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LEGS 68-82—Tentative GLOMAR CHALLENGER Schedule*

Leg	Port of Departure	Leg Begins	Leg Ends	Days At Sea	Purpose
68	Curacao	13 Aug 1979	18 Sept	32	HPC—Paleoenvironment
69+	Guayaguil	18 Sept	29 Oct	40	Costa Rica Rift
70	Balboa	03 Nov	16 Dec	43	Galapagos Spreading Center—Mounds Area
TRANSIT—Callo, Peru to Stanley, Falkland Islands					
71	Stanley, Falkland Islands	06 Jan, 1980	15 Feb	40	Falkland Plateau Paleoenvironment
72	Santos, Brazil	20 Feb	02 April	42	Rio Grande Rise Paleoenvironment
73	Santos	07 April	25 May	48	Mid-Atlantic Ridge Paleoenvironment
74	Cape Town	30 May	09 July	40	Walvis Ridge, Cape Basin Paleoenvironment
75	Walvis Bay	14 July	02 Sept	50	Walvis Ridge, Angola Basin—Paleoenvironment
TRANSIT—Recife to Port of Spain (Curacao)					
76	Port of Spain	16 Sept	05 Nov	50	Blake-Bahama-Passive Margin
77	Nassau	10 Nov	28 Dec	48	Florida Straits—Passive Margin
78	Curacao	02 Jan, 1981	15 Feb	44	Caribbean
79	Curacao	25 Feb	19 April	53	Off W. Africa/Portugal Passive Margin
80	Brest	24 April	09 June	46	Bay of Biscay Passive Margin
81	Plymouth	14 June	06 Aug	53	Rockall—Passive Margin
82	Halifax	11 Aug	30 Sept	50	U.S. east coast, Delaware Rise—Passive Margin
83	Norfolk				

*This is a major revision from the previously published schedule (revised 09/11/79)

+Leg 69 I.R. will include instrumental mini-leg Leg 68/Site 501

SUMMARY OF DEEP SEA DRILLING PROJECT

LEG 65

(Co-Chiefs: B. Lewis and P. Robinson)

The principal objective of Leg 65 was to sample oceanic crust near the crest of the fast-spreading East Pacific Rise (EPR). Drilling was planned near the mouth of the Gulf of California where high sedimentation rates make it possible to spud into nearly "zero-age" crust. The crust in this area has relatively high in situ compressional wave velocities, similar to those of old oceanic crust in the Atlantic Ocean successfully drilled at Sites 417 and 418.

Four sites were occupied and a total of 15 holes were drilled, 8 of which reached basement (Figure 1). Re-entry holes were started at Sites 482 and 483, but both were lost because of operational problems.

Site 482

Site 482 (GCA-1) lies about 12 km east of the axis of the EPR and about 15 km south of the Tamayo Fracture Zone. The age of the crust as determined from magnetic anomalies is about 0.5 Ma, and the sediment thickness from reflection data is about 150 m. The principal objectives of this site were to drill a deep re-entry hole into young oceanic crust, to log the hole, and to install a downhole seismometer into the crust to record natural seismicity for a two-month period.

Seven holes were drilled at Site 482, only four of which reached basement. Hole 482 recovered only a mud line core, 482A was drilled to 44 m, and 482B to 229.0 m. Hole 482C was a single bit hole drilled from 44.5 to 186.5 m for emplacement of the downhole seismometer. The first re-entry hole, 482D, was drilled to a depth of 186.5 m before the pipe became stuck and had to be blown off. Hole 482E recovered no core, being washed to a depth of 48.5 m while attempting to set casing for a new re-entry hole. Finding that the casing could not be washed down to full depth in Hole E, it was pulled out and washed down again in Hole F. Hole F was then cored from 49 to 56.5 m, washed from 56.5 to 113.5 m, and then continuously cored to 145 m.

The principal holes, 482B, C, and D are about 100 m apart and lie along a line roughly at right angles to the ridge axis and to the axis of the sediment pond in which the site is located, Hole D being closest to the pond axis.

Approximately 137 m of sediment overlie acoustic basement at this site. The sediments are predominantly olive gray, hemipelagic clay to silty clay with an average composition of 60–70% clay, 30–35% silt, and 0–5% sand. Biogenic material includes calcareous nannofossils, foraminifers, radiolarians, and diatoms. Rare layers of silty sand with abundant detrital minerals and reworked foraminifers are interpreted as fine-grained turbidites. These layers contain abundant quartz and feldspar and lesser quantitites of amphibole, mica, zircon, and tourmaline, all indicative of a continental source. The turbidites were probably derived from sediment previously deposited on the continental shelf and slope of the Mexican mainland. Sands and silty sands are somewhat more abundant in the section cored in Hole D than in the other holes, suggesting that turbidite deposition was greatest along the axis of the sediment pond.

Recovery of the basal sediments above basement was poor but sediments near the contact show some induration and dehydration. The top of the basalt was usually marked by a glassy rim but no clear evidence of baking in the sediments was observed. Pyrite and dolomite rhombs increase downward in the lower 3.5 m of sediment and in Hole C several layers of dolostone occur just above the basement contact.

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All of the cored sediments above basement are probably Quaternary. The absence of the radiolarian species Druppatractus acquilonius, which occurs nearby at Site 475 of Leg 64, suggests an age of less than 310,000 years B.P. Nannofossils could fall into either zone NN21 beginning at 250,000 years B.P. or zone NN20, beginning about 400,000 year B.P. The calculated sedimentation rate ranges from a minimum of 343 m/Ma to a maximum of 548 m/Ma.

Numerous pieces of mudstone and siltstone were recovered within basement and many are indurated or dolomitized. Sedimentary layers were inferred only where sediments were actually recovered from a given interval, and the drilling rate was used

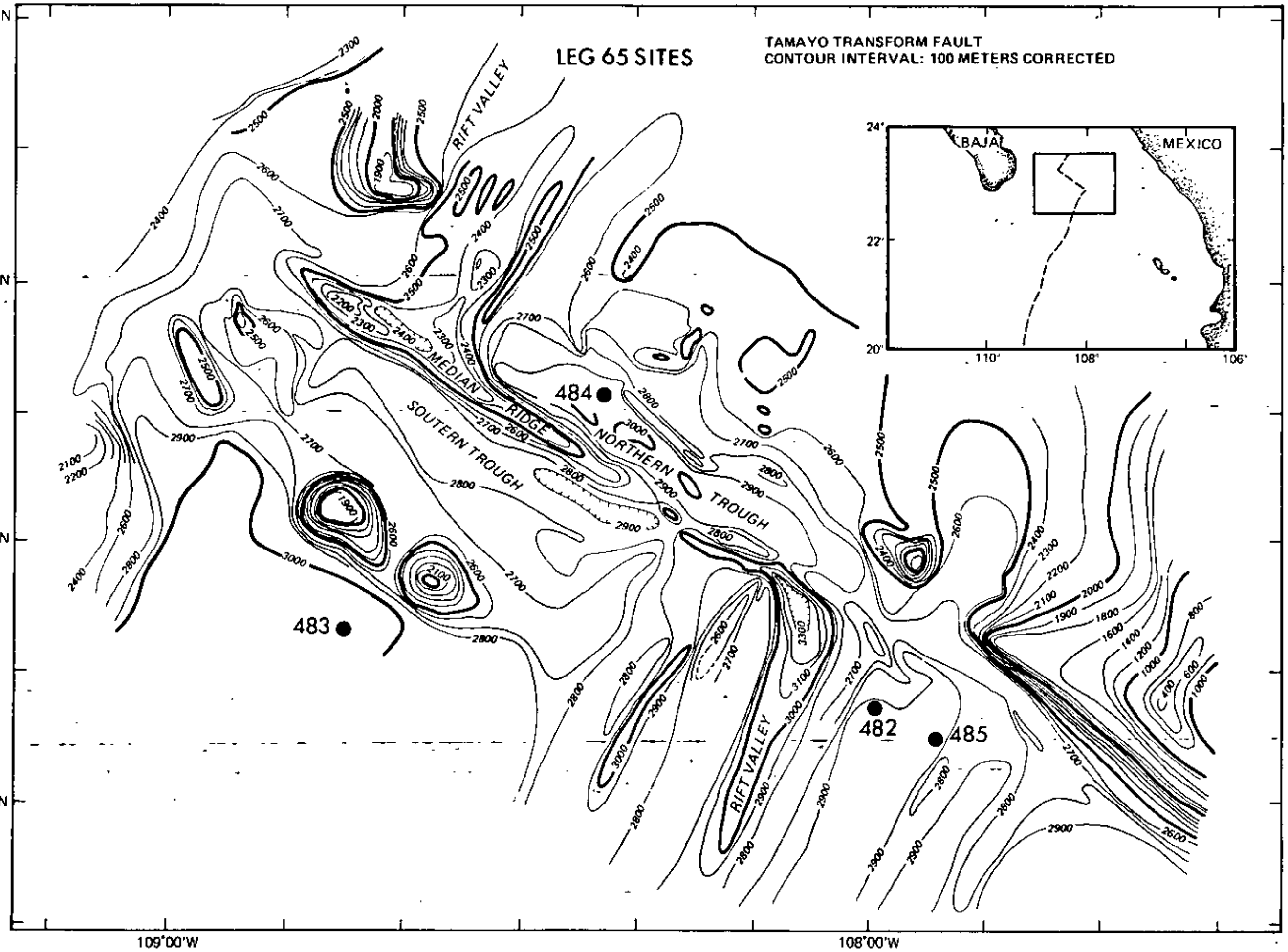

FIGURE 1: Site Locations for Leg 65 Sites

to determine probable thickness. Layers identified in this way range from 0.5 to 4.0 m in thickness, and are distributed throughout the entire drilled section.

Basement was cored in Holes 482B, C, D, and F. The deepest penetration was 90 m in Hole B; Holes C and D each penetrated about 50 m and Hole F about 8 m. Basement recovery averaged about 46% in Hole B, 57% in Hole C, 41% in Hole D, and 40% in Hole F.

Seventeen cooling units are recognized in Hole B, 8 in Hole C, 17 in Hole D and 1 in Hole F. Most cooling units are at least 5 m thick and some exceed 10 m. They are tentatively interpreted as submarine lava flows because of their thickness, lack of curved glassy selvedges, relatively coarse grain size, and lack of obvious intrusive relationships. The relatively coarse-grained nature of the basalts and the presence of interstitial ground-mass quartz indicate slow cooling of thick units, but are not considered proof of an intrusive origin. Some thinner cooling units between 0.5 and 1.0 m thick are present, particularly in Hole D; these might represent individual pillows, or more probably, thin flows because their glassy rinds are generally thin and flat, and vesicle zones, characteristic of pillow margins are absent. Obvious baking of basement sediments was not recognized but many of the sediments interlayered with basalts are indurated and dolomitized.

Most basalts are aphyric to sparsely phyric with up to 5% phenocrysts, chiefly plagioclase with minor amounts of green clinopyroxene and altered olivine. The phyric basalts occur in the lower parts of the basement section and are overlain by aphyric varieties. Ground-mass textures are generally medium- to fine-grained, intergranular to subophitic, and coarse grained with holocrystalline mesostasis in the central part of the thicker cooling units. Plagioclase and well-crystallized clinopyroxene are the most abundant groundmass minerals, with plagioclase being generally more abundant than clinopyroxene. Olivine and titanomagnetites are present in all specimens and range from about 2-5% each. The mesostasis is glassy (generally replaced by smectite) in fine-grained rocks; in coarse-grained rocks it consists of tridymite (?), quartz, and apatite needles.

The basalts are tholeiites with a composition characteristic of the East Pacific Rise. Fresh basalts have MgO contents generally between 6.5% and 8.5%, TiO_2 between 1.2% and 1.9%, Al_2O_3 between 14% and 17%, CaO between 11% and 13%, and K_2O less than 0.1%. Six chemical types have been recognized in the four basement holes. Two chemical types are recognized in the aphyric basalts and these cannot be related to each other by any simple fractionation scheme, making them good candidates for derivatives from separate parental melts. At least some of the phyric rocks may be related by phenocryst accumulation and fractionation, suggesting some high level crystal fractionation.

Although a temperature of about 90° C was estimated for the basement-sediment contact from heat flow measurements in Hole C, most of the basalts are not more altered than other oceanic tholeiites. Sparse vesicles (nearly always less than 1 volume per cent and less than 1 mm in diameter) and hairline fractures are filled with brown smectite, sometimes associated with carbonate and sulfide. Groundmass olivine and glassy interstitial material are replaced by smectite and serpentine (?) in thick cooling units and rarely by carbonate. This type of alteration is characteristic of low temperature interaction between basalt and sea water with probable deuteric alteration in thicker flows. The principal chemical changes associated with this type of alteration are losses of CaO and MgO and, in some rocks SiO_2, and increases in H_2O. However, enrichment in K_2O was observed in only one sample.

Higher temperature hydrothermal alteration was found in the upper part of Core 11, Section 2, Hole C. Here olivine and clinopyroxene have been partly to completely altered to chlorite and actinolite, possibly with associated zoisite (?) and sphene (?). These rocks are the first reported specimens of hydrothermally altered basalts from DSDP drill holes in "normal" ocean crust. Chemical trends in these rocks are quite different from those of low temperature alteration, as indicated by increases in MgO and Na_2O and losses of CaO.

Site 482 is located in crust with probable age of about 0.5 Ma and a positive surface magnetic anomaly (Bruhnes). The expected inclination of the axial geomagnetic dipole is about +39° and the expected range of magnetic inclinations due to secular variation is about +23° to +54°.

All reliably oriented specimens have positive magnetic polarities and the stable NRM inclinations fall within the range postulated for secular variation. The average inclination in Hole 482B is close to that expected from an axial diapole. Magnetic intensities in the basalts range from 2.6 x 10^{-2}g to 5.5 x 10^{-9}g. The median destructive field is low, ranging from 51 Oe in Hole C to 110 Oe in Hole D in keeping with the relatively coarse grain size.

Measured compressional wave velocities in the basalts range from 5.5 to 6.0 km/s and average about 5.8 km/s, reflecting the very fresh character of the rocks. Comparison with the in situ velocities suggests that the upper few hundred meters of basement contains about 7% water-filled cracks or interlayered sediments. Basalt densities range from 2.74 to 3.11 g/cm^3 and show velocity decrease with increasing alteration.

The close spacing of Holes 482B, C, D, and F and the relatively high recovery for East Pacific Rise basement afford an unusually good opportunity to compare lithologic, chemical and magnetic units in a transverse strip of 400,000-year-old oceanic crust about 50 m thick and 200 m long.

The correlation of lithologic units is excellent. An upper aphyric unit is 22 m thick in Hole 482B, 24 m thick in Hole 482C, and 29 m thick in Hole 482D. A sequence of sparsely plagioclase-phyric basalts underlies the aphyric basalts in all three holes, being 18, 26, and 39 m thick in Holes D, C and B respectively. In the aphyric basalts, thick cooling units predominate in the upper part and thin cooling units in the lower part in all three holes. Similarly, the phyric lithologic unit is characterized by thick cooling units in all three holes. A fairly close coincidence of chemical and magnetic units with lithologic units is also observed.

The recognition of discrete, sequential, lithologic, chemical and magnetic units that correlate quite well between holes suggests that basement at this site was emplaced as a series of eruptions of different or alternating compositions. The continuity of units over a 200-m interval and the regular stratigraphic succession argues against emplacement as intrusions.

Site 483

Site 483 (GCA-3) is located about 52 km west of the East Pacific Rise crest and about 25 km east of the base of the continental slope off Baja California, along a transect extending from Site 482 to Site 474, the latter having been previously drilled on Leg 64. The site lies in a NE-trending sediment pond about 8 km wide underlain by a very flat, regular basement reflector. The sediment thickness is estimated to be about 105 m and the water depth is 3088 m.

The primary scientific goal at the site was to sample the basement for lithologic, magnetic, and geochemical comparisons with rocks drilled at Sites 482 and 474, in order to characterize young crust formed at a fast-spreading ridge in an area of relatively high sedimentation.

Four holes were drilled at this site, including a multiple re-entry hole. Hole 483 was continuously cored to a sub-bottom depth of 204.5 m, of which 94.5 m were in basement. Holes 483A and B were drilled 100 m east of Hole 483; Hole A was a wash test in the sediments during which no cores were recovered and B was the re-entry hole. Hole 483B was cored continuously from 91.5 to 267.0 m sub-bottom with 157 m of basement penetration. Four cores were taken in Hole 483C, drilled 500 m east of Hole B; three of these were in sediment, and one in basement.

Basement recovery averaged 40% in Hole 483, 48% in Hole B, and 100% in Hole C. Sediment recovery, mostly in Hole 483, averaged about 67%.

Three units were recognized in the 110 m of sediment above basement. Unit 1 consists of 36.5 m of nannofossil marl and radiolarian ooze with minor clayey silty sand. Unit 2 extends from 36.5 to 52 m sub-bottom and consists of clayey silt grading downward into nannofossil marl and radiolarian-diatom mud. The lower 9 m of this unit consist of fine-grained silty sand, interpreted as a turbidite, which passes downward into silty clay and radiolarian-diatom mud. Except for the silty sand, the sediments of unit 2 contain abundant glass shards scattered through the core and concentrated in small patches of tuffaceous clay. Several fragments of indurated claystone contain abundant fresh and altered sideromelane shards, probably representing an hyaloclastite deposit. Unit 3 is a 58-m-thick interval of hemipelagic silty clay and clayey silt with a few siliceous fossils.

The sediments above basement are all estimated to be Quaternary. Cores 483-1 to the upper part of Core 5 (0-33 m sub-bottom) are assigned to zones NN20-21 and the Artostrobium miralestense radiolarian zone. Cores 483-5 (lower part) through 13 are assigned to zone NN19 and the Axoprunum angelinum and Anthocyrtidium angulare radiolarian zones. The lowermost

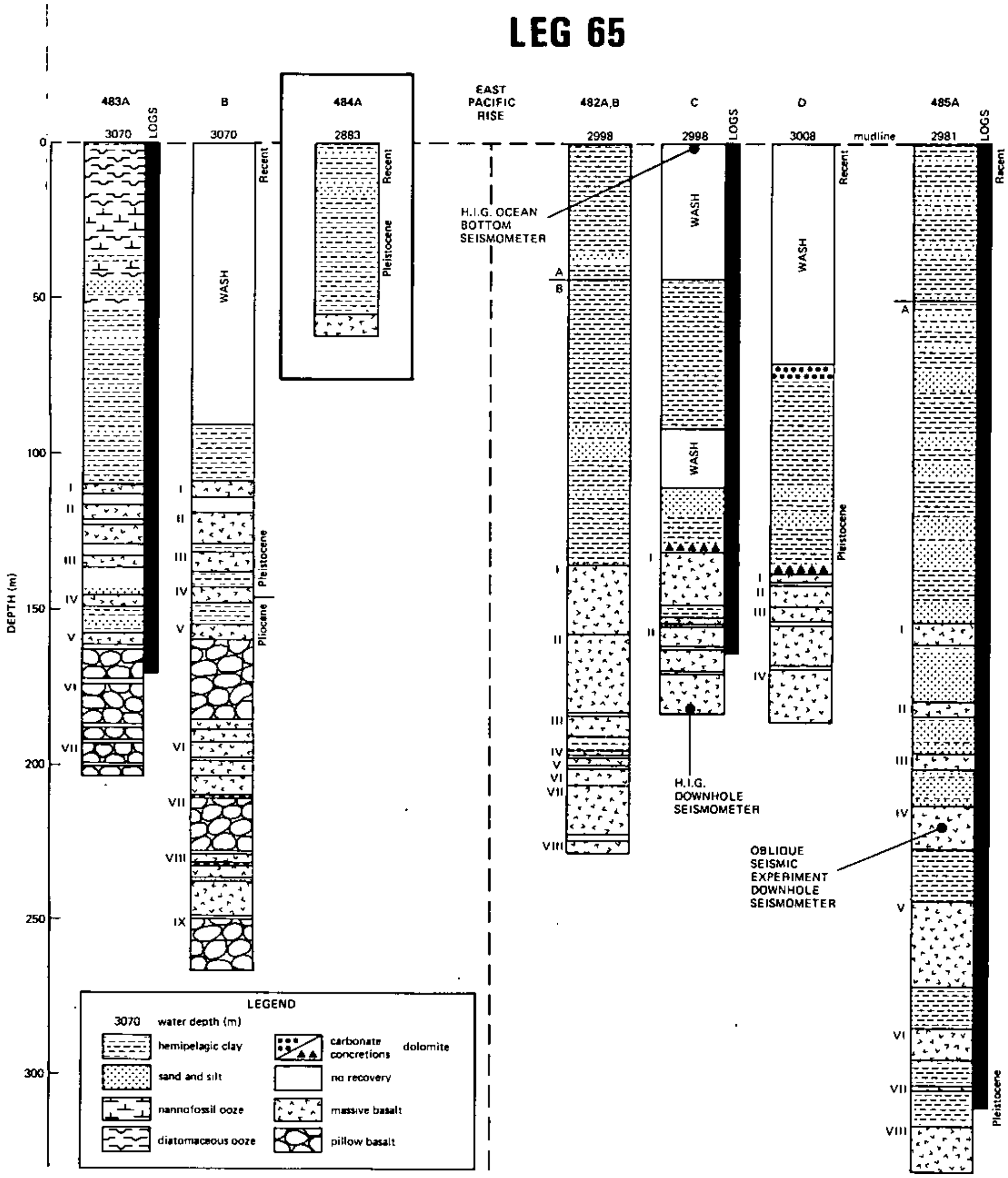

FIGURE 2: Stratigraphic Columns for Leg 65 Sites

sediments above basement are estimated to be between 1.51 and 1.65 Ma old based on the nannofossil zone Cyclococcolithina macintyrei of Gartner (1977) which spans this interval of time. The calculated sedimentation rate averages about 62 m/m.y.

Physical properties in the upper 70 m of sediment are very uniform, with a wet bulk density between 1.40 and 1.44 g/cm^3, a compressional wave velocity of 1.47 to 1.49 km/s, and a porosity of 73% to 76%. From 70 m to the top of the basement at 110 m, the properties change markedly in response to increasing compaction. Wet bulk densities increase to about 1.7 g/cm^3, compressional wave velocities to about 1.67 km/s and porosities decrease to about 55%. Sediments within the basement have even higher densities and velocities and lower porosities in response to increased compaction and possible diagenesis.

As at Site 482, the upper part of the basement consists of interlayered massive basalts and sediments. Sediment layers up to 9 m thick comprise nearly 50% of the upper 50 m, but below this level the per cent of sediment decreases markedly and basement consists largely of interlayered pillowed and massive basalts.

The interlayered sediments are chiefly hemipelagic, slightly to moderately fossiliferous clays and silty clays similar to the sediments above basement. A thin altered hyaloclastite layer occurs directly above basalt in Section 1, Core 8, Hole 483B. This consists of angular glass shards replaced by smectite and zeolite in a matrix of radiating fibrous zeolite, probably phillipsite. A 20 cm-thick layer of hard, black, well-bedded silty claystone occurs in Section 2, Core 25, Hole 483B. The bedding in this piece seems to be inclined about 25° from the horizontal. There is no clear evidence of baking or extensive diagenesis in most of the interlayered sediments but some are well indurated, black and unfossiliferous. Moderately to poorly preserved nannofossils, radiolarians, and foraminifers occur in some of the interlayered sediments, however, and many of these may be reworked. Based on calcareous nannofossils, the Pliocene/Pleistocene boundary is placed between Cores 13 and 17 in Hole 483 and between Cores 8 and 9 in Hole 483B.

The massive basalts in the lower part of the basement section are interpreted as submarine lava flows based on their textures and contact relationships although basalt-sediments contacts are rarely preserved. At one well-preserved contact in Hole 483, Core 26, Section 1, the overlying sediment shows clear imprints of the underlying basalt. This could only form by deposition of the sediment onto the basalt. Pillow basalts first appear at a sub-bottom depth of about 178 m and are interbedded with massive flows in the lower part of the hole.

Dikelets were found in Cores 15 and 16, Hole 483. These range in width from 1-2 cm to about 20 cm, and are usually subhorizontal. Some have sharp, chilled margins, others have diffuse margins grading into the host rock. The dikelets have magnetic inclinations and chemical compositions identical to those of the host rock and, hence, are interpreted as last stage segregation veins or "auto-intrusions."

Both phyric and aphyric basalts occur at this site. The most common phenocryst assemblages in the phyric varieties are plagioclase (with minor olivine), plagioclase + olivine, and plagioclase + olivine + clinopyroxene. Plagioclase and olivine are the most common phases, usually occurring as euhedral to subhedral crystals. Clinopyroxene occurs as anhedral intergrowths with plagioclase in glomeroporphyritic clots or as single rounded crystals, some of which have well-developed sector zoning. The partly resorbed nature of some of the phenocrysts and the presence of small spinel inclusions in some olivine phenocrysts suggest two stages of crystallization; one at pressures above about 5 kb and a later one at shallower levels.

Alteration of the basalts is similar to that occurring at Site 482. An early pervasive alteration results in replacement of olivine and interstitial glass by smectite and minor carbonate. Veins and selvedges are filled or partly altered to smectite, carbonate and zeolite. One patch of higher grade alteration in Section 2, Core 8, Hole 483B, is indicated by the presence of chlorite and actinolite (?) replacing clinopyroxene. The amount of alteration increases slightly downhole but no systematic change was noted in alteration grade.

The upper four massive units in Holes 483 and 483B are chemically distinct from those below, being more magnesian and lower in TiO_2, P_2O_5 and Zr than the lower units. Some of these have primitive compositions with $Mg/(Mg + Fe^{+2})$ ratios up to 0.69 suggestive of unfractionated mantle-derived melts.

The lower basalts are considerably more fractionated, with higher contents of TiO_2, P_2O_5 and Zr. Stratigraphic relations of the chemical types suggest this lower sequence may show a cyclic pattern, with a series of massive lavas (and sediments) succeeded by cogenetic pillow lavas. Most of the basalt variation within these series can probably be explained in terms of shallow level fractionation processes. However, Ti/Zr changes may indicate slight changes in the parent magma compositions for successively erupted magma batches. In contrast to predictions for fast-spreading axes, diverse liquid lines are required to explain the compositions observed.

Basalt densities range from 2.83 to 2.99 g/cm^3 in reasonable agreement with the formation densities obtained by logging and vary inversely with porosity which ranges from 1.1% to 9.3%. Compressional wave velocities average 5.9 km/s, range from 5.29 to 6.18 km/s and decrease irregularly with depth, perhaps due to increased alteration. The physical properties measured at this site are typical of fresh, relatively young basalt and, except for velocities, show no clear downhole trends.

Paleomagnetiic measurements were completed only for Hole 483. The uppermost basalt layer, encountered in Core 13, has a positive inclination averaging about +34°. Below this level, measured polarities are mostly negatiive with inclinations ranging from -11° to -500°. Magnetic intensities range from 1.21 to 47.6 x 10^{-3}g, with the low values being from massive units and the high values from pillow basalts. The median destructive field ranges from 18 to 339 Oe, again with the low values from massive units and the high values from pillows.

Site 484

Two holes were drilled at Site 484, located on top of a basement high interpreted as a magnetic "diapir." Hole 484 penetrated 5 m of sediment before encountering basement; Hole 484A was drilled to a sub-bottom depth of 62 m, 59.5 m in sediment and 2.5 m in basement. Recovery in the sediment section was 69%, but only one small piece of basalt was recovered from the basement in Hole 484A.

The sediments at Site 484 are largely grayish olive, hemipelagic clay with minor nannofossil and diatomaceous ooze and interlayered beds of clayey silt and sand. The relatively coarse-grained silts and sands are generally a few cm thick and are confined to the upper 15 m of the section. They consist of quartz, feldspar, pyroxene and glauconite with some reworked foraminifers. The clays contain varying proportions of diatoms, radiolarians, and sponge spicules up to a minimum of about 50%. Calcareous nannofossils generally make up 10% to 20% of the sediment but increase to as much as 40% in the lowest 15 m.

All of the recovered sediments are late Quaternary. The boundary between nannofossil zones NN19 and NN20 is at the base of Core 5, about 45 m sub-bottom. Sediments above this level are assigned to the Artostrobium miralestense radiolarian zone and those below to the Axoprunum angelinum zone. Sediments just above basement are estimated to be about 0.45 Ma old, giving a sedimentation rate of about 110 m/Ma

The physical properties of the sediments are more characteristic of compacted material than of the young sediments drilled in other holes on Leg 65, suggesting possible removal of the upper part of the sediment section by erosion. The wet bulk density averages 1.47 g/cm^3, the compressional wave velocity 1.52 km/s, and the porosity about 71%. Only the shear strength shows significant downhole variation, ranging from 0.08 tons/ft^2 at the mudline to 0.39 tons/ft^2 at a sub-bottom depth of 51 m.

The one piece of basement recovered consists of sparsely plagioclase-olivine-spinel(?)-phyric tholeiitic basalt with a quench-textured groundmass. Plagioclase and rare olivine and spinel(?) phenocrysts make up about 2%. Excellent skeletal plagioclase crystals and rare skeletal olivine crystals also occur in the groundmass which consists largely of sheaf-like intergrowths of poorly crystallized clinopyroxene, plagioclase, and magnetite. The basalt has an MgO content of 5.7% and an Mg/(Mg + Fe^2) ratio of 0.514. This is the most chemically evolved basalt drilled on Leg 65 and would appear to be more characteristic of transform fault or off-ridge volcanism than of rift zone volcanism.

The magnetic "diapir" drilled at Site 484 appears to consist of a basalt basement hill with a sediment point at the top. Some other lithology could exist beneath the basalt but penetration was insufficient to identify the source of the magnetic anomaly. The sediments are mostly hemipelagic muds and clays but include significant proportions of silt and sand of probable turbidite origin.

Site 485

Two holes were drilled at Site 485; 485 was cored from the mudline to 50.5 m sub-bottom and 485A was continuously cored from 50.5 to 331.0 m sub-bottom. Drilling conditions were excellent, and the average recovery respectively was about 73% and 50% in Holes 485 and 485A.

One hundred and fifty-three m of sediment overlie acoustic basement. These are chiefly hemipelagic clays with minor terrigenous material. Two units are recognized on the basis of the frequency and thickness of sandy and silty layers interpreted as distal turbidites. The upper unit, extending from the mudline to 79 m sub-bottom, is chiefly soft to firm, grayish olive clays with a 5-15% silt fraction. A few layers of silty clay, clayey silt and, rarely sandy silt range up to about 30 cm in thickness. These layers contain detrital quartz, feldspar, and heavy minerals and some plant material.

The lower unit from 70.5 to 153.5 m sub-bottom is similar to the upper one except that clayey silts and silty sands comprise about 35-40%. Most of the sandy and silty layers are poorly indurated and poorly recovered. Calcareous nannofossils average about 15-20% of the clays but increase to 40% or 50% just above the basement contact.

All of the sediments, both above and within the basement, are assigned to the Quaternary. The upper 36 m are assigned to nannofossil zone NN20-21 (undifferentiated) and the Artostrobium miralestense radiolarian zone. The Axoprunum angelinum radiolarian zone is recognized definitely to a sub-bottom depth of 79 m and possibly to a depth of 277.5 m, well within acoustic basement. The lowest sediment recovered at this site (about 314 m sub-bottom) is assigned to nannofossil zone NN19. These sediments are probably no older than 1.22 m.y. No definite age could be assigned to the lowest sediments above basement.

The physical properties of the sediments at this site are somewhat different from those measured at Sites 482 and 483. Instead of remaining constant in the upper 50-70 m of the section they change regularly downward from the mudline to the basement. The wet bulk density increases from about 1.4 to 1.9 g/cm^3, the compressional wave velocity increases from 1.5 to 1.7 km/s, and the porosity decreases from 75% to 45%. This pattern suggests little drilling disturbance in the upper part of the section; thus the measured values listed above may approximate in situ values.

Basement was cored from 153.5 to 331.0 m sub-bottom with an average recovery of 51%. As at Sites 482 and 483, the upper part of the basement consists of interlayered massive basalts (44%) and sediments (56%). Because of poor recovery in the sediments, both the drilling record and downhole logs were used to define basement stratigraphy. The interlayered sediments are moderately indurated clayey siltstones with minor sandstone and claystone. Nannofossil marls are present in a few cores and several pieces of limestone were recovered in Core 22. Pyrite-filled burrows and concretions are fairly common. The massive basalts are similar to those found at Sites 482 and 483 except that they are often thicker, are sometimes much coarser-grained, and have better evidence of intrusive contacts. We recognize 8 lithologic units in the basement based on the criteria used at Site 483. Possible baked contacts occur at the top of Units 4, 7, and 8, and Units 4 and 8 have coarse-grained "gabbroic" textures similar to those expected from slow cooling in a sill.

The basalts are sparsely to moderately phyric with mainly plagioclase and olivine phenocrysts; minor clinopyroxene and spinel sometimes occur in glomeroporphyric clots with plagioclase. The coarse-grained basalts have ophitic "gabbroic" textures and are characterized by the presence of both pigeonite and augite, as well as interstitial groundmass quartz.

Compositionally, the basalts are more uniform than at the other sites drilled on Leg 65, generally with a relatively narrow range of MgO (7.0 to 7.9%). One nearly aphyric basalt from cooling Unit 1 has 10% MgO and probably reflects a mafic liquid magma composition. The basalts could all be related to a common parent liquid by crystal fractionation.

Most of the basalts exhibit low temperture alteration characterized by replacement of olivine and interstitial glass by smectites and minor carbonate. Veins and sparse vesicles are usually filled with smectite, carbonate, and pyrite; more rarely, they contain minor epidote. The coarse-grained rocks exhibit extensive evidence of deuteric alteration with actinolite and minor epidote replacing clinopyroxene. In a few basalts, chlorite replaces smectite, suggesting some higher temperature, hydrothermal alteration.

The basalt physical properties are also similar to those at Sites 482 and 483. The wet bulk density ranges from 2.80 to 3.02 g/cm^3, the compressional wave velocity from 5.0 to 6.2 km/s, and the porosity from 3% to 4%. These variations reflect alterations of the basalts rather than regular downhole trends.

In sum, the basement at this site is similar to that at Site 482 and 483 but the thickness of the upper section composed of interlayered sediment and basalt is thicker, probably because of a higher sedimentation rate. Many of the basalts here are probably or definitely intrusive, and have developed textures and mineralogies reflecting slow cooling.

CONCLUSIONS

Drilling in the Gulf of California confirms that this is an area of high sedimentation with large contributions from adjacent continental landmasses. The sediments above basement are largely hemipelagic clays with sparse nannofossil and radiolarian oozes and some silty or sandy layers interpreted as distal turbidites. All of the drilled sediments are Quaternary in age and calculated sedimentation rates range from about 50 to 625 m/Ma

Acoustic basement consists of an upper sequence of interlayered massive basalts and sediments from about 50 to more than 160 m thick. Below this at Sites 483 and 474 (drilled on Leg 64) is a sequence of interlayered pillowed and massive basalts that are probably submarine lava flows; some are definitely sills with intrusive contacts and coarse-grained "gabbroic" textures.

Drilling on the East Pacific Rise does not support speculations that basalts erupted along fast-spreading ridges are compositionally more uniform than those erupted along slow-spreading ridges. A number of distinct chemical groups can be recognized in the basement basalts and at least two of these probably represent separate parental magmas. Chemical and mineralogical evidence also indicates shallow level crystal fractionation with a range of compositions similar to some Atlantic Ocean sites. Generally, the upper massive basalts are the most mafic with MgO values up to 9% or 10% whereas the lower pillowed and massive basalts are more chemically evolved.

Temperature measurements in the sediments at Site 482 confirmed that crustal rocks near the ridge crest are relatively hot. Despite an extimated basement temperature of 90°C, the rocks are relatively fresh and most observed alteration is the result of low temperature basalt-sea water interaction. The observed temperature gradients strongly suggest that hydrothermal circulation is occurring in the oceanic crust and a few small zones of hydrothermal alteration were found in the basalts. This probably developed around fractures or channelways through which hot water was flowing.

The magnetic polarities of the basement rocks are generally in accord with the observed surface anomalies, but the stabilities are low, probably reflecting the relatively coarse-grained nature of most of the basalts. An upper basalt unit with a positive inclination overlies basalts with negative inclinations at Site 483. Measured stable NRM inclinations mostly fall within the range expected for secular variation, but some tilting or rotation in the basement cannot be ruled out on the basis of magnetic evidence alone. However, the continuity of lithologic, chemical, and magnetic units between adjacent holes at several sites argues against significant tectonic disruption of the crust.

The expected correlation between high in situ seismic velocities and good drilling seems to be generally confirmed. The massive basalts were fairly easy to drill and recovery was good, but the pipe became stuck in two holes. We believe, however, that this may be due to collapse of the sediments above basement around the pipe rather than to jamming with basalt rubble since the bit was raised above the basement-sediment contact in both instances. If this interpretation is correct, hole stability can be achieved by casing the sedimentary section to basement, as was done at Site 483.

LEG 66
(Co Chiefs: C. Moore and J. Watkins)

The active margin transect off southern Mexico constitutes one of two across the Middle America Trench, the other being off Guatemala. The transect off southern Mexico is characterized by a narrow shelf, steep trench slope, and no fore-arc basin. As such, the drilling off Mexico has focused on the nature of the ocean-continent transition across a subduction zone abbreviated in space and possibly time.

Convergence between the Mexican portion of the North America Plate and the Cocos and other Pacific Ocean plates has been occurring at least intermittently for 100 Ma (e.g., Coney, 1972). In view of this long history of convergence, an extensive accretionary zone and fore-arc basin should have developed; instead Mesozoic to Precambrian crystalline basement rocks, intruded by a Mesozoic magmatic arc, crop out at the coast within 65 km of the trench axis (Mejorada, 1976). The proximity to the trench of both the basement complex and a Mesozoic magmatic arc suggest truncation of the margin with the removal of a pre-existing accretionary zone and fore-arc basin (e.g., Karig et al., 1978) but the timing and mechanism of truncation are not well defined (de Czerna, 1971; Malfait and Dinkelman, 1972; Karig et al., 1978). The present phase of accretion probably commenced in the Neogene coupled with the inception of magmatism in the trans-Mexican volcanic belt to the northwest. The probable youthful stage of this convergent margin provides a unique opportunity to examine the contact of the continental crust and the accretionary prism in the absence of overlying fore-arc deposits.

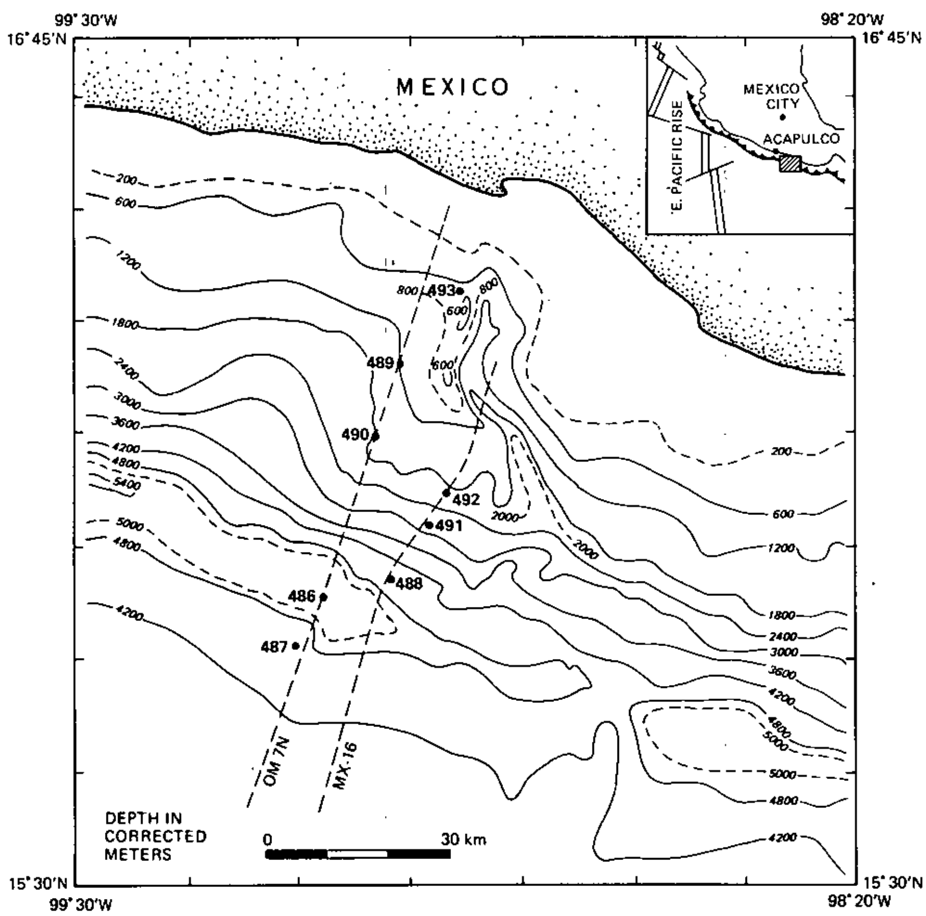

FIGURE 3: Location and Bathymetry for Leg 66 Sites

Specific problems addressed by Leg 66 include:

1. The dynamics of accretion at trenches: The lower slope sites of Leg 66 test whether offscraped deep-sea sediments, including trench deposits, or deformed slope deposits constitute the accretionary zone, and whether the offscraped deposits increase in age landward with stratigraphic inversion as predicted by a simple accretionary model. The popular trench-slope models (e.g., Seely, Vail, and Walton, 1974) are supported primarily by marine seismic data but have yet to be definitively tested by drilling.

2. Consumption of oceanic sediments and tectonic erosion of continental crust at subduction zones: Part of the trench and oceanic crust sediments entering the subduction zone in the Leg 66 area may be consumed in the sense of being deeply under thrusted, never to return to the surface in recognizable form. Sedimentologic and paleobathymetric data from drilling coupled with high-quality multichannel seismic data in the Leg 66 area yield quantitative estimates of volume and age of sediment in the accretionary prism. This coupled with estimates of input of sediment into the subduction zone provide a measure of sediments being consumed by the subduction process. Tectonic erosion of a pre-existing accretionary wedge and fore-arc basin may account for the truncation of continental basement off southern Mexico. Leg 66 data constrain this hypothesis but do not altogether resolve it.

3. Onset and early evolution of subduction: Little is known in general about the beginning or early history of subduction largely due to masking by subsequent sedimentation and deformation at mature convergent margins. The probable youth of subduction off southern Mexico allows us to study artifacts of late pre-subduction and early subduction phases, and so reconstruct geologic history through this fundamental tectonic transition.

4. Gas hydrate: The expected occurrence of gas hydrate in the Leg 66 area posed a problem unrelated to major tectonic objectives but pertinent to the geology and energy resources of continental margins. Site summaries recount our efforts to recover hydrates predicted in the drilling area.

SITE SUMMARIES

Eight sites were drilled including a continental and oceanic reference site, a site in the trench, three sites in the accretionary wedge, and two in the transition zone between continental crust and the accretionary wedge (Figure 3). The data, reviewed site by site in the following section, were evaluated in terms of depositional environment, provenance, deformation, structural style and age. The site summaries occur not in numerical order but in sequence along the ocean to continent transect. Multifold seismic reflection profiles provided by the UTMSI strongly influenced both pre-drilling site selection and post drilling interpretation (Shipley et al., 1978a).

Site 487

Site 487 is located on the oceanic plate about 11 km landward of the Middle America Trench (Figures 3 and 4). Here 182 m of sediment and rock that comprise two lithologic units were penetrated (Figure 5). Unit 1 consists of 115 m of Pleistocene and latest Pliocene hemipelagic mud with a high content of quartzo-feldspic silt and displaced benthic foraminifers that indicate derivation from the Mexican continental margin. Fifty-five m of late Miocene to Pliocene brown pelagic clay comprise Unit 2 which overlies basalt. The entire brown clay unit probably accumulated below the carbonate compensation depth.

The late Miocene age of the oldest sediment recovered at Site 487 agrees reasonably with the middle Miocene age of the oceanic crust estimated from magnetic anomalies (Lynn and Lewis, 1976). The hemipelagic sediments at Site 487 are similar to trench slope deposits elsewhere in the Leg 66 area but the pelagic mud unit is distinct from any modern sediment accumulating locally.

Site 486

Site 486 is in a small sediment pond representative of the discontinuous sediment fill of the Middle America Trench off southern Mexico. The seismic reflection profile through the site indicates a sediment thickness of about 425 m composed of approximately equal amounts of density current deposits and subjacent hemipelagic to pelagic deposits. The stratigraphic section cored in Hole 486 consists of 38 m of predominantly fine to medium muddy sand and in Hole 486A of 22 m of fine to medium muddy sand and very coarse sand.

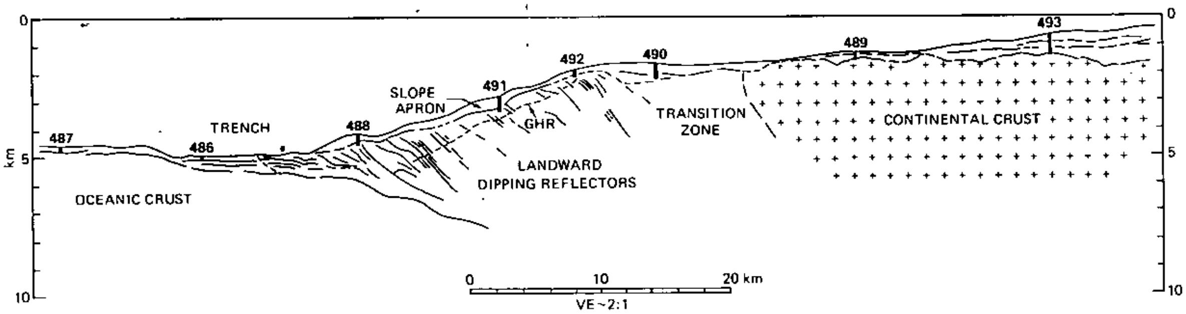

FIGURE 4: Schematic Cross-Section through Leg 66 Sites

All cores recovered are of Quaternary age and contain redeposited benthic foraminifers of nearshore or shelf environments. Flow of sand into both holes caused abandonment of drilling. The sands at Site 486 constitute the coarsest material ever recovered by drilling on a trench floor.

The coarse sands at Site 486 were undoubtedly derived from the Mexican continental margin probably via a prominent submarine canyon located to the southeast (Figure 3). Piston cores taken by the UTMSI during the site survey recovered medium and coarse massive sand at the base of the submarine canyon and graded sand beds elsewhere in the trench. The trench sediment differs from cores from the slope apron and lower slope basins that contain mud with rare fine sand and silt beds less than 1 cm thick. Apparently the coarse sand cored at Site 486 is being transported across the very narrow continental shelf, down the submarine canyon to the trench and effectively bypassing the slope.

Site 488

At Site 488 on the lower slope of the Middle America Trench 428 m of sediment comprising of two lithologic units (Figure 3) were penetrated. Unit 1 consists of 313 m of lower-middle to upper Quaternary mud-mudstone with local thin silt and muddy sandy beds in its lower portion. Lower-middle Quaternary mud-mudstone, sand, and pebbly sand of Unit 2 extends from 313 to 428 m.

The coarse sand of Unit 2 must have accumulated in a major turbidite channel or basin. In view of the similarity of these sands to the deposit cored at Site 486 in the trench, and the lack of a large turbidite channel or basin near the site, Unit 2 was interpreted as an uplifted trench sequence. Furthermore, the virtual absence of significant sand beds in slope and slope basin cores from the entire site survey area and the probable topographic diversion of down-slope sand transport from the site (Figure 3) argue against depositon of Unit 2 sands on the slope.

The uniform hemipelagic muds of the upper portion of Unit 1 probably accumulated at about their present position on the lower slope. The thin silt and sand beds of the lower portion of Unit 1 require a nearby conduit intermittently supplying relatively coarse material. As such, the lower portion of Unit 1 probably was deposited when the underlying Unit 2 was slightly elevated from the trench floor but still receiving fine-grained turbidites. The upper 210 m of Site 488 display nearly horizontal bedding except where deformed by drilling. Dips averaging 20-40° are common in Unit 1 from 210 to 265 m. Sediments from 210 to 248 m are characterized by healed fractures that truncate bedding, producing wispy discontinuous lenses of silt within a matrix of silty mud. Dips in Unit 2 range to about 50°. Cores showed no evidence of overturned bedding at Site 488 but top indicators are rare.

In places the lower portion of Unit 1 is as deformed as Unit 2 judging from the dipping beds and small-scale structural features. The similar structural development of these two units is consistent with the deposition of the lower porition of Unit 1 over modestly folded and elevated trench deposits near the base of the trench slope. The gradual decrease in deformation up-section in Unit 1 is due to decreasing age of the sediments and possibly lessened intensity of deformation landward of the trench.

The interbedded sands and mudstones of Unit 2 can be correlated with a series of landward dipping reflectors shown on the multichannel seismic reflection profile through Site 488. One of these landward tilted reflectors projects through the hole at about 80 m to a possible fault scarp at the surface. Though no stratigraphic inversion occurred at this depth, the recognition of a fault could have been hindered by monotonous lithology and high sedimentation rates. Conversely, between 200 and 230 m anomalies in water content, hydrocarbon concentration, and small-scale deformation suggest faulting but the seismic evidence is ambiguous.

Site 491

Site 491 is located in the mid to lower slope regions about 14 km landward of the Middle America Trench. A total of 542 m of sediment, comprising three lithologic units were penetrated (Figure 6). Unit 1 extends 0 to 57.5 m and consists of upper Pliocene to upperQuaternary mud. Lower to upper Pliocene mud with minor fine sand layers constitute Unit 2 cored between 57.5 and 437.5 m. Unit 3 which extends from 437.5 to 542 m is composed of mud and mudstone with interbedded fine to coarse pebbly sand layers up to 40 cm thick. Sediment accumulation rates, uncorrected for structure or compaction, are low (24-50 m/Ma) about 80 m but increase substantially (to 321 m/Ma) below this depth to the base of the hole (Figure 6).

At Site 491 tilted beds and fracturing occur initially at about 120 m and continue to total depth through the lower two lithological units (Figure 5). In Unit 2, dips are variable and range to nearly vertical; fracturing is present throughout. Slickensides are rare. Dip angles in Unit 3 range up to 30° and are more uniform than in Unit 2. Paleomagnetic restoration of bedding in both Units 2 and 3 indicate modal dip directions to the north with considerable scatter.

The multichannel seismic reflection profile through Site 491 shows a series of discontinuous and indistinct reflectors above about 0.4 s that overlie more coherent landward dipping reflectors. Using an interval velocity of 2.2 km/s, it was calculated that the base of the discontinuous and indistinct reflection occurs at 440 m near the top of Unit 3 which is defined by the first occurrence of sand.

The depositional environment of Site 491 sediment is most directly interpreted by reference to the modern sedimentary regime as well as the Quaternary sequence of Site 488. In the modern environment coarse sands occur only in the modern trench and presumably in the large submarine canyon feeding the trench. As such, the sands of Unit 3 at Site 491 may represent trench deposits, since the profiles through the site show no evidence of buried canyons. Alternatively the coarse sands could have accumulated in a slope basin, though the seismic data show no evidence of remnants of such a basin. Moreover, piston cores from modern slope basins in the area show no coarse sand. Much of the mud of Unit 2 at Site 491 accumulated below the CCD at sedimentation rates comparable to those of Site 488. Thus, Unit 2 sediments were probably deposited as lower slope hemipelagic muds.

Deformation occurs only in sands and muds accumulated at high sedimentation rates, probably in the trench and or lowermost slope environments. This deformed sequence is overlain by about 120 m of flay-laying sediment, most of which accumulated at a low rate at or above the CCD and within 700 m of its present bathymetric position. Thus, the structural history of this site indicates deformation in the trench and/or lower slope environment associated with rapid uplift from about 4.5 to 3 Ma B.P. followed by an interval of negligible deformation and slow uplift. Apparently the toe of the trench slope is a zone of concentrated tectonism that diminishes in intensity upslope.

Failure of the pressue core barrel prevented an attempt to sample in situ gas hydrates at Site 491 but Cores 10 and 19 contained gassy frozen sediment. Released gas in excess of 7 times the volume of one sample may indicate the presence of hydrate.

Site 492

Site 492 constitutes the landwardmost site transect NE of the Middle America Trench. Here 279 m of sediment comprising two lithologic units were penetrated. Unit 1 extends from 0 to 247 m and consists predominantly of Quaternary to upper Miocene mud-mudstone. Upper Miocene mudstone with interbedded sand and granular gravel constitutes Unit 2 cored between 247 and 290 m. The sediment accumulation rate for most of Unit 1 is about 26 m/Ma, and for the lowermost part of Unit 1 and Unit 2 about 80 m/Ma.

The level of dissolution of calcareous microfossils and depth diagnostic trace fossils define a paleobathymetric curve indicating that Site 492 underwent an initial uplift rate of about 400 m/Ma till about 4 Ma B.P. after which the uplift slowed to a rate of about 137 m/Ma. The higher rate is comparable to that observed for the Site 488 at the base of the slope and the lower rate approaches that observed at Site 490 upslope (Figure 7).

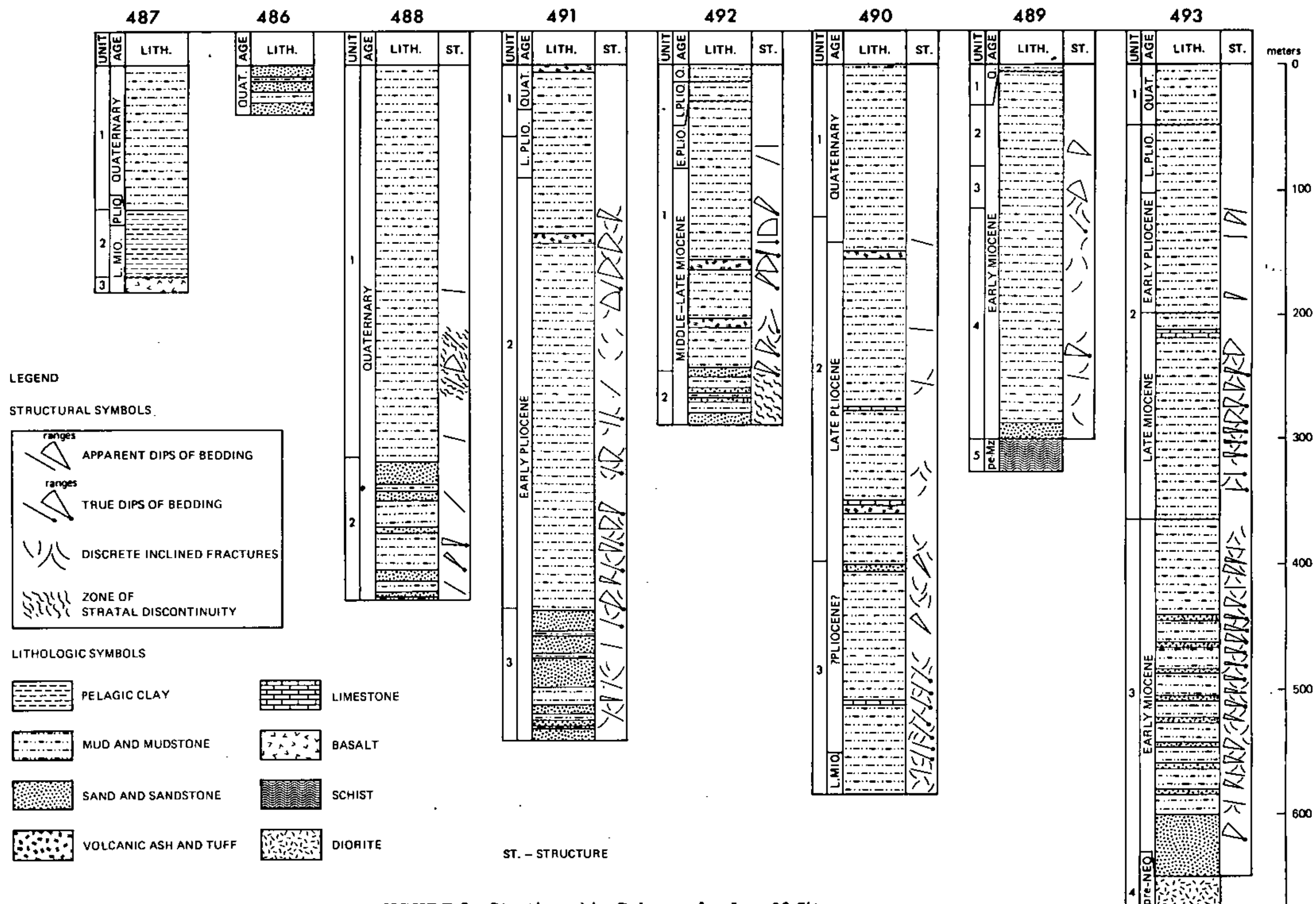

FIGURE 5: Stratigraphic Columns for Leg 66 Sites

At Site 492 the intensity of deformation is greater at shallow depths than at any other mid or lower slope site. Bedding in Unit 1 ranges from horizontal to overturned and locally defines several folds. Mudstone intervals below 250 m resemble "scaly argillite" where they are cut by slickensided anastomosing fractures.

The multichannel seismic reflection profile through Site 492 shows a series of poorly defined slope-subparallel reflectors from 0.0 to 0.2 s sub-bottom covering numerous high-amplitude, landward dipping reflectors. The dipping reflectors correlate with the first occurrence of significant sand beds as is the case at Sites 488 and 491.

The interpretation of the depositional environment of Site 492 hinges on both lithology and paleontology with appropriate comparisons to the modern setting and the results of Site 488. The mudstone of Unit 1 above 50 m accumulated near the CCD, probably within 1 km of their present depths on the mid-slope. Trace fossil assemblages and sediments barren of calcareous microfossils suggest deposition of the lower part of Unit 1 at depths of 4 km or greater. Mudstones barren of calcareous microfossils and associated sand and granular gravel of Unit 2 accumulated below the CCD in a channel or turbidite basin of the lower slope or trench. The interbedded sand and mudstone at Site 492 correlate with the landward tilted reflectors as do similar lithologies at Site 488 which were interpreted as trench deposits. The sediment accumulation rate for the lower portion of Units 1 and 2 is less than that of comparable sequences at Sites 488 and 491, suggesting that in late Miocene the sediment flux to the trench and lower slope was lower than in the Pliocene and Pleistocene.

At Site 492 deformation occurred before 5 Ma ago in probable lower slope and/or trench deposits that were undergoing relatively rapid uplift (Figure 7). The contact with the overlying undeformed deposits is gradational. As at Site 491, the results here suggest early complex deformation during the initial uplift of trench and/or lower slope deposits with diminishing intensity of tectonism as this sequence is elevated to mid-slope.

Penetration at Site 492 occurred above a weak reflector subparallel to the seafloor which may represent the hydrate-gas phase boundary. Gassy frozen ash layers encountered at 141 and 170 m released up to 9.4 times their volume in gas. Porosity of the ash is above 0.46, thus the water combined up to 20.4 times its volume of gas. Maximum in situ solubility of methane in seawater is less than 4 times the volume of water. This may indicate the presence of gas hydrate.

Site 490

Site 490 was drilled in 1977 m of water at 16°09.56'N, 99°03.34'W to determine the nature of sediments immediately seaward of inferred continental crust at Site 489. At this site, information was sought about the early evolution of the accretionary wedge, as well as evidence relating to tectonic erosion of nearby continental crust.

Hole 490 bottomed at 588 m after penetrating three lithologic units, ranging in age from late Miocene to Quaternary. Fracturing with slickensides, first observed in the lower part of Unit 2, were pervasive throughout Unit 3. A significant increase in induration accompanied the development of pervasive fracturing at 400 m. Paleomagnetic data and slickenside orientation suggest NW dipping normal faults with minor reverse faults between 400 and 430 m.

Paleontologic data show that the pre-middle Pliocene part of this section was deposited below the carbonate compensation depth (CCD). Subsequent uplift raised the section through the CCD ca. 5 m.y.B.P. and thence to its present position. Post mid-Pliocene rates of uplift were 67-150 m/Ma depending on depth of the CCD.

The Pliocene-Miocene boundary is at about 250 m. Reworked Miocene and late fauna evident in middle Pliocene and younger parts of the section probably were derived from upslope as evidenced by unconformities at Sites 489 and 493

Methane was evident throughout the section. Ethane ranged from lower limits of detectability to a maximum of 0.18% near the bottom of the hole. Smaller amounts of C_3-C_5 were also detected. A gas-releasing ice inclusion at 137 m produced a 0.91 ml CH_4 per ml of interstitial fluid. Organic carbon content ranged from 0.8%-3.0% with highest percentages occurring in the upper 200 m. All organic carbon showed a low degree of thermal maturity. Traces of more mature hydrocarbons (C_2-C_5) probably migrated from rocks below the hole.

Oldest sediments observed in Hole 490 were probably deposited in a lower slope environment. Younger rocks were deposited in progressively shallower environments as the section was uplifted, probably due to underplating during accretion.

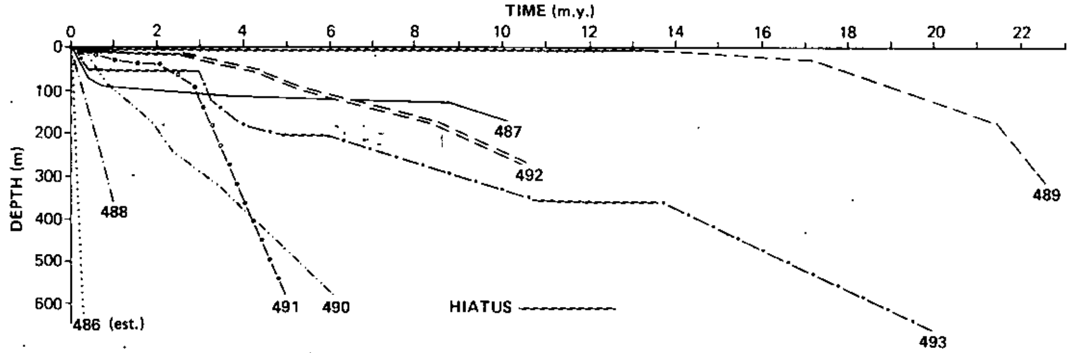

FIGURE 6: Sediment Accumulation Rates—Leg 66

Tectonic erosion should cause subsidence of a margin rather than uplift. Consequently uplift of sediments at Site 490 argues against tectonic erosion of any underlying continental basement during the late Miocene-Quaternary.

Differential uplift probably caused the normal faulting during the middle(?) Pliocene. The small basin to the west of Site 490 may have formed at the same time.

Uplift documented at 490 may also be related to hiatuses in the sedimentary records at Sites 489 and 493, as sediments removed from Sites 489 and 493 by erosion are the probable source of redeposited microfossils found at Site 490.

No firm evidence links Site 490 sediments to the accretionary wedge. No sands have been found suggestive of deposition in a trench environment, no steeply landward-dipping bedding indicative of rotation during underplating, no fracture orientations indicative of north-south compression and no landward-dipping reflectors in the immediate vicinity of Site 490 except for one possible reflector at great depth. Lack of these features does not prove that the section is not part of the accretionary wedge, but it seems more likely that it was deposited on the lower slope between accretionary wedge sediments and the seaward lip of continental basement.

The magnitude of compressional stresses transmitted to Hole 490 sediments during underplating was evidently inadequate to strongly deform the sediments, probably because underplating occurred relatively deep beneath the bottom of the hole.

Site 489

Two holes, 489 and 489A, were drilled at 16°16.19'N, 99°01.13'W to determine the nature of a strong acoustic basement reflector and to document the depositional and subsidence history of this segment of the margin. Landward correlation of the acoustic basement reflector with seismic reflection and dredge haul data suggested that the reflector represented continental metamorphic basement rocks. This was of considerable interest because a landward-dipping reflector thought to belong to the accretionary wedge could be traced to within 10 km of a point immediately seaward of Site 489 where the inferred basement reflector broke up. Thus, Site 489 was closest to the seaward limit of continental crust and the site most likely to yield data on pre-subduction and early subduction movements of the continental basement adjacent to the subduction zone.

After aborting Hole 489 due to mechanical problems, Hole 489A was drilled to a schistose basement of a pre-Tertiary age at 300 m sub-bottom. Sediments overlying the basement consisted of 10 m of basal sand and 283 m of mud and mudstone of lower Miocene age, which in turn were overlain by 7 m of Quaternary mud. Fracturing and steeply dipping bedding suggested deformation of lower Miocene units, uplift, and erosion prior to deposition of the flat-lying Quaternary silts.

Sediment accumulation rates were 87 m/Ma between 302 and 160 m, 35 m/Ma between 160 and 90 m, and 10 m/Ma between 90 and 7 m. Lowermost Miocene sediments document a marine transgression followed by deposition in an outer shelf environment. Overlying younger sediments indicate deposition in slope environments. Absence of benthonic and planktonic foraminifera between 200 and 7 m sub-bottom suggest carbonate dissolution, i.e., deposition below the carbonate compensation depth.

Investigation of geochemical properties of Site 489 samples revealed small amounts of higher (C_2, C_3, ...) hydrocarbons. These are thought to have migrated from deeper more mature sediments into their present

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position. Magnetic properties investig[...]etic showed that magnetization of Site sediments was 1.5-2.0 orders of magnit[...] lower than magnetization of sedime[...] recovered at Site 488 and 487. Either source for Site 489 sediments differs fr[...] that of Sites 487 and 488 or magne[...] minerals have been winnowed at Site 489.

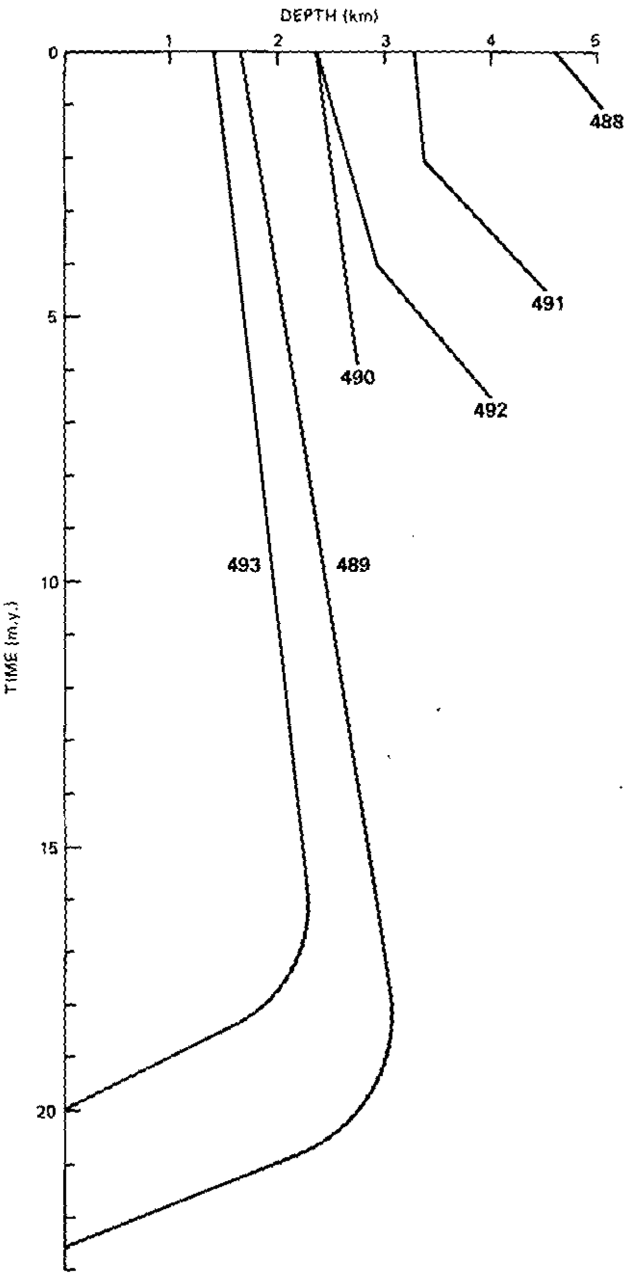

FIGURE 7: Uplift of Leg 66 Sites

Site 493

Site 493 includes three holes drilled i[...] 670-675 m of water at 16°22.86'N, 98°55.53'[...] about 15 km from the Mexican mainlan[...] (Figure 3). Site 493 was spudded 1.85 km south of a UTMSI seismic line which ties t[...] line OM7N (Figure 3). Hole 493 covered the interval 120 to 675.5 m sub-seafloor, Hole 493A the interval 0-12 m sub-seafloor, and Hole 493B the interval 12-120 m subseafloor. Hole 493A was an inadvertent re-entry into Hole 493 at 12 m.

Data from Site 493 reveals a transgression in early Miocene slightly later than the transgression at Site 489. Site 489 began to be uplifted about 18-19 Ma ago, but Site 493 continued to subside another 2-3 Ma before beginning to rise. Site 489 subsided to a maximum of about 3 km below sea level whereas Site 493 sank only about 2 km or less below sea level before rebounding (Figure 7).

Sinking of the margin may represent the thermal response of the Mexican margin to the rifting or transforming away of its seaward segment in pre-Miocene time or the response of the margin to tectonic erosion. Uplift may represent the beginning of underplating during the early stages of subduction, or it may represent an upward buckling of the continental margin during trench formation.

Sediments above basement document four hiatuses. The entire middle Miocene is missing during the longest hiatus. Later hiatuses occur in the late Miocene, late Pliocene-late Quaternary, and in the latest Quaternary.

Impoverished faunal assemblages and thinly laminated sediment suggest an oxygen deficient environment from the late Miocene through the Quaternary. This condition may have been caused by elevation of the section through the oxygen minimum zone or formation of a basin with restricted circulation.

Basement diorites closely resemble outcrops of Cretaceous intrusives on shore roughly 20 km from the site. Basement rocks in the region are diverse as evidenced by diorites at Site 493, schists at Site 489, and gneisses dredged by UTMSI from a canyon wall about 10 km from Site 489.

Gas, mainly of biogenic origin, was present in moderate amounts in Site 493 cores. No evidence of quantities of mature hydrocarbons or of bitumens were found.

Conclusions

The conclusions regarding the tectonic development of the Middle America Trench are summarized in the context of the objectives outlined in the introduction. The gas hydrate problem is addressed in a brief subsequent section.

DYNAMICS OF ACCRETION

The multichannel seismic profile through Sites 488, 491, and 492 shows a mantle of discontinuous, indistinct reflectors overlying a zone of higher amplitude more continuous landward dipping reflectors. The drilling results indicate that hemipelagic muds with thin fine sand beds, probable slope deposits, constitute the discontinuous and indistinct reflectors. On the other hand, landward dipping reflectors correlate with interbedded sand and mudstone observed in the lower portions of Site 488, 491, and 492. The interbedded sand and mudstone units are probably trench deposits, although they may also represent basin or channel deposits of the lower slope that have been tectonically incorporated into zone of landward dipping reflectors.

The age of the landward dipping reflectors increases from Pleistocene to early Pliocene to late Miocene at Sites 488, 491, and 492, respectively, indicating progressive seaward accretion of the trench slope (Figure 8). Since the dipping reflectors probably represent bedding, a stratigraphic inversion between Sites 488, 491, and 492 suggest thrust faulting, probably along surfaces subparallel to bedding. While the documentation of progressive accretion and thrusting is in accord with predictions from seismic data, the fact that the landward tilted reflectors represent bedding was unexpected.

Deformation occurring at Sites 488, 491, and 492 includes features such as overturned folds, small-scale disruption of layering, and "scaly clay" which are common to uplifted subduction complexes. At Site 488 the intensity of deformation decreases gradually up-section across the contact between the trench and lower slope deposits. Similar relationships also occur at Sites 491 and 492. At each of these sites the deformation occurred during rapid uplift in sediments presumably accumulated in the trench and/or lower slope environment. Deformation largely ceased when the sequence was

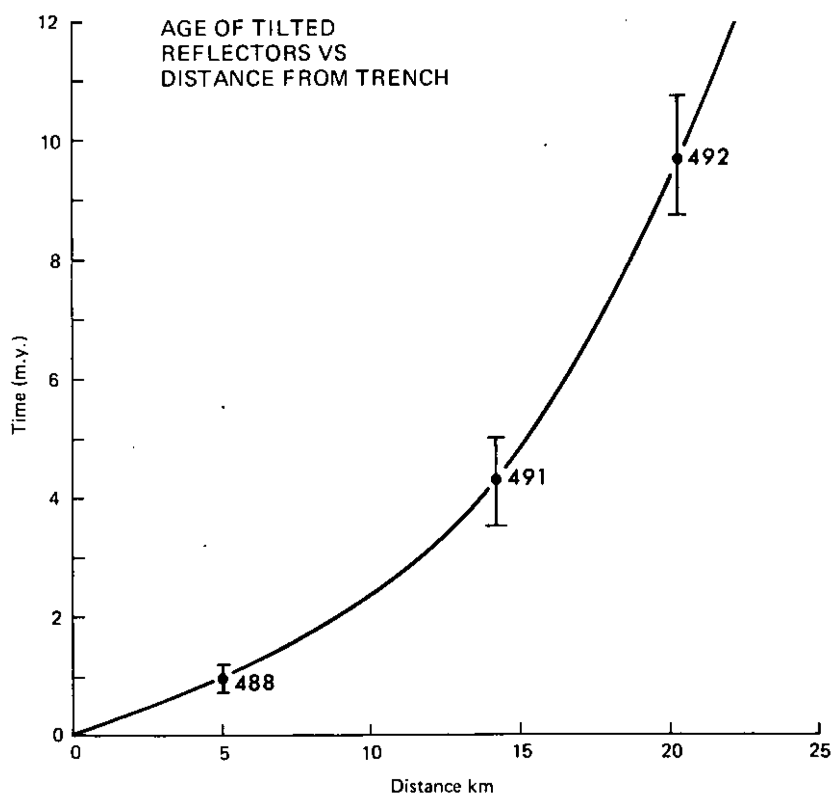

FIGURE 8: Leg 66—Age of Tilted Reflectors vs. Distance from Trench

elevated to mid-slope depths and uplift slowed as witnessed by the undeformed sediment blankets respectively 3 and 5 Ma old at Site 491 and 492. Thus, the evidence indicates initial intense deformation in the lower slope environment synchronous with rapid uplift, followed by relative quiescence and slow uplift. The seismic reflection profile through Sites 488, 491, and 492 shows that beneath the lowermost slope the dipping reflectors become progressively more steeply tilted but retain a uniform tilt beneath the remainder of the lower and mid-slope region.

CONSUMPTION AND TECTONIC EROSION

Accurate estimates of accreted and consumed volumes of sediments are difficult to obtain in most subduction complexes because of the impossibility of directly measuring the volume of consumed sediments. To circumvent this problem, the sediment input into the subduction zone is estimated during a specified time interval, the volume of the accretionary wedge formed during this time is also estimated. The amount consumed is derived by subtraction of accreted volume from total input . The sedimentary input and accretionary volume are often poorly known with the result that the calculation of subducted volume is subject to large erros. Leg 66 data, however, permit a variation on this method which provides a significantly more accurate estimate of the sediment input rates and volume of accretion.

The approach used utilizes paleobathymetric curves to determine additions to the volume of the accretionary wedge during a specified time interval and a good survey of the trench, lower slope, and oceanic crust to provide input data. Paleobathymetry of the Leg 66 transect is well defined for the interval, 0-7 Ma B.P. Hence, these data yield good estimates of the volume of sediments added to the wedge above the level of the trench. Isostatic stripping yields volumes added below the level of the trench due to loading and depression of the crust by the accretionary process. Preliminary calculations suggest that up to one-half the sediments being input into the subduction zone in the Leg 66 transect are being consumed.

Early Miocene subsidence of the continental margin observed at Sites 489 and 493 could be indicative of tectonic erosion along the seaward margin. On the other hand, it was expected that faulting of continental basement and overlying sediments would accompany tectonic erosion. No evidence of such faulting in cores collected at Sites 489 and 493, nor in suprabasement seismic records in the area, was seen. Thus, while tectonic erosion could have occurred in the Leg 66 region in early Miocene, no firm evidence of it was seen.

ONSET AND EARLY EVOLUTION OF SUBDUCTION

The present episode of accretion in this region appears to have begun between 7 and 20 Ma ago. The younger age is constrained by the discovery of lower slope or trench sediments at Site 492 showing rapid uplift from 7 to 4 Ma B.P. This rapid uplift is interpreted as evidence of subduction and underplating. Accretion may, however, have begun somewhat earlier.

Site 490 sediments are problematical. Lack of deformation of the style observed in lower slope and trench deposits at Sites 488, 491, and 492 favors deposition of Site 490 sediments in a tectonically inactive zone between the accretionary wedge and continental crust. However, the possibility of older accretionary wedge sediments below the bottom of Hole 490 cannot be ruled out.

We can estimate the maximum volume of the pre-492 accretionary wedge, project post-492 rates accretion backward in time, and derive a maximum age of the accretionary wedge. Shipboard calculations suggest a maximum age of 10-15 Ma for the accretionary wedge. Thus, in summary, good evidence of accretion during the period 0-7 Ma is found with weaker evidence for the period 7-15 Ma. The causes of the subsidence and uplift inferred for the period 15-22.5 Ma are not clear.

GAS HYDRATES

The occurrence of gas-hydrated sediments was predicted offshore Mexico from seismic reflection evidence (Shipley et al., 1979b). The geothermal gradient derived from logging at Site 492 confirms that the sub-bottom reflector subparallel to the seafloor is nearly coincident with the base of the methane-hydrate stability field.

The frozen sediments discovered within the zone of hydrate stability at Sites 490, 491, and 492 probably contained some hydrated sediments. Gas analysis showed methane to be the dominant component (greater than 99%). Volume of gas released from the water within sediments yielded up to 20.4 ml of CH_4 per ml H_2O. This is more than 5 times greater than solubility of methane in seawater at in situ conditions. Thus, the frozen sediments probably contained partially hydrated methane.

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SITE REPORTS

Leg 66

Co-chief scientists C. Moore and J. Watkins report:

Site:	491 (M-3c)	Lat:	16°01.74'N
		Long:	98°58.33'W
		Water Depth:	2877 m

Site 491 is located in a mid-slope position landward of the Middle America Trench. 532 m were penetrated, recovering 59 cores that comprise three lithologic units. Unit 1 extends from 0 to 57.5 m and consists of upper Pliocene to upper Quaternary mud. Lower to upper Pliocene muddy silt with minor fine sand layers constitutes Unit 2, cored between 57.5 and 437.5 m sub-bottom. Two occurrences of gassy ice in this unit suggest the presence of gas hydrate. Unit 3 extends from 437.5 to 542 m and is composed of muddy silt and siltstone with interbedded fine to coarse pebbly sand. Tilted beds and fracturing first occur at about 120 m and continue to total depth, being restricted to sediment older than 3 Ma.

Comparisons with the modern setting (Site 486 and piston cores) and Quaternary deposits at the toe of the slope (Site 488) suggest that Unit 3 and much of Unit 2 accumulated in a trench and/or lower slope environment. Deformation of these sediments occurred shortly after deposition with probable rapid uplift to their present mid-slope position. As at Site 488, interbedded sand and muddy silt of the probable trench deposit correlate with the dipping reflectors evident on the seismic reflection profile. The landward dip of these reflectors, their correlation with a bedded sequence, and the landward increase in age from Sites 488 to 491 together suggest progressive accretion and a stratigraphic inversion requiring large-scale thrust faulting.

Site:	492 (M-3d)	Lat:	16°04.73'N
		Long:	98°56.72'W
		Water Depth:	1971.5 m

Site 492 constitutes the landwardmost of three sites on the lower to mid-slope portion of the Leg 66 transect NE of the Middle America Trench. 279 m of sediment comprising two lithologic units were cored. Unit 1 extends from 0 to 247 m and consists predominantly of upper Miocene to Quaternary silt-siltstone. Gassy ice recovered at 141 and 170 m may indicate gas hydrate. Upper Miocene muddy siltstone with interbedded sand and granular gravel constitutes Unit 2, between 247 and 279 m. Bedding in Unit 1 ranges from horizontal to overturned and locally defines folds. Muddy siltstone intervals below 250 m resemble "scaly argillite." Here, they are cut by slickensided and anastomosing fractures. Interbedded sands and mudstones of Unit 2 probably represent uplifted trench or lower slope deposits. They correlate with the landward dipping reflectors evident on the seismic reflection profile through the site. The location of the late Miocene landward tilted reflectors at Site 492 above the early Pliocene landward tilted reflectors at Site 491 downslope suggests thrust faulting. Small-scale deformation at Site 492 occurred before 5 Ma, during rapid uplift, probably in the trench and/or lower slope environment. Deformation increased during the lower uplift after 5 Ma B.P.

Site:	493 (M-3a)	Lat:	16°22.86'N
		Long:	98°55.33'W
		Water Depth:	670-675 m

Site 493 comprises three holes in water depth of 670-675 m where we set a new standard of positioning by inadvertently re-entering Hole 493 after drilling 12 m in Hole 493A. The holes, aggregating 676.5 m, sampled dioritic basement of probable Cretaceous age overlain by shelf sands of early Miocene to Quaternary age. Four unconformities document erosional events which removed parts of the section including the entire middle Miocene. Faunal assemblages suggest a marine transgression about 20 Ma B.P. followed by rapid subsidence to depths of 2 km below sea level. The site began rising about about 17 Ma ago and has continued to rise slowly and at a uniform rate up to the present. Oxygen deficient conditions indicated by late Miocene-Quaternary faunal assemblages and thinly laminated sediments suggest deposition in an oxygen-minimum zone or perhaps in a restricted basin environment.

Leg 67

Co-chief scientists J. Aubouin and R. von Huene report:

Site:	494 (G-IB)	Lat:	12°43.00'N
		Long:	90°55.97'W
		Water Depth:	5529 m

Site 494, on the landward slope of the Mid-America Trench off Guatemala, is 3 km from and 580 m above the trench. It is on a narrow long terrace interpreted from seismic records as a large thrust slice. Drilling ended at 367 m because of hole conditions. Below the Pleistocene, the recovery of whole core pieces was rare, yet overall the strata occur in an orderly temporal sequence of young over old. The environments represented and the nature of the hiatuses between them are interpreted from top to bottom as follows:

1. 0-223 m, Plio-Pleistocene, consisting principally of material transported from the shelf and upper slope to the site.

2. An Upper Miocene unconformity coincident with the widespread one on the shelf.

3. 223-245 m, Lower Miocene hemipelagic clays that accumulated at depths near 3000 m and at rates an order of magnitude slower than age equivalent deposits on the shelf; a distal terrigenous sequence.

4. An Upper Eocene-Oligocene hiatus of unknown origin but of equivalent age to a widespread unconformity on the adjacent shelf.

5. 245-304 m, Eocene hemipelagic clay deposited below a 3000 m depth at rates at least 5 times slower than age equivalent shelf deposits; a distal terrigenous sequence.

6. A hiatus of unknown origin and of an age represented by thick, Paleocene sediment on the shelf.

7. 304-321 m, Upper Cretaceous claystone deposited in an open ocean environment, above the CCD, and at a depth equivalent to, but at rates lower than age equivalent shelf rocks.

8. A contact of unknown origin.

9. 321-367 m, altered igneous rock originally of basaltic and andesitic composition and atypical of igneous oceanic crust. The type of deposit or body sampled is unknown.

10. A layered sequence at least 1500 m thick, resting on Miocene igneous ocean crust as indicated by seismic and magnetic records. The hiatuses of unknown origin below the Miocene, juxtaposes rocks in a normal and not reversed age sequence and thus major thrust faulting and subduction must be confined to the undrilled section. This portion of the trench lower slope appears to have been part of the continent since at least Pliocene time and to consist of Tertiary distal terrigneous and open ocean Cretaceous deposits.

Site:	495 (G-6A)	Lat:	12°29.78'N
		Long:	91°01.25'W
		Water Depth:	4150 m

Site 495, the oceanic reference for the Mid-America Trench transect off Guatemala, is 22 km seaward of the trench axis and about 1925 m above it on an isolated ridge. Forty cores with 75% recovery were obtained. The sediment sequence is typical of low latitude oceanic areas and it has a hemipelagic sediment cover: (1) 0-171 m, hemipelagic, diatomaceous green and olive-gray mud; (2) 171-178 m, brown abyssal clay; (3) 178-406 m, chalky carbonate ooze with chert in the lower section; (4) 406-428 m, manganiferous chalk and chert; and (5) 425-446.5 m, basalt.

Microfossil assemblages indicate an unbroken sequence from Quaternary to Lower Miocene. This section records the northward passage of the Cocos Plate through the equatorial carbonate belt to a deep ocean environment of slow deposition and finally to an environment in the proximity of a terrigenous source. The effects of subsidence as the newly formed ocean crust moved away from the ocean ridge are superimposed on the sections as well. The development of a hemipelagic cover, especially of this thickness, is impressive because the site is almost 2000 m above the trench and 20 km seaward. The Mid-America Trench is about 3000 km long. This requires considerable transport of silt and even sand-size material across the trench. The age of the crust now entering the trench is lowest Miocene or possible Late Oligocene.

Site:	496	Lat:	13°03.82'N
		Long:	90°47.71'W
		Water Depth:	2064 m
Site:	497	Lat:	12°59.3'N
		Long:	90°49.7'W
		Water Depth:	2412.5 m

Two sites were abandoned on the Mid-America Trench transect off Guatemala because of gas pressure observed in the core barrels. The gas, composed mainly of methane, was approaching potentially dangerous pressures if it reflected <u>in situ</u> conditions. We now believe the gas may have resulted from the melting of a gas hydrate during core retrieval. Site 496 on the trench upper slope was drilled to 378 m (40 cores) in green-gray mudstone as old as Lower Miocene. No sand beds were recovered but thin sandy volcanic ash occurs locally. In one of the last cores, a sandy piece expelled from the core liner by gas pressure was frozen, but no other ice was observed in samples from this hole. The concern over intermittent ejection of core, as well as the appearance of trace amounts of higher order hydrocarbons, led to abandonment of this site.

At Site 497, about 8 km downslope, the conditions were similar. Expelled frozen, vitric sand was observed from Cores 36-40 and mounting concern led to hole abandonment after pieces of core shot out of the core liner. Pressures measured in the core liners were from 0 to 17 psi. However, the gas was without hydrocarbons heavier than ethane, and in mudstone of Pliocene rather than Miocene age. At both sites, frozen vitric sand and elevated gas pressure were observed in cores from about the same depth. Thus, the development of gas hydrate was suspected despite the local nature of freezing and the absence of a bottom simulating reflection in seismic records. On review, it appeared that P/T conditions in the gas hydrate stability field could have been reached. Calculations based on subsequent logging at Site 497 confirmed these suspicions and it appears, in addition, that much of the drilling at Site 496 and 497 was done in rock at pressure and temperatures in the range where gas hydrates can form. If the measurements from logging are projected downward, there may be no gaseous zone at greater sediment depth. Thus, no bottom simulating reflection at the transition between a high velocity hydrate and a lower velocity gas charged sediment may occur in the seismic records. We cannot assess with certainty the pressure contributed by melting of gas hydrate during core retrieval. However, methane solubilities have been determined from shipboard measurements on recovered clathrates. Pressure bomb measurement of gas from the clathrate recovered from Core 39 (Site 497) indicates that the STP volumetric ratio of methane to water is approximately 50:1.

Site:	498	Lat:	12°42.68'N
		Long:	90°54.99'W
		Water Depth:	5497 m

Site 498 was drilled to increase knowledge of the unusual stratigraphy noted at Site 494 and to establish the nature of critical contacts missed during the previous drilling. Records made by the KANA KEOKI during emplacement of the HIG Downhole Seismometer indicated the presence of faults at Site 494 that might have caused the poor recovery. Site 498 was offset 1.8 km along strike to an area that both KANA KEOKI and CHALLENGER records showed as less deformed. The recovery of clathrate caused abandonment. At Site 498, above 213 m, the lithology is similar to the lithology at Site 494. However, from 213 to 309 m, the lithologies of the the two sites differ. Muds and mudstone of Pliocene age characterize the entire section at Site 498 whereas Miocene and Eocene rocks were recovered from this interval at Site 494. Gas hydrates were encountered at about 310 m. The single occurrence of hydrates was accompanied by a single, rapid increase in methane/ethane ratio. The presence of hydrates was again confirmed by placing the icy sediment in a sealed vessel and measuring pressure as the hydrate came to ambient temperature.

Site:	499 (G-7)	Lat:	12°40.26'N
		Long:	90°56.69'W
		Water Depth:	6126.5 m

Seismic reflection records at Site 499 show an upper sequence of horizontal reflections underlain by a second sequence of reflections dipping gently landward. Five holes were drilled at this site. The first hole (499) was located to avoid sampling the thickest part of both sequences. After drilling the uppermost section which consisted of turbidite muds, a topographic channel was drilled (499A) to compare lateral changes in the uppermost sedimentary section. Hole 499B, paralleled Hole 499, and was drilled to basement where rubbly basalt prevented further drilling. Since basalt cobbles were not a convincing basement indicator, another hole (499C), offset 305 m along strike, was washed to basement to try to obtain a better sample. Again, the rubbly nature of the basalt caused sticking of the drill and abandonment of the hole. To obtain a log, Hole 499D was washed, but it encountered a rubbly conglomerate about 50 m above basement and drilling stopped.

The lithologic sequence at Site 499 is the same as at Site 495, the oceanic reference site, but has a cover of trench fill turbidite, 117 m thick, which is predominantly muddy although preferential recovery of mud versus sand is suspected. The same turbidite units appear in the channel hole (499A), about 1 km away, without any apparent lateral change. The turbidites pass abruptly downward into burrow-mottled, hemipelagic muds, calcareous ooze and chalk, and basalt rubble, in that order. The calcareous section, however, is about one-third as thick as it is at Site 495.

Microfossils occur in the same succession as at Site 495 with the addition of a Quaternary trench-fill sequence. The latter has abundant reworked and transported calcareous microfossils and the 400,000 year radiolarian zonal marker becomes abundant below it. Within the calcareous section, stronger dissolution of foraminifers than at Site 495 occurs, indicating deposition nearer the CCD. The oldest sediment is of earliest Miocene age, as at Site 495.

The physical properties and gaseous hydrocarbons of the trench fill differ markedly from the underlying section. There is a surprisingly large amount of gas in the trench fill, methane being the major variety. Ethane was also present, although in much lower amounts than at sites up the landward slope. It was unexpected in trench fill (present in quantities up to 20 ppm), and may have been transported with the sediment flowing down slope into the trench.

Site:	500 (G-7A)	Lat:	$12^{\circ}41.35'$N
		Long:	$90^{\circ}56.49'$W
		Water Depth:	6123 m

Site 500 is located in the Mid-America Trench axis, at the juncture of the landward slope and the trench floor. The lithologies and ages encountered are basically the same as at Sites 499 and 495, but basement and hard, undrillable, cobble conglomerate zones were encountered at unexpectedly shallow depth in all three holes. In Hole 500 the Quaternary trench-fill turbidite sequence is either faulted or deposited against a fault scarp in lower Miocene chalk; basalt basement is at 161 m. In Holes 500A and 500B, near the center of the trench, the trench-fill turbidites are deeper. Coarse basalt and sandstone cobbles were encountered at 114 and 125 m sub-bottom depth, respectively.

Generally the section at Site 500 shows no more deformation than the equivalent sections at Sites 499 and 495. A fault between turbidite and chalk cuts out at least 100 m of section is interpreted as a normal fault. Seismic records and cores indicate that bedding in both turbidite and chalk units is nearly horizontal.

The biostratigraphy, as the lithostratigraphy, is the same as in the oceanward sites but the depositional rate of trench-fill turbidite is about one-third the rate previously observed. This may be a function of not having recovered the base of the turbidite. The trench-fill contains biogenic components such as wood fragments that are more characteristic of the slope deposits at Site 494 than the turbidites in Site 499. The composition of gaseous hydrocarbons is much as would be expected in a trench; ethane values are low and most of the gas is methane. Large amounts of pyrite and H_2S, even in some of the chalk cores, indicate that anoxic conditions may exist in the trench.

Leg 68/Site 501*

Co-chief scientists J. Cann and S. White report:

Site:	501 (CR-1)	Lat:	$1^{\circ}13.6'$N
		Long:	$83^{\circ}44.1'$W
		Water Depth:	3467 m

Site 501 is on 5.5 Ma crust, spread from the Costa Rica rift. Hole 501 was intended as a pilot hole for re-entry. The sediment section (264 m thick) was spot cored because continuous piston coring in intended later. The section consists of pelagic siliceous nannofossil ooze, with some volcanic ash, becoming more calcareous and indurated with depth. Near the base, chert and chert limestone bands were recovered. Basalt basement was cored for 73 m and consists of alternating massive flow units and rubbly pillow units. The upper petrographic unit is aphyric whereas the lower unit (below 25 m) is plagioclase and olivine phyric. Alteration varies from weak to intense, with clay and carbonate filling veins. In-hole temperature at 120 m is 32°C, which is consistent with the site survey heat flow. The Packer was used to recover water samples and attempt permeability measurements. The borehole televiewer, Soviet downhole magnetometer, and resistivity tool were successfully deployed, and a complete logging program run.

*Information from Leg 68/Site 501 will be included in the I.R. for Leg 69.

SHIPBOARD SCIENTIFIC STAFFING

Leg 68—(HPC Leg)

J. Gardner	Co-Chief Scientists	USA	U.S. Geological Survey
W. Press		USA	Brown University
C. Adelseck	Staff Representative/ Sedimentologist	USA	S.I.O.
M. Ledbetter	Sedimentologist	USA	University of Georgia
U. Mann	Sedimentologist	FRG	Universitat Heidelberg
H. Zimmerman	Sedimentologist	USA	Union College
A. Fleet	Sedimentologist	U.K.	Open University
G. Blechschmidt	Paleontologist (nannofossil)	USA	LDGO
L. Keigwin, Jr.	Paleontologist (foraminifera)	USA	Univ. of Rhode Island
W. Riedel	Paleontologist (radiolaria)	USA	S.I.O.
C. Sancetta	Paleontologist (diatom)	USA	LDGO
D. Kent	Paleomagnetist	USA	LDGO
D. Spariosu	Paleomagnetist	USA	LDGO
L. Mayer	Physical Properties Specialist	USA	Univ. of Rhode Island

Leg 69/Site 501

J. Cann	Co-Chief Scientists	U.K.	Univ. of Newcastle upon Tyne
S. White		USA	DSDP
J. Natland	Staff Rep./Igneous Petrologist	USA	DSDP
N. Pertsev	Igneous Petrologist	USSR	USSR Academy of Sciences
J. Lawrence	Sedimentologist/ Geochemist	USA	LDGO
T. Francis	Geophysicist/ Resistivity	UK	Inst. of Oceanographic Sciences
R. Anderson	Geophysicist/Hydro- fracture Spec.	USA	LDGO
M. Zoback	Hydrofracture Spec.	USA	USGS
V. Nechoroshkov	Magnetometer Spec.	USSR	Institute of Geophysics
V. Ponomarev	Magnetometer Spec.	USSR	Institute of Geophysics
H. Kinoshita	Heatflow Spec.	Japan	Chiba University

Leg 69

J. Cann	Co-Chief Scientists	UK	Univ. of Newcastle upon Tyne
M. Langseth		USA	LDGO
J. Natland	Staff Rep./Igneous Petrologist	USA	DSDP
N. Pertsev	Igneous Petrologist	USSR	USSR Academy of Sciences
A. Adamson	Igneous Petrologist	UK	Univ. of Birmingham
H. Beiersdorf	Sedimentologist	FRG	BGR
Y. Noack	Geochemist	France	Laboratoire de Mineralogie et Petrographie
C. Sancetta	Paleontologist (nannofossil and diatom)	USA	LDGO
R. Wilkens	Physical Properties Specialist	USA	Univ. of Washington
R. Anderson	Geophysicist/Hydro-fracture Spec.	USA	LDGO
V. Nechoroshkov	Magnetometer Spec.	USSR	Institute of Geophysics
V. Ponomarev	Magnetometer Spec.	USSR	Institute of Geophysics
T. Furuta	Heatflow Spec.	Japan	Ocean Research Inst.
M. Mottl	Inorganic Chemist	USA	Woods Hole Ocean. Inst.

IPOD AVAILABLE DATA*

Introduction

The dissemination of geologic data gathered by deep-sea drilling is a primary function of the Deep Sea Drilling Project (DSDP). The Initial Reports of the Deep Sea Drilling Project, a series of volumes published by the U.S. Government Printing Office, is the primary publication of DSDP. Space limitations however prevent the Initial Reports from including all of the observational data. It has been necessary to develop other methods of making this data available to the scientific community. The Information Handling Group (IHG-DSDP) has developed a coordinated, automated Master Data file with associated computer software to process, store, and retrieve DSDP data in a useful form. A series of informal specific memoranda entitled "Data Data" contain more detailed descriptions of the procedures and capabilities of the IHG. They are obtainable by writing to the group at DSDP.

A Sample Distribution Policy has been adopted by DSDP (approved by the National Science Foundation, September, 1976) which restricts the release of scientific data gathered aboard D/V 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 only track charts and data indexes that has immediate unlimited distribution. (If a data request costs more than $50.00, reimbursement for expenses will be charged.)

Physical Properties and Other Quantitative Core Data

All of the quantitative data are processed through a series of data reduction programs. These programs also convert the standard DSDP labeling notation to a subbottom depth in meters, providing a more readily interpretable sample location. Before a file is declared clean (in an ALGOL-readable format), the data is scanned for points that are clearly in error.

MUDPAK is a flexible graphics program which is used for displaying and comparing sets of coordinated data against a common depth axis. It can make a composite plot of curves from individual data files as well as the superimposition of like parameters measured by different methods. (Requests for quantitative data should be addressed to Barbara Long, Data Resource Coordinator**.)

Aids to Research

In addition to the filling of requests for prime data, the IHG is developing secondary tools to assist researchers in finding materials relevant to their studies. Two of these are discussed below.

The Guide to DSDP Cores summarizes the core material and available information that is published in the Initial Reports. Thirty categories of data have been established in which to select relevant information. A computerized online search system to the Master Guide File, GUIDESEARCH, is available for formulating online searches. The guides are available in microfiche and on magnetic tape. Requests for a list of cores per specific criteria through use of GUIDESEARCH should be addressed to Lillian Musich, Geologist. Inquiries for documentation describing the syntax used in GUIDESEARCH should be addressed to Peter Woodbury, Principal Programmer/Data Manager**.

A computer-generated Keyword Index has been developed to retrieve information relating to current research on core material after an initial shipboard description has been prepared. The Index aids in planning future investigations by enabling scientists to know what studies are currently in progress, and will help in preventing duplication of research. The data base is constructed from the sample request and bibliography files of DSDP, and is updated every six months. (Index requests should be addressed to Trudy Wood**, and requests for core samples should be addressed to the Curator**.)

DSDP Core Photographs

The west and east coast core repositories of D.S.D.P. each maintain a complete collection of black and white and color photographs of all cores retrieved by GLOMAR CHALLENGER. Legs 1 through 44 are archived as prints. Legs 45 onwards are archived as 35 mm slides. They are available for viewing at any time at the repositories.

Individual copies of prints or slides are available upon request to the Associate Chief Scientist, Science Services**.

*This contains information about the availability of DSDP data and how to obtain it. For a detailed discussion of the history and management of DSDP data, see Rosenfeld, M.A. and Davies, T.A., 1978, "Management of Deep Sea Drilling Information," JOIDES Journal, Vol. IV, No. 2, p.67-84.

**Deep Sea Drilling Project, A-031
University of California at San Diego
La Jolla, CA 92093.

DEEP SEA DRILLING PROJECT—DATA BASE STATUS

GENERIC DATA FILE	COMPLETE THROUGH LEG	STORAGE MEDIUM	COMMENTS
CARBON CARBONATE DSDP Shore Lab	59	FT	No carbonate for Leg 46
CHEMISTRY Water content/ Shipboard Lab	66	FT	No chemistry for Leg 41
DEPTHS From underway recording	66	FT	
GRAIN SIZE (Sand/Silt/Clay) DSDP Shore Lab	59	FT	No grain data for Leg 16
G.R.A.P.E. (Gamma Ray Attenuation Porosity Evaluator) Points taken on board. Data processed and edited onshore.	62	FT	G.R.A.P.E. data were not collected on Leg 46; Leg 45 G.R.A.P.E. is not complete.
SCREEN Output from JOIDESSCREEN. Computer-generated lithological classifications. Includes basic composition data, average density, and geologic age of classified layer.	44	T	Leg 38 SCREEN file has not been created yet.
SMEAR SLIDES Shipboard observations	44	FT	
SONIC VELOCITY On board ship-Hamilton Frame method	66	FT	There are no SONIC data for Legs 1 and 2.
VISUAL Shipboard observation	44	FT	

UNDERWAY DATA: Recorded on board between drilling sites. The underway data is processed jointly by DSDP and the SIO Geologic Data Center.

Bathymetry	Legs 07-09 13-56 61-66	FT
Magnetics	Legs 07-09 12-66	FT
Navigation	Legs 03-66	FT
Seismic	Leg 66	

T=magnetic tape
F=microfilm

REPORT FROM IPOD SITE SURVEY MANAGEMENT

DATA BANK

The following data have been received:

I. MID-AMERICA TRENCH—From UTMSI, M.C.S., PDR, and sonobuoy monitor records of IDA GREEN cruise 15-2.

II. "A Reflection Seismic Survey of the Vema Fracture Zone on the Mid-Atlantic Ridge"—Tech Report TR79-3 of R.S.M.A.S. by D. Varchol from Mahlon Ball, U.S. Geological Survey.

III. "IPOD Multichannel Seismic Site Survey in the Blake Bahama Basin," from R. Markl and G. Bryan, LDGO.

IV. Computer tape and charts of navigation and bathymetry of ATLANTIS II—97 Leg 2, IPOD Site at 2.3 post survey, from M. Purdy and S. Gegg, Woods Hole Oceanographic Institution.

V. Costa Rica Rift final site survey report and scientific prospectus for drilling Leg 68, from M. Langseth, LDGO.

VI. Site Survey Report for drill site 483 (Gulf of California), from Brian Lewis, U. of Washington.

VII. SOUTHEAST ATLANTIC SITE SURVEY—Microfilm of seismic profiler records of THOMAS B. DAVIES, cruise 388, from the University of Cape Town (Professor Eric Simpson), DB #868.

VIII. JAPAN TRENCH--Multichannel seismic profiles and navigation for lines 78-3 and 78-4, taken by R/V KAIYOO MARU, from N. Nasu, Ocean Research Institute, University of Tokyo. DB #869 and DB #870.

IPOD DATA BOOKS

At their April meeting the JOIDES EXCOM approved the proposal to prepare site survey information in three documents, a Data Bank Catalogue, Data Bank Books (also called folios), and large-scale reproductions of the original data. The IPOD Data Bank catalogues have been prepared and are continually being updated. These list data that are available for different IPOD drill sites. The IPOD Data Bank Books will contain small-scale (8x10) reproductions of the data available for each site, and summaries of the site survey cruise results written by the chief scientists. Approximately four site survey books are planned, each emphasizing a different geographic location. The Atlantic volume is currently being prepared. It will contain data for 13 Atlantic sites, with approximately 25 pages per site. Data for the U.S. sites should be camera ready by early fall. Input from non-U.S. IPOD members will then be solicited. This data will be drafted in a format consistent with the U.S. data. Camera-ready copy for the Atlantic Volume should be ready by late winter/early spring.

DRAFT REPORT
EXECUTIVE COMMITTEE
14-16 August, 1979—Reykjavik

CHALLENGER OPERATIONS

I. SCHEDULE REVISIONS

At the PCOM meeting in July, two major revisions were made in the CHALLENGER schedule. These revisions were prompted by the time loss because of emergency drydocking in Curacao and the addition of a short leg for the hydraulic piston corer. To save time and because of weather constraints, the PCOM recommended that the CHALLENGER transit the West coast of S. America and do all of the S. Atlantic drilling before going into the N. Atlantic. Twenty days for the HPC Leg were to be taken from the S. Atlantic program and the rest of the time loss was to be equally divided among the remaining legs. The problem panels were to decide how they wanted the time to be distributed among their legs.

Extensive discussion developed concerning the scientific and political implications of the time loss, both to the overall Atlantic program and to the North Atlantic in particular. Both the U.K. and France had written letters to NSF and JOIDES asking for a reconsideration of the time distribution. However, the Memorandums of Understanding between NSF and the IPOD countries do not guarantee drilling in any particular location. Suggestions to readjust the time loss included:

1. Consolidating and thereby shortening Legs 69 and 70.
2. Shortening the S. Atlantic drilling time.
3. Transiting the East coast of South America.
4. Asking PCOM to readjust program.

After extended discussion the EXCOM requested that the PCOM modify the 1979-81 program with the objective of adding at least two weeks to the N. Atlantic Program. In doing this the EXCOM recognized that in adjusting the schedule PCOM had to choose between equally attractive scientific objectives. However, the representatives of UK, USSR, France and FRG feel very strongly that it is of great importance for their continuing participation in the future phases of the program that more time be spent in the North Atlantic. Implicit in this request was the need for immediate action by the PCOM and DSDP.

II. BUDGET CONSTRAINTS

Fuel costs in the S. Atlantic are expected to be in excess of $1.60/gal. This coupled with the large transits will cause an unexpectedly high fuel bill. NSF will be asked for additional funds.

Other measures will also be taken to reduce fuel costs. Since fuel in the Caribbean/Central America area is among the cheapest in the world, the CHALLENGER will leave the area with nearly full fuel tanks and probably return at the end of the S. Atlantic program with small fuel reserves.

Other fuel funds could be obtained by reducing the engineering program and producing our own logging equipment. The engineering program includes studies of drill string fatigue, and downhole instrumentation. Since Gerhart-Owen will now sell logging tools, it may be cheaper to buy theirs and hire our own logging engineer and analyst. The U.S.G.S. (Denver) and Sandia Laboratories have their own logging tools.

The U.S.S.R. also has sonic logging equipment. It operates under the same system as their downhole magnetometer. Since the downhole magnetometer was apparently successful, the rest of the Soviet logging equipment should be adaptable to CHALLENGER use. This equipment would be available free of charge. The equipment could be left onboard and non-Soviet engineers/technicians trained to use it. The U.S.S.R. was thanked for this offer. DSDP will actively pursue the Soviet offer.

EXPLORER PLANS

I. NSF DISCUSSIONS

A. U.S. Considerations

The Blue Ribbon Panel Report strongly endorsed the scientific merits of the EXPLORER program and recommended that industry, interagency U.S. and international cooperation be emphasized. The U.S.G.S. will produce a document discussing their expectations of their role in the EXPLORER Program. By November the National Science Board (NSF) will also make recommendations on the program. If their recommendation is favorable the EXPLORER budget will go to the

Office of Management and Budget to be included in the budget that the President submits to Congress this winter (1980).

B. Non-U.S. Considerations

The role of non-U.S. countries in the EXPLORER program has not been determined yet. Two possible scenarios are being discussed:

1. An annual fee for all non-U.S. participants. This would be similar to the current CHALLENGER program.

2. Non-U.S. countries pay a minimal amount each year, and then pay extra if they want to drill in their particular areas of interest.

A meeting at NSF for non-U.S. members is tentatively scheduled during the first two weeks of December, 1979.

II. ENGINEERING REPORTS

A. EXPLORER Conversion

Donhaiser Marine, Inc. is the NSF sub-contractor doing the feasibility and design studies for the GLOMAR EXPLORER conversion and riser system. Their studies and a possible time sequence for EXPLORER conversion were discussed.

They performed a variety of vessel motion and station-keeping tests at sea this February and March. The results of these tests are included in their July, 1979 Status Report to NSF. In their conclusions they see a need for more oceanographic data (e.g. combined wind speed, wind direction, currents, wave heights, wave periods and directions, and swell heights, swell periods and directions) before combined station-keeping and vessel motion response can be fully determined. In the DMI studies, using 80% of the available thrust, the vessel had difficulty maintaining a reasonably fixed position in moderate winds, particularly if the wind was 30° or more off the bow. They recommend that two bottom-mounted thrusters be added to provide additional lateral thrust.

B. Hocott Committee-NRC Engineering Report

Claude Hocott gave an informal presentation of the NRC's investigation. Some of their information, particularly relating to risers, was not as optomistic as the DMI report. There are many problems involved in developing and utilizing long riser systems and blow-out preventers. Some of these areas were outlined and included:

1. Reduced tolerance between the mud weight that is maintained and formation fracture pressure in greater than 12,000 ft of water.

2. Riser size for expected current profile and maximum mud weight to be used.

3. Casing design which will be influenced by the well head design, core bit size, fracture (pore pressure) gradients, well control philosophy, and penetration.

4. Riser disconnect location and handling procedures during disconnect. These designs will depend upon vessel station keeping, the control transmission system, and the time and cost for development.

5. Selecting riser buoyancy type, taking into account the tensioning capabilities of the vessel and current profiles.

The NRC committee's feeling is that late '83 for a full riser is too optimistic, however, a shallow riser (e.g. 6000 ft.) could be made available next year. They estimate that a 9-10,000 ft. riser may be available by '85 and a 12-13,000 ft. riser by '87 or '88. This would be keeping pace with industry's development of risers. It might be possible to procure a 12,000 ft. riser prior to '87-'88 but the cost might be prohibitive.

III. EXPLORER PLANNING COMMITTEE

More interaction between the engineering and scientific aspects of EXPLORER planning is clearly needed. It was decided that the panel reorganization committee recommended at the last meeting should be expanded and their mandate changed. The expanded committee would consist of two EXCOM members, two PCOM members, a representative from the NRC committee, a representative from DMI, and one from DSDP.

This committee was charged with determining the best mode for EXPLORER planning, i.e. what size group(s) should be involved, who reports to whom, etc. It was hoped that an EXPLORER planning group established by this committee could meet at least on an ad hoc basis before the next EXCOM meeting.

1981-83 CHALLENGER PROPOSAL

The PCOM's draft of the 1981-83 CHALLENGER proposal was reviewed and overall favorably received. This proposal would be used in, and therefore must be adaptable to three different situations.

1. There is no EXPLORER Program.

2. There is an EXPLORER Program but it is delayed.

3. The EXPLORER Program comes on line when expected, and the 1981-83 CHALLENGER proposal is used to supplement the EXPLORER work.

In the later two situations the 1981-83 CHALLENGER proposal should interface smoothly with the EXPLORER plans. In the second situation, a CHALLENGER program will be important to continue the flow of non-U.S. money. All of the IPOD countries agreed, however, that the chances of their government's simultaneously funding two drilling programs were less than remote.

The proposal as currently written consists of one year of Atlantic and one year of Pacific drilling with roughly 60% of the work being done with the hydraulic piston corer. Since this instrument was developed at DSDP, there is some strong feeling in the community that JOIDES should be responsible for making sure that the HPC is well utilized. DSDP was asked to investigate utilizing smaller and/or less expensive ships for hydraulic piston coring on both a full and part-time basis. In the 1981-83 proposal some of the objectives, e.g. sedimentary processes and waste disposal, need a larger diameter core than is currently recovered. A larger core HPC could be developed for use on the EXPLORER.

NSF asked to have a final draft of the proposal by early February, 1980. EXCOM asked PCOM (working with DSDP) to revise the 1981-83 CHALLENGER proposal. Included in the revision should be:

1. A clear and logical progression into the EXPLORER program--on both a one- and two-year basis.

2. A realistic evaluation of the feasibility (including rates, availability, etc.) of using other ships for hydraulic piston coring.

3. Elimination of the inconsistency in discussing the benefits of the HPC.

ICELAND DRILLING PROGRAM

Three scientists from Iceland's National Energy Authority gave presentations of the results of their work including their safety and logging programs. After the presentation the EXCOM went on record as enthusiastically supporting the Icelandic research as it is providing useful and complementary information to the work of the GLOMAR CHALLENGER and gave their endorsement to the drilling of a deep (4 km) hole in Iceland.

DRAFT REPORT
PLANNING COMMITTEE
16-18 July, 1979—Italy

REVIEW OF ACTION ITEMS

A report on the use of diamond bit drilling was distributed. Diamond drill bits were used on some of the early legs. The results were less satisfactory than the four-cone core bits now used. Poor recovery is often due to variations in bit weight caused by the vertical ship motion. DSDP is developing an extended core barrel to improve this situation. The extended barrel will have a diamond cutting edge and be shock mounted within the regular bit.

A report from the chairman of the OGP regarding the canning of gassy samples was read and discussed. Cans provide the optimum containers for C_1-C_7 hydrocarbon analyses. The present canning method is not very efficient. The OGP was asked to contact NASA to see if the NASA canning method could be implemented aboard the GLOMAR CHALLENGER.

DSDP

I. CHALLENGER SCIENTIFIC EQUIPMENT

A computer system for organic chemical analysis on the gas chromatograph has been ordered, but the software for the system is not available yet. The computer can also be used for sound velocity and other data processing.

II. HPC

A. Shipboard Measurements

Once the impact of the higher resolution HPC samples has been determined, modifications in shipboard measurements may be necessary. All HPC samples should be GRAPED since they yield much better information than rotary drilled cores. This may necessitate changes in GRAPING, such as increasing the speed.

To maintain uniformity, oriented HPC samples will be split N-S. The W side will be sampled and the E side archived.

B. Shore-Based Measurements

Continuous strip photographs were taken of the Leg 64 varved sediments. These as well as X-radiographs may be routinely taken on all HPC-samples. It was suggested that continuous strip photography be done on all cores from Leg 45 onward.

C. HPC Developments

In order to prevent hydraulic piston coring from slowing operations on the ship, two developments are being undertaken by DSDP. One is the development of an HPC device that will not require a special bit, and the other is to extend the length of the HPC stroke from 4.5 to 9.0 meters.

III. GLOMAR CHALLENGER PERFORMANCE

The new oil leak in the forward aft thruster prompted a lengthy discussion about the GLOMAR CHALLENGER's ability to carry out the tight schedule planned for the 1979-81 program and proposed for the 1981-83 program. Maintenance problems are discouraging and disrupt continuity. The CHALLENGER currently undergoes a major yard period every two years. In addition, in preparation for the Atlantic program several extensive modifications have been made. These include: deepening the draft, and rewiring of the electrical panels. It was suggested that maybe a longer yard period with major preventative measures at the beginning of the 1979-81 extension could eliminate or minimize the need for emergency yard work.

The leaky thrusters were replaced at the end of Leg 64 (January, 1979). It is not clear if the leaks are a result of defective thrusters, poor yard work, or a deteriorating ship. DSDP was asked to update the last "ship fitness" report to PCOM, with particular attention to fatigue in light of a future 2-4 year program. A full-scale study may be necessary in the near future pending the outcome of the DSDP report and funding. It was emphasized that abrupt cancellation of CHALLENGER operations due to ship malfunctions is extremely costly on science operations and demoralizing on scientists who have already had a difficult time making room in their schedule for CHALLENGER cruises.

NSF

I. NEW STAFF

The Ocean Sediment Coring Program is beginning to increase staff in preparation for the EXPLORER program. Two new positions have been filled. Tom Cooly, a biological oceanographer, is helping to write environmental impact statements, and Bill Sherwood, an engineer, will help with the engineering planning. Fritz Theyer from HIG will be the next Program Associate. He starts in September, replacing Bill Orr who is returning to the University of Oregon. Orr was thanked for his help during the past year.

II. ADVISORY COMMITTEE ON POST-INTERNATIONAL PHASE OF OCEAN DRILLING (IPOD) SCIENCE—("BLUE RIBBON PANEL")

The report of this panel has been completed and should be available in the near future. The panel endorsed the EXPLORER program. Resource implications were a significant factor in the justification. NSF was recommended as the lead agency. Interaction with other government agencies (e.g. DOE, USGS), industry, and non-U.S. countries (modeled along the lines of the current IPOD members) will be important.

III. COMMITTEE ON ENGINEERING CONSIDERATIONS FOR CONTINUATION OF DEEP SEA DRILLING FOR SCIENTIFIC PURPOSES—(NRC—HOCOTT COMMITTEE)

The NRC committee will meet again 10-12 September in Boulder. At that time the committee would like to see the general areas that are planned for EXPLORER drilling. More extensive knowledge of the physical parameters of proposed site locations will be required for EXPLORER drilling. Wind, current, and internal waves will effect the riser design. Site surveys may have to be expanded to measure these parameters. Current plans call for a 4 km riser and 10 km drill string.

The NRC Committee also addressed the question of EXPLORER management. They felt the top management should be small and flexible enough to respond rapidly to EXPLORER needs.

STATUS OF GLOMAR CHALLENGER PLANS FOR 1979-81

I. BACKGROUND

An oil leak in the forward aft thruster necessitated the CHALLENGER going into dry dock at the end of the experimental phase of Leg 68. The nearest dry dock is Curacao. Transit and repair time were estimated to take 30 days. PCOM reviewed CHALLENGER's schedule through the end of the 1979-81 program taking into account the delays and additional requests for shiptime. Additional requests for shiptime included:

1. Hydraulic Piston Coring "mini-leg" to sample two sites in the Equatorial Pacific and one in the Caribbean.

2. Return to Site 494 of Leg 67.

3. Downhole Instrumentation "mini-leg."

4. Engineering Transit "mini-leg."

5. Geochemical Transect.

Discussion developed concerning the allocation time, especially in view of the time lost because of the emergency yard work in Curacao and weather constraints. Arguments were made for leaving the schedule as planned, particularly in light of national interests; and for making major changes, because of time lost in transit and escalating fuel costs. Weather, staffing, and the readiness of site surveys could be taken into account in either argument.

II. HYDRAULIC PISTON CORING "MINI-LEG"*

The HPC allows a new type of record to be obtained of the deep ocean Cretaceous and Upper Tertiary unconsolidated sediments, and thereby knowledge of global climatic changes during those geologic areas.

A 35-day leg to piston core sites 83, EP I, 157 and CAR-8 (WC-1) was proposed. The inclusion of EP-1 was on the condition that HPC engineering developments would increase the speed of core recovery. These improvements will not be ready so EP-1 was dropped. The proposed sites address the problems of:

1. The detailed record and spectral character of late Neogene and Quaternary climatic variations (all sites).

2. The biotic and volcanic history associated with the closing of the Isthmus of Panama and with long-term climatic change (CAR-8).

*Post-Meeting Note: This will be called Leg 68.

3. The development of detailed stratigraphy which relate magnetic stratigraphy to faunal and floral stratigraphies of all major microfossil groups and to the volcanic history of Central America (all sites).

4. The nature of change in the physical properties over the upper 200 to 250 m of sediments in calcareous rich, siliceous rich, and hemipelagic sedimentary sections, including an opportunity to compare cyclic lithologic changes with the acoustic reflection record (all sites).

5. The pattern of hydrothermal alteration and metaliferrous sediment deposition in the lower part of the sedimentary section (site 83).

A large segment of the ocean paleoenvironmental and sedimentological community expressed interest and helped to prepare a proposal for use of the HPC. Information from this proposal has been used in the 1981-83 CHALLENGER proposal and for the "mini-leg." Details of the mini-leg proposal were worked out at an ad hoc meeting of OPP members on 20-22 June.

The HPC 30-35 day equatorial mini-leg was accepted as outlined in the proposal.

It was decided that 20 of the 35 days for the HPC mini-leg be taken from the S. Atlantic program.

III. SITE 494

The Leg 67 scientific staff requested that they be allowed to return to Site 494 for an additional 200 m of penetration, in which they hoped to penetrate the toe of the accretionary zone on the landward side of the trench. It was estimated that 15 days would be needed. During Leg 67 several holes on the upper trench slope had to be abandoned because of what appeared to be gas hydrates. These hydrates were not found at Site 494 but drilling 1.1 miles along strike from Site 494 encountered them. The shipboard request to redrill close to Site 494 was denied because the HIG downhole seismometer was in place.

The PCOM reviewed the Leg 67 request. There was discussion about the uneven stratigraphy along strike, safety considerations, the amount of information which could be gained from the additional 200 m, and the limited time available for a mini-leg. In favor of the proposal was the possible opportunity to show clear evidence of subduction at this location. The PCOM rejected the proposal to return to Site 494.

IV. INSTRUMENTATION/DOWNHOLE EXPERIMENT LEG

A proposal to use a previously drilled re-entry hole (Site 395A) was submitted by several scientists who are currently involved with CHALLENGER downhole measurements. PCOM discussed the status and success of the previously performed measurements and the feasibility of the new experiments being proposed. The specific problem being addressed in this proposal and the general scientific rationale were not explicit.

PCOM asked that the proposal be expanded with more scientific rationale and then resubmitted.

V. ENGINEERING LEG

The outline of a program for an 8-9 day engineering leg was submitted. The work for this leg was intended to take place near Site 415 (off NW Africa) and would include a number of ongoing and new engineering tests. PCOM felt that this work should be coordinated with DMP plans. A decision on the engineering leg was withheld until more information on the program became available and until it is seen how it fits the new CHALLENGER schedule.

VI. SCHEDULE CHANGES

At this time the CHALLENGER was in transit to Balboa and the PCOM did not know if emergency repairs could be made in Balboa, or if yard work in Curacao would be necessary. The following two plans were adopted:

1. Plan A: Assumed Leg 68 was interrupted for yard work in Curacao. The HPC leg should then be done before the continuation of Leg 68, followed by Leg 69, a transit down the west coast of S. America with the first S. Atlantic drilling in the Falkland Plateau area. This plan would save 9 days of SA transit and 2 days in the canal over going to the S. Atlantic via the Caribbean. No additional site surveys are planned for the Falkland

region. UTMSI agreed to process the site survey data in a sequence to accommodate PCOM's plans.

2. Plan B: Assumed that the necessary repairs could be done in Balboa. The HPC mini-leg would then be done after the completion of Leg 69.

The following schedules were proposed for the remainder of 1979-81 drilling, and evaluated with the assumption that Plan A would be in effect:

1. Reversing the previously planned east and west sequence in S. Atlantic (CCW around S. America)

   2 legs SW Atlantic
   3 legs NE Atlantic
   3 legs SE Atlantic
   4 legs NW Atlantic

   This was considered good for weather and medium for expense.

2. Do all of S. Atlantic first (CCW around S. America)

   5 legs S. Atlantic
   7 legs N. Atlantic
   Caribbean NW Atlantic before NE Atlantic

   This was considered to be medium for weather and good for expense.

3. Sequence as presently planned

   3 SE Atlantic
   3 NE Atlantic
   2 SW Atlantic
   4 NW Atlantic

   This is the currently proposed schedule and was considered to be bad for weather and fair for expense.

Considerable discussion developed evaluating the merits of the different schedules. The PCOM adopted schedule number 2, a general plan to drill all of the S. Atlantic before going to the North Atlantic.

This was done with the realization that all plans were subject to continual review.

Distribution of lost yard time was then addressed. (The distribution of lost time for the HPC mini-leg had already been considered.) It was estimated that the schedule would have to absorb 30 days for yard work. (This time estimate took into account the 9 + 2 days gained back by CCW transit of S. America) until the end of the contract period in October, 1981.

PCOM decided that the 30-day potential loss of future drilling time be distributed on a ratio of 11 days OPP, 15 days PMP, and 4 days OCP, and in the event that the time loss is less than 30 days, the additional time be preferentially distributed to the PMP.

1981-83 GLOMAR CHALLENGER PROPOSAL

I. SCIENTIFIC PROPOSAL

The current GLOMAR CHALLENGER extension goes into effect this October and runs for two years. If funds for the GLOMAR EXPLORER are approved, conversion will begin about FY '81 but the ship probably won't be on line until late 1983. If funds for the GLOMAR EXPLORER are not approved, the program would end in October, 1981.

There are still many important scientific problems which can be addressed by a CHALLENGER-type vessel. PCOM was asked by EXCOM to prepare an 1981-83 proposal by August. EXCOM will review the proposal, and if approved, it will be submitted to NSF in September. An ad hoc committee of PCOM members, Panel Chairmen, and a few other interested people met in Washington on May 30 to discuss scientific objectives and priorities for this proposal. It was agreed that work by the hydraulic piston corer should form the major scientific framework of the program with associated and compatable special programs being worked in as convenient.

II. GEOCHEMICAL TRANSECT

In reviewing the different objectives, there were many EN Atlantic sites with OPP objectives. If the OCP's geochemical transect could be done in the eastern Atlantic, then both objectives could be met in a single transect. The OCP was asked to consider doing their transect in the eastern rather than western N. Atlantic.

III. CHALLENGER FUNDING—1981-83

Soliciting funds from other agencies (i.e. non-NSF) was discussed. It was strongly felt that programs from other agencies should only be incorporated if they had a good scientific rationale and could be fit into a coherent scientific program. The seabed waste disposal program was mentioned as a possible non-NSF source of funds which might fit into the program. They are interested in better generic and site specific studies, and obtaining long wide cores of undisturbed sediments. Many persons associated with these studies are already on JOIDES Panels.

Discussion also developed concerning the use of other less expensive ships during the 1981-83 program. The ALCOA SEAPROBE was mentioned but it is very unstable and the HPC requires a stable platform. It would also have to be outfitted with a long drill string. The political effect of going to a smaller vessel when asking for a larger vessel (EXPLORER) might not be favorable.

Starting two new ships in 1981 (EXPLORER conversion and another new ship) might give the impression that two completely new programs were being started. The CHALLENGER is not overly expensive for a drill ship.

It was also suggested that the EXPLORER might be available for part of this time while RFP's for conversion were out. It could be run with a minimum crew and be used for piston coring. NSF will look into the availability of the EXPLORER, and the feasibility of using it during part or all of the 1981-83 time frame. DSDP was asked to make an estimate to convert the EXPLORER for piston coring and to estimate its daily operating cost in that mode.

STATUS OF EXPLORER PLANS

I. REGIONAL/SITE SURVEYS

Site survey lead times (regional and site specific) of approximately 4 years are necessary to properly plan for EXPLORER drilling. If the EXPLORER comes on line at the end of 1983 as scheduled, site surveys should be beginning now. At their last meeting, the U.S. Site Survey Panel, urged the PCOM to submit locations and site survey requirements for the first EXPLORER sites.

II. SCIENTIFIC PROGRAM

Concern was expressed about the lack of detailed EXPLORER planning. The Ocean Sediment Coring Office at NSF has begun to increase their staff in preparation for the EXPLORER. There is money in the FY '80 budget for EXPLORER planning. Brett will investigate using some of this money to increase the JOIDES staff for EXPLORER planning, including help with synthesizing scientific information, site survey requirements, and engineering problems. Other problems which must be addressed include staffing, and staffing changes for the long legs. It was suggested that PCOM, a sub-committee of PCOM, or a special EXPLORER Planning Committee meet more frequently to specifically address EXPLORER plans. With the present meeting schedule there is not enough time to devote to the long range plans necessary to prepare a viable EXPLORER program.

The Panels were also asked to continue their participation. They were asked to consider their EXPLORER scientific programs and site survey requirements for their proposed regions and sites, keeping in mind that it may not be possible to change locations as easily as it has been with CHALLENGER drilling.

All panels were also asked to suggest analytical facilities and scientific requirements for the EXPLORER, and to design optimum laboratory and reference spaces. These recommendations should take into account the distribution between shipboard and shorebased studies, especially in light of the increased ship space and time at sea. Until plans for the alterations of EXPLORER are initiated, it will be difficult to be specific but EXPLORER is a large vessel and should be able to accommodate major facilities.

SYNTHESIS VOLUMES

U. Von Rad distributed an outline for a proposed synthesis volume on the NW African Passive Margin. It will include DSDP results, as well as structural, geodynamic evolution, and continental geologic information, and is being edited by Seibold, Von Rad, Hinz, Sarnthein, and Wiedmann. PCOM felt that this would be an important volume to synthesize drilling results off NW Africa.

DRAFT REPORT
DOWNHOLE MEASUREMENTS PANEL
24-25 May, 1979—Victoria, B.C.

REPORT ON RECENT LOGGING

A report on recent logging results was presented. The success rate for downhole logging appears to be increasing. About half the recent holes drilled have at least some good logs. The main problem continues to be hole stability—either hole collapse that prevents logging, or hole washout and enlargement that result in poor quality logs. Failures of the bit release mechanism and of the logging equipment have also occurred.

The quality of the logs also appears to have improved although poor quality arising from hole washout and enlargement remains common.

There was some concern in the Panel that the logs were not being adequately analyzed and reported on all legs. DSDP provided a tentative list of onboard scientists that appear to be responsible for each leg and that will write logging sections for the Initial Report.

LOGGING PROGRAM

There was considerable discussion on the value of the logs and of the uses to which they have been put. It appears that even with the relatively poor quality of the earlier logs, they have been used extensively. In the sedimentary portions of holes, most interest in the logs has been for outlining the detailed lithology; in the basement portions of holes, the main application has been for obtaining in situ physical properties. A list of publications and reports involving DSDP logging data is available.

The Panel felt that the present suite of logs and logging program should be continued for the immediate future without major change (with the possible addition of some log analysis—see below). It appears that the present contract logs will be continued with the addition of a tool for water sampling and high temperature measurements.

The improved quality of logs in recent legs appears to have occurred in a large part from the Project having one logging contractor who has provided the continuity of the same good logging engineers for a period of over a year. The Panel recommends that the Project make every effort to have long term logging contracts and that the contractor be pressed to provide the same experienced logging engineers over as long a period as possible.

The Panel considered how future logging could best be provided:

1. The best results should be obtained with the Project having its own tools, equipment and logging engineers. However, in the present employment market good logging engineers are difficult to find and extremely expensive, and logging companies probably will not provide the best tools for sale or lease.

2. There is a strong case for the Project having a professional log analyst on staff to interfac between the raw log data an scientists. The Panel recommends, if and when funds are available and if a suitable person can be found, that the Project hire a log analyst.

   As a second option DSDP and the Panel chairman should contact the management of the logging contractor to see if an arrangement can be made for the contractor to provide log analysis and scientific liaison.

3. To ensure that the logs on each leg are adequately treated and reported, the Panel recommends that an effort be made to designate one member of the shipboard scientific staff on each leg as the "logging specialist" in a similar manner as is at present attempted for the "physical properties specialist."

4. Only radioactivity and temperature logs can be usefully run through the pipe. Most radioactivity logs are severely affected by the variable steel thickness of the joints and drill collars etc. and are of little value. Temperatures inside the drill pipe will take somewhat longer to equilibrate than in the open hole but the effect frequently will not be serious and good logs can be obtained.

5. A number of DSDP logs have reflected significant oscillations of the tools due to the ship's motion. This problem generally is not too serious in industry. The problem seems to be emphasized by the slow logging speed used in DSDP holes to otherwise obtain the highest log quality. It is possible for the logging engineer to partially follow the ship heave manually with the winch speed. The complete solution lies in an accelerometer or other vertical position reference winch speed

control, or a mechanical compensation. (One Jageler system has a rocker arm with the logging sheave on one end and a sea anchor at some depth in the water on the other.)

REPORT ON DOWNHOLE EXPERIMENTS

A report was presented on downhole experiments recently carried out and planned. Several experiments planned for off the coast of Mexico were postponed because of a time limit on the approval from the Mexican government for the GLOMAR CHALLENGER to work in Mexican waters (hydrofracture, permeability and borehole televiewer; large-scale resistivity; and Soviet downhole magnetometer). They are tentatively planned for a two-week mini-leg in July. On Leg 65 (Gulf of California) the oblique seismic experiment was again successfully carried out although the hole depth was much less than desired. The downhole recording seismometer was also successfully deployed and recovered later by an oceanographic ship. Some data was recorded while the ship was still over the hole but unfortunately no subsequent data was recorded. The deployment and recovery of this instrument is a major step toward the use of a wide variety of downhole recording instruments.

PROMOTION OF DOWNHOLE EXPERIMENTS

The Panel considered ways of promoting and expediting downhole experiments. It is clear that downhole measurements and experiments will play an increasing role in the GLOMAR CHALLENGER drilling program and be even more important in the very expensive few deep holes that may be drilled by GLOMAR EXPLORER. To aid potential experimenters in getting started with new downhole experiments, and to try to avoid their being put off by the complex organizational relationships (DSDP, JOIDES, IPOD, JOI, NSF etc.), the Panel made up an operation flow chart (Figure 9).

To facilitate downhole measurements and experiments, the Panel recommends that a number of downhole experiment mini-legs, of about two weeks' duration, be scheduled. These mini-legs would (a) eliminate the pressure to limit non-drilling activity by the drill coreoriented chief scientists and scientific staff and (b) eliminate the need for experimenters to spend two months at sea for at most a few days of experiments. At least one mini-leg should be scheduled to take advantage of old, still open holes. One suggestion is to re-occupy the mid-Atlantic ridge site 395. An appropriate time might be the proposed Atlantic transit. A list of old, still open holes that might be suitable for experiments has been produced.

HYDRAULIC PISTON CORER

The Panel considered the advisability of hydraulic piston coring being required on the upper part of every hole. The question is somewhat outside the Panel function but there was a general feeling that the case was similar to that for continuous coring. The upper sedimentary section is certain to be an important part of the scientific data bank for future studies, even if it is not of great interest to the on-board scientists of a particular leg.

NEW JOI (NSF) FUNDS FOR DOWNHOLE EXPERIMENTS

The Panel considered providing suggestions on how new money for downhole experiments should be spent and how proposals should be evaluated. There were no clear suggestions on evaluation procedures but the flow sheet of Figure 9 seems appropriate.

Four general areas where funding should be particularly productive were considered by the Panel

1. Data Recording, Transmitting and Retrieval Systems

   All long-term recording borehole experiments require some data recovery system. The simplest is a seafloor recorder that is recovered at intervals by any ships that are available. The most sophisticated and ultimately satisfactory system is data transmission to a sea surface buoy, perhaps acoustically, then to a satellite for relay to a land station. A number of other groups are interested in seafloor data recovery, so that cooperation and coordination should be explored.

2. Downhole Experiments

   Measurements that monitor *in situ* stress and strain were thought to have significant potential. For example, mid-plate stress may give information on plate motion driving driving mechanisms; stress and strain

HOW TO UNDERTAKE A DOWNHOLE EXPERIMENT IN DSDP BOREHOLES
(without getting lost in the maze)

1. IDEA

2. FEASIBILITY

A. Is it being undertaken or has it been proposed by others?

ASK: JOIDES Downhole Measurement Panel Chairman
or
DSDP Chief Scientist

B. Is the experiment technically feasible?

ASK: DSDP Science Operations and Engineers
and Engineers

3. ENDORSEMENT

Describe Experiment: JOIDES Downhole Measurement Panel
and/or
JOIDES Subject/Problem Panels

PCOM Recommendation: JOIDES Planning Committee

4. FUNDING AGENCY

Peer Review: NSF, ONR, JOI, Industry, Other Government (U.S. and non-U.S.) Agency, etc.

5. EXECUTION

JOIDES Planning Committee Schedule

DSDP Science Operations and Engineers

monitoring in an active margin borehole could help to outline the details of the subduction process; and in a tectonically active area, the strain before, during, and after earthquakes could be monitored. Many experiments and instruments could be used. Any measurements that would help to outline the details of hydrothermal circulation in a system penetrated by a borehole would also be very valuable.

3. New Logging Tool Development

Some tools for which development would be particularly valuable for deep sea boreholes are: (a) a tool motion arrester; (b) a spectral gamma ray tool; (c) downhole neutron activation capability; (d) a borehole gravimeter; (e) a shear wave velocity tool; (f) a geochemical monitoring tool; and (g) high temperature tools. Some efforts are being made by the logging industry to develop these tools. New tool development is very costly so they probably they should have lower priority than downhole experiments.

4. Geotechnical Measurements of the Upper Sedimentary Section

DOWNHOLE MEASUREMENTS REPORT

A report by the Panel outlining downhole logging, measurements, and experiments that are presently employed, proposed, or possible is in progress. The second day of the Panel meeting was spent in producing a draft copy. The intention of this report is to provide comprehensive reference information and to assist in future planning of downhole measurements in deep sea boreholes.

DRAFT REPORT INORGANIC GEOCHEMISTRY PANEL 4-6 June, 1979—Scripps

I. CHEMICAL DATA

The publication of chemical data on bulk sediment composition was again discussed. It was strongly recommended that such data be channeled to DSDP for storage in the data bank. Since the meeting, arrangements have been made for Dr. T. W. Donnelly to publish his extensive set of data on DSDP sediment (chemistry) in the Leg 54 I.R. volume.

Dr. Tardy expressed his concern that studies of the bulk chemical composition of the solids be accompanied by careful mineralogical work. This received the general support of the Panel.

II. DSDP DEVELOPMENTAL ENGINEERING

The pressure core barrel was discussed. In view of the finding of Legs 56 and 57, the panel is of the opinion that the engineers should be encouraged to further develop the apparatus.

The success of the hydraulic piston corer at Sites 480 and 481 during Leg 64 was received with enthusiasm. Though Site 480 has been widely publicized, results in Hole 481 were also such that sedimentological work became very much more detailed than would have otherwise been possible. The Panel wholeheartedly supports efforts to expand coverage of the ocean with long cores obtained with this equipment.

III. LEG 68/69 (now Legs 69/70) PLANS

Chemical data on pore water from the Leg 64 Guaymas Basin Hydrothermal Sites (477, 478, and 481) was discussed. Data from the Galapagos Mounds area, indicating chemical evidence for possible advective flow of hydrothermal waters, was presented.

The following is a summary of Panel recommendations for Legs 69 and 70:

1. The Panel recommends sediment and basalt coring in the same hole to ensure contact recovery. This hole should be hydraulic piston cored to as close as the basalt-sediment interface as possible, especially in the Galapagos area.

2. The Panel recommends at least two piston cores at all mound sites to ascertain lateral inhomogeneity of the mounds.

3. One piston core hole should be taken at all other sites when feasible. In every core at least one 15 cm section should be taken for interstitial water and other inorganic studies (preferably one sample for every 3 meters recovered in the mounds area).

4. The Panel recommends that, after piston coring and changing of the bits, drilling be undertaken with limited recovery, allowing at least

3 Barnes-Uyeda in situ pore water/temperature measurements in the mounds area (or more in deeper sediment sections).

5. Interstitial water samples should be taken with greater frequency near basement, so that transport across the basalt-sediment interface can be studied.

6. Basalt drilling should be carried out to the greatest depth, with emphasis on maximum recovery.

7. The Panel encourages experiments to recover water from basement rocks (Anderson hydrofracture), downhole conductivity experiments (Tim Francis), and other downhole measurements in basaltic rocks.

DRAFT REPORT
PASSIVE MARGIN PANEL
11-15 June, 1979—Oslo, Norway

1979-1981 CHALLENGER PROGRAM

I. WESTERN N. ATLANTIC PROGRAM AND REVISIONS

Sites ENA 9 and 10 in the Orphan Basin were deemed potentially hazardous in a preliminary safety review. No site surveys will be undertaken and the Canadians have been notified of this.

As sites ENA-9 and 10 were dropped, Sites ENA-12 and 13 in the Gulf of Mexico proposed by University of Texas (MSI) were considered. These are:

A. Base of Compeche Escarpment

Pre-salt basement is "very shallow." This is a deep penetration target and has potential safety problems. It is recommended for riser drilling. The site is unsuitable for Neogene biostratigraphy.

B. Western Florida Strait

The site lies near Site 97 (T.D. in Upper Cretaceous). It is of interest in tracing the origins of the Gulf Stream. The site will also attain Jurassic objectives that can be extrapolated into the Gulf and are thus of regional importance. The Jurassic mayalso be contiguous with that in the Blake Bahama Basin. A large part of Florida is now thought to be oceanic. The OPP strongly supports this proposal and a tentative programme would be of single bit hole for Tertiary palaeoenvironments and re-entry for the Jurassic. Some of these sites would also provide a good link with the Blake-Bahama and Caribbean proposals.

Additional site surveys have been requested. The Working Group would like Texas to connect regional seismic lines on to Lamont lines in Florida Strait and provide ties along the east margin of the USA. WHOI is to survey ENA-3 and 4 to provide regional connections as well as to meet safety requirements. UTMSI will connect sites ENA-1 and 6 and LDGO will survey ENA-8 and 11. Site surveys are scheduled for summer 1980 together with an expanded spread 3-ship seismic experiment. The USGS will also survey ENA-5 using 12-channel reflection. BRG will be conducting a 7500 km multi-channel seismic survey of the N. American continental slope and rise this summer. The study will begin off the Nova Scotian Margin, including Georges Bank and extend to New Jersey, tying in the COST B-3 well. The work is being done in connection with the USGS and the Bedford Institute's Atlantic Geoscience Center.

II. EASTERN NORTH ATLANTIC

The weather limitations, drilling time requirements and priorities were assigned to the proposed Eastern North Atlantic sites. (See Table next page.)

III. BAY BISCAY, ROCKALL PLATEAU

Site surveys are planned for summer 1979. D. V. Resolution will survey sites in Biscay and in Gobar Spur. A two-ship seismic refraction/reflection experiment is planned by IOS/IFP/COB in July. Site surveys in Rockall will also be conducted in summer 1979.

Area	Weather	Drilling Time	Program	Priority
Biscay	May-mid Sept	2 months	2R + 1S	1
Rockall	June-Aug	1 month	1R + 3S	2
Goban Spur	May-mid Sept	15 - 20 days	3S	3
Voring	June-Sept	2 months	2R	4
NW Africa	All Times	10 - 20 days	3S	5
Galicia-Vigo	May-mid Oct	1 month	3S	6
Faeroes	June-Aug	1 month	2R	

R = Re-entry
S = Single bit

IV. NORTH WEST AFRICA

Siebold presented a drilling proposal entitled "Cenozoic" oceanography and paleoclimate. This proposal emphasized the importance of horizontal and time transgressive oceanographic gradients in understanding margin palaeoenvironments. Main elements of the proposal were:

1. A systematic N-S traverse to examine climatic gradients
2. Sites off Gibraltar to examine the Tethyan link and Tertiary circulation.
3. Palaeocurrents.
4. Isotope stratigraphy.
5. Volcanic events in the Canaries.

There should be no safety problems as these are all short holes. Many of the sites would be ideal for the HPC although sites with Neogene sands might be difficult. Site surveys will begin in September, 1979 with a combined geology and geophysics cruise. Geochemical surveys will be made over the sites to detect hydrocarbons and heatflow measurements will be made. Airguns and waterguns will be used to provide site specific data and to follow the black sholes. The data will be avialable by December. During February, March and April, 1980, deep refraction profiles will be occupied to study different types of crust and to look at the extension of the salt basin. Hinz also presented a seismic section off the North Atlas Basin.

Many of the sites in this proposal can be linked to those in the OPP 1981-83 proposal. OPP views on these sites have not yet been sought. It was felt that a close link should be maintained between the geology of the continent and the slope by drilling acoustic stratigraphy.

V. NORWEGIAN SEA, GREENLAND, FAEROES, ICELAND—FAEROES RIDGE

A. Norwegian Sea

The history of the Norwegian Sea was outlined, drawing attention to the problem posed by the Voring Plateau. The results from Leg 38 and new multi-channel seismic profiles obtained by R/V CONRAD were discussed. Similarities between the Voring Plateau and the geology of the margin north and west of Spitsbergen was also reviewed.

The unusual feature of the Voring Plateau is the sink of strong dipping reflectors that underlie the western part of the Plateau. Magnetic evidence suggests that the reflectors are underlain by oceanic crust of anomaly - 24 age. High seismic internal velocities characterize the reflectors. The origin of the reflectors is enigmatic. Are they lavas? Prograding sediments? What is their relationship to the history of break-up? A series of re-entry holes was proposed to penetrate through the overlying basalt with these reflectors.

B. Greenland

A seismic reflection profile across the East Greenland margin was discussed. Reflectors can be related to the spreading history of the Kelbeinsey Ridge and to the opening of the Norwegian Sea. "Sub-basement reflectors" observed off East Greenland are thought to be old post-rift sediments rather than reflectors of the Rockall-Voring Plateau type.

C. Faeroes

A multi-channel seismic line north of the Faeroes platform was presented. The profile showed some similarities to the Voring Plateau.

A long discussion then followed on comparisons and contrasts that might be made between the Voring Plateau, Faeroes, Rockall Plateau and other areas.

D. Iceland-Faeroes Ridge

A report on the NATO funded research program in the Iceland-Faeroes Ridge was given.

LOGGING

There is no provision in the budget for logging during Leg 69 (now Leg 70). Also with the increased fuel costs, severe financial constraints will exist in 1980. Implications for the logging program were discussed at length and the PMP approved the following statement: A full logging program should be carried out during all passive margin drilling legs and that every effort should be made to ensure that adequate financial support is available for a full logging program. Logging is the only way to achieve the following objectives:

1. Precisely relate seismic reflections and seismic stratigraphy to lithology using synthetic seismograms and relative impedance.
2. Identify hiatus.
3. Determine physical properties in situ of value in the diagenesis of deep water sediments.
4. Bridging coring gaps and inferring stratigraphy across coring gaps.
5. Precisely define lithostratigraphic boundaries.
6. Determine nearflow and temperature in situ.

CHALLENGER 1981-83 EXTENSION PROPOSAL

The PMP discussed at length the PM input into the 1981-83 CHALLENGER proposal. It was agreed to emphasize sedimentary processes and margin palaeoenvironments, noting plate reconstructions. Specific areas of interest included:

1. Slumping on the upper slope off the eastern USA. The slumping here has precluded lease sales. Hydraulic piston coring would be scientifically valuable and economically important to both commercial drilling and IPOD-II. One obvious target would be the physical properties of upper slope sediments. Such a program would also interest the OPP. It was noted, however, that this type of program could be carried out by the USGS, given the availability of a hydraulic piston corer.
2. A single re-entry hole in the Gulf of California during the 1981-83 program. The hole will require 10-14 days with the objective of reaching true basement, and it would also be of interest to the OPP.
3. Possibly the Biscay Deep Sea Fan. The fan has been studied in detail using Seabeam high-resolution multi-channel seismic profiles and 3.5 kHz seismic profiles. The fan would be an ideal candidate for hydraulic piston coring.

ARCTIC DRILLING

A proposal for Arctic drilling was discussed. Structural and palaeoenvironmental objectives include studying the change from a warm Mesozone to a glacial ocean. The Arctic may have been ice-free during the Pleistocene. Ongoing Arctic exploration programs include studies around Svalbard by the Univ. of Bergen and Oslo and an expedition to the north of Greenland by a Swedish Icebreaker.

Some Arctic sites could be drilled by CHALLENGER but others would require ice-rafts. The GLOMAR CHALLENGER could reach the Yermate Plateau to the North of Spitsbergen which should thus be considered in the 1981-83 program. There are many high-priority targets in the Arctic that could be addressed by GLOMAR EXPLORER.

GULF OF ADEN DRILLING

A letter ...
asking

the Gulf of Aden. In view of logistic limitations, such drilling was not deemed possible.

HPC MINI-LEG (NOW LEG 68)

The proposed 30-day HPC leg and its implication on and possible redirection of the Atlantic program were discussed. The PMP stated that the 30 days presently proposed for further evaluation of the hydraulic piston corer should be undertaken during the normal course of a DSDP leg. Proposed sites for hydraulic piston corer evaluation should be consolidated within the OPP legs for the South Atlantic and should not be considered as a new insertion in the program. Every endeavor should be made to test and develop the HPC on the variety of sediments that will be encountered during routine drilling.

PANEL REORGANIZATION

The Panel reorganization plan prepared by a PCOM subcommittee was discussed. The idea is that regional panels should be formed for EXPLORER drilling, but the PCOM does not wish to abandon subject panels. It is suggested that the regional working groups be changed to target panels. The implication is also that PCOM will need strengthening perhaps with paid members involved in site selection. Only 2 or 3 passive margins will be drilled so there is a strong case for regionality, e.g., N.E. and N.W. Atlantic Working Groups. The function of the target groups would be to lead the pre- and post-drilling studies. They would be independent of subject panels.

With so few holes being drilled, site selection procedures must be very responsible. A very different site and scientific management program will be needed. Subject groups should be strengthened so that the best scientific input is available and decisions are made on their merits.

An EXCOM subcommittee is further reviewing the panel reorganization situation.

CONTINENTAL SCIENTIFIC DRILLING PROGRAMS

The Report on Continental Scientific Drilling published by the National Research Council was reviewed. Proposed sites include buried Mesozoic margins in the continent, e.g. in the Gulf of Mexico. Site 4 on the Georgia Plain would link into the COCORP line, the IPOD line, and sites in the east. Geophysical surveys of the Gulf of Mexico suggest the site may be seaward of the continent-ocean boundary. The COCORP data are the site survey data. The role of continental drilling and its relationship with IPOD was discussed.

DRAFT REPORT
POLLUTION PREVENTION AND SAFETY PANEL
8 August, 1979

I. (NEW) LEG 68—HYDRAULIC PISTON CORING

The Safety Panel reviewed the material on two sites at which hydraulic piston coring to depths of 250 m to 300 m has been proposed. These locations are:

PR-1	(Former DSDP Site 83)	
	Lat:	04°02.80'N
	Long:	95°44.25'W, and
CAR 8/ WC-1	Lat:	11°40'N,
	Long:	79°15'W

Use of the Hydraulic Piston Corer to the depths proposed should pose no safety problems and is approved.

If rotary drilling below about 300 m is anticipated at the Caribbean site, a separate request for safety review should be made. The location is not at the formerly drilled DSDP 154 as first intended, and therefore must be regarded as a new site. In the absence of adequate geological and geophysical information on the deeper section, and because it sits on top of a large structure, the Panel does not feel that it can properly assess the safety risk of rotary drilling here.

DRAFT REPORT
STRATIGRAPHIC CORRELATIONS PANEL
28-29 June, 1979—Washington, D.C.

MANDATE

The mandates were reviewed. The SCP is to provide:

1. Overseeing the quality and resolution of correlation.
2. Organizing and overseeing shore work, including certain publications.
3. Filling of gaps in control information for correlation.
4. Correlation of stratigraphic data and materials to maintain consistency in standards.

REPORT FROM PCOM

The role of SCP as a "watchdog" on stratigraphic affairs was emphasized. These include:

1. The management responsibilities of SCP related to the shipboard laboratory, guide books and looseleaf note books for shipboard personnel, and data base management.

2. Watching the Initial Reports, particularly that stratigraphic input into the IR's has a priviledged position that cannot be abused by poor quality control.

After a brief review of the history of SCP including its period of experimentation, SCP has begun to focus less on issues concerned with basic science and more with quality control and providing services. All agreed that there were no conflicts between the mandates as given. The reorganization of SCP and classification of mandates is expected to streamline input to PCOM.

IR STATUS/INPUT

The present status of IR volumes (43 through 53) was given, and the new editing staff described. A new policy to reduce waste space will include placing captions of plates underneath a foreshortened plate and placing of raw data in microfische at the end of the volume.

It was decided that the former practice of assigning individual members to particular IR volumes be abandoned in favor of closer SCP cooperation in overseeing publication quality of individual articles. A current list of reviewers of paleo publications and publication instructions will be sent to SCP members for review. SCP members will then provide a corrected or amended list of possible reviewers. Periodically a list of titles and authors of upcoming articles with "problem articles" indicated will be circulated and SCP members may request to see these articles and/or recommend a reviewer.

PALEO-DATA BASE

About 160 of the 325 sites remaining to be encoded into the Paleo-Data Base (PDB) still need to be selected. The sites designated for sampling by the reference centers will be sent to DSDP for encoding. The following statement of principle regarding the PDB was endorsed by SCP:

"The Data Base of paleontological information including the designation of the presence of fossil species found in the DSDP-IPOD cores collected and encoded by DSDP for the Tertiary and the Bundfesanstalt fur Geowissenschaften und Rohstoffe for the Cretaceous (under the direction of P. Cepek) is of immense real and potential importance for the monitoring of the paleontologic exploration and biostratigraphic control of sediments of the ocean floor. The Stratigraphic Correlation Panel recognizes the contributions of these two institutions and encourages in every way possible the continuance of these projects."

To follow through with this statement the SCP recommended to PCOM that DSDP be instructed of the value of the Paleo-Data Base and that encoding of the Tertiary fossil distribution be continued with all possible haste in order to come in line with the BGR contribution.

PALEO-REFERENCE CENTERS

A background description of the history and present status of the PRC's was given.

A presentation was made for the need to accelerate development of the Reference Centers as a means of showing industry a willingness to make material collected by DSDP-IPOD available. At present they are not available in a U.S. national repository. The Smithsonian Institution was cited as the desirable repository. SI does not having funding for preparation but is willing to accept all of the other responsibilities of curatorship of the Reference Center.

REPORT OF WORKING GROUPS

Working Group A has been dissolved. The report of Working Group C was reviewed and, their work completed, the group disbanded. The work of Working Group B was reviewed. It was the opinion of the SCP that the wwork was beyond the extent of the panel. Working Group B was placed into a holding pattern to await more specific problems.

STRATIGRAPHIC GAPS

A working group was formed to examine the completeness of the biostratigraphic record in North Atlantic cores. The information will be used to make recommendation for the upcoming North Atlantic drilling, and should be ready by mid-December.

SHIPBOARD LAB PRACTICES

The elevator door on the paleo-lab level of the CHALLENGER does not allow access to the cores, making it necessary to sample upstairs with the lab work being done downstairs. This necessitates spending time running up and down stairs. The system should be more flexible.

An inventory of references on board ship is necessary. A technician will be asked to check out the lab between Legs 69 and 70 during steaming. Afterward the problem of completeness and the need for the compilation of a note book or revised guide book can be addressed. The matter of an adequate reference collection and guide references is a continuing problem. New shipboard paleontologists are advised (as has been past practice) to bring necessary materials with them as the loss of reference specimens and articles has become too large to replenish easily.

PANEL INPUT

Closer contact will be maintained with the two subject panels closest to SCP interests (OPP and PMP). A closer relationship will also be established with the IHP. This may be accomplished by SCP members attending other panel meetings.

DRAFT REPORT
CARIBBEAN WORKING GROUP
21-22 May, 1979—LDGO

REEXAMINATION OF CARIBBEAN DRILLING SITES

I. CAR 1—BARBADOS RIDGE

The objective of this hole is to drill through the tectonized sediments of the Barbados Ridge down to the Atlantic Oceanic Crust. CAR 1 is located between the Tiburon and the Baracuda Ridges. Both ridges are considered to be extensions of Atlantic fracture zones. Sediments are thin and probably of pelagic origin with possible volcanogenic components. A single bit hole, or a couple of single bit holes, is sufficient unless down hole experiments are planned.

Detailed single channel seismic reflection surveys have been done by LDGO to the North of the site, and the setting is not significantly different. The front of the tectonized zone is well defined to the South until the latitude of Trinidad. The tectonic style changes with increasing sediment thickness. Drilling there was not considered during this phase of IPOD for safety reasons. Westward of CAR 1, on top of the ridge, one other hole could be drilled to investigate possible differences in the style of deformation. Additional seismic lines would be necessary. This site is near shot point 300 on CEPM profile A3.

Site CAR 1 is maintained as it was proposed initially. All data are ready for safety panel review. The Working Group recommends a synthesis of all data existing on the Barbados ridge. University of Durham will work in the area during 1980 (Gloria, seismic reflection). IFP - CEPM - CNEXO will also make seabeam surveys and high resolution MCS in the area during 1980.

II. CAR 2—GRANADA TROUGH

This hole is proposed to investigate the age, nature, and origin of the Granada basin between the Lesser Antilles and the Aves ridge. The site is on the Western side of the basin to avoid thick turbiditic deposits. An additional site could be proposed on top of the Aves Ridge but a complementary survey would be necessary. This site is maintained. All data are ready for safety panel review.

III. CAR 3 and CAR 4—VENEZUELA BASIN

Present knowledge of the structure of the Venezuela basin was discussed and new LDGO, MCS lines were presented. They reinforce the initial proposal. Two areas with different crust can be defined in the Venezuela basin. To the W and NW below the smooth horizon " corresponding to the lava flows of Upper Cretaceous age, seismic reflection shows a series of coherent reflectors. The Infra " series have a velocity around 5.2 km/s and are probably volcanics. CAR 4 is intended to investigate the nature and age of formations. To the South East the picture is completely different. " does not exist and rough normal oceanic crust seems to be present. In this area, CAR 3 is intended to investigate the normal oceanic crust of the Venezuela basin. The contrast between the two types of crust is striking on MCS profiles.

The transition zone corresponds to a sharp deepening of the crust accompanied by increasing sediment thickness over a few tens of km.

CAR 3—To avoid excessive sediment thickness CAR 3 is situated near the boundary between the two types of crust, and takes advantage of an uplifted fault block. Sediment thickness is around 1500 m. The fault blocks induced draping of the overlying sediments and form anticline structures. This site will probably encounter difficulties passing Safety Panel review. IFP site surveys demonstrated that the fault zone is limited in extent. It is thus proposed to look for an alternate site south of CAR 3 in a non-faulted area. For that purpose a complementary site survey is proposed. CAR 3 would be a re-entry site.

CAR 4—The discussion concerned the penetration limitation of such a hole. There is no well defined reflector which could be the final target. Drilling conditions could be similar to those encountered in the Nauru basin. Therefore, the Working Group recommends that CAR 4 remain a re-entry hole but that penetration should be limited to 300 m in or below " in absence of interbedded sediments in volcanics.

IV. CAR 5—NORTH COLOMBIA BASIN

Located between the Beata ridge and the Nicaragua rise in the northern Colombia basin, the objective of the hole is to investigate the nature and age of the basin. The initial site proposal remained unchanged. Line C 6 - 3A of UTSMI should be included in the package.

V. CAR 6—SOUTH COLOMBIA BASIN

Site CAR 6 was located on a basement ridge in the Southern Colombia basin, probably in a prolongation of the North Panama rise. MCS lines from UTSMI (CT1-21 and CT1-22) and LDGO (123-124) are available and allow a definitive location to be proposed.

VI. CAR 7—YUCATAN BASIN

Knowledge of the nature and age of the Yucatan basin is considered to be of prime importance for understanding the geological history of the whole Caribbean including the Gulf of Mexico. UTMSI has carried out intensive MCS profiling in this area. The results were discussed by the WG.

A complementary survey is requested and will be proposed to the SSP. A provisional location is defined on line GT2/52 C, at shot point 6430 on the flank of a small basement high. Sediment thickness is about 600 m UTMSI is responsible for proposing the final location after the survey.

SITES PROPOSED BY THE PALEOENVIRONMENT PANEL

I. CAR 1 (1 P)

Located on the Beata ridge at the previous site 151, this site is proposed to recover a complete Tertiary sequence in the Caribbean deposited above the CCD. The location would be the best to recover:

1. A complete sequence.
2. A well preserved open marine Miocene-Pliocene boundary (water depth at the site is about 2000 m).
3. Material for studying the paleooceanographic effects of the closing of the Panama isthmus.

No other site surveys are necessary for this site.

II. CAR 8 (2P)—(WC1)

Located on the North Panama rise, not far the previous site 154, the site would allow recovery of a complete Neogene carbonate sequence to determine the effects on biogeography, paleooceanography, and biostratigraphy of the closing of the Middle American Seaway in the late Neogene. This represents a first order paleooceanographic event that appears to have had major repercussions on global climates and oceanic circulation.

The Working Group considered that this site could also meet the objectives of CAR 6 in the Southern Colombia basin, with a 1000 m penetration until the basement. It is therefore proposed as a new Site CAR 8 (WC1) by the Working Group. Several MCS lines (IFP-CEMP lines 109 and 112, UTSMI line CT1-12) cross the area. No complementary site survey is necessary. Nevertheless some more regional lines would be useful and it was suggested that the DISCOVERY might be able to survey the North Panama rise during her transit from Panama to the Antilles.

HYDRAULIC PISTON CORING
WORKING GROUP
20-22 June, 1979—SIO

BACKGROUND

There was a meeting inspired by the development of the HPC and by the proposal submitted to the JOIDES PCOM by J. Hays and supported by a large representation from the palaeoentologic community. The meeting addressed the proposed "mini-leg" for hydraulic piston coring in the tropical Pacific and western Caribbean, and the use of the hydraulic piston corer during 1981-83.

HPC "MINI LEG"—(NOW LEG 68)

The hydraulic piston corer (HPC) recently developed by the Deep Sea Drilling Project, provides a means for writing a new chapter in the study of the unconsolidated deep-sea section through greatly extending the depth of recovery of undisturbed sediments. Already its use has afforded us the opportunity to study the details of such diverse geologic processes as:

1. Variations in the Late Pleistocene climate in the Gulf of California.

2. The changes in the physical properties of sediments in the upper part of the marine section.

The coincidence of timing in the technological development of the hydraulic piston corer and the present location of the GLOMAR CHALLENGER provides an excellent opportunity to use this tool to great advantage in an area which is ideal for addressing several important scientific problems that cannot be attacked using conventional drilling techniques.

An adjustment in the present drilling plan is requested to take advantage of the technological breakthrough achieved by the HPC to address the following specific scientific problems:

1. The detailed record and spectral character of Late Neogene and Quaternary climatic variation (Sites 83, EPl, 157, CAR 8/WCl).

2. The biotic and volcanic history associated with the closing of the Isthmus of Panama and with long-term climatic change (Sites CAR 8/WCl, EPl).

3. The development of detailed stratigraphies which relate magnetic stratigraphy to faunal and floral stratigraphies of all major microfossil groups and to the volcanic history of Central America. (Sites 83, EPl, 157, CAR 8/WCl)

4. The nature of change in the physical properties over the upper 200 m to 250 m of sediments in calcareous-rich, siliceous-rich, and hemipelagic sedimentary sections. This includes an opportunity to compare cyclic lithologic changes with the acoustic reflection record. (Sites 83, EPl, 157, and CAR-8/WCl)

5. The pattern of hydrothermal alteration and metaliferrous sediment deposition in the lower part of a sedimentary section (Site 83).

In addition to investigating these problems, the proposed mini-leg would provide an opportunity to more fully evaluate the capabilities of the hydraulic piston corer in an area where the presence of cyclic sedimentation (i.e. fluctuations in carbonate concentration), volcanic ashes, and known long-term oscillations in the oxygen isotope record will allow a rapid and detailed correlation of the recovered sections. Such an evaluation, using multiple (2 to 3) holes at a single site, will allow us to tell how complete the recovery is likely to be at a site where the section is cored only once.

If a 9m HPC is not available at the time of the cruise, a first-priority site (EPl) will have to be dropped. It is felt, however, that even if DSDP is unable to provide a 9 m piston core, achievement of the objectives at sites WCl and 83 will justify the proposed mini-leg.

Site CAR 8/WC-1 (Lat.: 11°40'N,
Long.: 79°15'W)

CAR 8/WC-1 is located in the western Colombian Basin. The two primary objectives of this site are to:

1. Collect a complete record of the late Neogene and Quaternary

climatic fluctuations in a carbonate section with relatively high accumulation rates; and

2. Obtain a detailed record of the biotic and volcanic history associated with the closing of the Isthmus of Panama.

A few conventional piston cores have recovered records of Pleistocene climate which extend back 2 Ma. The accumulation rate in these cores is usually less than 2 cm/kyr; thus, the time resolution of these relatively long records is limited. Inspection of the oxygen isotope records from these cores, together with spectral analysis of the data, indicate marked changes in the spectral character of the isotopic record at the relatively low frequencies (periods of 100 kyr to 400 kyr). Sediment accumulation rates at site CAR 8/WC-1 are expected to be on the order of 4 cm per thousand years; thus, the section recoverable by the HPC should reach back into the Late Miocene. The complete recovery of this section would allow not only a thorough analysis of changes in the low frequency component of the climatic record, but also an analysis of the higher frequency oscillations during the regimes of both Northern and Southern Hemisphere glaciations. Presently the details of climate oscillations with periods on order of 10^4 yr to 10^3 yr can only be adequately studied in the latest Quaternary. This is because conventional piston cores normally only recover a few hundred thousand years of high resolution (high accumulation rate) sections. CAR 8/WC-1 will allow us to compare the changing spectral character of these high-frequency oscillations during the late Neogene and Quaternary as the global climatic state and spectral character of the low-frequency oscillations gradually change.

This site is also ideally located to monitor the closing of the gateway between the tropical Atlantic and Pacific Oceans. Gateways between the major and even the minor oceans play a special significance in paleoceanography and biogeography. These are the communication routes for biogeographic dispersal and the mixing of gene pools of species, and they exert significant control over the circulation of both surface and deep water. The closing of an important gateway can have major ramifications. Such was the case with the closing of the Central American Seaway during the Pliocene Epoch. This, the latest of the major Cenozoic ocean boundary changes, seems to have finally closed at a time so close to the initiation of Northern Hemisphere ice caps, that cause and effect relations are very strongly suggested. However, we are still not sure exactly when they happended. Biogeographic evidence from available DSDP cores suggest that the closure was about 3 Ma ago in the Middle Pliocene. Unfortunately, the stratigraphic resolution of the existing core intervals are inadequate. These materials are marked by coring gaps and mixing due to drilling disturbance. A chronology cannot be directly obtained for DSDP cores and has been interpolated indirectly from paleomagnetically dated piston cores which are located outside the regions of interest. Hydraulic piston coring at site CAR 8/WC-1 should provide the undisturbed material for high-resolution biostrategraphic, stable isotopic and paleomagnetic work that is required to answer two fundamental questions:

1. What is the age of the closing of the Central American Seaway?

2. What were the paleocenographic effects of this closing initially with respect to bottom water and later to surface water?

The most powerful tool for determining the timing of the gradual shoaling and closing of a gate is biogeographic evidence. The Panama Isthmus represents a geographic barrier which, in the present day, separates gene pools between the Pacific and Atlantic equatorial regions. Site CAR 8/WC-1 is well located in the western Caribbean to make detailed comparisons of both benthonic and planktonic microfossil faunas and floras with sequences of equivalent age in the eastern equatorial Pacific (such as at DSDP sites 83, 157, and 158). Information gained from these studies can also be integrated with the timing of possibly related phenomena elsewhere (e.g. intensified current flow of the Gulf Stream through the Yukaton Straits, Florida Straits and Blake Plateau, the initiation of North American ice cap formation, changes in the CCD between the Atlantic and Pacific Oceans, and changes in the stable isotopic ratios in calcareous microfossils).

CAR 8/WC-1 is located on a ridge east of site 154. Comparison of reflection records indicate that accumulation rates in the upper part of the sedimentary section are probably similar at the two locations, while turbidites found in the lower part of site 154 may be avoided at CAR 8/WC-1. It is planned that at least the Plio-Pleistocene part of the record will be cored three times in order to assure complete recovery of the sedimentary section.

Site 83—(Lat: 04°02.80'N;
Long: 95°44.25'W)

Site 83 is located on the eastern flank of the East Pacific Rise and was cored to basement on Leg 9. The section is 240 m thick and has an average accumulation rate of about 2 cm/kyr. The sediments are calcareous and siliceous-rich and show the marked lithologic oscillations which have been reported in late Neogene sections throughout much of the eastern Pacific Ocean. These changes in lithology are thought to denote climatic oscillations which have resulted in changes in carbonate preservation and/or carbonate and opal productivity. From the few rather undisturbed bits of section recovered in the equatorial Pacific, it has been estimated that these oscillations have a period of about 500 kyr.

The recovery of a complete section of undisturbed sediments spanning the Quaternary and late Neogene will greatly aid in addressing most of the problems listed in the Introduction. It will be of particular importance in establishing the spectral character of the lithologic, isotopic, and biotic variations which occur at this site and in refining a detailed magnetic stratigraphy and biostratigraphy down to the mid-Miocene. The nearly constant average accumulation rates at this site together with an ability to obtain a magnetic stratigraphy (and thus more detailed estimated ages) for the section offers us the ideal opportunity to investigate the periodicities found in the preserved record and to compare the phasing of the signals with the calculated parameters of the Earth's orbit. The presence of all the major microfossil groups at this site also make it ideal for detailed stratigraphic and evolutionary studies.

Finally, the presence of marked lithologic changes in the section will allow the use of relatively rapid GRAPE and NRM measurements to aid in correlating overlapping cores and in establishing the completeness of the recovery.

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PCOM		16-18 July			22-24 Moscow				25-29 Wash, DC				
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IHP								∿ 9-11 SIO					
IGP	4-6 SIO												
OCP				5-7 Albany									
AMP				5-7 SIO									
PMP	11-14 Oslo							7-9 WHOI					
OPP				5-6 Barbados									
OGP				24-25 Bristol									
PPSP													
SP4						2-3 SIO							
SSP						29-30 SIO							
SCP	28-29 Wash, DC											7-9 SIO	
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October, 1979	Vol. V No. 3		