foc[*ortant*] who should attend, and when it should [*pro-*] held, recommended:

1. that the purpose of COSOD is to exa[oing] the question *How can the planning for dr[ean] and associated scientific programs be organ[ua-] and coordinated to attack the most impor[m-] scientific problems in the most orderly and p[an] ductive way?* [ed]

   The conference will not replace the ongoi[nt] operational planning efforts for the Oce[e] Margin Drilling or the *Challenger* continua tion programs. Rather it will serve to exam ine how these and other scientific efforts can be coordinated, supplemented and structured in order to achieve the most important scientific goals for the next decade in the most cost effective manner.

2. The conference would be organized around the study of 8 to 10 major topics. The following is a preliminary list of topics. (Undoubtedly this list will be modified — by addition, as well as by combination of topics.

   Scientific topics

   • Subsidence • Diagenesis • Ocean climate • Deep tectonics (e.g. rifting) • Diapirism • Hydrogeology • Continental break up, collision, subduction • Physical properties of the earth's crust (including magnetic properties) • Seismic stratigraphy — in the sediments and within basement.

   Background topics

   • Drilling technology and anticipated advances • Sampling by means other than drilling

   To facilitate the work of the conference, groups usually of three members each (with a designated leader) would be appointed, and asked to write a "white paper," for each topic, and mail it to all the conference attendees six weeks before the start of the conference. The white papers on the scientific topics will address the question *How will drilling advance the state of knowledge in a given topic?*

3. The JOIDES Executive Committee will appoint a steering committee consisting of ten members. It will consist of five —

of the JOIDES organization and five outside members. It will primarily be the task of the steering committee to select the groups that will write the white papers and generally organize the conference. The invitees to the conference will consist of steering committee members, the members of the groups that write the white papers and some additional attendees.

4. The conference report will have a "front end" written by the entire steering committee. The remainder of the report will consist of white papers (including the discussion of the white papers at the conference).

5. Proposed timetable

a. JOIDES EXCOM to appoint steering committee for conference **as soon as possible**
b. JOIDES members of the steering committee meet **as soon as possible** and select groups to write white papers and tentatively select the remaining attendees.
c. The PCOM and COSOD Steering Committee to solicit ideas from JOIDES panels and the community at large. **(Ongoing)**
d. Steering committee receives comments and ideas by **22 June 1981**
e. Groups prepare white papers between **22 June and 28 Aug 1981**
f. White papers to be mailed out to conference attendees by **28 Aug 1981**
g. Conference **5 - 9 Oct 1981**
h. First draft of report — **9 Oct 1981**

Proposal for Challenger Drilling after October, 1983

Also during its Atlanta meeting, the JOIDES Executive Committee, in a motion supporting the full 2 years of funding for 1981-83 drilling from *Glomar Challenger*, mandated an "early review of the scientific problems that may require even longer-term use of *Challenger* beyond 1983." During the discussion, many EXCOM members favored the idea of preparing a proposal for a relatively long period of *Challenger* use — for as many as 5 years.

In preparing a proposal for post-'83 drilling, we should keep several points in mind. First, such a proposal must be submitted soon; struggles with the 1981-83 proposal probably stemmed as much from our being a year late as from any other cause. The normal timetable for U.S. consideration of proposals to be funded in FY 84 would require submitting a complete proposal in March of this year. But of course we simply cannot have ready by this coming March a completed proposal that reflects adequate thinking from the JOIDES Advisory Panels, approval by PCOM and EXCOM (for JOIDES), and approval by the Regents of the University of California (for DSDP). Moreover, we should make our proposal consistent with the recommendations of the planned EXCOM-sponsored Conference on Scientific Drilling in the Oceans in the Next Decade (COSOD), which is not scheduled to take place until early October, 1981.

A more realistic schedule is as follows:

January-February 1981
1. Winterer (JOIDES) and Peterson (DSDP), in consultation with JOIDES Panel and Working Group chairmen, prepare a draft Proposal Planning letter for NSF setting out the broad outlines of the proposal, its time frame and a budget. This letter would especially outline the planning process that would link our proposal to COSOD, and set out the rationale for final proposal submission following COSOD.
2. JOIDES Panel chairmen receive guidelines for preparation of post-'83 proposal material.

February 1981
The PCOM reviews the draft letter at its meeting in La Jolla, 24-27 February.

March 1981
1. Winterer revises letter as needed.
2. The EXCOM reviews the revised letter at its meeting in La Jolla, 19-30 March.
3. JOIDES submits the letter to NSF.

February - May 1981
JOIDES Panels revise white papers and prepare materials for post-'83 drilling proposal.

June 1981
1. All proposal materials from JOIDES panels due at JOIDES Office on or before June 1.
2. Winterer (JOIDES) and Peterson (DSDP) prepare a draft proposal for post 1983 drilling.

July 1981
The PCOM reviews the draft proposal at its meeting in Hannover, 8-10 July.

August 1981
1. Winterer revises the draft proposal as needed.
2. The EXCOM reviews the revised draft at its meeting in Hannover, 13-14 August.

October 1981
1. Winterer and Peterson revise the proposal as appropriate following COSOD.
2. DSDP submits proposal to the Regents, University of California for approval.

November 1981
DSDP submits proposal to NSF.

As to the substance and format of the proposal, that will, of course, follow from the advise of the JOIDES panels and working groups and suggestions from individual scientists or groups of scientists — within or outside the JOIDES community. Nonetheless, it might be efficient to structure the proposal along the lines of the scientific topics around which COSOD will be organized. I will thus ask JOIDES Panels (1) to revise their white papers, in which they set out in whatever way they deem appropriate the broad problems to be attacked, but in which they will also deal with the specific COSOD subject topics; and (2) to translate their white papers into actual drilling proposals, aimed at certain areas or sites, which should be specific enough to provide guidance to the JOIDES and JOI Site Survey Panels (JOI, Inc., must submit a site-survey proposal to accompany the drilling proposal).

After more than a decade of drilling, some scientific problems are at the crucial stage of testing rival hypotheses, many are at the stage of model-building, while some others are still in the stage of exploration — wildcatting. I would hope we could single out those in the first category for early intensive effort. I trust that our panels will seize on the fact that a term of several years would give us the time to circumnavigate the globe, and to drill, for example, in the Indian Ocean. I also hope that we can exploit much further the possibilities for imaginative down-hole experiments in post-'83 drilling. We have the lead time to develop the hardware if we plan ahead now. As you can see, I am confident that we will have more than enough exciting science to frame an excellent proposal.

Finally, I want to express my gratitude to all of you for your help and support over these past months, during the time when our 1981-83 drilling proposal was at its most crucial stages of review and funding.

E. L. Winterer
Chairman, JOIDES
Planning Committee

NEWS BRIEFS

Congress has confirmed **John B. Slaughter** to the post of **Director of the National Science Foundation.**

NSF has recently created the **Division of Ocean Drilling** under which will deal with all NSF-funded ocean drilling programs. The Foundation effectively elevated the Ocean Sediment Coring Program, previously under the Division of Earth Sciences, to division level. **Peter Wilkniss** is **Acting Division Director, Anton Inderbitzen** is **Acting Chief Scientist for Science** (Ocean Marging Drilling — OMD), and **William Sherwood** is **Acting Chief Scientist for Engineering**, OMD. **Bilal Haq** will continue in his capacity as **NSF liaison** to JOIDES within the new division.

The **Ocean Margin Drilling Program** formally began 1 October 1980. NSF has issued a 5-volume report dealing with the preliminary scientific and technical planning that has gone into development of that program.

PUBLICATIONS

The DSDP Curator has supplied this list of recent publications. If you have published a paper using data or samples collected by, or in conjunction with, the Deep Sea Drilling Project, please send five reprints of it to the Curator, Deep Sea Drilling Project, A-031, La Jolla, CA 92093.

Beckman, Jan, 1980. Miocene-Pliocene nannofossils and sedimentation rates in the Hatton-Rockall Basin, NE Atlantic Ocean. *Stockholm Contributions in Geology*, v. XXXVI, no. 1, p. 1-91, 8 pls., Acta Universitatis Stockholmiensis.

Baldauf, Jack G. and John A. Barron, 1980. *Actinocyclus ingens* var. *nodus*: a new stratigraphically useful diatom of the circum-North Pacific. *Micropaleontology*, v. 26, no. 1, p. 103-110, pl. 1.

Bujak, Jonathan P., 1980. Organic type and maturation of 1343 DSDP samples from the Atlantic Basin and adjacent areas: Status Report No. EOGS-DOM. 4-80JPB. 16 pp.

Casey, Richard E. and Richard A. Reynolds, 1980. Late Neogene radiolarian biostratigraphy related to magnetostratigraphy and paleoceanography with suggested cosmopolitan radiolarian datums. *Cushman Foundation Special Publication no. 19. Memorial to Orville L. Bandy*, p. 287-300, pls. 1, 2.

Chow, Tsaihwa J., John L. Earl and Carrie B. Snyder, 1980. Lead isotopes in Atlantic DSDP sediment cores. In *Isotope Marine Chemistry*, eds., Goldberg, E. D., Y. Horibe, and K. Saruhashi, p. 399-412. Uchida Rokakuho Publ. Co. Ltd., Tokyo.

Columbo, Maria Rosa and Maria Bianca Cita, 1980. Changes in size and test porosity of *Orbulina universa* d'Orbigny in the Pleistocene record of Cape Bojador (DSDP Site 397, Eastern North Atlantic). *Marine Micropaleontology*, v. 5, p. 13-29, Elsevier, Amsterdam.

Diester-Haass, L. and H. Chamley, 1980. Oligocene climatic, tectonic and eustatic history off NW Africa (DSDP Leg 41, Site 369). *Oceanologica Acta*, v. 3, no. 1, p. 115-126, Gauthier-Villars.

Gombos, Andrew M. Jr., 1980. The early history of the diatom family Asterolampracae. *Bacillaia*, v. 3, p. 227-272. J. Cramer, Braunschweig, Germany.

Guerin, S., 1980. Comparaison des associations de foraminiferes de l'Albien de l'Atlantique nord (Echantillons DSDP) et du Bassin Vocontien (Sud-Est de la France). *8th Reunion Annuelle des Sciences de la Terre*, Marseille, Soc. Geol. Fr., edit. Paris, p. 176.

Keller, Greta, 1980. Middle to late Miocene planktonic foraminiferal datum levels and paleoceanography of the north and southeastern Pacific Ocean. *Marine Micropaleontology*, no. 5, p. 249-281.

Ludwig, William J., Valery Krasheninnikov, and the Leg 71 Scientific Party, 1980. On Leg 71, SW Atlantic yields records of its currents. *Geotimes*, v. 25, no. 8, p. 22-23.

Prell, Warren L., James V. Gardner, and the Leg 68 Scientific Party, 1980. Hydraulic piston coring of late Neogene and Quaternary sections in the Caribbean and equatorial Pacific: Preliminary results of Deep Sea Drilling Project Leg 68. *Geol. Soc. of Amer. Bull.*, pt. I, v. 91, p. 433-444, 9 figs., 2 tables.

Robert C., 1980. Climats et courants cénozoiques dans l'Atlantique Sud d'après l'étude des minéraux argileux (Legs 3, 39 et 40 DSDP). *Oceanologica Acta*, v. 3, no. 3, p. 369-376.

Schrader, Hans, and the Leg 64 Scientific Party, 1980. Laminated diatomaceous sediments from the Guaymas Basin slope (central Gulf of California): 250,000-year climate record. *Science*, v. 207, p. 1207-1209.

Siesser, William G., 1980. Late Miocene origin of the Benguela upswelling system off northern Namibia. *Science*, v. 208, p. 283-285.

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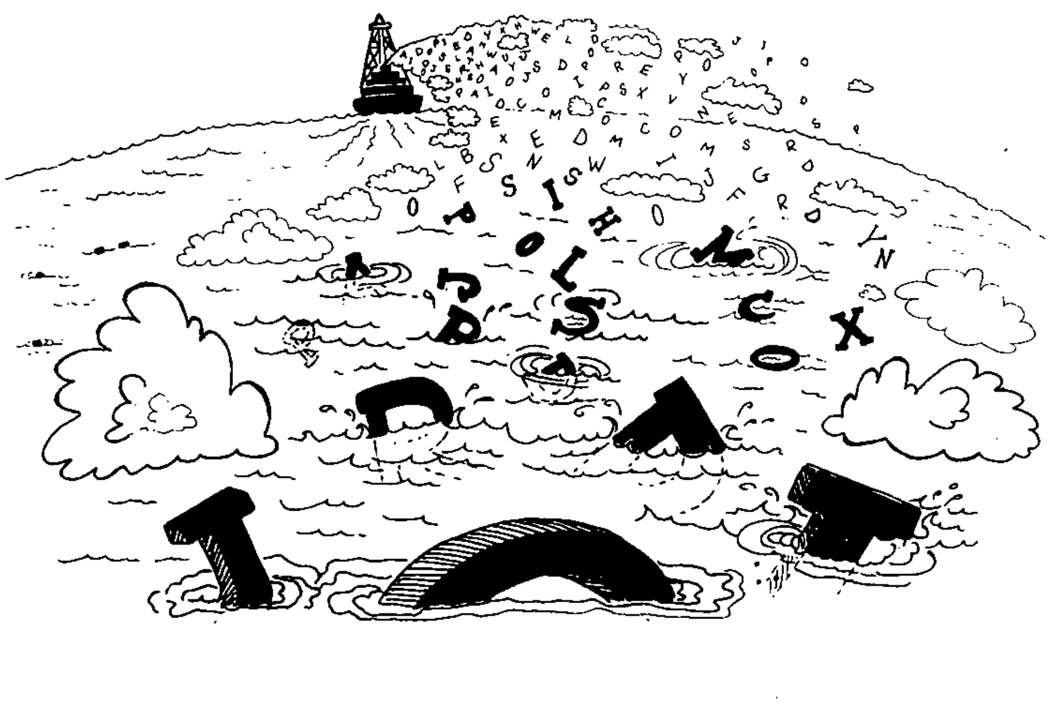

Look for a glossary of JOIDES acronyms and buzz words, next issue. (We thank Jean Westberg, SIO, for the drawing.)

APPROVED JOIDES PANEL MEETINGS

	COMMITTEE / PANEL	Jan 1981	Feb 1981	Mar 1981	Apr 1981	May 1981	June 1981	July 1981	Aug 1981	Sept 1981	Oct 1981	Nov 1981	Dec 1981
	Executive Committee (EXCOM)			19-20 SIO					12-14 Hannover				
	Planning Committee (PCOM)		24-27 SIO					8-10 Hannover				11-13 Corvallis	
SUBJECT / AREA	Ocean Crust Panel (OCP)			30-31 U. Rhode Is.	1 U. Rhode Is.								
	Ocean Margin (Active) Panel (AMP)				7-9 Menlo Park								
	Ocean Margin (Passive) Panel (PMP)	17-19 Galveston											
	Ocean Paleoenvironment Panel (OPP)		4-5 Bermuda										
DISCIPLINE	Inorganic Geochemistry Panel (IGP)												
	Organic Geochemistry Panel (OGP)												
	Sedimentary Petrology & Physical Properties Panel (SP^4)												
	Stratigraphic Correlations Panel (SCP)					6-8 SIO							
OPERATIONS	Downhole Measurements Panel (DMP)				30 HIG	1 HIG							
	Industrial Liaison Panel (ILP)												
	Information Handling Panel (IHP)	15-16 SIO											
	Pollution Prevention & Safety Panel (PPSP)			10-11 SIO									
	Site Surveying Panel (SSP)												
	Ad hoc Panel												
	Working Group (Mesozoic)	20 SIO*	3 Bermuda*										

*in part

JOIDES COMMITTEE AND PANEL REPORTS

We have extracted the following items from either the draft minutes of recent JOIDES committee and panel minutes or from brief summaries provided by panel chairmen. We omitted items from the minutes reported elsewhere in the JOIDES Journal (e.g. NSF and DSDP, OMD reports, and/or certain items of limited interest.

EXECUTIVE COMMITTEE

William A. Nierenberg, Chairman

The Executive Committee (EXCOM) met 17-19 November in Atlanta, Georgia. A. Maxwell substituted as chairman in the absence of W. Nierenberg. The following includes items from the **draft** minutes of that meeting which are not reported elsewhere in the Journal.

1981-83 *Challenger* Program

NSF Review

P. Wilkniss (NSF) reported on the status of FY 1982-83 *Challenger* drilling proposal.

NSF peer review of the FY 1982-83 proposal is complete; the addendum to the proposal prepared by JOIDES/DSDP and submitted in early September fully responded to all concerns of the reviewers. The *ad hoc* review panel gave the proposal excellent marks and urged the Foundation to seek its full support.

NSF will present the proposal to the Program Committee, then to the full National Science Board on Thursday, November 20th. The Board will devote four hours, an extraordinarily large block of time, to a review of the JOIDES and OMD proposals. NSF will know and relay the NSB's action on late Friday (November 21st) or the following Monday.

Wilkniss added that Francis Johnson (Assistant Director, Astronomical, Atmospheric, Earth and Ocean Sciences, NSF) understands the difficulties the IPOD partners face in committing support before the U.S. has acted. NSF wholeheartedly supports the 1982 drilling, but because the 1981-83 proposal was submitted about a year too late to be budgeted for 1982, NSF has no funds set aside other than those for phasing out the program. Offices above NSF (in the U.S. budgeting chain) have yet to give their official support to the *Challenger* drilling. NSF is also seeking support from other U.S. Government agencies, and is doing all possible to justify and achieve the goal of further *Challenger* drilling.

(See "Letter from the Planning Committee Chairman," this issue for an update on the NSF review.)

Defense Advanced Research Project Agency (DARPA)

E. Winterer also reviewed the proposed DARPA program. During its July 2-4 meeting the PCOM supported, in principle, a DARPA program to (a) test the implantation of a downhole seismic monitoring package during Leg 78B (then called Leg 78A) and (b) to implant the system in the NW Pacific during the proposed 1981-83 drilling program.

During discussion the EXCOM members expressed their concern over the inadequate information provided about the costs involved to the project, the additional funding agreed to by DARPA and the effect of the DARPA proposals on the scientific objectives and planning of the 1981-83 *Challenger* drilling.

The Executive Committee adopted the following position regarding the DARPA test during Leg 78B, but took no specific position on the proposed DARPA experiment in the N.W. Pacific.

Executive Committee approves a 6-10 day DARPA test during 1981 provided that:

1. **DARPA provides the funds for the operation**
2. **results of the experiment are published in the Bnitial Report of that leg**
3. **the current drilling program be extended by the number of days consumed by the DARPA experiment**
4. **DARPA be responsible for leaving a clean hole,** and
5. **DARPA be responsible for the integrity of the drilling system during the experiment.**

U. S. Geological Survey

E. Winterer alerted the EXCOM to the U.S. Geological Survey's interest in cooperating in the 1981-83 *Challenger* program. N. T. Edgar (Chief, Office of Marine Geology) had presented the Survey's proposal at the recent Planning Committee (PCOM) meeting (15-17 October). The Survey proposes drilling off the (a) east coast U.S. — shallow seismic discontinuities and gas hydrates, slope stability and (b) the Gulf Coast U.S. to study fans, salt diapirism and organic chemistry of anoxic basins. (*The areas of USGS interest are outlined in more detail in the PCOM report, below.*)

The USGS would be willing to contribute funds to the program and all results would be included in the DSDP Initial Reports.

Drilling to study slope stability, seismic discontinuities and, to some degree fans and anoxic basins, overlap previously defined JOIDES objectives. The PCOM asked Edgar to prioritize the survey's objectives and to present them to the Passive Margin Panel during its next (January 1981) meeting.

Alternative Drilling Programs

A. Maxwell relayed that the IPOD partners, during their meeting at Woods Hole (18-20 September 1980), anticipated a short-fall in funding for the entire 2-year program; $39 million of the needed $52 million was perhaps "in sight." JOI asked the JOIDES Executive Committee, which in turn asked the Planning Committee, to prepare alternative, incremented drilling programs assuming reduced levels of funding.

E. Winterer reported model alternative drilling programs developed during the recent Planning Committee meeting.

Recognizing the many problems that a shortened program would cause, the PCOM devised the alternative programs in response to the JOI/EXCOM charge. (*More detail of the PCOM discussions is given below in the PCOM report.*)

To develop the incremented programs the PCOM, (a) reviewed drilling objectives and priorities of all the JOIDES subject panels, (b) kept outside interests in mind, (c) proposed 18- and 15-month programs on the basis of the $39 million "seen" by the IPOD partners, while recognizing that this was a linear solution to a non-linear problem (Because of fixed costs of operating *Challenger* and contractual agreements with Global Marine, a 25% reduction in funds could mean as much as a 50% reduction in drilling.) and (d) recognized that any commitment less than 22 months results in only one high latitude summer, thus either parts of the North Atlantic or North Pacific could not be drilled. Table PCOM-1 (PCOM report, below) summarizes the model alternative drilling programs.

24-Month Program: The PCOM felt that most of the presently defined, highest, priority scientific objectives could be accomplished within a 13-leg program and supported the 2-year 1981-83 proposal as a coherent plan, agreed to in principle by the IPOD partners.

18-Month Program: The PCOM accepted a Pacific bias in the 18-month program. This eliminates the eastern North Atlantic high latitude paleoenvironment work, slope stability and seismic discontinuity studies off Eastern North America, and sampling of Jurassic sediments and crust in the Pacific.

15-Month Program: A 15-month program requires a choice between oceans. Two 15-month programs are proposed and only one leg, a leg in the Caribbean, is included in both models.

Site Survey Constraints

Winterer also reported on the PCOM's discussions concerning site surveys. JOI cannot issue RFP's for the U.S. surveys until NSF approves the program and because site surveys require many months lead time, certain areas already cannot be drilled.

Recognizing the need for better communications between site proponents and the JOIDES Site Survey Panels, the PCOM asked specific people to effect liaison for each proposed site or region. It also encouraged the Site Survey Panels to meet as soon as possible, preferably at L-DGO (IPOD data bank).

The EXCOM also noted that the site survey for the proposed DARPA work in the Pacific had not been done, nor was it clear who would pay for it.

EXCOM Resolution

Following extensive discussion during which each EXCOM member relayed his personal and/or his institution's views regarding the 1981-83 drilling program, the Executive Committee unanimously adopted the following position.

The Executive Committee, having re-examined the scientific merit of the program embodied in the renewed proposal for drilling during 1981-83 and the alternatives to this two-year program presented to it by the PCOM,

1. **unanimously and vigorously supports a full 2-years of additional funding for the drilling program of *Glomar Challenger***
2. **recognizes that funding of the program for less than two years would raise difficulties both in funding from non-U.S. member countries and in efficient scheduling of the ship to reach high priority objectives.**

3. **focuses the need for an early review of the scientific problems that may require even longer-term use of *Challenger* beyond 1983.**

In addition, the U.S. members resolved that:

The U.S. members of the Executive Committee also unanimously and vigorously support the proposed Ocean Margin Drilling Program and believe that the proposed *Challenger* and Ocean Margin Drilling programs are complementary.

North Atlantic Drilling Program

E. Winterer reported on drilling priorities recommended by the Planning Committee during its 15-17 October meeting in Rhode Island. (*The PCOM recommendations (Legs 76, 77, and 78 are given in detail below in the Planning Committee report.*)

The Executive Committee **accepted the Planning Committee's North Atlantic program as proposed and thanked E. Winterer for his detailed presentation.**

Expanding International Participation

A. Maxwell and W. Hay reported on a meeting between JOIDES EXCOM representation and Canadian scientists and government officials regarding future JOIDES membership. The meeting had been arranged to address questions surrounding classes of membership, and initiate conversations with, and evaluate Canadian interest in, JOIDES membership. Because no non-US JOIDES representatives attended the meeting, the committee did not discuss the first point.

W. Nierenberg and A. Maxwell (both EXCOM) and W. Hay (JOI) attended the meeting on 23 October at the University of Toronto with representatives from Canadian universities, industry and government.

Both the *Challenger* extension and OMD programs were discussed, but the Canadians showed particular interest in the OMD program. They are primarily concerned about whether Canadian objectives can be addressed in the OMD program and whether the extended *Challenger* program is sufficiently flexible to accommodate change.

Other members of the EXCOM reported on communications with other countries.

Australia is very interested. A meeting in Australia scheduled for early 1981 was originally to address only on the Ocean Margin Drilling, but now will include extended planned *Challenger* planning.

The **Dutch** show continued interest. J. van Hinte has contacted officials in the Hague and W. Nierenberg has sent him information on the OMD and *Challenger* programs.

The **Germans** (F. Bender) have corresponded with the Chinese Ministry of Geology in Peking. The Peoples Republic of China have requested more information on procedures for joining JOIDES.

W. Hay reported that the **Norwegians** are enthusiastic about OMD. M. Talwani will also be talking to a Norwegian representative next month.

The EXCOM consensus regarding potential new members was to **press ahead on full membership**; consortia or other classes of membership would be considered only as necessary.

Ocean Marging Drilling

Scientific Planning

In his report to the EXCOM, A. Maxwell, Chairman of the OMD Science Advisory committee (SAC), emphasized that the scientific planning for *Explorer* drilling was very complex, thus SAC was proceeding very slowly and cautiously. The *Explorer* may be on station for up to nine months at a time and planning is quite different from that for *Glomar Challenger*. Inasmuch as the oil industry first defines objectives, then evaluates costs, a careful assessment of how funds are to be spent is required.

The oil companies support doing most of the scientific laboratory work on shore. The planners must decide whether to pursue this philosophy and, if so, whether to support one or many shore-based labs. Should the program go ahead an RFP will be distributed for construction and maintenance of the lab facility.

The OMD program requires detailed planning for each site — from the bottom of the hole up. JOI is using the HUSOD document as a starting model. The advisory committee is carefully examining eleven target areas, defined during the Houston meeting. JOI expects to have the preliminary geological and geophysical syntheses completed by June 1981 and is also encouraging participating oil companies to make their data from the target regions available. In addition to the SAC, JOI has developed five Planning Advisory Committees (PACs) (East Coast, West Coast, Gulf of Mexico, Mid-Atlantic Ridge/East Pacific Rise, and Antarctic committees) comprising members from the scientific community and participating

...oil companies. (Neither participants from non-US JOIDES partners nor from non-contributing oil companies, however, are included.) JOI is presently establishing technical advisory panels dealing with geophysics, geotechnical problems, information handling, drilling safety, and publications.

Non-U.S. Participation

Maxwell also reported that the Scientific Advisory Committee encourages non-US participation in the OMD program, but is not yet prepared to resolve the problems. These include (1) whether non-US oil companies would be treated as an independent oil company or a partner of the non-US government, (2) how to adapt a drilling program now focused on U.S. margin drilling to non-US interests, (3) how the new US administration will view the program. The SAC hopes to address these questions in about a year ~ after it knows whether or not the program will continue.

Conference on the Future Course of Scientific Ocean Drilling

Background

E. Winterer reported that the Planning Committee had been asked by the Passive Margin Panel to consider convening a conference to reassess the long-term goals of passive margin research. During its October 1980 meeting, the Planning Committee viewed the proposed conference in a wide context and recommended that it be organized under the auspices of the National Academy of Sciences.

Because of the limited time to initiate such a conference, Winterer independently contacted the National Academy of Sciences, in particular the Geodynamics Committee, to assess areas of support and possible funding. Winterer reported that generally good and growing support exists among marine geologists, and that such a conference is viewed as a means to ensure coordinated planning between ocean margin and continental drilling interests.

EXCOM Consensus and Charge

The EXCOM recognized that to organize a conference on the future ocean drilling, it must (1) focus the meeting so that workable solutions emerge, while maintaining a sufficiently broad scientific base to ensure overall support and allow for valid coordination (2) look for new solutions without the constraints of tapping only the JOIDES community (3) i... representatives from JOI, JOIDES, Ind... continental drilling, and (4) ensure that r... address long-term (5-years) drilling prioriti...

mittee Heath Hay rence hould The

The EXCOM appointed a steering comm... comprising M. Talwani (chairman), Ross H... (EXCOM), E. Winterer (PCOM) and W. ... (JOI) to recommend how such a confere... should be organized, and focused, who sho... attend, and when it should be held. T... steering committee will report at the EXCOM... next meeting.

M's ittee pro-

(See also "Letter from the Planning Committe... Chairman," this issue for an update on the pro... posed conference.)

Panel Membership

The Executive Committee approved the potential new Panel members as recommended by the Planning Committee.

E. Winterer reported that, as chairman of the Planning Committee, he plans to reenforce the 2-year tenure for panel members. He has strongly uged the Passive Margin and the Organic Geochemistry panels to rotate membership and is also pursuing the problem in all panels.

The EXCOM generally agreed that rotation of membership, particularly in the subject panels, was important, but that exceptions should be allowed (especially in certain service panels such as the Information Handling Panel which meets only once a year.) The invitation letters to new members should explicitly state that the appointment is for a two-year term; the option to extend membership may or may not be exercised at the end of that period.

Status of Repositories

E. Winterer alerted the EXCOM to W. Riedel's draft proposal (written for JOI for submission to NSF) for preparing radiolarian slides as part of the microfossil reference collections. The proposal contains background information and progress to date on the reference collections. Riedel is also proceeding with negotiations to establish a reference collection at the New Zealand Geological Survey at Lower Hutt.

In conjunction with the reference centers, M. Talwani distributed a letter from F. McCoy suggesting L-DGO serve as a U.S. microfossil reference center.

The EXCOM asked Winterer to relay the L-DGO proposal to W. Riedel and suggested that Riedel and McCoy discuss the plan and submit a formal proposal (if this seems reasonable) at the next EXCOM meeting. The EXCOM noted that plans to organize reference centers date back to 1975. It will plan to take specific action on the L-DGO (and other proposals) during its next meeting.

Future Meetings

The Executive Committee will next meet **19-20 March 1981** at Scripps Institution of Oceanography. It will conduct its summer meeting on **12-14 August 1981** at the Bundesanstalt für Geowissenschaften und Rohstoffe in Hannover, FRG.

PLANNING COMMITTEE

Edward L. Winterer, Chairman

The Planning Committee met 15-17 October 1980 at the W. Alton Jones Center, University of Rhode Island. The following includes key items from the **draft** minutes of that meeting.

North Atlantic Challenger Plans

During its 8-10 September 1980 meeting in Barbados, the Ocean Margin Passive Panel (PMP) made several recommendations regarding drilling priorities during Legs 76-79. The Planning Committee (PCOM) acted upon the recommendations as follows:

Leg 76 (Blake-Bahama Basin)

The Planning Committee recommended that the drilling sequence at ENA-1 (oldest sedimennts, Blake-Bahama Basin) be as follows:

a. **set re-entry cone and casing without drilling a pilot hole (inasmuch as the previously drilled Site 391 is nearby),**

b. **continuously core the lower part of the hole — below 500 meters,**

c. **continuously core the upper 500 meters,**

d. **log the hole.**

Leg 77 (Florida Straits)

The Planning Committee recommended that **the general drilling priorities be as follows:**

a. **drill ENA-12E (a new hole to replace ENA-12A) and ENA-12B to sample the upper Mesozoic including the mid-Cretaceous seismic discontinuity and the discontinuity below.**

b. **drill ENA-14C and -14B to sample basement (possibly continental crust) where the presence of high horst blocks with only a thin sediment cover have placed it within reach** of within reach of Challenger's **drill string.**

c. **if time remains, drill CAR-7 (Yucatan Basin), and/or ENA-13 (to sample the Cenozoic and upper Cretaceous to the middle Cretaceous unconformity), and/or ENA-14A. Selection of site to be made on the basis of time available (CAR-7 requires the most drilling time; ENA-14A the least.)**

It further recommended that **the sequence of coring operations at CAR-7 be:**

a. **spot core the upper half of the sedimentary column,**

b. **continuously core the lower half of the section to basement,**

c. **continuously core the by-passed upper part of the section.**

The PCOM approves drilling CAR-7 "upside down" to increase the chance of attaining the prime objective at that site (resolving the origin and age of the Yucatan Basin crust), but reiterates its position that *standard* drilling procedure is continuous coring of all holes.

The PCOM understands the need for flexibility in planning the Leg 77 drilling and recognizes that the co-chief scientists will need to make certain on-the-spot decisions regarding drilling priorities.

Leg 78

In view of the shortenned drilling time for Leg 78, the Caribbean Working Group emphasized the need to drill a reference hole on the oceanic floor to provide a comparison with CAR-1 and a hole on top of the Aves Ridge to collect data on Neogene paleoenvironments in relatively shallow water.

During discussion of the Leg 78 drilling, the PCOM addressed questions partaining to Safety Panel approval of CAR-1. Although the PPSP approved CAR-1 at their 28 August 1980 meeting, it may reconsider the site, should the sediments be interpreted as a tectonically transported proximal (oil-bearing) formation rather than a fine-grained distal (non-oil-bearing) deposit.

Following considerable discussion, the PCOM recommended the following drilling plan.

Drill CAR-1 if PPSP approves.

Drill CAR-3 if PPSP does not approve CAR-1

If CAR-1 drilled successfully, then drill CAR-1D or -1E (reference site), then (if time remains) drill CAR-2B.

If drilling at CAR-1 not completed (safety problem), and adequate time remains, drill CAR-3.

If drilling at CAR-1 is not completed, but insufficient time to drill CAR-1 remains, drill CAR-2B.

Leg 79 (Mazagan)

K. Hinz presented data to the Passive Margin Panel which showed that although granites had been dredged from the area, the Mazagan block might be a salt diapir. The PMP proposed drilling a series of holes — MAZ-3, MAZ-2, and MAZ-4 (itself a series of short holes), or MAZ-4 and MAZ-8 (if MAZ-3 and -2 cannot be drilled) — on the Mazagan Plateau.

The PCOM deferred discussion of the Mazagan sites until after the Safety Panel review of the sites (on 5-6 November 1981).

Outside Interest in 1981-83 Drilling

Defense Advanced Research Agency (DARPA)

During its 2-4 July meeting in Paris, the Planning Committee reviewed and considered favorably a proposal by DARPA to deploy a marine seismic system in the northwest Pacific, and to test the emplacement procedure during the transit between Legs 78 annd 79. (*See October 1980 JOIDES Journal*)

The PCOM reiterated its understanding that **ALL data obtained would be available to the scientific community.**

United States Geological Survey

The U.S. Geological Survey is interested in cooperating with JOIDES/DSDP in a drilling program using *Glomar Challenger* in the western North Atlantic and Gulf of Mexico. N. T. Edgar (Deputy Chief of Marine Geology, USGS) presented the proposed USGS drilling program. The program contains elements addressing both basic science and geotechnical problems. The geotechnical studies, planned partly in conjunction with JOI, Inc., would serve as a part the basis for design of the *Explorer*'s sea-floor well-control system, as well as providing data needed by the USGS in foreseeing conditions that bear on commercial wells on the deeper parts of the continental margin.

The USGS objectives are to:

1. **Define clearly the stratigraphy and geological history along the North Atlantic continental slope and rise, and study the processes of mass wasting.** USGS proposes a series of three transects along the Georges Bank, Mid-Atlantic (States) slope and rise, and Carolina Trough.

   a. **Georges Bank Slope and Rise** — to determine the age, environments and history during key intervals of slope and rise construction: Late Cretaceous-early Tertiary and late Tertiary-Quaternary intervals.

   b. **Mid-Atlantic (States) Slope and Rise** — to reconstruct the depositional changes between, and climatic history during, the shelf to basin transition.

   c. **Carolina Trough** — to sample the Tertiary-Cretaceous stratigraphic and environmental records to complement the mid- and north Atlantic data.

The drilling would also help identify major slump(?) blocks in the upper 200 meters of the lower slope and upper rise. Some of the so-called slumps may be remnant erosional blocks surrounded by canyons. In this case they would pose no special geologic hazard to (oil) drilling operations, and thus the study is important to the future of offshore drilling.

2. **Study gas hydrates on the Carolina Slope** to establish why gas hydrates occur? Are they a potential gas resource? Are they a serious geologic hazard to exploration drilling?

3. **Study the geochemical properties of some 21 salt diapir structures along the East coast magnetic anomaly off North Carolina.**

4. **Study the depositional processes associated with the channeled unconformity (Horizon A^u) on the continental rise off Georgia.**

5. **Gulf of Mexico**

   a. **Mississippi Fan** — to determine depositional and stratigraphic characteristics of a large fan that is receiving sediments in an environment with low sand/clay ratios.

   b. **Gyre/Orca Basins** — to study (with the HPC) different types of basins influenced by vertical movements of diapirs and details of anoxic accumulations, including the rate of formation and geochemical processes acting in highly saline waters (with the hydraulic piston corer).

c. **Sigsbee Escarpment** — to verify the existence of a extended salt wedge thought to form the Sigsbee Escarpment and to study the processes which extruded it.

6. **Geotechnical drilling related to the Ocean Marging Drillinng Program.**

The Ocean Margin Drilling Program calls for drilling an open hole to about 2000 meters sub-bottom to reach the uppermost competent level (level at which sediments can support the riser and blow-out preventer).

The *Glomar Challenger* is the only vessel which can readily establish depths to the "level of competency" (using the HPC to limit of penetration, the pressure core barrel, *in situ* penetrometer and other techniques). OMD planners also envision some ongoing program of geotechnical study associated with each planned site.

• • •

The PCOM recognized that several areas of overlapping interests exist between USGS and the JOIDES partners -- especially within the purview of the Passive Margin Panel.

The Planning Committee **recommended that T. Edgar establish USGS priorities within the proposed program in the western North Atlantic and present the program to the Passive Margin Panel at its January 1981 meeting.**

1981-83 Drilling Program

1981-83 Proposal Update

E. Winterer reviewed the status of the 1981-83 drilling proposal.

At its first meeting in August, the NSF *ad hoc* Review Panel, chaired by John van Couvering, unanimously recommended full support of the 1981-83 drilling program. The Panel directed most of its recommendations toward improving the proposal by more detailed treatment of certain aspects (e.g. convergent margins, and studying organic carbon budgets). The NSF Climate Panel's review was somewhat less enthusiastic but primarily questioned the relevancy of the drilling plans to the U.S. Climate Program.

DSDP and JOI with help and advice from JOIDES (T. Moore, E. Winterer, J. Hays, K. Kvenvolden, J. Gieskes, and others) submitted detailed responses to the points raised by the reviewers to NSF during the first week of September. The NSF *ad hoc* review panel then met 26 September to complete the review and issue its final recommendation. The final recommendation strongly urged funding for the full 2-years. (*NSF presented its recommendations to the National Science Board on 20 November 1980.*)

EXCOM Charge to PCOM

E. Winterer reported that the Chairman of the Executive Committee asked the Planning Committee to develop revised 1981-83 drilling programs assuming the availability of only about 75% of the $52 million required for the 24-month program.

The request came as a result of a September 18-20 meeting at WHOI of IPOD representatives from the Federal Republic of Germany, France, Japan, United Kingdom, and United States. During the meeting, the non-US representatives indicated that their respective governments strongly supported the proposed scientific work and continuation of the drilling program through September 1983. The Germans have committed $2 million; the Japanese are expected to do so shortly. The French and United Kingdom are exploring ways to bring their contribution up to the full amount. The NSF, however, estimated that of the $52 million required only about $39 million is "in sight." The chairman of JOI (W. Hay) asked the JOIDES EXCOM Chairman to develop alternative programs requiring less than $52 million and showing additional scientific tasks and returns at incremental budget levels.

Alternative Drilling Programs

Following extensive discussion the Planning Committee **agreed to develop 24-month, 18-month, and 15-month drilling programs in response to the Executive Committee's request.**

The PCOM felt that most of the presently defined, highest priority scientific objectives could be accomplished within a **2-year, 13-leg program.**

The PCOM supports the 1981-83 proposal and considers it a coherent, well thought out plan, agreed to in principle by the non-US participants. The PCOM was very reluctant to propose shortened programs because of many problems including (1) uncertainty about the source of the funds ($39 million) noted in the IPOD statement (18-20 September meeting), (2) possibly that non-US countries will reconsider commitments, should the program be truncated, (3) nonlinear relationship between dollars and potential science owing to fixed costs of *Challenger* and DSDP operations, (reducing scientific party on board would not allow a substantial increase in drilling time either, as scientific costs are small relative to operational costs), (4) seasonal weather constraints (any drilling program with less than *22* months would allow only one summer of drilling in high latitudes. This means abandoning drilling in either the North Atlantic or in the North Pacific.) (5) a shortened program would not allow full utilization of the hydraulic piston corer and (6) the present coherent 24-month plan cannot simply be truncated; a new program would have to be developed. The PCOM also noted that *no unanimous* support for a shortened program was possible because either the North Atlantic or Japanese drilling program would be lost.

Drilling Priorities

In order to develop the incremented programs the PCOM asked the subject panels to submit drilling priorities.

A. Ocean Crust Panel

P. J. Fox presented the Ocean Crust Panel's priorities, which are:

1. **North Atlantic - (Geochemical heterogeneity of the mantle)**. Basalts recovered from below the North Atlantic appear to be depleted in light rare earths; those recovered south of the Hayes transform fault, however, are not depleted in those elements. The OCP proposes to drill six holes to establish the nature of the boundary and how (if) the depletion progressed through time. Drilling would help resolve the first-order question of whether the geochemical heterogeneity results from mixing chemical signatures of magmas from different sources or whether a wide spectrum of sources exist, and the patterns reflect broad regional differences in the composition of the earth's mantle.

2. **Costa Rica Ridge - deepen old Hole 504B** to penetrate a level of major velocity change. The velocity change may reflect a fundamental change in crust and be (1) extruded "fresh" dikes, (2) a sharp change in state of metamorphic facies, (3) a change in porosity, or a combination of all three. The OCP gives an equal priority to deepening Hole 504B and the crustal heterogeneity transect. "We have here a golden opportunity to sample below seismic Layer 2 in the ocean crust," says Fox.

3. **Pacific Ocean - 15°S** to document crustal geochemical evolution and chemical exchange between oceanic crust and sea water in an area of fast-accreting plate boundary. The OCP sees the holes as part of a program to study the properties of basalts at plate-tectonic end members: slow-, intermediate-, and fast-accreting crust.

4. **Fracture zones in the North and Equatorial Atlantic.** Geologic and geophysical surveys have shown that the relief seen in the transform faults which offset the mid-Atlantic Ridge system is formed by numerous faults of small throw. The deep troughs of the fractures are the sum of many smaller faults and the trough topography persists across older and older lithosphere. The fault blocks in the fracture zones are believed to consist of much-thinned ocean crust (including gabbros and ultramafic rocks). *Challenger* could drill through the thinned crust (± 2000 m) into the uppermost mantle in such areas.

B. Ocean Paleoenvironment Panel

R. Douglas presented the Ocean Paleoenvironment Panel programs, divided into large-scale and small-scale experiments.

Large-Scale Experiments

1. Pacific

   a. **Equatorial Pacific (west of the East Pacific Rise)** — zone of pelagic sedimentation to study the highly amplified stratigraphic record, especially fluctuation of carbonate solution levels in the Neogene.

   b. **Southwest Pacific (New Zealand-Ontong-Java transect)** - to sample good carbonate sections (with all planktonic fossil groups preserved) which have been deposited at different latitudes, in order to study the evolution of oceanographic climatic changes in a key area for understanding the relations between the Southern Ocean and the Pacific.

   (These two programs are interlocked and deal with major oceanographic problems, thus they are of prime importance to the Ocean Paleoenvironment Panel.)

2. Atlantic

a. **North Atlantic** — ten sites to study the origin and development of the deep-water part of the mid-Atlantic. The transect crosses the most sensitive parts of the paleoceanographic and paleoclimatic fronts and is designed to document the history of changes in the region.

Small-Scale Experiments

1. Pacific

a. **Northwest Pacific** — to sample Cenozoic sediments, in order to monitor change in currents and oceanographic regimes, in the region of the Kuroshio current and its extension, as well as refine the stratigraphy by capitalizing on overlapping occurrences of siliceous and carbonaceous faunas.

b. **Northeast Pacific** (Gulf of Alaska to Borderland off California) — to sample Cenozoic sediments across the North Pacific and down the California current system, to document the evolution of planktonic communities and changes in a region of strong contrasts.

c. **Western ("old") Pacific** — to sample the lower Cretaceous and Jurassic pelagic sediments from what is probably the world's only surviving area of genuinely oceanic facies of Jurassic age.

2. **Caribbean/Gulf of Mexico** — to study evolution of the oceanographic connection between the Caribbean and the Gulf of Mexico. The top of the Neogene has been sampled, but stratigraphers need to sample the rest of the Tertiary to better understand the sequence of events that led to the development of the modern-day Gulf Stream.

3. **Circum-Sahara** (Includes Bay of Biscay) — to study eolian transport from the Sahara to the Atlantic and, if possible, back into the Mediterranean. The history of regional dessication is recorded here.

4. **Peruvian Transect** — to study laminated (varved) sediments in an area of exceptional fertility. The long-term history of El Nino, productivity changes in the Humbolt Current system, are targets.

C. Active Margin Panel

R. von Huene reported the Active Margin Panel's priorities as follows:

1. **Japan Trench (including Nankai Trough)** — to study the structure and evolution of a forearc trench. Geophysical properties show that the margin opposite the Nankai trough is an accretionary margin. To maintain a net sediment balance, however, requires also that some subduction of sediment has occurred. In addition, seismic evidence also shows that tectonic erosion (slumping) has also shaped the margin. By contrast, the IPOD drilling results across the Japan Trench margin show little evidence of accretion. Several more drill sites are needed to document the nature of processes in the two contrasting regimes represented by the Nankai and Japan Trenches.

2. **Middle America Trench** — to drill more deeply into the complex explored in a preliminary way during Leg 66 and 67 could provide information on the dynamics and volumetric importance of accretion along this instructive margin.

(Priorities 1 and 2 are very high and almost equal.)

3. **Aleutian Trench** — a series of short holes to study sedimentary facies in a modern trench to establish a realistic model for trench sedimentation. The overprint from the high latitude climate, however, might distort what otherwise would be typical trench facies.

The AMP would prefer to drill a second leg off Japan rather than drill the Aleutian trench.

4. **Peru-Chile** — This is a very high priority area because of the extensive geological and geophysical work done on the nearby land areas, but it probably could not be surveyed in time to drill during the 81-83 program.

Although the full Active Margin Panel has not reviewed the PAC-A-BERS proposal (presented below) it might be expected to support many of the PAC-A-BERS objectives and proposed sites.

D. Passive Margin Panel

E. Winterer presented the Passive Margin Panel drilling priorities for R. Sheridan who is at sea.

1. **Fans** - to study the clastic accumulations along the continental margins, especially those along the east coast of the US and in the Mississippi cone. Other fans meriting study include those in the Bay of Biscay and those off California such as Navy Fan and Astoria Fan. The drill data would carry the modelling beyond where geophysical methods have taken it, and would help to make valid comparisons with sections exposed on the land.

2. **Seismic discontinuities** - to establish the nature, age, and processes forming seismic discontinuities and nature of the sediments between. These are most clearly developed -- and theories about their origin and significance are most testable -- along the East and gulf Coasts of the United States.

The highest priority Passive Margin Panel objectives on deeper structure and stratigraphy are being addressed by the current (79-81) DSDP drilling. If goals are not accomplished during the present program the PMP will doubtless want to return to these sites rather than focus on new objectives.

E. Other Panels

Various discipline panels have indicated special interests in the 1981-83 drilling.

1. **Inorganic Geochemistry Panel** — Large ^{3}He anomalies in the area of 15°S (Pacific) indicates that the region has been subjected to hydrothermal activity. The IGP proposes a transect to study the hydrothermal sediments, their diagenesis, and the mechanics of the pore water circulation. The transect is along same line as the Ocean Crust Panel transect.

2. **Organic Geochemistry Panel** — Cariaco trench (Orca Basin?) to sample an anoxic basin with the hydraulic piston corer.

3. **Sedimentary Petrology and Physical Properties Panel**

a. Slide complexes on the continental slope off the Wilmington area,

b. Submarine fan complexes

c. Anoxic sediments on the continental slope (O_2 minimum)

d. Caribbean erosion

e. Contourites

The JOIDES, USGS, and DARPA drilling priorities are graphically summarized in Table PCOM-1.

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In response to the EXCOM charge and on the basis of subject panel priorities, the PCOM developed, in additiion to the 24-month plan, an 18-month and two 15-month plans. The PCOM judged that more science per time available could be accomplished in the North Pacific than in the North Atlantic and thus opted to cut the North Atlantic drilling in the truncated schemes.

The example of drilling programs are presented on Table PCOM-2.

The PCOM noted that an 18-month (or less) program would not address the following objectives.

1. North Atlantic — Cenozoic climatic history

2. Atlantic margin of U.S. — sediment dynamics-slope stability, gas hydrates, seismic discontinuities (potential USGS objectives).

3. Northeast Pacific and Offshore California

4. Gulf of California

5. Mediterranean climatic history.

The North Atlantic mantle heterogeneity drilling would be forced into a season of marginal weather conditions.

Site Survey Plans

Problem

D. Hayes reported that several areas in the proposed 18-month and 24-month schedules have not been adequately surveyed. Because of long lead times required to plan the survey ship's schedule and acquire and dissiminate information, the survey work for the program must be organized *immediately*. Otherwise certain objectives will be sacrificed simply because of inadequate survey data.

The problem is three-fold: (1) Firm planning for future drilling has been impossible because of uncertainties surrounding the funding for 1981-83. (2) the Site Survey Panel needs more specific information about location requirements for certain of the proposed sites from site proponents, (3) requests for site survey proposals have not yet been issued by JOI (US site-survey managers).

D. Hayes reiterated the need for better communications and earliest possible designation of survey areas.

Solution — Site Survey Liaison Responsibility

The Planning Committee, to ensure adequate flow of information between site proponents and the Site Survey Panel, assigned specific liaison responsibilities.

It also asked E. Winterer to contact E. J. Jones and L. Dorman (JOI Site Survey Panel Chairman) to arrange a Site Survey Panel meeting at L-DGO as soon as possible after the NAS 1981-83 proposal review. Site proponents should be asked to attend, if feasible, to help establish the flexibility in site selection.

Table PCOM-1. Summarized 1981-83 Drilling Priorities

OCP	OPP	AMP	PMP	IGP	OGP	SP[4]	USGS	DARPA
N.Atl. Crust (Mantle heterogeneity) Costa Rica Rift (Deepen 504B) 15°S Pacific (Geochem./ crustal transect) Equat. Atl. (Fracture zone crust)	Western ("old") Pacific (Mesozoic facies) Equat. Pac. (Pelagic strat. record) SW Pac. (Paleoenv. HPC transect) NE Atl. (Cenozoic climate history) NW Pac. (Cenozoic paleocean.) NE Pac. (Cenozoic paleocean.) Carib/Gulf of Mexico (Panama connection) Circum-Sahara (Eolian transport) Peruvian transect (Laminated seds.)	Japan Trench (Active margin tectonics Middle America Trench (Active margin tectonics) Aleutian Trench (Sedimentary facies) Peru-Chile Trench (Active margin tectonics)	W. N. Atl. Miss. Cone (Fans) W. N. Atl. (Seismic strat./ slope stability)	15°S Pac. (Hydrothermal seds.)	Cariaco Trough (Organic geochem. of anoxic basins)	W. N. Atl. (Submarine slides) (Submarine fans) (Anoxic sediments on continental slope) Carbonate (Erosion) (Contourites)	N. Atl. Cont. Slope & Rise • Cretaceous & Cenozoic history • Sed. Dynamics/ slope stability • Gas hydrates • Salt diapirs • Geotechnical properties Gulf of Mexico • Miss. Fan • Anoxic accum. • Diapirs	N. W. Pac.

Table PCOM-2 Typical Programs

Leg (8 weeks)	Dates	24-month	18-month (One Northern Summer)	15-month (Pac) (One Northern Summer)	15 month (Atl)
83	Oct 15 - Dec 10, 1981	SE-U.S./Gulf	Costa Rica	Costa Rica	Costa Rica
84	Dec 10 - Feb 4, 1982	Hydrogeology	Hydrogeology	Eq. Pacific	Mid America
85	Feb 4 - Apr 1, 1982	SW Pacific	SW Pacific	SW Pacific	Caribbean
86	Apr 1 - May 27, 1982	Old Pacific	Japan	Old Pacific	NW Africa
87	May 27 - Jul 22, 1982	Japan	NW Pacific	Japan	N. Atl. Crust
88	Jul 22 - Sep 16, 1982	NW Pacific	Eq. Pacific	NW Pacific	N.Atl. Paleoclim.
89	Sep 16 - Nov 11, 1982	Eq. Pacific	Mid America	Mid America	East US
90	Nov 11 - Jan 6, 1983	Mid America	Caribbean/Gulf	Caribbean/Gulf	SE US/Gulf
91	Jan 6 - Mar 3, 1983	Costa Rica	NW Africa		
92	Mar 3 - Apr 28, 1982	Caribbran/Gulf	N. Atl. Crust		
93	Apr 28 - Jan 23, 1983	NW Africa			
94	Jun 23 - Aug 18, 1983	N. Atl. Paleoclim.			
95	Aug 18 - Oct 13, 1983	N. Atl. Crust			

N.B.: PCOM favors Pacific, rather than Atlantic, summer.

Committees, Panels, and Working Groups

We have given most committee and panel reports under separate headings, but include here those items from Panel meetings on which the PCOM took specific action. (Ed.)

Active Margin Panel — PAC-A-BERS

Von Huene alerted the Planning Committee to a proposal being prepared by a group of researchers led by D. Scholl and T. Vallier. The proposed program in the North Pacific, Aleutian and Bering Seas (PAC-A-BERS) is an integrated package serving many objectives. A regional, rather than topical orientation, the proposal includes aspects normally addressed by the Active Margin, Ocean Paleoenvironment, and Ocean Crust Panels, and thus does not easily fall within the scope of any one panel. Planned to unravel the evolving tectonic, oceanographic and climatic history of the area, the proposal addresses many objectives, but because the selected sites may not be the best possible place to solve specific problems, it also enbodies some compromises.

The PAC-A-BERS group thinks that most of its objectives could be accomplished on a 2-month transect from Adak to Kodiak, drilling the:

a. **Zodiac fan** to establish where the fan was formed and how it reached its present position.

b. **Sounder Ridge** to sample the Bering Sea basement and establish the existence of the Kula plate in the Gulf of Alaska and the Bering Sea, and to clarify the absolute (relative to spin axis) and relative motions of Pacific Plate during the past 60-70 million years.

c. **Meiji sediment body** to determine the origin of this thick accumulation of fine-grained sediments so far from a continental source.

d. **Shirshov Ridge** to study the age and stratigraphic evolution of buried basement knolls and seamounts of the Aleutian Basin.

e. **Amlia Corridor** to investigate a region of highly oblique subduction.

f. **East Aleutian Trench and Slope (Astoria, Navy fans)** to better understand the sequences and associations of sediment facies associated with deep sea fans.

The PAC-A-BERS proposal has not been reviewed by the full Active Margin Panel.

Following discussion concerning the appropriate way to handle the PAC-A-BERS proposal, the PCOM recommended that **the Active Margin Panel establish a North Pacific-Bering Sea Working Group to develop drilling programs in that area. The Working Group should include members from both the Active Margin and Paleoenvironment panels, with its chairman coming from the Active Margin Panel.**

The PCOM further recommended that in addition to PAC-A-BERS proposers, members outside that group be invited to join the working group.

Submarine Hydrology Working Group

During it July 1980 meeting, the Planning Committee encouraged the formation of a Submarine Hydrology Working Group and asked the chairman of interested panels to submit nominations to the working group at the October PCOM meeting.

The PCOM considered nominees to the Working Group from the Ocean Crust, Downhole Measurements, and Inorganic Geochemistry panels. In selecting members the PCOM attempted to include at least one nominee from each interested panel, and to obtain a balance betweenn "hands on" and theoretical members. It also considered a balance of representatives among institutions.

the PCOM invited the following people to form a Submarine Hydrology Working Group: R. N. Anderson (L-DGO), L. Cathles (Penn. State), R. McDuff (MIT), R. von Herzen (WHOI), M. Zoback (USGS, Reston), and designated R. Anderson to chair it.

Membership — All Panels

E. Winterer reiterated his intent, as Chairman of the PCOM, to encourage rotation of membership on all JOIDES Panels. U.S. members are generally expected to step down after serving about two years on a panel. (The rotation of non-US members is controlled by their respective IPOD agencies.) Rotation of membership ensures participation by a broad segment of the scientific community and also provides the mechanism by which panels may adapt and respond to new programs.

The PCOM also reiterated its own responsibility in nominating panel members to the EXCOM. Although usually responsive to nominations and suggestions from JOIDES Panels regarding their membership, the PCOM does not simply endorse nominees recommended by panels or individual panel members.

Background

E. Winterer reported that during its September 1980 meeting in Barbados, the Passive Margin Panel asked the JOIDES Planning Committee to initiate organization and funding of a conference to review and reassess scientific goals of marine geological and geophysical research.

T. Moore in a separate letter proposed that JOI and JOIDES sponsor a conference to develop an integrated program addressing both *Challenger* and *Explorer* potentials involving both industry and the scientific community.

Discussion

Other PCOM members reported conversations suggesting that many scientists involved in ocean drilling are interested in convening such a panel.

During the ensuing discussion PCOM members noted that:

- The 1977 Future of Scientific Ocean Drilling (FUSOD) report is in part out of date because of advances in the earth sciences including advances those obtained by the *Challenger* drilling.
- On the basis of advances since 1977, earth scientists have refocused their scientific objectives and research needs pertaining to the oceans and their margins. A timely conference needs to assess these broad research goals and address questions of how to realize objectives over the coming years, and to determine what role drilling should play in this effort.
- New tools and technology have been developed. Some tools could be deployed from ships other than *Challenger* and *Explorer*. These aspects should also be explored.
- Coordination among major research projects that overlap with Ocean drilling, e.g., TRANSECTS and COCORP, needs improvement.

Recommendation

The Planning Committee strongly supports the concept of a conference to review and reassess goals and direction of scientific ocean drilling. It particularly emphasizes the need to integrate presently conceived ocean and other related scientific drilling programs, to utilize most effectively available tools, and to develop a coherent plan for the decade ahead.

The PCOM further suggested that s
conference be sponsored by an organi
outside of JOI or JOIDES. This would e
representation of the broadest pos
scientific community, and allow assessmen
the impact the ocean drilling has on the e
scientific community and enhance the possi
ties for proper coordination of ocean drill
with related projects. The National Acade
of Science would be a possible sponsor.

The PCOM asked E. Winterer to direct memorandum to the JOIDES Executive Committee asking their endorsement of such conference. The memorandum should outline the PCOM's views on the need for, timeliness of, and potential sponsorship of the conference.

Future Meetings

The Planning Committee will next meet **24-27 February 1981** at Scripps Institution of Oceanography.

Later scheduled meetings are,

8-10 July 1981
Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, FRG
H. Beiersdorf - Coordinator

11-13 November 1981
Oregon State University
Salishan Meeting Center, Oregon
J. Corliss - Coordinator

OCEAN CRUST PANEL

P. Jeff Fox, Chairman

The Ocean Crust Panel (OCP) met 8-10 October 1980 at the University of Washington. The following summarizes the results of that meeting.

The major product of the Fall 1980 meeting was to outline the ocean crustal objectives to be addressed during the 1981-1983 *Glomar Challenger* drilling program. In this regard three legs were proposed: North Atlantic, Costa Rica Rift, and the East Pacific Rise at 15°S.

North Atlantic

The primary objective of this proposed leg is to elucidate how the systematic, large-scale mantle heterogeneity, at present defined for relatively young oceanic lithosphere (< 10 m.y. old) in the North Atlantic, has behaved in time and space. Two mantle sources have been recognized on the basis of light rare earth elements: an *undepleted/enriched mantle* thought to be representative of a deep source and associated with melting anomalies/hot spots (in the Azores and Iceland) and a *depleted mantle* with respect to light rare earth elements and the parent of the mid-Ocean Ridge Basalts (MORB). On the bases of the analyses of samples collected by drilling and dredging down the axis of the mid-Atlantic Ridge south of the Azores, a relatively sharp boundary is recognized at 33°N (Hayes Transform) between undepleted basalts (Azores affinities) to the north and MORB-type basalts to the south. We propose to drill two latitudinal transects located on the western flank of the mid-Atlantic Ridge. One transect would be positioned on anomaly 13 (35 m.y. old crust), the other positioned on anomaly 32 (70 m.y. old crust). The northernmost end of the two transects would be located along a throw line with the Azores; the southernmost end of the transects would be located south of the western extension of the Hayes fracture zone. Approximately 6 to 8 single-bit holes would be drilled at localities along these transects to provide important data on the evolution of the geochemical heterogeneity pattern.

Costa Rica Rift

During Leg 69 and 70 a re-entry hole was drilled 562 meters into basement at Site 504. Although drilling conditions were excellent the hole was abandoned because of time limitations. The shallow water depth (3.5 km) at this site allows a technical advantage for deep crustal penetration. Ongoing studies of rock properties and downhole experimental data obtained during Legs 69 and 70 indicate that the hole ended only a few hundred meters from a crustal interval characterized by a pronounced increase in P-wave velocity. We would also expect a significant increase in the metamorphic grade here. Site 504 represents the first opportunity to drill a really deep hole into oceanic crust with all the attendant petrological, geochemical, structural, and downhole environmental information.

East Pacific Rise at 15°S

Recent investigations argue persuasively that the axis of ridge segments that are accreting at very fast rates (>12 cm/yr full rate) should be characterized by intense circulation of waters at high temperatures through the crust at shallow levels. In an effort to understand the shallow level manifestations of the process associated with fast accretion, we have proposed, in conjunction with the Inorganic Geochemistry Panel, to drill a series of single-bit holes (hydraulic piston cores would be obtained in the overlying sediments as well) across the western flank of the East Pacific Rise. A multiple re-entry hole would be drilled at the end of the transect to establish both the structure of the upper few hundred meters of the volcanic pile and how the sequence has evolved in time in respect to circulating fluids. (*P. J. Fox*)

INORGANIC GEOCHEMISTRY PANEL

Joris M. Gieskes, Chairman

The Inorganic Geochemistry Panel (IGP) met 4-5 August 1980 at Scripps Institution of Oceanography. The following summarizes the main results of that meeting.

Among the most important topics discussed were the recent efforts on Legs 64, 65, 68, 69, and 70. The hydrothermal studies during Leg 64 (Guaymas Basin), Legs 68, 69 (Costa Rica Rift), and Leg 70 (Galapagos) have shown that detailed geochemical studies of interstitial waters and sediments and/or basalts can lead to a better understanding of hydrothermal interactions between seawater, basalts and/or sediments.

Interstitial water studies allow us to determine the direction of chemical exchange, as well as the mode of transport of dissolved constituents (diffusive or advective) through the pore water column. Chemical analyses of formation waters in basalts of Layer 2 obtained from packers (Leg 70) or from stagnant waters in revisited Holes (e.g., planned re-occupation of Site 395) will also support such exchange studies. Though we now have techniques either available or in development to sample pore fluids in Layer 1 and formation waters in Layer 2, little is known about the "plumbing" of the hydrothermal system in Layer 2. The latter deserves further study and can only be approached through drilling operations.

As a result of enhanced recovery of undisturbed sediment cores by the hydraulic piston corer (HPC) more meaningful studies of detailed downhole variations in chemistry and mineralogy have been possible. This technique has been valuable especially during the studies of the hydrothermal mounds in the Galapagos area (Leg 70). Such studies allow intensive studies in relatively thin sediment sections.

The *in situ* pore-water sampler/temperature probe developed by R. Barnes and S. Uyeda has been successfully used to obtain *in situ* pore water samples, and is particularly useful for trace gas studies. In addition, heat flow information gathered by this probe is extremely important. The Panel regrets to report that too little use is made of this extremely valuable tool.

Because of the success of the hydrothermal program during previous legs the Inorganic Geochemitry Panel strongly endorses the Submarine Hydrogeology Working Group (see also PCOM minutes) and intends to keep close contact with this group. In particular the Panel recommends that the following be addressed:

1. Exploration of the "plumbing" system in Layer 2 (downhole experiments);
2. Studies of the nature of hydrothermal sediments near ridge crests and of their subsequent diagenesis with age and burial underneath the sediments;
3. Studies of the importance of hydrothermal sedimentation with respect to its contribution to the formation of red clays.

   The red clay problem has not received the attention it deserves, and the Panel wishes to go on record in declaring this as an important problem for the 1981-83 drilling program.

After some discussion, the Panel decided that the most suitable target for the above studies would be a transect across the East Pacific Rise at approximately 15°S into the South Pacific red clay region. The area east of the East Pacific Rise has been intensely studied during the Nazca Plate Project, and hydrothermal activity has been shown to be important not only from sediment studies but also from excess ^{3}He studies in the water column. We are currently preparing a report detailing the reasons for this choice of transect.

Shipboard Procedures

As the organic geochemitry and inorganic geochemistry programs have been growing steadily, the Panel deems it appropriate that, especially during legs with more intense geochemical operations (e.g., Legs 76,78,79,81) two well trained geochemistry technicians be available to carry out the routine work in both the organic and inorganic geochemistry laboratories.

Sampling of piston cores

The Panel recommends that in the near future comparisons be made on interstitial waters obtained from regular undisturbed 10-cm sections as well as from core-catcher materials of HPC cores in order to establish the validity of sampling the latter. If tests are successful, then interstitial waters can be obtained from the core-catcher samples. This will preserve sediments in which structures must be preserved. The procedure, however, must be tested and not be initiated before tests prove satisfactory.

Integration of Inorganic Studies

We discussed the importance of integrated inorganic geochemical studies. For example, pore water studies should be combined with studies on the solids using a multifaceted approach — mineralogy, chemistry on separate phases, isotope geochemistry. The importance of this problem will be discussed in the document we are preparing on hydrothermal drilling/red clay studies. The Panel, however, agreed that the DSDP sample distribution policy should ensure that studies as broad based as possible be performed on samples obtained. (*J. Gieskes*)

POLLUTION PREVENTION AND SAFETY PANEL

Louis E. Garrison, Chairman

The Pollution Prevention and Safety Panel (PPSP) met 5 and 6 November 1980 at Scripps Institution of Oceanography to review additional Leg 77 and 78 sites and proposed Leg 79 Sites.

Safety Review Leg 77 - Additional Sites (Florida Straits-Caribbean)

ENA-12E: Approved as proposed.

ENA-12F: (Following its regular meeting the PPSP approved (by consensus) a new site, ENA-12F, located on seismic line SF-15 6.6 km southwest of the intersection of SF-15 and GT3-65. The panel understands that the hole will be washed down through the upper sequence of approximately 350 m of unconsolidated material, then continuously cored to bit destruction.)

ENA-13: Approved as proposed. Buffler presented a structure map on the mid-Cretaceous unconformity, and depth calculations along seismic line SF-12 as requested by the PPSP at the September 3 review. These data demonstrated that the broad arching of the mid-Cretaceous unconformity suggested by the records examined previously did not in fact exist, and that no dip reversal lies between ENA-13 and its outcrop updip to the northeast.

CAR-7: The Panel acted on a Planning Committee request that it consider an exception in the case of CAR-7 to the general rule that all holes be continuously cored. Because the section to be penetrated is young and pelagic the PPSP gave safety approval to the plan to spot core only in the upper half of the section, and then core continuously to total depth.

Safety Review, Leg 78 - Additional Sites (Caribbean)

CAR-1F: Approved to 500 meters depth subject to the following restrictions:

Drilling should be conducted with extreme caution. Careful monitoring for indications of hydrocarbon should be continuous and rigorous, and drilling should be terminated and the hole plugged if porous and permeable sediments older than Neogene are encountered.

Members of the Safety Panel held divergent views on the drilling of this site, and varying degrees of concern about the possibility of a Barbados-type Paleogene section occurring. One member disapproved the site, one abstained, two approved only with the above-stated restrictions. The remaining four members held the opinion that risk was minimal since CAR-1F appears to be some 250 km farther than Barbados away from a Paleogene sediment source, and moreover, is located near the thin distal edge of the accretionary wedge where accumulations of coarse, porous sediments are least likely. Finally, owing to the probable highly fractured condition of the sediments, the presence of hydrocarbon accumulations would probably be detectable well before being reached by the drill because of the leaky nature of imperfect seals.

CAR-1E: Although approved as proposed at the safety review of September 3, the Panel recommends that the same restrictions placed on CAR-1F (above) also be placed on CAR-1E because of the similarity of setting.

Safety Review, Leg 79 (Mazagan Plateau)

MAZ-1: Approved, but the Panel recommends that the site be cored with the hydraulic piston corer to refusal before starting rotary coring. Drilling should not proceed beyond the lowest stratigraphic unit that projects toward an outcrop on the adjacent scarp.

MAZ-2: Approved, but with the same restrictions as for MAZ-1.

MAZ-3: Approved, but location should be moved northwesterly to a position as near the scarp as possible. The same restrictions as placed on MAZ-1 and -2 should be observed here.

MAZ-4: Approved as proposed.

MAZ-5: Approved as proposed.

Note: In dissent from the Panel's approval of MAZ-4 and -5, J. Laherrere offered the following:

Owing to the steep slope of the Mazagan Plateau escarpment, the seismic record (Meteor 53-08) is confused by refraction and lateral reflection events between SP 700 and SP 760 and there is a slight chance that the interpretation presented is incorrect. The Lower Cretaceous formation may pinch out in a closed trapping condition against what could be interpreted as a fault on the MAZ-4 location and the time contour map of the "red" horizon. The closure is limited by the 4200 ms contour and MAZ-4 and -5 sites are inside the closure.

MAZ-6: Approved as proposed.

MAZ-7: Approved as proposed.

MAZ-8: Approved as proposed. At the proponents' request, Panel approved a move of the drilling location eastward along M53-08 as far as SP 975, if necessary, to find sufficient sediment cover to spud in. Penetration at the location finally chosen, however, is to be limited to a depth equivalent to 2.75 sec reflection time.

MAZ-9: Approved at the location proposed, but may not be drilled below a stratigraphic depth equivalent to 6.1 sec on the time section diagram of Meteor Line 53-07.

Note: The Panel considers structural entrapment to be unlikely at MAZ-9 because it is below the indicated spill point on the "red" horizon and well down the flank of the structure on the "blue" horizon. Moreover, data from previous drilling in the Moroccan Basin suggest that organic matter in the section to be penetrated at MAZ-9, as well as at MAZ-1, -2, and -3, is immature. The probable deep water depositional environment for Cretaceous and Jurassic sediments at MAZ-9 minimizes the risk of encountering a small accumulation of biogenic methane.

Safety Review, Leg 79 (Galicia Bank)

The Planning Committee selected Galicia Bank as an alternative to drilling on the Mazagan Plateau, in case the Safety Panel did not approve the Mazagan sites. The Mazagan sites, however, were approved, thus the Galicia Bank will not be drilled during Leg 79. (Ed.)

GAL-1A: Approved as proposed.

GAL-1B: Approved as proposed.

GAL-1C: Approved as proposed.

GAL-1D: Approved as proposed.

Note: D. McKenzie dissented from the Panel's approval of GAL-1C and -1D for the following reasons:

a. Site surveys are inadequate with no line crossings at proposed locations;

b. There is clear structural closure of sediments draped over a high on existing E-W lines;

c. Although maximum sediment thickness shown is only 1 km to 1.5 km, seismic coverage is not sufficient to rule out locally thicker sections;

d. Pre-Tertiary sediments draped over basement highs may contain potential reservoir beds;

e. Terminal history of the underlying crust *may* have resulted in generation of liquid hydrocarbons at the base of the sedimentary section.

f. Even in the absence of oil, biogenic gas may have accumulated in amounts sufficient to exceed solubility, even at water depths of 7 seconds.

The Panel approved the sites because (1) they appear to be located on oceanic crust, (2) the sediment section is shown to be relatively thin, and (3) the sediments themselves are pelagic, and (4) data from previous drilling (Hole 398) suggest a low potential for hydrocarbon maturation, and the indicated low rates of pelagic deposition diminish possibilities for the generation of biogennic methane.

GAL-2A: Approved as proposed.

GAL-2B: Approved for penetration only to the lowest stratigraphic unit that outcrops on the seafloor in the scarp face to the west.

GAL-2C: Approved as proposed.

GAL-2D: Disapproved. The pinch out and/or apparent drape or Lower Cretaceous and Jurassic limestones over the crest of a tilted block of continental basement, even though only conjectural at this point, presents too great a risk to be acceptable. The Panel was unanimous in its disapproval.

GAL-2E, 2F: The Panel was asked for safety approval for two new sites that would be located somewhere between GAL-2A and GAL-2B. It decided that in order to avoid misunderstandings, no action would be taken until the proponents submitted the request, along with appropriate documentation, to the Chairman. This request and the Panel's recommendations can be handled by mail.

GAL-3A: Approved for limited penetration to only the lowest reflector that can be projected to an outcrop on the small rise about 2.5 km to the west.

GAL-3B: Approved as proposed.

Other Business:

The Chairman read a letter from Phil Rabinowitz reporting the Leg 74 results of drilling into the basement reflector on Walvis Ridge. In reviewing those sites, the Panel had expressed some concern because of the possibility that this reflector was the top of an older sedimentary sequence and placed certain restrictions upon the drilling of those sites. As predicted, however, basement proved to be layered basalt and carbonates.

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