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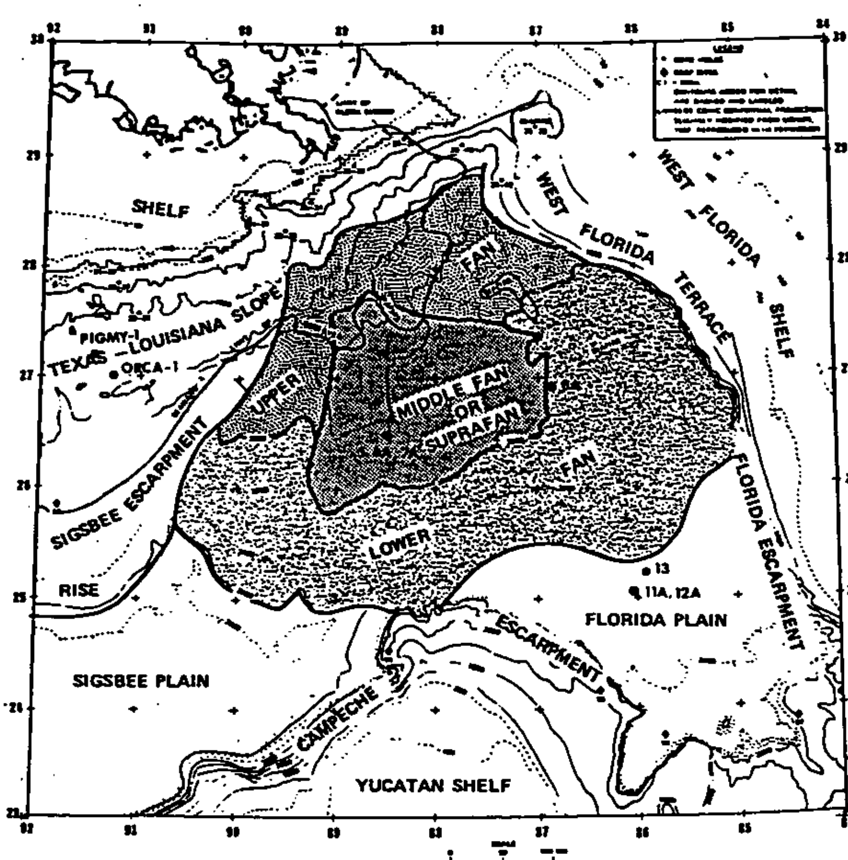

Mississippi Fan - Leg 96
Final Leg of the Deep Sea Drilling Project

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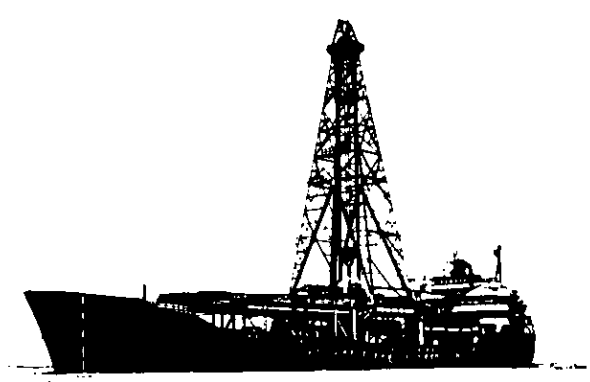

TENTATIVE GLOMAR CHALLENGER SCHEDULE, LEG 96

Departs Ft. Lauderdale 29 Sep 83, **Arrives** Mobile, Alabama 08 November 1983; **Objective** - Mississippi Fan; **Total Days** - 40; Days Oper. - 35; **Days Steam.** - 05; **Reentry** - No.

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Leg 96

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GLOMAR CHALLENGER OPERATIONS

CRUISE SUMMARIES

Leg 92 - East Pacific Rise

Leg 92 began 23 February 1983 in Papeete, Tahiti, and ended 19 April 1983 in Balboa, Panama.

General Setting and Objectives

The primary purpose of Leg 92 of the Deep Sea Drilling Project was to determine the nature and history of basalt-seawater, "hydrogeology" interactions at the East Pacific Rise and on its flanks at present and in the past.

To achieve these objectives a series of areas west of the East Pacific Rise (EPR) crest along at 19°S (Fig. 92-1) were selected and surveyed for drill sites in February and March of 1982. Choosing the transect of 19°S made it possible to investigate hydrothermal activity at the fastest-spreading portion of the world's rift system while avoiding excessive dilution of the hydrothermal sediment component by terrigenous and biogenic materials and complication of the pore water and sediment chemistry by reducing conditions associated with organic diagenesis. To relate the fluid and sediment chemistry to the basalt crust and its structure we planned a reentry hole to recover and complete a logging program in basalts from a fast-spreading ridge which was old enough to have undergone alteration, and to recover some basalt from each drill site for a comparison. Furthermore, we planned to continue the efforts of the site surveys to locate evidence of ridge-flank hydrothermal activity by measuring heat flow and analyzing pore waters for evidence of fluid advection. A final objective of Leg 92 was to reoccupy the deep reentry site, Hole 504B in the Panama Basin, for the purpose of downhole temperature and water sampling, a borehole-seismometer refraction survey, and logging and packer experiments.

Operations Summary

Leg 92 cored 19 holes at six sites. Most of the sedimetns were recovered with the variable-length hydraulic piston corer (VLHPC) or the extension core barrel (XCB). The XCB was used at most sites in efforts to recover the sediment/basement contact and to drill into basalt without tripping the drill string to change bits. Standard rotary bits were used at Holes 597B and 597C, the pilot and reentry holes at the oldest site, where basalt drilling was relatively trouble-free the recovery high. Three holes (598A, 59 and 601A) were devoted entirely to downh experiments, in situ pore water sampling sediment temperature measurements for h flow calculations; no sediment recovery w attempted at those locations. This procedu improved the downhole experimental dat reduced sediment disturbance in cored hole and took very little additional time in the thi sediment sections we were coring.

At Sites 600, 601 and 602 we encountered a variety of problems, all of which arose from attempting to core very thin, 0-25 m sedimentary sections. These problems included shearing off VLHPC barrels, getting a VLHPC barrel stuck in the bit and poor recovery and disturbance in VLHPC cores which penetrated only a few meters of sediment before hitting hard rock.

The site survey cruise, Ariadne II, used bottom transponders to conduct precisely-navigated heat flow, pore water, and coring stations and left transponders in the three surveyed regions for use by the Challenger. We found the Challenger to be an ideal ship for this kind of precise target work because its dynamic positioning system allowed exact ship moves to be made within the transponder network.

Significant Scientific Results

Sedimentary Patterns and Accumulation

Similar patterns of sediment accumulation were observed at all Leg 92 sites. The sediments were mixtures of nannofossil ooze and clay, the latter being a mixture of clay and component described by Leg 34 (Quilty, et al., 1976) as reddish yellow, semiopaque objects, or RSO's. The only clay minerals which appeared in X-ray diffractograms were poorly crystalline smectites. Lesser amounts of foraminifers, zeolites, volcanic glass, palagonite and opaque grains were also present in the sediment. No siliceous microfossils were found.

For the purposes of a preliminary evaluation of sedimentation patterns associated with hydrogeology, we assume that the hydrothermally-derived sedimentary component is represented in our samples by the smectites, "RSO's" and opaque Fe-oxide grains. This definition would encompass both hydrothermnal sediment com...

hydrogenous components which are largely derived from alteration of hydrothermal sediment as described by Heath and Dymond (1977) and Dymond (1981). Our drill sites are far from South America and there is very little terrigenous material carried by the tradewinds in the sediments as indicated by very low quartz concentrations. Since no biogenic silica is preserved and since the concentration of volcanic ash is negligible, the noncarbonate sediment is essentially all hydrothermal in origin.

The sedimentary sections at Sites 597, 598, and 599 had thin, slowly-accumulating, clay-rich upper portions, were dominated by clay-bearing nannofossil ooze and had indurated chalk or limestone in the lowest few meters. The lithified sediment occurred even at the youngest site.

Estimates of prior calcite compensation depths (CCD) can be made for the three oldest drill sites by comparing the age when sedimentation rates fell below 1.25 mm/10^3y, a rate typical of red clays, to the appropriate level on the age-depth backtrack curve for that site. These estimates suggest that the calcium carbonate compensation depth at 19°S under the low-productivity sub-tropical gyre was at 3670 m 17.6 Ma ago, at 3420 m 8.0 Ma ago, and at 3540 m 1.8 Ma ago. This pattern of a minimum in the late Miocene CCD is consistent with the history of Neogene CCD changes, but depths determined from Leg 92 drill sites are about 500 m shallower than those at other nonequatorial Pacific DSDP sites and core sites (van Andel and others, 1974, Broecker and Broecker, 1974).

Redistribution of sediments by bottom currents and downslope transport was common despite the fact that we had selected areas for their lack of relief. Most sediments contain reworked microfossils and some holes have thin graded beds, sharp contacts between layers, and in one case, older sediments overlying younger ones.

To evaluate changes in sedimentation patterns, sedimentation rates can be recalculated as mass accumulation rates (MAR, g/cm^2/ky). The MAR of any sediment component is the product of the linear sedimentation rate (cm/ky), the dry bulk density (g/cm^3), and the weight percent of that component. Changes in MAR then represent absolute changes in the mass flux of any component and do not depend on or vary with the flux of any other component.

All sites show an increasing noncarbonate (i.e. hydrothermal) component with depth in hole, and thus nearer the rise axis, and fluctuations in the mass accumulation rate (MAR) of this hydrothermal component occur at various levels above basement at each site. Sediments recovered along the 19°S hydrogeology transect provide a history of the mass flux of hydrothermal material to the seafloor. To make a first-order estimate of the variability of hydrothermal MAR through time we took the temporal pattern of hydrothermal accumulation at each site, converted the age, via spreading rate, to distance from the rise axis, and compared that information to the present hydrothermal accumulation rate in the region west of the EPR axis between 17° and 20°S (Fig. 92-2). The present axis-distance pattern, which was chosen as the arbitrary standard of comparison, was subtracted from that observed at each site to generate a hydrothermal-anomaly or difference-diagram which shows deviations from the present accumulation rate (Fig. 92-3). Given the assumption about the hydrothermal component, an estimate of the overall accuracy of this information is that variations of a factor of 2 or greater are real and that those less than ± 50% may not be real.

Figure 92-3 reveals three types of temporal fluctuation. First, the long term regional accumulation of metalliferous sediment at the Leg 92 drill sites was 50 to 150 mg/cm^2/ky greater in pre-Pliocene times than it is at present. Since about 4.5 Ma ago there have been no significant differences in hydrothermal accumulation rate from the present rate. Second, two pulses of hydrothermal accumulation occur, one about 5 to 8 Ma ago, and another between 221 and 25 Ma ago, when accumulation increased three-fold above the extant background levels. Such increases could be the result of changes in ridge crest hydrothermal activity or of changes in regional transport of hydrothermal sediment to depositional sites. The pulses do not correspond in time to the reasonably well-known pulses of plate-margin and mid-plate volcanic activity which occur about every 5 Ma (Kennett, et al., 1977; Rea and Scheidegger, 1979). Nor are they coincident with minima in hiatus abundance (Moore, et al., 1979; van Andel, et al., 1975). Finally, the accumulation pattern has an apparent 2 Ma periodicity. This periodicity is not an aritifact of the linear sedimentation rate determinations and, since the peaks are usualy defined by several points, may reflect a real cyclicity in hydrothermal accumulation.

Chemistry of Interstitial Waters

Interstitial water samples squeezed from sediments and collected with the Barnes/Uyeda in situ sample were analyzed from every site. Very small changes in major constituents with depth occur (Mg:less than 20%; K:no change; Ca:increases up to 10%). At none of the sites do interstitial waters, chemistry, major ion concentration changes or in nutrient concentrations (nitrate, silica) show any unequivocal evidence for advection of interstitial water through the sediments as a result of water flow into or out of Layer 2. Increases in dissolved calcium can best be understood in terms of calcium carbonate dissolution in the upper 10 to 15 m of the sediment column and not just at the benthic boundary layer.

Igneous Rocks and their Alteration

A major landmark for Leg 92 was the successful drilling of fast spreading crust at Hole 597C where 91 m of basement were drilled and 48.48 m of basalt were recovered (53.2%). Apart from a single pillow fragment at the top of the basalt, all the core recovered from Hole 597C appeared to come from massive basalt flows and it is likely that the high ratio of massive flows to pillows in the drilled interval was the major factor responsible for the unexpeted success at the site. The rocks are olivine-free to olivine-poor basalts and are mostly aphyric in texture. In chilled contact zones the rocks contain opaque areas made up of coalesced spherules rich in interstitial magnetite, indicating that they be close to ferrobasalts in composition. In the centers of massive flows ophitic textures are common and there is evidence of mineral layering.

At least three stages of alteration can be recognized: an early, possibly deuteric stage characterized by a pale blue trioctohedral smectite; a later, nonoxidative alteration stage characterized by a dark green smectite $\pm$ celadonite, talc, chlorite and mica; and an oxidation alteration stage characterized by brown smectites, iron oxyhydroxides, calcite, aragonite and zeolite, commonly phillipsite. Sulfides and native copper are found in veins, vesicles, and sometimes the groundmass in association with minerals of the second alteration stage. The intensity of alteration ranges from moderate at the vesicular, more strongly veined top of the section to slight at the base.

Massive basalt flows also were sampled in Hole 597B and pillow fragments were recovered from Hole 597A, 597B, 599, 599B, 601B, and 602B. These samples support the picture of an uppermost crust which is made up of pillowed and massive flows of basalt to ferrobasalt composition and which has undergone a multistage history of alteration.

Geophysical Studies

Heat flow measurements were made at every Leg 92 drill site in which we were confident of not damaging the tool. Both the Barnes/Uyeda probe and the Von Herzen heat flow shoe for the VLHPC were used; the latter proved to be the more reliable instrument. Low to moderate heat flow values were recorded at all sites except Site 600, a high heat flow drilling target chosen on the basis of the site survey data, where we measured a heat flow of 580 mW/m^2.

Paleomagnetic analyses of the Hole 597C basalts show that the entire section, with the exception of a brief normal event, is reversely magnetized placing the site within the reversely-magnetized interval between Anomalies 8 and 9. Magnetic inclinations of 50^o to 52^o imply that the basalts were emplaced at 32^oS. This latitude does not fit into any reasonable model for the tectonic evolution of the South Pacific. There is at present no reasonable explanation for these unusually high inclinations, which also occur in basalts recovered at Sites 319 and 320 lying to the east on the Nazca Plate.

Downhole Operations at 597C

Hole 597C was logged successfully with the caliper log (four runs) and the borehole televiewer (two runs at different frequencies). These logs show most of the hole to be smooth and of uniform diamater and show rubble-washout zones that correspond to depths where core recovery was low. The borehole televiewer shows high-angle fractures which a gross level cannot be correlated with veins in the recovered basalts. Attempts to log with a 12-channel sonic tool were unsuccessful.

A packer experiment conducted 123 m below seafloor, 71 m into the basalt was only partially successful. Preliminary analysis of the data indicate a high but uncertain permeability. However the packer experiment definitely indicates that 597C like 504B is underpressured. The in situ formation pressure of five bars subhydrostatic is a well-constrained value.

Downhole Operations at 504B

At the end of Leg 92, the Challenger returned to Hole 504B for 9.5 days of downhole experiments. Detailed temperature measurements were completed above and below the underpressured high permeability zone in the upper 100 m of igneous basement (107 to 449 m below seafloor, BSF) of Hole 504B using both the HPC temperature shoe and the Barnes/Uyeda tool. These data indicate that downhole flow has decreased from 25 m/hr. measured on Leg 83, November 1981, to 2 to 3 m/hr. Temperature measurements lower in the hole were complicated by sensor problems, but indicate a gradient of 0.080°/m in Layer 2C and bottom hole temperatures of 160° to 165°C.

Four water samples were collected using the Barnes/Uyeda tool at 564, 650 and 735 m show gradual changes in major ion composition, bottom-water chloride contents and no dissolved nitrate. Although the large volume, go-devil samples from below 735 m show evidence, in NO_3^- of bottom water contamination, even the more pristine samples at about 1200 m show no evidence of surface water chlorinities. We conclude that most or all of the surface water originally pumped into the hole has been replaced by downhole mixing since the end of Leg 83.

The correlation between calcium and magnesium concentrations in the hole is linear after a correction is made for anhydrite precipitation (using measured sulfate depletions). The changes in clacium are 1.9 times larger than those in magnesium. The excess calcium production appears to be balanced by decreases in potassium and sodium. These observations suggest that alteration of the basalts (and possibly suspended bentonite) is responsible for the release of calcium, and that magnesium and sodium decreases are due to the formation of smectites and Na-montmorillonite. Potassium decreases are probably the result of celadonaite formation in the basalts.

The oblique seismic experiment planned at the hole was frustrated by repeated leaks in the cable adaptor for the borehole seismometer. In spite of this a complete shot pattern was completed at 3780 m (317 m BSF), and 4000 m (537 m BSF), and partial shot patterns were completed at 4190 m (727 m BSF) and 4405 m (942 m BSF). A multichannel

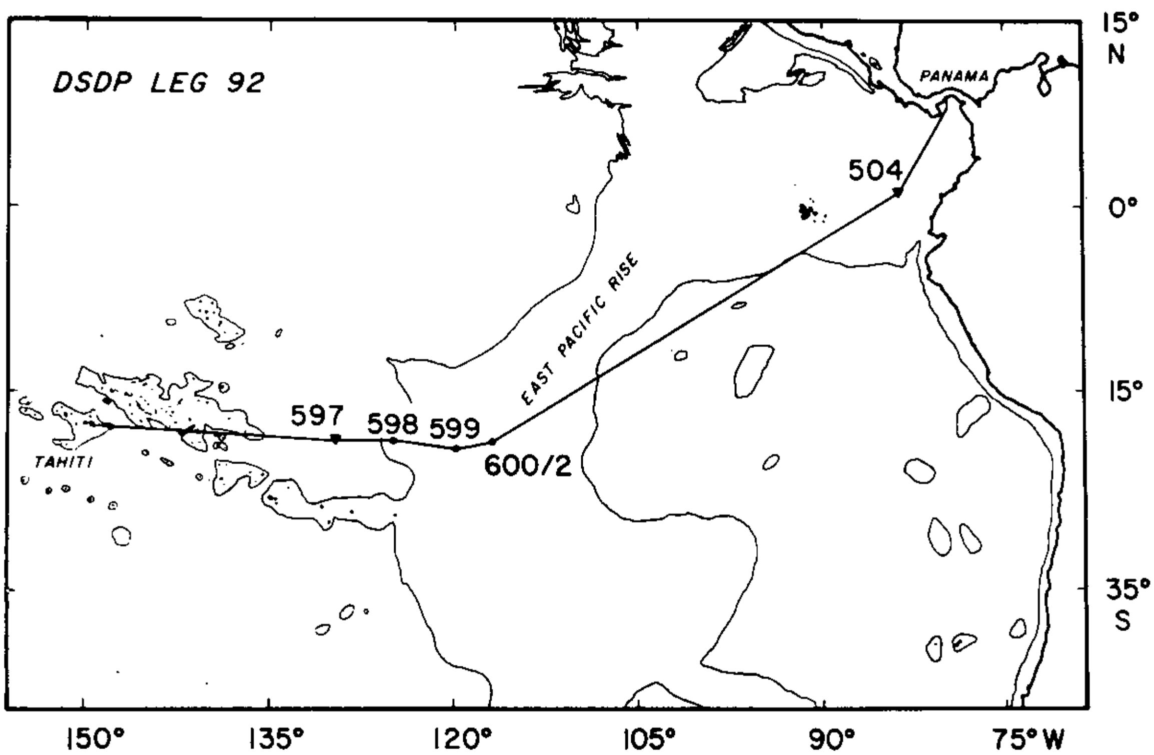

Figure 92-1. Index map of the eastern Pacific showing Leg 92 drill sites and trackline.

sonic log of the upper 150 m of basalt (Layer 2A including the underpresured zone) was completed. The shape of the waveforms varied with the degree of fracturing indicated by previous borehole televiewer logs. A packer experiment run at 972 m BSF failed because the rubber packer element was unable to withstand the high temperatures at the bottom of the hole.

During down times of other experiments we pumped 150,000 gal. seawater to 1271 m BSF to remove an estimate 99% of the bentonite contamination.

Results from Each Site

Site 597

Coring at DSDP Site 597 produced two important sample sets for the interpretation of hydrothermal processes (Fig. 92-5): The first is the lower Miocene to upper Oligocene clay-bearing nannofossil oozes recovered at Holes 597 and 597A that contain a good record of 15 5o 28.5 Ma old sedimentation which can be used to interpret hydrothermal activity. The second is the basalt and Hole 597C where we drilled 91 m into crust generated at a fast spreading rise crest and recovered 48.5 m of rock. The basalts are essentially all massive flows and show three distinct stages of alteration.

The Sediments

Two sedimentary units were recovered from Hole 597 and 597A. At 597C only the lowermost unit was recovered. Unit I is 1.4 m of Pleistocene to middle Miocene zeolitic clay. Unit IIA is about 40 m of clay-bearing nannofossil ooze that averages 80% calcium carbonate and 20% Fe oxides and hydroxides, RSO's (reddish yellow, semiopaque objects) and poorly-crystalline clays. Unit IIB comprises the lower 7 to 10 m of the section. It is clayey nannofossile ooze made up of the same components as Unit IIA except the carbonate contents are only 65 to 70%. Foraminifers comprise a few percent of Unit IIB but are present only in trace amounts in Unit IIA. A single, probably correlative ash layer occurs 3 to 6 m above basalt in Holes 597, 597A, and 597C. The sedimentary column is of generally uniform porosity, about 65%, grain density, 2.62 g/cm^3 corrected for salt content, and sonic velocity, 1.52 km/s.

Unit I spans Pleistocene to early middle Miocene time with a linear sedimentation rate (LSR) of 0.1 mm/10^{3}y. The temporal record of such low LSR materials commonly include numerous lacunae. Sedimentation rates increase downcore to values of about 7 mm/10^{3}y. In the upper portion of Unit IIA, the LSR's of the two cores, taken about 100 m apart, are very different. There are two possible explanations. The first is that the biostratigraphic zonation, which is difficult in this portion of the core because of the poor preservation of the calcareous microfossils, is in error. The second is that there is local variability in sedimentation. If the latter is the case, this variability reached an extreme 17 to 19 Ma, resulting in the observed LSR patterns. Mass accumulation rates (MAR), calculated from LSR, porosity and grain density values, range from 0.01 to 0.7 g/cm^2/10^{3}y. In the lower of the core where the poorly crystalline to amorphous, iron-rich (inferred hydrothermal) component comprises 30% of the sediment, its MAR exceeds 200 mg/cm^2/10^{3}y.

The decrease of nearly two orders of magnitude in LSR that occured about 18 Ma apparently corresponds to the submergence of Site 597 through the early Miocene calcium carbonate compensation depth, then at about 3700 m.

Analysis of interstitial waters, from both squeezed and in situ samples revealed no evidence of fluid advection through the sediment column. Dissolution of $CaCO_3$ may be continuing in the uppermost 10 m of sediment.

Igneous Rocks

Igneous basement was recovered from all four holes at Site 597. Recovery was of 2 m of basalt fragments at Hole 597, 25 cm of basalt-glass breccia at Hole 597A, 5.4 m of basalt (out of 24.6 m drilled at the pilot Hole 597B, and 48.5 m of basalt (of 91 m drilled) at Hole 597C, the re-entry hole. The penetration and recovery at HOle 597C make it the most successful hole drilled into fast-spreading oceanic crust.

The basalts are olivine-poor tholeiites to ferrobasalts containing plagioclase, clinopyroxene, magnetite, glass, and olivine. They are medium- to fine-grained, moderately vesicular (in Unit I) and fractured. Massive flows appear to comprise the entire sequence; only one small fragment, possibly a pillow margin, with a glassy rim was recovered. Two units can be discerned within the basalt sequence. Unit I is 46 m thick and characterized by vesicular subspherulitic to intersertal texture and Unit II, 45 m thick, is dominated by intergranular and poikilophitic textures. Within both units olivine increases in abundance with depth. Several individual flows, defined by finer-grained flow boundaries, comprise each unit.

Three stages of basalt alteration have been identified. First, a late magmatic, possibly deuteric, alteration in which saponite has replaced olivine and basalt groundmass and filled fesicles. A second episode is characterized by dark green smectite, celadonite, chlorite, pyrite, chalcopyrite, and native copper. This alteration stage is clearly associated with veins. A third, late-stage, oxidative alteration has resulted in the presence of calcite, aragonite, zeolite, iron oxides, and a brown smectite. This alteration is pervasive in Unit I and vein related in basalt Unit II.

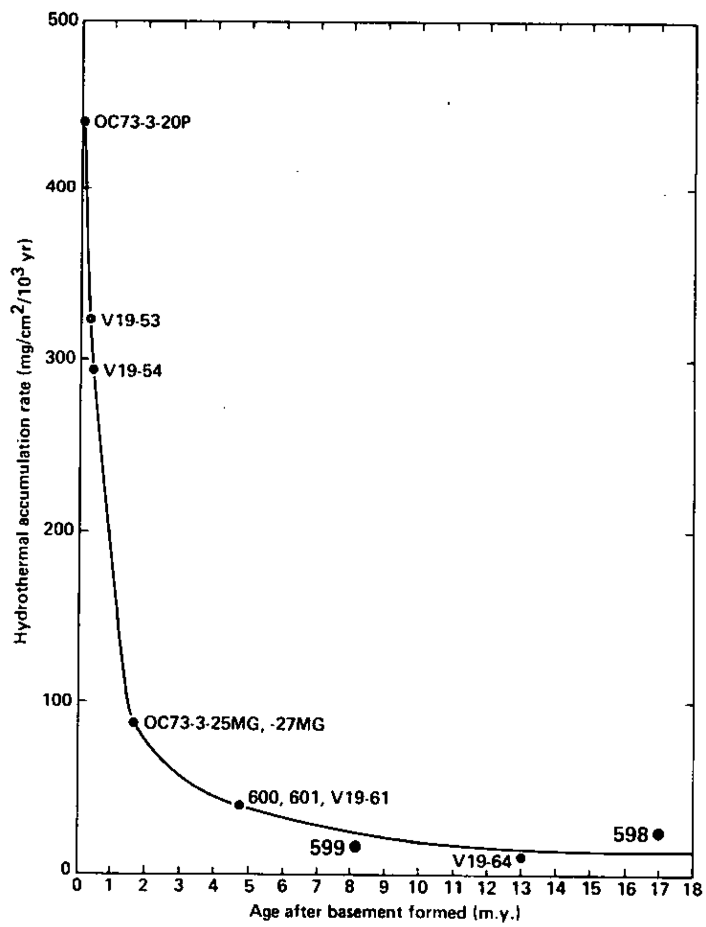

Figure 92-2. Present day pettern of hydrothermal sediment accumulation on the west flank of the East Pacific Rise between 17° and 20°S. Abscissa is core location converted to crustal age determined by magnetic anomalies, data collected by Dymond (1981), McMurtry, et al. (1981), and from Leg 92 results.

The basalts in Hole 597C have sonic velocities typical of crustal layer 2, about 5.8 km/s above Core 597C-10 and about 6.3 km/s in the fresh rocks from Cores 597C-11 and -12. Paleomagnetic studies show the basalts to be reversely magnetized and therefore probably from the reversed interval between Anomalies 8 and 9. This would imply an age of 28.5 Ma for Site 597 (Cox, in Harland and others, 1982), an age consistent with the nannofossil zonation of the basal sediments. Two magnetic reversals occur in the basalts of Core 597C-7, resulting in a brief period of normal polarity. NRM intensities are about 1.6 emu/cc. Magnetic inclination values are unusally high, 50^{o} to 52^{o}, the expected inclination for Site 597 (18.8^{o}S) is about 34^{o}. Unusually high magnetic inclinations also characterize basalts from DSDP Sites 319 and 320 (Ade-Hall and Johnson, 1976), also on crust generated at the fossil Galapagos Rise. As yet there is no satisfactory explanation for these high inclinations.

Four downhole experiments were attempted in the re-entry hole. Caliper and televiewer logs were successful and showed variations in formation fracturing that can be associated with both recovery and petrology of basalt. A 12-channel sonic log was not successful at either Hole 597B or Hole 597C. A packer experiment released prematurely but gave indications of high permeability and underpressuring in the bottom of 597C.

At the end of our time at Site 597, while awaiting the rendezvous with the French naval ship AO Papenoo we tried the second wire-line re-entry test attempted by the Challenger. Re-entry was not achieved but it was obvious that with the proper (bottom-mounted) navigational and guidance equipment the operation could easily become routine.

Site 598

The primary goal of Site 598 was to document the middle to late Miocene history of pelagic and gydrothermal sedimentation at a location on crust generated at the East Pacifc Rise. Pleistocene to latest early Miocene sediments were recovered which document calcareous pelagic sedimentation at the site and indicate a much higher flux of hydrothermal material during the latter portion of the Miocene than is occurring now (Fig. 92-5).

The Sediments

Two sedimentary units were cored at DSDP Site 598. Unit I is 44.6 m of clay-bearing to clayey nannofossil ooze. RSO's (reddish yellow, semiopaque objects) are common in the clay fraction throughout the unit; the unit also contains trace amounts to a few percent of foraminifers, volcanic glass and palagonite, zeolites, micronodules and opaques. The oozes of Unit I are unusually dark in color for their carbonate content, ranging from shades of brown through very dark brown even though carbonate content averages about 60%. A cyclicity of coloration occurs which spans tens of centimeters in the upper portions of the core and a meter or two in the lower portion. At the sedimentation rates for the respective portions of the cores these cycles have a periodicity of hundreds of thousands of years. The lower third of Unit I contains a few thin foraminifer-rich sandy layers which display a fining-upwards size gradation. In addition to these inferred turbidite layers, there are in Core 598-5 a number of darker layers, 1 to 20 cm thick, spaced tens of centimeters apart that have reasonably sharp contacts. It is not clear if these layers represent distal turbidites, but they appear to record episodes of bottom-current controlled, rather than ordinary peagic deposition.

Unit II, between 44.6 and 52.4 m sub-bottom depth, is a much more indurated sediment. Recovery was very low and consisted of pieces of yellowish brown clay and foraminifer-bearing nannofossil chalk, which were similar in color and composition to the foraminifer-bearing turbidites of Unit I. Drilling records suggest that softer layers may be interspersed with more resistant ones. Hole 598 ended in a hard nannofossil limestone at 52.4 m sub-bottom depth.

Sediments at Site 598 range in age from Pleistocene, the top 1.5 m, back to latest early Miocene. The Miocene/Pliocene boundary occurs at about 6.5 m depth and the late/middle Miocene boundary at about 13 m. The basal nannofossil Zone CN4-3 (Okada and Bukry, 1980), which spans the time from 14.2 to 17 Ma (Haq, 1983). Rates of sedimentation determined from the nannofossil zonations increase from 1.23 m/Ma during the late Miocene to Pleistocene to 3.25 m/Ma in the late middle Miocene to late Miocene and 4.8 m/Ma in the early middle Miocene.

Measurements of physical properties of the sediments of Unit L show a sonic velocity of 1.51 km/s, an average porosity of about 71% and a grain density of 2.72 g/cm^3. Using these last two values, sedimentary mass accumulation rates corresponding to the three linear sedimentation rates are 0.10, 0.26, and 0.38 g/cm^2/10^{3}y, repectively. The inferred gydrothermal component of the middle and late Miocene sediments (RSO's) ranges from about 20 to 40% of the total, recording a mass flux of this component at Site 598 of 50 to 150 mg/cm^2/10^{3}y for at least 8 Ma after crustal formation at the spreading center. This time span can be converted to destance from the Miocene EPR axis and the calculated fluxes compared with modern values. Results of this exercise document that Miocene hydrothermal input during the time 8 to 16 Ma was a factor of 2 or more higher and late Miocene has been shown to be a period of increased volcanic activity in both plate margin (Kennett, et al., 1977) and mid-plate (Rea and Scheidegger, 1979) settings.

Downhole Experiments

At Site 598A a decision was made to devote and entire hole to experimental work without trying to recover any sediments. This improved both the quality of sediment recovery in the cored hole and permitted a number of downhole temperature and in situ pore water samples to be taken at positions determined only by the specific requirements for that information. Four temperature measurements and a mudline calibration value were made with the Von Herzen heat flow shoe fitted to the VLHPC barrel. These data indicated in a heat flow value of 74 mW/m^2.

Two lowerings of the Barnes/Uyeda pore water-heat flow sampler were completed resulting in one good in situ pore water sample, at 35.4 m sub-bottom depth, and one sample of pipe water. Results of all the interstitial water analyses from both squeezed and in situ samples reveal no evidence of fluid advection through the sediments, although Ca++ shows a dissolution related gradient in the upper 20 m.

Site 599

Site 599 was drilled to provide a continuous record of late Miocene to Recent sedimentation for the evaluation of past hydrothermal activity, paleoceanography and paleoclimate, to obtain data appropriate for

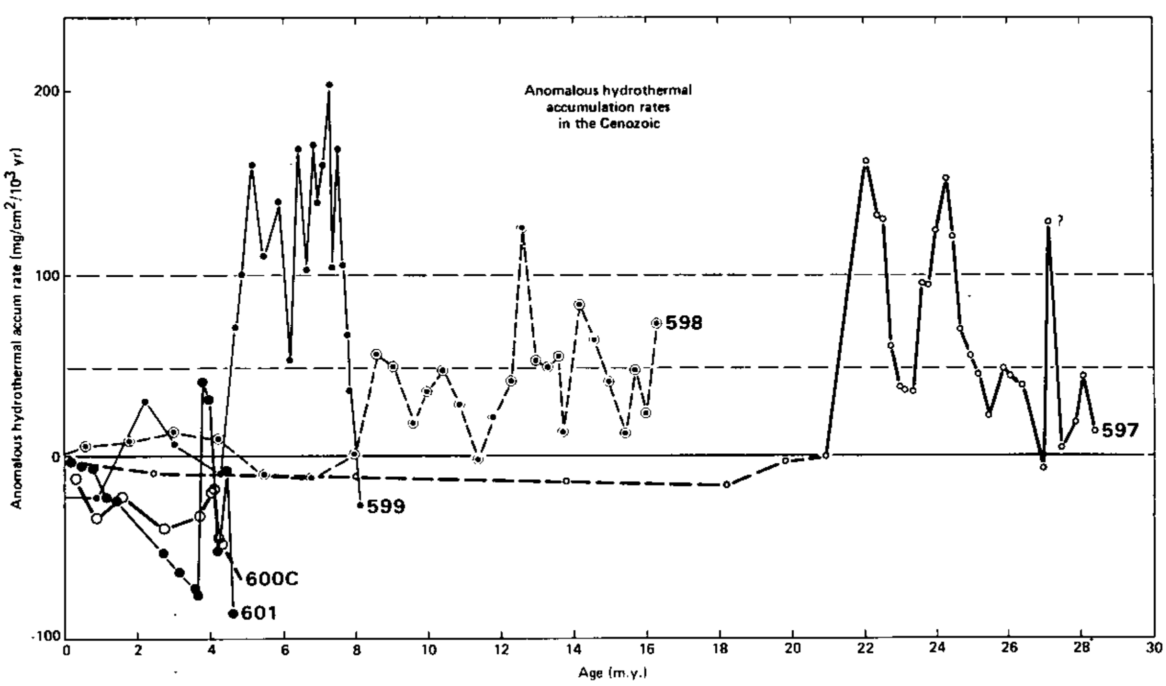

Figure 92-3. Difference in hydrothermal accumulation rate through time between that observed at Leg 92 drill sites and the present situation as shown in Figure 92-2. Plot is observed hydrothermal MAR vs. sediment age above basement at each site minus the present case.

constraining models of ridge flank hydrothermal convection, and to collect basalt generated at the fast-spreading East Pacific Rise for comparison with those collected at Site 597 which were generated at the Galapagos Rise (Fig. 5). Magnetic anomalies from Conrad-13, Ariadne-II, and Leg 92 underway magnetics indicate an age of about 8.0 Ma (Anomaly 4A) for Site 599. Three Holes were drilled. Hole 599 ws cored to a depth of 40.8 m using the VLHPC, and 34.76 m of sediment were recovered. Hole 599A was devoted entirely to heat flow and in situ pore water sampling. Three heat flow measurements and one pore water sample were taken. Hole 599B was washed 23.6 m where an in situ pore water sample was taken and a temperature measurement made for heat flow determination. One VLHPC core was taken between 32.2 and 40.8 m to obtain the basal sediments at the site. Two XCB cores of basement rock were drilled to a total depth of 49.8 m.

The Sediments

The sediments recovered in Holes 599 and 599B consist of clayey and clay-bearing nannofossil oozes. Only one lithologic unit is present. The sediments show alternating light and dark colored zones (generally 10 cm to 1 m thick) and bands (2 to 5 cm thick). The color variations are the result of variations in the amount of calcium carbonate (70 to 80% in light colored sediments, 55 to 70% in dark sediments) versus the noncarbonate fraction which is primarily clays and RSO's (reddish yellow semiopaque objects). The sediments are significantly darker than those with equal carbonate contents at Site 597 and more similar to those from Site 598.

Most of the sediment column, particularly the upper 21 m, appears to be extensively reworked. Some of the color zones have sharp lower contacts and in one case (599-3-3, 21 cm), sediments with nannofossils in the upper darker unit are 1 to 2 Ma older than those in the underlying lighter material. One complication in interpreting the significance of the sharp contacts is that there are no abvious changes in grain-size either across the contacts or within the units indicative of turbidity current deposition. In spite of this, the existence of homogeneous sediment above sharp contats in 599-3-1 suggests that these units represent the deposition of materials that have moved rapidly downslope. The sediments above the contact at 599-3-3, 21 cm are extensively mottled, however, suggesting that redeposition of these sediments was more complex, and probably intermittent. Many parts of the sediment column (e.g. 599-2-5 to -2-6; 599-3-1 and -3-2, 599-4-2 and -4-3) have many alternating color bands with fairly sharp upper and lower contacts. These may be caused by redeposition, dissolution or dilution cycles, or some combination of the three.

Foraminifers were abundant in the sedimentary section but the age zonation based on them is substantially different from that based on nannofossils, probably as a result of preservation. A basement age of 5.2 to 6.4 Ma is indicated by foraminfers while a 8.1 to 8.6 Ma basement age is indicated by nannofossils. Because of the better agreement between the latter and the magnetic anomaly age and because the nannofossil preservation was good enough for a fairly detailed zonation, sediment ages and deposition rates were based on nannofossils.

The upper 1.5 m of sediment were dated as Pleistocene and have a sedimentation rate of 0.7 mm/ky. A Pliocene age (CN12 through CN10c) was assigned to sediments below 1.4 m in Core 599-1 (sedimentation rate 2.3 mm/ky); 599-1-CC was of latest Miocene to early Pliocene age. The remainder of the sediments were of late Miocene age and ranged in sedimentation rate from 7.7 to 11.6 mm/ky at the base of the section.

Physical properties measurements showed a small amount of variation from mean values of 1.57 g/cm^3 for wet bulk density 69% for porosity, 2.78g/cm^3 for grain density, 1.52 km/s for sonic velocity, and 2.22 for formation factor. Using dry bulk densities calculate from the wet bulk densities and porosities listed in the Physical Properties section, mass accumulation rates for the sediments can be calculated. They range from 0.06 gkm^2/ky in the Pleistocene sediments near the surface to 0.93 h/cm^2/ky in the clayey nannofossil ooze near the sediment/basalt contact. The mass accumulation rate of the hydrothermal component, clays and RSO's, varies from 200 to 350 mg/cm^2/ky in the lower half of the core and decreases toward the top.

Igneous Rocks

Igneous basement rocks were recovered from Holes 599 and 599B. Oly a few small altered, glassy basalt chips were recovered from Hole 599, but 2.08 m of drilling breccia and basalt cobbles were recovered at Hole 599B. The basalt cobbles may all be fragments of pillows, but only two pieces have glassy rims. All pieces have an altered outer zone and a relatively fresh interior. They are almost nonvesicular, spherulitic to intergranular basalts which are transitional between olivine poor tholei[illegible] ferrobasalts.

599A
devi
dow
refl Two interstitial water samples were sed eezed from each core and two in situ water adv nples were taken, one each from Holes 9A and 599B. Only Ca++ showed any viation from conservative behavior wncore and the Ca++ deviations appear to flect dissolution of carbonate in the diments. There was no evidence of dvective pore water flux at the site.

Three temperature measurements were made with the VLHPC heat flow shoe at Hole 599A; one Hole 599B. The temperature gradient measured at Hole 599A was 106 mK°/m. Using the thermal conductively of sediments recovered on the site survey cruise, the heat flow is 101 mW/m^2, a value about half of the theoretical heat flow for 8 Ma crust.

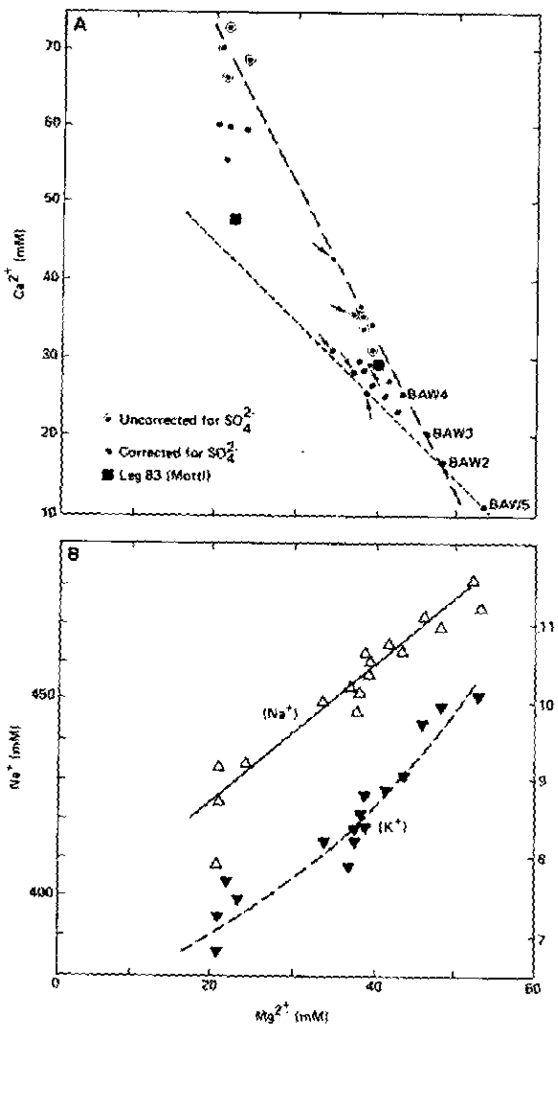

Figure 92-4. 4a: Concentration in 504B borehole waters of Mg^{++} vs. CA^{++} that has been corrected for anhydrite using $SO_4^{=}$ data.
4b. Decreases in Na^+ and K^+ as a function of Mg^{++} decreases in 504B.

Site 600

Site 600 was drilled in very thin sediment cover on the flank of an abyssal-hill ridge (Fig. 5). Transponder navigation was used to bring the Challenger to within the distance of random pipe offset, (about 1% of the depth) of the two target locations where measured heat flow exceeded 700 mW/m^2. Three attempts to core the first area resulted in: 5.38 m of sediment and a sheared-off barrel at Hole 600, another broken barrel at 600A, and 1.9 m of recovery at 600B. At the second high heat flow location, Hole 600C, which ws 170 m west-northwest of the first target, two VLHPC cores recovered 11.80 m of sediment, the best section from Site 600.

The Sediments

The sedimentary section at Site 600 is divided into two units of different lithification. All sediments recovered from Holes 600 and 600B and the top 10.0 m at 600C are part of Unit I, a clay-bearing to clayey nannofossil ooze which is yellowish brown to dark brown in color. Components of Unit I include 70 to 80% calcareous nannofossils, 2 to 10% foraminifers, and 15 to 25% clay plus RSO's, a fraction considered hydrothermal in origin. Dark-colored bands lower in the unit contain up to 45% hydrothermally derived material.

Unit II is 1.8 m of yellowish-browm to dark brown foraminifer-bearing clayey nannofossil ooze. It is composed of 50 to 55% calcareous nannofossils, 12 to 15% foraminifers, 25 to 30% clay plus RSO's and a number of minor and trace components. X-ray diffraction showed the clays to be poorly-crystalline smectites. A pebble in the core catcher was composed of clear glass shards cemented by yellowish brown calcite.

Physical properties of the sediments recovered at Hole 600C were measured for every section. Averages are 69.6% for porosity, 2.74 g/cm^3 for grain density, 1.54g/cm^3 for wet bulk density, a formation factor of 2.45, and an acoustic velocity of 1.54 km/s.

Linear sedimentation rates (LSR) are 2.3 m/Ma in the Pleistocene, less than 1m/Ma in the late Pliocene, and 6.0 m/Ma during the early Pliocene. The low-LSR interval of the late Pliocene corresponds to a zone of intensified reworking in Section 600C-1-4 which overlies a sharp contact at 600C-1-4, 82 cm. We presume this contact represents the tle of a locuna which includes most of the ea Pliocene. It may also include some of the [illegible] Mass accumulation rate (MAR) [illegible] recove

sediment MAR is 0.2 g/cm/^{2}mal M. Pleistocene. It is very low, 0.07 and rang upper Pleocene sediments and increedimer g/cm^2/ky in the lower Pliocene Plioce as Hydrothermal materials constitute aximum constant 20 to 30% of the sediment [illegible] A at Hole 600C, thus the hydrotherm [illegible] it reflects that of the total sediment an [illegible] e from 39 mg/cm^2/ky in Pleistocene se [illegible] f to a low of 18 mg/cm^2/ky in upper Pt was sediments increasing down core to a maxe on of 120 mg/cm^2/ky. [illegible] A that ure of

Experimental Results

One in situ temperature measurement he made using the Von Herzen heat flow shoe is the first VLHPC core barrel at Hole 600. [illegible] flux of 580 mW/m^2 was calculated from th single point and the ocean-floor temperatur using the average thermal conductivity o sediments recovered from the area during the site survey. The sheared-off VLHPC barrels at Holes 600 and 600A obviated further use of in situ temperature sensors and pore-water samplers at Site 600.

Analyses of interstitial waters squeezed from recovered sediments show no evidence of pore-water advection at either of these high heat flow locations.

Discussion

Coring operations at Site 600 reaffirmed that very thin sediment sections are not suitable for drilling by the Glomar Challenger. Even when the depth of basalt basement was known from the "tagging" operation we lost two VLHPC barrels and recovered only partial sections on three of the four successful core attempts, Holes 600-1 (5.38m), 600B-1 (1.90 m) and 600C-2 (2.42 m). If the sheared barrels had merely been bent, we would have had to pull the pipe and, under the time restrictions on Leg 92, abandon the site. This problem did occur at Hole 602B.

Transponder navigation works especially well on the Challenger since the beacon location can be included in the transponder net and the dynamic positioning system permits the ship to maintain station and to make precise offset in terms of both distance and direction. The navigation problem then reduces to the simple one of where you are and where you want to be.

This high heat flow site did not provide evidence of either pore water advection within the sediment or flux of hydrothermal material to the seafloor by advection in the past. Since the percentage of the hydr[illegible] component remains more-[illegible]

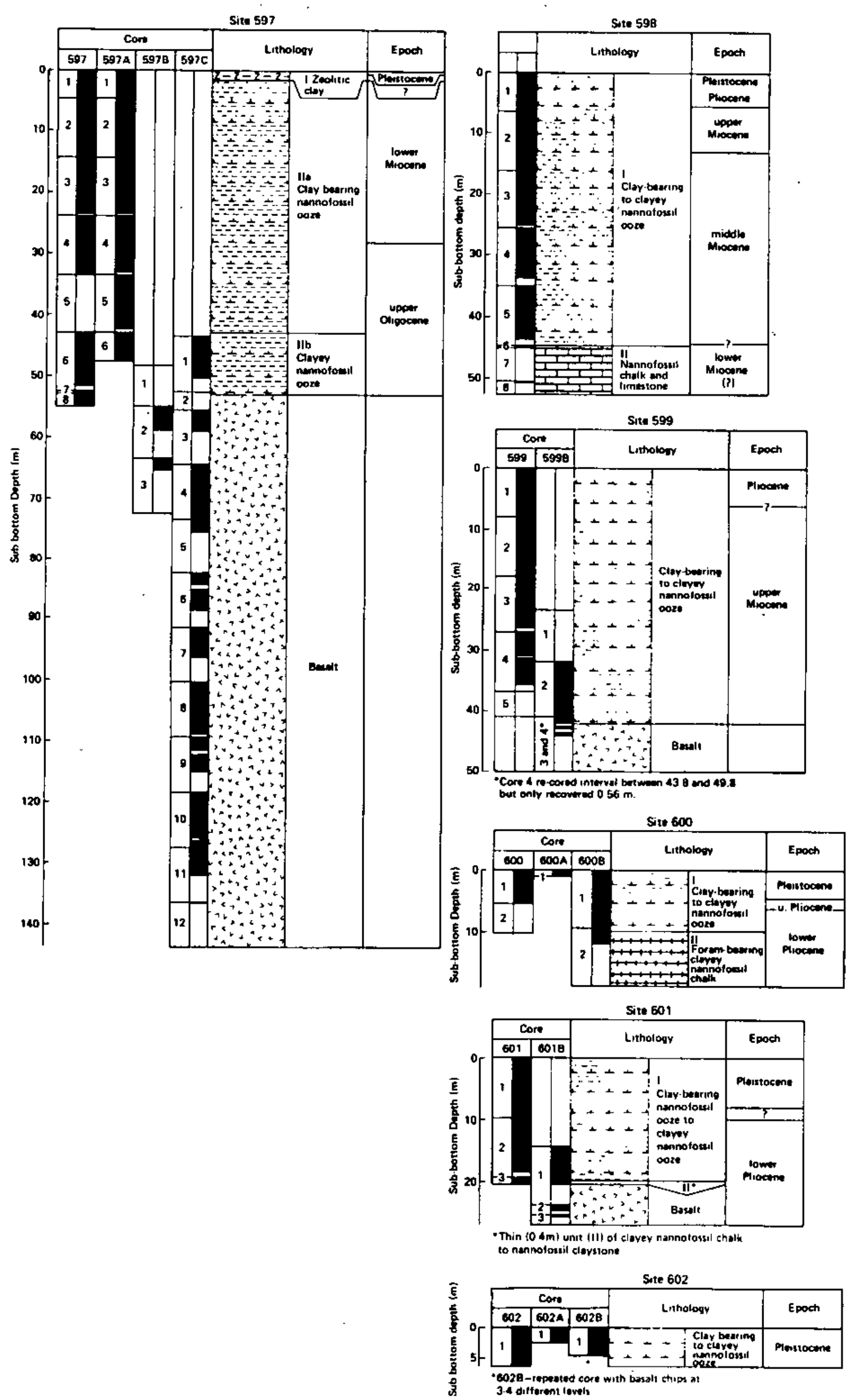

Figure 92-5. Lithology, age, and recovery of sediment and rock drilled at Sites 597-602.

MAR, depends almost entirely on the LSR of the nannofossil ooze. This implies that the accumulation of hydrothermal phases at his site depends not on supply from the ridge axis or from a ridge flank hydrothermal source, but is subject primarily to the influences that cause the nannofossil ooze LSR to vary, especially local episodes of winnowing, nondeposition and redeposition.

Site 601

Site 601 was one of three sites drilled in the youngest area surveyed for the East Pacific Rise hydrogeology transect (Fig. 92-5). The site lies in an area of moderate heat flow and flat lying sediments and was drilled to provide a comparison for the high and low heat flow sites (Sites 600 and 602, respectively) which were drilled nearby. In addition, since tha latter two sites were being drilled in anomalously thin sediment, site 601 was chosen to provide a representative sediment column for the interpretation of Pliocene to Recent hydrothermal activity, paleoceanography and paleoclimate. Three holes were drilled. Hole 601 was cored to a depth of 20.4 m using the VLHPC, and 19.5 m of sediment were recovered Hole 601A was devoted entirely to instrumental operations: three heat flow determinations and one in situ pore water sample. Hole 601B was devoted to coring with the XCB to recover the sediment/basement contact and basement rock. It was washed to 14.4 m and cored to a depth of 27.0 m with 5.70 m of sediment recovery and 1.05 m of basalt recovery.

The Sediments

The sediments recovered in Holes 601 and 601B consist of clay-bearing and clayey nannofosil ooze, foraminifer-nannofossil clay (Unit I, 0.0-20.0 m in Hole 601; 14.4-24.0 m in Hole 601B) and clayey nannofossil chalk (Unit II, 20.0-20.4 m in Hole 601). The sediments generally contain 2 to 5% foraminifers and 2 to 3% palagonite, micronodules, and opaque minerals. Nannofossils make up about 55 to 70% of the sediment. The remainder consists of clay and reddish brown semiopaque objects (RSO's).

The color of the sediments changes abruptly from light to medium brown at the base of Core 601-1-6. This color change occurs in an interval which is bounded by samples of Pleistocene and early Pliocene age. Reworked microfossils in the interval, discontinuous nannofossil zones, and a very slow sedimentation rate suggest that some late Pliocene and Pleostocene sediment may be missing.

Foraminifers were moderate to abundant in Site 601 sediments and became more poorly preserved with depth in the holes. A basement age no older than 5.0 Ma is indicated by foraminifers. Nannofossils were abundant and some reworking is present throughout the sediment column. Preservation was moderate with dissolution and overgrowth increasing with depth. The maximum age indicated by nannofossils is 4.6 Ma.

The upper 8.0 m of sediment were dated as Pleistocene and have a linear sedimentation rate of 4.8 m/Ma. Sediment between 8.0 and 9.0 m in Hole 601 were not zoned but probably represent late Pliocene and possibly Pleistocene age sediments and have a minimum sedimentation rate of 1.0 m/Ma. The remainder of the sediment column is early Pliocene and has a sedimentation rate of 7.1 m/Ma.

Physical properties measurements made on each section of core have average values of 69.2% porosity, 1.56 g/cm^3 for wet bulk density, 1.52 km/s for sonic velocity, 2.75 g/cm^3 for grain density, and 2.26 for formation factor. Combining the porosity and grain density values with the linear sedimentation rates permits calculation of the total mass accumulation rates: 0.44 $g/cm^2/ky$ for the Pleistocene sediments and 0.58 $g/cm^2/ky$ for the early Pliocene. If the clay plus "RSO" fraction represents hydrothermal input, that flux averages approximately 45 and 155 $mg/cm^2/ky$ for the two zoned time intervals.

Igneous Rocks

Hole 601B penetrated 3.12 m into igneous basement recovering 1.05 m of basalt cobbles. The rocks are fragments of relatively fresh gray, vesicular ferrobasalts whose outer rims have been slightly oxidized. The outer surfaces are coated with secondary minerals, commonly Fe and Mn oxides and hydroxides, clays, calcite, or zeolites.

Experimental Studies

A total of nine interstitial water samples from squeezed sediments and one in situ water sample were analyzed. Unlike other sites the potassium content of the in situ sample suggests that the temperature-of squeezing effect increases with depth in the core. If this is true the magnitude of the effect would apply to the magnesium data also and would indicate that the small changes in Ca in the pore waters are due to carbonate dissolution as at Sites 597, 598, and 599. If the potassium data are contaminated by bottom water, however, the bottom water corrected Ca and

Leg 92 Coring Summary

HOLE	DATES (1983)	LATITUDE	LONGITUDE	WATER DEPTH	PENETRATION	NO OF. CORES	METERS CORED	METERS RECOVERED	PERCENT OF RECOVERY
597	02-03 March	18°48.38'S	129°46.23'W	4166.5 m	54.7	8	54.7	42.1	77.0
597A	03-04 March	18°48.43'S	129°46.22'W	4162.6 m	48.6	6	45.0	42.9	95.0
597B	05-06 March	18°48.43'S	129°46.22'W	4162.6 m	72.6	3	24.6	5.43	22.0
597C	07-15 March	18°48.43'S	129°46.22'W	4164.0 m	143.5	12	100.0	55.21	55.2
598	17-18 March	19°00.28'S	124°40.61'W	3699.0 m	52.4	8	52.4	41.29	78.8
598A	18-18 March	19°00.28'S	124°40.61'W	3699.0 m	33.0	0	0.0	0.0	0.0
599	20-21 March	19°27.09'S	119°52.88'W	3654.0 m	40.8	5	40.8	34.76	85.0
599A	21-21 March	19°27.09'S	119°52.88'W	3654.0 m	22.6	0	0.0	0.0	0.0
599B	21-22 March	19°27.09'S	119°52.88'W	3654.0 m	49.8	4	23.6	11.56	49.0
600	23-24 March	18°55.74'S	116°50.37'W	3346.0 m	10.4	2	10.4	5.38	51.7
600A	24-24 March	18°55.74'S	116°50.37'W	3346.0 m	9.6	1	9.6**	0.0	0.0
600B	24-24 March	18°55.74'S	116°50.37'W	3346.0 m	1.9	1	1.9	1.9	100.0
600C	24-25 March	18°55.70'S	116°50.45'W	3398.0 m	19.0	2	19.0	11.8	62.1
601	25-25 March	18°55.22'S	116°52.11'W	3433.0 m	20.4	3	20.4	19.45	95.3
601A	25-25 March	18°55.22'S	116°52.11'W	3433.0 m	15.0*	0	0.0	0.0	0.0
601B	25-26 March	18°55.22'S	116°52.11'W	3433.0 m	27.0	3	12.6	6.75	53.6
602	26-27 March	18°54.41'S	116°54.68'W	3535.0 m	6.2	1	6.2	6.19	99.8
602A	27-27 March	18°54.41'S	116°54.68'W	3535.0 m	2.3	1	2.3	2.28	99.1
602B	27-27 March	18°54.41'S	116°54.68'W	3535.0 m	4.2	1	4.2	4.24	101.1

Mg profiles indicate changes of about 6% in these constituents and suggest exchange with basement.

One temperature measurement was made at Hole 601 and three were made in adjacent Hole 601A with the Von Herzen VLHPC heat flow shoe. Both temperature gradients (using bottom water temperature and one measurement at Hole 601) were approximately 160 mK/m. Using the thermal conductivity of sediments recovered on the site survey cruise, the heat flow is 160 mW/sq.m, compared to a theoretically expected value of 235 mW/sq.m for crust of 5 Ma.

Site 602

Parts of a very thin sedimentary section were recovered from three holes at Site 602 (Fig. 92-5). Since the 3.5 and 12 kHz records did not show any sediments, and XCB was run in the bit to determine whether any sediments were present while washing down to determine the depth of basement. The XCB recovered 6.19 m of watery sediment and flow-in. After it was clear that sediment was present a VLHPC was taken at Hole 602A which recovered the most representative section at this site, 2.28 m long. At 602B the core barrel stuck in the bit but recovered 4.24 m of sediment which represent repeated sections cored as the ship rose and fell on the 2-m swell. Very thin sediments and irregular sediment recovery prevented heat flow measurements and command caution in any use or interpretation of interstitial water data.

The Sediments

Sediment recovered at Site 602A is yellowish brown to dark yellowish brown clay-bearing to clayey nannofossil ooze. It consists of 80 to 85% calcareous nannofossils, 10 to 20% clay plus RSO's (the presumably hydrothermal fraction), and 1 to 3% foraminifers. Ziolites, volcanic glass and opaques occur in minor to trace amounts. The core from Hole 602B recovered chips of basaltic glass and highly vesicular rock fragments in a dark brown nannofossil clay at three levels, presumably recording separate punches of the stuck core barrel. Unlike most other Leg 92 drill sites, no indurated basal layer was recovered at Site 602, although two 1-cm chalky pieces were recovered at 602B-1-3, 17-19cm.

Biostratigraphic analyses show that all the sediments at 602 are Pleistocene in age (foraminifer Zone N22, and nannofossil Zone CN14-CN15). The dark layers that occur in association with the rock chips contain common reworked Pliocene forms; reworking is rare in the lighter-colored sections of the cores. The linear sedimentation rate for Site 602, a minimal value based on the assumption that the entire biostratigraphic zone was recovered, is 0. 14 cm/ky.

Physical properties of the sediments recovered in Hole 602B average 67.9% for porosity, 2.65 g/cm^3 for grain density, 1.55 g/cm^3 for wet bulk density, 1.53 km/s for acoustic velocity, and a formation factor of 2.52. Combining the porosity and rain density values with the minimal LSR values gives a minimum mass accumulation rate of 0.12 g/cm^2/ky for the bulk sediment. The minimum MAR value of the hydrothermal component is then about 20 mg/cm^2/ky in the lighter-colored oozes of Site 602, and about 65 mg/cm^2/ky in the darker-colored layers of Hole 602B.

Discussion

The extremely thin sediment cover at site 602 made coring difficult and eventually, because of the jammed core barrel forced us to abandon the site.

No Pliocene sediments were recovered from this 4.5 Ma old location, although Pliocene fossils were reworked into the Pleistocene sediments and Pliocene sections were present at adjacent Sites 600 and 601. The absence of Pliocene section at Site 602 probably indicates that the low trough in which the site is located served to localize current-flow, keeping the seafloor essentially free of sediment during the Pliocene. Instead of being the site of sediment ponding this trough appears to be an area of winnowing and nondeposition.

The MAR of the presumed hydrothermal component, 20 to 65 mg/cm^2/ky, is about half of that at Sited 597, 598 and 600. The values for hydrothermal MAR at Hole 602 are probably artificially low because the calculated LSR is a minimal value only.

Hole 504B

A number of different sampling and measurement programs were conducted at Hole 504B at the end of Leg 92. Extensive temperature logging during Legs 69, 70, and 83 showed a water flow downhole of 90 m/hr. in December 1979, decreasing to 25 m/hr. in November of 1981, directed to an underpressured high-permeability resevoir in the upper 100 m of basement. Leg 92 temperature measurements showed that this flow has been reduced to 2 or 3 m/hr., or 100 to 200 l/hr., in April of 1983. Downhole temperature measurements were complicated by sensor problems but indicate a gradient of 0.080^{o}/m in crustal Layer 2c and bottom-hole temperatures of 155° to 165°C.

Water sampling showed the borehole fluid in Hole 504B in April of 1983 to be a mixture of seawater and "bentonite" drilling mud. We found uniform bottom-water chlorinites dowm the hole but a clearly developed major-ion alteration chemistry characterized by down-hole increases in Ca^{++} and decreases in M^{++} and K^{+} and Na^{++} (Fig. 92-3). The good correlation between Ca^{++}, after adjustment for anhydrite precipitation observed lower in the hole, and Mg^{++} suggests a value of 1.95 for Ca/Mg ratio. Dissolved silica concentrations follow, but lie slightly above the quartz solubility curve.

An oblique seismic refraction experiment shot to a three-component seismometer clamped to the borehole wall at depths of 3780 m (317 m below seafloor), 4000 m (537 m BSF), 4190 m (727 m BSF), and 4405 m (942 m BSF, at temperatures of about 155°C), was conducted by Dr. Ralph Stephen of Woods Hole Oceanographic Institution, using the R/V Ellen B. Scripps as the shooting ship. The experiment was designed to investigate regional fracturing density regional anisotropy, and low velocity layers. Data analysis has not been completed but the Leg 92 borehole seismic experiment is the most intensive completed to date, even though failures of cable connectors plagued the experiment. The preliminary data show clear evidence of anisotropy.

Sections of the upper portion of Hole 504B were logged with a multi-channel sonic tool to interpret mesoscale fracturing from the acoustic behavior of crustal Layer 2A in the immediate vicinity of the borehole. The results of this logging show that differences in the shape of the waveforms correspond to differing degrees of fracturing as indicated by previous borehole televiewer logging. A packer experiment, to determine the bulk formation permeability, sit at 45c0 m, 1067 m BSF, hole failed because the rubber borehole seal was not able to withstand the high ambient temperatures.

During two interludes between other operations we pumped 150,000 gal. of seawater through the hole form 4734 or 1271 m below the seafloor. Our estimate is that this represents 6.8 flushings and thus should have removed 99% of the bentonite not caked on the walls of the hole.

Appendix A
Overview Interstitial Water Studies, Sites 597-601

Introduction

At this stage it appears appropriate to attempt a synthesis of the data obtained at the various sites fo the East Pacific Rise 19° S transect. We will emphasize the distribution of the major ionic constituents calcium, magnesium, and potassium. Studies of these constituents are part of the regular program of interstitial water studies both on board ship (Ca, Mg) as well as on shore. In many cases substantial changes with depth ih these constituents have been observed, i.e., increases in calcium, decreases in magnesium and potassium. Often these changes, particularly when accompanied by decreases in the $\delta^{18}O$ of the interstitial waters, can be traced back to reactions involving the alteration of volcanic matter dispersed in the sediments or the underlying basalts of the oceanic crust (Gieskes and Lawrence, 1981; Lawrence and Gieskes, 1981; Elderfield and Gieskes, 1982). However, reactions involving carbonate diagenesis may leave imprints of top of the concentration-depth profiles of calcium and magnesium. This is usually best detected by the study of dissolved strontium, which is released during carbonate recrystallization (Baker, et al., 1982; Elderfield, et al., 1982). These signals indicating carbonate diagenesis usually are small and obscured by signals caused by volcanic matter alteration. However, in sites with small gradients, i.e., with interstitial waters close to seawater in composition, the carbonate signals may predominate. With this in mind we shall now scrutinize the data obtained during Leg 92.

Data Quality

Analytical precisions for the constituents under consideration are as follows:

Ca^{2+}: $\pm$1% (titration)
Mg^{2+}: $\mp$1% (titration)
K^{+}: 4% (Wescan ion chromatography)

To this analytical uncertainty, of course, one should ad a potential "handling" error, which is reduced by the good coring with the HPC, but used to be quite bad with rotary drilling.

Systematic errors also occur in the data, especially because interstitial waters are not obtained under in situ conditions, with the exception, of course, of the in situ sampler. Generally extractions were carried out as soon as possible after core retrieval at temperatures of 28°C $\pm$ 2. For constituents whose temperature of squeezing artifacts are mainly determined by ion exchange processes (Sayles, et al, 1973), e.g., Mg^{2+} and K^{+}, this will lead to systematic errors, e.g., low Mg^{2+} and high K^{+} values. For species involved in carbonate equilibria, however, the case is not simple. For instance our data clearly suggest that not only does a negative shift in Ca^{2+} occur as a result of ion exchange reaction, but also a partially compensating shift occurs as a result of enhanced temperatures. The reasons for the latter are not clear, espeially because calcium carbonate solubility increases with decreasing temperature and increasing pressure. Of course, release of hydrogen ions as a result of ion exchange artifacts could offset the simple effect, causing Ca-dissolution. Clearly this is a problem. Previous experience (Gieskes, MANOP report of NSF) shows that data obtained on board ship at in situ temperature (centrifugation extraction) were much lower than in situ values for Ca^{++} concentration. Clearly errors appear to cancel and immediate extraction at temperatures of about 20°C leads to good agreement with in situ (Fig. 92-1).

Site 597 (Fig. 92-2)

Data for Mg^{2+} and K^+ show offsets as well as trends with depth. Perhaps slightly enhanced clay and RSO contents (top and bottom of hole), lead to enhanced temperature artifacts from the on-board sample squeezing. Thus small down hole changes in Mg^{2+} and K^+ do occur, in agreement with in situ data. The gradient in Mg^{2+} is probably maximal and may indicate a 2-3% depletion in Mg^{2+} at about 50 m, a change not much larger than the possible error.

The change in Ca^{2+} is quite systematic and the dashed curve probably represents the real profile. This implies a change of almost 1mM at depth or a 10% increase in concentration. An equivalent Mg^{2+} change would amount to a reduction of about 2%. the curvature of the upper portion of the profile suggests that Ca^{2+} is generated in the sediment column most likely as a result of carbonate dissolution.

Site 598 (Fig. 92-2)

Trends in Mg^{2+} are similar to those in Site 597 although the K^+ data show more scatter. No change in Mg^{2+} with depth should occur, in agreement with the in situ result. Again a distinct increase in Ca^{2+} occurs in the upper portion of the core suggesting carbonate dissolution.

Site 599 (Fig. 92-3_

No significant change in Mg^{2+} and K^+ occurs downhole at Site 599 with a possible decrease of 2/5 (1mM) in Mg^{2+} at the base of the site.

Increases in Ca^{2+} are relatively large (similar to Site 597) and are again best understood in terms of carbonate dissolution.

Site 601 (Fig. 92-3)

This site shows an apparent gradient in Mg^{2+}, although not supported by in situ data. If temperature artifacts as a result of ion exchange equilibria do increase with depth (as suggested by K^+ profile) then the dashed line might represent the true Mg^{2+} gradient, which would require questioning the in situ data. Support for latter comes from the relatively low Ca^{2+} concentration from the in situ sample. Thus, if Mg^{2+} depletions do occur they should range from about 1.5% to about 6% at the base of the site, as is observed.

Increases in Ca^{2+} are about 4 to 8% (0.4 to 0.8 mM). As profiles do not apear profoundly different from those of Sites 597 through 599, we presume again carbonate dissolution and perhaps recrystallization are the primary causes of the increase in Ca^{2+}.

Site 600 (Fig. 92-4)

No in situ samples were taken at Site 600, but profiles based on squeezed samples above 10 m show similarities to those of Site 601. The return to seawater values at the base may be real or due to seawater contamination. At this stage without supporting data this is difficult to decide.

General Discussion

None of the sites drilled during Leg 92 (with the possible exception of sites 601 and 600) show any strong indications of the influence of formation water in the underlying basalts on the chemistry of the interstitial waters in the overlying sediments. Any observed changes, particularly in dissolved calcium appear related to reactions involving carbonates.

Dissolved Nitrate and Ammonia

Figure 92-4b presents a composite profile of disolved nitrate for Site 598-601. Each hole shows similar profiles, the distribution of nitrate is probably a function of in situ metabolic activity. As expected this metabolic activity is usually highest in the upper sediment layers and generally slight maxima are observed in the upper 10 m. The ammonia profiles (Fig. 92-5) show more variability, but also indicate higher values in the near surface sediments. In our opinion the various sites visited along the transect, even adjacent sites such a 600 and 601, have matabolic processes that do not occur at the same rate or to the same extent. These processes are probably related to small relative differences if burial of reactive organic carbon.

Silica

Dissolved silica measurements made during Leg 92 were generally obtained at temperatures different from in situ temperatures (about 18°C vs. about 2-6°C) so offsets from the real in situ concentration will occur (Gieskes, 1973; Sayles, et al., 1973). Generally these differences tend to be of a constant nature and in the present study amount to about 90 µm ±10. This easily seen from the composite presented in figure 92-6. Below we summarize the set of in situ data:

Site	Depth Below Seafloor (m)	H_4SiO_4 µm
597	14.5	273
598	35.4	260
599	15.0	426
	34.3	501
601	17.0	272

The in situ values in Sites 597, 598, and 601 are very close, but in Site 599 much higher concentrations are reached. Dissolved silica concentrations usually are a strong function of local lithology so that large concentration differences over short intervals can occur. This is well demonstrated by the silica profile of Site 599 which shows a well developed maximum Most profiles in Figure 92-6 yield concentrations of about 270 µm at a depth of 1.5 m, which would mean an in situ concentration of about 180 µm which is about 55 µm above bottom water values. Below this, however, concentrations rise in a variable manner, presumably as a result of local changes in sediment lithology. These lithologic changes are not readily detected, although in Site 599 the changes in dissolved silica are very substantial.

Conclusions

Studies of interstitial waters obtained along a transect of the East Pacific Rise west flank at about 19°S (Sites 597 through 602) have revealed:

1. Major constituents of interstitial waters show little change in concentration with depth:

a) Potassium: no change;

b) Magnesium: no change or very small depletions with depth, usually less than 2% with the possible exception of Site 601, in which depletions might be as large as 6% or about 3 mM at the base of the sediment column (20 m);

c) Calcium: shows consistent increases in concentration with depth, amounting to as much as 1 mM or 10% (Site 599). These increases can be understood best in terms of carbonate dissolution and/or carbonate diagenesis. No "basement signal" (i.e. diffusion from underlying basalts) is apparent, with the possible exception of Site 601.

2. Nutrient components, nitrate and ammonia indicate variability in their distribution, with metabolic activity varying from site to site and resulting in slight maxima in nitrate and slightly higher ammonia concentrations in near surface sediments.

3. Dissolved silica profiles show generally complex patterns, related to small changes in lithology (clay, glass contents), with Site 599 showing high values compared to the other sites. Concentrations obtained by in situ sampling techniques show concentration in excess of 250 µm below about 10 m in all sites where in situ data have been gathered.

4. None of the studies carried out during Leg 92 show evidence for advection of fluids through the sediment column.

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Leg 93
U.S. East Coast Continental Rise

Leg 93 began 4 May 1983 and ended 17 June 1983 in Norfolk, Virginia.

Objective

The objective of the leg was to continuously core and sample basement and the entire Jurassic-Recent sections of the lower continental rise and the Maestrichtian-Recent section of the upper rise. All drilling capabilities of the Glomar Challenger (rotary coring, reentry cone, hydraulic piston coring, extended core barrel) were to be used to meet this objective.

The main scientific objectives were:

- to correlate oceanic and continental margin stratigraphy;

- to calibrate the seismic reflection stratigraphy;

- to unravel the history of depositional processes on the rise, and especially

- to determine the age, nature and depositional environment of the oldest (Callovian) sediment on normal oceanic basement;

- to determine the age and nature of the Jurassic oceanic crust.

Six holes were drilled at three DSDP sites on the continental rise off the U.S. East Coast: 603, 604 and 605. (Fig. 93-1, Table 93-1).

The basement target was not reached for the drill string failed and the reentry hole (603B) terminated at 1585.2 m in Valanginian limestone, 60 m above Reflection Horizon J1 and 240 m above basement.

Highlights of Leg 93

- The discovery of a Lower Cretaceous sandy turbidite fan complex in the lower continental rise.

- The recovery of a complete upper Maestrichtian-middle Eocene section, including the Cretaceous/Tertiary boundary.

- The correlation and age determination of widely used oceanic reflection horizons and continental margin seismic sequence boundaries;

- The dating of the onset of the Western Boundary Undercurrent (13 Ma) and of the Labrador Current (49 to 50 Ma).

Site 603, Lower Continental Rise

Site 603 consisted of three holes drilled in 4634-4639 m of water on the lower continental rise 270 mi. east of Cape Hatteras, North Carolina. The principal objectives were to:

1) Sample and identify the several prominent seismic reflectors in the Mesozoic and Cenozoic sedimentary section (β, A*, A^U, and X).

2) Sample the upper sedimentary section via hydraulic piston corer (HPC) to understand active current-controlled depositional processes which predominated in the area during the late Cenozoic.

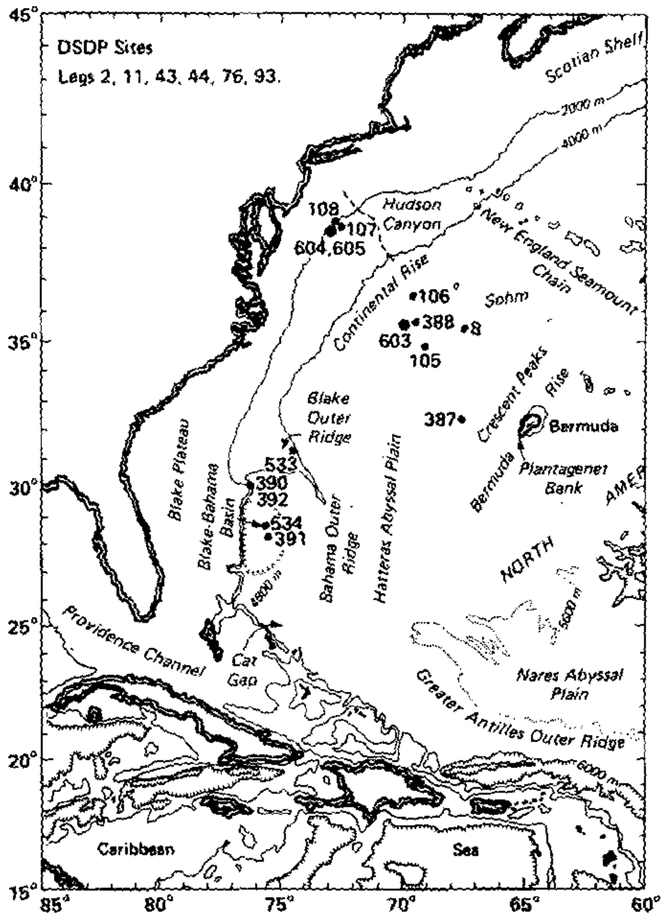

Figure 1. Location map with physiographic features of the North American Basin and location of DSDP sites. Bathymetry after Uchupi, 1971.

Table 1. Leg 93 coring summary.

HOLE	DATES (1983)	LATITUDE	LONGITUDE	WATER DEPTH*	PENETRATION	NO OF. CORES	METERS CORED	METERS RECOVERED	PERCENT OF RECOVERY
603	5-11 May	35°29.66'N	70°01.70'W	4634.00 m	832.6 m	41 (13)	393.0	226.38	58
603A	11-12 May	35°29.69'N	70°01.69'W	4633.00 m	0.0 m	0	0.0	0.00	0
603B	12-31 May	35°29.71'N	70°01.71'W	4642.50 m	1585.2 m	75 (8)	683.6	484.44	71
603C	31 May-6 June	35°29.78'N	70°01.86'W	4639.50 m	366.0 m	40	366.0	314.44	86
604	8-10 June	38°42.79'N	72°32.95'W	2364.00 m	294.5 m	31	294.5	117.58	40
604A	10 June	38°43.08'N	72°33.64'W	2340.00 m	284.4 m	4 (1)	34.8	2.17	6
605	11-17 June	38°44.53'N	72°36.55'W	2197.00 m	816.7 m	70 (1)	662.4	532.08	80
						261 (23)	2434.3	1677.09	69

3) Sample the oldest sediments deposited on oceanic crust at a location landward of nearby DSDP Stie 105 where Upper Jurassic sediments had been cored over a prominent basement high.

4) Sample basement.

Operations

The sediments were sampled in three phases. First, an exploratory hole (Hole 603) was washed and spot cored through Cenozoic sediments down to 573 m, continuously cored to 803 m, then washed and rotary cored to 833 m. Next, an attempt was made to set a reentry cone in Hole 603A. This cone, however, was lost when the unlatching mechanism failed to release the cone form the drill string, and the reentry assembly had to be jettisoned. No sediment was recovered from this hole The next attempt to set a cone was successful, and reentry Hole 603B was then washed and drilled down to 821 m, wash and rotary cored over short intervals to 927 m, then continuously cored to a total depth of 1585.2 m. The hole and the last core were lost just 240 m short of our basement objective when the drill string parted at the kelly cock sub (a blowout prevention link just below the power sub at the top of the drill string). Following that mishap, Hole 603C was continuously cored from the surface via HPC down to 91 m, and then via extended core barrel (XCB) down to 366 m where the hole was terminated to allow time to drill the remaining sites on the leg.

Despite the accident at Hole 603B which robbed us of our final objective (sampling Jurassic strata and the underlying oceanic basement), and excellent lower Pleistocene to Lower Cretaceous sections was obtained with outstanding recovery. The 1025.26 m of total sediment recovery is a DSDP record for any one site. This has allowed us to identify and date important seismic reflection horizons and to charaterize Mesozoic and late Cenozoic sedimentation along this passive margin at the interface between continental and deep-sea environments. The major discovery was the coring of a deep-sea fan complex within the Lower Cretaceous, described below.

Stratigraphy

The lithologic units penetrated at Site 603 between 0 and 1576 m subbottom are outlined in Table 2 and depicted in Figure 2. Despite facies differences due to the influx of terrigenous sediments from the nearby continent, correlations can be made between these units and the oceanic formations proposed for the North American Basin by Jansa et al. (1969). In descending order, these units and their correlations are:

Unit I: 960 m of lower Pleistocene-middle Miocene hemipelagic clay and claystone (Blake Ridge Formation).

Unit I is subdivided on the basis of lithology and color into four subunits. The dark green clays of Subunit IA contain nannofossils and planktonic foraminifers deposited above the calcium compensation depth. Greenish gray clays of Subunits IB and IC are largely devoid of calcareous microfossils except for the more dissolution resistant discoasters. Subunit IC contains radiolarians in some numbers at selected intervals as well as the first unambiguous evidence of sporadic silt and sand turbidites below 827 m. In contrast to the

Table 2. Site 603 lithostratigraphy.

UNIT	LITHOLOGY	CORES	SUBBOTTOM DEPTH M	AGE
I	Hemipelagic Clay/Claystone	603-1 to 603-54,CC 603B-1 to 15-4, 45 cm 603C-1 to 40,CC	0-960.75 (603B)	Pleistocene-middle Miocene
I A	Nannofossil-Bearing Clay/Claystone	603-1 to 603-19,CC 603B-1 to 603B-2,CC 603C-1 to 40,CC	0-419.8/448.6 (603)	Pleistocene-early Pliocene/late Miocene
I B	Quartz-Mica-Bearing Claystone	603-20 to 603-41,CC 603B-3 to 603B-4-5	419.8/448.6- 698.2 (603)	early Pliocene/ late Miocene- middle Miocene
I C	Biogenic Silica-Bearing Clay/Claystone and Silt-Bearing or Silt-Rich Claystone	603-42 to 603-54,CC 603B-4-5 to 14-3, 65 cm	698.2 (603)- 949.85 (603B)	middle Miocene
I D	Silt-Rich Claystone	603B-14-3, 65 cm to 15-4, 45 cm	949.85- 960.75	middle Miocene?- Eocene?
II	Radiolarian Claystone	603B-15-4, 45 cm to 22-2, 68 cm	960.75- 1022.78	Eocene
III	Variegated Claystone	603B-22-2, 68 cm to 33-1, 60 cm	1028.78- 1119.1	late Turonian- Campanian (?early Paleogene?)
III A	Variegated Claystone without carbonaceous claystone	603B-22-2, 68 cm to 23,CC	1022.78- 1038.6	
III B	Variegated Claystone (with greenish gray mostly >reddish brown) and some carbonaceous claystone	603B-24 to 29-2	1038.6- 1083.8	
IIIC	Variegated Claystone (with reddish brown >greenish gray) and no carbonaceous claystone	603B-29-3 to 33-1, 60 cm	1083.8- 1119.1	
IV	Black Carbonaceous Claystone	603B-33-1, 60 cm to 44-1, 32 cm	1119.1- 1214.72	(?Barremian) Aptian-Albian
IV A	Black carbonaceous and pelagic greenish gray clasystones, lacking any reddish brown color	603B-33-1, 60 cm to 38-2	1119.1- 1166.5	
IV B	Less black carbonaceous, more pelagic (greenish gray and reddish brown) claystone	603B-38-3 to 41-4	1166.5- 1196.5	
IV C	Black carbonaceous and pelagic (greenish gray only claystones)	603B-41-5 to 42,CC	1196.5- 1204.8	
IV D	Pelagic greenish gray, reddish brown and less black carbonaceous claystone.	603B-43-1 to 44-1, 32 cm	1204.8- 1214.72	
V	Interbedded Laminated Marl and Bioturbated Limestone with Sandstone to Claystone Turbidites	603B-44-1, 32 cm to 82,CC	1214.72- 1576.2	Barremian- Valanginian
V A	As above with the turbidites	603B-44-1, 32 cm to 76-1, 120 cm	1214.7-1512.3	Barremian- Valanginian
V B	As above without the turbidites	603B-76-1, 120 cm to 603B-82,CC	1512.3-1576.2	Valanginian to Berriasian?

Table 3. Site 604 lithostratigraphy.

	LITHOLOGY	CORES	SUB-BOTTOM DEPTH (m)	AGE
I	Gray to dark greenish gray. Alternations of clay and silt.	604-1 to -10-1, 7 cm	0.0- 84.0	Pleistocene
IA	Interbedded clay and silt layers.	604-1 to -5, 0 cm	0.0-35.3	
IB	Gray and dark greenish gray clay and silt with slump structures.	604-5, 0 cm to -10-1, 7 cm	35.3-84.0	
II	Greenish gray clay with glauconite-rich intervals and variable amounts of biogenic silica.	604-10, 7 cm to -26-2, 46 cm	84.0-238.9	early Pleistocene - latest Miocene
IIA	Greenish gray clay with glauconite-rich sand and and biogenic silica.	604-10-1, 7 cm through -13,CC.	84.0-121.7	
IIB	Greenish gray clay with glauconite-rich sand.	604-14 through -19,CC.	121.7-179.3	
IIC	Greenish gray clay with biogenic silica.	604-20 through -24,CC.	179.3-227.3	
IID	Greenish gray clay with glauconite-rich sand and biogenic silica.	604-25 through -26-2, 46 cm.	227.3-238.9	
III	Glauconite- and biogenic silica-rich silty claystone and conglomerates.	604-26-2, 46 cm to -31 and 604A-2 through -4,CC.	238.9-294.5	late Miocene

Table 4. Site 605 lithostratigraphy.

UNIT	LITHOLOGY	CORES	SUB-BOTTOM DEPTH (m)	THICKNESS	AGE
I	Gray silt-rich clay.	605-1 to 6-4, 125 cm	0 -198.00	198.0	Pleistocene
II	Green biogenic silica-bearing calcareous-rich clay.	605-6-4, 125-149 cm	198.00-198.14	0.14	late Pliocene
III	Greenish-gray biogenic silica-rich nannofossil chalk.	605-6-4, 149 cm to -22-3, 50 cm.	198.14-350.00	ca. 152	lower middle Eocene
IV	Greenish-gray nannofossil limestone with varying amounts of foraminiferids and calcified radiolarians.	605-22-3, 50 cm to 44-5, 33 cm	350.00-564.00	214	upper early Eocene
V	Dark greenish-gray clay-rich to clayey nannofossil limestone (marl).	605-44-5, 33 cm to -64-1, 54 cm.	564.00-740.00	184	late Paleocene
VI	Olive gray, silt-rich or foraminifer-rich, clayey nannofossil limestone.	605-64-1, 54 cm through -71,CC	740.00-816.70	77	early Paleocene to middle Maestrichtian
VIA	Dark greenish gray, glauconite-bearing and silt-rich nannofossil clayey limestone.	605-64-1, 54 cm to -66-1, 120 cm.	740.40-760.20	19.8	Paleocene
VIB	Olive gray, clay-rich foraminifer-nannofossil limestone.	605-66-1, 120 cm to -71,CC	760.20-816.70	56.5	Maestrichtian

green clays above, Subunit ID is composed of barren yellowish brown to brown clays.

Unit II: 63 m of variegated Eocene radiolarian claystone (Blake Ridge or Bermuda Rise Formation).

This unit is extremely colorful at the top, with hues ranging from pale green, grayish green, reddish brown, yellow-brown, to pale orange. Radiolarian content varies from 50% to less than 10%. Incipient diagenesis has converted some of the biogenic opal to opal-CT, but not in quantities exceeding 50% of the rock, therefore the sediment is not a procellanitic "chert" in the strict sense. A lithium spike noted in interstitial water samples may be due to the dissolution of biogenic opal.

Unit III: 97 m of Conician-Campanian (early Paleogene?) variegated claystone (Plantagenet Formation).

This unit is subdivided into three subunits based on the presence or absence of dark gray carbonaceous claystone. These organic-rich clays first appeared in Subunit IIIB and were subsequently encountered in each of the underlying lithologic units (Units IV and V) as well. Carbonaceous claystones are not present in sediments from Subunit IIIA or IIIC. Nearly all cores of Unit III contain 1-10% terrigenous silt and sand. Considered turbiditic in origin, these are also found in all underlying lithologic units. This landward locality, however, is the only DSDP site in which terrigenous clastics have been reported from the Plantagenet Formation.

Unit IV: 106 m of Aptian-Albian (Barremian?) black carbonaceous claystones (Hatteras Formation).

This unit is subdivided on the occurrence or relative abundance of pelagic reddish brown claystones which are present in Subunits IVB and IVD. This unit contains the highest concentration of "black shales" (carbonaceous claystones) in the section. Organic carbon contents, which range from 4.1 to 13.6% in these rocks, are the highest yet reported from the North American basin. Sharp basal contacts and graded silts at the bases of the black claystones suggest that they were emplaced as mud turbidites.

Unit V: 261 m of Valanginian-Barremian interbedded nannofossil clays and limestones with sandstone to claystone turbidites (Blake-Bahama Formation).

This unit is distinguished from Unit IV by the presence of abundant calcareous nannofossils. It is subdivided into two units based on the presence or basence of turbidites. Unit VA is characterized by abundant claystone, siltstone, and sandstone turbidites. These are of two main types: siltstone-sandstone and organic matter-rich claystone. The presence of intermediate types and complete sandstone to claystone graded sequences indicate that the two textural types are related. Unit VB is composed of in situ pelagic carbonates which consist of alterations of laminated and bioturbated nannofossil chalks and limestones. These lithologies also occur in Unit VA.

Depositional History

Better than at any other site yet drilled on the North American passive margin, Site 603 records the interplay between allochthonous and pelagic sedimentation at the juncture where continental and deep ocean realms meet. Over the 130 Ma of time represented by the section, the largely continuous, quiescent background of hemipelagic and pelagic sedimentation was interrupted by pulses ranging from light touches to violent bursts of turbidites. Only in its latter history did the influence of bottom currents become the dominant force in shaping the character of the sedimentary deposits.

The oldest sediments (Valanginian) recovered at Site 603 are characterized by carbonate cycles consisting of laminated marls that alternate with well bioturbated homogenous chalks and limestones. These represent alternating periods of oxic and anoxic bottom conditions, respectively, perhaps caused by periodic changes in the intensity of ocean circulation, upwelling, and oxygen replenishment in the otherwise narrow, restricted incipient North Atlantic ocean basin. This pelagic sequence is first interrupted in the upper Valanginian by organic-rich claystone turbidites which contain exceptionally well preserved calcareous nannofossils probably derived from the slope or upper rise where deposition was taking place within a broad oxygen minimum zone. Whole ammonites from unsplit cores provide additional biostratigraphic control for this part of the section.

Silt and sandstone turbidites appear in the upper Hauterivian, reaching a peak in the Barremian, then continuing intermittently into the Senonian (Unit III). Over a 218 m interval (Unit VA), they comprise about 47% of the section. Largely unconsolidated terrigenous sands (disturbed by drilling) constitute nearly all of the recovered sediment from Cores

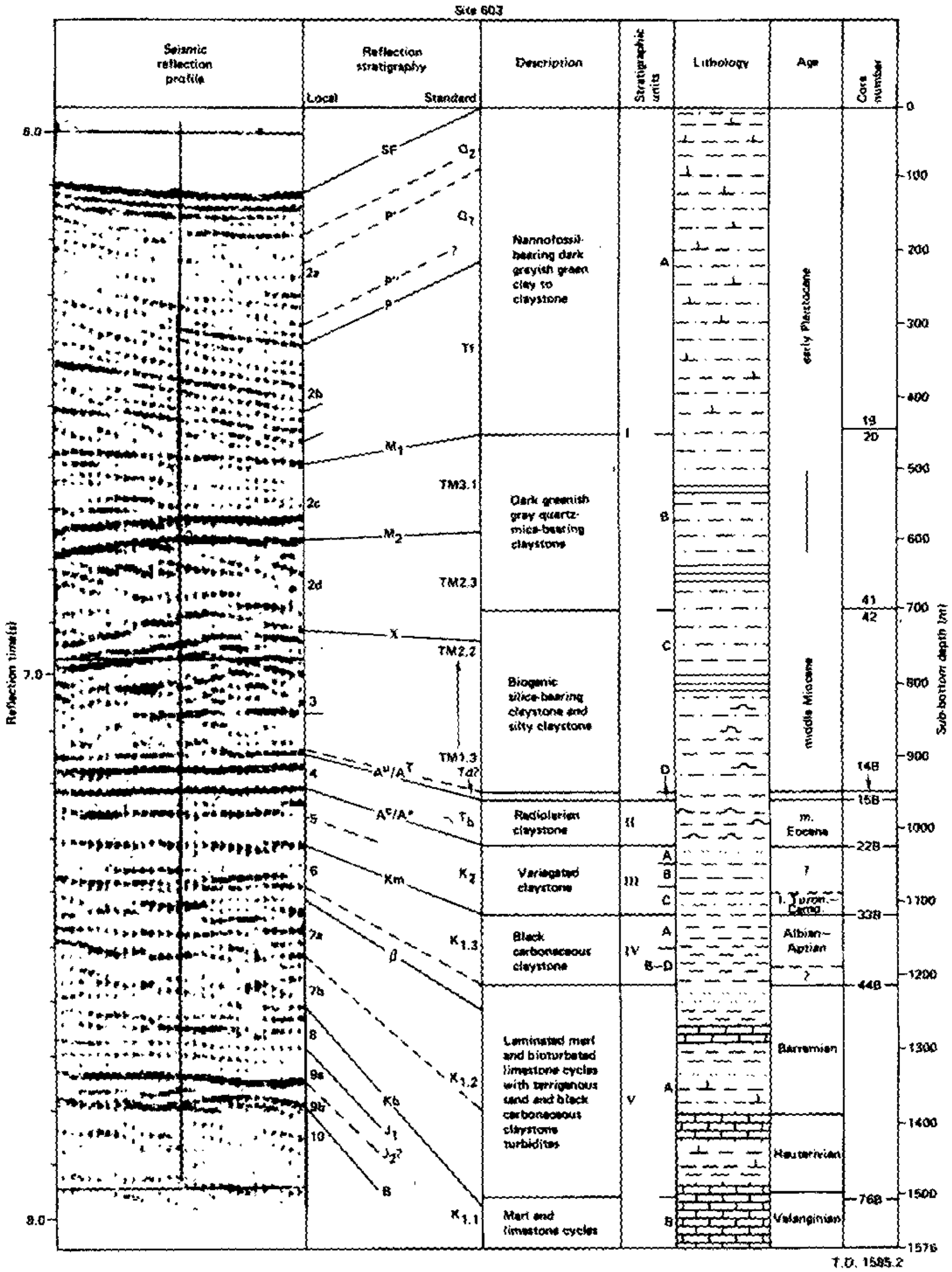

Figure 2a. Stratigraphic summary of Site 603 (Holes 603A, 603B, 603C). Units I-V are local lithostratigraphic units. Standard seismic sequence notation after Vail, et al., 1979.

603B-45 to -48 (39 m). Below that interval, individual turbidites range up to 2 m in thickness and are dominated by subangular quartz with abundant feldspar, mica, heavy minerals, opaques, wood fragments (locally up to 20%), glauconite and shallow-water bioclastics. They exhibit the entire range of Bouma textures with the basal sequences dominant (Ta to Tc). Included are intraclast-rich deris flows that contain plastically-deformed blocks of pelagic sediments up to 25cm across. Interbedded with the sand turbidites are the black claystone turbidites and intervals of pelagic chalks or limesones. Apparently Hole 603B intersected a complex of one or more deep-sea fans which perhaps form part of an apron of clastic-rich sediments of this age along the lower continental margin of eastern North America.

At the end of Unit V deposition, the CCD shoaled rapidly as witnessed by the abrupt loss of calcareous nanofossils. This change, which left the section depleted in carbonate, was predicted rather precisely by plotting Site 603 on the CCD-subsidence curve drawn up by DSDP Leg 43 scientists. During the Albian, at the end of Unit V deposition, brief fleeting blooms of calcareous nannofossils represented only by the genus Nannoconus suggest highly restricted surface water environments at the peak of "black Shale" (carbonaceous claystone) deposition (Subunit IVA). The absence of benthic foraminifers in the black claystone turbidites suggests a greatly expanded oxygen minimum zone on the shelf and slope. Reddish lithologies and the absence of any organic matter at some intervals indicate that the deep basin environment was, at least at times (Subunits 4B and 4C), strongly oxidizing.

Dark carbonaceous turbidites continued into the overlying Senonian of Unit III. This lithology accumulated over a longer period of time (Hauterivian to mid Late Cretaceous) at this landward site than at any other DSDP site drilled to date.

Despite the occasional influx of sand, silt and mud turbidites, sedimentation during the Late Cretaceous was on 3 m/Ma, by far the lowest rate for the section. There may well

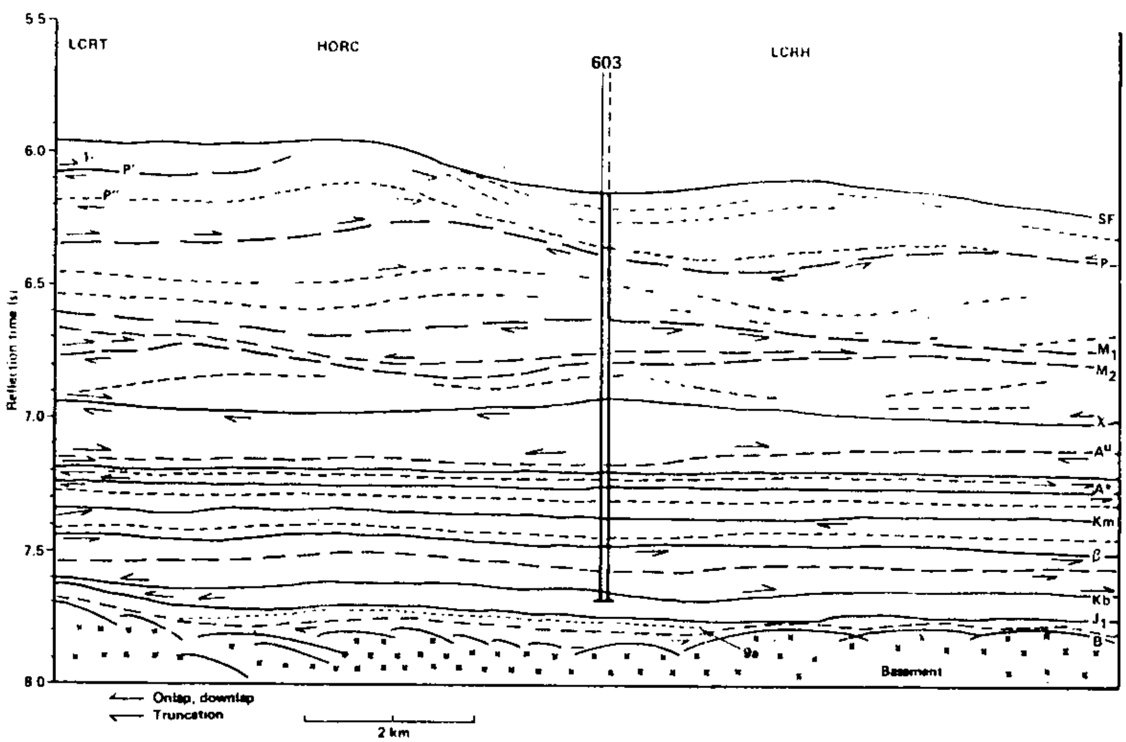

Figure 2b. Line drawing after multichannel seismic reflection profile Conrad 2101, Line 77. LCRT = Lower Continental Rise Terrace. HORC = Hatteras Outer Ridge Crest. LCRH = Lower Continental Rise Hills.

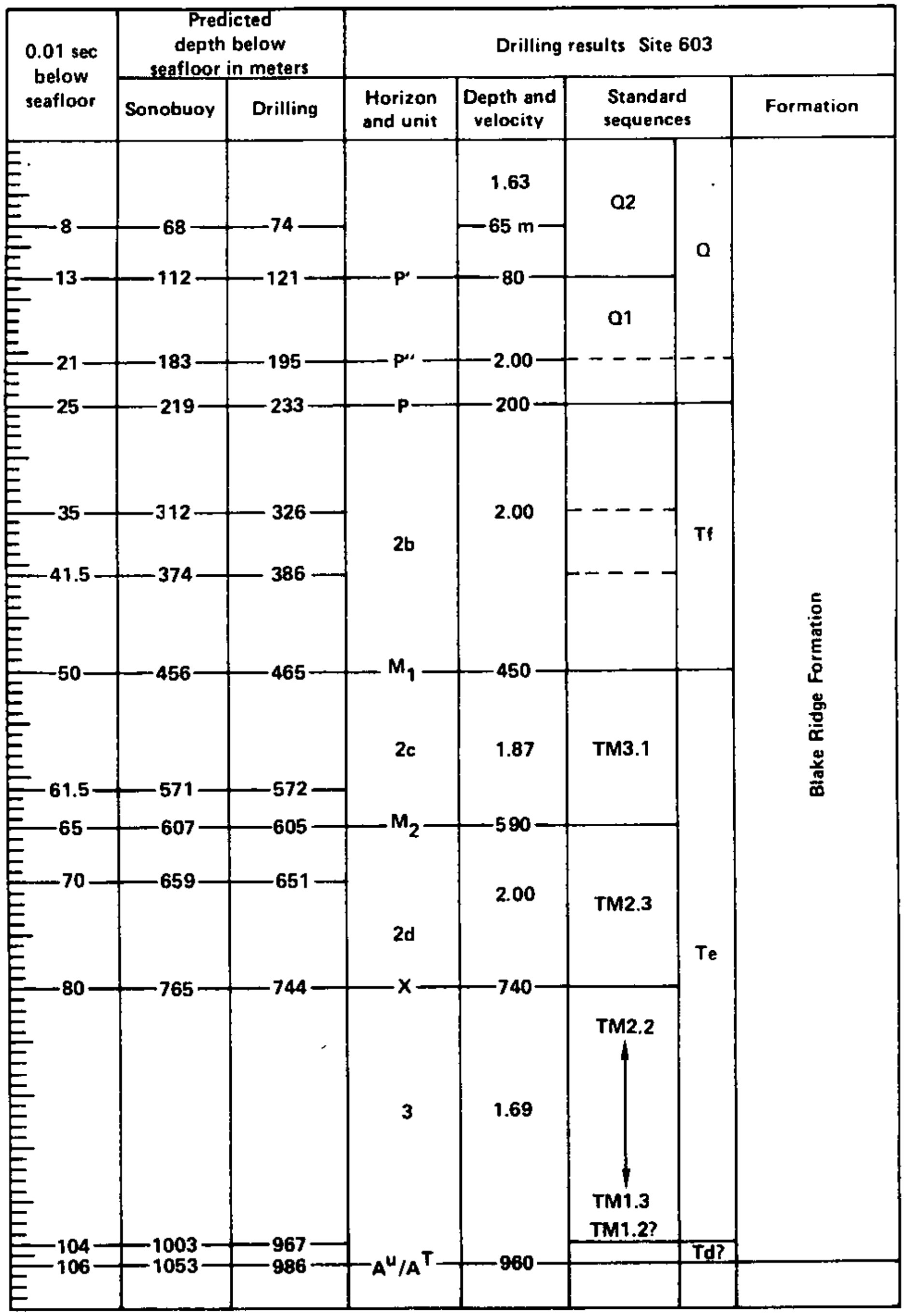

Figure 3. Interpretation of seismic stratigraphy using drilling results at Site 603. Standard sequences after Vail, et al. (1979), formation names after Jansa, et al. (1979).

be hiatuses in this part of the section which could not be detected due to the lack of microfossils. This period of sediment starvation was followed by the deposition of the mid-Eocene biosiliceous claystones of Unit II. The existence of this unit was another surprising discovery because it had long been concluded by some that sediments of this age were absent along the continental rise. Because the characteristic seismic reflector produced by Eocene cherts in the area (Horizon A^C) has not been detected in the vicinity of Site 603, it was assumed that all Eocene sediments had been swept from the lower continental margin by strong boundary currents active during the Oligocene. We attribute the lack of appreciable porcellanitic "chert" in Unit II to the strong dilution of the biogenic silica by clays, which tend to inhibit the conversion of biosiliceous material to opal-CT, causing the absence of the requsite lithology necessary to produce the high amplitude signature characteristic of Horizon A^C. Erosion along the A^u disconformity following Unit II deposition, however, accounts for the sharp contact between it and Unit I.

Dark hemipelagic clays and occasional sand or silt turbidites began to accumulate at a rapid rate during the (early?) middle Miocene, fed by the outflow of terrigenous material (including wood debris, mica, etc) from the slope. Generally flat-lying at first (Subunit IC), these sediments began to be shaped into large-scale (50 x 500 km) elongate "drift" deposits by the Western Boundary Undercurrent by the time Subunit IB was deposited. This marked the birth of the feature now called the Hatteras Outer Ridge (HOR). As the material was built up above the

0.01 sec below seafloor	Rredicted depth below seafloor in meters		Drilling results Site 603				
	Sonobuoy	Drilling	Horizon and unit	Depth and velocity	Standard sequences		Formation
							Blake Ridge
106.0	1053	986	A^u/A^T	960 m			
109.0	1088	1014	4	191		Tb	Unnamed
112.5	1129	1046	A^C/A^*	1022			
117.0	1181	1088	5	1.85		K2	Plantagenet formation
123.0	1253	1144	km	1119			
			6	2.26	K1.3		Hatteras formation
131.5	1355	1223		1215			
				2.80			unnamed
135.0	1398	1256	β	1264			
						K1	
143.0		1376	7	2.90	K1.2		Blake-Bahama Formation
153.0		1526	Kb	1525			
			8		K1.1		
				T. D. 1585.2 m			
161.0		1646	J_1				
			9a				
167.0		1736	J_2 (?)				
			9b				
173.0	1996	1826	B				

Figure 3. (cont'd.)

level of the CCD (which was falling at an increased rate by the end of middle Miocene times), appreciable numbers of calcareous microfossils began to accumulate, the first since the site passed beneath the CCD during the Barremian.

It is suggested that a relatively constant bottom current and an input of fine clays from the margin led to the formation of antidune-like sediment waves which grew until at least early Pleistocene times to form the Lower Continental Rise Hills. the crest of the HOR grew apace, forming a dam behind which coarse terrigenous turbidites have been ponded, particularly during the Pleistocene (DSDP Site 106). Remarkably, no coarse clastics bypassing the pond have been deposited with the clays of the HOR although our seismic analysis suggests that the two grew contemporaneously during the Pleistocene. As a result, sediments of the HOR are monotonously uniform in grain size, consisting only of "hemipelagic" clay. No sandy contourites are present in our section.

Seismic Stratigraphy

In analyzing seismic reflection profile Conrad 2101-77, we first identified sequence boundaries and the units they delineate, then recognized the internal reflection configuration (seismic facies) of the units. Most sequence boundaries correlate with "reflectors" of oceanic geophysical literature and could be named accordingly (Reflection Horizon X, Reflection Horizon A*, etc.). The sequence boundaries proved to correlate with (1) lithologic boundaries, and/or (2) biostratigraphic boundaries, and/or (3) changes in physical and chemical properties of the sediment, and/or (4) changes in drilling rate. Several reflection units correlate with regional formations (Jansa, et al., 1979). Most units can be interpreted in terms of standard seismic sequences (Vail, et al., 1980), which confirms the hypothesis of Vail, et al. (1980) that deep-sea reflection horizons are correlative with seismic sequence boundaries on the continental shelf and slope. The section at Site 603, however, does indicate

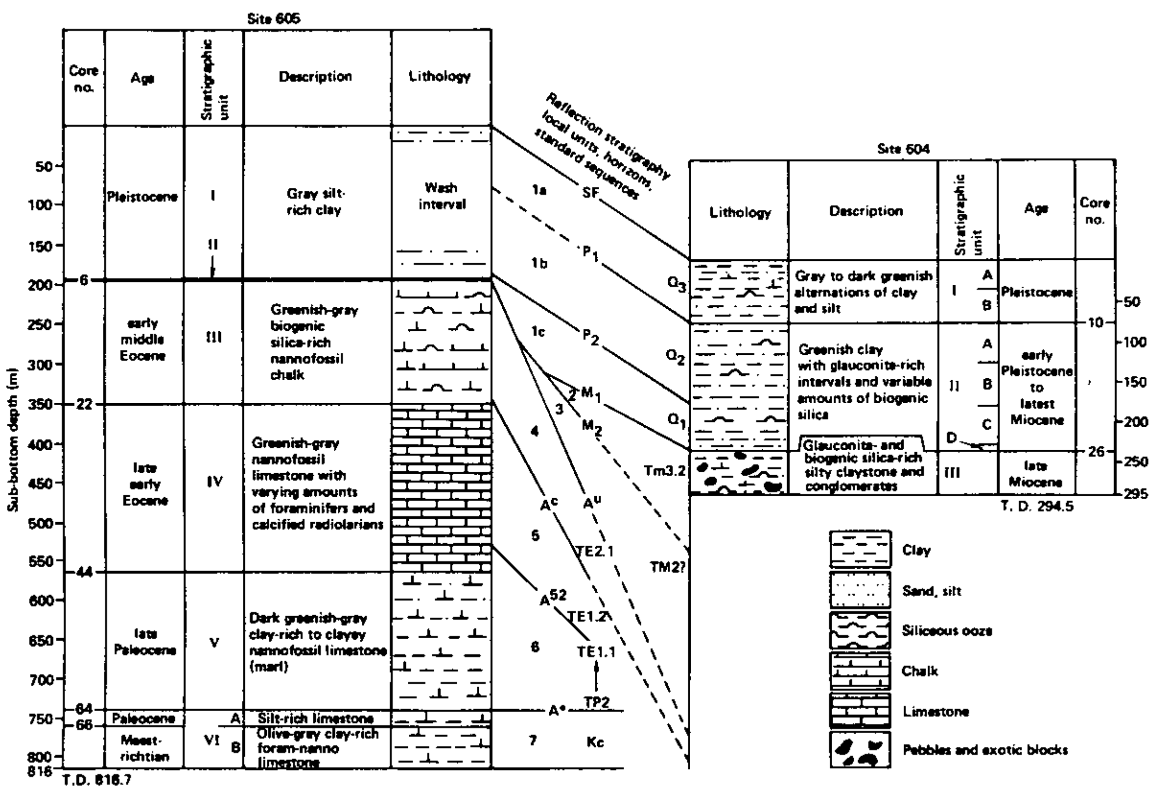

Figure 4a. Stratigraphic summary of Sites 604 and 605 (Holes 604, 604A, 605). Units I-III and I-VI are local lithostratigraphic units. Standard seismic sequence notation after Vail, et al., 1979.

that their preliminary approximations were slightly off for Horizons M and X, but confirms their approximate correlations of Horizons A^u and β. See Figures 93-2 and 93-3 for our preliminary interpretation.

The Lower Cretaceous "Cape Hatteras" Deep-Sea Fan Complex: Correlations, Significance and Implications

The intersection of a major Lower Cretaceous passive margin deep-sea fan complex consisting of up to 47% sand over a 218 m interval, came as a surprise. This possibility has only been hinted at speculatively in recent U.S. Geological Survey assessments of the petroleum potential of the eastern North American continental margin. No such sediments were found in rocks this age cored at DSDP Site 105 just 60 mi. southeast of Site 603. The only indication that such a deposit may have existed is given by the presence of coeval coarse turbidites at DSDP Sites 391 and 534 to the south (off the Bahama Banks). There, however, the turbidites consist mostly of redeposited carbonate whereas at Site 603 they are predominatly terrigenous sand. Interestingly, the deposition of deep-sea clastics at Sites 603, 391 and 534 coincides with a major progradation of terrestrial deltas along the adjacent continental shelf of the eastern seaboard of North America. A similar phenomenon has been recorded in the southern Wessex Basin of England (Wealden Beds).

Nevertheless, it has been widely accepted that during the Early Cretaceous between the Balanginian and mid-Barremian, (1) worldwide sea levels were progressively rising, and (2) an extensive reef complex developed along the outer continental shelf from Mexico to Nova Scotia. This reef system, plus the presumed rise in eustatic sea level, were thought to have effectively confined most terrigenous clastics to the inner continental shelf (particularly in depressions such as the Baltimore Canyon Trough ,e.g., Poag, 1980). Presumably little clastic material would have bypassed the reefs to the deep-sea environment.

Our results clearly show that large amounts of terrigenous sands did bypass the outer shelf. They were deposited interbedded with organic-rich claystones in deep-sea fan complexes along the continental rise and abyssal plain, later to be convered by younger deposits consisting predominantly of clays. Among other things, this demonstrates that many of the ingredients considered favorable for petroleum accumulation are present in this passsive margin, deep-sea environment.

The implications of the above are complex and will be dealt with further as our shore-based studies progress. At the outset, however, it is apparent that: (1) Large deep-sea fan complexes can be associated with older passive margin deep-sea environments. Large deep-sea fans are traditionally associated more with active margins or with Quaternary environments. (2) The continental rise environment of passive margins should no longer be neglected as potential petroleum provinces. (3) The assumption of a progressive worldwide sea level rise from the Hauterivian to the mid-Barremian should be reexamined in light of the outpouring of terrestrial clastics that occurred along the shelves and rises of the North American Atlantic margin. (4) The extent of Lower Cretaceous reef development should be reassessed, particularly considering the turbid water conditions which must have prevailed on the shelf during the period in question. Such conditions should have inhibited reef development. We question whether any significant reef development existed along the mid-eastern seaboard of the United States during this time. (5) Lateral and vertical sedimentary facies changes are far more rapid and complex beneath the continental rise than in the more seaward environments traditionally explored by deep-sea drilling. More deep penetration holes will be necessary to understand this important province at the interface between deep marine and continental environments.

Sites 604 and 605, Upper Continental Rise

Following the completion of Hole 603C, about nine operational days remained for the leg. On the advice of the JOIDES Planning Committee, we were directed to proceed to a site on the New Jersey transect, rather than to the seamount of Site NJ-8 which was originally planned. We were also asked to arrive 36 hr. earlier in port for reloading pipe and repairs.

The New Jersey Transect is to consist of four DSDP sites located along USGS multichannel line 25 which trends southeastward across the continental slope and rise. When completed on this and future legs, these sites can be joined with existing wells along the shelf to form a shelf-slope rise transect which can also be related to Site 603 on the lower continental rise. This would be the first comprehensive dipwise transect of an entire passive margin from the coastal plain to the abyssal plain. The chief scientific objectives of the overall study are:

1) to document the presence of

unconformities, and to determine their nature, correlation with seismic discontinuities, and relationships to sea-level fluctuations;

2) to examine the relationship between the faunal and lithic conpositions and the variable character of seismic sequences seen on line 25;

3) to describe and correlate litho- and biofacies sequentially along the transect, and

4) by virtue of the above, to document the upbuilding, outbuilding, and subsidence history of this passive margin.

Site 604 (= NJ-4 of the proposed New Jersey transect) was located in 2364 m of water on the uppermost continental rise, 100 mi. southeast of Atlantic City, New Jersey. As the seaward end-member of the New Jersey transect, the section here could be expected
to show the strongest influence of open marine conditions. Lithologies expected were Pliocene-Pleistocene clays and turbidite sands, lower Tertiary marls and oozes, mid-Miocene hemipelagic muds, Messinian slump and turbidies. Several strong reflectors and sequence boundaries, visible on the multichannel seismic profile, were used to predict the section (Fig. 83-4b). The profile showed the upper units wedging out updip against more continuous Eocene beds which were cored at Site 108 some 13 km to the north. The target depth was set at 1000 m, the presumed level of the Maestrichtian.

Operations

Operations reports from nearby Site 107 indicated that Pleistocene sediments in this area might be too stiff to penetrate to an appreciable depth with the HPC. Therefore, Site 604 was rotary drilled, continuously from the surface with fair core recovery but good hole conditions. At about 260 m sub-bottom depth, the drill encountered soft glauconitic sand in an upper Miocene debris flow. The sand began packing off and sticking to the bottom-hole assembly despite mud flushes and all attempts to stabilize the hole. Our copy of USGS seismic line 25 (photographically enlarged by the shipboard photographer from a journal reprint since no other copies were on board) indicated that the sand-bearing unit would continue another 150 m. Prospects of successfully deepening the hole appeared nil and the hole was abandoned.

On the reference profile the sandy unit appeared to pinch ouut rapidly to the northwest. An optimum relocation site was chosen about 2.5 km northwest of Site 604. The profile indicated that the sand body could be avoided at this location while all other target strata could be cored. Unfortunately, a move of 2.5 km was not technically feasible because positioning beacons on the only two usable operating frequencies had been dropped at Site 604. A move of at least 6 km would be necessary to avoid interference from the old beacons. The only option open, therefore, was for a second attempt to core Site 604 at a maximum offset from the old beacons. This would put us closer to the edge of the sandy unit which we hoped would be sufficiently thinned to avoid any significant hole problems. The vessel was consequently offset about 1.2 km northwest along the seismic line.

Hole 604A at a water depth of 2340 m was washed to 249.8 m and continuously cored thereafter. After three cores the bit again broke into upper Miocene sand which quickly packed off and stuck the pipe. Fifteen minutes were required to work the pipe free and another core was attempted after the hole had been cleaned and a mud flush circulated. After 6 m penetration the pipe became stuck again. Freeing it the second time was even more difficult, and it was apparent that the site was not drillable with Challenger's drilling system.

With the loss of Site 604, the scientific options for the leg became quite limited considering the mission and time remaining. We were now constrained to relocate west-northwest along the reference profile at least 6 km from the Site 604 beacons. However, the Miocene strata of interest (Reflection Unit 3) appeared to pinch out less than a kilometer past that point if not sooner. Within another 4 km, Eocene siliceous chalks cropped out which were too firm to be spudded. We therefore elected to try the minimum offset of 6 km and again set our target on the Maestrichtian which was thought to lie about 663 m.

Site 605 was spudded in 2197 m of water, washed to 154 m BSF. and continuously cored to 816.7 m. The hole was terminated after a 24-hr. cruise extension, which permitted us to core the Cretaceous/Tertiary boundary.

Stratigraphy

The lithologic units penetrated at Site 604 between 0 and 295 m are outlined in Table 93-3 and depicted in Figure 93-4. From top to bottom they are:

Unit I: 84 m of Holocene(?) to Pleistocene gray to dark greenish gray clays and silts in alternating sequences.

This unit contains some slumped or redeposited Eocene biosiliceous chalk in the upper 35 m (Subunit IA) and exhibits internal slump structures in the lower part (Subunit IB).

Unit II: 155 m of lower Pleistocene to upper Miocene greenish gray clay with variable amounts of glauconitic shelf sand turbidites and biogenic silica. This unit is divided into four subunits based on the presence or absence of sand and biogenic silica.

Unit III: 56 m of upper Miocene glauconitic, biosiliceous silty claystone, sand and conglomerate.

In this unit, the sands are inferred from the drilling characteristics. The conglomerates contain rounded quartz pebbles up to 1 cm long, clasts of claystone, chalk, and limestone up to 10 cm in diameter, and rare shell fragments. Elsewhere in the unit are found exotic blocks of nannofossil chalk up to 50 cm thick. These and the conglomerates appear to represent debris flows whereas some of the sands could be turbiditic.

Lithologic units penetrated at Site 605 between 0 and 816.7 m are outlined in Table 93-4 and are depicted in Figure 93-4. In descending order they are:

Unit I: 198 m of Pleistocene gray silt-rich clay.

Unit II: Pliocene(?) green biosiliceous and calcareous clay. This 30 cm unit is separated by a disconformity from the underlying unit and contains some reworked siliceous microfossils from that unit.

Unit III: 153 m of lower middle Eocene biosiliceous nannofossil chalk rich in radiolarians and diatoms.

Unit IV: 214 m of lower Eocene greenish gray nannofossil limestone with varying amounts of foraminifers and calcified radiolarians.

Unit V: 176 m of upper Paleocene dark greenish gray clayey nannofossil limestone (marl).

Unit VI: 77 m of lower Paleocene to middle Maestrichtian olive gray clayey limestone.

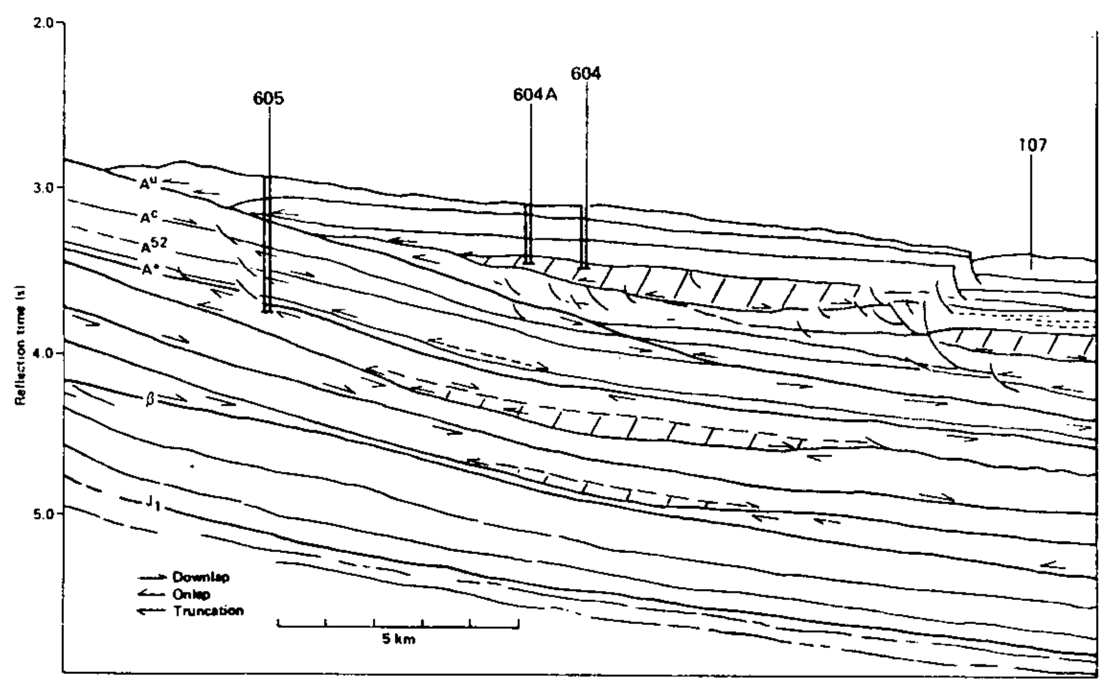

Figure 4b. Line drawing after multichannel seismic reflection profiles U.S. Geological Survey Line 25. Leg 93 holes and nearby DSDP Site 107 are shown.

All of the Paleogene to Maestrichtian units are strongly bioturbated. Preservation of trace fossils is excellent and several examples of whole Zoophycos burrows are noted. The preservation of siliceous and calcareous microfossils is generally good in Unit III (except for foraminifers), poor in Unit IV, and much improved in Units V and VI. Excellent recovery throughout most of the section, particularly the long (200 m) Paleocene interval, will allow detailed correlations of biozones with the magnetostratigraphy of the cores.

Depositional History

The oldest sediment cored at Sites 604 and 605 was middle to upper Maestrichtian clayey limestone (Hole 605, Subunit VIB). The terrigenous silt content of this material is quite low, averaging about 3% whereas the carbonate content is high, usually greater than 60%. It contains only trace amounts of glauconite. Going upsection we had reasonably complete recovery of a Cretaceous/Tertiary boundary sequence displayed in an expanded section. At the contact, the foraminiferal Globigerina eugubina Zone (P1A) and the coccolith Cruciplacolithus primus Zone (CP1A) overlie (respectively) the Abathomphalus mayaroensis and Nephrolithus frequens Zones. At that point begins an unusually thick (200 m) Paleocene section which, like the boundary sequence, is expanded due to the continental margin depositional setting.

Unlike the Maestrichtian limestone below, the earliest Danian sediments (Subunit VIA) show a marked rise in the percentage of terrigenous silt (15-20%) and glauconite (2-4%). Assuming that the silt and glauconite are shelf-derived, this may indicate a drop in sea level at the time of the Cretaceous/Tertiary boundary event or, alternatively, an increase in the velocities of the prevailing ocean currents. The silt and glauconite contents drop rapidly in the top of Subunit VIA where the lithology becomes a foraminifer-bearing nannofossil limestone. This rapid decline may reflect a subsequent sea level rise. The abundance of detrital material of Subunit VIA is high in comparison with the rest of the Maestrichtian-middle Eocene limestone column; it is also higher than at any other Paleogene time of low sea level. This suggests that the basal Tertiary sea level drop is short but much more severe than noted on the Vail, et al. (1979) curve. To some shipboard scientists this is a strong indication that the terminal Cretaceous asteroid impact did hit the ocean.

Marl-limestone cycles (shown by a faint to distinct color zonation) are well developed in Units IV and V, especially in Cores 605-51 to -55, and 605-58 to -62. Since carbonate dissolution at this shallow site would not have been a factor in the genesis of these cycles, their cause could have been (1) fluctuations in carbonate input related to productivity or, (2) fluctuations in the input of terrigenous clay which dilute the background of continuous carbonate sedimentation (sea level fluctuations, climate). Another type of cyclicity is manifested in Core 605-33 to -35 and -40 where intensely bioturbated and faintly laminated undisturbed horizons alternate. These cycles may represent fluctuations in bottom water oxygen contents.

In general, the Meastrichtian-Eocene sequence (lithologic Units II to VI) is heavily bioturbated, indicating a steady input of nutrients (either via surface producivity or terrestrial influx) into the sediments. Productivity in the overlying waters, however, increased dramatically beginning with Unit III deposition during the early middle Eocene as shown by the sharp increase in biosiliceous material (diatoms, radiolarians, silicoflagellates). Although this contrast may have been further accentuated by silica diagenesis, this is not likely to be a significant factor. The clay content drops markedly going into Unit III yet despite that, the biogenic opal is quite well preserved. A direct relationship between preservation and higher clay content might be expected if productivity were not the overriding factor. The cause for the enhanced productivity at the beginning of the middle Eocene may well have been upwelling associated with the incursion of the Labrador current into this area.

Because of drilling problems at Site 604, we obtained no direct information on the Oligocene-middle Miocene interval. Reworked upper Eocene and middle Miocene microfossils in the upper Miocene sediments of Site 604 indicate that those units are present in the area. To date, no reworked Oligocene material has been identified, and at Site 605 these sediments were missing. There, Pliocene sediments were separated from the middle Eocene by a pronounced disconformity which represents the A^u seismic reflection horizon.

The upper Miocene glauconitic, biosiliceous silty claystone, silt, sand and conglomerate with quartz pebbles and displaced blocks of middle Eocene chalk in Unit III (Hole 604) clearly represent debris and turbidite flows from upslope. The matrix of these materials, some of the most exotic obtained during the cruise, have been well dated as latest

Miocene. Their emplacement coincided with the Messinian Event when severe glaciations on the Antarctic continent (and possibly in the Arctic as well) apparently induced a significant eustatic sea level drop. Upper Miocene sediments are practically absent in offshore boreholes along the east coast of the United States and have not been identified in land outcrops of the coastal plain. During this period of lowered seal level, the shoreline migrated out to the shelf break where rivers spilled their loads. the debris flows and turbidites we drilled at Site 604 result from this period of deposition in an unstable shelf edge environment. Diatomaceous sediments associated with these deposits indicate further upwelling in this area, perhaps again related to incursions of the Labrador Current system. Glauconite sands, shallow water shell fragments, and occasional displaced Eocene material in Units I and II reflect further unstable sea level and current conditions into the Pliocene and Pleistocene, particularly in the latter epoch. Highly contorted and convolute patterns in the Pleistocene Subunit IB are interpreted as internal slump structures, features which indicate unstable slope conditions as well.

Seismic profile records and driling at Site 108 reveal large areas upslope where post-Eocene sediments have been removed by erosion and slumping. The incorporation of this material, along with middle Miocene microfossils, in the upper Miocene and Plio-Pleistocene indicates that denudation of the Eocene units was not limited to the Oligocene A^u Event.

Seismic Stratigraphy

Drilling at Site 604 and 605 was highly successful for delineating unconformities and calibrating the seismic straigraphy. A shipboard analysis of multichannel seismic reflection profile USGS line 25 (photographic enlargement of illustration in Klitgord and grow, 1980) served to predict the section to be drilled at Site 604. Our prediction for the upper section differed significantly from the prediction made by the USGS which was provided to us by telex. For the lower part of the section the two predictions largely agreed.

After Hole 604 had to be aborted, the same interpretation of line 25 used for Hole 604 was used to predict the section for Hole 604A. by that time we had received clearance from the JOIDES Safety Panel to drill beyond the Maestrichtian if time allowed, therefore the analysis of the seismic profile was optimistically extended to Reflection Horizon β at 1757 m. Hole 604A, however, also failed to penetrate past the upper Miocene, and a new site (605) had to be selected to drill Paleogene and older sediments. Again, a new prediction was made.

A total of ten reflection units and nine subunits were delineated for the section at Site 604 and 605. Units 8 through 10 have not been reached by the drill and will not be discussed. Figures 93-4a and 93-4b provide a summary of the results.

All units that were penetrated have been dated and can be related to supercycles and cycles of the "Global Cycles of Relative Sea Level" chart by Vail, et al. (1979), which was proven by the drilling at Sites 603, 604 and 605, to be a most valuable predictive tool. Because of excellent core recovery, we experct to ultimately have a most detailed magneto- and biostratigraphy to determine the ages of unconformities very precisely. It should also be possible to calculate the duration of hiatuses at the unconformities. For the Paleocene and Eocene the hiatuses will not exceeed a biozone; at first examination (core catcher samples only), the section appears complete and unconformities manifest themselves only as changes in sediment accumulation rates, observed lithologic changes and changes in drilling rate.

The cored sections at Sites 604 and 605 date oceanic reflection horizons A^c (52 Ma) and A* (60 Ma as was predicted by Vail, et al., 1980), and probably P (2.8 Ma) and M1 (5.2 Ma). Also P1 (0.7 Ma) and P2 (1.7 Ma) may prove to be regionally useful horizons. These results complement very well our findings at Site 603. The section drilled and sampled at Sites 604 and 605 will also help determine the age of all Eocene and Paleocene unconformities on the continental slope with great precision; it will document the Vail et al. (1979) cycle chart and possible refine its age assignments.

In general the drilling confirmed the shipboard prognosis of Reflection Units 1 and 2. The (lower) Pliocene probably is hardly present and Unit 1c may largely consists of "glacial" deposits (younger than 2.8 Ma; = upper Pliocene to lower Pleistocene). Further micropaleontological analysis of the samples will date this section precisely, although the abundance of reworked material could cause difficulties and discrepancies among the various disciplines. it is expected that the sequence interpretation (Q1, Q2, and Q3) will be further confirmed. Unit 2 did prove to be the "dump" of older and shallow water material that we predicted.

It is most unfortunate that all three attempts (Holes 604, 604A and 605) failed to sample reflection Unit 3, where a major disagreement exists between the USGS and the shipboard prognosis. The USGS expects the onlapping unit to be of Oligocene age, whereas we predict it to represent the middle Miocene high sea level stand. The presence of reworked middle Miocene and the absence of reworked Oligocene in Unit 2 strongly support the shipboard interpretation.

Reflection Units 4 through 7 represent an exceptionally complete middle Eocene to lower uper Meastrichtian section. Reflection Horizons A^c and A* were precisely dated in terms of nannofossil zones and, more broadly, by planktonic foraminiferal zones. The Paleocene proved to be 100 m thicker than expected. As a consequence, the erosional truncation which we expected at the Cretaceous/Tertiary boundary was in fact at the basal Thanetian and we had the good fortune to drill a complete K/T boundary section.

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Sediment Paleomagnetism Data Now Available

The sediment paleomagnetism data base contains shipboard paleomagnetic measurements taken by the discrete-sample spinner magnetometer, the alternating-field demagnetizer and the long-core spinner magnetometer. The file is restricted to paleomagnetic measurements of cores recovered by the hydraulic piston corer. The long-core spinner-magnetometer sediment-paleomagnetism file is complete with measurements from DSDP Legs 68, 70-72 and 75. Discrete-sample spinner magnetometer sediment-paleomagnetism data are available for DSDP Legs 71-73 and 75.

Address requests for these data to:

Donna Hawkins
Information Handling Group
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093
Tel: (714) 452-3526

DSDP Site Map Updated

Topography of the Oceans with Deep Sea Drilling Project sites now available through Leg 82. To request map contact:

Barbara J. Long
Information Handling Group
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093
Tel: (714) 452-3506

Shipboard Organic Geochemistry Guide/Handbook

Prepared by the JOIDES Advisory Panel on Organic Geochemistry, Berndt R. T. Simoneit, Chairman.

Copies available from:

Science Operations
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, CA 92093
Tel: (714) 452-3503

PLANNED CHALLENGER DRILLING

Leg 95 - New Jersey Transect

St. Johns, Newfoundland to Ft. Lauderdale, Florida, 21 August to 26 September 1983. Co-chief scientists: W. Poag and A. Watts.

Introduction

The Baltimore Canyon trough, which encompasses the coastal plain, continental shelf and continental slope of New Jersey (Fig. 95-1), is the most intensely studied sedimentary basin of the United States Atlantic margin. Outcrop and subsurface investigations of the coastal plain have been carried out since the early 1900's. Offshore studies began in the 1950's (e.g. Drake, et al., 1959) and have intensified since 1973 as a result of renewed interest in offshore petroleum leasing. Forty-one boreholes and numerous seafloor samples now provide a geologic basis for interpreting thousands of kilometers of seismic reflection profiles. Summaries of the structural and stratigraphic framework and depositional history have been published by Klitgord and Grow (1980), Schlee (1981) and Poag (in press). Thus, this margin was chosen as the location for the first marginwide transect to extend from the outcrop belt of the coastal plain (central New Jersey) to the lower continental rise. Sites 603, 604 and 605 were drilled during Leg 93 as the initial step in developing the rise segment of this transect (Fig. 95-1). The continuously cored sites proposed for Leg 95 provide a crucial link between the shelf sites and the rise sites. This leg will also complete sampling of the Lower Cretaceous, Jurassic and basement rocks at Site 603 (lower rise).

Data Base

The U.S. geological Survey and the Bundesanstalt fur Geowissenschaften and Rohstoffe (BGR) have collected more than 6,000 km of multichannel and 15,000 km of single channel, high-resolution seismic reflection profiles in the Baltimore Canyon trough region (Figs. 95-2, 95-3; Robb and Kirby, 1980; Schlee, 1981). An additional large number of lines has been collected by Lamont-Doherty Geological Observatory, Woods Hole Oceanographic Institution, and other institutions. These lines provide a dense network of seismostratigraphic sections along the New Jersey slope and rise.

Calibration of these profiles is provided by a series of boreholes. Sixteen wells in New Jersey (Olsson et al., 1980), four wells on the shelf and slope (Poag, in press) provide the principal geologic control (Fig. 95-1). Approximately 26 additional commercial wells have been released to the public domain but have not yet been analyzed (Fig. 95-1).

Seismic and borehole data have been integrated in a detailed analysis of U.S. Geological Survey. Line 25, which crosses the depocenter of the Baltimore Canyon trough, serves as the standard stratigraphic reference section for the New Jersey margin (Poag, in press). Four of the principal and alternate sites proposed for Leg 95 are located on or near Line 25 (as are DSDP Sites 108, 604 and 605) in order to maximize the accuracy of seismic correlations along the transect (Figs. 95-3 - 95-9).

Stratigraphic Framework and Depositional History of the New Jersey Margin

The Baltimore Canyon trough occupies approximately 200,000 km^2 of the continental shelf and slope between Cape Hatteras, North Carolina and Long Island, New York. Its depocenter lies seaward of Atlantic City, New Jersey, where more than 18 km of sedimentary fill is present. The bulk of these strata are of Jurassic age (more than 11 km maximum thickness). The Cretaceous and Cenozoic sections are each approximately 2 km thick at a maximum. The Leg 95 holes are designed to penetrate no deeper than the top of Campanian strata, thus only the Maestrichtian and younger stratigraphy is summarized here.

Maestrichtian Strata. Maestrichtian sediments have been identified in control wells and can be widely traced on seismic profiles in the area (Figs. 95-5 - 95-9). From a maximum thickness of 200 m beneath the outer shelf, Maestrichtian rocks thin to about 6 m at the present shoreline and to 24 m beneath the upper slope near proposed Site NJ-1A (Figs. 95-5, 95-7). The entire section has been thinned by a major erosive event that terminated Cretaceous deposition. The litho-facies range from gray, calcareous, glauconitic clay at the shoreline to dark brown-gray, calcareous, silty mudstone beneath the upper slope. Paleoenvironments range from inner sublittoral to upper bathyal.

Table 95-1. Proposed Leg 95 Sites.

Site	Priority	Coordinates	Water Depth (m)	Distance from Nearest Land (n.mi.)	Juris-diction	Penetration (m)	Objective
NJ-1A	Alt. 1	38°54'30"N 72°45'12"W	976	76	USA	730	Sample Pleistocene through middle Eocene sediments; date unconformities and seismic reflectors; determine paleoenvironments; identify lithofacies and biozones; document depositional sequences.
NJ-2	1	38°48'9"N 72°46.2"W	1500	80	Int'l	700	Sample Pleistocene through upper Campanian sediments. Other objectives as at NJ-1A.
NJ-10	Alt. 2	38°54'41.7"N 72°18'27.7"W	2442	91	USA	1200	Sample Miocene through Santonian-Coniacian sediments. Other objectives as at NJ-1A.
NJ-11	3	38°34'14.1"N 72°43'32.8"W	2524	91	USA	1040	Sample Pleistocene through upper Maestrichtian sediments. Other objectives as at NJ-1A.
ENA-3D	2	35°29.71'N 70°01.71'W	4634	265	Int'l	1840	Sample Jurassic sediments and basement. Determine age and nature of reflector J_1.

Uppermost Maestrichtian strata have not been identified in this region, having been eroded along with lower Paleocene strata prior to late Paleocene deposition.

Paleocene Strata. The late Paleocene ushered into the Baltimore Canyong trough a carbonate regime that lasted through the late Eocene. From a maximum thickness of 250 m, the upper Paleocene section thins to 47 m at the shoreline and to less than 50 m beneath the middle slope (Fig. 95-5). Paleocene strata thicken again downslope to about 200 m near the proposed location for Site NJ-11 (Fig. 95-9). The lithofacies range from glauconitic sands of inner sublittoral origin at the outcrop to white, chalky, bathal limstones beneath the slope and upper rise.

Eocene strata. Carbonate deposition continued during the Eocene at the same time that a major transgression brought outer sublittoral environments landward as far as the present shoreline. As much as 650 m of Eocene strata accumulated beneath the inner shelf. Beneath the present shoreline, the section consists of 110 m of light to dark greenish-gray, calcareous, glauconitic clay containing fragmental limestones (Manasquan Formation). Beneath the upper slope, calcareous claystone and chalk have been documented (Fig. 95-5). Resistant Eocene carbonates are exposed in a wide outcrop belt along the lower continental slope (Fig. 95-4; Robb et al., 1981a,b; 1983) where cores reveal white to light gray, clayey, biogenic oozes and nannofossil limestones containing radiolarians (e.g., DSDP Sites 108, 605). The late Eocene is incompletely represented on the shelf and upper slope because a major erosional episode took place near the Eocene/Oligocene boundary. However, a more complete Eocene section may be present beneath the upper rise near Site NJ-11 (Fig. 95-9).

Oligocene Strata. A siliciclastic depositional regime returned to the Baltimore Canyon trough during the Oligocene and has been maintained to the present. Early Oligocene rocks are missing over most of the shelf and upper slope, but are known at Site ASP-15 (near proposed Site NJ-2) where they comprise 9 to 40 m of gray, calcareous, glauconitic marl and clay (Figs. 95-5, 95-6).

Upper Oligocene strata, on the other hand, are widespread on the shelf and upper slope, reaching a maximum thickness of 200-250 m beneath the outer shelf. Approximately 15 m of Oligocene greensand is present near the shoreline and 91 m of light olive-gray, glauconitic clay is present beneath the upper slope (Fig. 95-5). The Oligocene section thins to a feather edge and may crop out on the

Table 95-2. Leg 95 Site Occupation Schedule.

Site	Location	Transit Time (days)	Time on Site (days)	Departure Date
DEPART	St. John's, Newfoundland	5		21 August 1983
NJ-2	38°48.9'N, 72°46.2'W	1	5	30 August 1983
ENA-3D	35°29.71'W, 70°1.71'W	1	16.5	17 September 1983
NJ-11	34°34'14.1"N, 72°43'32.8"N	5	3.5 (13 to TD)	22 September 1983
ARRIVE	Ft. Lauderdale, Florida			26 September 1983
		Alternate Sites		
NJ-1A	38°tr'30"N, 72°45'12"W		4	
NJ-10	38°54'41.7"N, 72°18'27.7"W		17.5	

lower slope. A thin Oligocene section may be present within the upper rise prism, but its presence awaits documentation by coring at Site NJ-11 (Fig. 95-9).

Miocene Strata. Miocene strata constitute the thickest Cenozoic sedimentary unit in the Baltimore Canyon trough. It consists of a series of prograding deltaic wedges that reach a maximum thickness of 1000 m near the shelf edge. Most of the unit is of middle Miocene age and several periods of erosion have reduced its original thickness. Miocene strata thin toward the coastline where about 100 m of glauconitic, micaceous, shelly, medium to coarse sand contains several beds of gray lignitic clay.

Downdip on the upper slope, 364 m of lower, middle and upper Miocene strata comprise chiefly glauconitic, micaceous, organic rich silty clays and traces of glauconitic sandstone (Fig. 95-5). Farther down the slope the Miocene section is exposed at the seafloor (Fig. 95-4). Miocene strata are absent from the wide Eocene outcrop belt, but are present in the thick wedge of upper rise channel-fill at Site 604. They thin over the interchannel ridge beneath proposed Site NJ-11 (Fig. 95-9).

The chiefly middle Miocene sands, silts and clays are unusually enriched in biogenic silica at the expense of calcareous microfossils. Poag (in press) has concluded that nutrient

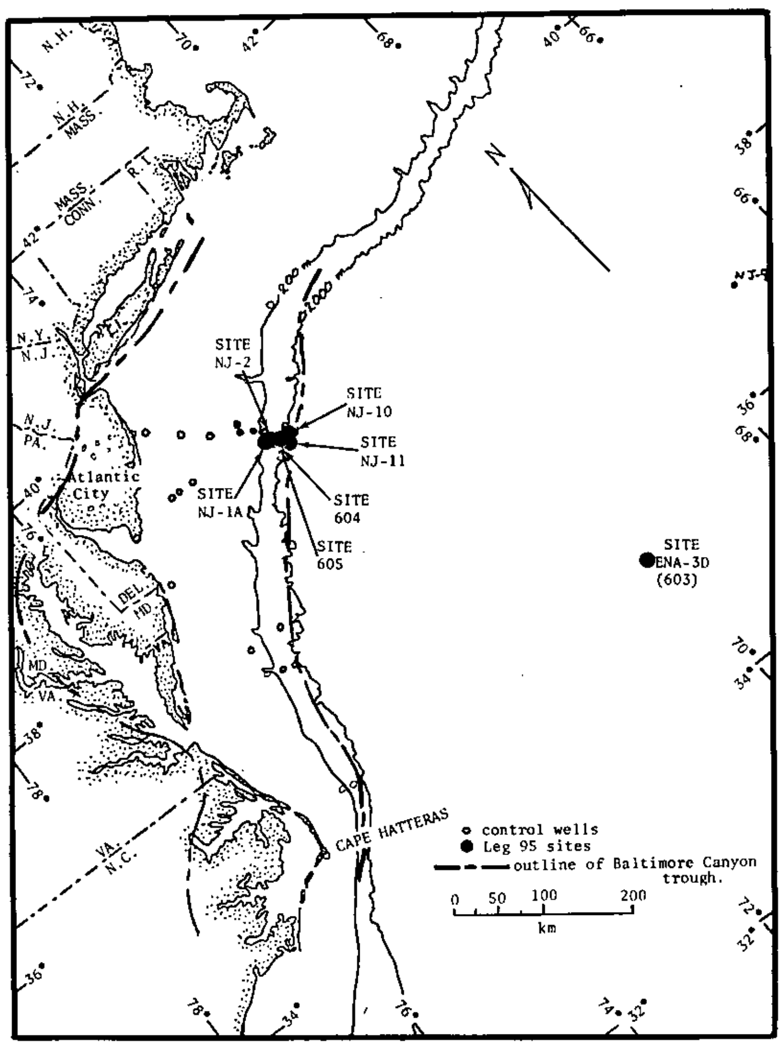


Figure 95-1. Location map of chief control wells and proposed Leg 95 sites.

enrichment due to upwelling and deltaic sources combined to create a highly productive photic zone on the margin during the Miocene.

Pliocene Strata. Pliocene rocks in the Baltimore Canyon trough are only tentatively identified and of limited distribution. The maximum thickness of presumed Pliocene strata on the upper slope is around 200 m (Fig. 95-5). Pliocene strata are not documented under the New Jersey coastal plain, but a few planktonic foraminifera and radiolarians of Pliocene age have been reported from the COST B-3 well (Poag, in press). Pliocene strata were encountered (70 m) beneath the upper rise in Hole 604 and are expected as a thinner section at proposed Site NJ-11 (Fig. 95-9).

Pleistocene Strata. The surface sediments of the Baltimore Canyon trough are part of a prism of chiefly Pleistocene strata that thickens to more than 400 m near the shelf edge (Fig. 95-5). From there, the Pleistocene strata thin rapidly to a pinchout along the shoreward edge of the continental slope outcrop belt (Fig. 95-4). A thin layer of Pleistocene ooze covers large patches of near-surface Miocene and Eocene beds in the outcrop belt and a thick wedge of Pleistocene strata constitutes the younger beds of the upper rise (150 m at Site 604; Sig. 95-9). A characteristic feature of the surficial bathal Pleistocene strata is the common presence of displaced shelf-type benthic microfossils.

Unconformities

Poag (1980; 1982a,b; in press) and Poag and Schlee (in press) have discussed the widespread and frequent occurrence of stratigraphic gaps in the sedimentary basins of the Atlantic offshore region, including the Baltimore Canyon trough. In the boreholes, the presence and duration of hiatuses have been documented by the absence of biostratigraphic zones. Seismic sequence analysis also reveals

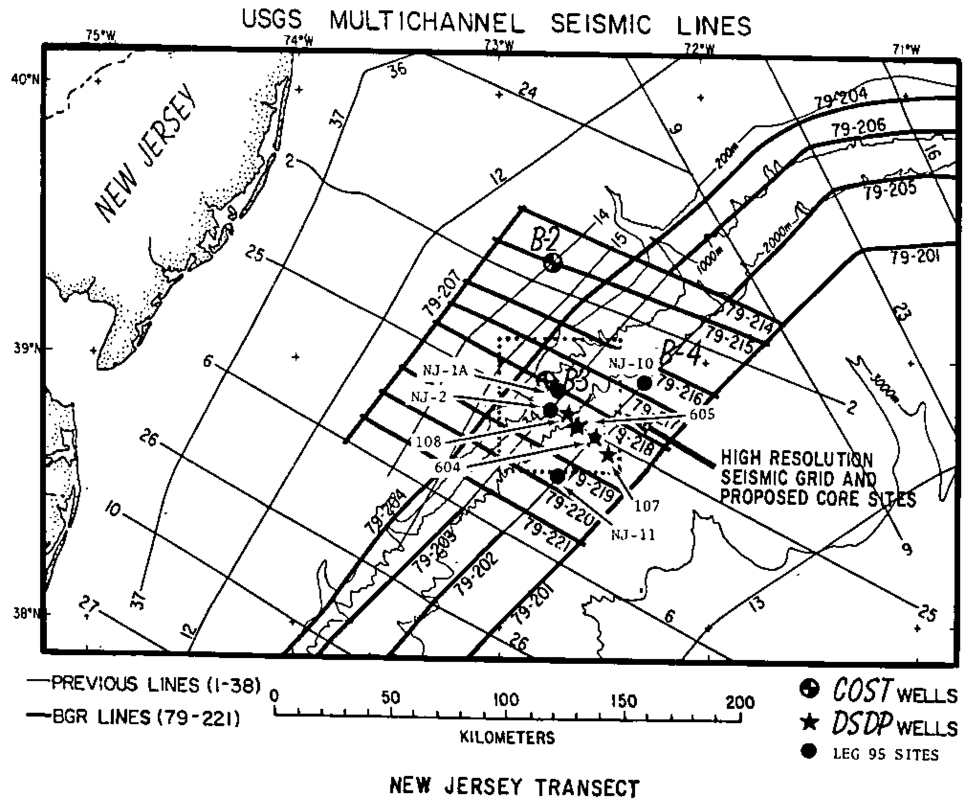


Figure 95-2.

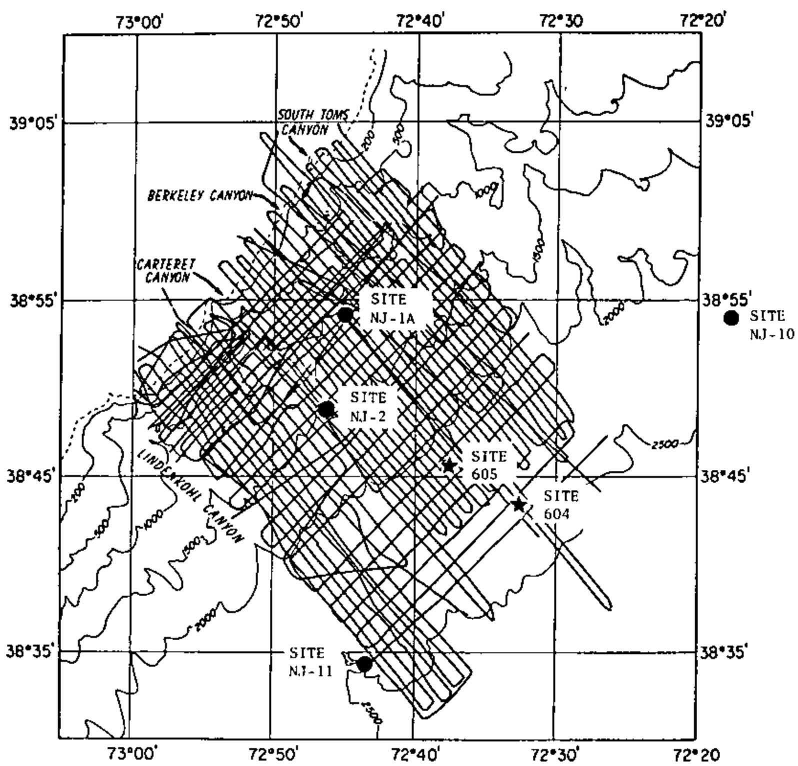
the presence of these unconformities crossing the boreholes and in undrilled sections as well. Within the shelf sequences of the trough, major stage boundaries are often distinguished as distinct reflections and can be seen to truncate underlying reflections at scattered locations along their lengths, indicating erosion. Above them, the reflections often onlap or downlap, indicating intervals of nondeposition. However, the vertical resolution of the seismic systems used is limited to around 5 m at depths of less than 2 km, so that truncated or onlapping strata of lesser thickness would not show up on the profiles studied (Sheriff, 1977). The boreholes show that unconformities sometimes appear to be conformable seismic boundaries in places where they represent gaps. On the continental slope, the angles between reflections are much more disparate, which makes unconformable contacts easier to recognize (Fig. 95-5 - 95-9). A a general rule, the unconformities fall into two categories:

1) those that can be recognized from basin to basin (Figs. 95-11, 95-12) and appear to be nearly coincident with the "global" periods of erosion postulated by Vail, et al. (1977); and

2) those that have more limited extent within a single basin and do not necessarily coincide with those of the Vail scheme.

The oldest major gap expected to be encountered in the Leg 95 boreholes is the gap

SINGLE CHANNEL
HIGH RESOLUTION PROFILES



NEW JERSEY TRANSECT

● Rotary coring sites proposed for Leg 95.

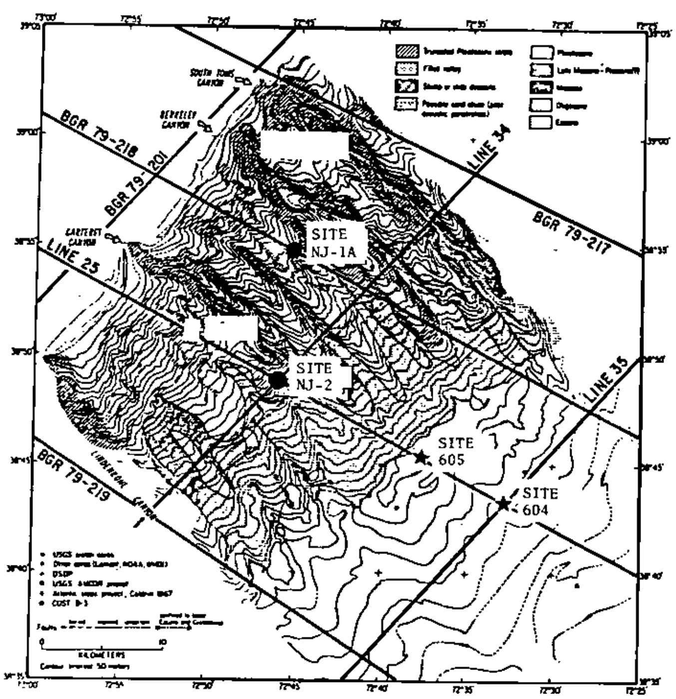
★ Rotary coring sites drilled on Leg 93.

Figure 95-3.

at the Cretaceous/Tertiary contact (Figs. 95-11, 95-12). In the COST B-3 well, lower Paleocene (Zones P.1 to P.4) and upper Maestrichtian (Zones UC15, 16, 17) strata are missing at a hiatus of about 17-18 m.y. A coeval gap and equivalent seismic unconformity can be traced widely in adjacent basins. At B-3 the outer-sublittoral paleoenvironment does not change across the unconformity, but the lithology changes from dark silty mudstone below to white biomicritic limestone above. The missing section may have been eroded by a series of subaerial and submarine processes during the lengthy hiatus.

At B-2, however, the paleoenvironmental conditions changed markedly across the contact along with a marked lithic change. The youngest Maestrichtian strata present are lignitic, gypsiferous, quartzose sandstones that contain a paralic (estuarine or lagoonal) assemblage of agglutinated foraminifera. Subaerial exposure is likely to have eroded part of this section prior to marine inundation in the Paleocene and consequent deposition of white chalky limestone containing outer-sublittoral foraminifera.

The next youngest well-documented unconformity separates upper Eocene beds (Zone P.15) from upper Oligocene strata (Zone P.21b) at about 1821 m (689 m BSF) in the B-3 well (Figs. 95-10 - 95-12). The hiatus is approximately 11 m.y. in duration. A nearly coeval unconformity is present in several other wells. This gap appears to be the result of at least two periods of intense erosion; one near the Eocene/Oligocene boundary (Olsson et al., 1980) and one near the middle of Zone P.21 (Vail and Mitchum, 1979). The paleoenvironment on either side of the unconformity at B-3 is interpreted to have been lower bathal. At B-2, on the other hand, the paleoenvironment changed from upper bathyal below to outer-sublittoral above. A lithologic change from white Eocene limestone to olive gray, glauconitic, upper Oligocene clay takes place in both B-wells. The resulting velocity contrast forms a distinctive reflector that can be traced widely on seismic profiles (Carlson, 1979). One of the most significant periods of channel cutting on the continental slope appears to have accompanied this shelf erosion (Schlee et al.; Mountain and Tucholke; Dillon, in press).



NEW JERSEY TRANSECT

● Rotary coring sites proposed for Leg 95.

★ Rotary coring sites drilled on Leg 93.

—— Multichannel seismic lines.

Figure 95-4. A geologic map of the continental slope between Lindenkohl and South Toms Canyons.

At 1356 m (524 m BSF) in the B-3 well, a stratigraphic gap is present between Zone N.5(?) of the lower Miocene and Zone N.9 of the middle Miocene (hiatus of 5 m.y.; Figs. 95-10 - 95-12). An even longer hiatus separates upper Oligocene from middle Miocene strata in B-2 (9 m.y. hiatus) confirming the regional distribution of this erosion event. The paleoenvironment changed from lower to upper bathyal across the contact at B-3, while at B-2 the change was from outer- to inner-sublittoral. Submarine currents appear to have been the erosive agents at each site. No lithologic change is associated with this unconformity at B-3, but at B-2, a thin quartzose sandstone lies below and olive-gray clay lies above the contact. This unconformity also is clearly seen on seismic profiles and on the shelf segment of Line 25, prograding middle Miocene clinoform reflections are seen to downlap Oligocene and lower Miocene reflections over long distances. This indicates that nondeposition played a major role in forming this stratigraphic gap.

Several other subaerial erosion events apparently took place in the Miocene, Pliocene and Pleistocene as indicated by repeated zones of intensely oxidized microfossils and sediments in the B-2 well and in AMCOR 6009 and 6010 cores. However, in these sections the detailed biostratigraphic zonation required to estimate the duration of hiatuses is not available. Several of these unconformities can also be seen on seismic profiles, but the relatively minor lithic differences (small impedance contrasts) within the Neogene and Quaternary strata do not produce the high-amplitude unconformable reflectors so typical of older sections.

The major unconformities cited above are correlative with the global periods of erosion outlined by Vail et al. (1977) and Zeigler (1982), and provide a means of identifying major depositional cycle boundaries (Figs. 95-11, 95-12).

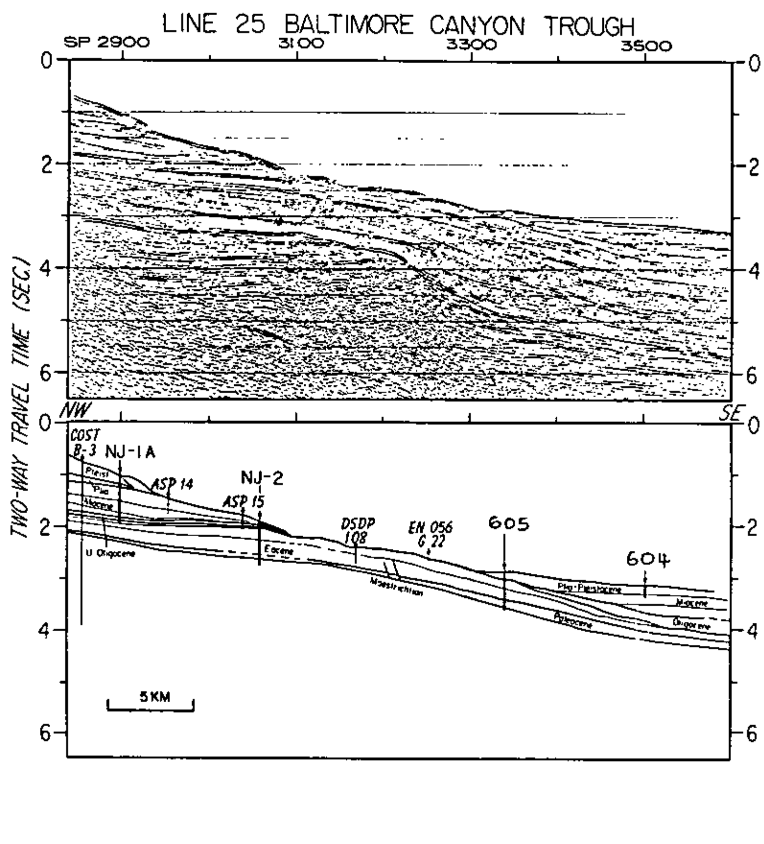


Figure 95-5. Site locations and general stratigraphy for Leg 95.

Sea Level Change and Paleobathymetric Cycles

Studies of paleobathymetric cycles inferred from analyses of Atlantic offshore boreholes have revealed good correlations with the supercycles of sea level fluctuation described by Vail et al. (1977); see Poag and Hall, 1979; Poag, 1980, 1982a,b; and Poag and Schlee, in press). Figure 95-12 shows a comparison of this sea level curve with paleo-bathymetric curves derived from the B-2, B-3, GE-1 (Southeast Georgia embankment) and G-1 and G-2 wells (Georges Bank basin). In general, the correspondence of deep and shallow bathymetry with high and low sea levels is remarkably close in the Mesozoic section and supercycles are easy to identify; it is more difficult to correlate the Cenozoic section. Depositional cycles are broadly uniform from basin to basin for Mesozoic strata, but interbasin variability increases considerably in the Cenozoic.

Several important Cenozoic uniformities fit the framework of low sea levels, but the paleobathymetric curves are not as responsive as might be expected. The Cenozoic record in the Baltimore Canyon trough begins with the middle of supercycle Ta and the paleobathymetry seems to increase somewhat in both B wells (with some fluctuations in B-2), Although both maintained generally upper bathal depths.

Supercycle Tb is marked by major deepening in both B wells, but during the middle part of supercycle Tb, the waters at the B-well sites shoaled.

The major sea level drop at the Tb/Tc boundary is clearly represented at the B-well sites as discussed above. There is, moreover, a significant paleobathymetric change at the Tb/Tc boundary position in the B-2 well. A major early Miocene gap signals a low stand at the B sites near the middle of supercycle Tc, and the paleoenvironments above the gap at B-2 were shallower than those below.

Supercycle Td is not well represented in any boring in the Baltimore Canyon trough, but the upper Pliocene part appears to have been deposited during a transgressive phase. Pleistocene sea level variations have not been carefully studied to date.

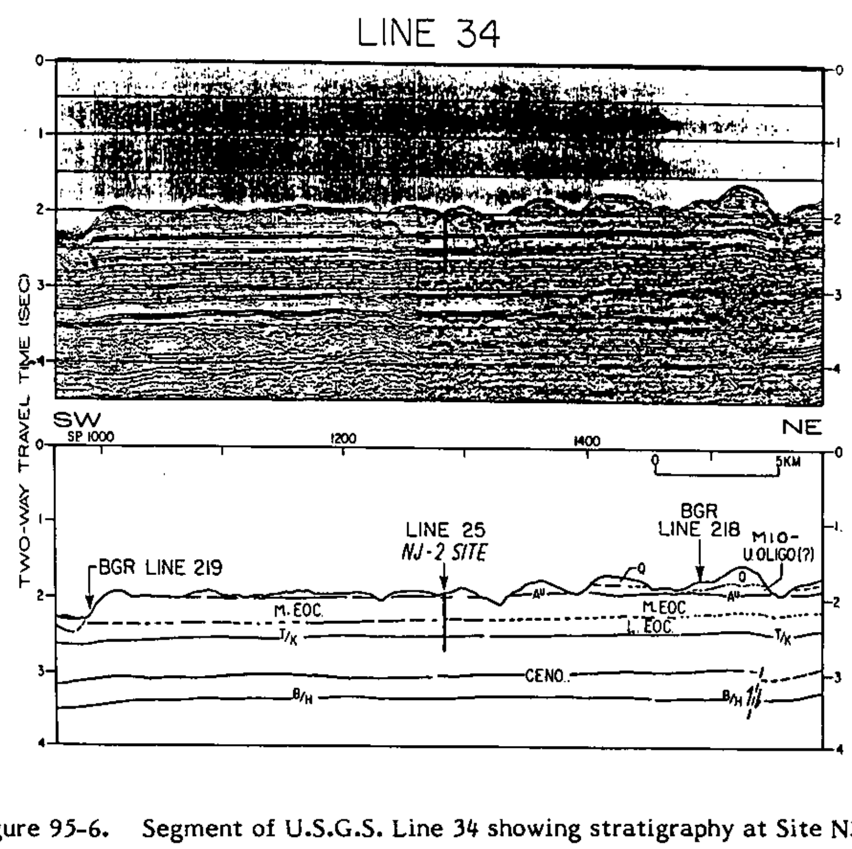


Figure 95-6. Segment of U.S.G.S. Line 34 showing stratigraphy at Site NJ-2.

Deep Stratigraphy at DSDP Site 603

Drilling at DSDP Site 603 (Fig. 95-13) during Leg 93 was terminated when the drill string parted before the Jurassic target was reached. Thus the principal goal of sampling the Jurassic and basement rocks remains to be achieved during Leg 95. The major seismic Reflector J_1 onlaps a northwest-southeast trending basement high just to the east of Site 603 (Fig. 95-14). At Site 603, J_1 is estimated to be at 1664 m below the seafloor, and the basement is at 1814 m. The basement predates magnetic anomaly M25 and is presumed to be Callovian in age.

Principal Objectives of Leg 95

The principal scientific objectives of Leg 95 are to document the Cenozoic and latest Cretaceous depositional history of the New Jersey continental slope and upper rise and to complete documentation of Jurassic and Early Cretaceous deposition at Site 603. Geologic and geophysical analysis of continuously cored strata from these sites will allow us to:

1. Establish the composition, stratigraphic framework and depositional environments of sediments constituting the shelf/rise transtion.

2. Accurately date the biostratigraphic gaps and major seismic reflectors (both conformable and unconformable) present in the section.

3. Document lateral variability in bio- and lithofacies and compare the facies observed with analogues from the modern slope and rise.

4. Establish paleoenvironmental cycles, detailed biostratigraphic zonations and stable isotopic stratigraphy.

5. Calibrate poorly known silicious planktonic and benthic biozones with the widely applied calcareous microfossil zonations.

6. Identify depositional sequences and evaluate their relationships with seismic sequences, eustatic sea level curves, oceanic current patterns, water mass composition, sediment provenance and accumulation rates, and with basin subsidence history.

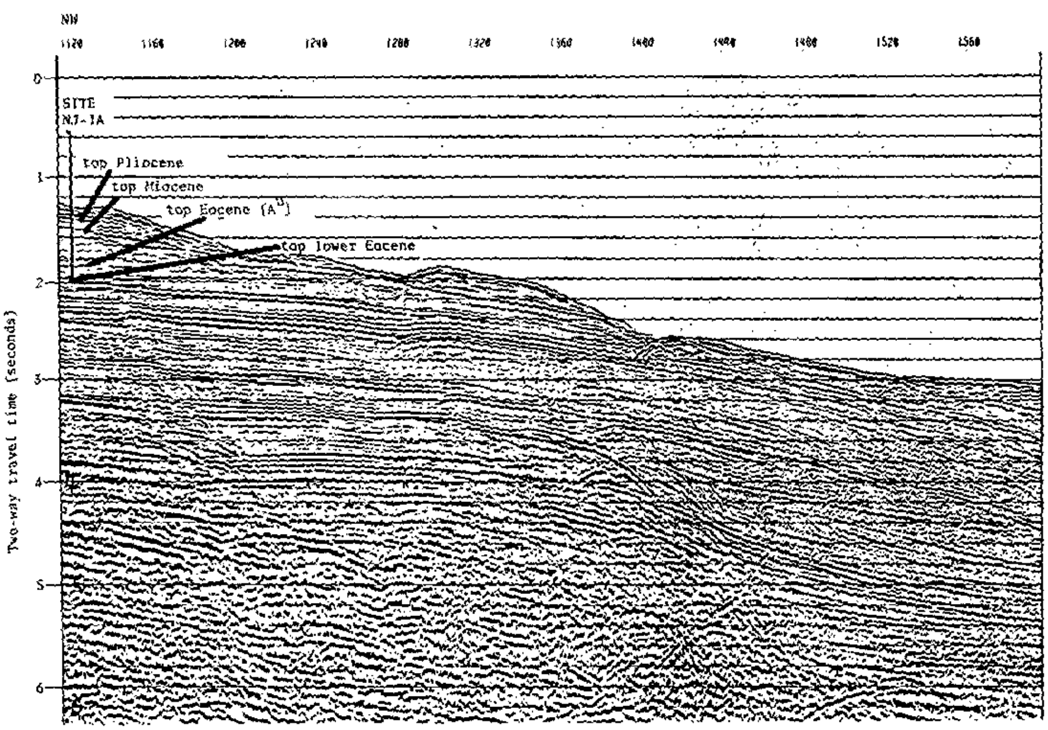


Figure 95-7. Segment of BGR Line 79-218, showing stratigraphy at proposed Site NJ-1A.

7. Determine the age and nature of Reflector J_1.

8. Determine the age and nature of the oldest sediment deposited on oceanic crust at a location landward of Site 105 and not situated on a basement high.

9. Compare and correlate the geological and geophysical record of the slope and upper rise with that of the adjacent shelf and lower rise (especially that at Site 603) and with other passive margins such as the Goban Spur (drilled on Leg 80).

Site NJ-1A (New Jersey Transect)

Position: 38°54'30"N, 72°45'12"W
Water Depth: 976 m
Sediment Thickness: 10-12 km
Priority: 1 (alternate)

Proposed Drilling Program: Continuous rotary coring to about 730 m (just below top of Eocene). Log, then HPC the top of the section if available.

Ojectives: 1) Determine age and nature of sediments; 2) Date major unconformities and seismic reflectors; 3) Identify depositional sequences and compare with other Leg 95 sites and DSDP Sites 604 and 605; 4) Calibrate siliceous biozones with calcareous biozones; 5) Document depositional history of upper continental slope and relationship between deposition and sea level change.

Heat Flow: Yes　　Logging: Yes

Seismic Profiles: U.S. Geol. Surv. MCS Lines 25 (SP 2900) and 34. BGR MCS Lines 79-204, 218 (SP 1120) and 219.

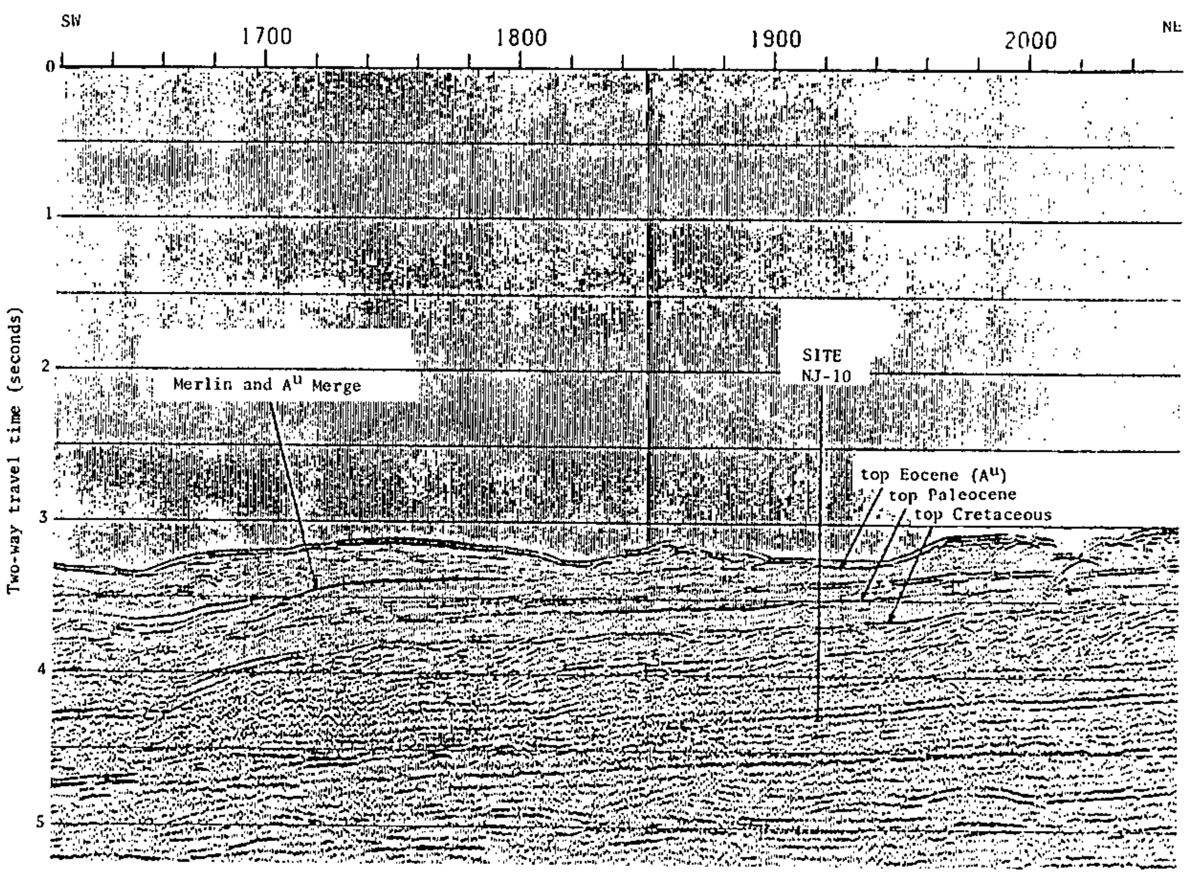


Figure 95-8. Segment of U.S.G.S. Line 35, showing stratigraphy at proposed Site NJ-10.

Expected Lithology:

0-113 m: Pleistocene sands, silts and silty clays deposited in pro-delta setting on upper slope.

113-182 m: Pliocene silty and sandy clay of bathyal origin.

182-460 m: Miocene gray calcareous silty, sandy, glauconitic clay, rich in radiolarians and diatoms. Deposited by prograding deltas in shelf-edge region of upwelling.

460-524 m: Oligocene light olive-gray, glauconitic clay of bathyal origin.

524-730 m: Late and middle Eocene light gray to white calcareous clay and limestone of bathyal origin.

730 M: Early Eocene light gray to white calcareous clay and limestone of bathyal origin.

Site NJ-2 (New Jersey Transect)

Position: 38°48.9'N, 72°46.2'W
Water Depth: 1500 m
Sediment Thickness: 10-12 km
Priority: 1

Proposed Drilling Program: Continuous rotary coring to about 700 m (just below top of Cretaceous). Log, then HPC the top of the section if time available.

Objectives: 1) Determine age and nature of sediments; 2) Date major unconformities and seismic reflectors; 3) Identify depositional sequences and compare with other Leg 95 sites and Site 603 (ENA-3D); 4) Calibrate siliceous biozones with calcareous biozones; 5) Document depositional history of lower continental slope and relationship between deposition and sea level change.

Heat Flow: Yes | Logging: Yes

Seismic Profiles: Intersection of U.S. Geol. Surv. MCS Lines 25 and 34.

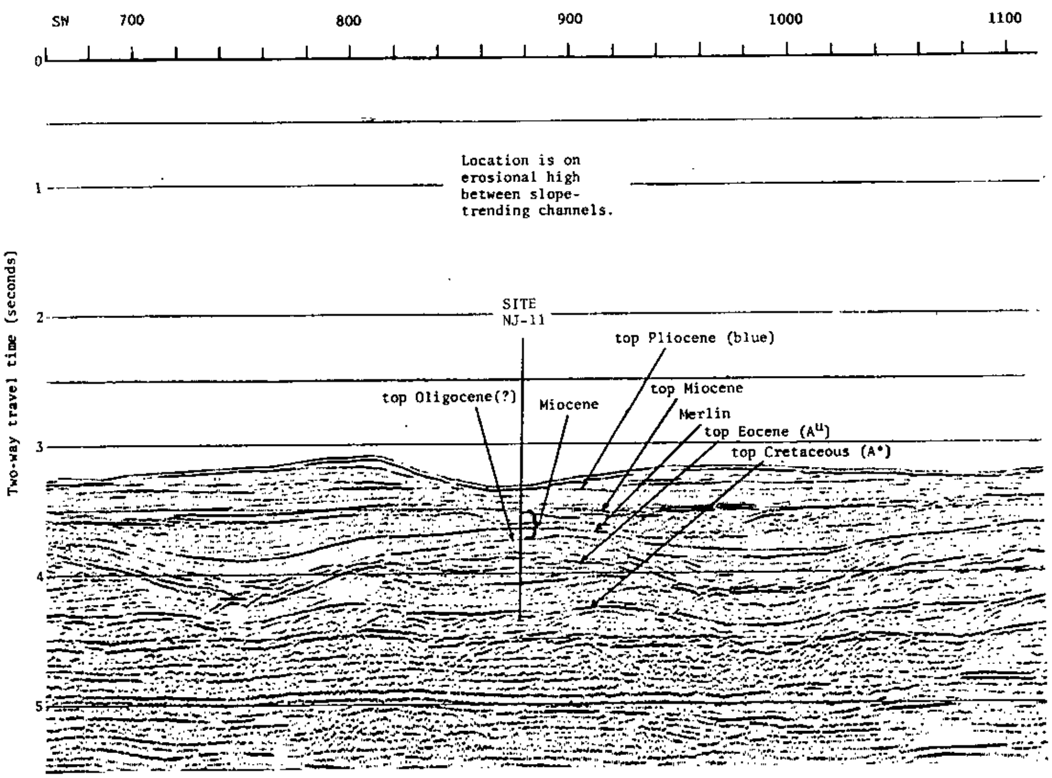


Figure 95-9. Segment of U.S.G.S. Line 35, showing stratigraphy at proposed Site NJ-11.

Expected Lithology:

0-100 m: Thin veneer of Pleistocene sand and silty clay and middle to lower Miocene silty, sandy, glauconitic clay, rich in radiolarians and diatoms. Deposited in bathyal paleoenvironment.

100-200 m: Oligocene dark, glauconitic, calcareous clay of bathyal origin. Siliceous microfossils common.

200-680 m: Eocene light gray to white, sandy, calcareous clay and clayey, micritic limestone of bathyal origin, containing abundant radiolarians and planktonic calcareous microfossils.

680-700 m: Paleocene light gray calcareous clay and limestone of bathyal origin.

700 m: Maestrictian dark gray, chalky, calcareous mudstone of bathyal origin.

Site NJ-10 (New Jersey Transect)

Position: 38°54'41.7"N, 72°18'27.7"W
Water Depth: 2442 m
Sediment Thickness: 8-10 km
Priority: 2 (alternate)

Proposed Drilling Program: Continuous rotary coring to about 1200 m (Santonian-Coniacian?). Log, then HPC the top of the section if time availabe.

Objectives: 1) Determine age and nature of sediments; 2) Date major unconformities and seismic reflectors; 3) Identify depositional sequences and compare with other slope-rise sites.

Heat Flow: Yes

Logging: Yes

Seismic Profiles: U.S. Geol. Surv. Line 35 (SP 1920), BGR Line 79-217.

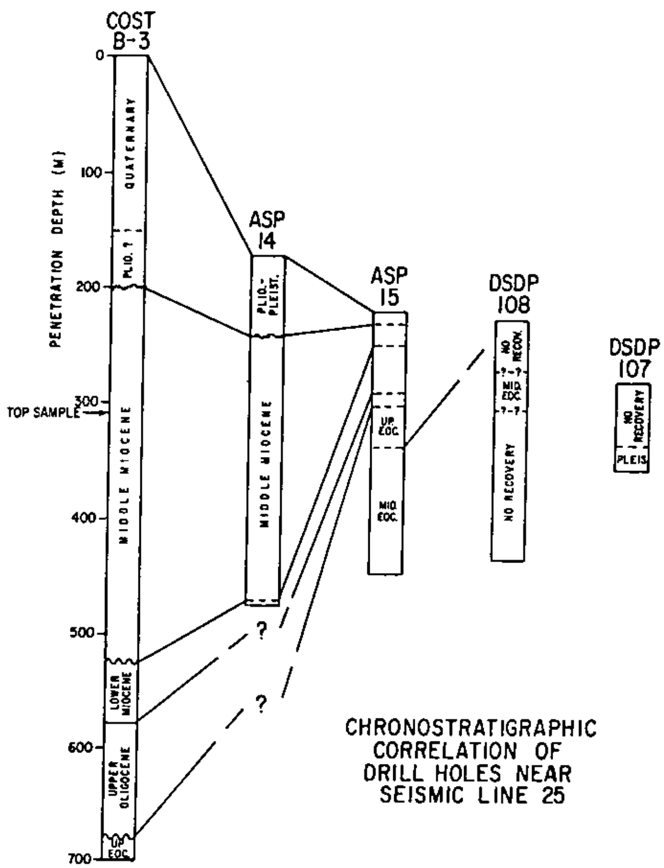


Figure 95-10.

Expected Lithology:

0-27 m: Quaternary and upper Miocene silt and fine to medium sand deposited on shoulder of slope-base channel.

27-410 m: Eocene and Paleocene clayey chalks and nannofossil limestones deposited as basin fill.

410-1200 m: Maestrichtian-Coniacian(?) chalks, mudstones, limestone and glauconitic siltstones deposited as high stand slope and basin fill.

Proposed Drilling Program: Continuous roatary coring to about 1040 m (just below top of Maestrichtian). Log, then HPC the top of the section if time available.

Objectives: 1) Determine age and nature of sediments; 2) Date major unconformities and seismic reflections; 3) Identify depositional sequences and compare with other Leg 95 sites and DSDP Sites 604 and 605; 4) Calibrate siliceous biozones with calcareous biozones; 5) Document depositional history of upper continental rise wedge and relationship of deposition to sea level change and deep-water circulation.

Site NJ-11 (New Jersey Transect)

Position: 38°34'14.1"N, 7243'32.8"W
Water Depth: 2524 m
Sediment Thickness: 8-10 km
Priority: 3

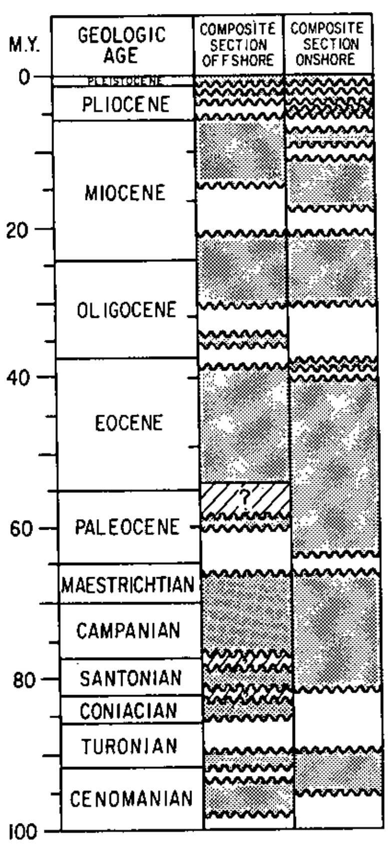


Figure 95-11. Composite geologic columns showing major sedimentary sequences and unconformities of Baltimore Canyon trough.

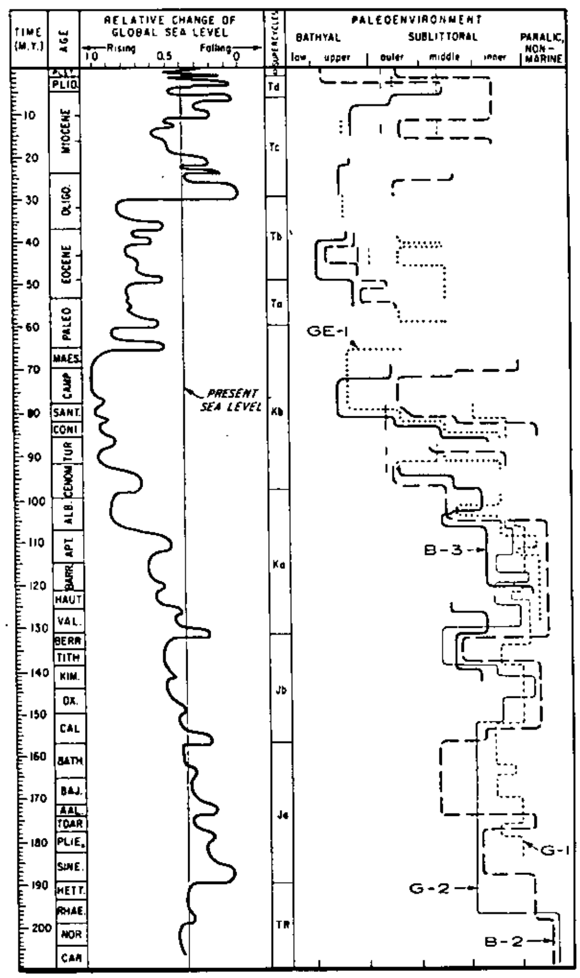


Figure 95-12. Comparison of sea level curve and paleoenvironmental curves of U.S. Atlantic margin wells. GE-1 well is in southeast Georgia embayment; G-1 and G-2 wells are in Georges Bank basin.

Heat Flow: Yes Logging: Yes

Seismic Profiles: U.S. Geol. Surv. Lines 25 and 35 (SP 880), BGR Lines 79-119 and 79-220.

Expected Lithology:

0-46 m: Pleistocene dark, sandy, silty clays deposited as gravity flows.

46-192 m: Pliocene gray clay, turbiditic sands and biogenic silica.

192-316 m: Miocene dark, sandy, silty clays deposited by gravity flows as onlapping slope-front fill.

316-454 m: Oligocene(?) olive gray clay and glauconitic silt on interchannel ridge.

454-740 m: Eocene green gray, calcareous claystone, chalk and limestone with some gravity flows.

740-1040 m: Paleocene green gray, calcareous claystones, chalk and limestone with some gravity flows.

1040 M: Maestrichtian silty, calcareous mudstone and limestone of hemipelagic origin, including some coarser-grained gravity flows.

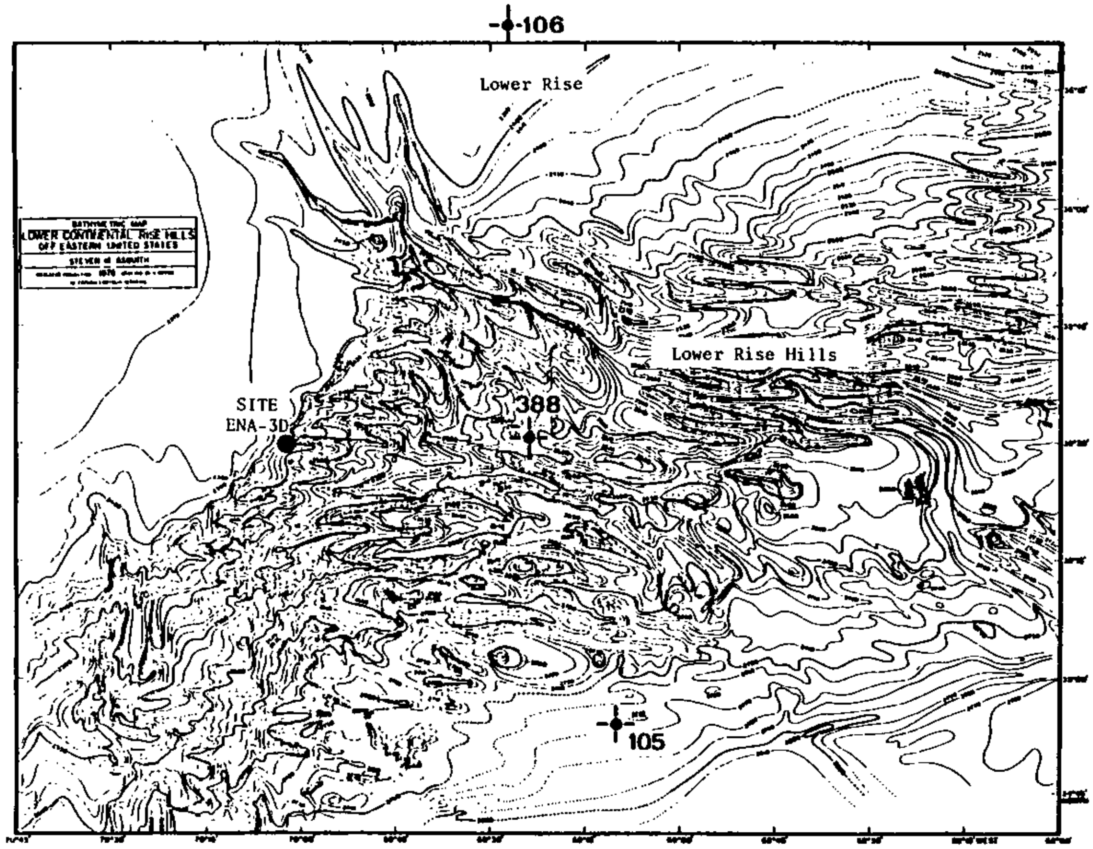


Figure 95-13. Bathymetric map showing location Site ENA-3D along boundary between the lower continental rise terrace and the lower continental rise abyssal hills. Also shown are locations of previous DSDP sites in the area.

Site ENA-3D North American Basin)

Position: 35°29.71'N, 70°01.71'W
Water Depth: 4634 m
Sediment Thickness: 1814 m
Priority: 2

Proposed Drilling Program: Wash and rotary drill to 1570 m; from there, continuously core to just below basement surface. Log entire hole.

Objectives: 1) Determine nature of Early Cretaceous and Jurassic sediments and basements; 2) Determine age and nature of Reflector J_1; 3) Correlate results with downhole logs; 4) Compare sediment and microfossil facies with slope and upper rise facies.

Heat Flow: Yes Logging: Yes

Seismic Profile: R/V Conrad 21, Leg 1, MCS Line 77, 23 September 1977, 1731 hr.; R/V Knorr 80, MCS regional surveys; R/V Fay regional surveys.

Recovered Lithology:

0-960 m: Blake Ridge Formation. Early Pleistocene to lower Miocene heimpelagic silty claystone; dark gray except for a thin, barren brown clay horizon at the base of the unit just above Reflector A^u/A^c.

960-1022 m: Bermuda Rise Formation. Eocene green and variegated radiolarian claystone. Reflector A* lies at the base of the unit.

1022-1119 m: Plantagenet Formation. Mostly barren, red-green variegated claystone with some sand-silt and carbonaceous claystone turbidites; Coniacian to Campanian at the base of the unit.

1119-1215 m: Barremian to Albian, black carbonaceous claystone with some sand-silt turbidites accompanying mud turbidites; upper contact gradational.

1215-1576 m: Blake-Bahama Formation. Valanginian to Barremian interbedded nannofossil claystone and limestone with sandstone to claystone turbidites. Coarse terrigenous sands, often unconsolidated, are the predominant lithology between 1224 and 1252 m. Sands are absent below 1478 m where rhythmic laminated-bioturbated carbonates predominate.

Expected Lithology:

1576-1664 m: Tithonian-Oxtordian(?) to Valanginian limestone and shaley limestone.

1664-1814 m: Callovian(?) shale grading upward through tithonian-Oxfordian(?) shaley limestone.

1848 m: Jurassic (Callovian?) basalt.

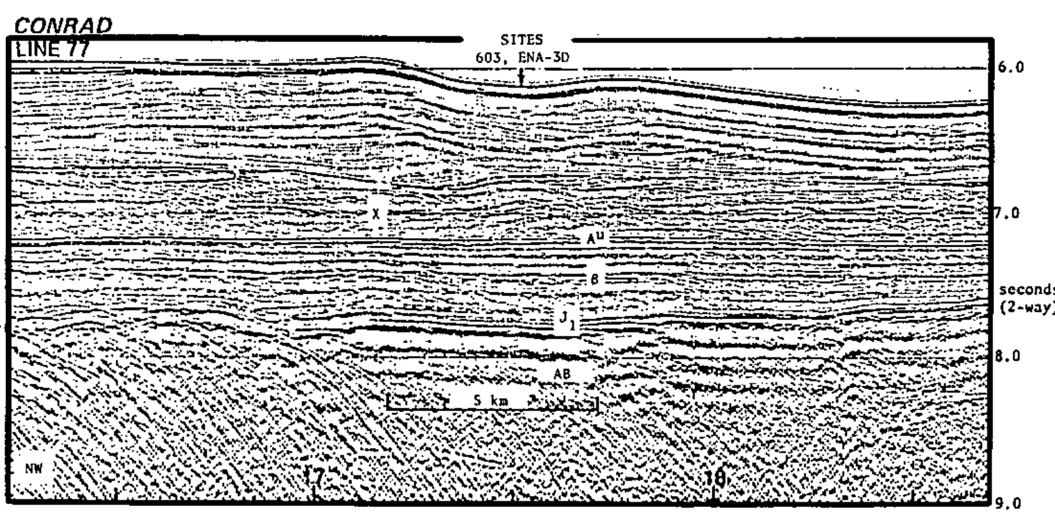


Figure 95-14. Multichannel seismic reflection profile showing location of Sites 603 and ENA-3D, R/V Conrad 21, Leg 1, MCS line 77, 23 September 1977, 1731 hr. X, A^u, β, and J_1 reflectors. AB represents acoustic basement.

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Major- and Minor-Element Analyses

Major- and Minor-Element Analyses for igneous rocks are now available as listings or for computer searches. Both shipboard and shore laboratory data are included for DSDP Legs 13-62 and Legs 63-65. For information contact:

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Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093
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Leg 96 - Mississippi Fan and Intraslope Basins

Ft. Lauderdale, Florida to Galveston, Texas, 29 September to 8 November 1983. Co-chief scientists: A. Bouma and J. Coleman.

Introduction

One of the most dramatic of deep-sea sediment accumulations typically occurs seaward of large river deltas and at the seaward mouths of submarine canyons. In short periods of geologic time, large volumes of sediment are transported downslope from the shelf, often via narrow canyons, onto the lower continental rise and ocean basin floor, resulting in a thick sedimentary accumulation referred to as a deep-sea submarine fan. Research on submarine canyons and deep-sea fans is a relatively young science, and little is known concerning the type and distribution of sediments, the mechanisms of sediment transport, and the distribution of depositional facies. Leg 96, the last phase of the D/V Glomar Challenger survey and the International Phase of Ocean Drilling (IPOD) of the Deep Sea Drilling Project (DSDP), will study the history of sedimentation on one of the larger modern submarine fans, the Mississippi Fan in the Gulf of Mexico.

Leg 96 is scheduled to commence from Fort Lauderdale, Florida, on 29 September 1983. The ship will drill seven sites within the Mississippi Fan and two sites on the adjacent continental slope in intraslope basins formed between large, diapirically intruded salt structures. Leg 96 will end in Galveston, Texas, on 8 November 1983.

Scientific Objectives

The Mississippi Fan is a lobe-shaped, slope-rise depositional system composed of Quaternary sediments extending about 600 km from near the present Mississippi River delta onto the Sigsbee abyssal plain in the northern Gulf of Mexico. It covers an area greater than 300,000 km^2 and contains a sediment volume slightly in excess of 290,000 km^3. The thickest sedimentary sequence is 4.5 km thick; it occurs in water depths of approximately 2500 m at the base of the continental slope. On the basis of seismic evaluation we conclude that the entire prism of fan sediments is of Quaternary age.

Site survey data and previously acquired seismic data indicate that the most modern fan lobe is characterized by a single large, highly sinuous channel that extends from the mouth of the Mississippi Canyon to water depths of 3500 m, a distance of more than 350 km. The modern fan lobe is elongate in shape and convex in cross section; the convexity is most obvious in the mid-fan region. This lobe commences at the mouth of the Mississippi Canyon, a large cut-and-fill structure that was formed between 25,000 and 20,000 yr. before present.

The upper fan is characterized by a large, often complex cut-and-fill structure with a much smaller centrally situated, slightly sinuous channel. In the middle fan, this channel becomes much larger, some 3 km wide, and has well-developed levees and large, well-defined overbank deposits. The channel is more sinuous and side-scan sonar data indicate the presence of abandoned ridge-and-swale morphology. This morphology is indicative of active channel migration. High-resolution side-scan sonar data from the channel floor show large migratory bed forms on the surface, indicating downchannel flow activity in the recent past. Channel migration occurred within definite boundaries, remaining near the central convex part of the fan lobe, and large volumes of overbank sediments were responsible for construction of this most recent lobe. Seismic data indicate that older lobes exist beneath and lateral to this youngest lobe and that seismic facies in the older lobes are quite similar to those apparent in the younger lobe.

The sinuous channel can be followed continuously on the side-scan sonar data onto the lower fan to the termination of the most recent fan lobe in approximately 3400 m of water and very near the Campeche Escarpment. The channel, however, becomes

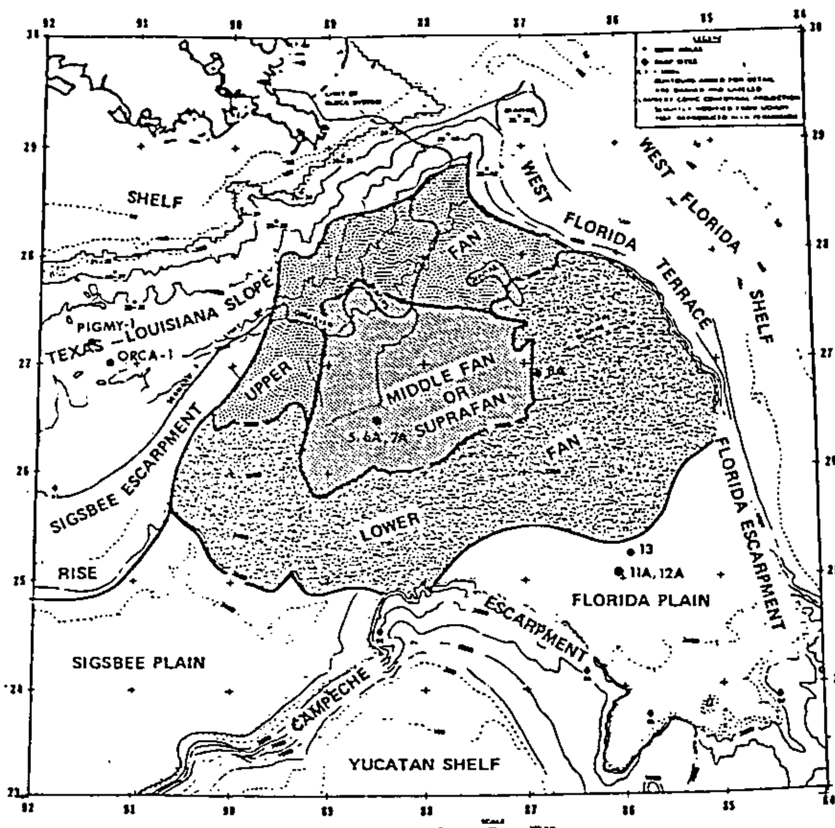


Figure 96-1. Location of Leg 96 drill holes.

LEG 96 Deep Sea Drilling Project
Mississippi Fan, Orca Basin
Locations of Proposed Sites

Drill Sequence	Site Number	Latitude	Longitude	Depth	Subenvironment	Type Holes
#1	MF-11A	24°59'N	86°07'W	3296 m	Lower fan lobe	HPC-200 m
#2	MF-12A	25°04'N	86°08'W	3290 m	Lower fan lobe (inactive)	HPC-200 m
#3	MF-13	25°12.2'N	85°59'W	3282 m	Lower fan lobe (channelized)	HPC-200 m Geotech-200 m Rotary-660 m, logging
-	MF-10 (alt)	25°25.1'N	86°03'W	3245 m	Lower fan lobe (upper part)	HPC-200 m
-	MF-9 (alt)	25°46.4'N	86°13.6'W	3173 m	Lower fan (channel)	HPC-200 m
-	MF-3B (alt)	26°53.06'N	88°10.55'W	2692 m	Middle fan (fan lobe flank, slump)	HPC-200 m, Geotech-200 m
#4	MF-8A	26°48.72'N	86°53.12'W	2978 m	Middle fan (fan lobe flank, slump)	HPC-250 m, Geotech-250 m
#5	MF-5	26°41.75'N	88°31.95'W	2465 m	Middle fan (inner channel point bar)	HPC-200 m
#6	MF-6A	26°42.85'N	88°30.7'W	2543 m	Mid-fan channel	HPC-200 m
#7	MF-7A	26°50'N	88°22.8'W	2477 m	Mid-fan overbank	HPC-200 m, Geotech-200 m Rotary-774 m, logging
-	MF-7 (alt)	26°45.1N	88°28.3'W	2465 m	Mid-fan meander belt	HPC-200 m
#8	ORCA-1	27°00.5'N	91°15.49'W	2447 m	Center north basin	HPC-200 m (2 times?)
-	ORCA-2 (alt.)	26°57.75'N	91°21.25'W	2217 m	Outside anoxic zone	HPC-200 m
#9	PYGMY-1	27°11.5'N	91°23.85'W	2311 m	Center basin	HPC-200 m
-	PYGMY-2 (alt.)	27°11.5'N	91°25.75'W	2301 m	Basin: off-center	HPC-200 m

much narrower and less sinuous. In many instances, the channel displays mid-channel islands and becomes somewhat braided in nature. Near the terminal end of the recent fan lobe, several smaller channels bifurcate off the main channel and give the appearance of the formation of several small individual depositional lobes or sheet sands. Numerous abandoned channels, still easily recognized on the side-scan sonar data, are present; all seem to have been active within the recent past. The overbank sediments become extremely thin and low-frequency seismic data display numerous individual thin lobes comprising the bulk of the recent fan lobe. Adjacent to the depositional lobes, the side-scan sonar data show extremely irregular, hummocky reflections and acoustically opaque sub-bottom reflections. Within this irregular reflection zone, extremely hard reflection targets exist that display little or no topographic expression.

The seven drill sites within the Mississippi Fan have been planned so as to identify the sedimentary characteristics of the various subenvironments of the channel proper, the overbank and levee deposits, the interchannel sequences, and the channel termination lobes. Radiocarbon dating and paleontological analysis of sediments comprising the recent lobe will result in obtaining a better understanding of the time required to deposit a single lobe and provide important information on the relationship between active deposition, sea level fluctuations and formation of the Mississippi Canyon. Analysis of the two deeper drill sites will allow an assessment of the relationship of the formation of multiple stacked lobes and sea level variations and of the changes in the location of the shallow-water depocenters. Detailed analysis of the sedimentary charcateristics of the various depositional environments will provide data on the mechanisms responsible for deposition of the sedimentary sequences.

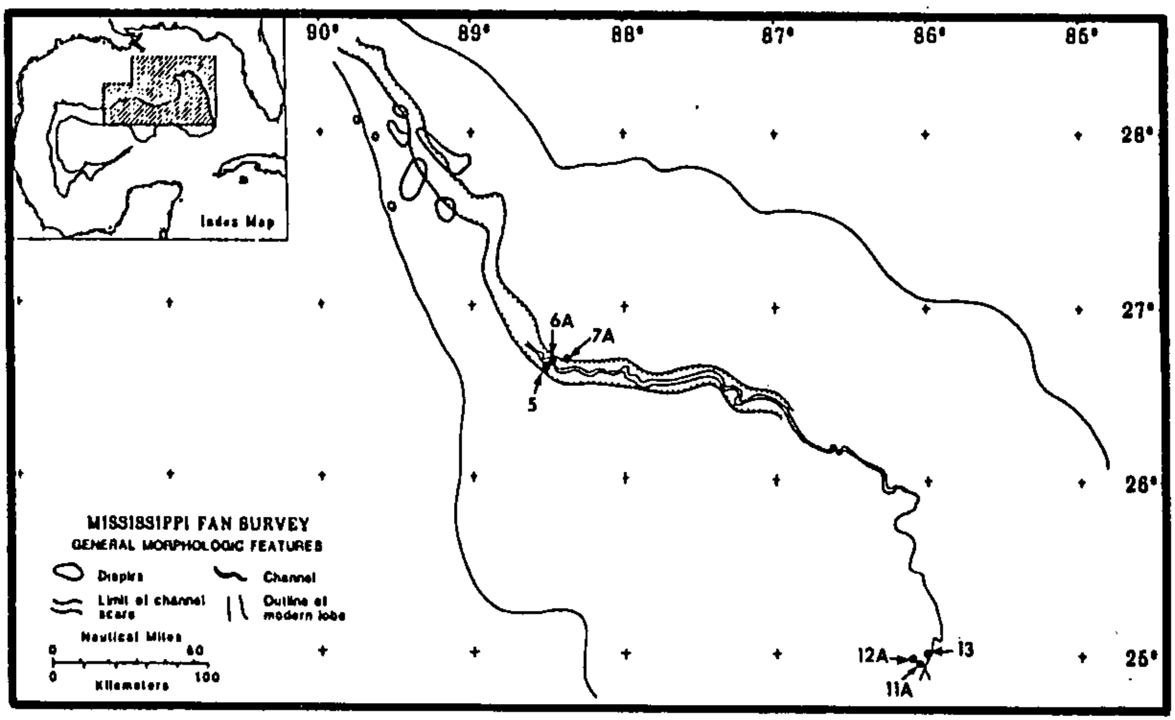


Figure 96-2. Location of Leg 96 Mississippi Fan drill holes on base map showing the morphology of the recent fan lobe.

Site Occupation Schedule
Leg 96

Site	Location	Travel Time (Hours)	Drilling Time (Days)	Departure Date (Approx.)
DEPART: Fort Lauderdale, Florida				29 Sept 83
Underway		50		
MF-11A	24°59'N 86°07'W		2.5	3 Oct 83
Underway		2		
MF-12A	25°04'N 86°08'W		2.5	5 Oct 83
Underway		6		
MF-13	25°12.2 'N 85°59.0 'W		8.0	13 Oct 83
Underway		17		
MF-8A	26°48.72'N 86 °53.12'W		4.0	17 Oct 83
Underway		12		
CREW CHANGE AT SITE MF-5				
MF-5	26°41.75'N 88°31.95'W		2.5	20 Oct 83
Underway		1		
MF-6A	26°42.85'N 88° 30.7 'W		2.5	23 Oct 83
Underway		3		
MF-7A	26°50.0 'N 88°22.8'W		7.8	31 Oct 83
Underway		24		
ORCA-1	27°00.5 'N 91°15.49'W		2.5	3 Nov 83
Underway		6		
PYGMY-1	27°11.50'N 91°23.85'W		2.5	6 Nov 83
Underway		23		
ARRIVE: Galveston, Texas				8 Nov 83
		149 hr (6.2 days)	34.8 days	40 days

Intraslope basins are extremely common features on a large part of the continental slope of the northern Gulf of Mexico. Little information exists on their mode of formation, sedimentation history as related to the adjacent movement of diapirically intruded salt, and mechanisms responsible for deposition of the often thick sedimentary sequence observed within the basins. Orca Basin is at present the only known intraslope basin that contains anoxic, high-salinity bottom water. Anoxic conditions are ideal for preservation of microfossils and organic matter. It is highly possible that the sediments from this basin will provide a complete Pleistocene stratigraphic record that will allow a much better microfaunal zonation to be established. Such a zonation can serve as a guide for the thick Pleistocene depocenter sequences, which attain thicknesses of up to 7 km beneath the shelf off Louisiana and Texas. Analysis of the pore fluids and organic matter within these sediments will afford a unique opportunity to study the early maturation of organic matter and initial migration of hydrocarbons.

The drill site in Pigmy Basin, an adjacent intraslope basin, will recover sediments that have been deposited in a similar type of structural basin but not in present-day anoxic conditions. It is highly possible that these cores will yield important information concerning the cyclic nature of the seismic facies that are common in many of the intraslope basins but that until now have been speculative with reference to their origin.

The results of drilling at each site will contribute significantly to a better understanding of one or more problems in oceanography, allowing us to do the following:

1. Confirm or modify facies characteristics and three-dimensional geometry for modern fans that are currently based solely on acoustical properties and analysis of near-surface sediments.

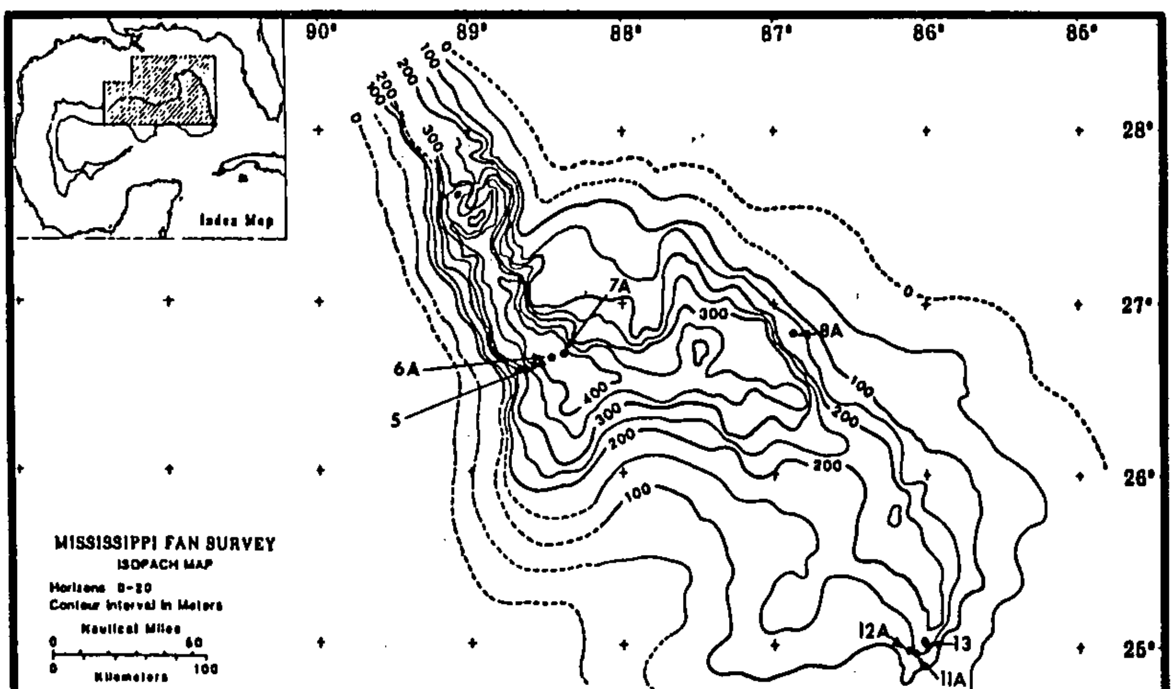
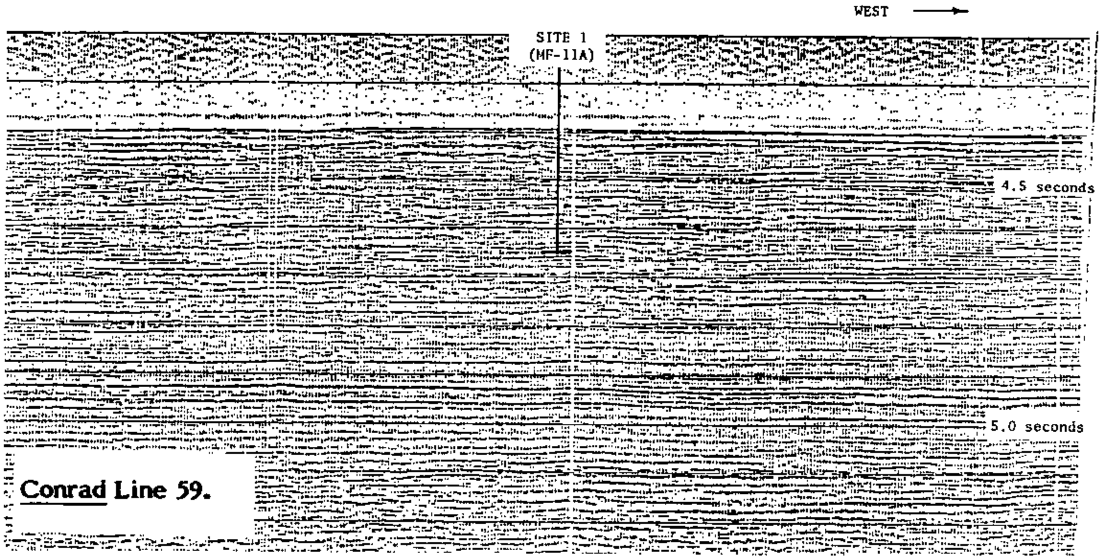
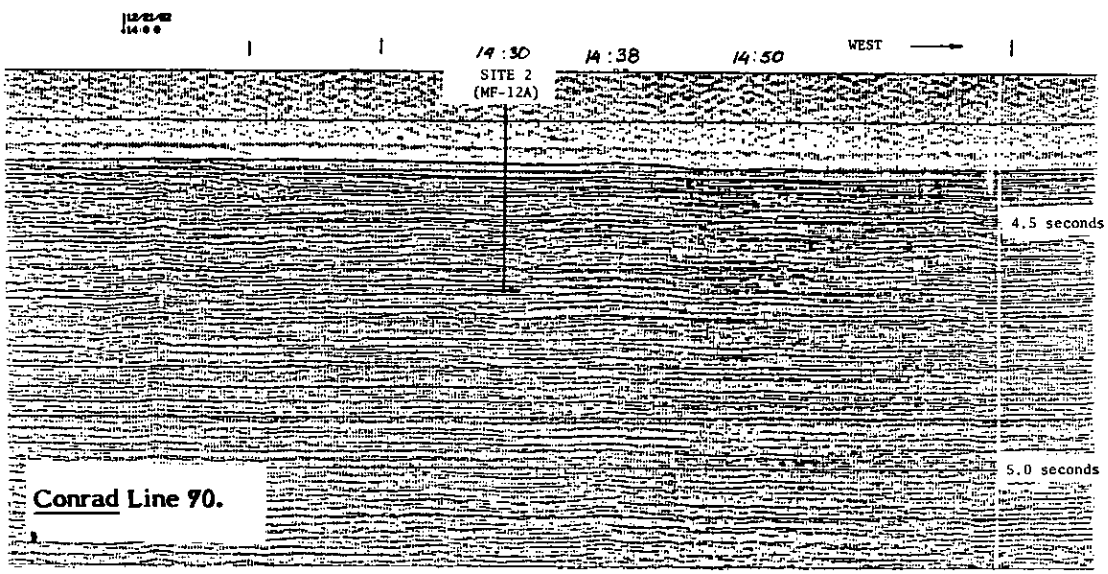


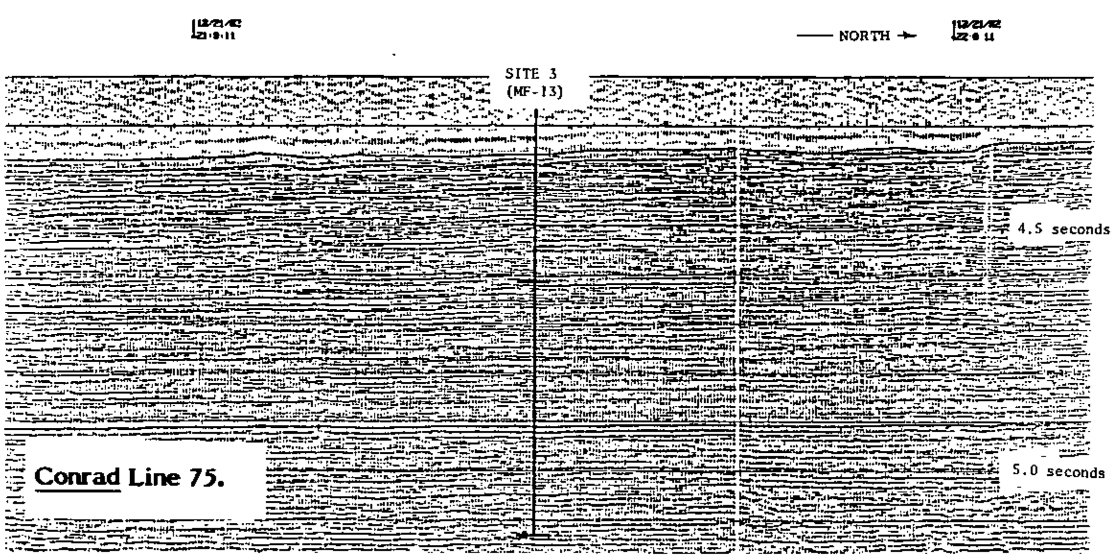
Figure 96-3. Location of Leg 96 Mississippi Fan drill holes on base map showing the thickness of the recent fan lobe.



Conrad Line 59.



Conrad Line 70.



Conrad Line 75.

2. Determine if the sinuous channel pattern visible on the surface represents active channel migration and concentration of coarse clastic deposits, and possibly determine the mechanisms responsible for its formation. Such channel patterns are common in many of the modern deep-sea fans that have been studied utilizing side-scan sonar techniques.

3. Determine the charateristics of the channel terminations on the outer fan and whether these depositional lobes display coarsening-and thickening-upward cycles.

4. Determine the characteristics of levee deposits and overbank deposits and the mechanisms responsible for their formation.

5. Evaluate the role of mass movement processes (such as submarine slides and debris flows) and turbidites in the fan subenvironments.

6. Establish the sedimentary characteristics responsible for the development of the prominent seismic reflectors that are prevalent in many modern submarine fans.

7. Determine the age of the modern fan lobe and the directly underlying lobes and obtain data on variations in sedimentaion rates during deposition of individual lobes.

8. Study the relationships between the constructional phases of the fan lobes and sea-level variations.

9. Characterize the sedimentary, geochemical, and geotechnical properties from the various depositional environments within the fan lobe.

10. Improve or construct new predictive depositional models that best describe the distribution of lithologic facies and the three-dimensional geometry of these deposits.

11. Utilize the drilling program, together with seismic data, to relate modern fans to ancient counterparts.

12. Provide a near-complete biostratigraphic sequence for the Pleistocene in the Gulf of Mexico.

Site MF-11A (lower fan)

Position: 24°59'N; 86°07'W
Water Depth: 3296 m
Sediment Thickness: 6-7 km
Priority: 1

Proposed Drilling Program: Hydraulic piston coring to 200 m.

Objectives: To determine the sedimentary characteristics and depositional history of the thin outer fan deposits. To determine the time required for the formation of these thin lobes and determine from an analysis of the sedimentary characteristics the mechanisms responsible for the deposition of the sediments. To evaluate whether these types of outer fan deposits fit the "compensation cycle" model proposed by Mutti. To evaluate the sedimentary characteristics responsible for the chaotic and semitransparent nature of the acoustic reflections seen on seismic records.

Heat flow: Yes — Logging: No

Seismic Record: Conrad Line 59, 20 December 1982 (10:05z).

Sediment Type:
0-200 m: Alternating silt and clay.

Site MF-12A (lower fan)

Position: 25°04'N; 86°08'W
Water Depth: 3290 m
Sediment Thickness: 6-7 km
Priorty: 1

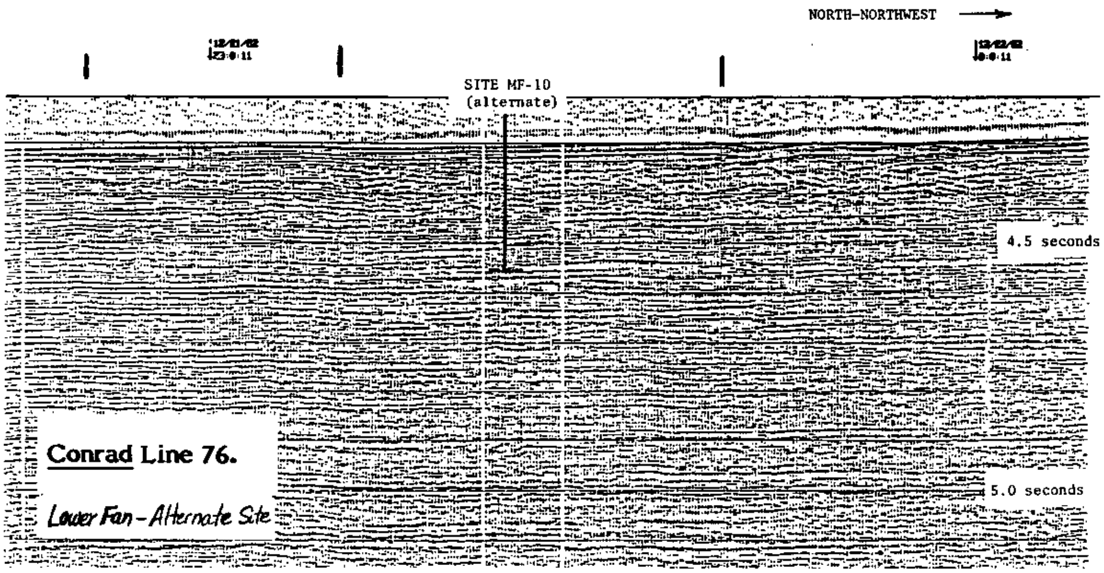
Proposed Drilling Program: Hydraulic piston core to 200 M.

Objectives: To determine the sediment characteristics of an inactive outer fan lobe that is capped by a highly irregular reflective surface cover. To identify the length of time since abandonment of the lobe. To evaluate the role of bottom currents in stripping the surface sediments from an abandoned terminal lobe of the recent fan lobe. To evaluate similarity in compensation cycles.

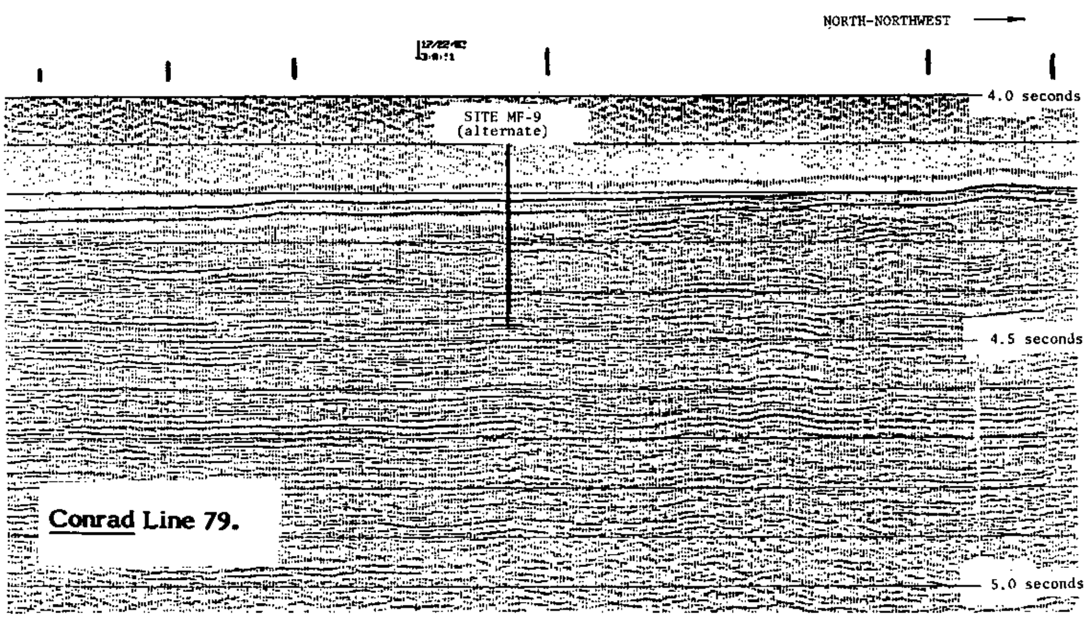
Heat Flow: Yes — Logging: No

Seismic Record: Conrad Line 70, 21 December 1982 (14:30Z).

Sediment Type:
0-200 m: Alternating silt and clay.



NORTH-NORTHWEST
SITE MF-10
(alternate)
4.5 seconds
5.0 seconds
Conrad Line 76.
Lower Fan-Alternate Site



NORTH-NORTHWEST
4.0 seconds
SITE MF-9
(alternate)
4.5 seconds
5.0 seconds
Conrad Line 79.

Site MF-13 D(lower fan)

Position: 25°12.2'N; 85°59'W
Water Depth: 3282 m
Sediment Thickness: 6-7 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m, then rotary core to 660 m. One additional 200-m hydraulic piston core for geotechnical purposes. Electrical logging of boring.

Objectives: To identify the sediment characteristics of the channel and overbank deposits in the outer bank environment and determine their vertical sequence. To obtain electric log charateristics of the terminal lobe sequences. To determine the biostratigraphic sequence and age relationships of the various lobes to at least the mid-Pleistocene. To determine the significance and characteristics of the intercalated pelagic deposits that separate the individual lobes. To identify the age of the deeper reflector horizons. To determine in detail the various physical and geotechnical properties of outer fan sediments.

Heat Flow: yes　　　Logging: No

Seismic Record: Conrad Line 75, 21 December 1982 (2124Z).

Sediment Type: Alternating mud, silt and clay layers.

Site MF-10, Alternate (lower fan channel)

Position: 25°25.1'N; 86°03'W
Water Depth: 3245 m
Sediment Thickness; 6-7 km
Priority: 2

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the sediment characteristics of a cut and fill channel that displays some sinuosity in the lower fan setting.

Heat Flow: Yes　　　Logging: No

Seismic Record: Conrad Line 76, 21 December 1982 (2323Z).

Sediment Type:
0-200 m: Alternating silt and clay.

Site MF-9, Alternate (lower fan channel)

Position: 23°46.4'N; 86°13.6'W
Water Depth: 3173 m
Sediment Thickness: 6-7 km
Priority: 2

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the sediment characteristics of a channel cut and fill structure that displays chaotic reflection patterns in seismic records. To determine the characteristics of a channel fill in the lower fan setting.

Heat Flow: Yes　　　Logging: No

Seismic Record: Conrad Line 79, 22 December 1982 (0307Z).

Sediment Type:
0-200 m: Alternating silt and clay.

Site MF-8A (mid-fan lobe flank, slump)

Position: 26°48.72'N; 86°53.12'W
Water Depth: 2978 m
Sediment Thickness: 6-7 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 250 m for stratigraphic purposes and an offset hole of 250 m for geotechnical purposes.

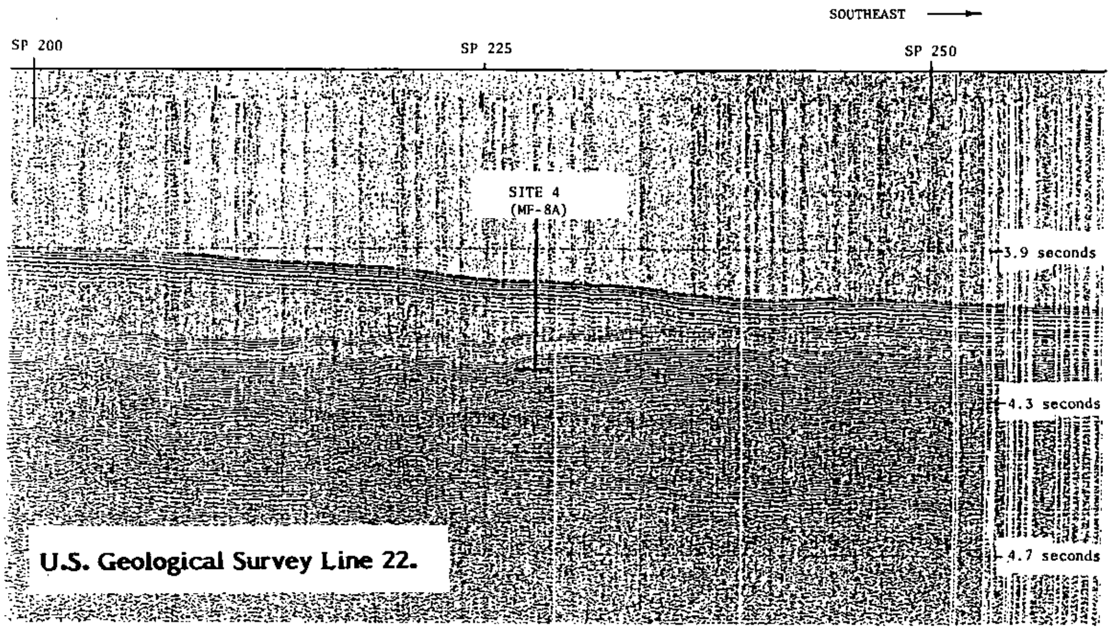
Objectives: To determine the lithologies of a possible mass movement sequence of sediments and to ascertain the types of mechanisms responsible for its emplacement. To obtain the sediment characteristics of the outer flanks of the recent depositional lobe and to determine the nature of the pelagic sediments that separate lobes in the mid-fan setting. To analyze the geotechnical and physical properties of possible displaced sediments and those of the outer fringes of a mid-fan lobe.

Heat Flow: Yes　　　Logging: No

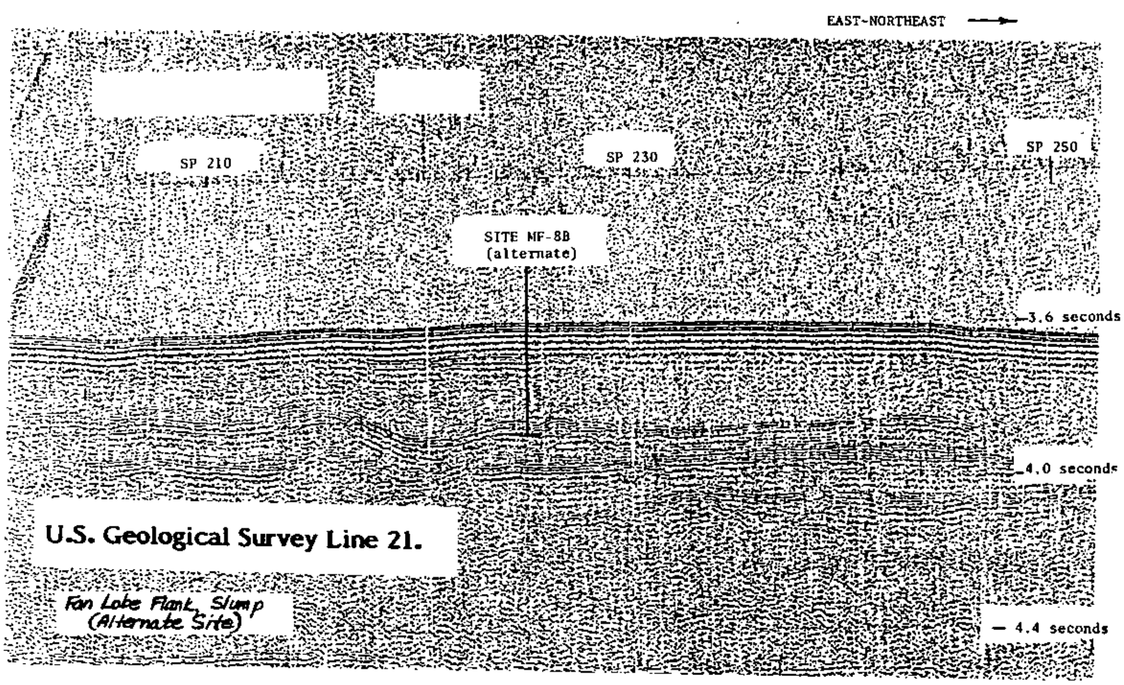
Sediment Types:
0-150 m: Alternating silt and clay.
150-180 m: Clay.
180-250 m: Alternating silt and clay.

Site MF-8B, Alternate (fan lobe flank, slump)

Position: 26°53.06'N; 88°10.55'W
Water Depth: 2692 m
Sediment Thickness: 6-7 km
Priority: 2



U.S. Geological Survey Line 22.



U.S. Geological Survey Line 21.

Proposed Drilling Program: Hydraulic piston core to 200 m for stratigraphic purposes and an offset hole of 200 m for geotechnical purposes.

Objectives: To determine the lithologies of a possible mass movement sequence, analyze the mechanism responsible for the movement, and determine whether the sequence represents single or multiple events. To attempt to age-date the emplacement of the disturbed sediments. To analyze the geotechnical properties of the remolded sediments.

Heat Flow: Yes   Logging: No

Seismic Record: U.S. Geological Survey Line 21, SP 225.

Sediment Types:
0-150 m: Alternating silt and clay.
150-180 m: Clay.
180-200 m: Alternating silt and clay.

Site MF-5 (middle fan channel point bar)

Position: 26°41.75'N; 88°31.95'W
Water Depth: 2465 m
Sediment Thickness: 6-7 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To establish the fact that the sinuous channel represents channel migration and determine the nature of the migratory channel deposits. To determine from an analysis of the sedimentary sequence the mechanism responsible for the deposition of the channel deposits.

Heat Flow: Yes   Logging: No

Seismic Record: Conrad Line 1017, 11 December 1982 (1850Z).

Sediment Type:

0-30 m: Alternating silt and clay.
30-200 m: Sand or alternating sand and clay.

Site MF-6A (middle fan channel fill)

Position: 26°42.85'N; 88°30.7'W
Water Depth: 2543 m
Sediment Thickness: 6-7 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the nature of the sediment fill in the large, sinuous channel that exists on the middle fan and to determine the date of the abandonment of the channel or ascertain whether it is still an active channel, as suggested by the high-resolution side-scan sonar data.

Heat Flow: Yes   Logging: No

Seismic Record: Conrad Line 1017, 11 December 1982 (1902Z).

Sediment Types:
0-20 m: Sand.
10-50 m: Alternating sand and clay.
50-70 m: Sand.
70-200 m: Alternating sand and clay.

Site MF-7, Alternate (middle fan meander belt)

Position: 26°45.1'N; 88°28.3'W
Water Depth: 2465 m
Sediment Thickness: 6-7 km
Priority: 2

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the characteristics of the migratory channel-fill deposits and the nature of the thin overbank sediments that cap the ridge and swale topography.

Heat Flow: Yes   Logging: No

Seismic Record: Conrad Line 1017, 11 December 1982 (1925Z).

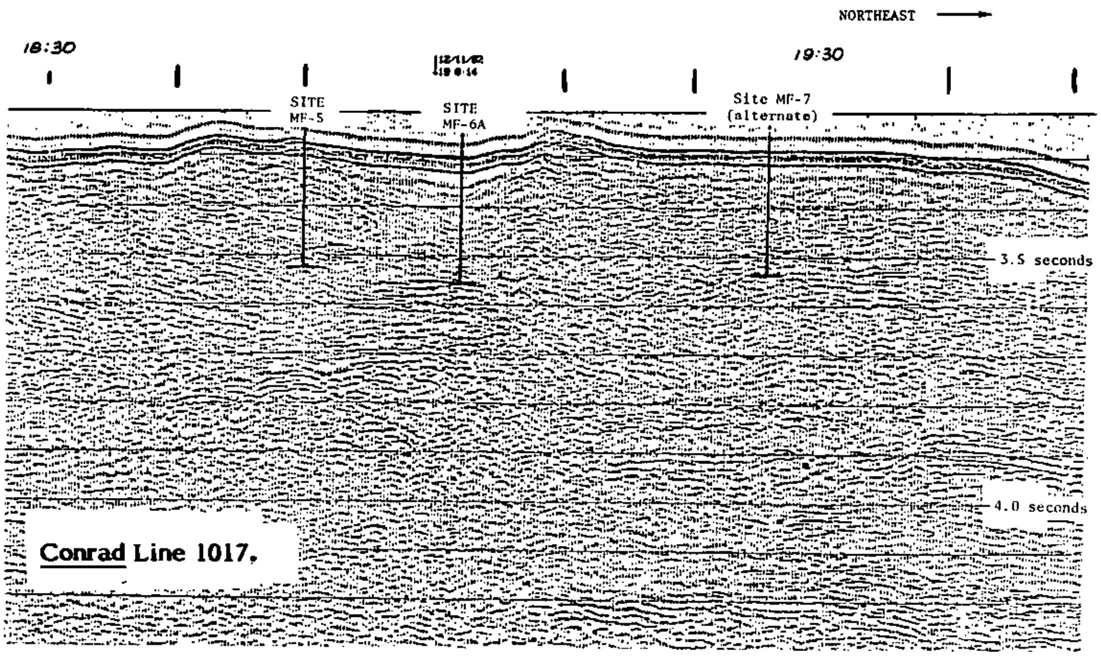
Sediment Type:
Alternating mud, silt and clay layers.

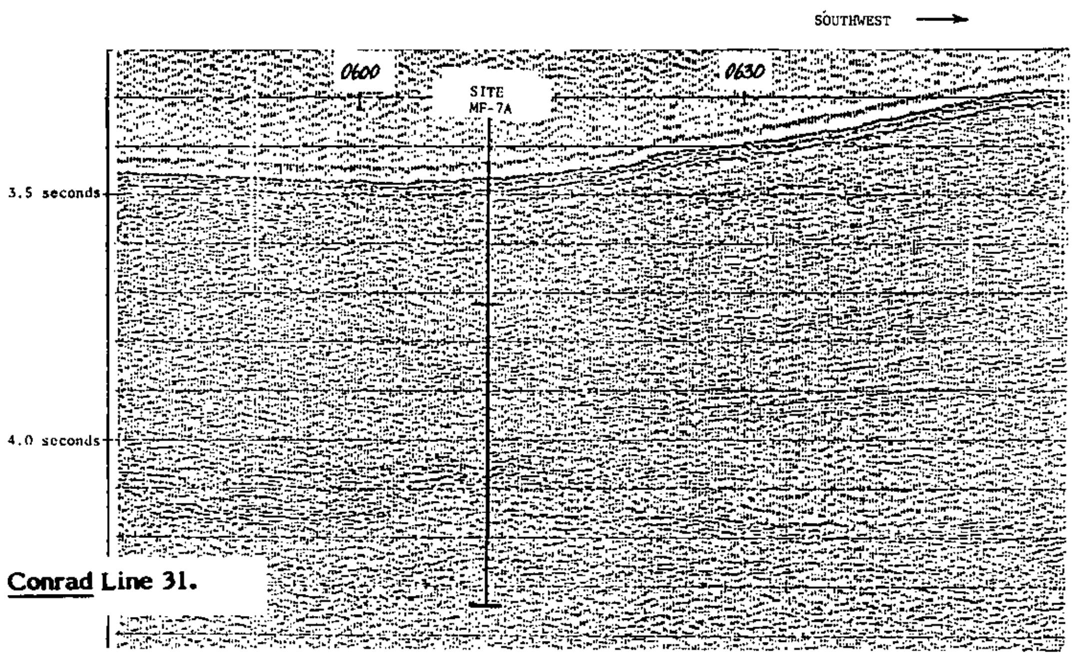
Site MF-7A (middle fan overbank)

Position: 26°50'N; 88°22.8'W
Water Depth: 2477 m
Sediment Thickness: 6-7 m
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m and rotary core to 774 m with logging. Obtain an additional HPC core to 200 m for geotechnical analysis. Electrical logging.

Objectives: To determine sediment characteristics of overbank deposits in the middle fan setting and to determine the mechanism responsible for sediment deposition. To determine the length of time required for deposition of the overbank sediments and to determine the ages of older underlying deposi-


NORTHEAST
18:30
19:30
SITE
MF-5
SITE
MF-6A
Site MF-7
(alternate)
3.5 seconds
4.0 seconds
Conrad Line 1017.


SOUTHWEST
0600
0630
SITE
MF-7A
3.5 seconds
4.0 seconds
Conrad Line 31.

tional lobes. To obtain the thicknesses of the pelagic sediments that separate the depositional lobes and determine the amont of time represented by the pelagic sediments. To determine the amount of time represented by the pelagic sediments. To determine the geotechnical and physical properties of overbank sediments in the middle fan setting.

Seismic Record: Conrad Line 1017, 11 December 1982 (0610Z).

Heat Flow: Yes Logging: Yes

Sediment Type: Alternating mud, silt and clay layers.

Site ORCA-1 (center of anoxic basin)

Position: 27°00.5'N; 91°15.49'W
Water Depth: 2447 m
Sediment Thickness: 8-10 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m or not more than 20 m into underlying shale. If time permits, obtain an additional HPC to the same depth.

Objectives: To determine the sedimentary and geochemical characteristics of sediments deposited in an anoxic environment. To determine the early maturation of organic sediments. To establish a biostratigraphic zonation of the Pleistocene for the Gulf of Mexico.

Heat Flow: Yes Logging: No

Seismic Record: U.S. Geological Survey Line 74 (1120Z).

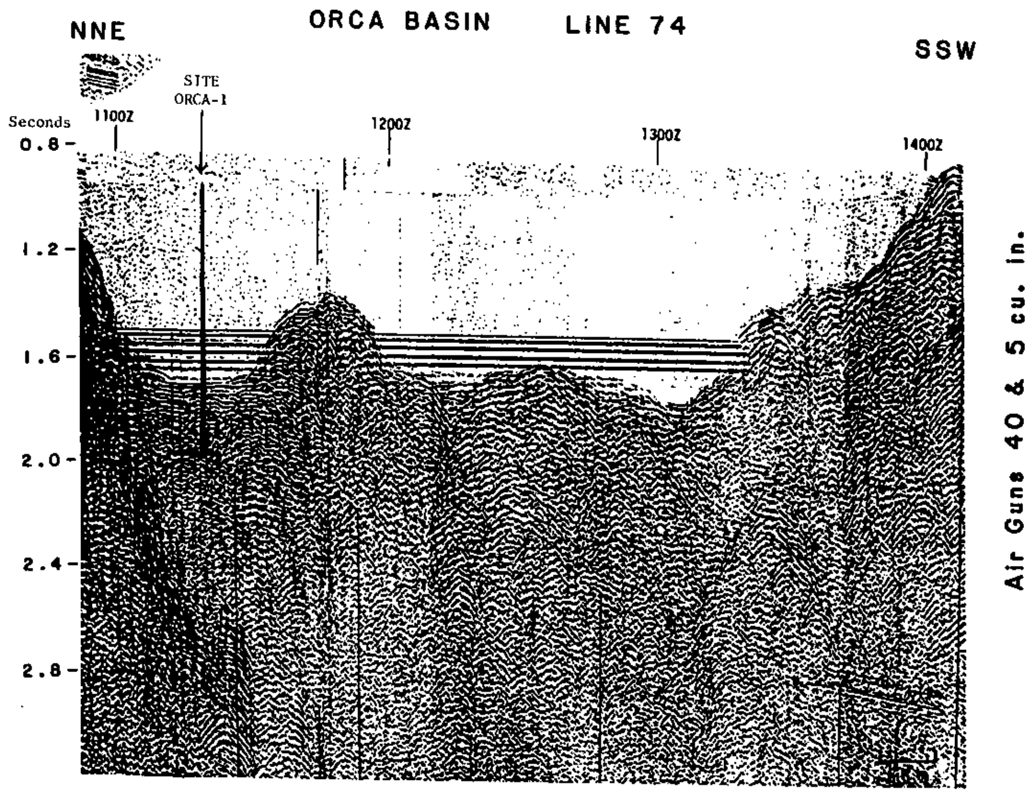
Sediment Type:
0-200 m: Clay.

Site ORCA-2, Alternate (outside anoxic zone)

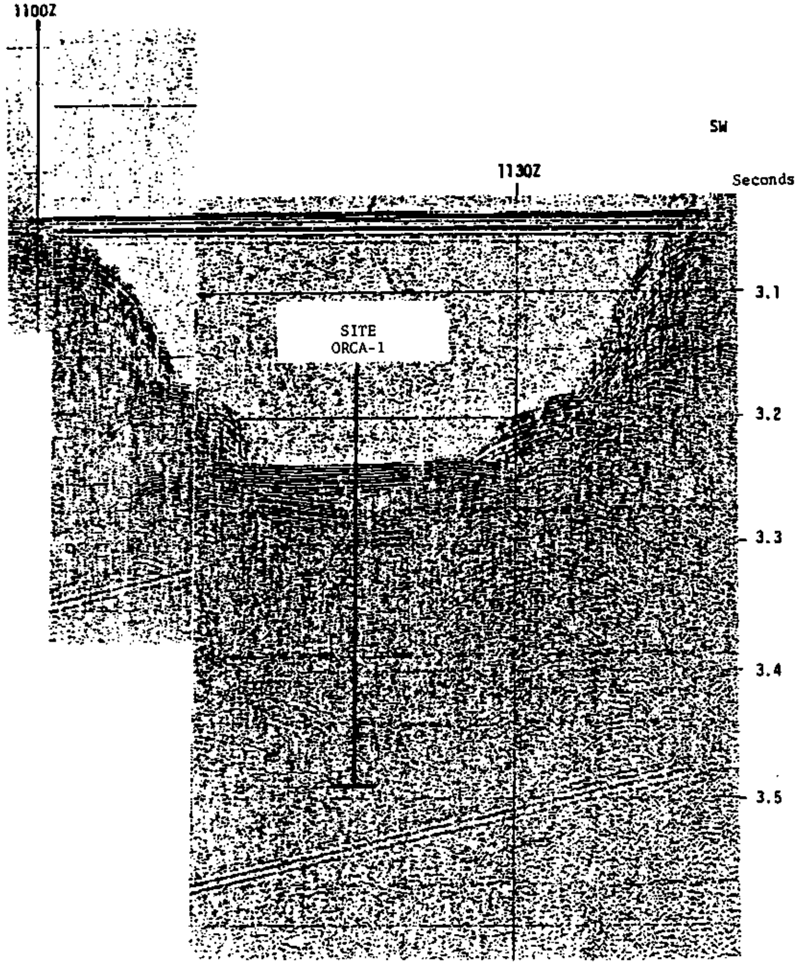
Position: 26°57.75'N; 91°21.25'W
Water Depth: 2217 m
Sediment Thickness: 8-10 km
Proirity: 2

Proposed Drilling Program: Hydraulic piston core to 200 m.

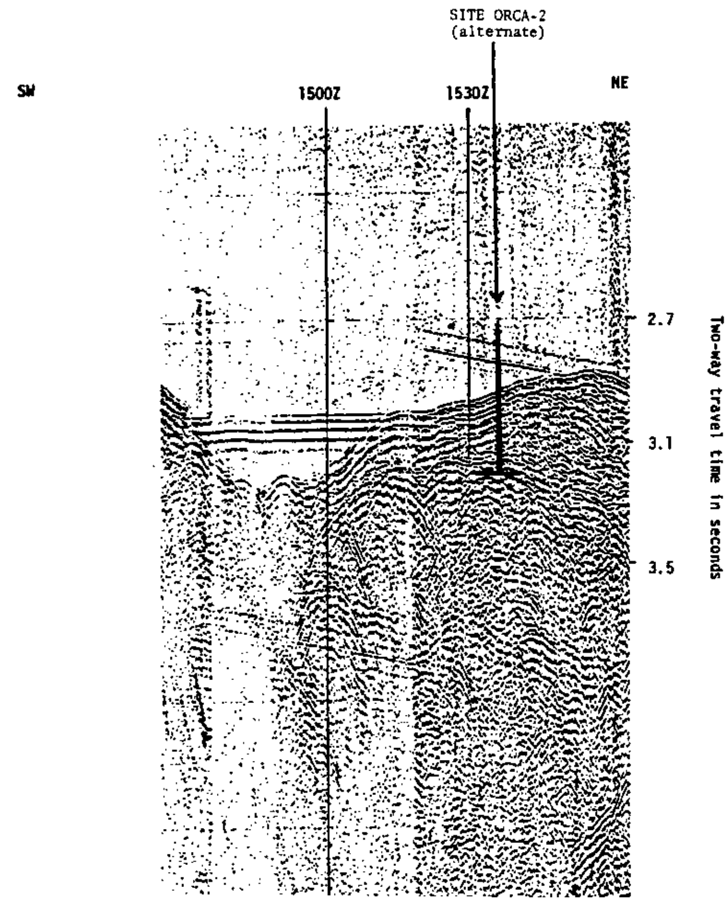
Objectives: To determine the sedimentological and geochemical characteristics of sedi-



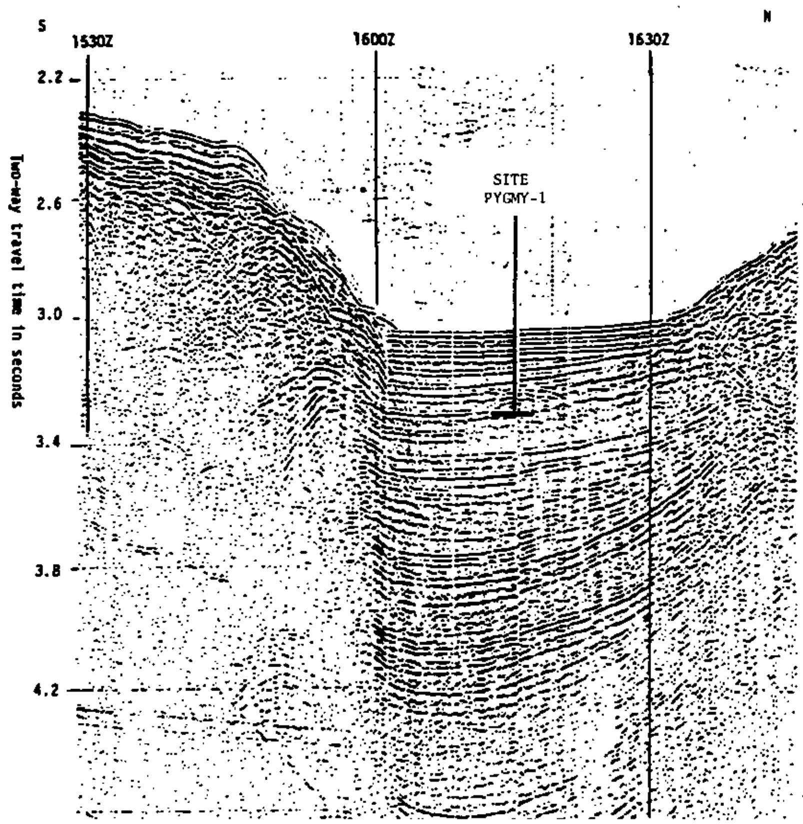
Orca Basin Line 74, 5 & 40 cu.in. airgun, 4 sec. sweep. Two-way travel time in seconds.



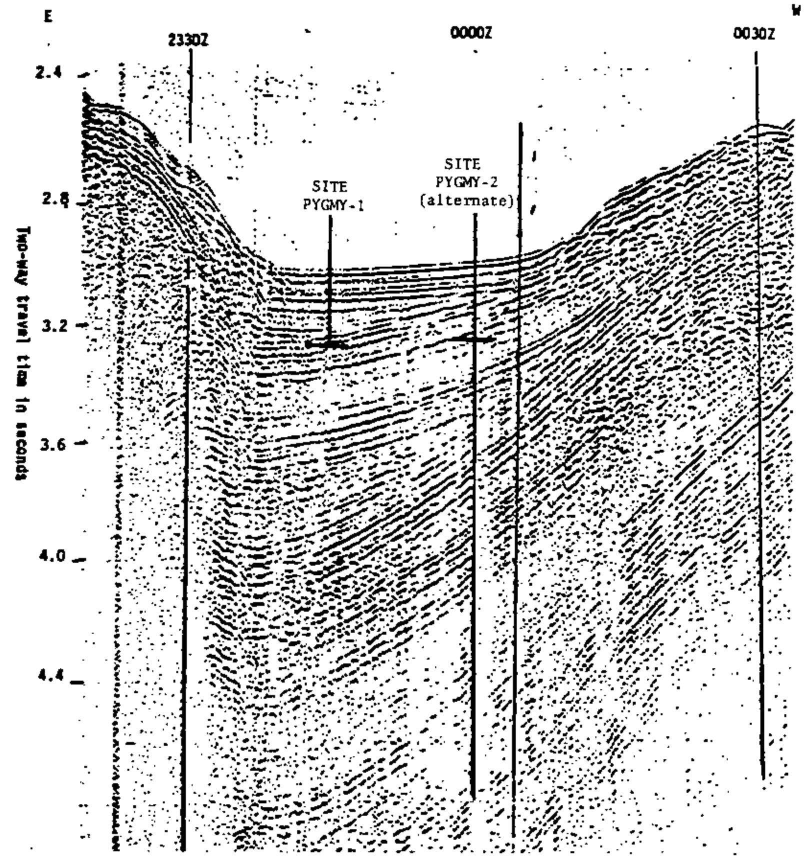
Orca Basin, Line 74, 800 J Sparker.
Travel time in seconds.



U.S. Geological Survey Line 90 Orca Basin,
5 & 40 cu.in. air gun, 4 second sweep.



U.S. Geological Survey Line 110 Pygmy Basin,
airgun 5 & 40 cu.in., 4 second sweep.



U.S. Geological Survey Line 117 Pygmy Basin,
airgun 5 & 40 cu.in., 4 second sweep.

ments laid down in an intraslope basin and compare these sediments to those laid down in the adjacent anoxic environment.

Heat Flow: Yes Logging: No

Seismic Record: U.S. Geological Survey Line 90 (1535Z)

Sediment Type:
0-200 m: Clay.

Site PYGMY-1 (center intraslope basin)

Position: 27°11.5'N; 91°23.85'W
Water Depth: 2311 m
Sediment Thickness: 8-10 km
Priority: 1

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the sediment characteristics of the cyclic seismic facies common in these basins. To determine the mechanisms responsible for deposition of the sediments in the intraslope basins. To establish a biostratigraphic zonation of the upper to mid-Pleistocene.

Heat Flow: Yes Logging: No

Seismic Record: U.S. Geological Survey Lines 110 (1615Z) and 117 (2345Z).

Sediment Type:
0-200 m: Clay

Site PYGMY-2, Alternate (off center of basin)

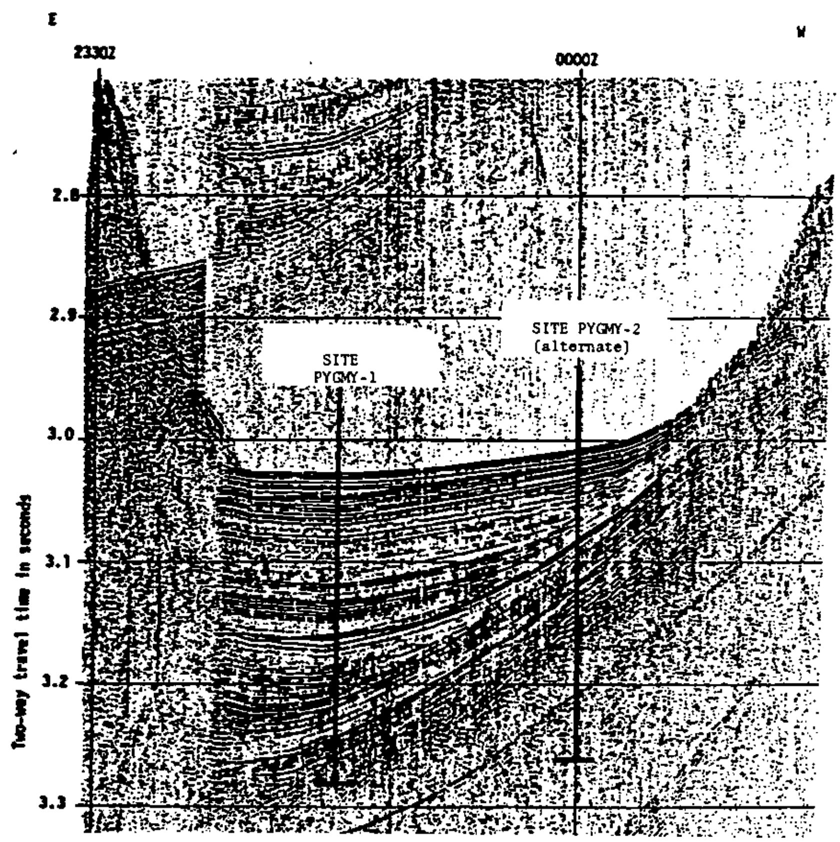
Position: 27°11.5'N; 91°25.75'W
Water Depth: 2301 m
Sediment Thickness: 8-10 km
Priority: 2

Proposed Drilling Program: Hydraulic piston core to 200 m.

Objectives: To determine the sediment characteristics of sediments deposited in an intraslope basin. To determine the amount of time required to form a cyclic sediment sequence on seismic records and the nature of the discontinuities.

Heat Flow: Yes Logging: No

Sediment Type:
0-200 m: Clay



U.S. Geological Survey Line 117 Pygmy Basin, mini sparker, 1 second sweep.

DEEP SEA DRILLING PROJECT

INFORMATION HANDLING GROUP

Background

The DSDP data bank is a dynamic library of information. As the Project has expanded so have the areas of responsibility of the DSDP Information Handling Group (IHG). Not only has the volume of data multiplied, but the kinds of data and information handled have also increased. The IHG manages all aspects of routine collection, storage, and retrieval of data, in addition to specialized areas of scientific interest which require computer-assisted technology. The development of tools and technology onboard Glomar CHALLENGER has required development of new software to integrate the resulting data in a harmonious fashion with other DSDP departments, creating programs to enhance their operations with greater efficiency and reliability. We have three primary goals in this work: (1) to preserve the data collected by DSDP operations for future use; (2) to make data readily available to qualified scientists upon request; and (3) to provide advice and assistance by means of computer reduction and display of data to contributors to the Initial Reports.

Data Availability

The DSDP Sample Distribution Policy restricts the release of scientific data gathered aboard GLOMAR CHALLENGER to those immediate members of the respective shipboard scientific party for a 12-month period following completion of the cruise. This policy excludes the Preliminary Report on underway data containing track charts and data indexes; these data have immediate unlimited distribution. DSDP may require reimbursement for expenses if a data request costs more than $50.

Table DSDP-1 summarizes and categorizes the data. With the exception of the seismic data, which are available only on microfilm or hardcopy, all data are stored and are available on magnetic tape and microfilm. Investigators can also obtain copies of the original data (shipboard forms) on microfilm, or they can view them at DSDP headquarters at Scripps Institution of Oceanography or at Lamont-Doherty Geological Observatory.

A major work effort towards updating the data bases for visual core descriptions, smear slide descriptions, and paleontology is in its final stage of completion. We will soon have computer-generated lithological classifications (output from JOIDESSCREEN program) through Leg 75.

The hard rock minor- and major-chemical analyses files continue to be modified and updated as more data is published and coded. The hard rock paleomagnetics data base is now available upon request for those legs specified in Table DSDP-2.

Logging data were collected on selected legs. These data are available on magnetic tape or analog strip charts for Legs 60, 61, 63-65, 67, 68, 70-76 and 78; analog records are only available for Legs 66 and 69; magnetic tapes are available for selected sites from Legs 46, 48, 50 51, 52 and 57.

Data Handling and Retrieval Tools

The special reference files (Sitesummary, Guide, Ageprofile, and Coredepth, see Table DSDP-2) are used independently and in coordination with other files in (a) multi-step searches, and (b) generation of standard files with assigned ages (from Ageprofile) and/or sub-bottom depths (from Coredepth).

The Sitesummary file contains key data for each hole including drilling statistics, site location, age of sediments, presence of basement sediment and hard rock descriptions. The file is continually updated from data reported in DSDP Initial Reports, Hole Summaries, and Initial Core Descriptions.

The Guide (to DSDP cores) also summarizes data published in the Initial Reports (Legs 1-34)[1], but in a different format than in the Sitesummary file. It comprises thirty categories of data which summarize the characteristics of each core. The Guides are available on microfiche and magnetic tape. All of these files can be accessed by DATAWINDOW - DSDP's principal program for the retrieval and display of data.

DATAWINDOW transfers data between tape and disk storage, updates tapes, corrects records, and monitors the tape status within a tape series (storage unit for our data base files). Access is accomplished through

[1]DSDP is no longer encoding for the Guides.

Table DSDP-1.

DEEP SEA DRILLING PROJECT - DATA BASE STATUS
Physical Properties, Quantitative and Analytical Core Data

DATA FILE	LEGS	COMMENTS
Carbon-carbonate (shore lab)	1-79	No data for Legs 46, 72
Grain-size (sand-silt-clay) (shore lab)	1-76	No data for Leg 16. Legs 64 & 65 not yet available.
G.R.A.P.E. (gamma ray attenuation porosity evaluator) (shipboard measurements, processed and edited onshore)	1-87	No data collected on Leg 46. Leg 45 GRAPE is not complete.
Hard Rock Major-Element Chemical Analyses (prime and onshore labs)	13-19, 22-30, 32-39, 41, 42A, 43, 45-46, 49, 51-55, 58-65, 68-70.	No data for Legs: 1-12, 20-21, 31, 40, 42B, 44, 47-48, 50, 56-57. Includes igneous and metamorphic rock and sediment composed of volcanic material.
Hard Rock Minor-Element Chemical Analyses (prime and onshore labs)	13-19, 22-26, 28-34, 36-39, 41-42A, 43, 45-56, 49, 51-55, 58-65, 68-70	No data for Legs: 1-12, 20-21, 27, 35, 40, 42B, 44, 47-48, 50, 56. Same set of data source as major-element file.
Hard Rock Paleomagnetics	14-16, 19, 23, 25-29, 32-34, 37-38, 41-43, 45-46, 49, 51-55, 58-66, 70.	No data for Legs: 1-13, 17-18, 20-22, 24, 30-31, 35-36, 39, 40, 47-48, 50, 56-57.
Sonic Velocity (shipboard, Hamilton Frame)	3-93	Leg 71 not completed.
Water Content (shipboard lab)	1-88	No data for Leg 41
Long-core Spinner Magnetometer Sediment Paleo-magnetics	68, 70-72, 75	From hydraulic piston cores. This is a CLOSED data base due to rust contamination of cores and sediment disturbance.

Table DSDP-1 (continued)

DEEP SEA DRILLING PROJECT - DATA BASE STATUS
Physical Properties, Qualitative and Analytical Core Data

DATA FILE	LEGS	COMMENTS
Discrete Sample Magnetics, sediment	71-73, 75	From hydraulic piston cores.
Alternating Field Demagnetization	72, 73, 79	From hydraulic piston cores.

Lithological and Stratigraphic Core Data

Paleontology (onshore labs)	1-65	From Initial Reports. Includes 10,000 species from 24 bug groups.
SCREEN	1-66	Output from JOIDESSCREEN. Computer-generated lithological classification includes basic composition data, average density, and age of layer.
Smear Slide Descriptions	1-91	Shipboard observations. (Except Legs 83 & 88)
Thin Sections	49 only	Legs 37, 45, 46, 51-55, 57-64 keypunched.
Visual Core Descriptions	1-73	Shipboard observations.

Table DSDP-2

DEEP SEA DRILLING PROJECT - DATA BASE STATUS
Underway Data

DATA FILE	LEGS	COMMENTS
Bathymetry	7-9, 13-56, 61-80	
	7-9, 12-80	
	3-80	
	1-80	Seismic data available only in hardcopy or microfilm.
Merged format files (MDG77)	1-80	
SPECIAL REFERENCE FILES		
Sitesummary	1-94	Hole oriented. Regularly updated.
DSDP/Guide	1-34	Core oriented. Microfiche or tape.
Ageprofile	1-86	Hole, core, section. From biostratigraphy.
Coredepth	1-95	Hole-core. Primary reference tool.
AIDS TO RESEARCH		
Datawindow		Search & retrieval program, data base maintenance.
Mudpak		Plotting program, handles multiple parameters.
Maps		Topographic maps with DSDP sites.
DASI/Inquiry		DSDP affiliated scientists & institutions searchable.
Keyword Index-Search		Constructed from bibliography & sample request files. Searchable keywords & site numbers.
Sample Records		Point data inventory.
Data Data		Series of informal specific memoranda containing detailed descriptions of procedures and capabilities of the IHG.

independent easily modifiable data dictionaries which the program references in both its interactive and batch modes of operation. Individual requests can easily be constructed using DATAWINDOW's versatile search commands. Through DATAWINDOW, investigators can search the data bases by leg(s), site(s), ocean area(s), and age(s), in addition (or linked) to specific elements stored in each data base.

Areas of Support and Endeavor

The DSDP programming staff continues to provide the engineering group with mathematical and computer support for advanced engineering data collection (shipboard), reduction, and analysis.

Requesting Information or Data

We encourage researchers to use all these extensive data systems described above. Address your requests for information or data to:

Information Handling Group
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, CA 92093
(Tel: (619) 452-3526.

(Nancy Freelander, DSDP Information Handling Group, October 1983).

CORE REPOSITORIES

Samples from DSDP Legs 1-88 are available to investigators for studies which will result in published papers. We encourage investigators who desire samples to obtain a statement of the NSF/DSDP sample distribution policy and a sample request form from the DSDP Curator before submitting requests. (A statement of the sample distribution policy also appears in the Initial Reports and in the Initial Core Descriptions.) We ask that requests for samples be as specific as possible. Requestors should specify the hole, core, section, interval in centimeters measured from the top of each section, and sample volume in cubic centimeters. Refer to the graphic core descriptions in the Initial Reports and/or the Initial Core Descriptions for core details.

Samples for research which will be reported in publications other than the Initial Reports cannot be distributed until one year after the completion of a cruise or two months after publication of the Initial Core Descriptions for the cruise, whichever occurs sooner. Beginning with Leg 76, the Initial Core Descriptions are available only on microfiche. This change in production format does not affect the sample distribution policy.

The DSDP Curator can approve many standard requests in his own office, but requests for material of particularly high interest (e.g., certain hydraulic piston cores, key stratigraphic boundaries) or for large volumes of material must be forwarded by the Curator to the NSF Sample Distribution Panel for review and approval.

Cores from the Atlantic and Antarctic oceans and the Mediterranean and Black seas (Legs 1-4, 10-15, 28, 29, 35-53 71-82, and 93-95) are at the East Coast Repository at the Lamont-Doherty Geological Observatory. Cores from the Pacific and Indian oceans and the Red Sea (Legs 5-9, 16-27, 30-34, 54-70, and 83-92) are at the West Coast Repository at the Scripps Institution of Oceanography. The thin sections and smear slides from a particular cruise are stored at the same repository as the cores from that cruise. Photographs of all cores and prime data and publications from all legs are kept at each repository. Frozen samples (collected specifically for organic geochemical analyses), interstitial water samples, and gas samples from all DSDP legs are kept at the West Coast Repository. Interested scientists may view the cores, core photographs, or other associated data at either repository by making arrangements in advance with the Curator. Investigators wishing to visit the West Coast Repository are urged to request appointments well in advance because the repository is currently booked with visitors three to four months ahead.

Many thin sections that were loaned to investigators are missing from the collection. Their absence diminishes the usefulness of the collection to the entire scientific community. We ask all investigators who have borrowed thin sections or smear slides to return them as soon as possible to the repository where the corresponding cores are stored.

Please address your questions or sample requests to:

The Curator
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093
Tel. (619) 452-3528

(Amy B. Altman, DSDP Assistant Curator).

JOINT OCEANOGRAPHIC INSTITUTIONS, INC.

REPORT FROM JOI INC.

JOI Site Survey Program

The Request for Proposal to perform the Bahama-Blake Site Survey associated with proposed ODP Leg #2 was issued on August 23, 1983. Two responses were received by the closing date, 30 September 1983, and these are under review by an evaluation team designated by Frederick Duennebier, Chairman of the JOI Site Survey Planning Committee. The team will meet 2-3 December in San Francisco to hear verbal presentations from competing PI's and formulate an award recommendation.

Ocean Drilling Program - FY 84

Texas A & M University issued the Request for Proposal for a drillship time charter on 8 September and responses are due 8 November 1983. Business and technical review panels have been appointed and will meet during the week of November 14 to evaluate the proposals. December 15 has been targeted as the selection date. There were nine prospective respondents at a bidders conference conducted by TAMU in Houston on 29 September 1983.

IPOD SITE SURVEY DATA BANK

The IPOD Site Survey Data Bank at Lamont-Doherty Geological Observatory has recently (July-September 1983) received the following data:

- -Final report for Mesozoic Pacific IPOD Site Survey (R/V Kana Keoki Cruise 81, Leg 6), from T. Shipley.
- -Navigation plot and seismic profile from M/V Farnella (relating to Leg 94, site 3A), from C. Jacobs.
- -Catalogues for French Oceanographic Expeditions, 1977, 1978, 1980, 1981, 1982, from CNEXO-BNDO, France.
- -Preliminary report of Hakuho Maru Cruise KH 82-4, "Geophysical and geological Investigation of Seafloor Around Ogasaware (Bonin) Islands, Amami Plateau and Southwestern Part of the Sea of Japan", from Ocean Research Institute, University of Tokyo.

RECENT JOIDES PANEL AND COMMITTEE MEETINGS

June 1983	1-3	Planning Committee (Morpeth, England)
July 1983	27-28	Inorganic Geochemistry Panel (SIO)
August 1983	24-26	Ocean Crust Panel (Halifax, N.S.)
	25-26	Ocean Paleoenvironment Panel (URI)
	30-31	Executive Committee (Swindon, England)
September 1983	1-2	Passive Margin Panel (SIO)
	13-15	Planning Committee (U of Washington, Seattle)
October 1983	13-14	Information Handling Panel (Texas A & M University)

FUTURE JOIDES PANEL AND COMMITTEE MEETINGS

November 1983	9-10	Executive Committee (Texas A & M)
	15-17	ODP Downhole Measurements Panel (Albuquerque, NM; Tentative Date)
	28-29	Site Survey Panel Meeting (Tentative Date)
January 1983	10-13	Planning Committee (Texas A & M)
March 1983	6-7	Executive Committee (Washington, D.C.)

FOCUS

LETTER FROM THE PLANNING COMMITTEE CHAIRMAN

The science advisory structure of the new drilling program is now a reality. At the last Planning Committee meeting in Seattle, WA (13-15 September 1983) a nucleus membership for each of the panels was nominated. Approximately half of the nucleus membership of the three thematic panels (Ocean Lithosphere, Tectonics, and Ocean Sediments and History) and the five regional panels (Atlantic, Central & Eastern Pacific, Indian Ocean, Southern Oceans, and Western Pacific) is composed of scientists without previous experience on JOIDES advisory panels. The Planning Committee feels strongly that as many scientists as possible should particpate in the JOIDES science advisory structure during the 10 or so years of the new drilling program. Membership of the Planning Committee will be renewed every four years and, commencing in January 1984, one quarter of its members will be replaced. The membership of all but one of the service panels remains fairly intact, as the pool of specialists is rather limited. The major exception among the service panels is the Downhole Measurement Panel whose membership has been changed. Seven logging specialists belonging to the oil industry, USGS and Sandia Laboratories have been invited to join the DMP to bring the panel abreast of the most recent technological developments in wireline logging. We are having some difficulty getting the Engineering and Technology Development Committee (ETDC) started because it is proving to be the most difficult to populate. The mandate of this panel calls for PCOM to nominate engineers whose responsibility it would be to ensure that the proper drilling tools/techniques are available to meet the objectives of targets to be drilled according to the planned schedule and to help JOI/Science Operator write RFP's leading to the development of necessary tools/techniques. We would appreciate receiving suggestions to staff the ETDC. Letters of invitation to nominees for all the new panels have been sent by the JOIDES Office and we are awaiting replies. Most of the service panels will have met once before Christmas, and as soon as the membership is firm, the other new panels will be requested to meet to begin consideration of the initial legs of the new drilling program. Planning for the first 18 months (approximately 9 legs) is already underway and two working groups (Norwegian and Mediterranean) have been established by PCOM and will soon meet to begin planning for those legs. Meanwhile, the existing advisory structure will continue to function until all work relating to IPOD legs is completed.

At the request of the Executive Committee, I have prepared an announcement of the new drilling project which will appear in several scientific journals in the U.S. and abroad. The purpose of the announcement is to extend an invitation to the scientific community at large to participate in the ocean drilling program. The announcement will request proposals and will provide information on the evaluation process leading to actual drilling. We hope the announcement will promote the "openess" of the drilling program and lead to increased partcipation. I will present the draft of the announcement to the Executive Committee at the November meeting at Texas A & M University. The announcement will also be published in the next issue of the JOIDES Journal.

The uncertainties relating to the new drillship will begin to dissipate at the November EXCOM meeting. By that time the bids for the new drilling platform will have been received and conversion costs and time requirements will be known in a general sense. On 8 November, the day before the Executive Committee meeting, the Glomar Challenger will dock at Mobile, Alabama, after the completion of Leg 96, the final leg of the International Phase of Drilling.

We extend our sincere congratulations to the Deep Sea Drilling Project staff and to Scripps Institution of Oceanography on the successful completion of the drilling phase of one of the most significant projects in the history of science.

J. Honnorez

JOIDES COMMITTEE AND PANEL REPORTS

EXECUTIVE COMMITTEE

A. Berman, Chairman

The Executive Committee met 30 August-1 September 1983 at NERC Headquarters in Swindon England. Items from the minutes of that meeting are reported here.

JOI Board of Governors Report

J. Baker, JOI President, reported.

The BOG approved the AODP proposal on 8 July; the proposal was then sent to NSF on 15 July. The drilling ship RFP was delivered to NSF on 29 August. An NSF review panel is expected to convene on 21 September.

A JOI newsletter is being distributed monthly to keep the community aware of progress in the Advanced Ocean Drilling Project.

An award has been made to the University of Hawaii for site survey of the Peru-Chile target area. The closing date for the Bahamas RFP is 30 September.

National Science Foundation Report

G. Gross (NSF) reported that activity dealing with ocean drilling at NSF has increased since approval of the ocean drilling budget. Efforts have shifted from Explorer to a leased drilling vessel. Effective 1 October, ocean drilling will become a program in the Ocean Sciences Division, reporting to Division Director. S. Toye (NSF) will head the program.

Budget

S. Toye reported on ocean drilling. Much progress has been made since the April EXCOM meeting. The AODP has received Administration approval, as well as budgetary approval.

Additional funding in the amount of $4.5M has been released for FY 1983. $2.0M will go to DSDP for completion of work (publications, etc.) relating to the current drilling project, and $2.5M for AODP (US site surveys, planning, etc.).

The FY 1984 budget is intact at this time. The NSF appropriation has been signed by the President. Funds will be available in the fall for ship conversion, staffing, shakedown cruise, etc.

We estimate that $29.5M will be available for ocean drilling in FY 1984. Of that amount, $26.3M will be from the US and $3.2M from DARPA and IPOD members.

The FY 1985 NSF budget is under consideration in the Executive Branch, so details are not yet available. The ocean drilling budget for FY 1985, however, is planned at the same (FY 1984) level in both the optimistic and pessimistic budget models. A clear endorsement has been given for full support of the first field year of AODP.

Should an unforeseen financial problem arise, it could be accommodated by a late start in drilling or deferrance of some capital costs. Funding for subsequent years could be a problem, however, if the estimated costs for ship conversion and operation are substantially in error. The actual costs will be known when the responses to the RFP are evaluated.

Other items

NSF will review the JOI Proposal for management of AODP on 21 September. IPOD members have been invited to nominate reviewers.

DSDP is proceeding normally during the final legs. Some functions are phasing down whereas some (publications, etc.) will continue at the normal level. $0.75M recovered from Explorer contracts is being made available to the ongoing drilling program.

DARPA will reimburse NSF for the Tonga Trench leg; the funds will be available to DSDP for FY 1984 Challenger expenses.

International

Canada and the Foundation have agreed on the final language of the Memorandum of Understanding (MOU) leading to candidate membership in AODP.

Brazil has expressed increased interest in joining AODP. The "Interagency Council" which oversees ocean science in Brazil is considering creation of a committee to explore Brazilian membership in AODP.

NSF Personnel

A. McLerran, the NSF representative at DSDP, will retire at the end of September.

S. Toye will be in charge of the ocean drilling program.

A. Sutherland at NSF will be in charge of engineering/operations relating to AODP.

H. Zimmerman will be Program Associate for Science Coordination. He will represent NSF at the Planning Committee and JOIDES panel meetings beginning 1 September 1983.

Deep Sea Drilling Project Report

M. Peterson reported for DSDP.

It is anticipated that the DSDP budget for this year will end in the black. The project plan was submitted to NSF in July, then resubmitted after consultation with NSF for a basic project cost of $6.7M in FY 1984. This is a phase down budget with the number of DSDP personnel reduced from 100 to 57.55 persons. Some added functions would require an additional 10 persons at the end of the year. Engineering, operations and logistics will be totally phased out at the end of the year; science services and project management will continue. Approximately 36 months will be required for publication of the outstanding Initial Reports. The add-on functions mentioned earlier include: core maintenance; increasing the publication rate of the Initial Reports; data handling and increased computer input; compilation of a shipboard techniques handbook; and compilation of a comprehensive index of the Initial Reports.

DSDP Budget

Phase-down budget - $6.7M:

$235K	Personnel
$7-10K	Science & Engineering
$300K	Index (Initial Reports)
$ 38K	Core Photography
$580K	

Leg 95 (Northeast Atlantic Paleoenvironment)

The glacially sensitive area off Newfoundland was successfully cored. The HPC (hydraulic piston core) gave a very high rate of recovery; about 3400 m of core were recovered. The advanced HPC was a success but it did fail on a run following a 100,000 lb. pull-out. The failure could have been related to the strain experienced on the pull-out, or to the bumper sub assembly.

Leg 95 (ENA-3)

Drilling will proceed quickly (without core recovery) in the section previously drilled. A new type of "diamond drag bit" is being used and will be evaluated. A ship belonging to Shell Offshore Incorporated (SOI) is also drilling in the same area. Scripps (SIO) expects some confusion in the press regarding drilling.

The wire-line reentry is ready for testing, but so far a test has not been scheduled.

Demobilization

The Challenger will be demobilized in the Galveston area. A shipyard has not yet been selected. Twelve days will be required to strip the vessel before delivery to Global Marine. DSDP and TAMU are currently deciding on equipment now aboard Challenger to be transferred to the new AODP vessel.

Planning Committee Report

J. Honnorez, PCOM chairman, reported.

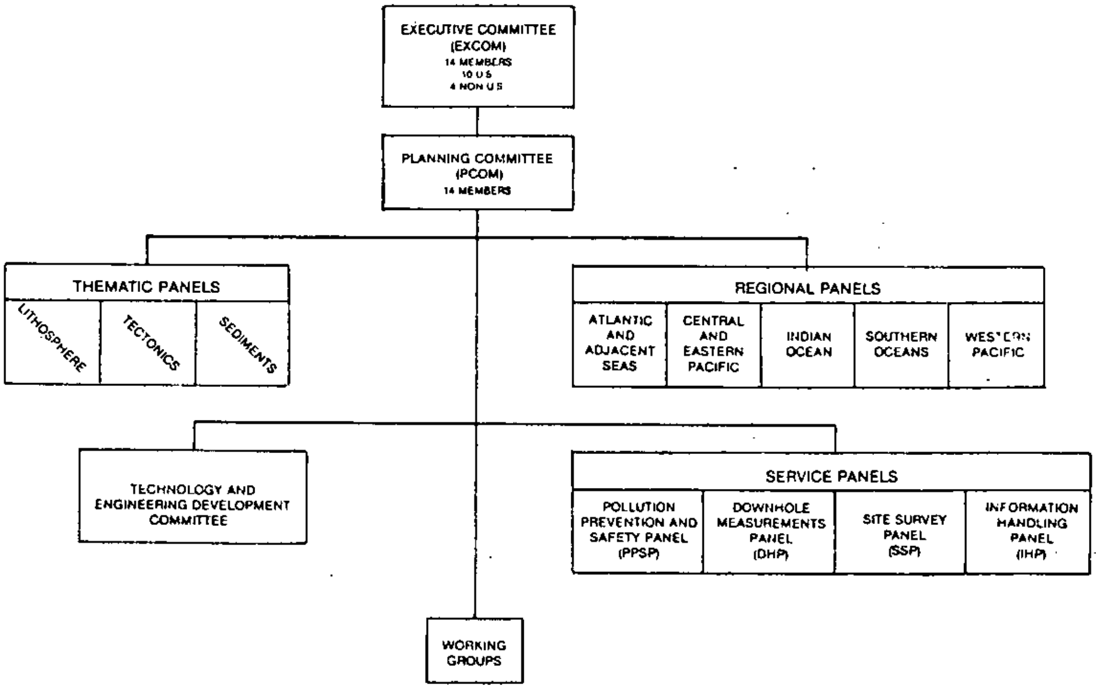
Science Advisory Structure

J. Honnorez presented a diagram (Fig. 1) of the proposed JOIDES organization and Science Advisory Structure. He noted that the structure incorporated changes suggested by the Executive Committee at their 19-20 April 1983 in Easton, Maryland. The number of thematic panels, for example, has been reduced from five to three. Five regional panels with overlapping geographic boundaries are part of the new structure (Fig. 2).

Most of the Planning Committee members met as several ad hoc groups during the field trip after the 1-3 June 1983 PCOM meeting in Morpeth, England to compile a list of potential panel chairmen and members. The planning Committee expects to designate panel chairmen and most panel members at the September PCOM meeting in Seattle, Washington. Funds are available for phasing in the new advisory structure, and to support the existing structure until DSDP matters are completed.

The Planning Committee requests that the Executive Committee define PCOM terms of membership. (Other PCOM matters were discussed later as separate agenda items.)

JOIDES ORGANIZATION



A draft statement of PCOM membership resulted and after discussion and modification, was introduced as a motion and adopted.

Move that the draft PCOM membership statement be submitted to the Planning Committee for comments and suggestions for implementation:

Draft:
Membership of Joides Planning Committee
Committee Advanced Ocean Drilling Program

Each member of the Executive Committee shall designate one member of the Planning Committee and an alternate to serve in the absence of the designated member. Commencing January 1, 1984, one quarter of the Planning Committee members shall rotate off the Committee annually, so that its membership is replaced every four years. Reappointment shall be made only in exceptional circumstances. All appointeees to the Planning Committee shall satisfy the fundamental criteria of having the ability and commitment to provide mature and expert scientific direction to the program. Balance of fields of specialization on the Planning Committee shall be maintained, as far as possible, by informed consultation amongst the U.S. member institutions prior to selection of their appointees. The chief scientists of the science operations and wireline logging contractors and an appointee of the NSF are non-voting, liaison observers.

Discussion revealed no major faults with the proposed AODP advisory structure. The following motion was adopted:

The Executive Committee accepts and approves in concept the science advisory structure presented by PCOM and illustrated in Figure 1.

Core Repository

J. Honnorez requested that the Executive Committee consider PCOM recommended actions dealing with core curation. (The following six PCOM recommendations appear on page 78 of the June 1983 issue of the JOIDES Journal.)

PCOM recommendations:

1. The existing sample distribution policy should be adopted without substantial change.

2. One core curator should be in charge, regardless of the number of repositories.

3. One core repository having a convenient location should house all existing and future cores.

4. Initial Core Descriptions should be reinstated.

5. HPC cores should be routinely x-radiographed and videotaped.

6. Sample distribution should be accomplished within 2 months of receipt of request.

The Executive Committee adopted the following modified PCOM recommendations:

1. The existing sample distribution policy is adopted without substantial change.

4. Initial Core Descriptions should be reinstated in the published form.

6. It is desirable that sample distribution should be accomplished within 2 months of receipt of request.

PCOM recommendations 2, 3 and 5 were **not** adopted by the Executive Committee.

Member Country Reports

France (B. Biju-Duval reported.)

Not much to report since the April EXCOM meeting. The final phase of IPOD is underway in France and the annual meeting to discuss IPOD results has been scheduled and will be held in Brest. The science community in France is pleased that the new drilling program appears to be well underway. A committee has been asked to review and coordinate science for the new ocean drilling program (proposals, site surveys, etc.). Part of the 1984-85 ocean science activity in France will be related to the AODP. The R/V Jean Charcot, for example, will circumnavigate the globe and may survey target areas.

A problem in France is membership in AODP. The problem is not with the science or with 1984 funding; the problem is with possible funding difficulties beyond 1984 (FY=January). These issues are now under consideration. Membership will first be considered by the French IPOD committee next week; then examined by a separate committee; then by the CNEXO scientific committee. A final decision will come after recommendations by the various committees; until that time, membership is not assured. Other internal expenses relating to AODP (geophysics, shore-based laboratory studies, additional equipment, etc.) will also be considered before a final decision is reached.

Germany (H. Durbaum reported.)

Germany is optimistic that it will join the AODP. Minor issues to be resolved before signing the MOU were discussed at a meeting in Bonn last week. The various interest groups (funding agencies, research societies, Ministry of Research and Technology, etc.) all endorsed membership in AODP.

Last month geological and geophysical studies were carried out in the South China Sea area. These studies have led K. Hinz and others to reconsider accepted ideas about subduction. A potential problem is the availability of survey ships. Meteor may be removed from service. A decrease in the use of vessels by industry will result in higher costs to be born by government agencies.

United Kingdom (J. Bowman reported.)

The AODP ship bidders meeting was attended by a UK representative. An IPOD meeting has not been held in the UK since prior to the April EXCOM meeting. It is expected that activity will soon increase in both science and funding considerations. As a rule science funds are protected in the UK, but some difficulty is expected. The UK is reasonably optimistic that it will join the AODP. It is hoped that the MOU will be signed within a few days.

Japan (N. Nasu reported.)

Not much has changed since the April EXCOM meeting. The Japanese IPOD committee hopes to continue as part of AODP. Japan is optimistic but a final decision by the Japanese Government has not yet been made.

DSDP results have received much publicity in Japan. The widely circulated and respected journal Koroku (Science) recently devoted a special issue to DSDP results. Other government agencies are made aware of the scientific achievements and importance of ocean drilling through such publicity.

Observer reports:

European Science Foundation (B. Munsch reported.)

Membership in AODP was put before the ESF Executive Council at the end of June. The Council unanimously agreed to proceed toward eventual membership. After an initial survey of ESF members, each country was asked for a formal declaration of interest. A deadline of 20 September was set for receipt of the statements of interest. The Executive Council will meet again that same week. A final decision is expected by 10 December.

Possible member countries include:

Sweden
Netherlands
Norway
Switzerland (Parliament unlikely to agree to AODP membership)
Italy (no response)
Denmark (uncertain interest)
Belgium (uncertain interst)
Finland (uncertain interest)

Discussion:

S. Toye (NSF) - What has been the response to the request for a formal statement of interest? B. Munsch - Only the Irish Research Council has replied to date (negative reply).

Sweden (K. Bostrom reported.)

Interest in AODP is increasing among Swedish scientists. Interest in Norway appears to be at about the same level as before. The response from Finland has been low and generally not positive. Denmark is showing some interest and is considering sending an observer to JOIDES meetings.

Netherlands (J. Stel reported.)

Discussion in the Netherlands about AODP and potential membership have increased since the April EXCOM meeting. There is an interest to join AODP, but a decision would be influenced by the level of interest among other non-US countries.

Involvement through ESF needs more definition of the role of the smaller European countries.

Discussion:

S. Toye (NSF) - The Foundation wishes to clarify that the AODP is an international program. Although the US can fund the initial phase of AODP, the continuation of AODP is dependent on non-US participation.

Canada (M. Keen reported.)

An application to spend existing money for candidate membership is pending with the Treasury Board of the Canadian Government. If and when that is received and MOU will be signed. I am hopeful that will happen within a few weeks.

A Canadian Planning Committee is in existence and beginning to function. It will produce an "Australia" type planning document. A sub-set has just produced a draft proposal for the Labrador Sea which will go via Charlotte Keen to the Passive Margin Panel this week. A lot of work is in progress off the west coast which could lead to a proposal.

Mel Peterson (DSDP) and Yves Lancelot (DSDP) hosted David Strong and Chris Barnes (Memorial University) and M.J. Keen on Challenger in St. John's, Newfoundland. This was useful because D. Strong is a member of the Natural Science and Engineering Research Council of Canada (the equivalent of the US NSF) and C. Barnes is interested in seeing a Canadian AODP headquarters at Memorial University.

It is worth pointing out that our Dr. Hutchison spoke generally about a consortium with both Australia and the European Science Foundation.

New Zealand (F. Davies reported.)

Attempts to involve New Zealand in the Advanced Ocean Drilling Project were turned down by the New Zealand Cabinet. It is unlikely that membership will be reconsidered until a general improvement in the economy occurs. Reconsideration may not occur for 4 or 5 years. New Zealand hopes to continue to be involved in the ocean drilling project through its individual scientists. New Zealand thanks the Executive Committee for its invitation to participate as an observer.

AODP Management Proposal

J. Baker, JOI President, reported.

The JOI mangement proposal was distributed to all EXCOM members. It was sent to NSF on 15 July, and some comments from NSF have been received. During the past 2 months the major activity has dealt with drilling vessel RFP. It was delivered to NSF this week (29 August).

AODP Science Operator Report
Texas A & M University

W. Merrell, AODP Principal Investigator, reported.

The drilling vessel RFP was assembled by TAMU in consultation with Doty Associates, a private firm.

The request covers 10 years, a 1 year startup and 9 years of drilling.

The scientific and technical requirements were based on many sources including various JOIDES and JOI reports, and input from JOIDES via the PCOM chairman. The RFP schedule is:

7 September	Mail RFP
29 September	Bidders Conference at Houston
8 November	Bids Due

The RFP states the different weight levels for criteria of acceptance. The RFP has also been advertised in the Commerce Business Daily, Wall street Journal, trade journals, etc. The time required for the selection process will depend on the number of bids received.

L. Garrison, JOIDES Safety Panel chairman, has been appointed Deputy Project Director for AODP at TAMU.

The AODP building at TAMU will have 36,000 sq.ft. of assignable space. An actual building plan will be available within a few months.

J. Honnorez, JOIDES PCOM chairman, has been asked to convene an Information Handling Panel meeting so that the required space can be planned for.

U. Texas facilities at Galveston have been made available to DSDP for Challenger demobilization.

Figure 3 indicates the project organization at TAMU.

AODP Logging Proposal - LDGO

R. Anderson reported.

LDGO has formed an Institute of Borehole Geophysics with R. Anderson as head.

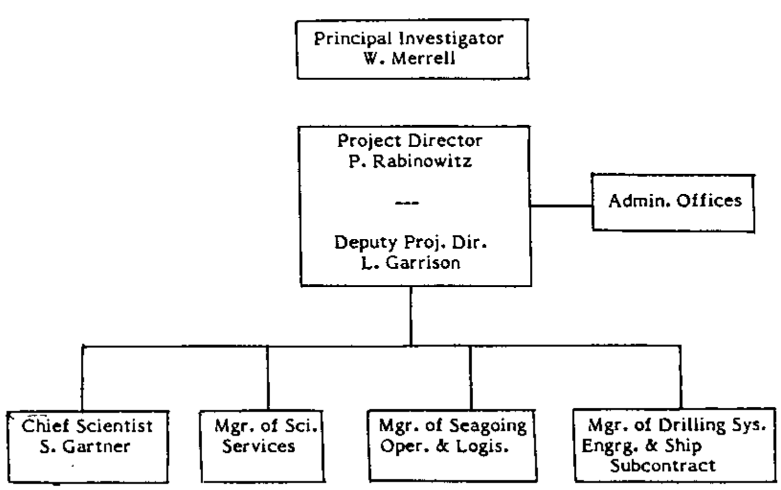
As recommended by PCOM, standard tools will be operated by a commercial logging firm. Schlumberger has been selected because of numerous benefits to the project. Schlumberger has a huge research budget and is the leader in advanced logging technology. The same standard tools used on Challenger will be employed on the new ship. A difference between DSDP and AODP is that a logging engineer will be on permanent assignment to LDGO.

The Schlumberger contract price is non-negotiable. The cost is $1.183M/yr. with the price tied to ther Africa scale costs and recalculated on 31 December.

Specialized tools planned for AODP include:

Science Operator

TAMU/AODP Organization Chart



- borehole televiewer (almost operational at this time) with digital image enhancement.

- 12 channel sonic logging tool for small refraction experiments.

A shipboard logging computer will give real-time analyses.

Scientists will be able to visit the LDGO analysis center for further logging studies.

It is felt that AODP should eventually operate its own standard logging tools. The EXCOM should set up a logging advisory panel so that AODP can keep up with the latest logging technology available in Germany and in numerous oil comparnies (ARCO, EXXON, Shell, etc.).

Discussion:

M. Peterson (DSDP) - Will the Challenger shipboard computer be used? R. Anderson - No. A $80K dedicated minicomputer will be used.

N. Nasu (Japan) - The Challenger produces good logging data only if the seas are calm. Will this situation be improved? R. Anderson - Yes. We plan to tie the logging cable directly to the heave compensator.

J. Steele (WHOI) - Discussions at JOI revealed a need to separate routine logging from downhole measurements work, that is to separate routine work from development work. WHOI has a proposal with JOI to coordinate and supervise the development of downhole measurements for the US community.

M. Peterson - There may be a problem with liability for loss of logging tools; the science operator and logging contractor may share joint responsibility.

R. Anderson - JOI has set up an Interface Working Group to examine this problem. TAMU will insure the tools as part of the insurance package.

H. Durbaum - How are new tools incorporated into the program; e.g. a 3-D magnetometer is available in Germany? R. Anderson - The proposed logging panel would consider new tools.

J. Honnorez - The logging panel could be a panel by itself or a subgroup of the new Technology and Engineering Development Committee.

Consensus:

Logging differs from the concerns of the Downhole Measurements Panel. A logging panel should be part of the advisory structure. The Planning Committee should determine the status of the logging panel.

The panel would consist of geologically competent and technologically expert people capable of advising the AODP wireline services contractor regarding future program plans and existing technological problems. The group should be drawn from all facets of the worldwide logging industry (e.g. mining, petroleum, geothermal, etc.).

The following motion was adopted:

The JOIDES Executive Committee authorizes the Planning Committee to reinstate the Logging Advisory Panel as a component of the AODP advisory structure.

AODP Drilling Schedule - 1st Year

J. Honnorez presented the first year proposed drilling plan formulated by the Planning Committee (Table 1).

The October 1984 start date requires that the initial targets are selected now, so that preliminary work (site survey, safety, etc.) can be completed in time for drilling. The plan starts from the east coast of the US.

The Gulf of Mexico target does not yet have a formal proposal because Leg 96 results are not yet available.

The Bahamas has been considered under the DSDP program. A site survey RFP has already been issued.

The Mid Atlantic Ridge site is technically difficult and the science operator is therefore under some pressure to develop the technology for bare rock drilling.

The following motion was adopted:

The Executive Committee endorses the 1st year AODP drilling plan of PCOM shown in Table 1.

EXCOM Terms of Reference

J. Clotworthy (JOI) reminded the Executive Committee that the EXCOM Terms of Reference were sent to each member as part of the meeting package.

Table 1

PROPOSED FIRST YEAR DRILLING
and
SHIPTRACK 1984-1987

1984	Oct	Gulf of Mexico	1985	Dec	Mediterranean Sea (or
	Nov	"	1986	Jan	Equa. Fracture Zone)
	Dec	Bahamas		Feb	NW Africa
1985	Jan	"		Mar	"
	Feb	Barbados (T)		Apr	Costa Rica/Venezuela
	Mar	"		May	/Columbia (T)
	Apr	Mid Atl. Ridge (T+)		Jun	Hole 504B
	May	"		Jul	"
	Jun	Labrador Sea		Aug	Peru Trench (T)
	Jul	"		Sep	"
	Aug	Norwegian Sea		Oct	Chile (triple junction)
	Sep	"		Nov	"
				Dec	Weddell Sea
			1987	Jan	"

Note: First 6 legs are definite. First 18 months require consideration.

Discussion revealed that additional changes to Annex B may be required. EXCOM requested that J. Clotworthy reexamine the document and make any required changes.

J. Clotworthy also distributed a list of erata for the JOI AODP Management Proposal submitted to NSF.

Flow of AODP Proposals

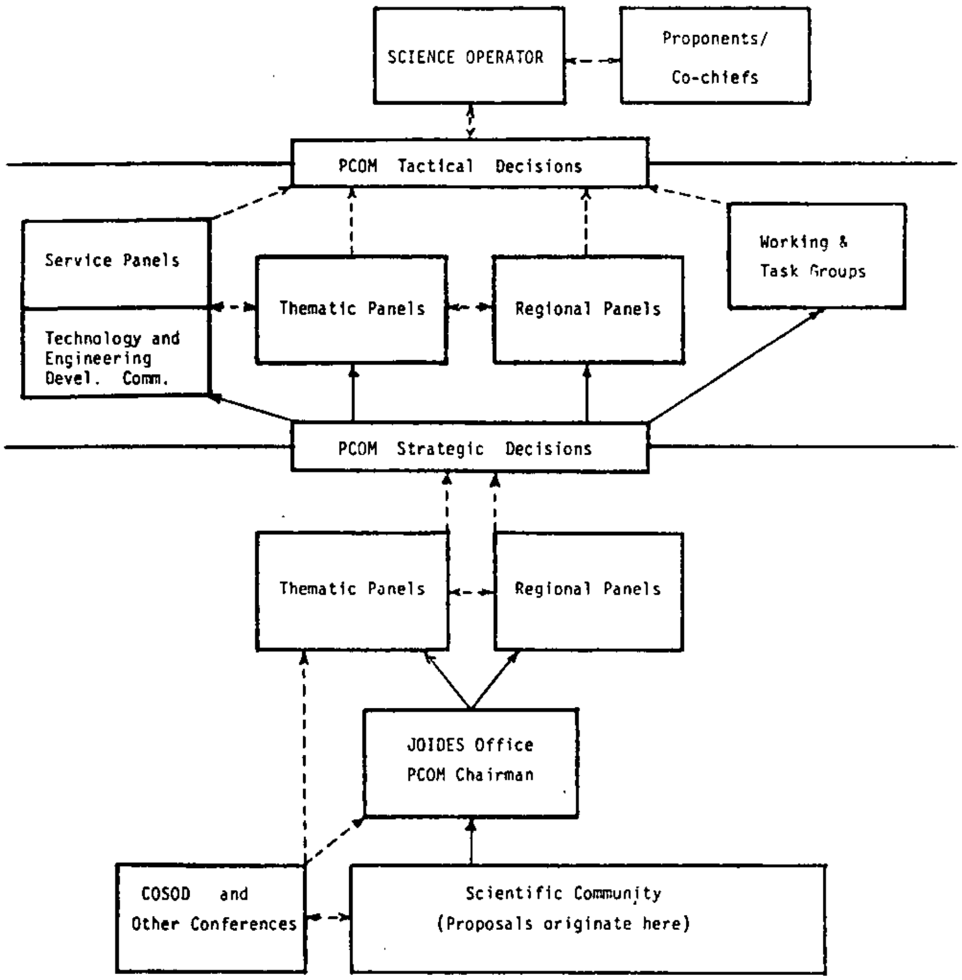
J. Honnorez presented the schematic flow chart (Fig. 4) for consideration by the Executive Commitee.

Consensus:

Figure 4 is somewhat confusing. It is important that the procedure for submitting drilling proposals be made widely known to the scientific community.

J. Honnorez should compose a statement explaining the proposal and planning process, and solicit input from the community. The notice should be published in EOS and Geotimes.

Members of the Executive Committee will try to have the notice published in their respective countries or institutional newsletters.



JOIDES DSDP Panel Records

J. Honnorez requested that the Executive Committee decide on the fate of records belong to JOIDES panels.

R. Berman appointed J. Clotworthy (JOI), M. Peterson (DSDP/SIO) and J. Honnorez (PCOM chairman) to determine a policy for the records and to report their recommendations to the Executve Committee at the next meeting.

BRAZIL - POTENTIAL ADOP MEMBER

A. Berman informed the EXCOM that NSF requires some guidance in pursuing Brazilian interest in becoming an Ocean Drilling Program member. The requirements for membership are stated in Annex A:

"The members of this (Executive) committee shall be representatives of oceanographic and marine research institutions or other organization which have a major interest in the study of the sea floor and an adequate capability in terms of scientific manpower and facilities to carry out such studies."

Consensus:

Brazil qualifies as a potential member of the AODP. NSF is reminded that membership is limited to civilian (non-military) organizations.

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