JOIDES Journal

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Front cover: Leg 135 logo

The Leg 135 logo was drawn to look like the tapa cloth designs indigenous to the Polynesian islands, in particular those passed through on Leg 135: Fiji, Tonga, and Hawaii. These designs use repeated geometric figures in layers around a central design which may involve sea animals or flowers. For the Leg 135 logo, images relevant to the cruise were woven into the design. There is the ship, of course, and a shark, whose cousins kept the ship company during the leg. The turtle is merely a pretty design seen on Tongan tapas. Around the periphery are drill bits: RCBs on the top and sides and XCBs at the corners. Also included in the design are reentry cones, "Ocean Drilling Program Leg 135" in Morse code, the lithologic symbols for ooze and basalt (two common types of material found in Leg 135 cores), and even the wiggly lines that denote severely disturbed core on barrel sheets. Finally, the crenulated motif represents the ocean waves. (Logo and explanation supplied by the designer, Will Sager of Texas A&M University.)

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Focus

Hello again from the JOIDES Office here in sunny Texas, where recently things have been heating up (in more ways than one). Both at sea and ashore, spring 1991 has brought a varied harvest to ODP. On the floating front, within ~6 days Leg 137 successfully cleaned/milled junk from Hole 504B left as a result of Leg 111 operations. However, while advancing the hole ~60 m into sheeted dikes, Leg 137 also left a Diamond Core Barrel, bit, and fishing equipment in Hole 504B. Based upon recommendations by the Leg 137 science co-chief and ODP-TAMU engineers that Hole 504B can be cleaned of this new junk quickly, PCOM has just decided that Leg 140 will return to Hole 504B for a specified period of time for fishing activities, preparatory to deepening Hole 504B with continuous coring. If after ~1week to 10 days, Hole 504B is not being advanced, the drillship will proceed to Hess Deep for planned operations there.

On land, things have been just as frenetic. First, the issue of ODP renewal. I recently attended a meeting at the Royal Society in London entitled "Britain in the Ocean Drilling Program." Talks were well-received, poster sessions were excellent, and the powers that will decide the United Kingdom's continuing participation in ODP seemed favorably impressed. Jim Briden and Lin Kay of the Natural Environment Research Council and Hugh Jenkyns of Oxford (PCOM) are to be congratulated for a job well done. Second, supplemental funding to pursue scientific goals emphasized by ODP's Long Range Plan. The U.S. National Science Foundation has informed PCOM that $2.1M will be made available in the course of Fiscal Year 1992 (October 1, 1991 to September 30, 1992) to advance ODP's major scientific themes. Responding to that charge, PCOM has formed OPCOM (the "Opportunity Committee") to develop creative strategies for the use of these funds. OPCOM is composed of selected members of PCOM, thematic and selected service panel chairs, representatives from ODP's subcontractors, and guests invited for their specific expertise. OPCOM is considering additional support for the Diamond Coring System, high-temperature slimhole logging, the use of alternate drilling platforms, and high-latitude support vessels for anticipated FY93 Arctic drilling. Finally, the reality of Soviet participation in ODP. Two Soviet colleagues are participating on Leg 138, and a group of us have just returned from a rewarding visit to Moscow. Dr. Nikita Bogdanov (EXCOM) was our host, and we met many of the distinguished earth scientists who will soon be lending their knowledge to JOIDES advisory panels. The Soviets are eager to participate, and JOIDES welcomes them to what I trust will be a mutually beneficial (and I hope long-standing) relationship.

One more thing. Over the past few months, the JOIDES Office has received thought-provoking letters from members of the scientific drilling community on issues ranging from the wisdom of ODP renewal to ways to improve publications. Of course, the JOIDES Office encourages constructive input to ODP from anyone at any time, and I make every effort to answer all letters received. However, as a part of our continuing effort to improve the *JOIDES Journal*, we are going to start a Forum section with the next (Fall '91) issue. The JOIDES Office will select a small number of letters from those received within the previous 60-90 days (maximum ~300 words) and publish them, along with responses either from myself or from other members of ODP's advisory structure. We hope that the Forum section will encourage anyone with something to say about ODP to put pen to paper (or fingers to keyboard).

—Jamie

James A. Austin, Jr.
Planning Committee Chairman

Science Operator Report

LEG 135: LAU BASIN

ODP Leg 135 drilled and cored eight sites across the Lau Basin and adjacent Tonga Ridge to study the geological evolution of a backarc basin and adjacent oceanic arc and forearc. Six sites (Sites 834-839; Figures 1 and 2) were drilled within the Lau Basin, each within smaller and narrower (<10 km) north-south fault basins, and collectively represent a broad east-west transect. Two other sites were drilled on the Tonga Ridge, in the forearc of the Tofua Arc. Site 840 lies on the crest of the Tonga Ridge, a shallow, uplifted carbonate platform overlying older volcanic basement, while Site 841 lies on the arc-trench slope in 4800 m of water. Results will provide crucial data for determining the geological history of the Lau Basin-Tofua/Tonga Arc oceanic-arc system, as well as provide a heretofore unavailable observational base for understanding oceanic-arc and backarc spreading systems in general.

Principal results of Leg 135 differed from expectations, with two results being of particular significance. First, the Lau Basin is much older than expected (>5.6 Ma instead of 2.5-3 Ma), with seafloor-type spreading having occurred in the backarc only in the last 1 to 2 m.y. or so. Prior to this, extension occurred by a combination of repeated extensional rifting ("basin and range") and associated local volcanism, with new crust created, if at all, only within north-trending fault basins (Figure

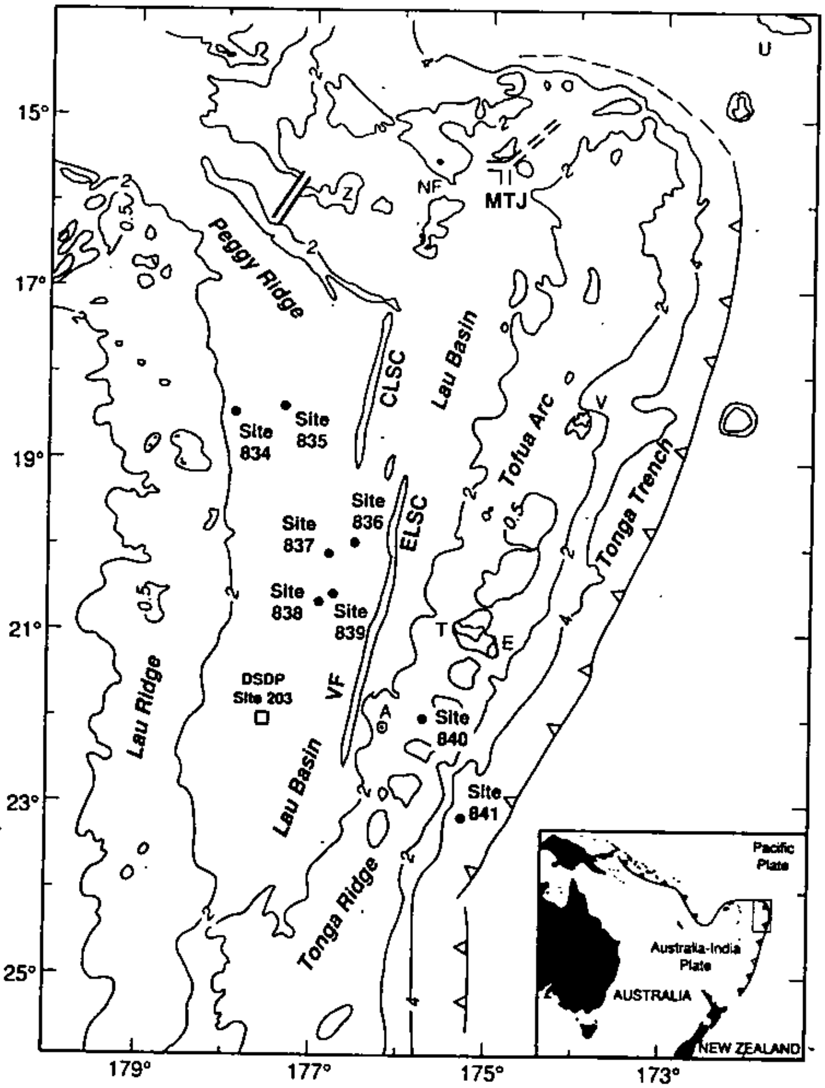

Figure 1. Regional setting for Leg 135 drill sites showing major geologic features of the Tonga Trench and Lau Basin system. Site 203, drilled during the Deep Sea Drilling Project, is also shown. Z is Zephyr Shoal. Islands shown are as follows: T = Tongatapu, E = 'Eua, V = Vavau, NF = Niua Fo'ou, and U = Upolu. Locations of the Central Lau and Eastern Lau spreading centers, Valu Fa Ridge, and Mangatolu Triple Junction are shown as CLSC, ELSC, VF, and MTJ, respectively. Depths are in kilometers.

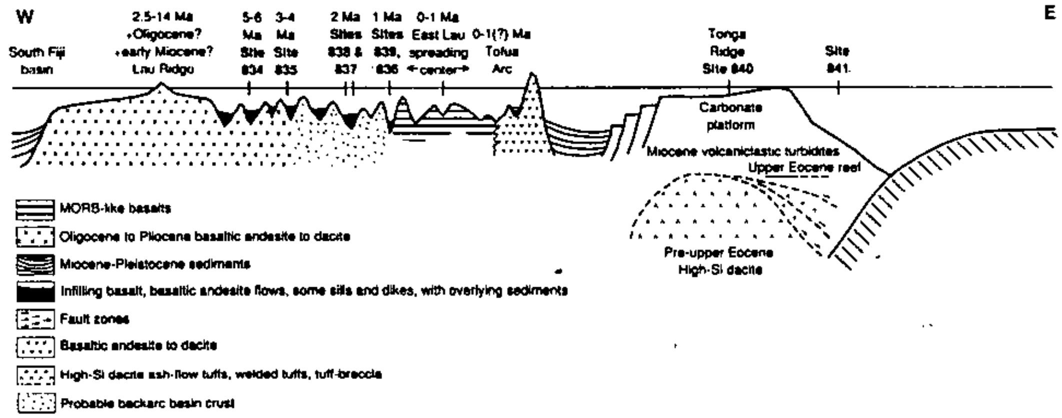

Figure 2. Schematic west-east cross-section across the Lau Ridge, Lau Basin, Tofua Arc, and Tonga Ridge. Depth and vertical dimensions are not to scale, but horizontal dimension is to scale.

2). No consistent variations in chemistry of Lau Basin volcanic products were noted either in time or space; igneous basement rocks collected represent basalts, basaltic andesites, and andesites with affinities to both oceanic-arc and mid-ocean-ridge lavas, and indicate complex heterogeneity of the mantle source. Volcaniclastic sediments collected in cores also showed that volcanism of arc affinity has likely occurred throughout much of the Lau Basin during extension, rather than being confined to a narrowly defined arc.

The second principal result was coring of high-Si dacitic tuffs, welded tuffs, and lavas of late Eocene or older age at the base of Hole 841B. These are in fault contact with overlying upper Eocene to lower Oligocene carbonates and a thick sequence of Miocene proximal and distal volcaniclastic sediments. These subaerially erupted dacitic igneous rocks have subsided more than 6 km since their formation, representing profound tectonic foundering. Similar rhyolites of Late Cretaceous age were cored at DSDP Site 207 on the Lord Howe Rise west of the Lau Basin; reconstruction of pre-Eocene plate geometry suggests a common source for the silicic volcanic rocks at both locations.

Site 834

Hole 834A:	18°34.058′S, 177°51.735′W; water depth, 2692.3 m
Hole 834B:	18°34.052′S, 177°51.737′W; water depth, 2688.6 m

Site 834 is located in the western Lau Basin ~100 km east of the Lau Ridge, a remnant arc of the trench-arc-backarc system related to the convergent plate margin of the Tonga Trench. The site is in a small, north-south-trending basin of ~200 to 400 m relief. Main scientific objectives for Site 834 were (1) to sample igneous rocks formed in the first 0.5 m.y. of crustal extension of the Lau Basin, and (2) to determine the age of initiation of basin opening.

A continuous sediment sequence was recovered at Hole 834A down to 112.5 mbsf. Below this, sediments are intercalated with basaltic sills or flows of varied thickness down to 164 mbsf. The sedimentary assemblage consists of clayey nannofossil oozes, turbiditic foraminiferal sands and oozes, clayey nannofossil mixed sediments, and claystones. Many of these units are interbedded with epiclastic vitric ash or, more rarely, pyroclastic airfall tuff layers. The sequence can be divided into four lithologic units.

Unit I (late Pleistocene to 2.3 Ma) is 42 m thick and composed predominantly of brown clayey nannofossil oozes with scattered interbeds of turbiditic calcareous sands and oozes and rare vitric-ash layers. Unit II (2.3 to 3.8 Ma, 42 to 78 mbsf) is composed of clayey nannofossil mixed sediment interbedded with vitric ash layers. Unit III (78 to 112.5 mbsf) is distinguished from Unit II by increased vitric-ash content. Thick vitric ashes are the dominant lithology, interbedded with iron oxy-hydroxide-stained nannofossil clayey mixed sediments and nannofossil clays. The base of Unit III is early Pliocene. Unit IV is composed primarily of firm or indurated claystones, vitric tuffs, and calcarenites, which are found as thin bands of intercalated sediments within lava flows. The sediments are generally shallow-water to neritic, probably deposited close to the time at which the basin began to open. Accumulation rates for the sequence above the basalts averaged 20 m/m.y. Interstitial waters from the sediments showed little variation in composition throughout the sampled section, and suggested that these fluids behaved as an open system.

Igneous rocks drilled at Site 834 consist of 13 flows intercalated with sediments. Interpretation of major-element data collected by XRF demonstrates similarity to Lau Basin backarc crust rather than to Lau Ridge arc samples. Unit 1, at 112 mbsf, is a sparsely phyric plagioclase olivine basalt. Aphyric basalt (Unit 2) was recovered at Hole 834B at about 112.5 mbsf. A series of thin flows (units 3 and 4) was cored in Hole 834A but not at Hole 834B; these are underlain by a distinctive poikilitic textured diabase (Unit 5) found in both holes, extending from 136 down to ~162 mbsf in Hole 834B. A sedimentary interbed, found at 162 mbsf in Core 135-834B-13R, separates Unit 5 from Unit 6. Units 6 through 13 alternate between aphyric, olivine-phyric, plagioclase-phyric,and plagioclase-olivine-phyric. Many of these basalt units have a microvesicular texture. Basalt layers range in age from early Pliocene to late Miocene (about 5.5 Ma).

Site 835

Hole 835A: 18°30.061'S, 177°18.162'W; water depth, 2916.5 m
Hole 835B: 18°30.050'S, 177°18.192'W; water depth, 2916.5 m

Site 835 is located in the west-central Lau Basin, ~200 km east of the foot of the paleovolcanic arc of the Lau Ridge and ~80 km west of the propagating ridge of the Central Lau spreading center. The site's regional setting is on the eastern flank of the broad, north-south bathymetric high centered on 18°35'S 177°25'W, which rises from a water depth of ~2700 m in the vicinity of Site 834 to ~1650 m at its summit.

The sedimentary sequence recovered at Site 835 consists of 155 m of clayey nannofossil oozes, mud-clast conglomerates, turbiditic foraminiferal sands and oozes, and clayey nannofossil mixed sediments. Many of these units are interbedded with epiclastic and volcanic silt layers. Epiclastic layers are much more common below 130 mbsf. Sediments are divided lithologically into clayey nannofossil ooze (Unit I) and volcanic sand and silt (Unit II). Calcareous nannofossils are abundant and well preserved throughout, but planktonic foraminiferal assemblages are less diverse and poorly preserved in Cores 135-835A-3H and -4H of Unit I and the lower part of Unit II. Sediments range from middle Pleistocene to late Pliocene in age, and those just above basaltic basement contain late Pliocene fauna and flora, indicating Zone CN12a of Okada and Bukry (1980) and Zone N21 of Blow (1969). Again, there was little change in interstitial-water chemistry throughout the section recovered at Site 835.

The Magnetostratigraphy of sediments of Hole 835A shows a complicated pattern of reversals which cannot be interpreted as a simple time sequence. Combined biostratigraphic and polarity records suggest that the topmost 55 m of Hole 835A reaches back into the Jaramillo Subchron (ca. 0.95 Ma), overlying at least two major slumps or allochthonous units showing truncated reversal sequences of parts of the Matuyama and Gauss polarity chrons. These allochthonous sequences in turn discordantly overlie the lowermost 84 m (64-153 mbsf) of the sequence, which covers the interval between the Jaramillo and Gauss polarity chrons, including the Mammoth Subchron (ca. 3.2 Ma).

A single unit of sparsely to highly phyric, fresh to moderately altered olivine-clinopyroxene-plagioclase basalts was recovered from 154.5-183 mbsf at Site 835. Porphyritic glassy pillow margins and diabasic fragments were recovered. The rocks are generally highly vesicular, and many parts of the unit appear to have a fine-scale, high porosity due to abundance of microvesicles in the groundmass. The geothermal gradient, established by five temperature measurements in the sediments, is extremely low for young crust (about 15°C/km), as compared to 50°C/km measured at Site 834. Low geothermal gradient and minor changes in physical properties with depth indicate that rapid fluid circulation through the sedimentary section may be dissipating heat derived from young backarc crust.

Site 836

Hole 836A:	20°08.494'S, 176°30.008'W; water depth, 2455.4 m
Hole 836B:	20°08.505'S, 176°30.011'W; water depth, 2457.7 m

Site 836 is located in the western Lau Basin 220 km east of the Lau Ridge and 48 km west of the East Lau spreading center, in a 20 km-long, 5 km-wide oval-shaped basin that trends north-northeast (020°). This basin is one of a number of linear depressions bounded on the west and east by discontinuous ridges interpreted as horsts separating grabens and half-grabens.

The sedimentary sequence at Site 836 is distinguished by abundance of volcaniclastic material at all depths. The uppermost 12 m comprises hemipelagic deposits, mostly dark brown to brown clayey nannofossil ooze interbedded with volcaniclastic sediments. Sediments contain up to 25% (volume) interspersed glass shards and are commonly mottled by bioturbation. From 12-20.8 mbsf, rapidly deposited glassy basaltic andesite volcaniclastics make up as much as 50% of the section. Source of this hyaloclastite volcanic detritus was <10 km from the site of deposition. Biostratigraphic and paleomagnetic data indicate that only the middle and late parts of the Pleistocene, all within the Brunhes normal polarity chron (0.73 Ma), are present in Site 836 sediments.

Five igneous-rock units were identified. The two uppermost units are glassy, sparsely phyric, andesitic hyaloclastites. Underlying these andesitic rocks are three basalt units: moderately phyric olivine-plagioclase basalt; sparsely phyric plagioclase basalt; and moderately phyric olivine-clinopyroxene-plagioclase basalt. All are highly vesicular, with up to 40% vesicles. Trace-and minor-element data suggest that the samples all have an "arc-like" geochemical signature and are distinct from lavas erupted at the nearby East Lau spreading center. In spite of the "arc-like" signature, they also are distinctly different from modern lavas of the Tofua Arc.

Site 837

Hole 837A:	20°13.307'S, 176°49.360'W; water depth, 2752.5 m
Hole 837B:	20°13.319'S, 176°49.362'W; water depth, 2753.0 m

Site 837 is located in the central Lau Basin 200 km east of the Lau Ridge and 69 km west of the East Lau spreading center, in a 10 km-long, 1-2.5-km wide sedimented trough, in a region of north-south-striking ridges and deeps interpreted as horsts and grabens or half-grabens. Bathymetric relief in the area is ~400 m.

The sedimentary sequence recovered at Site 837 is 84 m thick and ranges in age from latest Pliocene to Holocene. Unit I (0 to 13.5 mbsf) consists of clayey nannofossil oozes with thin calcareous and volcaniclastic turbidites. Unit II (13.5 to 84.0 mbsf) is subdivided into five subunits that define sedimentary cycles. The base of each subunit is a thick volcaniclastic turbidite (to 17.1 m) that thins and fines upward to a gradual transition into clayey nannofossil oozes. Volcaniclastics at Site 837 consist of clear, angular, and platy glass shards of rhyodacitic composition, but there is also a minor component of basaltic andesite composition.

A single igneous lithologic unit was recognized in Hole 837B. It consists of approximately 4 m of very fresh, vesicular, sparsely phyric orthopyroxene-clinopyroxene-plagioclase basaltic andesite. These rocks are low-K basaltic andesites with 3.5% MgO, very low Ni and Cr and low Ti, Zr, and Y. Incompatible trace-element characteristics are intermediate between MORB values and rocks from the Tonga and Kermadec volcanic arcs.

Heat flow measured at Site 837 is 24.4 mW/m^2, which is low if compared to theoretical heat-flow values of 175 to 200 mW/m^2 predicted for young ocean crust. Similar conclusions can be drawn with respect to sites 834 and 835: (1) sediments are not thick or diagenetically altered enough to act as an impermeable cap to impede fluid exchange between the sediments and seawater, and (2) the basins are zones of recharge for fluid circulation that serves to dissipate large amounts of heat.

Site 838

Hole 838A: 20°49.618'S, 176°53.402'W; water depth, 2322.8 m
Hole 838B: 20°49.629'S, 176°53.402'W; water depth, 2322.7 m

Site 838 is located in the central Lau Basin, ~55 km west of the active backarc axis of the East Lau spreading center and ~200 km east of the Lau Ridge axis. Regional topography at the site is dominated by broad, north-south-striking linear basins and highs, ranging in water depths from <1500 m to >2900 m. The site is close to an arbitrary north-south line separating Lau Basin floor characterized by rifting and amagmatic(?) extension from seafloor generated at the East Lau spreading center.

The sedimentary sequence recovered at Site 838 is 103.2 m thick and ranges in age from Holocene to late Pliocene. The sequence is subdivided lithologically into three units. Unit I comprises clayey nannofossil oozes with thin volcaniclastic turbidite interbeds and extends to 23.0 mbsf. Unit II, subdivided into five subunits, comprises volcanic gravel (pumice and glass), vitric sands, vitric silts and ic clayey nannofossil ooze, and is characterized by an overall upward-fining sequence. Sediments of Unit II were deposited by mass-flow processes, probably derived from a source toward the south or southwest, based on regional bathymetric trends. In the deepest sedimentary unit, Unit III (98.7-259.2 mbsf), detailed lithostratigraphy is poorly constrained due to low recovery. Sediments recovered consist of pumiceous volcanic gravel, conglomerate, vitric sandstone, and vitric clayey siltstone. Compositionally, volcaniclastics at Site 838 are dominated throughout by pumiceous material of rhyodacite composition, but there is also a minor component of basaltic andesite glass and lithic fragments. Basement was not reached at Site 838, but igneous-rock fragments recovered from breccias and very coarse sand layers comprised plagioclase-pyroxene phyric andesites (54%-57% SiO_2) and plagioclase-amphibole-quartz phyric pumices with 70%-72% SiO_2. Quartz and cryptocrystalline silica occur as secondary phases.

A low gradient in dissolved calcium and magnesium concentration-depth profiles calculated from interstitial-water samples suggests a diffuse exchange with underlying igneous basement. Temperature gradient at the Site is 8.7°C/100 m, the highest recorded at any of the sites to that point in the cruise.

Site 839

Hole 839A: 20°42.531'S, 176°46.492'W; water depth, 2617.4 m
Hole 839B: 20°42.539'S, 176°46.501'W; water depth, 2617.3 m

Site 839 is situated in the central Lau Basin 225 km east of the axis of the Lau Ridge and 55 km west of the East Lau spreading center. The site is located in a northeast-trending, 11-km-wide, 15 or more km-long irregular basin ... crust at Site 839 ...

patterns.

The sedimentary sequence at Site 839 consists of clayey nannofossil ooze, turbiditic glass-rich sands and silts, pumiceous volcaniclastic gravels, and rare pyroclastic airfall ashes. Three major units were recognized. Unit I (middle Pleistocene) comprises 17.85 m of iron oxide-hydroxide-stained clayey nannofossil ooze with sporadic layers of vitric sand and silt. Unit II (late Pliocene) is 81.65 m thick and is distinguished from Unit I by its very high content of volcaniclastic material. Unit II comprised thick to thick-bedded vitric sands and silts (turbidites) with some interbeds of clayey nannofossil ooze and is subdivided into six subunits with upward-fining sedimentary cycles. Unit III (late Pliocene) consists of nannofossil clays, clays, vitric silts and sands, and volcanic gravel below 99.5 mbsf. As at previous sites, cyclic variations in the magnetic modified Q-ratio (1mmT AF cleaned remanent intensity/susceptibility) may indicate a Milankovitch climatic cyclicity in the nannofossil-ooze sediments. Pore-waters were indistinguishable from average seawater, except for elevated Mn centered at 48.5 mbsf.

Nine highly vesicular (10% -25%) igneous units were recovered between 205.85 and 497.26 mbsf. Chilled margins and quenched mineral textures suggest that parts of extrusive flows and pillow complexes were cored. Two main petrologic varieties were recovered: olivine and clinopyroxene phyric basalt and orthopyroxene-clinopyroxene-plagioclase phyric basaltic andesite. The lowermost part of the section comprises a series of flows of moderately to highly phyric clinopyroxene-orthopyroxene-plagioclase basalts having high ratios of plagioclase to pyroxene, resembling many Tofua Arc rocks. These are overlain by three major eruptive units comprising numerous flows of very Mg-rich, aphyric to highly phyric clinopyroxene-olivine basalts with minor interlayers of basaltic andesite and sediment. The overall geochemical signature of the entire mafic-rock series at Site 839 has many similarities to island-arc tholeiite magmas. Some of the basalts have high concentrations of Mg, Cr, and Ni and are the most primitive igneous rocks encountered in the Leg 135 cores. They may represent near-parental magmas for some of the volcanic units in the Lau Basin that have an arc-like geochemical signature. The temperature gradient of 7.1°C/km, and the derived heat-flow value of 9.3 W/m^2, are the lowest values measured in the Lau Basin during Leg 135.

Site 840

Hole 840A:	22°13.249'S, 175°44.916'W; water depth 743.3 m
Hole 840B:	22°13.259'S, 175°44.918'W; water depth 743.3 m
Hole 840C:	22°13.234'S, 175°44.925'W; water depth 743.3 m

Site 840 is located on the south-central Tonga platform, 45 km east-northeast of Ata island and 130 km south-southwest of the islands of Tongatapu and 'Eua. Specific objectives were: 1) identification of the age of the regional angular unconformity known as Horizon "A," thought to be late Miocene/early Pliocene, and reasoned to coincide with initiation of rifting and opening of the Lau Basin; (2) identification and timing of the onset of volcaniclastic deposition associated with the early Tofua Arc; and (3) identification of depositional age of rocks presumed to be volcaniclastics below Horizon "A".

The sedimentary sequence recovered at Site 840 is 597.3 m thick and ranges in age from Holocene to late Miocene. The sequence is subdivided into three units. Unit I (0 to 109.98 mbsf) consists of nannofossil oozes, vitric silts, vitric sands, and pumiceous gravels. Unit II (109.98 to 260.5 mbsf) is dominated by nannofossil chalks and pumiceous gravels, but vitric siltstones and vitric sandstones are also common. Three depositional cycles can be distinguished, fining upward from predominantly pumiceous gravel into predominantly nannofossil chalk. Unit III (260.5 to 597.3 mbsf) consists of a sequence of volcaniclastic turbidites of vitric sandstone, and vitric siltstone, interbedded with nannofossil chalks. Near the base of the sequence, there are also beds of volcaniclastic breccia and conglomerate. Upward through the unit, there is a fining and thinning of individual turbidites, indicating a change from proximal to more distal deposition. Volcanic glasses are basaltic to rhyodacitic, as estimated from their refractive indices, and are strongly focused around intermediate compositions. The seismic-reflector Horizon "A," thought to be a regional unconformity, was not identified biostratigraphically. Within Unit III, a marked increase in average velocity at ~383 mbsf correlates with a drop in total carbonate percentage from ~30% to 40% to almost zero and with a discrete zone of significant smectitic alteration of vitric sandstones and siltstones. We believe that this corresponds to the 400-420 mbsf level of Horizon "A" on seismic reflection profiles predicted using sonobuoy velocities.

Paleomagnetic measurements were obtained from eight oriented APC cores of lower to mid-Pliocene sediments from the upper part of Hole 840C. Preliminary analysis of the data indicates a 21°±11° clockwise rotation of the Tonga Arc with respect to oriented sections in the western Lau Basin. Although there were some safety concerns prior to drilling this site because of known hydrocarbon occurrences within 100 km, methane concentrations remained at background laboratory level, and no other volatile hydrocarbon gases were detected. The organic-carbon content of these sediments is very low. Rock-Eval analysis indicates that the organic matter has no hydrocarbon potential and is presumably inertinite. Only one valid temperature measurement was obtained from Site 840; the temperature gradient derived from that point and the seafloor temperature is 29.3°C/km, a value similar to that recorded in wells on Tongatapu.

Site 841

Hole 841A: 23°20.746'S, 175°17.871'W; water depth, 4809.8 m

Hole 841B: 23°20.741'S, 175°17.872'W; water depth, 4809.8 m

Hole 841C: 23°20.720'S, 175°17.879'W; water depth, 4809.8 m

Site 841 was planned for comparison with forearc sites drilled in the Mariana and Bonin arc systems. Cores recovered a Site 841 give a record ranging from middl Pleistocene to late Eocene or older. Sedimentation began in late Eocene to early Oligocene time with accumulation of carbonates in a shallow-water environment on an igneous substrate formed of rhyolitic volcanic rocks. Carbonate sedimentation was disturbed by occasional influxes of volcanic debris from a nearby rhyolitic source. From early Oligocene to early middle Miocene time, there was a hiatus in sedimentation followed by a phase of relative subsidence. This resulted in deposition of volcaniclastic conglomerates, sandstones, and siltstones, mostly by gravity mass flows and turbidity currents. The sequence fines and thins upward, but younger cores show that in late Miocene time a fresh influx of volcaniclastic conglomerates reflected rejuvenation of the volcanic source. Volcanic debris in the Miocene section ranges from basaltic to dacitic. Subsidence continued until middle Pleistocene or possibly Pliocene time, when Site 841 subsided below the CCD. Epiclastic volcanic turbidites were reduced to very thin, rare intervals within pelagic clayey background sedimentation. Minor thin pyroclastic airfall deposits have also been accumulating from the middle Pleistocene to the Present. Nannofossil oozes are present in minor amounts in middle Pleistocene (to Pliocene?) sediments.

Two major igneous-rock sequences were recovered. Nine separate small bodies (dikes, sills, or flows) of basaltic andesite and andesite were cored in the upper Miocene to lower middle Miocene volcaniclastic series. The other major sequence comprises subaerially erupted lapilli tuff, welded tuff, tuff breccias, and massive lava of high-Si (76-90%... composition...

was totally unexpected. Similar rocks are rare in other intraoceanic island arcs, especially in their earliest stages of development. The closest known occurence of similar rocks in a submarine oceanic area is on Lord Howe Rise, where Upper Cretaceous rhyolitic flows and tuffs are found.

Pore-water chemistry is extensively modified from standard seawater values, consisting of Ca-and Cl-rich brines below 200 mbsf. Large variations were noted in Ca, Mg, K, Na, and Cl concentrations in pore waters from the uppermost 200 m of sediments. These variations are abnormal for marine sediments, and are probably caused by the combined effect of abundant volcanogenic material and high rates of sedimentation that have led toward very low pore-water diffusivity. Sulfate and phosphate sharply decrease, and ammonia sharply increases downcore to 200 mbsf, changes that are likely related to decomposition of organic matter by sulfate-reducing bacteria. Si, Sr, and Mn substantially decrease in concentration with depth, changes probably controlled by diagenetic alteration of volcanogenic sediments. The highest methane values recorded on Leg 135 were found in the lower part of Hole 841B, but were only 15 ppm and possibly derived from an unspecified nonbiologic process.

LEG 136: OSN-1

The primary objective of ODP Leg 136 was to drill a hole for future experiments needed to develop the Ocean Seismographic Network (OSN). The long-term (5- to 10-year) goal is to establish a global network of 15 to 20 permanent seismic observatories in the deep ocean. Such a network would revolutionize studies of global Earth structure, upper mantle dynamics and lithosphere evolution, earthquake-source mechanisms, oceanic crustal structure, tsunami warning and monitoring, and deep-ocean-noise sources and propagation mechanisms. The proposed site OSN-1 provides a location for future pilot experiments that include noise measurements, data recording from teleseismic events for comparison with existing nearby island stations, and testing new broad-band sensors and other long-term deployment instrumentation.

Secondary objective for drilling at proposed site OSN-1 was to characterize a poorly known part of the Pacific basin. The Hawaii area is important because it is the type locality for oceanic, intraplate hot spots, and it is centrally located well away from other tectonic and sedimentary influences. Coring sedimentary and basaltic sequences at the proposed OSN-1 site provided useful geologic information. Sediments and basalts at the site are analogs of material through which Hawaiian lavas first erupted. Analyses of chemical and physical properties of this material will provide a description of the contamination of Hawaiian magmas and shed light on the role that these sediments play in the mechanical behavior of Hawaiian volcanoes. The frequency of explosive volcanism of Hawaiian volcanoes will also be analyzed by evaluating cored volcanic ash blown downwind from the islands of Hawaii and Maui.

Another objective for Leg 136 was to test a prototype reentry-cone plug designed to seal boreholes for long-term temperature monitoring and fluid sampling. The reentry-cone seal (or "cork") consists of a mechanism that seals the throat of an ODP reentry cone and the 11-3/4-in. casing suspended below the reentry cone. The seal latches into the 11-3/4-in. casing hanger and thus prevents fluid flow into or out of the borehole. Housed in the seal is a removable data logger supporting a thermistor string with integral pressure transducers suspended in the borehole. A hydraulic feed-through is incorporated into the thermistor string to allow for borehole-fluid sampling. The seal has been designed to allow borehole-fluid samples to be retrieved and the data logger to be downloaded and/or removed without the drill ship, utilizing a remote observation vehicle (ROV) or a manned submersible. First deployment of the seal for scientific reasons will occur during Leg 139, Sedimented Ridges, July-September 1991.

Site 842

The principal objective of operations at Site 842 (first attempt at drilling proposed site OSN-1), was installation of a reentry cone on the seafloor and drilling a hole cased to basement for use as a test site for the Ocean Seismic Network. Site 842 lies on the shoulder of a low northwest-southeast-trending abyssal ridge (Fig. 1). Pre-drilling site-survey data indicated a total relief of ~75 m (4475-4400 m uncorrected depth).

Three holes were drilled at Site 842; the deepest, Hole 842C, attained a total depth (TD) of 242.5 mbsf. APC coring in 842B extended to 35.7 mbsf (Fig. 2), and drilling with intermittent XCB and wash cores extended from 35.7 to TD. Principal lithologies recovered were:

Unit I (0-19.9 mbsf): Quaternary to Pliocene(?) silty clay, clayey silt, and clay. The entire unit contains variable amounts of volcanic ash and radiolarians. Ash layers are fresh at the top and are altered almost totally to clay and zeolite at the bottom.

Unit II (19.9-35.7 mbsf): middle Miocene to upper Eocene clay and claystone with altered ash. Nodules of silica-cemented claystone are also present.

Unit III (nominally 35.7-242.5 mbsf): This unit is a "catch-all" for cherts and small samples of Santonian nannofossil ooze (at ~164 mbsf) returned in several wash core barrels and during attempts to cut regular core. Cherts are varicolored and contain both opal-CT and, deeper in the section, quartz.

Volcanic ash in Core 136-842A-1H is dispersed throughout the section and is also present as discrete layers. Ash layers are not seen at equivalent levels in the cores collected from Hole 842B, one of several puzzles in correlating shallow sediments sampled at these adjacent holes. Well-developed ash zones in Core 136-842A-1H contain fresh glass as well as minerals that may have been deposited as a result of explosive Hawaiian eruptions. Distinct ash layers in Unit I were deposited between 1 and 3 Ma, and are probably the result of explosive volcanism related to volcanic centers on the islands of Maui and Oahu. Ash zones are also seen within Unit II, but they are considerably altered. These older layers may record as yet unknown widespread central Pacific volcanic events.

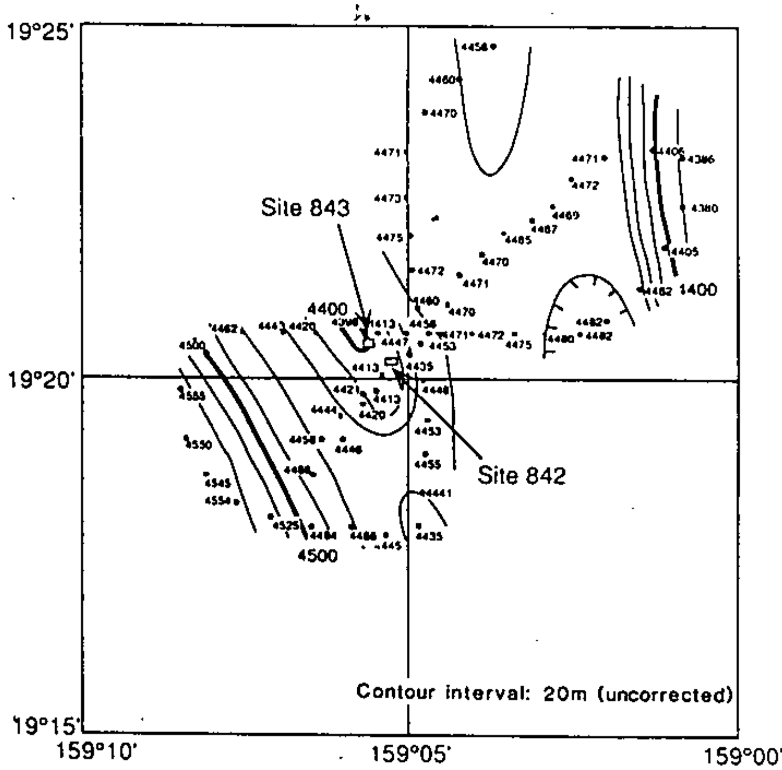

Figure 1. Site locations and bathymetry.

Paleomagnetic data from Cores 136-842A-1H, 136-842B-1H, and 136-842B-2H were generally in good agreement. The Brunhes/ Matuyama boundary was seen at ~1.8 mbsf, and the Jaramillo event at 4.5 mbsf. There appears to be 1 m or more of disturbed section at the top of Core 136-842B-2H. The base of Core 136-842B-2H is estimated to be 3.5 Ma on the basis of magnetic reversal stratigraphy. Cores 136-842B-3H and -4H suffer from coring-induced over-printing, which obscured the reversal record.

Physical-property-measurements of samples from the APC cores yield normal compaction and shear-strength trends with depth. Local maxima in compressional-wave velocity and bulk density are correlated with the presence of ash layers or increased concentrations of dispersed ash. Correlation between Holes 842A and 842B is relatively good. Of interest is apparent expansion of the section at Hole 842B relative to Hole 842A, best seen in the velocity record. Compressional-wave-velocity profiles correlate well near the surface, but become gradually offset up to about 0.5 m at 4 mbsf. Below this level, the offset remains constant.

The principal non-result of operations at Site 842 was the inability to drill and set a re-entry cone for later use as a test site of the Ocean Seismic Network. However, the recovery of 46 m of well-documented and dated sediments from a much undersampled area of the Pacific seafloor yielded substantial scientific benefit as well as several questions:

1. Both magnetic and biostratigraphic data suggest that sedimentation rates are substantially higher than open-ocean North Pacific norms (a rough average of 3 m/m.y. for the past 4 m.y.). The surprise is in the lack of a marked increase in volcanic-ash sedimentation during the past 1 m.y. of sediment accumulation. Emergence of the Hawaiian Island chain, and in particular the islands of Maui and Hawaii, should be reflected in an increase of air-borne ash being deposited at Site 842.

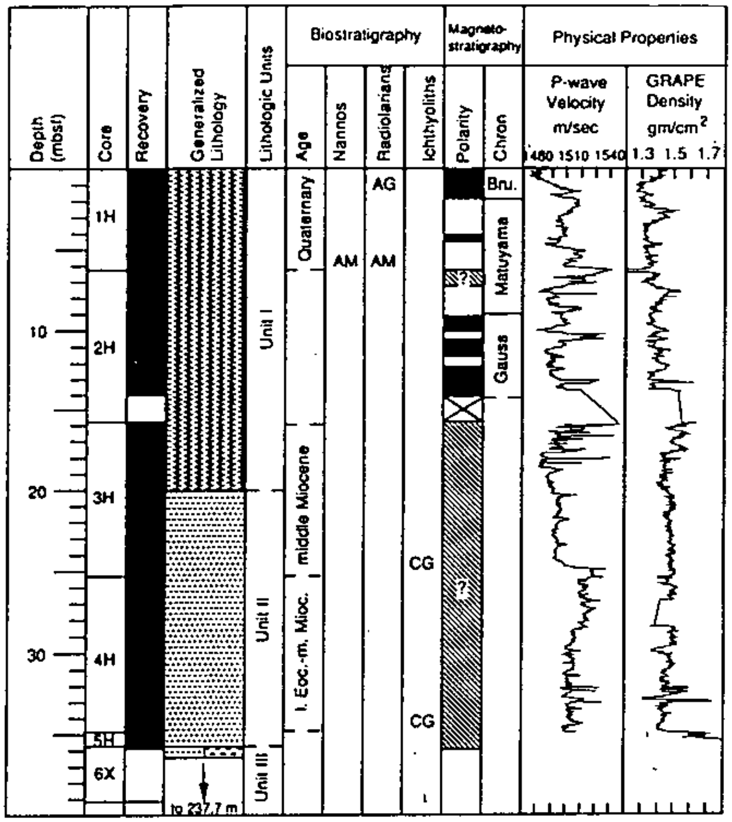

Figure 2. Hole 842B, composite log.

2. Holes 842A and 842B were cored within 10 m of each other, and yet there is a remarkable lack of detailed correlation between the two cored intervals. In particular, ash layers in Core 136-842A-1H are not seen in Cores 136-842B-1H and -2H, and apparent offsets of physical-property trends are different from those of the paleomagnetic record.

3. Volume and shallow occurrence of cherts encountered was unexpected. Extremely poor recovery leaves the nature and, for the most part, the age of these cherts unknown.

SITE 843

Poor hole conditions at Site 842 prompted an offset of the ship to a new drill site ~1 km northwest of the Site 842 location. Site 843 (also proposed site OSN-1), is located on top of the northwest-southeast-trending abyssal hill identified during the site survey prior to spudding at Site 842 (Fig. 1). It was hoped that drilling conditions on top of the ridge might be somewhat better than on the shoulder, with perhaps a slightly thinner sediment sequence and less potential for encountering chert rubble that had frustrated efforts to reach basement at the previous site. Hole 843A was washed to a depth of 228.0 mbsf. Two wash cores retrieved over the interval were filled with chert and chert rubble. Core 136-843A-3R was cut between 228.0 and 237.7 mbsf (Fig. 3). The core returned ~80 cm of Albian-Cenomanian nannofossil calcareous clay and limestone overlying 0.6 m of basalt. The sediment/basalt contact appeared to be well preserved within the core.

A reentry cone was prepared and set at Hole 843B. Casing was set through the sediment column and cemented approximately 10 m into basement. After drilling out the cement inside the casing, 6.87 m of altered basalt was recovered from a sub-basement interval of 17.0-26.5 m, in Core 136-843B-1R (Fig. 3). Drilling ahead deepened the hole an additional 19 m. A prototype Amoco PDC bit was installed and took Cores 136-843B-2R to -4R to a total basement depth of ~70 m (313.4 mbsf). A mud-line core was retrieved after offsetting 10 m north (Hole 843C) once drilling and logging at Hole 843B had been completed. Recovery of 4.22 m of ash-rich clays and several ash layers in the core revealed a Quaternary stratigraphy much like that of Site 842.

Beyond the establishment of Hole 843B as the first site of the Ocean Seismic Network, there were several geological points of interest. Sediments recovered from Core

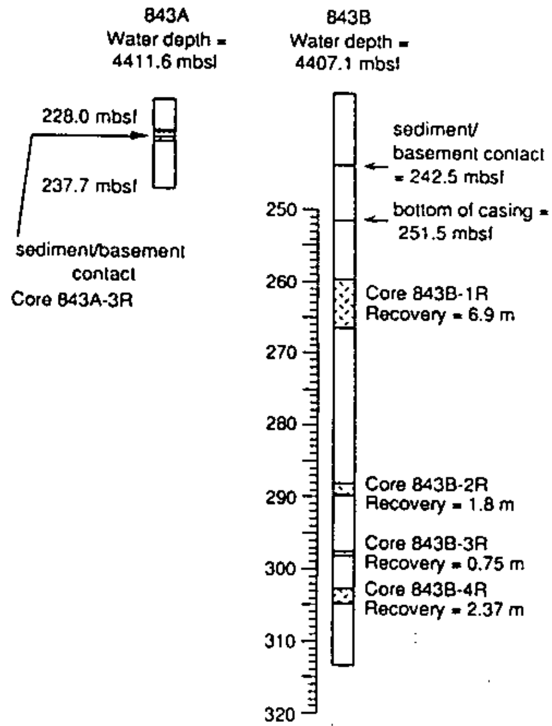

Figure 3. Core recovery at Site 843.

843C-1H appear to be lacking much of the Holocene record, or at least record very slow sedimentation during the last 0.5-1 m.y., as was seen at Site 842. Recovery of the basement/sediment contact provides a good age constraint for crustal formation. Paleomagnetic data from the basalt core suggest an origin at ~20°S latitude, consistent with an age of ~95 Ma and current reconstructions of Pacific plate motion. Basalt recovered from deeper in the section showed extensive evidence of hydrothermal alteration and mineral deposition. Site 843 may lie over a fossil hydrothermal upwelling zone.

Hole 843B was reentered with the ODP borehole seal on 18 March, and the pipe was successfully unlatched from the seal. On 19 March, the drill string was successfully reconnected with the seal. This test shows promise for permanent deployment of several seals on upcoming Leg 139.

LEG 137: HOLE 504B

The principal objective of Leg 137 was to revisit Hole 504B in the eastern equatorial Pacific in order to recondition it for future ODP operations. Hole 504B is by far the deepest penetration into oceanic crust and perhaps the important *in-situ* reference section for the structure of upper oceanic crust. However, its status was jeopardized when a coring assembly was lost at the bottom of the hole near the end of Leg 111. Therefore, the highest priority of Leg 137 involved engineering operations, including remedial measures to clean this junk from the hole and tests to prove the feasibility of continued coring on a subsequent expedition. If these objectives were sucessfully achieved during Leg 137, Leg 140 was committed to returning to the hole for a full scientific leg of coring and downhole measurements later in 1991.

Leg 137 was the sixth expedition of the Deep Sea Drilling Project (DSDP) or ODP to occupy Hole 504B (Fig. 1). The hole was originally spudded during Leg 69 in 274.5 m of sediments overlying 5.9-m.y.-old crust formed at the Costa Rica Rift, and was then deepened and/or logged during parts of four other DSDP/ODP legs: 70, 83, 92, and 111.

Although previous coring, logging, and geophysical programs at Hole 504B achieved unprecedented scientific success, the operational history of the hole was marred by downhole hardware losses and disappointing rates of core recovery. As with all other deep drilling programs, these tendencies have increased with depth of the hole. They were a particular problem during Leg 111, which experienced several premature bit failures, an overall core recovery rate of less than 13%, and loss of a large-diameter diamond coring assembly at the end of the leg. Lack of time and proper equipment forced temporary abandonment of the hole before the lost junk could be removed.

Leg 137 departed Honolulu on March 20, 1991, and began with a 17-day transit to Site 504. The leg ended in Balboa, Panama on May 1, 1991, after 21 days of operations and a two-day transit. During scheduled operations at Hole 504B, Leg 137 was to focus upon removal of the existing junk, assessment of the condition of the hole, its casing and reentry cone, and development of more efficient coring and drilling techniques for projected deepening of the hole on Leg 140. Additional objectives involved high-priority downhole measurements that could not be deferred to a later leg, including temperature logging, borehole fluid sampling, and permeability measurements.

TEMPERATURE DATA AND WATER SAMPLES FROM THE UNDISTURBED BOREHOLE

Before engineering operations began, temperatures in the undisturbed hole were logged, and 36 hours were devoted to sampling borehole fluids. Temperatures in

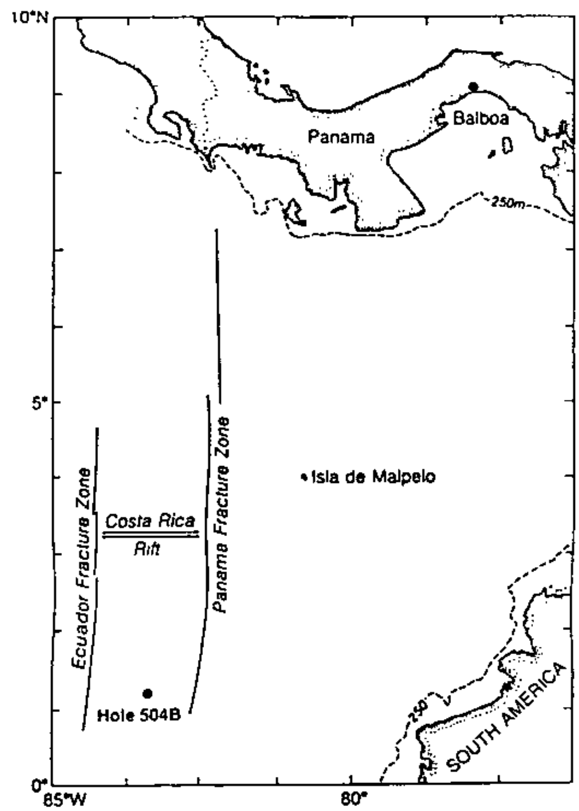

Figure 1. Location map.

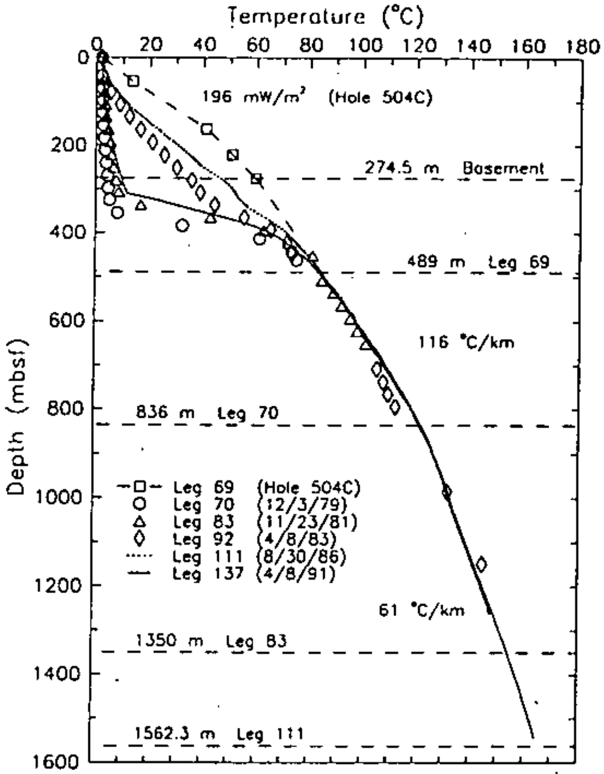

Figure 2. Temperature versus depth in Holes 504B and 504C, as measured on legs 69, 70, 83, 92, 111, and 137.

the deeper km of the hole were consistent with values logged during Leg 111, with a linear gradient of 61°C/km. This gradient extrapolates to a temperature of 165°C at the bottom of the hole at 1562 mbsf. In the upper 350 m of the hole, temperatures were considerably depressed, suggesting an unexpected renewal of downhole flow of ocean bottom water into the upper levels of basement (Fig. 2). Such downhole flow was fairly vigorous when the hole was first drilled during legs 69 and 70 in 1979, but had decayed to less than 1% of the original rate when Leg 111 revisited the hole in 1986. Leg 137 temperatures are similar to those measured during Leg 83 in 1981, suggesting that the rate of downhole flow has increased since 1986. This is a surprising result that raises many intriguing questions about hydrology at the site.

Using tools provided by Los Alamos and Lawrence Berkeley National Laboratories, eight fluid samples were obtained from the hole, at depths ranging from 350 to 1540 mbsf. Initial chemical analyses indicate that seven of these samples contain borehole fluid with characteristics in agreement with past sampling studies of the hole. Some contamination of the sample appears to have occurred, either by entrainment of fluids during the trip down prior to sampling, or as a result of leakage during the ascent as hot sampled fluids cooled and contracted. Fluid chemistry indicates bottom water present down to at least 359 mbsf, corroborating the inference of downhole flow from the temperature log. An interesting note is that during subsequent engineering operations at the bottom of the hole, many small pieces of platy anhydrite were recovered, consistent with predictions that anhydrite should reach supersaturation in borehole fluids near 150°C and 1500 mbsf.

Primary Objective: Clean-out Operations

Fishing/milling operations began on April 11. There had been suggestions during Leg 111 of possible problems with the casing in Hole 504B, but these problems did not materialize during Leg 137 (see below). A further worry was the possibility that wall-rocks might have caved in on top of the junk since Leg 111, but that had not occurred. One fishing attempt was run with a junk basket, and five mills were run with boot baskets to capture pieces of broken-up metal. These returned with parts or whole pieces of all the lost hardware, including recognizable pieces of the diamond bit. Thus, during only six days of remedial operations, the application of straightforward fishing and milling techniques succeeded in breaking up the diamond bit and in cleaning out the hole.

Coring Tests

After successfully achieving its most important priority, cleaning the lost diamond bit from the bottom of Hole 504B, Leg 137 proceeded with another important priority: to test coring systems and assess the feasibility of coring ahead during a subsequent full scientific leg to the hole. Once the hole was verified to be clean of all remnants of junk, two coring systems were tested, the standard ODP RCB wireline coring system and a conventional oil field diamond core barrel (DCB). These tests yielded mixed results, and unfortunately ended with a frustrating loss of very fishable coring equipment in the hole.

Two runs with the RCB system in a clean hole yielded penetration rates of 1-2 m/hr and average recovery of 14%. This is comparable to results with the same system during Legs 83 and 111. Cutting inserts of the bits failed quickly, in a manner suggesting that the formation is extremely hard and abrasive and that a more appropriate grade of bit could make more hole. But, while rotary core and drill bits could be used to advance the hole at a reasonable rate, it is clear that the RCB system cannot be expected to yield core recovery any better than 20% in this lithology.

The DCB also yielded mixed results, with extremely slow penetration, but very good recovery. Two runs resulted in a recorded advance of only 3.1 m (which could be in error because of the effects of tides) and a calculated recovery of 79%. The first diamond bit was extremely worn after less than 2 m of penetration, indicating that the bit matrix material was too soft for the hard, abrasive formation. The second diamond bit behaved in a similar manner downhole, but was not recovered, because all 18 m of the outer core barrel broke off in the hole, with the bit at the bottom.

Such a long, narrow piece is normally the easiest kind of junk to fish from a hole with appropriate tools, and in fact the first fishing overshot apparently did engage and lift it some distance up the hole. However, the fishing overshot itself broke off, leaving a compound fish that remains eminently fishable with the appropriate fishing tools. Unfortunately, the proper tools were not on board, although a second fishing attempt was made with a modified taper tap. When this failed, the decision was made not to risk damage to the fish by attempting to retrieve it with a "rig-engineered" solution, but instead to leave the fish in its easily retrievable condition, hopefully to be removed with proper equipment during a future leg.

Coring results

Drilling on Leg 137 deepened Hole 504B by 59.2 m, to a total depth of 1621.5 mbsf or 1347 m into basement. Of this interval, 48.6 m was cored, with a recovery of 8.77 m. Recovered rocks are all interpreted as a continuation of the sheeted dike complex, although no intrusive dike margins were actually recovered. Physical properties of recovered core support the inference that the formation is very hard and dense massive basalt, and therefore difficult to core. Chlorite and actinolite veins and actinolite-bearing alteration halos are common in the diamond cores with good recovery. It would therefore appear that the trend of increasing proportion of actinolite in the secondary mineral assemblage recognized on Leg 111 continues with depth.

Final logging

Attempts to fish the lost outer core barrel left time for only an abbreviated program of downhole measurements at the end of the leg. The planned open-hole packer inflation was cancelled because it posed the greatest risk of somehow disturbing or compounding the presentation of the fish. A digital borehole televiewer (BHTV) log of the casing was successfully conducted, but the tool failed shortly after logging only 85-90 m of the open-hole section. The complicated flowmeter/injection experiment was an operational success during two packer inflations in casing, but each time was cut short by premature packer deflations. The packer was recovered in good condition (with outer rubber fully intact), so the most plausible explanation for the packer deflations is that the inflation pressure was insufficient to maintain the grip against the smooth casing.

The casing inspection by BHTV disclosed that the casing flaw suspected after Leg 111 can in fact be attributed to a casing expansion joint, but that some casing damage, apparently due to wear, does exist. The most severe degradation is in the lowermost 30-40 m, where the casing appears to have several small holes connected by some sort of vertical split or separation. To date this has not affected operations at the hole, and it does not appear to require casing repair for the single science leg approved for the 1991-1992 schedule (Leg 140).

Conclusions and Recommendations for Future Operations at Hole 504B

Leg 137 achieved its primary objective, cleaning Hole 504B of the serious junk lost at the end of Leg 111. Operations throughout the leg showed no indication of supposed problems with casing, although BHTV inspection during the last day on site showed flaws with the lower 30-40 m of casing. Leg 137 clearly succeeded in demonstrating that Hole 504B can be advanced to the Layer 2/3 transition, the proposed target for Leg 140 later in 1991.

This important success was tarnished by a frustrating inability to retrieve a much less serious piece of junk lost at the end of coring tests. This disappointment can be attributed to a defective fishing tool and a lack of time to procure and deploy any further appropriate tools, not to any difficult presentation of the junk itself. In fact, such tool losses and fishing jobs are not at all unusual in drilling any deep hole, and in this case it is virtually certain that the lost outer core barrel can readily be fished with the proper tool. Furthermore, Hole 504B has a history of being open to total depth on multiple revisits, so the fish can be expected to remain clean and in easily retrievable condition for a reasonable period of time. With appropriate fishing tools, it should pose little risk to a revisit in the near future.

A more serious dilemma facing future legs to Hole 504B is the inability of both the RCB and diamond coring systems to simultaneously cut core and make hole in this lithology. The RCB system can make hole with recovery on the order of 20%, whereas the DCB gives excellent recovery but with very slow progress. Even with improved bit designs for these coring systems, trade-offs will have to be made between penetration and recovery. While Leg 137 has shown that key scientific priorities for deepening and logging Hole 504B to the Layer 2/3 and/or dike/gabbro transition(s) can be achieved on a later leg, these objectives may require compromise strategies for drilling, coring, and logging.

LEG 138 PROSPECTUS: EASTERN EQUATORIAL PACIFIC

Introduction

The primary objective of Leg 138 is to define the paleoceanographic evolution of the eastern equatorial Pacific during the last 12 million years. To address this objective, two drilling transects across the complex oceanographic circulation system of the equatorial Pacific are planned: four primary sites along an easternmost transect centered at 95°W, and five primary sites along 110°W (Table 1). To allow high-resolution paleoceanographic studies, all sites along the eastern transect will be double-APC cored and those along the western transect will be triple-APC cored.

This leg represents the fifth ODP expedition to examine the evolution of global climate change during the late Cenozoic through high-resolution studies of tropical ocean sediments. Previous legs have sampled the equatorial Atlantic (Leg 108), the Peru Current (Leg 112), the western tropical Indian Ocean (Leg 117), and the western equatorial Pacific (Leg 130).

Two north-south transects of advanced hydraulic piston cored (APC) holes are planned to obtain continuous, undisturbed sedimentary sections for studies of the late Cenozoic paleoceanography of the eastern equatorial Pacific Ocean. Planned sites will address the evolution of climate during the period when the Earth changed to a world dominated by extensive northern high-latitude glaciation. Focus of this study will be the eastern Pacific equatorial circulation system, a region responsible for over half of the world's primary productivity and a sensitive recorder of global climate change.

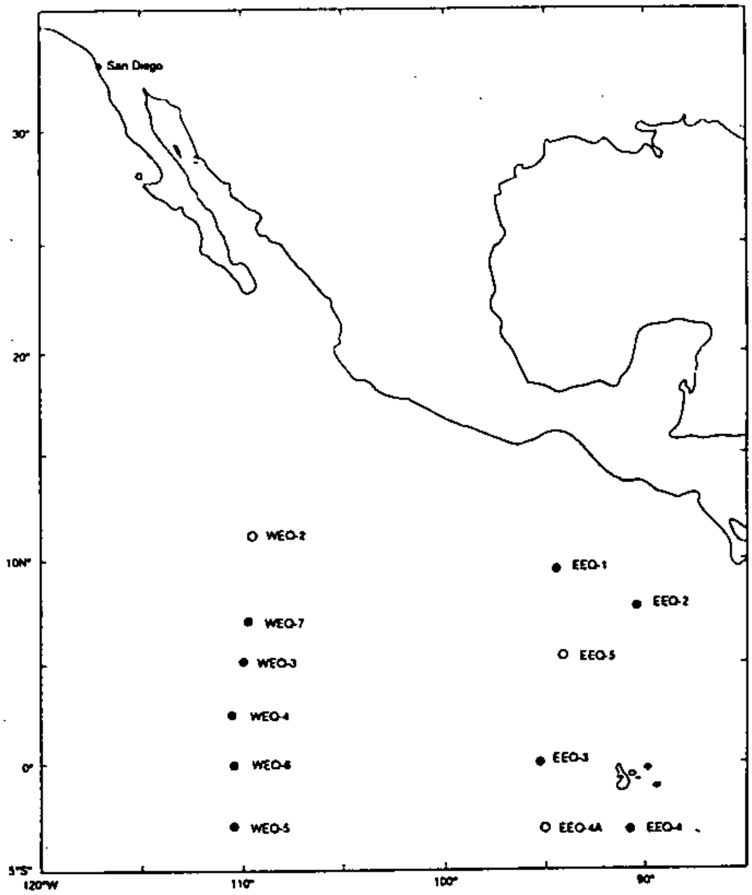

Figure 1. Location map.

Regional Oceanographic Setting

The regional setting of Leg 138 is the eastern equatorial Pacific, from the Central and South American coasts to approximately 120°W. To place the size of this area into perspective, this small portion of the Pacific is about the same size as the entire equatorial Atlantic Ocean.

The westward flowing South Equatorial Current (SEC) is located south of ~5°N and is, in part, a continuation of the Peru Current, which brings waters from higher latitudes to the equator. Strength of the SEC reflects southeast trade winds. North of ~10°N is the westward flowing North Equatorial Current (NEC), which is driven by northeast trades. Between the NEC and SEC is the eastward flowing North Equatorial Countercurrent (NECC), which brings low-nutrient tropical waters from the western Pacific into the eastern equatorial Pacific. These surface currents have been described as being part of two gyre systems, with the NEC and NECC forming an elongated subtropical cyclonic gyre north of the equator and the SEC being part of a southern hemisphere anticyclonic circulation cell.

A feature of the area that is an important part of the regional biological productivity is the Costa Rica Dome. This region of extremely shallow thermocline is centered at about 8°N and 90°W and is bounded by the NECC to the south, the NEC to the north, and the northward flowing Costa Rica Coastal Current to the east. The Costa Rica Dome was originally proposed to reflect cyclonic circulation of the eastern limb of the subtropical gyre. However, the strength of thermocline doming (the thermocline often is only 10 m below the sea surface) seems not to be correlated to the strength of the NECC, but rather to the intensity of wind-stress curl. It has been suggested that the "dome" features are a consequence of atmospheric circulation of the Intertropical Convergence Zone, and are also found in other areas of the tropical ocean.

The eastern equatorial Pacific is a locus of a large part of the Earth's primary and new productivity in today's ocean. Careful study of the region is required to define variability in the global budget of productivity or paleoproductivity. Clearly, the circulation system of the equatorial Pacific should be highly sensitive to climate change and associated changes in atmospheric circulation. Drilling transects will provide necessary sediment records to document late Cenozoic circulation changes in this important oceanographic region.

Scientific Objectives

From complete, undisturbed cores, answers to the following questions can be expected:

1. How did Pacific equatorial circulation evolve through the late Cenozoic as a response to increased global glaciation?

2. Are oceanographic changes hemispherically symmetrical or asymmetrical?

3. What was the nature of the circulation system during the late Miocene, when open communication with the Atlantic occurred through the Panamanian seaway?

4. What was the nature of oceanographic variability during the late Miocene and Pliocene, and how does this compare to the Pleistocene (i.e., do changing boundary conditions modify the sensitivity of the system)?

5. What was the nature of circulation during the Pliocene after the closure of Panama, but before the onset of Pleistocene glaciation in the northern hemisphere?

6. How do oceanographic changes affect productivity in equatorial Pacific surface waters?

Answers to these questions will provide important clues needed to understand the cause and nature of oceanographic and climatic variability. The last million years of Earth's history are characterized by large changes in northern hemisphere ice cover. These changes have been linked to changes in solar radiation, the Milankovitch Hypothesis. Identification of the oceans' and atmosphere's response is complicated by the presence of both large ice-volume changes and changing external (insolation) forcing. Examination of the ocean system at times before the existence of major northern hemisphere ice sheets (question 5) provides the means for determining effects of external forcing and changes in boundary conditions due to ice-volume changes. Comparison between variability and nature of oceanographic conditions during the late Miocene and Pliocene (question 4) provides information on the sensitivity of the climate system to changes in major oceanic boundary conditions.

Study of tropical climate systems in the Pacific, Indian, and Atlantic oceans will be critical to a global understanding of climate changes. Planned equatorial Pacific transects will provide an important late Cenozoic complement to transects drilled in the equatorial Atlantic, western equatorial Pacific, and the Indian Ocean monsoon region. Samples from these Pacific transects will ensure that comparisons can be made between the four tropical areas.

Drilling Strategy

Leg 138 departed Panama on 5 May 1990 after a 5-day port call and is scheduled to arrive in San Diego on 5 July 1991. Two complementary north-south transects will be drilled across the complex equatorial current system (Fig. 1). The western transect (five primary sites centered at about 110·W) crosses the equatorial Pacific current system where it is fully developed and removed from influences of eastern boundary currents. As such, it represents the easternmost (and highest productivity) end-member of an oceanwide study of equatorial sedimentation (legs 85 and 130). The north-south transect adds a new di-

Table 1. Leg 138 time estimates.

Site	Long.	Lat.	Water depth	Penet. depth	Drill* (days)	Log (days)	Total (days)	Transit† (days)
FIRST PRIORITY SITES:								
Panama								3.0
EEQ-2	7°55.3′N	90°28.9′W	3430	271	3.4	0.9	4.3	1.1
EEQ-1	9°34.9′N	94°35.3′W	3725	283	3.8	0.9	4.7	2.4
EEQ-3	0°12.1′N	95°19.2′W	3355	295	3.6	0.9	4.5	1.4
EEQ-4	3°05.8′S	90°49.6′W	3320	411	4.4	1.0	5.4	4.9
WEQ-5	2°59.7′S	110°28.9′W	3870	93	2.3	0.6	2.9	0.6
WEQ-6	0°06.2′N	110°30.3′W	3840	312	4.3	0.9	5.2	0.7
WEQ-4	2°45.5′N	110°34.3′W	3780	312	4.3	0.9	5.2	0.7
WEQ-3	5°19.6′N	110°04.6′W	3870	120	2.6	0.8	3.4	0.5
WEQ-7	7°12.7′N	109°45.1′W	3730	65	1.9	0.4	2.3	6.6
San Diego								
			Subtotals		30.6	7.3	37.9	21.9
			Total days at sea					59.8
SECONDARY SITES:								
WEQ-2	11°16.3′N	109°36.3′W	3520	27	1.4	0.3	1.7	
EEQ-4A	3°01.8′S	95°04.8′W	3520	181	2.7	0.8	3.5	
EEQ-5	5°36.2′N	94°12.2′W	3575	212	3.2	0.8	4.0	

* Triple APC all WEQ sites; double APC all EEQ sites; XCB to basement where necessary.
† Transit time assumes average speed of 10 kt.

mension to the study of this current system and allows a detailed look at the development of the equatorial current system in response to global climatic change. The eastern transect (four primary sites centered around 95·W) is designed to look at interaction of the equatorial current system with the Peru Current and the eastern boundary of the Pacific. This transect will provide insight into changes in coastal upwelling as well as the eastern boundary current system. Sedimentation rates are expected to be very high, allowing for extremely high-resolution studies.

Sites were chosen to sample each of the major oceanographic features of the equatorial current system. All sites will be double-APC cored (triple-APC if time permits) and extended core barrel (XCB)-cored to basement. A standard suite of downhole measurements will be collected at all sites where sediment thickness permits. All sites were surveyed during Leg 1 of the "Venture" expedition of the *R/V Thomas Washington* in the fall of 1989. Backtrack histories indicate that these sites would have remained within present water masses during the late Cenozoic, assuming that no major oceanographic changes occurred. These sites will provide a continuous record of the eastern tropical Pacific current system throughout the past 8 to 10 m.y., with some sites extending back to 15 Ma.

Ideally, all planned sites will be drilled in order to provide both east-west and north-south coverage. However, time constraints may preclude drilling all sites. Primary sites along the 95°W transect are EEQ-1, EEQ-2, EEQ-3, and EEQ-4. Primary sites along the 110°W transect are WEQ-3, WEQ-4, WEQ-5, WEQ-6, and WEQ-7. If time permits, the third APC hole at each site, presently scheduled to be drilled to 50 mbsf, may be deepened. Three alternate sites include EEQ-4A, EEQ-5, and WEQ-2. WEQ-2 is logistically the last site along the ship track, and will be cored only if time permits. Where penetration depths are sufficient, seismic-stratigraphic, geochemical, and FMS tools will be used to log each site.

LEG 139 PROSPECTUS: SEDIMENTED RIDGES I

Background and objectives of Leg 139 to the Middle Valley of the Juan de Fuca Ridge were described in the February 1990 issue of the *JOIDES Journal* (report from the Sedimented Ridges DPG) and are only briefly discussed here. Highest priority objectives for this program are:

1. Three-dimensional characterization of fluid flow and geochemical fluxes within a sediment-dominated hydrothermal system,

2. Systematic investigation of processes involved in formation of sediment-hosted massive sulfide deposits.

Leg 139 will address both of these objectives, but will concentrate principally on the first. A second leg in Middle Valley and the Escanaba Trough, which has been planned but not yet scheduled, will concentrate primarily on the second objective.

Drilling Strategy

In order to characterize fluid flow and geochemical fluxes in the Middle Valley hydrothermal system, an array of eight sites has been selected, including three alternate sites (Table 1; Figure 1). The highest priority is MV-3, a basement reentry site which has the objective of drilling into the high-temperature reaction zone of this active system. A reentry hole at MV-3 is targeted to drill ~50 m into basement during Leg 139 and will penetrate a well-defined heat flow high near, but not directly on, an active vent area. Complementing this site is an array of four additional sites designed to define the three-dimensional pattern of fluid flow over a 100-200 km² area. The main objective of holes at these sites is to characterize hydrogeology of this hydrothermal system following drill penetration into a few tens of meters of permeable basement.

Proposed sites are located in areas of high and low heat flow within both active discharge and potential recharge zones. Three of these sites will include holes that will be outfitted with reentry cones for potential subsequent deepening into basement to address both magmatic and hydrothermal problems. At four of the five sites, an extensive program of logging, fluid sampling, and borehole experiments is planned. The three reentry holes will be

Table 1. Summary site information, Leg 139

Site	Lat. (N)	Long. (W)	Water depth	Penet.* Sed.	Bsmt	Drill (days)	Log (days)	Total (days)
Departure from San Diego on 10 July, 1991								
MV-7	48°26.62'	128°38.55'	2480	250	50	12.3	5.8[1]	18.1
MV-2	48°26.96'	128°40.86'	2430	120		4.4	0.0[2]	4.4
MV-3	48°26.62'	128°42.65'	2450	470	50	9.9	6.1[3]	16.0
MV-1	48°27.40'	128°42.50'	2440	50-120	60	9.7	3.4[1]	13.1
MV-6	48°27.00'		2470	420	<50	5.8	1.5[4]	7.3
Returns to Victoria on 11 September, 1991								
Alternate sites:								
MV-2(reentry)	48°26.96'	128°40.86'	2430	120	50	5.9	3.4[1]	9.3
MV-4	48°27.45'	128°46.28'	2450	650	50	13.0	4.4[1]	17.4
MV-5	48°27.15'	128°41.58'	2450	400	50	6.4	2.1[4]	8.9
MV-8	48°30.00'	128°45.20'	2540	500		7.9	2.5[4]	10.4

*The penetrations given here do not imply that permission has been given to drill to these depths. Drilling in any hole will be curtailed if the Operations Superintendent believes that the temperature, H_2S, or other conditions encountered could unreasonably risk the safety of the operation.

[1] Downhole tools include standard logging suite, DLL, PTF tool, borehole fluid sampler, packer/flowmeter, WSTP and APC tools, and instrumented borehole seal.

[2] Downhole tools include WSTP and APC tools.

[3] Downhole tools include standard logging suite, DLL, PTF tool, borehole fluid sampler, VSP, packer/flowmeter, WSTP and APC tools, and instrumented borehole seal.

[4] Downhole tools include standard logging suite, PTF, WSTP, and APC tools

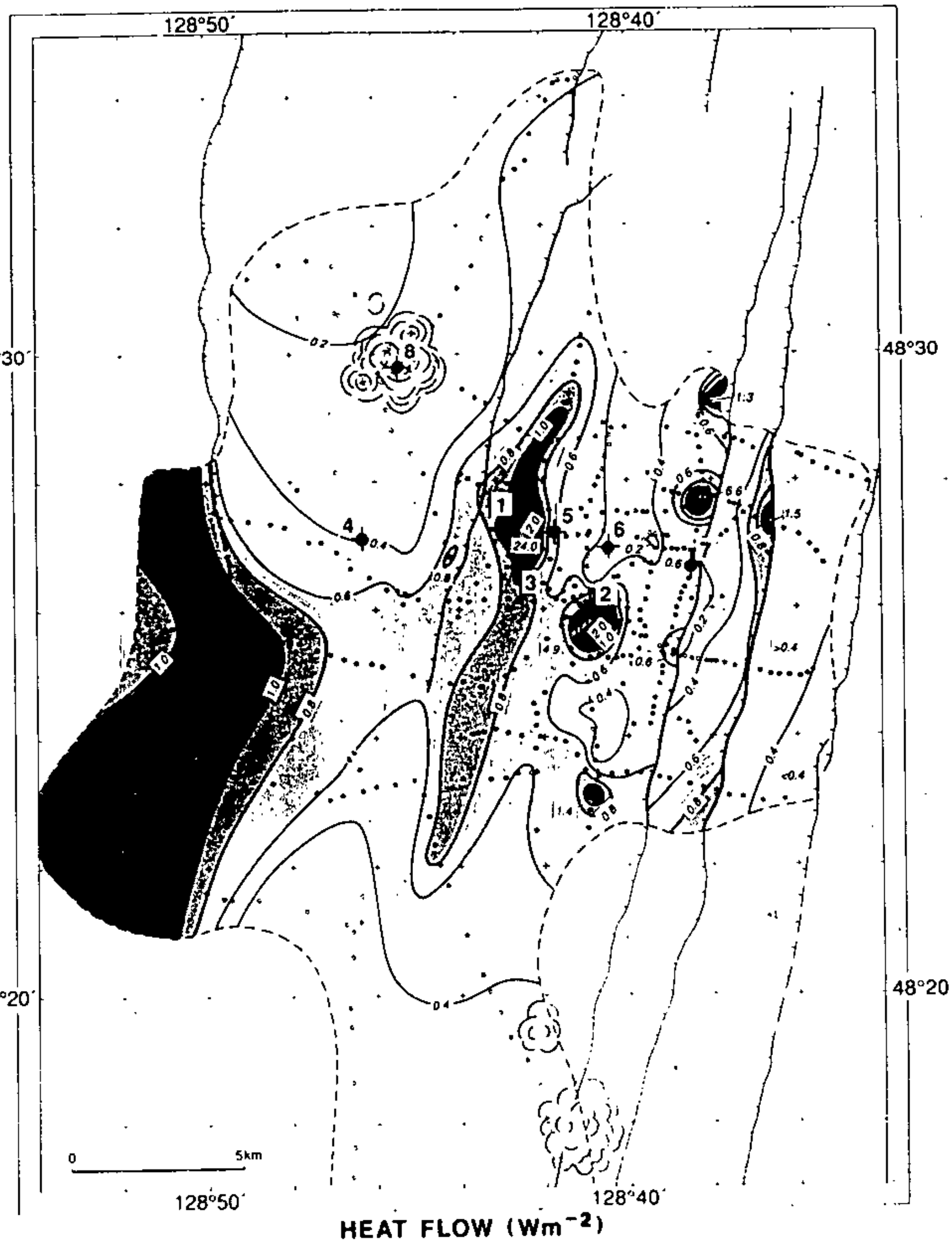

Figure 1. Site location map, showing local heat flow.

sealed for hydrogeological and geochemical monitoring and sampling.

To begin the investigation of the processes and products of hydrothermal discharge, detailed arrays of shallow holes will be drilled at two sites, MV-1 and MV-2. Where the sediment is sufficiently compressible, drilling will begin with APC coring. In many locations, indurated sediment or massive sulfide may outcrop at the seafloor, and XCB or RCB drilling will have to commence immediately. It is planned that acoustic beacons will have been well located with respect to a previously established acoustic transponder array that was used for acoustic and visual mapping of the areas. Thus, holes should be precisely sited without using a TV camera.

Site Descriptions

Proposed sites MV-1 and MV-2 are located in currently active hydrothermal discharge areas. MV-1 will be the location of a basement reentry hole. Vents here are discharging water at up to 286°C and local basement temperatures are estimated to be in excess of 300°C. Measured heat flow ranges from 2 to 24 W/m². Depth to basement in the vicinity of the vent field is ~400 m. Directly beneath the peak of the heat flow anomaly and the hydrothermal field, a local basement edifice rises to within about 120 m, or less, of the seafloor; above that level sediment reflectors are disturbed, but it is not clear whether this is due to hydrothermal induration (common within surface sediments in this area) or to the presence of volcanic rock.

Proposed site MV-2 is located in an area where massive sulfide deposits occur in near-surface sediments on the southern flank of Bent Hill. The mound is cored by a small reflective structure 120 m below the surface. The drill site is located just north of the conductive heat flow peak of ~5 W/m², where an active chimney has been sampled. The underlying sediment is relatively undisturbed to the depth of the small sill or volcanic edifice inferred to be at about 120 mbsf. Basement depths in the vicinity are ~250 m.

Proposed site MV-3 is located within the same thermal anomaly as site MV-1, but where no local basement edifice is visible. Heat flow at the site is ~1.0 W/m², sediment thickness is ~470 m, and the temperature at basement is estimated to exceed 300°C. It is anticipated that the deep hole at this site will penetrate a section of sediment where temperatures are high but where conductive heat transport dominates, and intercept a "reservoir" zone of high-temperature fluid in basement. This site is also a candidate for later, deep reentry basement penetration.

Alternate site MV-4 is located where basement temperatures are also expected to be high and fluid flux through the sediments low. Expected heat flow is about 0.4 W/m², the sediment thickness is 650 m, and basement temperature is estimated to be >200°C. Alternate site MV-5 and primary sites MV-6 and MV-7 are located between high-temperature discharge site MV-1 and the normal faults which bound the valley. Basement temperatures decrease systematically toward the faults (minimum estimates: 150°C at MV-5, 80°C at MV-6, and 60°C at MV-7). This pattern could result from hydrothermal recharge of seawater through basement outcrops at the normal fault scarps that bound the valley, and perhaps through thinner sediments that fill this part of the valley.

Alternate site MV-8 is located over a recent and clearly imaged sill that has intruded the upper part of the sediment section in the center of the valley. Either emplacement of the sill or deeper volcanic activity has deformed the sediment surface; this places the age of the activity at less than 8 ka. No heat flow anomaly is observed over this structure, which constrains the age to be younger still. Depth to the sill, which is the target at this site, is ~500 mbsf. Although surface heat flow is relatively low, temperatures at the level of the sill may be in excess of 300°C.

Downhole Measurements During Leg 139

To meet highest priority objectives of Leg 139, and because high formation temperatures and corrosive fluids are expected at most sites, several special tools are scheduled for use. Important measurements include subbottom formation temperatures, pore pressures, and fluid fluxes, as well as formation chemistry, sonic velocity, porosity, and resistivity in sedimentary and igneous sections. In the upper part of the sedimentary section, temperatures will be measured as frequently as possible with the APC temperature coring shoe (APC tool), and the water sample, temperature, and pressure (WSTP) tool. Both of these tools have recently undergone redesign and upgrading and will appear in their final forms for the first time during this leg. A slim-hole, high-temperature Japex pressure, temperature, fluid-flow (PTF) logging tool is also expected to be on board; this tool should operate at temperatures to 375°C.

The PTF tool will be run first in all holes that are to be logged. Because it will not require hole cooling during operation, this tool can be run without installing the sidewall entry sub (SES) in the drill string. Because high borehole temperatures are anticipated, however, a section of special logging cable will be added for this leg. Results of PTF logs will be used to determine the strategy for logging with other tool strings, which are not designed to operate at temperatures above 165°C. If PTF logs indicate that temperatures in the hole will remain below 150°C for the following 36 hours, then standard procedures can be used for logging with the other tools, and the SES would be necessary only if the hole is expected to be unstable. If PTF temperature profiles indicate that the hole has recovered, or will soon recover, to temperatures in excess of 150°C, then the SES will be installed in the string to assist with hole cooling during logging.

Specialty tools include the digital and analog borehole televiewers (BHTV), the dual laterolog, the multichannel seismic tool, and the wireline seismic tool (WST), which is run for vertical seismic profiles (VSP). Several other special tools are scheduled for deployment, including the drill string straddle packer and high-temperature borehole fluid samplers from Los Alamos National Laboratory and/or the Lawrence Berkeley Laboratory. The packer will also be used in conjunction with a third-party spinner-flowmeter system to determine the detailed permeability structure in several boreholes. Finally, several holes will be instrumented with a thermistor string and pressure sensor. These holes will be plugged with a removable seal (which was successfully tested during Leg 136), through which fluids and data can be sampled later by either a remotely operated vehicle (ROV) or submersible.

Operational Plan

JOIDES Resolution will leave San Diego on 10 July 1991 and steam toward proposed site MV-7, with a transit of 4.5 days. MV-7 will be drilled and cored, with an extensive series of shallow APC/XCB and RCB holes, and then with a deeper reentry hole.

Initial operations at this site will be done in a non-standard sequence. Three RCB holes will be drilled first to tag (A, B) and penetrate (C) basement. These holes will be closely spaced (50-100 m) along a line perpendicular to the normal fault scarp at this location, with the goal of intersecting basement at three different depths where the normal fault forms the contact between sediments in the hanging wall and basalts in the foot wall. After the third RCB hole is drilled, the bit will be dropped and logging will begin with the PTF tool. A full suite of logs will follow, including standard strings (litho-porosity, geochemistry, seismic stratigraphy, FMS) and the dual laterolog. One or more borehole fluid samples may be collected as well.

Results from the first three holes will help to constrain the geometry of the fault, so that holes D, E, F, and G can be optimally sited. APC/XCB holes D, E, and F will be drilled in a similar, possibly interspersed array with the goal of determining thermal and geochemical variations within the sediment above the dipping fault surface.

Frequent WSTP deployments will be made in the sedimentary section while drilling all non-reentry holes. The new APC (temperature) tool will be used extensively at this and all sites where APC coring is scheduled. Finally, a 250-m reentry hole (G), with standard cone and casing, will be drilled and extended ~50 m into basement. The reentry hole will be sited at a position where the inferred fault plane is fully within basement. After coring in basement is completed, a full suite of downhole measurements, including fluid sampling, temperature logs, and packer/flowmeter tests, are scheduled. Finally, the cone will be plugged with an instrumented borehole seal.

Leg 139 will next move to proposed site MV-2 to core a series of shallow holes into a sulfide deposit. Five holes are currently scheduled, all to be cored by APC/XCB to a maximum depth of ~120 mbsf with frequent WSTP deployments. No logging is planned at this site.

Operations at proposed site MV-3 will include emplacement of a second reentry system and borehole seal. Coring at MV-3 will begin with an APC/XCB pilot hole and a RCB exploratory hole, both with frequent WSTP deployments. A full suite of temperature and standard logs will be collected in the RCB hole following termination in basement, after the bit is dropped. A complete reentry cone and casing system will be deployed, with casing extending to a depth of ~260 mbsf (well into expected indurated sediments). Additional drilling will extend this hole ~50 m into basement. A full suite of downhole measurements will then be run, beginning with a borehole water sampler and PTF log, followed by standard Schlumberger logs, digital BHTV, VSP, and packer/flowmeter tests. The cone will then be plugged with an instrumented borehole seal.

Proposed site MV-1 will be drilled and cored next, beginning with four shallow APC/XCB holes to a maximum depth of ~120 mbsf. These holes are being drilled in part to determine the location of the shallowest basement at which a complete reentry assembly can be set. Sediment thickness, and thus the depth of each hole, will vary as a function of location relative to basement structure and massive sulfide bodies, with a probable range of 50-120 m. APC and WSTP tools will be used at this site while temperatures are sufficiently low, and one or more holes will be logged, if possible, with the PTF tool. A single-bit RCB exploratory hole will be drilled next, to complete sampling above basement and to determine depth to basement for reentry cone and casing. Position, and so sediment thickness, at the reentry hole will be constrained by the minimum amount necessary to set a reentry cone, probably ~50 m. Cone and casing will be emplaced next, and the hole will be drilled out to ~110 mbsf. A complete series of downhole measurements (nearly identical to that at proposed site MV-3) is planned to follow coring.

So that reliable temperature logs can be run, some operations at sites MV-1, MV-3 and MV-7 will be staggered to allow for partial thermal equilibration of cased sections of the reentry holes before the cemented casing shoe is drilled out (see Special Operations section).

Proposed site MV-6 will be drilled last. A single hole will be cored using a RCB BHA. This hole is intended to penetrate only the uppermost portion of basement, at a depth of ~420-450 mbsf. The bit will be dropped and the hole logged with the PTF tool, followed by the standard Schlumberger suite. Operations will be terminated at site MV-6 when the time for Leg 139 is exhausted, and the ship will steam for Victoria, B.C., arriving after a 0.9-day transit on the morning of 11 September 1991.

Special Operations

To measure temperatures and collect formation fluids during breaks in drilling operations in non-reentry holes, a means to pass the slim-line PTF tool and water samplers through APC/XCB and RCB bits, without the use of a lockable flapper valve, will also be required. For safety reasons, these tools will be run with the bit held in the holes near the seafloor, and only if there are no indications of there being up-pipe flow.

Temperatures at depth at sites MV-1 and MV-3 will probably be high. Standard logging under these conditions will require the use of the SES, so that temperatures in the vicinity of the logging tools can be kept low by continuous circulation. Runs of the PTF tool will be done prior to any logging to ascertain that the hole can be kept cool in this manner (e.g., that vigorous up-hole flow has not been stimulated by existence of the hole).

To allow time for partial thermal reequilibration of reentry holes, there may be a break between setting and cementing of casing strings and later deepening. The plan for operations at each reentry site is as follows: reentry cone and conductor casing will be installed in the standard way, and the hole below drilled out to the desired depth. Following installation and cementing of casing, the hole will be backfilled with a high-viscosity or thixotropic fluid and logged with the PTF tool; the ship will then move on to the next site and begin work. Mud left in the reentry hole will reduce the tendency of fluids in the hole to convect, but will not damage the geochemical environment around the hole because the hole will be lined with casing and cement. After some time has passed, the ship will return to the reentry site and operations will continue with a repeat PTF log before the hole is flushed and deepened. A final run with the PTF and fluid sampling tools will be completed after bit wear prevents further penetration, and then the remaining logs will be run. When all other operations are complete, an instrumented borehole seal will be emplaced in the reentry cone.

Cores collected will be stored in an oxygen-free environment to prevent degradation. Both archive and working halves will be placed in air-tight bags inside standard D-tubes and flushed with nitrogen before sealing. These and other special procedures will be carefully integrated with additional safety procedures to assure efficient core flow in the laboratories.

Safety Considerations

As drilling and coring operations will penetrate into known sites of hydrothermal activity, extraordinary safety precautions will be necessary to protect against hazards of hydrogen sulfide (in borehole and cores) and steam flash from superheated borehole fluid. Safety measures are set forth in the "Hydrogen Sulfide—High Temperature Drilling Contingency Plan" compiled by the ODP and SEDCO-FOREX. This plan has been submitted and approved by the Canada Oil and Gas Lands Administration (COGLA).

Specific measures will include installation of equipment such as H_2S detectors and alarms, ventilation equipment, portable breathing apparatus, and drill-string safety valves; extensive training and drills for shipboard personnel in steam blowout and H_2S emergency procedures; and special handling and storage procedures for cores containing high levels of H_2S.

In addition to these personnel-safety considerations, special precautions will be taken to protect drilling and logging tools from the effects of high downhole temperatures, corrosive fluids, and H_2S embrittlement. Equipment precautions include the use of extra circulation of cold seawater and of H_2S scavengers; these are detailed in the "Leg 139 Engineering and Operations Planning Document."

SCIENTIFIC DRILLING AND CORING OF MID-OCEAN RIDGES - ROLLER CONE VERSUS SLIMHOLE DIAMOND CORING TECHNIQUES

ODP Department of Engineering and Drilling Operations

INTRODUCTION

Throughout the history of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP), there has been keen scientific interest in conducting geological investigations on mid-ocean ridges around the world. A significant amount of data has been gathered with sophisticated seismic and sonar instruments, as well as with camera sleds and visual observations using manned submersibles. However, since typical mid-ocean ridge formations are characterized by young, highly fractured basalt, only limited core samples from shallow holes have been recovered. Typically, coring operations have been performed with tungsten carbide insert roller cone (TCI-RC) core bits, 9-7/8 inches in diameter or larger. In highly fractured basalt formations, cutting action of the roller cone bits further fractures the rock, resulting in core jamming in the throat of the bit. Core recovery in these fractured basalts is typically less than 10%. In addition to poor core recovery, cutting action of the large diameter roller cone bit damages the formation and results in a high degree of hole instability. Hole instability problems generally prevent significant progress towards scientific depth objectives. Recovery and hole stability problems experienced to date demonstrate that the use of conventional roller cone type drilling/coring techniques and equipment, in this type of environment, is often ineffective.

Conversely, the use of high speed, narrow kerf, "slim hole" diamond coring techniques by the mining industry has been demonstrated in land drilling operations as a very effective way to core fractured, highly unstable, crystalline rock formations. The significant reduction in hole size, coupled with the technique of grinding the rock at high speed and low bit weight rather than crushing the rock, results in extremely high recovery rates (typically 90% or better), less core jamming, and improved hole stability. ODP has under development a high-speed, deep-water, slim hole "Diamond Coring System" (DCS) designed for deployment from a dynamically positioned drill ship. Three specific types of formations have been identified as candidates for possible diamond coring. In addition to the fractured basalt formations described above, formations with sequences of alternating layers of chalk/chert and formations comprised of eroded reefal limestone could potentially be effectively cored in the future using DCS techniques. Previous attempts to core these types of formations using conventional large diameter TCI-RC bits have resulted in unsatisfactory core recovery.

This paper describes early attempts at drilling in a young mid-ocean ridge environment during DSDP Leg 54 and summarizes early ODP experience drilling on the Mid-Atlantic Ridge during legs 106 and 109. Details are also given concerning DCS Phase I and II development results on legs 124E and 132. Further plans for DCS Phase IIB (scheduled for testing on Leg 142 to the East Pacific Rise) and Phase III are outlined. Finally, a brief section of this report discusses potential scientific applications of the DCS.

DSDP LEG 54 (EAST PACIFIC RISE)

An early attempt to recover core samples from a young mid-ocean ridge occurred during Leg 54 of the DSDP. During May - June, 1977, the drilling vessel *Glomar Challenger* attempted coring operations at several East Pacific Rise (EPR) sites. From the onset, the cruise was plagued with problems of finding suitable drilling targets with an adequate amount of sediment cover. The capability to spud holes on bare crustal rock or in locations with minimal sediment cover did not exist at that time. Experience had shown that without adequate lateral support from the sediment overburden, the bottom hole assembly (BHA) was subjected to extreme risk of loss. Once suitable sites were located, most coring attempts resulted in dismal failure. These early attempts pointed out the need for vastly superior drilling/coring techniques for oceanic lithosphere.

Operations conducted on EPR sites 420-427 accomplished little more than destroyed core bits, stuck drill pipe, and lost operating time. Maximum penetration below seafloor ranged from 11.8 to 28.5 m. TCI-RC core bits lasted only a few hours before self destructing in the harsh environment. Even in these limited penetration depths, the pipe often became stuck for several hours. In some cases, up to 400,000 lbs of over pull was required before the pipe became free. Core recovery ranged from 4.3 to 7.6%, except in a few areas where relatively thin layers of massive basalt were encountered and where recovery increased to 44.0%.

ODP Legs 106/109 (Mid-Atlantic Ridge)

From its inception, one of the primary objectives of ODP was to develop the capability to spud and core holes into young crustal spreading centers with little or no sediment cover. The failure of DSDP to initiate these "bare rock" holes successfully left a noticeable gap in a highly desired geologic environment. Commencing in November 1985, and armed with a newer and more technically advanced drill ship, ODP embarked on a two-leg mission to obtain the first ever scientific cores from the Mid-Atlantic Ridge near the Kane Fracture Zone (MARK).

In addition to a more stable drilling platform, *JOIDES Resolution* provided a state-of-the-art heave compensation system considered paramount to successful drilling operations at MARK. Many man-months of engineering were spent during the previous year developing a seafloor structure required for bare rock spudding, the "hard rock guidebase" (HRB), and acquiring a modified version of an "oilfield" positive displacement mud motor (PDM). These motors are powered by circulation from the drill ship's mud pumps, thus providing a way to rotate the drill bit without rotating the entire drill string. This method of imparting rotary torque to the bit is vastly superior for bare rock spudding operations.

The HRB was a massive structure measuring 17 feet square and weighing 144,000 lbs when fully ballasted on the seafloor. This structure, although it performed its function, proved to be much too massive, technically complex, and expensive to be retained as a routine operational tool.

Although a bare rock spudding capability was admirably demonstrated during Leg 106, coring and drilling operations on that leg and the follow-on Leg 109 proved to be inadequate. Borehole stability was virtually nonexistent. The same few meters of hole were drilled/cored over and over again, only to be lost at each round trip of the drill string for bit replacement. Bit life was again only a few hours. Attempts at drilling a surface hole and casing off the unstable zone proved to be generally fruitless. Comprehensive cementing operations, the use of reamers, stabilizers, etc. and every other "traditional" oilfield drilling trick failed to accomplish the objective of stabilizing the upper, highly fractured, volcanic zone. Leg 106 managed only 33 m of penetration into basement, while recovering core at an average of 15.2%. When reoccupied for Leg 109, this same hole (Hole 648B) was deepened to only 50.5 mbsf with recovery deteriorating to only 7.8%.

While bare rock spudding was now deemed feasible, a new approach to drilling and coring mid-ocean ridge areas to the required depth had to be found. The decision was made to pursue the application of land-based "mining industry" slim hole diamond coring technology to ODP's offshore scientific research effort. This major technological effort was and is the biggest development engineering project ever undertaken by ODP. It was projected as a multi-million dollar, multi-year effort requiring multiple project engineers. From the beginning, ODP stressed the need for a minimum of three dedicated engineering legs to test and perfect the system before a demonstrated operational capability could be expected. The development effort fell into three major categories: an improved seafloor structure (mini-HRB), a means to stabilize the upper highly fractured zones of the formation (drill-in-BHA system), and the DCS itself.

DCS Phase I Development (Leg 124E, Luzon Strait)

During Phase I development of the DCS, ODP embarked on a path to deploy and evaluate proven mining coring equipment from a floating vessel. The slim hole diamond coring systems in use by the mining industry were considered proven technology. A major hurdle to be overcome consisted of providing adequate weight-on-bit control from a floating vessel. In addition, the configuration of the long, slim hole, tubing (coring) string had to be determined with offshore drill ship dynamics given consideration. Since adequate fatigue life was a concern, several strings of drill rod/tubing were tested to failure. The test consisted of rotating the test strings at high RPM inside a joint of ODP API drill pipe bent to a 500 feet radius, emulating the worst case angle of the drill ship's upper guide horn. Based on this test, a Hydril 3-1/2 series 500 tubing string with wedge lock connections was selected as the DCS coring string.

To demonstrate the concept and potential of a drill ship-deployed, high speed DCS, a low cost prototype system was deployed on Leg 124E and tested for a two week period in the Luzon Strait off the coast of the Philippines. This prototype system, had a 2000 m total depth (water depth plus penetration depth) capability. A proven mining coring system was inte-grated into a 40 foot mast and suspended in the existing ship's derrick. The DCS coring string was deployed inside the ODP drill pipe, and a narrow kerf diamond core bit (3.96" by 2.20" diameter) was attached. In addition, all coring and wireline equipment was deployed from the DCS mast/platform. All drilling controls were mounted on the platform console and were operated by a two man drill crew. Because of head room restrictions, the core barrels were limited to 10 feet in length. Operational efficiency was compromised, with the drill crew working 45 feet above the rig floor and constantly being subjected to inherent motions of the suspended platform.

The entire system was suspended from the primary, 400-ton passive heave compensator system. Residual heave motion/weight fluctuation, not compensated for by the primary compensator, was removed from the tubing string by an active secondary heave compensator system mounted on the DCS platform. The system was designed to maintain extremely accurate weight-on-bit (WOB) control. The goal being to maintain ±500 lbs WOB fluctuation on the narrow kerf diamond bit in water depths of up to 2000 m and in heave periods as short as 6 sec. A residual heave of ±6" had to be taken out with the secondary system.

The concept driving the secondary heave compensation system is as follows. When the secondary heave compensator is activated by the driller, the diamond bit is automatically advanced to bottom and the desired WOB or feed rate is established. After the core is cut, the computer automatically retracts the bit off bottom when commanded by the driller. The inner tube assembly is then retrieved by wireline. An empty inner tube assembly is dropped/pumped down the tubing string, landed in the outer core barrel assembly, and coring operations are resumed.

Rotational torque for the diamond bit is provided by a 3-1/2" coring ... from the ...

DCS platform. During Leg 124E, numerous cores were cut with this scaled down prototype system in heavy seas (4-6 feet coupled with 4-6 sec. period heave). Cores were cut in sedimentary formations with no structure deployed on the seafloor. Examination of recovered core samples revealed little or no disturbance, which was interpreted as an indication that the bit remained on bottom with good WOB control. Constant drilling torques at the surface and steady pump pressures confirmed that assessment.

At the end of sea trials on Leg 124E, although only limited drilling/coring tests were conducted, the concept of adapting high speed, slim-hole coring techniques to a floating vessel was deemed to be viable. Because of myriad problems involving hole instability, it was further determined that a seafloor structure and upper hole stabilizing capability was critical to future successful deployments of the DCS system.

DCS Phase II Development (Leg 132, Bonin Ridge)

During Phase II DCS development, total operating depth was extended from 2000 to 4500 m. This increased test site selection options dramatically, while taking the developing capability to a level useful for already identified scientific targets.

A purchased, high-load, high-speed electric top drive replaced the leased hydraulic top drive. The electric top drive is designed to maintain constant RPM while drilling torque varies, which is very valuable for coring operations where changes in RPM can dramatically affect core quality and recovery.

Complex electronic control technology was integrated into the ship's electrical system, allowing fine control of the rig's massive circulating pumps. This capability not only allowed low (3-40 gal./min.) flow rates required for diamond coring operations, but also allowed total control of mud pumps by the driller stationed on the DCS platform.

Secondary heave compensation capability was extended to ±12" of residual heave, with the same 6 sec. periods. A new, redundant, secondary passive compensator mode was built into the system in the event the active computer system failed. Depending on the heave motion, this new system would allow the driller to continue with the bit run using solely passive secondary compensation. Also, in the event the computer control system failed in heavy seas, the driller could then immediately switch to passive compensation to assist in retracting the string off bottom. This feature is important in helping to prevent damage to the core bit.

Other improvements to the Phase II system included a scaled down "mini" hard rock guide base. This new HRB measured 10 feet square, and when fully ballasted weighed 130,000 lbs. This guide base was much cheaper to fabricate, easier to ship and store aboard ship, and more efficient for operational deployment. Unlike it's predecessor used on legs 106/109 and 118, this HRB was deployable in one piece, ballasted on-deck (requiring no complex, time consuming seafloor cementing/ballasting operations) and had a gimballed reentry funnel built-in (requiring no second drill string round trip). The new HRB was designed to use syntactic foam (riser buoyancy) to maintain vertical orientation of the cone when the HRB was set on a slope of up to 20°. To be used in conjunction with the HRB was a newly designed tensioning sub and tapered stress joint. This hardware allowed deployment of the HRB without the need for steel cables, and also was used for tensioning the drill string against the seafloor structure, in much the same manner as an oilfield drilling riser.

A new drill-in-BHA (DI-BHA) system was also developed for use on Leg 132 to allow spudding a bare rock hole and isolating the upper, unstable, portion of the formation. This new capability was designed for deployment to a predetermined depth without requiring a trip of the bit and subsequent risk of hole caving/loss.

Finally, weaknesses of the "mining industry" wireline core barrel components identified during Leg 124E were redesigned and significantly strengthened for Leg 132 to withstand the rigors of deployment from an offshore oilfield drill ship.

Numerous problems and component failures were experienced during DCS deployment and testing of the prototype seafloor/DI-BHA hardware at the Bonin Ridge on Leg 132. In spite of these developmental problems, all systems were eventually made operational. By leg's end, a 79+ m penetration into young, highly fractured, basaltic crust was achieved. With the exception of some friable volcanic tuft zones which yielded little or no recovery, the majority of the fractured rock was recovered at a rate in excess of 60%. In addition, the nominal 4" DCS hole exhibited no instability. As a bonus, the leg yielded a demonstrated ability to move, and when required, recover back aboard ship the new "mini" HRB.

DCS Phase IIB Development (Leg 142, East Pacific Rise)

Phase IIB of the DCS development will continue to build on the prototype systems tested to date. The "mini" HRB has been redesigned into a hex-sided configuration nominally 13 feet across, and will be outfitted with three legs rather than four as in previous models. The reentry cone diameter has been reduced to 8 feet in diameter, as in the ODP free-fall funnel design, and is now mounted on a counter-balanced gimbal, negating the need for syntactic foam buoyancy panels. The improved guide base design currently has a 3:1 factor of safety on it's positive righting moment and will handle slopes of up to 25°. A redundant angle measuring capability will be available using both mechanical "bulls eye" and electronic tilt beacon technology.

The drill-in-BHA system has been expanded into a two stage "nested" design, allowing a second stage DI-BHA to be deployed after initial DCS coring operations have been attempted through the upper unstable crust. An optional slim-hole diamond coring system using a 7-1/4" diamond bit, 6-3/4" drill collars, and slightly modified RCB wireline core barrel components is also under development.

The DCS platform-mounted coring system will have improved low friction seals to alleviate "crabbing" experienced with the dual secondary compensation/feed cylinders during Leg 132 operations. Improvements will be made to the secondary compensation system to allow operations in a wider range of sea states and water depths. The winch control system will be improved and the hydraulic power pack outfitted with a high pressure filter system. The coring system will have more core catcher options, and will also have optional sampler type systems for use in friable, sandy, or otherwise difficult recovery situations.

Testing of the Phase IIB DCS is scheduled for January - February 1992 during Leg 142 on the East Pacific Rise. Goals for this most ambitious test yet of the ODP slim-hole coring capability include deploying the newest model "mini" HRB, spudding a bare rock hole on the East Pacific Rise (EPR) with the first stage of the "nested" drill-in-BHA, and coring with the DCS to a minimum 100 m below seafloor with a minimum 50% core recovery. Once the coring capabilities have been amply demonstrated, any remaining time will be spent testing the deployment of slim-hole temperature/caliper logging tools, attempting to ream the nominal 4" DCS hole out to 7-1/4", deploying conventional temperature/caliper logging tools if the reaming operation is successful (including maintainable hole stability), deploying and evaluating the second stage DI-BHA through the upper unstable hole, and evaluating the developmental 7-1/4" diamond core barrel (DCB) coring system.

Projected DCS Phase III Development

Phase III of DCS development represents the final major step into a fully refined, efficient DCS coring system. Phase

III plans include elimination of the platform-mounted system and replacing it with a mast-mounted, top drive/compensation system only. This system will not have men working aloft in the derrick, as in the Phase I and Phase II systems. Instead, the rig crew will function at the rig floor as in normal coring operations. The API drill string will likely be supported on riser tensioners located below the rig floor, or will be equipped with a bottom-mounted slip joint. Initial studies indicate that this ultimate system will be significantly more efficient and will have fewer operational limitations than the current platform-mounted system. Penetrations of 300 to 500 m below the seafloor and beyond should be possible in one-third of the operating time required with earlier systems. This could well equate to a future ODP slim-hole diamond coring capability available as an option to other more conventional coring systems on any given leg.

Scientific Applications of the DCS

The use of high-speed, slim-hole drilling/coring techniques have considerable potential for achieving yet unattainable scientific drilling objectives over the next three to five years. These techniques have been demonstrated in a variety of unstable formations (both sedimentary and crystalline rock) to produce excellent core recovery and to provide good hole stability, thus allowing significant drilling depths to be reached. The constant speed characteristic of the new high speed top drive is expected to further enhance core recovery rates.

In addition to offering the potential for good core recovery and improved hole stability in fractured basalt, the DCS has application in other types of formations. In alternating layers of chalk and chert, the high speed diamond core bits, small hole size, low flow rates and light bit weights have the potential to minimize core jamming/washing, resulting in the recovery of core samples that are normally lost when coring with large diameter roller cone core bits. Several diamond coring operations have been conducted into atolls from barges and small work boats working in shallow water. There, the use of slim-hole techniques have yielded high core recovery rates in unconsolidated reefal limestone formations.

Longer range drilling objectives include extensive coring operations in the vicinity of and possibly through a network of seafloor vents and drilling/coring to the top of an active shallow magma chamber on the East Pacific Rise. The latter drilling objective will require adaptation of geothermal well control equipment both at the surface and on the seafloor. The existing DCS configuration (i.e., deploying the 3-1/2" DCS coring string inside the ODP 5" drill pipe) lends itself to the development of a mini-riser drilling system complete with return circulation capability. The potential of obtaining drilling returns back to the drill ship opens up many potential scientific rewards. Real time processing of drill cuttings while ongoing coring operations continue, and the ability to use more sophisticated mud systems while coring difficult unconsolidated formations, may be just the beginning.

Wireline Logging Services Report

LEG 133: NE AUSTRALIA MARGIN

ODP Leg 133 drilled 16 sites on the NE Australian continental margin, with an overall average core recovery of 60%. Leg 133 logged twelve sites (Fig. 1); the average proportion of hole logged was 93%. The record-breaking quantity of logs on Leg 133 was obtained for the purpose of contributing to prime leg objectives: Neogene history of sea-level fluctuations, response of both shallow and deep water sedimentation to sea-level fluctuations, and margin diagenesis.

Preliminary log analysis suggests that Leg 133 logs contribute the following types of information with potential sea-level significance:

- continuous time/depth conversion, permitting paleontologic dating of seismic reflectors;
- test of the Vail assumption that seismic reflectors are chronostratigraphic;
- carbonate/clay cyclicity;
- presence of coarsening- and fining-upward cycles;
- sedimentary facies from sedimentary dip variations; and
- diagenetic signature.

Time/depth conversion: The link between core depth and seismic traveltime is more important for Leg 133 than for almost any other ODP leg, because the foundation of the Vail hypothesis, which Leg 133 sought to test, is the interpretation that seismic onlap/offlap patterns have diagnostic sea-level implications. Consequently, 12 sites were logged with the geophysical tool string, obtaining continuous logs of sonic velocity for conversion from core and log depth to seismic time. Because velocity logs do not work through pipe, and pipe was usually set at 80-100 mbsf for logging, postcruise studies are comparing and merging laboratory physical properties measurements to the logs to provide a more complete time/depth conversion than is obtainable from logs or cores alone.

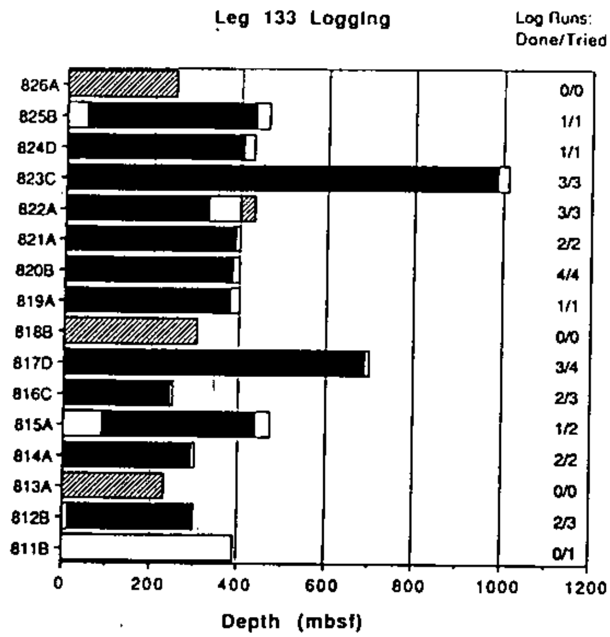

Figure 1. Penetration of the deepest hole at each site. Logged intervals are shown in black, unlogged intervals (usually because of fill at the bottom of the hole) are shown in white, and sites with no attempted logging are shown in hachures. Note that Site 811 was not logged because of junk in the bottom hole assembly, but logged Site 825 is a later return to the same location.

This conversion permits comparison of sea-level-sensitive variables from cores and logs to seismic onlap/offlap patterns.

Chronostratigraphic reflectors: Given time/depth conversion at two or more sites on the same transect, Leg 133 can test the Vail assumption that seismic reflectors are chronostratigraphic (i.e., the same age all along the reflector), by comparing ages of the same reflector from different sites. Initial shipboard analyses suggested that some reflectors may not be chronostratigraphic; postcruise analysis will provide a more diagnostic test.

Carbonate/clay cyclicity: Sites on the Great Barrier Reef transect show a clear provenance separation into two components: carbonate (low-Mg calcite, high-Mg calcite, dolomite, and aragonite) and terrigenous (primarily clay minerals, with some quartz). Relative proportions of these two components vary dramatically with depth, often with a semi-periodic cyclicity. Many logs provide continuous records of these variations (Fig. 2), which are thought to reflect sea-level changes.

Coarsening-upward and fining-upward cycles: The distinctive saw-toothed log signature of these cycles pervaded logs from the Great Barrier Reef transect. These cycles may be related to sea-level fluctuations or alternatively just to sedimentary facies variations. They are more obvious in logs than in cores, because logs are more sensitive than visual core descriptions are to changes in porosity and clay content.

Sedimentary facies from sedimentary dip variations: The Formation MicroScanner (FMS) is routinely used in the petroleum industry for determination of sedimentary facies, based on small-scale variations in sedimentary dip. On Leg 133, eight sites were logged with the FMS, providing the potential for postcruise examination of sedimentary dip variations within fining-upward and coarsening-upward sequences. Combination of these two facies indicators is much more diagnostic of sedimentary facies than is either indicator taken alone.

Diagenetic signature of sea-level change: Shipboard FMS data from reefal sediments at Site 812 detect a zone of obvious vugular porosity in a highly resistive (and therefore recrystallized) unit, overlain by a relatively porous unrecrystallized unit. Coupled with core-based information that this interval was deposited in a very shallow-water (<10 m) back-reef environment, we can infer that the FMS has detected diagenesis associated with temporary emergence and submergence of the horizon. A distinctive sawtoothed pattern of uphole porosity decrease is evident for this unit, as well as for several other units at sites 812 and 816. One such horizon, at 140 mbsf at Site 812, is interpreted similarly as a temporary emergence based on core data.

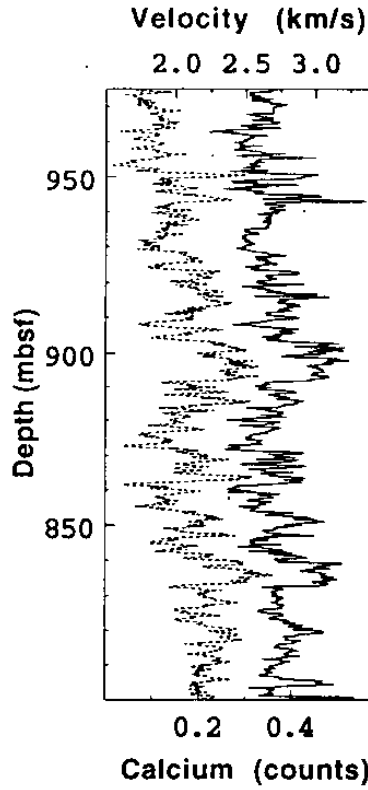

Figure 2. Comparison of calcium and velocity logs for a small interval from Site 823. Sediments here are composed primarily of calcite and clay minerals, two components that have very different calcium and velocity log responses. The strong correlation observed suggests that these two types of logs are reliably detecting variations in relative proportions of carbonate and clay, a parameter thought to reflect sea-level variations along the Great Barrier Reef margin.

Most log-based signatures above are not uniquely interpretable in terms of sea-level variations. For example, a fining-upward sequence can be caused by a rise in relative sea-level, a turbidite, or several other types of geologic change. However, in conjunction with core-based and other log-based clues, log results will help the shipboard party to achieve the sea-level objectives of Leg 133.

Detailed Planning/Working Group Reports

ATOLLS AND GUYOTS

The Atolls and Guyots Detailed Planning Group (A&G-DPG) met at the University of Michigan on February 27 and 28, 1991. Its purpose was to construct a two-leg drilling plan that includes the high priority targets of the two existing, highly-ranked proposals (202 and 203) for drilling atolls and guyots, selected so as to yield maximized and balanced scientific returns, and taking into account thematic panel priorities.

The original proposals were designed to address a number of important questions.

Proposal 202: Late Cretaceous through Cenozoic sea level history; the "paradox" of reef drowning (Eocene); vertical tectonic history of the west-central Pacific Basin related to volcanic events and sea level changes; paleolatitude track of the region as it relates to kinematic models of Pacific plate motion; sources of the Marshall Islands basalt in view of the DUPAL/SOPITA concept; diagenetic processes and acoustic stratigraphy of thick pelagic carbonate sequences.

Proposal 203: Early Cretaceous sea level fluctuations; causes and timing of mid-Cretaceous carbonate platform drowning - a global phenomenon; extent, magnitude, and timing of regional uplift associated with massive mid-plate volcanism in the western Pacific; Early Cretaceous Pacific plate latitudinal changes and plate kinematics; fixity of hot spots; longevity and stability of the DUPAL anomaly in mantle composition; Cretaceous history of the South Pacific "Superswell" and the Darwin Rise.

Low recovery rates have long been a problem associated with drilling in shallow-water carbonates. The opinion of A&G-DPG was that the best recovery would be achieved in the back-reef region, just on the lagoon side of the main reef structure. Accordingly, drill sites have been positioned either in this backreef setting or on the marginal reef itself. Sites where the main objective is the pelagic cap have been located more toward the guyot centers.

The three main basement objectives are to define the ages of the edifices, their paleolatitudes, and their geochemistry in relation to broad Southern Hemisphere geochemical anomalies (DUPAL, SOPITA). In order to study the geochemical and isotopic evolution of magmas over numerous flows, and also to have enough inclination data to average out secular variation in paleolatitude determinations, A&G-DPG recommended drilling deeply (300 to 400 m) into one edifice per leg, rather than drilling several intermediate-depth basement holes.

A&G-DPG also endorsed the use of the new Japanese 3-component borehole magnetometer, scheduled to be available in Spring 1992, in all basement sites as appropriate. This magnetometer is designed to be compatible with the Schlumberger tool strings and can be run in conjunction with other logs. DMP did not recommend the use of the downhole magnetometer on the A&G legs but LITHP suggested that its use for hard-rock orientation be evaluated. DMP did recommend one zero-offset simplified VSP per leg to enhance the tie between the sonic logs and seismic profiles and consideration of the deployment of the enhanced-resolution geochemical log at selected holes, if it is successful on Leg 137.

Almost all of the original objectives of both proposals have been retained in the drilling plan proposed by A&G-DPG. Only Majuro-1 was dropped from consideration, because it does not lie downslope from any of the guyot sites, and therefore would not provide a reliable distal record. Furthermore, DSDP Site 462 has already provided results similar to those expected

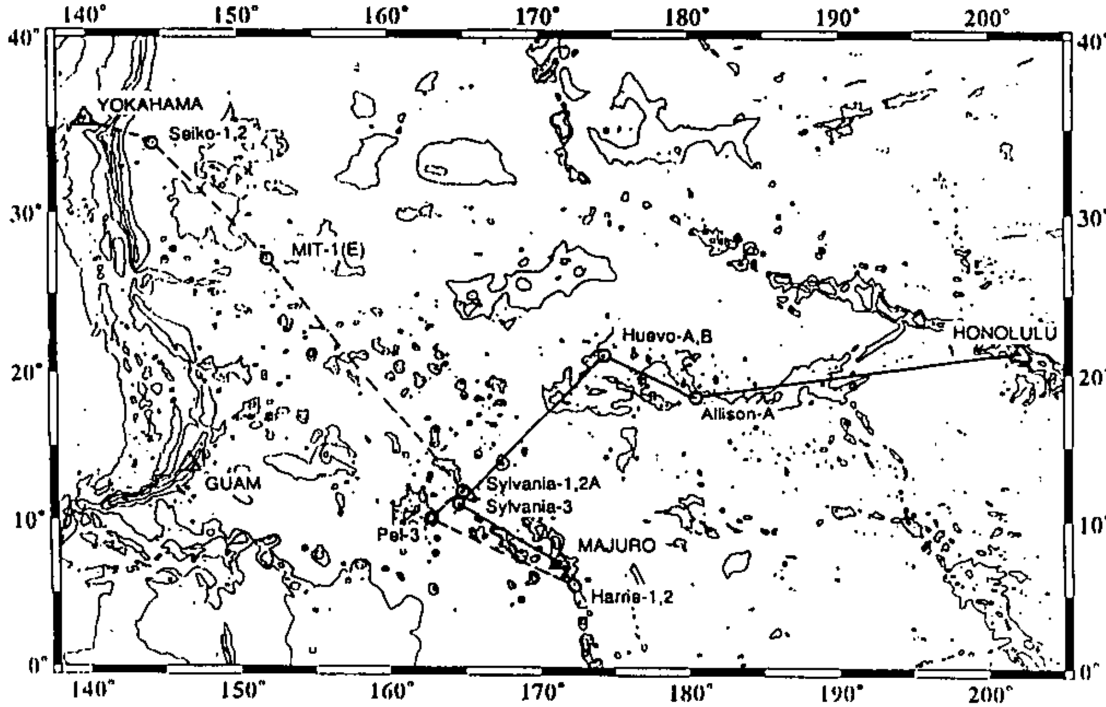

Fig.1. Ship track recommended for Legs 143 (solid line) and 144 (dashed line) by A&G-DPG

at Majuro-1.

Leg 143 (A&G Leg A) will leave Honolulu and conduct operations at Allison Guyot, "Huevo" Guyot (for which the name "Schlanger Guyot" has been formally submitted to the Board of Geographic Names), and the deep apron site Sylvania-3, before ending at Majro* (Majuro). This leg has 42.8 days on site and 12.5 days in transit for a total of 55.3 days (Fig. 1, Table 1).

Leg 144 (A&G Leg B) conducts operations at Limalok (Harrie), Lo-En (for site Pel-3), Wodejebato (Sylvania), MIT and Takuyo-Daisan Guyot** (Seiko), the last a substitute for Charlie Johnson Guyot which has several non-typical geophysical signatures and was therefore considered less representative of the Japanese Seamounts than was Takuyo-Daisan. This leg ends in Tokyo and has 45.1 days on site and 11.9 days in transit, for a total of 57 days (Fig 1., Table 1).

A&G-DPG proposed the use of both Majro and Tokyo as port calls. Use of Guam as the intermediate port, instead of Majro, would require deletion of entire sites from each leg: Allison Guyot (Leg 143) and anything below the pelagic cap at Pel-3 (Leg 144) and possibly the entire pelagic cap site Syl-2A (Leg 144).

Drilling objectives and strategy

Leg 143

Allison-A (Allison guyot, Mid-Pacific Mountains, drowned atoll). Objective: to correlate sea level and seismic stratigraphy to "Huevo" guyot.

600 m lagoonal (backreef) sediment, basalt. APC/XCB until poor recovery (A-hole). RCB until bit destruction or time on site (B-hole). Log.

Huevo-A and B ("Huevo" guyot, Mid-Pacific Mountains, drowned atoll, near DSDP Site 463). Objective: two holes, one (A) in lagoonal (backreef), one (B) in reef facies, to record relative sea level fluctuations, constrain the timing and environ-

*New names have been assigned to atolls and guyots by the Republic of the Marshall Islands: Majro for Majuro, Pikinni for Bikini, Wodejebato for Sylvania, Limalok for Harrie, and Lo-En for the guyot of site Pel-3.
**Takuyo-Daisan replaces Seiko (Hydrographic Office of Japan)

Table 1. Site summary table

Site/transit	Lat. (N)	Long. (E)	Penetr. (mbsf)	Transit (days)	Drilli (days)	Log (days)
LEG A (143)						
Honolulu to Allison-A				5.0		
Allison-A	18°27'	179°32'	~600		4.8	1.2
Allison to Huevo				1.5		
Huevo-A	21°19'	174°18'	1000+		14.7†	2.5
Huevo-B	21°22'	174°18'	400		3.5	1.0
Huevo to Syl-3				3.5		
Syl-3	11°00'	164°45'	~900		11.7	3.4
Syl-3 to Majro				2.5		
			Total days	12.5	34.7	8.1
			Total leg		55.3 days	
LEG B (144)						
Majro to Limalok				0.5		
Harrie-1	5°29'	172°20'	~450		4.6	1.2
Harrie-2	~5°35'	~172°23'	200		1.6††	0.9
Limalok to Lo-En				2.6		
Pel-3	10°07'	162°48'			5.7	1.2
Lo-En to Wodejebato			0.7			
Syl-1	11°58'	164°57'	~400		6.5	1.2
Syl-2A	11°54'	164°56'	150		1.6††	0.9
Wodejebato to MIT				4.9		
MIT-1(E)	27°18'	151°53'	820+		12.0†	1.2
MIT to Takuyo-Daisan				2.2		
Seiko-1	34°15'	144°15'	~200		2.6	0.9
Seiko-2	34°15'	144°15'	~200		2.1	0.9
Takuyo-Daisan-Tokyo Bay			1.0			
			Total days	11.9	36.7	8.4
			Total leg		57.0 days	

† Includes significant basement penetration; †† pelagic cap only.
Assumptions: 1.) Ports are Majro to Tokyo (or vicinity).
2.) Steaming times are for great circles at 10 kts.

mental conditions associated with drowning, document the latitude history of the guyot from the time of edifice building through reef drowning, characterize facies anatomy, and determine the relationship of the geochemistry of the basalts to the DUPAL/SOPITA anomaly. These two holes complement DSDP Site 463, drilled on the deep-water fan northeast of "Huevo" guyot, where Barremian and Aptian pelagic sediments are interbedded with redeposited shallow-water debris from the reef. The upper limit of redeposited reefal debris, in the lower Aptian, suggests that the guyot may have drowned at that time.

Huevo-A: re-entry site with full cone. Penetration of the entire section: post-drowning Cretaceous and Cenozoic pelagic cap (about 50m, as shown on the 3.5 KHz record), entire lagoonal (backreef) section and into basaltic basement: 800 m sediment, 200+ m basalt. APC/XCB until poor recovery (A-hole). Log. Set cone and casing and re-enter with RCB bits as necessary, drill to time on site (B-hole). Log.

Huevo-B: drill in main reef facies to 400 m, one RCB, carefully spudded, possible use of mini hard-rock base (A-hole). Log.

Syl-3 (Northern Nauru Basin, Marshall Islands). Objective: archipelagic apron southwest of both Wodejebato (Sylvania) Guyot and Pikinni (Bikini) Atoll. Reef growth on Wodejebato ceased in the Late Cretaceous but Pikinni continued its growth. Drilling will enable dating of low-stand shallow-water-derived turbidites of post-Late Cretaceous age from Pikinni, establish the chronology of reef development on Pikinni, and study depositional and diagenetic processes of thick carbonate sections.

900 m sediment, basement penetration not expected, but welcome. APC/XCB until poor recovery (A-hole). Log. RCB, wash to depth, drill to bit destruction or time on site (B-hole). Log.

Leg 144

Harrie-1 and -2 (Limalok Guyot, Marshall Islands, drowned atoll). Objectives: Limalok occupies a position with respect to Mili Atoll morphologically analogous to the Wodejebato-Pikinni situation. The reef on Limalok, however, survived through the early Eocene. Drilling will determine: whether there is a Wodejebato-type Cretaceous reef below the Eocene reef on Limalok, the chronology of reef growth and demise related to sea level and subsidence histories, the age of the Limalok volcanic edifice, and the subsidence history of the guyot.

Harrie-1: 450 m sediment, basalt. APC/XCB until poor recovery (A-hole). Log. RCB, wash to depth, drill to bit destruction or time on site (B-hole). Log.

Harrie-2: Pelagic cap only. Suggest location at crossing of tracklines A-A' and F-F' (different from location in proposal 202). 200 m pelagic sediment. Double APC (A, B-holes). Log.

Pel-3 (Lo-En Guyot, Marshall Islands). Objectives: full suite of objectives as at Harrie-1 or Syl-1. In addition, drilling will determine the history of shallow-water pelagic accumulation, and relate the acoustic stratigraphy of the cap to its depositional and diagenetic history and correlate reflectors with those seen in other settings.

400 m sediment, basalt. Double APC in pelagic cap. XCB until poor recovery (A, B-holes). RCB, wash to depth, drill to bit destruction or time on site (C-hole). Log.

Syl-1, -2A (Wodejebato Guyot, Marshall Islands, drowned atoll). Objectives: date the volcanic edifice below Wodejebato; determine the uplift and subsidence history of the northern Marshalls; examine the stratigraphy, faunas, and growth, drowning and diagenetic history of a Cretaceous reef as related to vertical tectonics and sea-level history.

Syl-1: 400 m sediment, basement. APC/XCB until poor recovery (A-hole). RCB, wash to depth, drill to bit destruction or time on site (B-hole). Log.

Syl-2A: pelagic cap only. 150 m sediment, double APC (A, B-holes). Log.

MIT-1 (E) ("M.I.T" guyot, isolated drowned atoll between Japanese and Wake groups). Objectives: One hole, to explore through the karstic lagoonal section into unaffected strata below, quantify the amount of the emersion of the guyot, determine the paleolatitude of formation of the edifice, and study basalt geochemistry and relationships to regional geochemical anomalies. This is the location of the original Engineering Leg 132 site (backreef) on MIT.

Mini hard-rock guide base, multiple reentry site. 520 m limestone, 300+ m basalt. RCB limestone depending on XCB experience from earlier sites. Re-enter with RCB as necessary for basalt drilling, drill to time on site (A-hole). Log.

Seiko-1, -2: (Takuyo-Daisan Guyot, Japanese Seamounts, drowned barrier reef). Objectives: two holes, to document sea level fluctuations, date the edifice, the beginning and cessation of reef growth (drowning), track latitudinal history and characterize the facies anatomy.

Seiko-1: Backreef setting, mini hard-rock guide base required. 200 m limestone, basalt. RCB to destruction or time on site (A-hole). Log.

Seiko-2: Lagoonal setting, otherwise drilling strategy as for Seiko-1.

A&G-DPG Membership

Members: F. Duennebier (Hawaii), R. Halley (USGS), M. McNutt (MIT), D. Rea (Michigan; chairperson), H. Staudigel (SIO), E. Winterer (SIO), D. Aissaoui (France), I. Premoli-Silva (ESF), K. Tamaki (Japan)

Liaisons: T. Atwater (TECP), R. Flood (SGPP), X. Golovchenko (ODP-LDGO), A. Palmer-Julson (ODP-TAMU), J. Watkins (PCOM)

Guests: S. Hovan (Michigan), B. Opdyke (Michigan), T. Quinn (Michigan)

NORTH ATLANTIC-ARCTIC GATEWAYS

Preface

The North Atlantic - Arctic Gateways Detailed Planning Group (NAAG-DPG) was established by PCOM in September 1990. The NAAG-DPG was charged with examining three drilling proposals related to Atlantic-Arctic paleoceanographic gateways and providing a prioritized plan for a drilling program. The NAAG-DPG met 18-20 February, 1991, at Lamont-Doherty Geological Observatory in Palisades, New York and developed the drilling prospectus outlined in this report. The 1989 SOHP White Paper was used as a guide for evaluating the proposed sites relative to key ODP scientific objectives. This prospectus summarizes the themes and scientific objectives to be addressed; reviews the regional groupings and settings of the sites; and discusses locations, drilling strategies, and special logistical problems posed by Arctic drilling.

Thematic goals and approaches

The Arctic-North Atlantic drilling proposed here directly follows many of the primary thematic goals set by SOHP/OHP, as well as the drilling approaches recommended for achieving those goals (Feb. 1989 *JOIDES Journal* Vol. XV, No. 1). The drilling directly addresses the first OHP Neogene Paleoceanography objective of reconstructing the temporal and spatial variability of the oceanic heat budget, and it also contains aspects relevant to the other two objectives (reconstructing the record of variability in the chemical composition of the ocean; understanding the evolution of marine organisms). It also addresses OHP's first two Pre-Neogene Paleoceanography objectives: (1) understanding circulation patterns in a warm ocean, and (2) studying the mechanisms of climatic change in a predominantly ice-free climatic system. In addition, the proposal includes collection of sequences containing records of biogenic fluxes ($CaCO_3$, opal, and organic carbon) and of stable-isotopic carbon and oxygen records that relate to (S)OHP objectives involving Facies Evolution and Depositional Environments and to Carbon Cycle and Productivity.

The drilling approach mainly focuses on rapidly deposited sediment sequences which can be used for high-resolution Milankovitch-scale paleoclimatic analysis. Most of the sites are arrayed in one of two forms: (1) broad north-south and east-west transects to monitor spatial paleoclimatic variability, and (2) closely spaced suites of cores across a range of depths to monitor vertical variability. Other approaches include: (1) sites chosen for deep drilling that will better constrain the time of opening of Fram Strait, and (2) sites placed to monitor downstream sedimentological effects of deep flow through narrow gateway constrictions.

The NAAG-DPG also discussed other Arctic and far northern regions in which critical drilling remains to be done, but which lie beyond our mandate of blending the three current proposals. This prospectus briefly summarizes the importance of these regions (the central Arctic and fans along the margins of the Nordic Seas).

Scientific Objectives

Introduction

The underlying rationale for this drilling prospectus is the importance of the Arctic and sub-Arctic areas to the global climate and ocean systems. Understanding global-scale causes and consequences of climatic and environmental change is an important challenge for humanity. High northern-latitude oceans are important components of the modern climate system at interannual time scales; they directly influence large-scale climate via several effects, including the albedo impact of permanent and seasonal sea-ice cover, the regulation of sensible and latent heat transfers to the atmosphere by sea ice, and the formation of deep-water, with subsequent effects on oceanic and atmospheric chemistry.

One major feature in the long-term evolution of Cenozoic environments has been the transformation from warmer Eocene oceans with weaker spatial and bathymetric thermal gradients to the colder late-Cenozoic oceans with stronger spatial gradients and vigorous thermohaline circulation. This transformation occurred as part of the overall change from a greenhouse to an icehouse earth, but cause and effect are difficult to separate. At a minimum, the Arctic and Nordic Seas are a key recorder of long-term northern hemisphere cooling, because of the natural poleward intensification of climatic changes provided by albedo feedback from ice and snow, even if the northern oceans only function as passive recipients of climatic changes forced from elsewhere in the climate system. On the other hand, the Arctic and Nordic Seas may play a key *active* role in this long-term climatic transformation via linkages such as the effects of gateway openings on deep circulation, ocean alkalinity, and atmospheric CO_2. Linkages between deep-ocean circulation and atmospheric CO_2 have already been proposed for late-Pleistocene changes at glacial-interglacial time scales. To address these fundamental long-term problems, the drilling proposed here will fill large gaps of time over which we have no oceanic record at all of climate change at high northern latitudes.

Much of the natural variability in the earth's environment on time scales less than a million years originates in the geometry of the earth-sun orbital system. It is likely that the sensitivity of the Earth system to orbital forcing increased during the late Cenozoic because of the increased extent of snow and sea ice, with particularly high sensitivity in the last million years. Obtaining records that document the development of these climatically sensitive latitudes is critical for elucidating how and when enhanced sensitivity evolved and for improving our understanding of the mechanisms by which orbital and tectonic factors have forced Cenozoic climatic change.

No scientific drilling has so far occurred in either the Arctic Ocean or the northwestern Norwegian-Greenland Sea. Due to its limited accessibility, very little material is available from conventional coring. Because sediment cores from areas north of 76°N (the latitude of DSDP Site 344) span less than 1% of the last 70 Myr, virtually no knowledge exists of the Cenozoic history of the Arctic Ocean. Although ice cover prevents entry of the *JOIDES Resolution* into most of the Arctic Ocean, areas on the Yermak Plateau north of Svalbard and Fram Strait are accessible in most summers.

Most objectives listed here (Table 1) require drilling long sequences of rapidly deposited (>20m./m.y.) sequences, with double APC coring to refusal (or occasional triple HPC coring as necessary). This approach permits retrieval of continuous sections for high-resolution analysis of the higher frequency (orbital-scale or higher) variations of the climate system. At the same time, it also provides sequences spanning millions of years, during which the long-term baseline climatic state may evolve toward generally colder conditions, as may the spectral character of orbital-scale variations. In the following discussion of objectives, references to the history, evolution or development of key components of the Arctic/Nordic climate system should thus be understood to include both orbital-scale and tectonic-scale changes.

Surface Water Mass Evolution

The Norwegian-Greenland Sea links the cold Arctic Ocean with the warm-temperate North Atlantic Ocean via northern and southern "gateways" (Fig. 1). Fram Strait in the north is the single passage to the Arctic Ocean through which surface and deep waters are exchanged. Similar exchanges occur farther south at both the Denmark Strait, Faeroe-Shetland Channel, and Iceland-Faeroe Ridge.

The Nordic Seas are characterized by strong oceanographic gradients not just latitudinally but also meridionally, due to

Table 1. Scientific Objectives

- Evolution of Surface Watermasses and Fronts
  - Onset and Development of north polar cooling and strong thermal gradients
  - Initiation and subsequent variability of major N/S and E/W fronts
  - Ocean-atmosphere interactions associated with deep-water formation
- Evolution of Sea-Ice Cover
  - Long-term expansion of sea ice in Arctic and northwestern Nordic Seas
  - Orbital-scale variability in sea ice
- Opening of Gateways
  - Northern Gateway:
    - Opening of Fram Strait
    - Subsequent exchanges of shallow and deep waters
  - Southern Gateway:
    - Subsidence of Denmark Strait and Iceland-Faeroe Ridge
    - Subsequent exchanges of shallow and deep waters
- Deep-water Evolution
  - Initiation of Northern-Source Deep water
  - Onset of current-sculpted sediments downstream from gateway passages
  - Spatial and vertical evolution of variability in deep-water chemistry
  - Coupling between Northern and Southern Hemisphere Deep-Water formation
- History of Ice Cover on Surrounding Continents
  - Initiation of mountain glaciation in near-coastal regions
  - Initiation of small ice sheets on Greenland
- Sediment Budgets and Fluxes
  - Fluxes of biogenic $CaCO_3$, opal, organic matter and lithogenic sediment
  - Spatial and temporal variations in silica preservation
  - Bathymetric variability of the CCD and lysocline
  - Arctic and sub-Arctic influence on biogeochemical cycles

the northward flow of warm Atlantic water in the east and southward flow of cold polar water and ice in the west. Strong seasonal variability also results in rapid migrations of sharply defined fronts. Apart from material obtained from the Norwegian margin by ODP Leg 104, the history of these surface-ocean gradients is almost totally unknown prior to the last few hundred thousand years. ODP drilling will provide material from the colder western regions for tracing the spatial

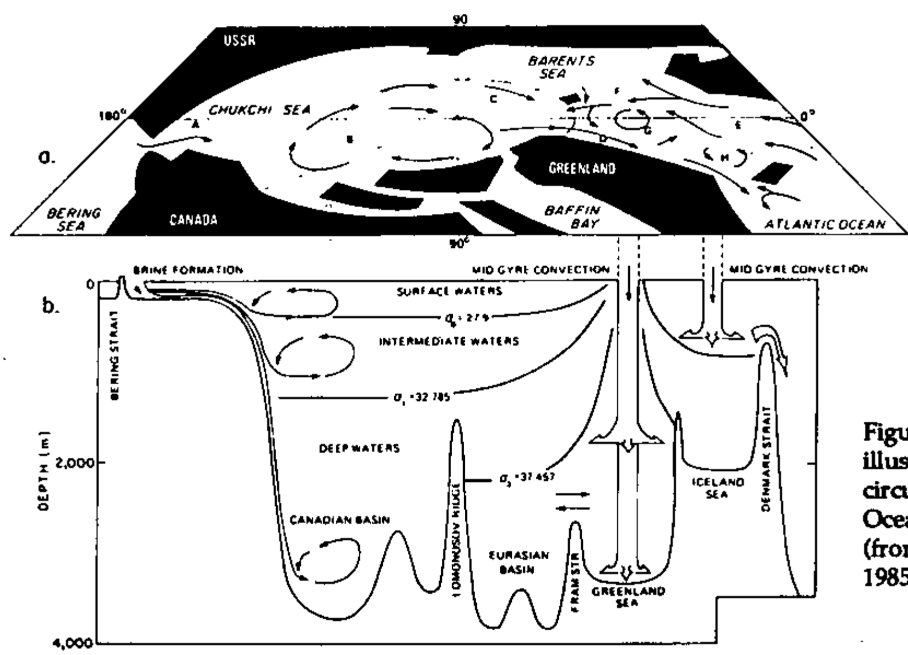

Figure 1. Schematic illustration of ocean circulation in the Arctic Ocean and Nordic seas (from Aagaard et al., 1985).

evolution of surface-water environments and thus enhancing our understanding of climatic change.

Temporal and Spatial Variation of Sea-Ice Distribution

The present Arctic climate is strongly influenced by its sea ice cover, which greatly increases the regional albedo and reduces heat and gas exchange with the atmosphere. Very little is known about how this ice cover first developed and subsequently varied. Although prevented from drilling within the permanent pack ice in the Central Arctic, *JOIDES Resolution* drilling along the present ice margins will provide better constraints on the history of sea-ice extent just north of a key Arctic gateway and southward into the Nordic Seas.

The Gateway Problem

The gateways in the north (Fram Strait) and south (Greenland-Scotland Ridge) are among the most important submarine topographic constrictions to global oceanic circulation. Opening of Fram Strait (Fig. 2) and subsidence of the Greenland-Scotland Ridge below critical levels are necessary conditions for deep water exchange between the Nordic Seas and Atlantic Ocean, although other tectonic changes may also play a role in determining the subsequent long-term evolution of meridional exchanges across these former barriers. The history of these gateways is thus a key component in understanding the long-term evolution of both Northern Hemisphere and global climate.

Aspects of this drilling prospectus focus on two key objectives not addressed in previous drilling: (1) constraining the tectonic history of opening of these barriers, primarily by drilling to obtain basement ages; and (2) defining the subsequent history of surface- and deep-water exchange across these barriers, based both on proxy watermass indicators and on current-sculpted features on the sea floor.

Deep Water-Mass Evolution

At present, deep waters of the subarctic North Atlantic form partly from dense saline waters cooled in the Greenland and Iceland Seas, and partly from deep waters flowing out of the Arctic Ocean. Because of their rapid formation and short residence times, these deep waters are rich in O_2 but poor in CO_2 and nutrients. The deep water spills over the Greenland-Scotland Ridge and mixes with warmer North Atlantic waters to form southward-flowing North Atlantic Deep Water (NADW). NADW helps to oxygenate the deep ocean and transfers heat and salt to the Antarctic. Glacial/interglacial changes in deep-water formation in the Nordic Seas are implicated in conceptual models of atmospheric CO_2 variations.

ODP drilling in the Nordic Seas will improve our understanding of deep-water evolution by providing: spatial/vertical transects that constrain the development of physical/chemical gradients in deep waters; sites located in regions where vigorous deep-water outflow has altered normal pelagic sedimentation; and evidence of surface-ocean climatic changes in regions of deep-water formation (as above).

History of Mountain Glaciers and Ice Sheets around the Nordic Seas

Results from ODP Leg 104 trace the glacial history of the Fennoscandian Ice Sheet back to 2.57 Myr. Sporadic earlier occurrences of minor quantities of ice-rafted debris in various North Atlantic drillsites indicate a still-earlier onset of limited glaciation around the Nordic Seas. Both the location and kind of ice remain uncertain: Were there mountain glaciers that reached the sea, or small ice sheets? Were they located on Greenland, on Svalbard, or over the Barents Sea? It is thus a primary drilling objective to obtain sediments from sites adjoining these regions to assess their glacial histories individually.

Sediment Budgets

In order to derive a broad understanding of global sediment budgets, it is necessary to integrate biogenic (and lithogenic) flux data from all ocean basins. The

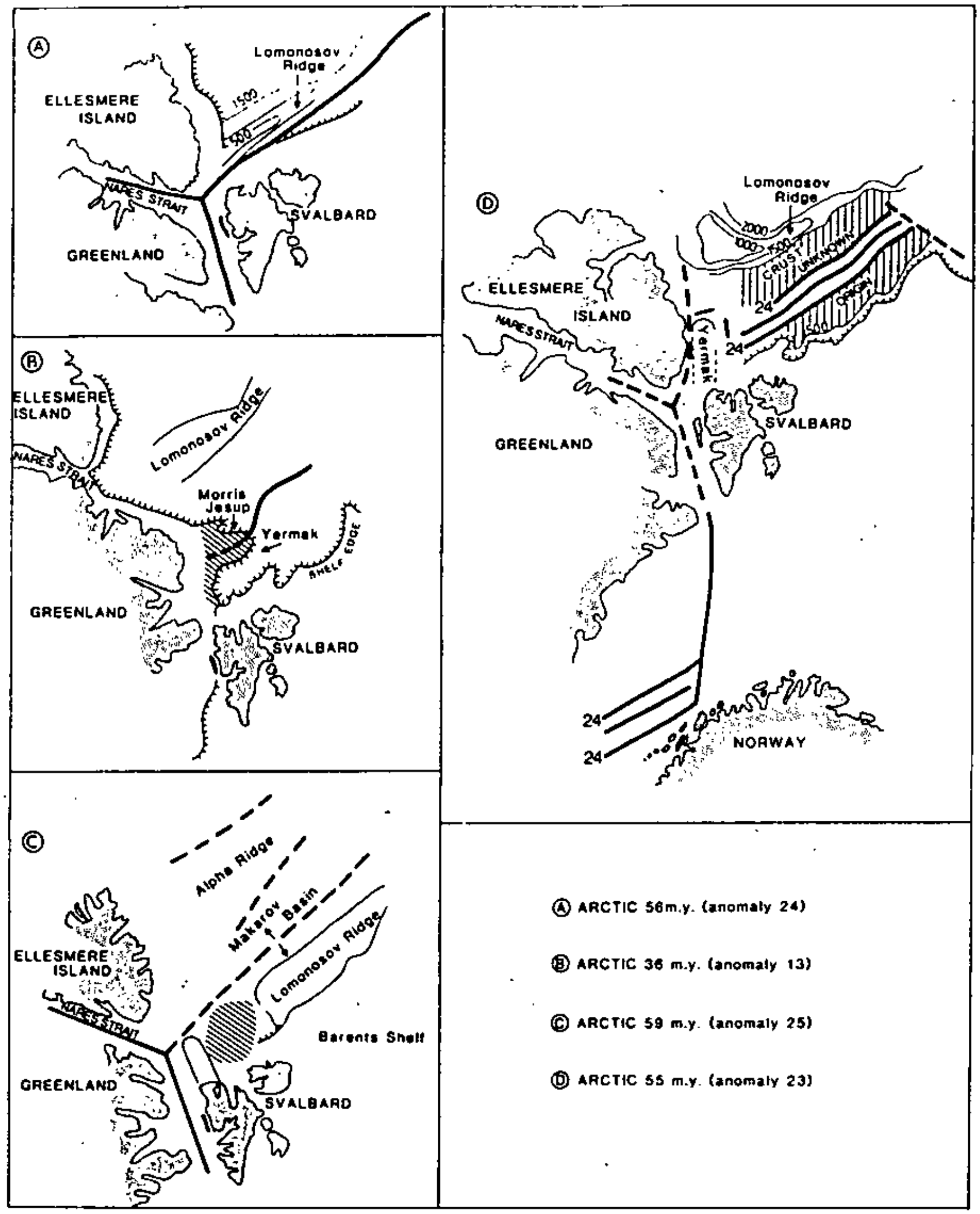

Figure 2. Proposed reconstructions of the Fram Strait region during the early-middle Cenozoic (from Sundvor et al., 1982).

present coverage of high-quality material from the Nordic Seas is insufficient both regionally (no sites in the central, western or northern parts) and vertically (lack of deeper sites). The proposed drill sites cover the major water masses and depth gradients and will permit calculation of burial fluxes of opal, $CaCO_3$ and organic carbon, as well as deductions about the intensity of $CaCO_3$ dissolution through time.

Drilling Regions

The 15 sites proposed listed as high-priority drilling targets in Table 2 are divided into four major geographic groups, from north to south: the Northern Gateway Region, the East Greenland Margin; the Greenland-Norway Transect (Iceland Plateau), and the Southern Gateway Region.

Table 2. Drilling Objectives at High-Priority Sites

SITE	Cenozoic Gateway Tectonics	Paleogene Climatic Evolution	Neogene Deepwater Circulation	Neogene Surface Circulation	Neogene Biogenic Fluxes	Neogene Glacial Inception
	MAJOR DRILLING OBJECTIVES					
NORTHERN GATEWAY						
YERM 1	X			X	X	x
ARC2a	X	X	X	X	X	x
YERM 4	X			X	X	x
YERM 5	X		X	X	X	x
FRAM 1b	X		X	X	X	x
FRAM 2	X		x		X	x
EAST GREENLAND MARGIN						
EGM 2	X	X	X	X	X	x
GREEN 2		X	x	X	X	x
EGM 4			x	X	x	X
GREENLAND- NORWAY TRANSECT						
ICEP 1			X	X	X	x
ICEP 2			X	X	X	x
ICEP 3			X	X	X	x
ICEP 4		X	X	X	X	x
SOUTHERN GATEWAY						
NIFR 1	X	x	X	X	X	
DST/DENS 1	X	x	X	X	X	X

X = Major objective
x = Additional objective

Northern Gateway Region

The tectonic opening of Fram Strait constrains the history of water mass exchanges between the Arctic Ocean and the Greenland-Iceland-Norwegian (Nordic) Seas. With a present sill depth of 2600m, Fram Strait represents the only deep connection between the Arctic and global ocean (Fig. 1). This connection may have begun as early as Anomaly 13 time, close to the Eocene/Oligocene boundary. The tectonic history is, however, characterized by complex processes that remain poorly understood, perhaps including stretching of the Svalbard continental crust and hotspot activity. In view of the highly oblique opening angle and small amount of cumulative separation to date, it remains possible that a deep opening did not occur until as late as Anomaly 6 time (Fig. 2). Documentation of this history depends on new drilling efforts to retrieve material from both sides of the gateway.

Yermak Plateau Sites

The Yermak Plateau is a topographic high due north of Svalbard (Fig. 2, 3). The Morris Jessup and northeastern Yermak Rises are a pair of plateaus rising to crestal depths of 0.5 to 1 km and apparently formed in Palaeocene-Oligocene times by excess Iceland-like volcanism along the southwestern Nansen Ridge. The southern part of the Yermak Plateau may be thinned continental crust. There is thick sediment draping on both the eastern and western flanks. Gravity and piston cores show normal pelagic sediment with some biogenic carbonate.

The area forms the northernmost end of a north-south transect of drillsites for reconstructing paleoceanographic gradients and establishing an Arctic Ocean reference chronostratigraphy. This would be the first scientific drilling in any part of the Arctic.

Site Yerm 1. The site is located on the eastern flank of the Plateau and is designed as a deep target to document the subsidence history of the Yermak Plateau and its effect on the watermass exchange through the Arctic gateway, and to determine the age and nature of basement. It will also provide records of surface and deep-water communication betweeen the Arctic and Norwegian Sea, and the IRD-sedimentation history of the Arctic. Site

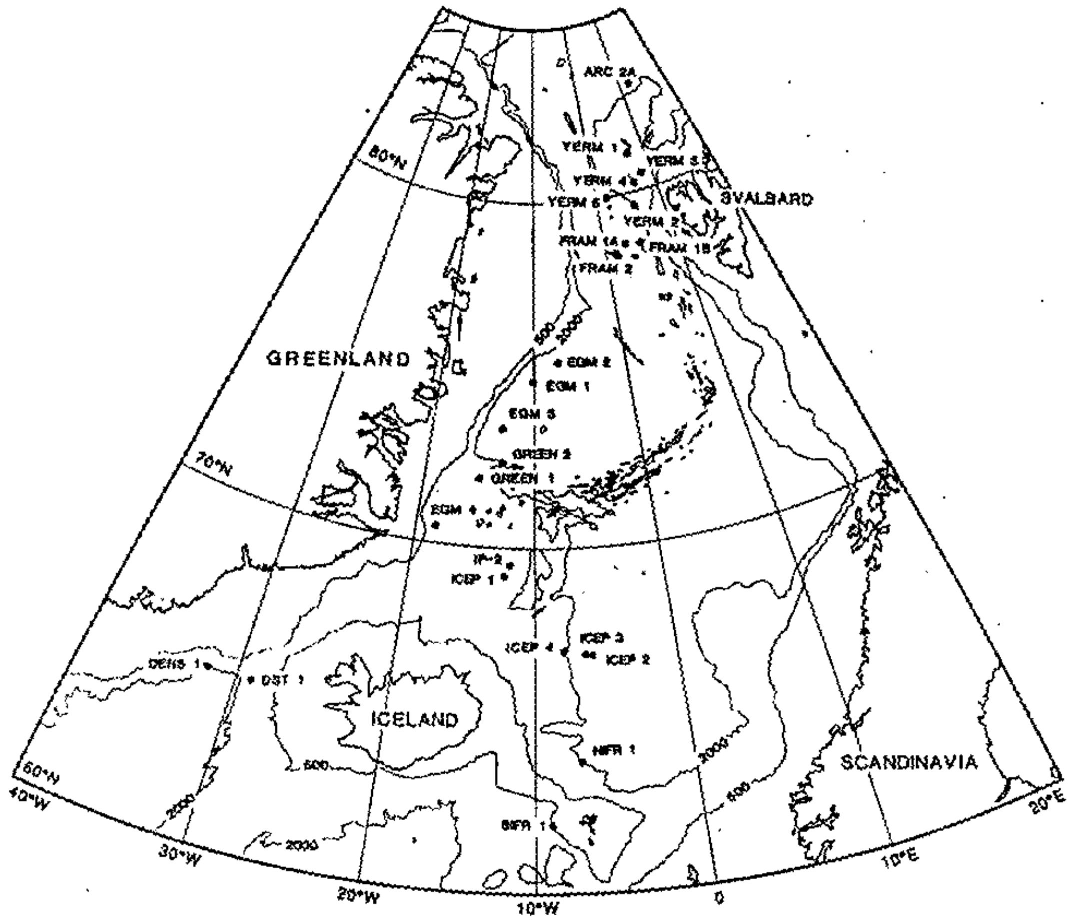

Figure 3. Bathymetry in meters and locations of NAAG sites (from proposals 305, 320, and 336). More detailed location maps are available in the original drilling prospectus, available from the JOIDES Office. (Map courtesy L. Gahagan, PLATES/UTIG.)

Yerm 2 is an alternate site.

Site Yerm 4. This site is located at 600m on a thick sequence of draped sediment cover on the western flank of the Plateau. It will permit study of Neogene variations in paleoclimate and paleoceanography, and particularly variations in Atlantic-water influx to the Arctic. It is also the shallow-water end member of the bathymetric transect. Site Yerm 3 is an alternate site.

Site Yerm 5. This site is located at 2850m on a conformably draped sediment sequence on the lower western slope of the Plateau. This site will be used to document the history of sea-ice cover, Atlantic-water influx, and deep-water variations. It is also the deep end-member of the bathymetric gradient.

Site ARC2a. In case of unprecedentedly favorable sea ice conditions, ARC2a will be drilled. This site would give the first continuous (?) Paleogene through Neogene stratigraphic and paleoenvironmental record for the eastern Arctic Ocean.

Fram Strait Sites

Drilling in central Fram Strait between the Hovgaard and Molloy Fracture Zones (Fig. 3) would provide the first tight constraints on the depth evolution of this crucial oceanographic gateway and on the initiation and evolution of deep-

Site Fram 1b. This site is located in Fram Strait northeast of the Hovgaard Fracture Zone on a locally elevated area of probable pelagic sedimentation. Piston cores (and seismic records) from this region indicate no slumps or turbidites, and there is good biostratigraphic and paleomagnetic age control in late Quaternary sediments. The site is desgined to document the timing of opening of a deep passageway through Fram Strait and the history of deep and shallow water exchange bewteen the Arctic and world ocean. Site Fram 1a is an alternate site.

Site Fram 2. This site is situated on the crest of the Hovgaard Ridge. Drilling objectives are (1) to determine the age and lithology of sediments in basins on the ridge crest, in order to determine the timing and sedimentary processes immediately postdating the opening of Fram Strait; and (2) to investigate the watermass exchange betwen the Arctic Ocean and Nordic Seas. It should be emphasized that the age of the sedimentary unit on top of the ridge is uncertain.

Greenland Margin

The proposed sites on the East Greenland Margin are located on a north-south transect paralleling the path of the East Greenland Current (Fig. 3). The objectives are: to date the onset of the EGC; to monitor deep-water formation and surface-water paleoenvironments in the Greenland Sea; to determine their influence on the variability of the polar front and on northern hemisphere paleoclimate; to decipher the evolution of the Greenland Ice Sheet; to monitor contour current activity and sediment drift deposition in the Greenland Basin; and to study Paleogene paleoceanography

Site EGM 2. This site is located on the lower slope of the East Greenland continental margin and is the northern end of a N-S transect along the margin. It is proposed in order to document the history of the EGC and of deep water flow out of the Arctic downstream from Fram Strait. Site EGM 1 is an alternate site.

Site Green 2. Green 2 is located on Anomaly 20 crust and is intended to core Paleogene and Neogene sediments to document ocean circulation in the Greenland Sea, especially the onset of deep-water formation. There is at present no available material to document the Paleogene history of this ocean basin. This site will also monitor Paleogene and early Neogene environmental gradients and oceanic fronts. Final location of this site awaits further site surveys. Sites Green 1 and EGM 3 are alternate sites.

Site EGM 4. This site is situated on the lower slope of the Trough Mouth Fan at Scoresby Sund (Fig. 3). It is intended for high-resolution studies of the late Neogene history of IRD input and evolution of the Greenland Ice Sheet. It is also located where intermediate and deep waters from the Greenland Sea flow towards Denmark Strait. The Trough Mouth Fan of Scoresby Sund was surveyed by the Greenland Geological Survey (GGU), the Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR), and Polarstern (ARK/V).

Greenland-Norway Transect

This transect is designed to cover the main thermal gradient between polar areas near east Greenland and temperate areas off Norway (Fig. 3). The sites drilled on the Voring Plateau during Leg 104 anchor the eastern end of the transect, while sites EGM 4 and Green 2 form the western end. Between these end members are located sites to: monitor the history of oceanic and climatic fronts moving east and west across the Iceland Plateau; derive an open-ocean record of IRD and carbonate; and determine the history of formation of northern-source deep waters. In addition, it is necessary to drill open-ocean sites isolated from the increased dissolution and dilution of carbonate typical near coasts.

The Iceland Sea is the final region for production and modification of deep waters initially formed in the Arctic and Greenland Sea, prior to export into the North Atlantic. Results from this region are necessary to determine the evolution of these water masses.

Three sites are also located on a bathymetric transect on the east flank of the Iceland Plateau. One site is also designed to retrieve a complete Norwegian Sea Paleogene sequence back to Anomaly 23.

Site ICEP 1. The site is located on Middle Miocene crust and is overlain by about 360m of sediment allowing high-resolution studies throughout the last 10-12 million years. Piston cores document Pleistocene pelagic carbonate sequences with pronounced glacial-interglacial cycles and ash layers.

Sites ICEP 2, 3 & 4. These sites form a bathymetric transect from the Iceland Plateau down into the Norway Basin. They will permit a study of the oceanic response to different stages in the opening of the Greenland-Scotland gateway south of the ridge. They will also provide a continuous high-resolution pelagic record of the upper Neogene. The bathymetric transect enables documentation of CCD and carbonate preservation as well as biogenic silica budgets and their response to changing oceanic and climatic conditions. As part of the east-west transect, they will also enable a study of variations on surface currents and fronts. They will also provide a record of pelagic IRD input well away from the ice sheets, thereby avoiding strong local continental influences and ensuring a more complete biogenic record.

The area is also suited for studies of the chemical (stable-isotope) character of intermediate and deep waters through time. This will help our understanding of the initiation of NADW and evolution of global ocean circulation.

Basement is of anomaly 23-24 age (50-55 Myr) and is overlain by 700-800m of sediment evenly draped on a gentle slope. The sites are located to the south of the flanks of the Jan Mayen Ridge. This location makes it possible to avoid disturbances caused by the large vertical movements of the Jan Mayen microcontinent during the Paleogene.

Southern Gateway

The Greenland-Scotland Ridge has a profound influence on present world hydrography (Fig. 1). Overflow from northern sources presently occurs in the Faeroe-Shetland Channel, in Denmark Strait, and across the Iceland-Faeroe Ridge.

Proposed reconstructons of the subsidence history of the ridge system suggest that its eastern parts probably sank beneath sea level sometime during the middle Eocene, whereas the Denmark Strait area remained emergent until the early or middle Miocene. Available data indicate that the Nordic Seas were effectively isolated from any "deep" Atlantic influence until middle Miocene time. The subsequent overflows have influenced the Atlantic and global deep-water masses through their contribution to North Atlantic Deep Water production. The history of drift deposition in the North Atlantic has been used to infer the development of deeper communication across the ridge, along with develpment of $S^{13}C$ gradients between the North Atlantic and Pacific-Antarctic Oceans. Yet, many critical changes in the North Atlantic sedimentary and isotopic records cannot be tied with any confidence to changes in paleoenvironmental conditions north of the ridge, due to lack of continuous stratigraphic sections.

As a consequence, one of the most important drilling objectives is to date the beginning of overflow across the Greenland-Scotland Ridge by direct evidence at sites located proximal to the main overflow areas. The strategy involves paired sites on both the northern and southern flanks of the Iceland-Faeroe Ridge and on the southern part of Demnark Strait to permit comparison of the impact of paleoceanographic events in the North Atlantic and Norwegian-Greenland Sea basins. These efforts will particularly focus on the Miocene, generally an interval of poor recovery in previous drilling at high northern latitudes.

Denmark Strait. A specific site cannot yet be proposed due to lack of detailed site survey data (Fig. 3). Obtaining survey data in this region during the next year (possibly by FGR?) would permit exploitation of this important region. The NAAG-DPG recommends that the proposed site should be located between 32° and 34°W and 64.5° and 65.5°N along the East Greenland margin or in the central Denmark Strait. The site should provide a complete upper Paleogene and Neogene sedimentary section.

This site represents the southern end of the north-south paleoenvironmental transect. It would also provide data critical for correlating stratigraphies of the Norwegian-Greenland seas with existing Atlantic Neogene stratigraphies. Results from this drill site would also provide data essential to determining the history of the East Greenland Current and the northwestern branches of the North Atlantic Drift. This site will also allow a determination of the timing and variations in the Norwegian-Greenland Sea overflow through the Denmark Strait and estimates of deep-water overflow.

Iceland-Faeroe Ridge

Site NIFR 1. Seismic data from the northern ridge flank (Fig. 3) correlated to DSDP Site 336 indicate a thick Oligocene-Miocene sequence. This sequence holds promise for describing and dating phases of subsidence of the ridge and the impact of this tectonic change on the watermass circulation on the Norwegian-Greenland Sea.

Southern Iceland-Faeroe Ridge Flank. No satisfactory site has been located yet (Fig. 3). Site surveys for this region are planned for the summer of 1991. The strategy here should be similar to that at Site NIFR 1.

Critical Gaps in Arctic Drilling

Two additional issues raised at the NAAG-DPG meeting provide a more complete perspective on Arctic/Atlantic gateway drilling.

Drilling on Nordic Sea Fans

Three major ice sheets have terminated along the margins of the Norwegian-Greenland Sea: the Fennoscandian Ice Sheet, the Barents Sea Ice Sheet, and the Greenland Ice Sheet. Through the Late Neogene, these developing ice sheets have influenced ocean/atmosphere circulation, temperature, flora, fauna and other aspects of climate and life. Although the combined effects of these and other ice sheets are preserved in regional-scale sediment parameters, it is also important to have independent records of each ice sheet to isolate the separate contributions each makes to climate at a more local scale.

The history of the Fennoscandian Ice Sheet is partly known from drilling on the Vøring Plateau (ODP Leg 104 sites), and the history of the Greenland Ice Sheet is the target of several sites in this proposal, particularly EGM 4. The absence from this prospectus of sites addressing the history of the Barents Sea Ice Sheet is a shortcoming, but one that can still be rectified. This ice sheet directly influenced terrigenous sedimentation in the northern Norwegian Sea. Sites on the Bear Island Trough Mouth and Spitsbergen fans along the eastern margin should contain records of direct detrital supply that monitor the waxing and waning of the Barents Ice Sheet. Recent investigations have shown that dense shelf brine formation on the Barents Shelf contributes to deepwater formation. Because the dense waters cascading downslope are loaded with suspended sediment, the history of deepwater formation can be read in the fan sediments.

Recently submitted drilling proposals include sites on these fans, but these proposals are not mature and have not been evaluated by the Ocean History Panel. We recommend that the Ocean History Panel evaluate these proposals in light of its thematic goals and with the goal of deciding whether to add them to the drilling program outlined here.

Drilling in the High Arctic

Because of the logistical constraint of permanent pack ice, this prospectus does not contain recommendations for drilling in the central Arctic Ocean. Yet the importance of eventually carrying out such a program is obvious. For example, it is extremely unlikely that the entire central Arctic Ocean acquired its present sea-ice cover at the same instant in time during the long history of Cenozoic cooling. More likely is a complicated history combining a gradual background trend of increasing sea ice with more abrupt step-like advances. In addition, orbitally induced variations in summer insolation probably caused higher-frequency orbital-scale cycles of sea-ice thickness and extent. Other issues such as the full history of Arctic fauna and flora also await retrieval of such records. The complete history of the Arctic Ocean will not be fully understood until sediments from a range of high-Arctic regions are recovered.

Drilling Strategy and Logistics

To meet the scientific objectives in the Arctic/Nordic seas, two legs are required and are outlined in Table 3. In the event that only one leg were to be made available, we also provide below a list of highest priority sites to fill one leg, as well as back-up sites in case it proves impossible to reach far-northern sites due to unfavorable ice conditions.

There are two primary reasons for two legs:

(1). The region contains a large number of paleoclimatic objectives of first-order scientific importance (Table 1), and it requires a large array of sites to address all these objectives (Table 2). Available Quaternary data indicate that documenting the dynamic evolution of the water masses and fronts in a region of strong climatic gradients requires a relatively large number of sites on N-S and E-W transects. In addition, much of the region has never been drilled, and it is advisable to have enough sites to provide partial redundancy in the event of unanticipated problems in recovering complete sections in particular sites. Several sites are also necessary to document the evolution of the two gateways and multiple passages.

(2). More critically, the highest priority targets are located in areas that have almost year-round sea-ice cover. Two legs in different summers would increase the chances that ice-free conditions in at least one year will permit reaching the highest priority objectives. If a single leg fell in an unfavourable ice year, the most valuable drilling objectives of the whole program could be lost.

Assuming that two legs are scheduled, they should be placed in the optimal August-September weather/sea-ice window and separated by one year. The drilling and logging times for sites in two legs are shown in Table 3. Leg 1 contains the highest priority targets that should be drilled if only one leg is available. In the event that sea-ice conditions prevent drilling some of the targets of the first leg, the next highest priority sites (from Leg 2) are: the NIFR 1 site in the southern gateway region, followed by the rest of the sequence from the top of the Leg 2 list to the bottom (more or less from north to south).

We generally give highest (Leg 1) priorities to the northernmost Arctic Sites (Yermak and Fram Strait) because of the strong need for records documenting the evolution of the Arctic. We also propose one site each for Legs 1 and 2 along the East Greenland Margin to document the onset of the East Greenland Current system, as well as the Paleogene/Neogene paleoenvironmental history of the Greenland Sea. Because sites EGM 2 and GREEN 2 are at present rated equally, no final decision has been made as to which site belongs on Leg 1 vs leg 2. Our time calculations arbitrarily assume that EGM 2 has the higher rank (and is thus included on Leg 1). A final decision on this matter will be deferred until new site survey data from GREEN 2 become available.

Site EGM 4 is included ... cause it ...

Table 3. Drilling and logging times

Site	Latitude	Longitude	Water depth (m)	Penetration (mbsf)	Drilling* time (days)	Logging** time (days)
LEG 1						
YERM 1	81°06′N	7°E	900	700	4.2	1.5
alt: YERM 2	79°38′N	5°35′E	1900	700	4.5	1.6
YERM 4	80°16′N	6°38′E	600	500	2.0	1.3
alt: YERM 3	80°28.5′N	8°13′E	975	500	2.5	1.3
YERM 5	79°58.5′N	1°42′E	2850	600	3.6	1.6
?: ARC 2A	~83°N	~12°E	3500	800	8.7	1.8
FRAM 1B	78°33′N	5°E	2500	810	5.2	1.8
alt: FRAM 1A	78°36′N	3°E	2590	675	4.5	1.7
EGM 2	75°25′N	7°20′W	3400	750	8.3	1.8
alt: EGM 1	74°52′N	10°06.5′W	3250	900	9.8	1.9
GREEN 2	~72°30′N	~13°W	2500	800	6.0	1.8
alt: GREEN 1	~72°N	~15°W	1600	500	2.4	1.4
alt: EGM 3	73°28.5′N	13°09′W	2650	900	9.0	1.9
EGM 4	70°30′N	18°20′W	1500	800	7.3	1.7
ICEP 4	67°02′N	7°58′W	1800	520	3.0	1.4
			Totals		33.6	11.1
		Leg 1 drilling + logging			44.7	
(Assumes: YERM 1,4,5; FRAM 1B; EGM 2; EGM 4; ICEP 4)						
LEG 2						
FRAM 2	78°22′N	1°25′E	1290	360	1.7	1.2
GREEN 2	~72°30′N	~13°W	2500	800	6.0	1.8
alt: GREEN 1	~72°N	~15°W	1600	500	2.4	1.4
alt: EGM 3	73°28.5′N	13°09′W	2650	900	9.0	1.9
EGM 2	75°25′N	7°20′W	3400	750	8.3	1.8
alt: EGM 1	74°52′N	10°06.5′W	3250	900	9.8	1.9
ICEP 1	69°10′N	12°25′W	1950	300	1.7	1.3
or: IP-2	69°30′N	12°W	2000	550	5.6	1.5
ICEP 2	66°54′N	5°56′W	3250	650	4.6	1.7
ICEP 3	66°56′N	6°27′W	2807	300	2.0	1.3
NIFR 1	63°50′N	7°05′W	2000	1000	8.6	1.9
SIFR 1	62°N	9°W	1500	500	5.2	1.4
DST 1	~65°N	~29°W	2500	500	5.2	1.5
alt: DENS 1	~65°N	~32°W	2500	800	4.9	1.8
			Totals		30.4	10.5
		Leg 2 drilling + logging			40.8	
(Assumes: FRAM 2, GREEN 2, ICEP 1-3, NIFR 1, SIFR 1, DST 1)						

* Assumes double HPC at each site and XCB to total depth.
** Uses rig up & log time estimates for side entry sub and std. log strings (geophys., geochem., FMS).

and the evolution of the Greenland Ice Sheet. Site ICEP 4 is included on Leg 1 because it will provide the best chance of getting a continuous Neogene carbonate stratigraphy for high-resolution studies, as well as retrieve Paleogene sediments from the Norwegian Sea.

Of the sites included in Leg 2, we give NIFR 1 our highest priority due to the need to obtain data which can document oceanic responses to subsidence of the southern gateway.

Sea-ice Conditions

The northern gateway and Greenland margin sites are located in areas with nearly year-round sea-ice cover. Sea ice is thus the major operational concern for drilling the proposed sites. A ten-year record of sea-ice extent shows that all northern gateway and Greenland margin sites could be affected in bad ice years. In normal ice years, all sites except Yerm 1, Yerm 5, and ARC 2a should be accessible. Sites YERM 1 and Yerm 5 can only be reached during favorable years. To our knowledge, ARC 2a has never been open during recent decades, but is included to permit taking advantage of unusually good fortune.

In short, most of the northern gateway and Greenland margin drilling can be accomplished in normal years, and all sites except ARC 2a can be drilled in good ice years. The chances of success are thus high, and the importance of drilling these frontier regions for the first time makes it worth doing. To assure that drilling occurs under optimal sea-ice conditions, we propose implementation of an ice forecast and surveillance program.

Time

Optimally favorable ice conditions generally occur during the latter part of August and first part of September. We thus suggest that the two legs take place in August and September of two consecutive years.

Ice Breaker Assistance

To allow for refreezing or sudden sea-ice drift toward the drill sites, the *JOIDES Resolution* should be assisted by an ice breaker while operating in the northern gateway and along the East Greenland margin.

Supporting Information

In addition to information shown on map in Figure 3 and additional, more detailed maps in the original prospectus, available from the JOIDES Office, seismic data are available in the three original proposals (305, 320, & 336). Additional questions about supporting material at specific sites can be addressed to the following people:

Eystein Jansen (U. Bergen): YERM, FRAM, GREEN, ICEP, and DENS Sites

Rudiger Henrich GEOMAR): FST, EGM, IP, NIFR, SIFR and DST Sites

Peta Mudie (Dalhousie): ARC Sites.

Selected Bibliography

Aagaard, K., Swift, J. H., & Carmack, E. C., 1985, Thermohaline circulation in the Arctic Mediterranean Seas. J. Geophys. Res. 90: 4833-4846.

Sundvor, E., Johnson, G. L., and Myhre, A. M., 1982, Some aspects of morphology and structure of the Yermak Plateau NW of Spitsbergen. Univ. Bergen Seismological Observatory Scientific Reports, No. 8, 15pp.

NAAG-DPG Membership

Members: W. Berggren (WHOI/OHP), R. Henrich (FRG), E. Jansen (ESF/OHP), L. Mayer (Canada), P. Mudie (Canada), W. Ruddiman (LDGO; Chairperson), T. Vorren (ESF)

Liaisons: M. Leinen (PCOM), M. Lyle (ODP-LDGO), T. Francis (ODP-TAMU)

SEA LEVEL WORKING GROUP

Guidelines for sea level drilling proposals and solicitation of proposals for Atlantic legs

The Sea Level Working Group (SL-WG) was formed by the Planning Committee (PCOM) of the Ocean Drilling Program to establish scientific objectives and prioritize site recommendations for a global sea level drilling program. At the SL-WG meeting in Littleton, Colorado, on March 2-3, 1991, scientific and technical issues facing a global sea level drilling program were discussed and outlined for a position paper that will serve as a guideline for sea level proposals. The position paper will detail the issues of global sea level in modern ocean basins and establish scientific and technical methodologies, objectives, potential site locations, and strategies for proposals. Sea level proposals should provide a strategy for estimating the timing, rate of change, and magnitude of the eustatic signal and the response of the sedimentary record. Testing the global sea level chart and sequence stratigraphy models are other critical issues to be addressed in proposals. A draft of the report is anticipated by November, with completion by the Spring of 1992.

Additional issues addressed by the SL-WG and presented to PCOM include the prerequisite for pre-site, high-quality data sets to accompany proposals; the potential for shallow-water drilling technology and supplemental platforms to complement the *JOIDES Resolution*; calibration with land data; and the necessity to improve core recovery. A secondary objective of the SL-WG is to encourage submittal of proposals for global sea level legs. Currently, there is a need for drilling proposals for 1993-1994 Atlantic legs. Mature proposals for 1993 legs should be submitted to the JOIDES Office by no later than August, 1991.

JOIDES Committee Reports

PLANNING COMMITTEE MEETING SUMMARY

PCOM met on 23 - 25 April, 1991 at the University of Rhode Island, Graduate School of Oceanography, in Narragansett, Rhode Island. The following decisions, with broad relevance for the scientific ocean drilling community, were made.

PCOM Motions

• PCOM sets the direction of the drilling vessel for the next four years as follows:

1) In the remainder of FY 91, confirmed as is in the current Program Plan.

2) In FY 92, and beyond to January 1993, confirmed as is in the Program Plan approved at its November 1990 meeting in Kailua-Kona, Hawaii, through Leg 147, Engineering EPR (in the event that DCS Phase III is not ready, Hess Deep will be substituted), ending in Panama on or about 21 January 1993. The Program Plan may include up to 10 days of supplemental science as moved at the November 1990 meeting.

3) Until April 1994, in the North Atlantic. FY 1993 Program to be finalized in December 1991 at the Annual Meeting of PCOM with Panel Chairs.

4) In April 1994 through April 1995, in the general direction of highly ranked proposals in the Atlantic Ocean and adjacent seas and the eastern Pacific.

5) PCOM's long-range commitment to engineering development in support of highly ranked thematic objectives must be considered in planning specific cruise tracks.

PCOM reaffirms its stand that at its spring 1992 meeting, and at subsequent meetings, it will evaluate again the state of panel recommendations, technological developments, and the overall state of the Ocean Drilling Program, and again set the general direction of the drilling vessel for the subsequent four years, with a relatively firm early track and a relatively flexible later direction.

• PCOM prioritizes engineering development as follows:

1) Improvement and development of the Diamond Coring System.

2) Improvement and development of the XCB Coring System.

After these major priorities, PCOM believes that development should respond to the needs of scheduled legs. This implies that the next priorities are:

3) Cork/PCS/high temperature preparations, in preparation for Leg 139.

4) Orientation needs (hard rock orientation, Sonic Core Monitor, electronic multishot), in preparation for Leg 141.

5) Vibra Percussive Corer, in preparation for scheduled 1992 SGPP objectives.

6) Motor Driven Core Barrel, in preparation for the use of GEOPROPS in Cascadia drilling, Leg 146.

Each of these development activities should be reevaluated after testing on the appropriate leg(s).

Other active development efforts should continue on an as-possible basis.

If there are short-term perturbations of the schedule, PCOM assumes that engineering development will respond to the schedule.

PCOM expects reports on the development schedule in the future so that it may reevaluate the priorities.

• PCOM establishes an Offset Drilling Working Group (OD-WG) to be charged with:

1) Establishing and setting into priority scientific objectives and a drilling strategy of a program for drilling offset sections of oceanic crust and upper mantle.

2) Identifying target areas where specific objectives can be addressed.

3) Identifying other survey information necessary to establish the geologic context of an offset drilling program.

4) Identifying the technological requirements to implement the strategy.

• In view of the awkward wording of paragraph 2 of the DPG mandate, PCOM moves that Paragraph 2 be stricken and replaced with:

"The DPGs are composed of a balance of U.S. and non-U.S. members, and proponents and non-proponents. The size of the DPG should be commensurate with the charge of the group".

• PCOM thanks the North Atlantic Arctic Gateways Detailed Planning Group (NAAG-DPG) and the Atolls and Guyots Detailed Planning Group (A&G-DPG) for their expeditious and informative reports. PCOM considers that both DPGs have fulfilled their charge and accordingly disbands them.

• PCOM recommends against the setting of a liner in Hole 504B unless it is absolutely necessary to compensate for failing casing in the hole.

• PCOM moves that Hole 504B should be advanced in future with continuous coring procedures, especially in light of critical transitions to be sampled.

PCOM Consensuses

• PCOM recommends that the highest priority for downhole tool acquisition or development be a sensitive downhole magnetic susceptibility tool.

Ideally, a susceptibility tool that can be incorporated into each tool string should be developed.

In the interim, or alternatively, existing susceptibility tools such as the French magnetometers should be used on Leg 141 and subsequent legs to implement core-log correlation.

• PCOM supports the convening of a specialist group to consider downhole fluid sampling. The meeting is to be organized by P. Worthington (DMP chairperson) and should be held, if possible, in conjunction with the June 1991 joint meeting of DMP and SGPP. If the specialist group does not meet at that time, it should meet as soon as possible. The specialist meeting is to be separate from the DMP meeting agenda.

• PCOM approves the change from an off-axis location, as originally recommended by the EPR-DPG, to an on-axis location for the first site to be drilled during Leg 142 on the East Pacific Rise.

• PCOM notes the tendency for shipboard scientific parties to be too large. Concerns are:

1) The difficulty of managing large groups.

2) The high ratio of scientists to technical support staff.

3) Crowding of laboratory facilities and work stations.

4) Amounts of time and effort needed to support individual scientists' needs (e.g., sampling).

• PCOM expresses its appreciation and thanks to T. Moore for his long and outstanding service as IHP chairperson. PCOM hopes that his schedule will permit him to remain on IHP as a member.

Preliminary OPCOM Mandate

• The U.S. National Science Foundation is asking the JOIDES planning structure to use $2.1M in "extra" funds in new and imaginative ways to advance scientific ocean drilling. JOIDES planning documents point the way. PCOM now has the opportunity to implement some of these plans and has authorized the formation of a OPCOM (OPportunity COMmittee) to develop a strategy for the use of the extra funds. The preliminary mandate for OPCOM is as follows:

1) DCS development and testing, including:

(a) Deployment from alternate platforms, for continuous testing.

(b) Consideration of downhole measurements.

2) Deep drilling.

(a) 2 to 2.5 km holes, leading to maximizing the capabilities of the *JOIDES Resolution*.

(b) Long-term planning, beyond

JOIDES Resolution.

3) Alternate platforms.

(a) 1995 - 1996: linkage with "other" programs (e.g., global change).

(b) Long coring facilities.

4) High-latitude support vessels (FY93 and beyond).

5) Staff costs for the above.

For each of the above, there must be discussion of the subject, costs and timing (i.e. flow charts).

LITHOSPHERE PANEL MEETING SUMMARY

LITHP met at Scripps Institution of Oceanography, La Jolla, California on March 14-16, 1991.

Liaison reports

DMP

LITHP is concerned about the status of the Wireline Packer, which it views as critical to meeting the high priority objectives of several upcoming legs. LITHP endorses DMP's requests for a group to be convened to address this issue, and stresses the urgency for the 1992 drilling schedule. In addition, high temperature capabilities need to be investigated.

North Atlantic Rifted Margins DPG

LITHP is in overall agreement with the preliminary selection of high priority transects. However, a number of concerns, particularly relating to timing of magmatism and development of testable models of magmatic evolution during early rifting need to be addressed. LITHP recommends to PCOM that an additional petrologist be added to the NARM-DPG, and nominates A. Saunders (U. Leicester) for that position. In addition, S. Cloetingh will act as LITHP liaison to NARM-DPG.

Results of recent cruises and plans for upcoming cruises

Preliminary results of Leg 135

This leg emphasized the need for 24-hour coverage of the XRF and thin section labs during cruises with hard rock objectives. LITHP endorses the recommendation of SMP that shipboard technician coverage on hard rock legs be sufficient for the XRF, XRD and thin section facilities to be operational continuously throughout each day.

Leg 137

The possibility exists that the viability of Hole 504B, or the likelihood of being able to deepen it significantly, may not be clear-cut after Leg 137. A decision to continue or to abandon future efforts at this Site will need to be made quickly so that appropriate preparations can be made for Leg 140. If this situation arises, LITHP will review the results of Leg 137 as soon as they are available and make a recommendation to PCOM regarding the future of Hole 504B.

Leg 142

LITHP strongly supports the change in primary siting for EPR drilling to the on-axis site, EPR-2. This recommendation is based on an examination of recent seismic data, consideration of the scientific objectives of EPR drilling, and the desire to select the least problematic drilling site to test the DCS Phase II system.

Update on engineering developments

LITHP is concerned with the current communication mechanisms that exist between the panel and ODP engineering activities. It is critical that concerns arising during engineering development that could seriously impact LITHP's planning process be conveyed to the panel. Given the sensitivity of LITHP decisions concerning scheduling of high priority drilling programs to the timeliness of engineering developments, LITHP requests that an ODP-TAMU engineer attend both of its meetings each year.

Ranking of proposals

Twenty-nine programs were considered. Each panel member ranked their top ten priorities. LITHP's top highly-ranked programs were:

1) 387-Rev, Hess Deep
2) 361, TAG Hydrothermalism
3) DPG, East Pacific Rise II
4) DPG, N Atl. Rifted Margins (volcanic: 392-396)
5) DPG, Sedimented Ridges II
6) 376, Vema FZ: layer 2/3 and 382, Vema FZ: deep crust
7) 369, MARK deep mantle
8) DPG, N Atl. Rifted margins (non-volc.: 334, 365)
9) 325, Endeavour Ridge
10) 142-Rev, Ontong Java Plateau
11) 368, Hole 801C return
12) 300, 735B: layer 3/mantle
13) 374, Oceanographer FZ
14) 362-Rev2, Chile Triple Junction II
15) 252, Loihi Seamount
16) 290, Juan de Fuca axial smt.
17) 379, Mediterranean drilling
18) 323-Rev, Alboran Basin/gateway
19) 373, Site 505 return
20) 360, Valu Fa hydro.

Two PCOM action items arose from this procedure:

1. There are now three programs within the top seven that relate to offset drilling strategies. The first leg of Hess Deep is on the FY1992 schedule, and offset drilling is specifically mentioned in the Long Range Plan. LITHP once again strongly urged PCOM to create an Offset Drilling Working Group to establish and prioritize the scientific objectives of a program for drilling offset sections of the crust and upper mantle. It is critical that this begin as soon as possible in order that a program be formulated for implementation within the upcoming drilling schedule.

2. The Red Sea is a region of high scientific interest to LITHP, but there are concerns over the availability of research clearance. LITHP requests an update from PCOM and/or ODP-TAMU concerning the status of obtaining research clearances in the Red Sea, and advice as to whether drilling in this region can now be considered.

Next Meeting

The next meeting will include a joint session with TECP and will be held on 9-11 October 1991 in Cyprus.

OCEAN HISTORY PANEL MEETING SUMMARY

OHP met at the University of North Carolina, Chapel Hill, on 28 February - 2 March 1991.

Proposal ranking

OHP reached the following global ranking among submitted proposals and DPG reports for the guidance of PCOM in their production of a tentative 4-year plan:

1) DPG, N Atl. Arctic Gateways
2) 348, New Jersey sea level
3) 339, Benguela Current and 354, SE Atl. upwelling
4) 388, Ceara Rise
5) 253, Shatsky R. black shales
6) 347, South-eq. Atl. paleo.
7) Pac. Prospectus, Bering Sea and 390, Shirshov Ridge
8) 386-Rev, California margin
9) 345, W Florida sea level
10) DPG, N Atl. Rifted Margins
11) 296-Rev, Ross Sea
12) 313, Eq. Atl. pathways

North Pacific Transect

OHP's strategy to investigate the history of the response of the ocean to high-frequency climatic variability requires a North Pacific Transect, now scheduled as Leg 145. The recovery of sequences there containing carbonate microfossils has appeared impossible until recently. These sequences will be of huge value despite evidence that the stratigraphic sequences are not as well displayed as in some other areas of the Pacific. The North Pacific is also very important in relation to longer time scale objectives.

OHP generated a drilling plan for this leg that will fit in a normal length leg (~59 days) providing that the leg starts from Yokahama. OHP urged PCOM and ODP-TAMU not to waste five days of science in this distant part of the ocean by returning to Honolulu after Leg 144.

Reviews

OHP reviewed many new proposals and also discussed several that have been "in the system" for a while. The proponents of some of these will be urged to update them for OHP's next meeting (see meeting schedule in *Bulletin Board*).

SEDIMENTARY AND GEOCHEMICAL PROCESSES PANEL MEETING SUMMARY

SGPP met at ODP, Texas A&M University, College Station, on March 5-7, 1991. The main topics of discussion were *Gas hydrates and ocean drilling* and the ranking of proposals from all oceans for drilling beyond Leg 147. The first topic was the subject of a workshop. The workshop proceedings will be reported separately, but its recommendations are listed below. The ranking of drilling proposals was preceded by grouping them according to the five themes of SGPP, as published in the panel's White Paper (June 1990 *JOIDES Journal*). The final ranking was by voting each time for one of the top-ranked proposals in each of the five thematic groupings, resulting in the following ranking.

1) (355-Rev2), Gas hydrate (generic)
2) 391, Mediterranean sapropels
3) DPG, Sedimented ridges II
4) 348, New Jersey sea level
5) 380-Rev, VICAP
6) 233-Rev3, Cascadia margin II
7) 339, Benguela Current and 354, SE Atl. upwelling
8) 059-Rev2, Sediment instabilities
9) DPG, East Pacific Rise II
10) 337, New Zealand sea level
11) 360, Valu Fa sulfides
12) 388, Ceara Rise
13) 368, Return to Site 801
14) 361, TAG hydrothermalism
15) 340, NW Australian margin
16) 330, Mediterranean Ridge
17) 378-Rev, Barbados accretion
18) 367, S Australian margin
19) 275, Gulf of California
20) 372, N Atlantic paleoc.

Gas hydrate workshop recommendations (endorsed by SGPP)

1. Dedicated gas hydrate leg

The interaction of natural gas hydrates with the thermal and fluid regime of continental margins, and in particular accretionary complexes, is the highest scientific priority of SGPP. Likewise, the presence of gas hydrates has uniquely influenced safety deliberations by PPSP in drilling deep margin holes. Hence, the participants of a gas hydrate workshop held in conjunction with the SGPP meeting recommend that a dedicated gas hydrate leg be planned and drilled similar to the one previously proposed for the Peru margin (355 -Rev2, see ranking above). SGPP and PPSP, along with outside proponents and investigators, should design such a leg with drilling opportunities in the Atlantic or the Pacific oceans. This planning process should take into account relevant gas hydrate results expected from legs 141(CTJ) and 146 (Cascadia).

2. PCS: Exchangeable pressure chamber

The pressure core sampler (PCS) under development by ODP is a coring system capable of retrieving samples at bottom hole pressure, and hence is the key tool for pursuing several major objectives of SGPP, notably the behavior of fluids, gases and hydrates in accretionary prisms. SGPP considers that successful completion of these objectives requires three exchangeable pressure core subassemblies and recommends that these be available for upcoming legs 141 and 146. These assemblies should be used on a rotating basis with one chamber attached to the PCS system during sampling, while the contents of the second one are subsampled and analyzed aboard ship and the third one is being readied for a new deployment. This approach allows a complete downhole profile, as opposed to a single measurement per hole. It provides adequate turn-around time for close sample spacing downhole, eliminates the costly construction of an as-yet-unavailable transfer chamber, and ensures back-up in case of damage. If trace metal concentrations are of high priority, the multiple subassemblies are to be made of titanium; if gases, dissolved metabolites or major sea water ions are to be measured, a less costly stainless steel version is adequate.

3. PCS: "Harpoon" for extracting pore waters

For shipboard analyses of the pressurized samples obtained by the PCS system, the "harpoon" is presently the most suitable attachment for subsampling fluids. It utilizes internal pressure of the sample chamber to self-squeeze pore waters from the center of the core, thereby eliminating possible contamination by drilling fluid. This attachment has been constructed to be used in conjunction with the pressure chamber subassembly, but has not been tested. SGPP concurs with the recommendations of workshop participants that construction, testing and operation of the harpoon be completed with input from shipboard geochemists of Legs 141 and 146.

4. PCS: Manifold for extracting free and hydrated gases

A gas sampling manifold is required to obtain contents and composition of free and hydrate gases. The existing manifold assembly of the PCS tool appears to be inadequate -due to large internal volumes- to conduct necessary experiments with gas hydrate contained inside the pressure chamber. SGPP concurs with the recommendation of workshop participants that a previous successful gas sampling manifold (Keith Kvenvolden; USGS Menlo Park) and a new but untested design (Jean Whelan; Woods Hole Oceanographic Institution) be perfected by ODP with input from both of these experts, as well as future shipboard geochemists.

5. Predictive equation for depth of gas hydrate stability

The temperature and pressure regime below the seafloor determines the stability field of pure methane and mixed gas hydrates. SGPP concurs with the recommendation by workshop participants that an analytical equation be tested and substituted for the graphic method -used unchanged since the days of DSDP- and that a software package, allowing numerical solutions for any environment of gas hydrate stability, be developed for use aboard the *JOIDES Resolution* to improve safety measures.

OTHER SGPP RECOMMENDATIONS

1. Wireline/packer water sampler

SGPP considers the wireline-packer water sampling device an important development which is necessary for obtaining fluids from hard rock sites. The recent failure on Leg 133 should not be allowed to hinder future development of this needed instrument. Notwithstanding the development of an ODP-TAMU water sampler, SGPP understands that there are some commercial water/wireline packers available from Schlumberger. Their possible deployment and use drilling could be pursued as an alternative in legs such as the upcoming atolls and guyots (legs 143 and 144), but the wireline packer should be the only method for obtaining fluid samples in the future. SGPP feels that the absence of this technology, combined with the lack of suitable sediment samples from which to squeeze pore fluids, will seriously impact the scientific results obtained from these legs. Pore fluids from the atolls and guyots drilling are needed to address questions of diagenesis and fluid circulation within these carbonate edifices, as mandated by SGPP.

2. Sand sampling

As outlined in the SGPP White Paper, there is a strong need to be able to collect undisturbed cores of unconsolidated sands and other coarse-grained lithologies. In the immediate future, high-priority SGPP objectives on Sedimented Ridges I (Leg 139), Cascadia margin (Leg 146), and, if approved, Navy fan (see 3. below) will require this capability. Two potential solutions have been pursued by ODP engineers for recovering the required sediments: a vibrating core and a break-away piston head within the APC coring system. Development of these tools, however, has apparently stopped. SGPP strongly urges PCOM to ensure that development of appropriate tools be given immediate high priority, so that they will be ready when needed.

3. S-1/Navy fan

The first supplemental science proposal following the new PCOM policy (December 1990) is a request to drill the prograding fan off the California borderland to determine the time variability of turbidite deposits in relation to late glacial sealevel. This request addresses high priority objectives of SGPP and the panel recommends the maximum of 4 days (PCOM policy) for drilling the Navy fan. S-1 should be carried out with an enhanced engineering staff on board that can assume the successful operation of a sand sampling tool. Under these requirements, drilling should take place at the beginning of Leg 147 (East Pacific Rise or Hess Deep), and should not impact Leg 146 (Cascadia margin).

TECTONICS PANEL MEETING SUMMARY

TECP met at the University of California, Davis, on March 21-23, 1991. The following items were addressed.

1992 Schedule

a.) The 1992 drilling schedule allows only 39 days of drilling on the Chile Triple Junction (CTJ), which is 4 days less than the minimum expressed by the proponents and Co-Chief Scientist-designate Jan Behrman for an optimum leg. TECP requested that changes in port locations be considered in order to squeeze a few days from the transit schedule to devote to CTJ drilling.

b.) The lack of site-survey information at Hess Deep, in addition to the fact that the two working cross-sections on which the drill-site may be based cannot be balanced, make it hard to predict what the drill will encounter. A serious mistake is unlikely, but MOHO penetration should not be the only objective of the initial approach to Hess Deep.

c.) TECP is concerned about coral recovery problems and its potentially negative impact on the proposed 2-leg program of atolls and guyots drilling (legs 143 and 144).

Proposals

TECP is finalizing a document, by former member M. Etheridge, about proposal quality and the review process. It has prepared a draft checklist of items expected in proposals, site surveys, and core descriptions (this document is reproduced below).

TECP recommends that proposals not renewed three (3) years after review be considered no longer active.

Offset drilling

Improved structural information is critical—a WG or DPG is needed. Two tectonic themes are dominant: formation of lithosphere at a spreading center, and its subsequent disruption. Drilling should be one part of comprehensive geological/geophysical study.

North Atlantic Rifted Margins

TECP concurs with NARM-DPG that their two-transect plan be considered as a package for future drilling.

Global rankings

1) DPG, N Atl. Rifted Margins
2) 323-Rev, Alboran Basin and 330, Mediterranean Ridge
3) 362-Rev2, Chile Triple Junction
4) 346-Rev, Equatorial Atlantic transform
5) Generic, Hess Deep II (tectonic)
6) 343, Caribbean crust
7) 265, Woodlark Basin
8) 378-Rev, Barbados acc. wedge
9) 334-Rev, Galicia margin
10) 363, Gr. Banks-Iberia plume volc.

11) Tie: Generic, Slow offset drilling; N. Australian margin
13) Generic, Red Sea, Gulf of Aden
14) DPG, Cascadia margin II
15) 379, Med. drilling (Tyr. Sea)
16) 392, Labrador Sea volc.
17) 333, Cayman Trough
18) 373, Site 505 return
19) 327, Argentine cont. rise
20) 367, S Australia margin

Status of tectonic themes

Many themes have received relatively little attention. TECP feels that a number of RFPs may be called for.

a.) Rifted margins. Much interest, subject of DPG, many proposals.

b.) Sheared (translational margins). Relatively little attention paid so far to tectonic questions. Possible subject of RFP.

c.) Convergent margins. Much interest, many recent legs. Need to finish work in Chile, assess status of Cascadia, Barbados. Oblique convergent margins possibly a subject of RFP.

d.) Divergent oceanic plate margins. Tectonic themes largely missing from the 20 or so proposals. Need conjugate approach on slow-spreading margins, more tectonic/structural input on fast-spreading ridges, new attack on back-arc basins. Need RFP on these subjects.

e.) Plateaus, microcontinents, aseismic ridges, and anomalous basins. Considerable recent activity. Possibly need RFP for joint land/sea/drilling attack on origin of Caribbean plate.

f.) Driving forces (stress, intraplate deformation). Need to continue borehole televiewer as integral part of logging. TECP encourages development of slimhole televiewer. Possibly need RFP on intraplate deformation in the NE Indian Ocean.

g.) Plate history, sea level changes. Prime target for watchdogs, as no project is worth an entire leg. Need more attention on basement ages, Cretaceous Quiet Zone, Mesozoic and Pacific hot spot tracks, "regional" problems such as Caribbean, timing of initiation of first oceanic crust in rifted margins.

h.) Collisional margins. Complex subjec. Difficult to formulate feasible drilling projects. Need combined land/sea/drilling studies. Foreland basins need more attention.

TECP watchdogs

1. Alistair Robertson—Transform Margins
2. Steve Cande, Tanya Atwater—Plate history, sea level change, magnetic questions
3. Dale Sawyer—Young rifted margins
4. Hans-Christian Larsen—Old rifted margins
5. Jeff Karson—Mid-ocean ridges
6. Yujiro Ogawa—Marginal basins
7. Casey Moore/Jan Behrman—Convergent margins (normal subduction)
8. Phil Symonds—Convergent margins (collisional)
9. Mark Zoback—Stress and mid-plate deformation

Deep drilling

Two model deep-drilling sites in nonvolcanic rifted margin proposals have been prepared and discussed with ODP-TAMU engineers. Model sites for a volcanic rifted margin and an accretionary prism are being prepared.

Suggested checklist of features of tectonic significance for ODP proposals, site surveys, and core descriptions

The Tectonics Panel of the Ocean Drilling Project (TECP) has been concerned for some time with the breadth and universality of tectonics in questions of ODP drilling. TECP has spent considerable effort in the review process trying to suggest ways in which proponents could enhance the tectonic value of (and TECP's interest in) their proposals. In this process, TECP has found that many proposals lack the items detailed below. TECP offers this checklist of features to be expected in proposals and from site surveys, as well as in core descriptions, as a means of both saving time as a proposal matures and of increasing the scope of scientific results from each drilling site.

Proposals and site surveys

1. Does the proposal narrative recognize and adequately address the tectonic significance of the proposed drilling?

2. Does the proposal team include appropriate experts in tectonics?

3. Is the structural and tectonic setting of each proposed hole clearly outlined? Items include:

Geophysical data.
- Seismic refraction data.
- Seismic reflection data.
  - multichannel (migrated?)

Structural information.
- Fault scarps: attitudes, fault plane features, etc.
- Igneous rocks: types, distribution, attitudes.
- Sediments: types, distribution, attitudes.
- Breccias: tectonic or sedimentary.
- Projection of surface information to depth.
- Predicted level of intersection of surface features in hole.
- Accurate scaled cross-sections (no vertical exaggeration).
  - Balanced.
  - Drill sites located on cross-sections.
  - Objectives of site discussed in context of inferred structure at depth on balanced cross-sections.

Seismicity.
- Maps.
- Focal mechanisms.

4. Is the tectonic setting adequately incorporated into the objectives of the proposed drilling site?

Offset sites:
- Are local variations of structure and lithology of a single site clearly documented?
- Are variations in structure and lithology between sites clearly documented?
- Is the tectonic rationale for use of proposed sites in composite clearly documented?
- Are tectonic questions to be answered by each site clearly formulated and adequate?

Holes and cores

1. Are the following features—predicted?—observed?

Breccias: tectonic, sedimentary.
- Matrix vs clast supported.
- Clast composition.
- Clast shape, surface features (striations, etc.).

Non-horizontal dips on sediments or lavas.

Non-vertical dips on dikes.

Faults.
- Dimensions of zone.
- Recovery.
- Slickenlines, useful for stress determination.

Juxtaposition of different magnetic polarity, chemistry, petrography.

Abrupt changes in magnetic inclination.

Ductile shear fabrics.
- Porphyrblasts.
- S/C fabrics.
- Tension gashes.
- Offset markers.
- Syntaxial or antitaxial growths.

Metamorphic features.
- Duplicated or missing metamorphic zonation.
- Mineralized faults or fractures.
  - Same or different from host rocks away from faults.
  - Straight or curved.
  - If curved, S- or Z-shaped.
  - Stress field inferrable, inferred.
- Vein mineralogy, comparison with host rocks.
- Fluid inclusion microanalysis.

Igneous contacts.

Any independent means of determining paleo-horizontal and azimuth constraints in addition to magnetic vectors?

2. Does the shipboard scientific staff include the requisite expertise to identify and interpret the predicted structural features in cores?

For further information, proponents and those conducting site surveys should contact Eldridge Moores (TECP chairperson), or any member of TECP (see directory section).

DMP RECOMMENDATIONS FOR LOGGING IN ACCRETIONARY COMPLEXES

Downhole Measurements Panel (DMP) formed a working subgroup to discuss borehole stability in tectonically active areas at its meeting on 6 - 8 February, 1991 at College Station. The group comprised a subgroup of DMP together with a number of invited guests. The working group agreed on the following recommendations and related observations pertaining to logging in accretionary complexes. These have been adopted by DMP. Many of these comments could be applied to logging in general. DMP appreciates that scientists planning legs are best equipped to consider this information, anticipate lithologies, and evaluate the relative importance of diverse scientific objectives before working out a strategy for drilling, coring and logging. DMP also recognizes that these choices will have an economic impact on operations.

RECOMMENDATIONS

The following options should be considered to enhance the prospects of borehole logging in accretionary complexes:

1.) Case off the upper portions of unstable holes either with a full re-entry system, or using the drill-in casing system (DIC) with or without a mini-cone.

2.) Drill offset dedicated holes for logging where cored holes become unstable.

3.) Log deep holes in several stages. During XCB drilling, this should not require additional pipe trips; during RCB drilling, additional trips may be needed.

4.) After drilling and coring, flush logging holes clean and then fill with heavy mud, probably weighted with barite, with a weight of at least 12 lbs/gallon. In many cases, mud density approaching the formation density (19-22 lbs/gal) will be more appropriate. Facilities and time on the ship will need to be available for mixing and delivering such a heavy mud. Flushing holes clean before using heavy mud may require pumping large volumes of fluid, particularly in cases where hole erosion is severe. The presence of barite mud will probably preclude lithodensity and photo-electric measurements (and will thus also reduce the quality of geochemical log measurements), but should have little impact on sonic, neutron porosity, natural gamma, resistivity and FMS logs. Borehole fluid sampling, packer measurements and BHTV runs will be compromised through the use of heavy mud (requiring that these measurements be made before heavy mud is pumped or in separate holes), but temperature logs may be improved if borehole convection is reduced.

5.) The need for heavy mud for each proposed hole should be identified and discussed by the co-chiefs, logging scientists, ODP-LDGO representative and operations superintendent during the pre-cruise meeting.

6.) As with drilling muds, add chemical inhibitors and viscosity enhancers to logging muds when necessary.

7.) Recognize that the sidewall entry sub (SES) is not designed to allow logging in unstable holes; it is best used in good holes with minor bridging problems.

8.) Deploy short logging strings where these are significantly easier to run than long strings.

9.) The time needed to make special preparations for logging must be included in time estimates for all legs during which these preparations are expected to be necessary.

DMP further recommends that, because expensive ship time has been lost while trying to log unstable holes, at least a major portion of a future engineering leg should be devoted to evaluating borehole stability strategies in an accretionary setting, in preparation for upcoming scientific programs.

In summary, it should be possible to increase ODP's ability to log in tectonically active regions, but it will take advanced planning and ship time, and be somewhat more expensive. While at sea, the decision to pump heavy mud will be made by the operations superintendent, in consultation with the co-chiefs, logging scientists, and ODP-LDGO representative. Ultimately, the importance of the scientific objectives which could be achieved through logging should be given strong consideration by those planning future legs.

Proposal News

JOIDES PROPOSAL SUBMISSION GUIDELINES (REVISED JUNE 1991)

INTRODUCTION

The purpose of the JOIDES scientific advisory structure is to formulate the most productive ocean drilling plan which will answer scientific questions about present-day and past processes of the earth. Drilling is based on proposals from the entire earth science community.

The Planning Committee (PCOM) monitors and directs the proposal review process, reviews recommendations made by advisory panels, decides the fate of proposals, sets ship tracks, and schedules drilling legs in two continuous and inter-related planning phases: setting a general four-year ship track based on highly-ranked proposals, and detailed scheduling two years in advance based on further thematic panel prioritization of the four-year plan, maturity of existing programs, and logistical considerations. PCOM depends primarily on its four thematic panels for advice on scientific objectives. Detailed Planning Groups (DPGs) may also be formed and mandated by PCOM to help thematic panels translate broad thematic programs and highly ranked proposals into concrete, prioritized drilling plans. The service panels, the Science Operator (TAMU: Texas A&M University), Wireline Logging Services (LDGO: Lamont-Doherty Geological Observatory), and Site Survey Data Bank (LDGO) also provide advice on optimum, safe drill sites. Figure 1 is a flow chart of the proposal review process.

According to previous proposal submission guidelines, JOIDES accepted both *Preliminary Proposals* and *Mature Drilling Proposals* into the planning process. Such a distinction depends on the definition of proposal "maturity", a complex issue that has to be continuously evaluated by the JOIDES advisory structure (based on panel mandates, thematic panel white papers, site survey and safety guidelines) rather than by proponents. In fact, most proposals are preliminary at the time they are submitted; only continued effort by proponents interacting with JOIDES leads to finalized drilling plans.

For this reason, JOIDES now only accepts ***drilling proposals*** (see below) that include a comprehensive outline of thematic objectives and drilling strategies, information on site survey data, and meet certain editorial requirements (see below) in order to be accepted into the formal review process. If a proposal is accepted by the JOIDES Office, proponent(s) will receive copies of thematic panel reviews within six months.

If a proposal is not complete as defined above, but contains ideas or prospects for such a follow-up document, it is accepted by the JOIDES Office as a *Letter of Intent*, which is then forwarded to thematic panels for information but <u>not</u> for procedural review. Response by thematic panels to authors of letters of intent is optional, but encouraged by the JOIDES Office.

REQUIREMENTS FOR A DRILLING PROPOSAL

ODP proposals must be submitted to the JOIDES Office, which rotates every two years among the ten JOI institutions. An ODP drilling proposal has to meet the following requirements in order to be accepted and forwarded to the four thematic panels by the JOIDES Office:

Thematic

- Scientific objectives must be outlined, and preferably linked to COSOD or ODP Long Range Plan (LRP) themes. (These documents are available from JOI, Inc. in Washington, D.C.)
- Drilling strategies must be tied to stated scientific objectives.
- Choice of sites must be supported by site-specific objectives within the framework of the stated drilling strategy.

Years before drilling	Review/Planning Procedures	Action of JOIDES advisory structure
2-?	Review of all incoming proposals; proponents are sent a completed review form from each panel within about six months after submission to the JOIDES Office.	Thematic panels at spring and fall meetings
2-?	Global ranking of all "active" proposals; relative rank of a proposal/program may change at subsequent meetings; theoretically, new, exciting and complete proposals along the general ship track may get onto the drilling schedule within the same year, and get drilled two years after submission	Thematic panels at early spring meetings
2-4	General ship track determined, based on thematically highly-ranked proposals/programs, with relatively firm early track (<2 years) and relatively flexible later direction (>2 years); refined at subsequent meetings based on reevaluation of panel recommendations, technological developments, and overall state of the ODP program	PCOM at spring meeting
	Merging of proposals or formation of Detailed Planning Groups (DPGs) may be recommended by thematic panels and approved by PCOM	Thematic panels PCOM
	Preliminary site survey data assessment and specific recommendations for highly ranked proposals/programs	SSP
	Preliminary safety review of highly ranked proposals/programs	PPSP
	Thematic prioritization of previously highly ranked proposals/programs	Thematic panels at fall meetings
1-2	Proposals/programs get on schedule based on thematic prioritization, and consideration of logistics, site survey status, technological developments, and balance of general ODP themes.	PCOM at Annual Meeting (Nov/Dec)
	Monitoring of scheduled proposals/programs	PCOM
	Preparations for drilling (staffing, equipment)	Science Operator
0.5	Final safety review	PPSP
	Final approval, if necessary, after PPSP changes	PCOM
0	Program/proposal is drilled	

Figure 1. Approximate timetable for JOIDES review and planning procedure

Site-specific

• Proposed sites must be given a site name, latitude and longitude, water depth, proposed total penetration depth and site-specific objectives. For each proposed site, a site summary form (SSF, Figure 2) must be included. In some cases, a general transect, or reference to scheduled sites of other proposals, may suffice.

• Information on existing or in-progress site survey data, with reference to site survey standards (see "site survey review" below), must be provided. (The Site Survey Data Bank at LDGO may assist.)

• Statement of known potential safety

ODP Site Summary Form 6/91 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	

	Proposed Site	Alternate Site
Site Name:		
Area:		
Lat./Long.:		
Water Depth:		
Sed. Thickness:		
Total penetration:		

	Sediments	Basement
Penetration:		
Lithology(ies):		

Coring (check): 1-2-3-APC VPC* XCB MDCB* PCS RCB DCS* Re-entry

Downhole measurements:

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A B C D E F G (check)ß

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity		
04	Seismic grid		
05	Refraction		
06	3.5 or 12 kHz		
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		
10	Heat flow		
11	Magnetics/gravity		
12	Coring		
13	Rock sampling		
14	Current meter		
15	Other		

Weather, Ice, Surface Currents:

Territorial Jurisdiction:

Other Remarks:

	Name/Address	Phone/FAX/Email
Contact Proponent:		

Figure 2. Site summary form (available from the JOIDES Office)

(see "safety review" below) and other (i.e., weather, physical oceanographic conditions, territorial jurisdiction, etc.) problems must be included.

Editorial

- A proposal must include an abstract of less than 400 words. Ideally, a copy of the abstract should also be sent to the JOIDES Office via electronic mail or on floppy disc (if possible: Macintosh).
- A short (not more than 150 words), comprehensive list of scientific objectives should be included in the proposal (and included with abstract on Email/floppy).
- Ten copies of the entire proposal must be submitted to the JOIDES Office.

Deadlines for proposal submission

Drilling proposals can be submitted at any time of year to the JOIDES Office. Thematic panels review proposals twice a year, once around March and once around October. In the past, proposals have often been submitted during the period when panels meet, adversely affecting proposal-handling in the JOIDES Office and proper review by panel members prior to meetings. The JOIDES Office will therefore only forward proposals to panels which are received not later than two weeks before the first of the thematic panel meetings of either the fall or spring review period. Meeting dates are published in the *JOIDES Journal* well in advance, and exact dates are also updated frequently on the telemail (Omnet) "drilling" bulletin board. As a general rule, submit proposals not later than January for spring reviews and August for fall reviews. Proposals submitted directly to thematic panels are not reviewed. Proposals received after the stated deadlines will be forwarded by the JOIDES Office to thematic panels for their next meetings.

Thematic review

Proposals submitted to the JOIDES Office are logged if proposal submission requirements outlined above are met. Proponents will then receive an acknowledgement. The JOIDES Office forwards complete proposals to each of the four thematic panels for review. Although it is unlikely that all panels have interest in any specific proposal, all thematic panels are requested to review all proposals in order to maintain a fair, proposal-generated and thematically-controlled drilling program. Informational copies of proposals are sent to JOI, Inc. in Washington, D.C., the Science Operator at TAMU, and the Site Survey Data Bank at LDGO.

Thematic evaluations are based on individual panel mandates, COSOD white papers, the LRP, and the experience and judgement of panel members. Proposal reviews are summarized in panel meeting minutes and on Proposal Review Forms (PRF, Figure 3). Each panel returns a completed PRF for each proposal to the JOIDES Office. The JOIDES Office then forwards PRFs to proponents. PRF comments may include suggestions on how to enhance strength of a proposal (in which case a *revised proposal* is expected), or may request additional information (in which case *addenda* may be submitted). Panels may also suggest merging similar or related proposals into one drilling program (i.e., incorporating proposals of limited scope into thematically or regionally related proposals of broader scope), or they may discourage proponents from pursuing a proposal with no prospect of being drilled within the present ODP. Thematic panels may also propose formation of Detailed Planning Groups (DPGs) to PCOM, with specific mandates to prioritize a drilling program incorporating two or more highly-ranked proposals.

Global ranking of proposals

Each spring, the thematic panels prioritize all available proposals they consider within their mandate. Global rankings are published in the (June) *JOIDES Journal*. The JOIDES Office summarizes these global rankings and PCOM sets a general four-year ship track based on these global priorities, with relatively firm early track (<2

ODP Proposal Review Form

Proposal received at the JOIDES Office: 00/00/00

Title:

Proponent(s):

Evaluation by: ☐ LITHP ☐ OHP ☐ SGPP ☐ TECP

For panel mandates, Long Range Plan themes, and reference to other relevant papers, see back page.
For site survey requirements, see Proposal Submission Guidelines (JOIDES Journal, June 1991).
For safety guidelines see JOIDES Journal special issue referenced on the back page.

1. Proposal objectives are not within the mandate of this panel (as listed on back).
2. Does not address high-priority thematic objectives (as detailed in Long Range Plan).
3. Is of secondary interest to this panel if it is of high priority to some other panel.
4. Addresses high-priority objectives, but with deficiencies, as noted below.
5. Addresses high-priority objectives of this panel.

Comments if within mandate of this panel (points 2-5):

Date returned to : JOIDES Office
Institute for Geophysics
University of Texas at Austin
8701 Mopac Blvd.
Austin, TX 78759

Contact proponent:

Figure 3. Proposal review form

years) and relatively flexible later direction (>2 years). The ship track is further refined at subsequent PCOM meetings, based on reevaluation of panel recommendations, technological developments, and overall state of the ODP program. On the one hand, complete and scientifically exciting proposals theoretically can become a top priority within one year, and could be drilled within two years after submission. On the other hand, relatively highly-ranked proposals may not get onto the drilling schedule at all, or stay on a waiting list, because final prioritization by thematic panels and scheduling by PCOM must take into account other criteria, such as technological feasibility and balance of major ODP themes.

SITE SURVEY REVIEW FOR HIGHLY RANKED PROPOSALS

Proposals prioritized by thematic panels as being highly ranked are monitored by the Site Survey Panel (SSP). The time required for a thematically prioritized proposal to become part of a drilling plan depends to a large degree on completeness of required site survey data. Proponents are therefore urged to submit as complete a data package as possible as early as possible, once their proposals are highly ranked. If survey data is still to be collected, the timing of cruises, firmness of funding, and period required for data processing before submission to the Data Bank should all be noted.

Site survey data standards

SSP review is based on identification of drilling target categories and site survey techniques that can provide the optimal data set for each target. The target/techniques table used by SSP members monitoring proposals is shown in Figure 4.

Target categories describe broad types of drilling objectives. Individual sites with multiple objectives may be required to meet the standards of two target categories. For example, sites frequently have shallow APC objectives (target A) and deeper sedimentary or basement objectives (target D or E). The Site Survey Panel member monitoring a proposal ("watchdog") will inform proponent(s) of the target category of each proposed site:

- Target A: Generally APC/XCB penetration.
- Target B: Greater penetration than a few hundred meters on a passive margin.
- Target C: Greater penetration than a few hundred meters on an accretionary wedge, forearc, or sheared margin.
- Target D: Greater penetration than a few hundred meters on oceanic crust. Often includes basement penetration.
- Target E: Sediment thicknesses of less than a few hundred meters on oceanic crust
- Target F: Bare rock drilling, e.g., ridge crest, fracture zone ridge.
- Target G: Elevated features with widely varying sediment thicknesses, e.g., seamount, fracture zone ridge, plateau. Sediment slumping may be a problem on flanks. Basement is often an objective.

All geophysical techniques are not appropriate for all sites, and specific combinations are chosen to get maximum useful information for minimum cost. Figure 4 shows site survey requirements for each target environment.

1. <u>Deep penetration SCS:</u> large sound source-single channel seismic.
2. <u>High resolution SCS:</u> watergun single-channel seismic (or small chamber airgun in some situations).
3. <u>MCS and velocity determination:</u> velocity determination (stacking velocity and semblance plots) when accurate depths are critical; velocity analysis to determine sediment thickness over proposed sites.
4. <u>Grid of intersecting seismic lines:</u> required density of seismic grid and/or crossing lines over proposed site depends on each particular situation.
5. <u>Refraction:</u> sonobuoy or OBS refraction profiles; expanding spread or wide-angle refraction profiles; near-bottom sources and receivers may be desirable for highest resolution.
6. <u>3.5 or 12 kHz:</u> to resolve small-scale sea floor morphological features and type of bottom material.
7. <u>Swath bathymetry:</u> as from a multi-narrow-beam echo sounder or an interferometric side-looking sonar system; required for all

	DATA TYPE	DRILLING ENVIRONMENT (TARGET)						
		A	B	C	D	E	F	G
		Paleoenvironment or Fan (APC/XCB)	Passive Margin	Active Margin	Open Oceanic Crust (>400m Sediment Cover)	Open Oceanic Crust (<400m Sediment Cover)	Bare-rock Drilling	Topographically Elevated Feature
1	Deep Penetration SCS	(X)	(X)	(X)	X or 3			(X)*
2	High Resolution SCS	X	(X)	(X)*	(X)	X	X	X
3	MCS & Velocity Determination		X	X	X or 1		(X)*	(X)*
4	Grid of Intersecting Seismic Lines	(X)*	X	X	(X)*	(X)	(X)	(X)*
5	Refraction		(X)*	(X)*	(X)*	(X)	(X)*	(X)*
6	3.5 kHz or 12 kHz	X	X	X	X	X	X	X
7	Swath Bathymetry	(X)*	(X)*	X or 8	(X)	(X)*	X	(X)*
8	High Resolution Side-looking Sonar	(X)*	(X)*	X or 7			(X)*	(X)*
9	Photography or Video			(X)			X	(X)*
10	Heat Flow		(X)*	(X)*		(X), H	(X), H	
11	Magnetics & Gravity		(X)	(X)	(X)*	(X)*	(X)*	(X)
12	Cores: Paleoenvironmental/geotechnical	X	(X), R	(X), R	R	R, H	X	(X)*, R
13	Rock Sampling					(X)*	X	(X)*
14	Current Meter (for Bottom Shear)	(X)*	(X)*	(X)*			(X)*	(X)*

X = Vital
(X) = Desirable
(X)* = Desirable, but may be required in some cases

R = Vital for re-entry sites
H = Required for high temperature environments

Figure 4. SSP drilling target/techniques table.

bare-rock drilling sites; may be required for any site with steep or complex topography; areas where slumping may occur should have swath bathymetry and/or side-looking sonar data.

8. High resolution side looking sonar: imagery-acoustical reflectivity from towed sonar devices is needed on fans and in topographically complex terrains; areas where slumping may occur should have multibeam bathymetry and/or side-looking sonar.
9. Video or still seafloor photography: visual imagery from towed vehicle or submersible is needed to site bare rock guidebase, and may be desirable to understand the tectonic or volcanic setting of some drill sites
10. Heat flow: pogo-type profiles or piston core heat flow measurements in detail, with *in-situ* thermal conductivity for highest accuracy, as appropriate to the scientific problem.
11. Magnetics and gravity: regional magnetics if magnetic age of crust is important; gravity for subsidence studies; SEASAT data may complement regional magnetic picture.
12. Coring: near paleoenvironmental sites. All re-entry sites should be supported by cores, core description and geotechnical measurements (contact Science Operator at TAMU for geotechnical requirements).
13. Rock sampling: dredging, submersible sampling, and/or rock coring may be required when basement drilling is included in the objectives.
14. Current meters: information on bottom currents will be required when bottom shear might be a problem. Shallow water sites may need tidal current information as well.

Physical Oceanographic Conditions

Information on ice, weather and near-surface currents, which might have a serious impact on the viability of a drill site, is also required at this stage. Information on ice conditions must be provided with high-latitude proposals, and on near-surface currents for some continental margin locations.

Data Deposition

Supporting data for proposals must be deposited in the ODP Site Survey Data Bank to ensure that a proposal stays viable. Data may be deposited in stages, while informing the Data Bank on data still to be collected. Guidelines for submission of data to the Site Survey Data Bank are detailed in the *JOIDES Journal Special Issue, Vol. XIV, No. 4, 1988* (p. 49).

Safety Review

The most critical safety and pollution hazards in scientific ocean drilling are possible release of hydrocarbons from a subsurface reservoir or penetration into a superheated hydrothermal system. The presence of gas hydrates or high concentrations of H_2S in pore waters may also sometimes constitute a hazard. In most deep-sea regions, the risk of hydrocarbon release can be reduced or eliminated by careful planning, judicious choice of drilling locations based on proper site surveys, and by taking special precautions when coring at potentially hazardous sites.

Although primary responsibility for documenting hazardous sub-seafloor conditions rests with the co-chief scientists, proponents can ensure at an early stage that adequate technical data are obtained and processed for examination by the Pollution Prevention and Safety Panel (PPSP) by becoming familiar with guidelines for safety reviews.

Safety review is a critical element in the process of planning a drilling leg. In addition to the PPSP, the Science Operator at TAMU also has an independent group of safety advisors. Advice and recommendations from both groups are incorporated into the final decision by the Science Operator on whether or not a proposed site will be drilled. PPSP guidelines are detailed in the *JOIDES Journal Special Issue, Vol. XIV, No. 4, 1988* (p. 33); they are being updated this year and will be published in an upcoming special issue of the *JOIDES Journal*.

Other Information for Preparation of Detailed Drilling Plan

Preliminary Time Estimates for Coring and Logging Operations

Guidelines have been prepared by both the Science Operator and the Wireline

Logging Services Contractor for estimating ODP coring and logging times. TAMU has compiled and revised curves for estimating these times in the following publication:

Preliminary Time Estimates for Coring Operations, ODP Technical Note No. 1 (Revised December 1986; available from ODP/TAMU).

In this publication, drill string and wireline trip time curves reflect actual operating times on ODP Legs 103 through 108 (excluding Leg 106, which was not considered representative of routine operations). Curves for drill string trip time and rotary (RCB), advanced piston (APC), and extended core barrel (XCB) coring cycles are included. They can be used for estimating times in both single-bit and reentry holes.

These curves, along with procedures for calculating approximate coring and logging times, are available to assist proponents in developing realistic drilling times. Whenever possible, time estimates for ODP holes should be based on data from similar locations and/or lithologies.

Because of the complexity of ODP operations, however, these estimates should not be used for detailed operational planning. Once a site has been approved and its objectives defined, detailed planning becomes the responsibility of the Science Operator.

List of Publications Relevant to Proposal Submission, and Where to Get Them

- Proposal submission guidelines: JOIDES Office
- COSOD II Report: JOI, Inc.
- ODP Long Range Plan: JOI, Inc.
- Thematic panel mandates: *JOIDES Journal Special Issue, Vol. XIV, No. 4, 1988*; JOI, Inc.
- Thematic panel white papers: various *JOIDES Journal* issues (1989/90), JOI, Inc. or JOIDES Office
- Guidelines for submission of data to the Site Survey Data Bank: *JOIDES Journal Special Issue, Vol. XIV, No. 4, 1988*; JOI, Inc.
- Guidelines for safety review: *JOIDES Journal Special Issue, Vol. XIV, No. 4, 1988*; JOI, Inc.
- Preliminary Time Estimates for Coring Operations: *ODP Technical Note No. 1*; ODP/TAMU

LISTING OF RECENT PROPOSALS

Received at the JOIDES Office from January through June 1991

Ref.No.	Abbreviated Title	Contact	Affiliation	Received
391——	Formation of sapropels, eastern Mediterranean	Zahn, R.	G/US/CAN	01/02/91
059-Add	Cont. margin sed. instability, drilling adjacent turbidites	Weaver, P.P.E.	UK	01/15/91
392——	Mantle plume origin, North Atlantic volcanic margins	Larsen, H.C.	ESF/CAN/UK	01/29/91
393——	Continent-ocean transition, Greenland volcanic margin	Larsen, H.C.	ESF(DK)/UK	01/29/91
365-Rev	Conjugate passive margins, North Atlantic	Srivastava, S.P.	US/F/ESF/CAN/UK	02/04/91
394——	Pre/syn-volcanic extensinal basins on passive v. margins	Kiørboe, L.V.	ESF(DK,IS)	02/04/91
323-Rev	Alboran basin and Atlantic-Mediterranean gateway	Comas, M.C.	ESF/F/UK/G/US	02/11/91
395——	Compressional tectonics on a passive volcanic margin	Boldreel, L.O.	ESF(DK)	02/11/91
396——	Testing hot-spot model for volcanic passive margins	Andersen, M.S.	ESF(DK)	02/11/91
363-Add	Paleoceanographic record at sites NR1, NR2, and NR3	Tucholke, B.E.	US	02/18/91
397——	Mantle plume and multiple rifting, North Atlantic	Gudlaugsson, S.T.	ESF(N/IS)	02/20/91
NAAG	North Atlantic - Arctic gateways DPG Report	Ruddiman, W.F.		02/20/91
398——	Quat. Paleoceanography, Grand Banks, Newfoundland	Piper, D.J.W.	CAN	02/22/91
361-Rev	Hydroth. system, slow-spread. ridge, MAR 26°N (TAG)	Thompson, G.	US/UK/F/CAN/G	03/01/91
A&G	Atolls and Guyots DPG Report	Rea, D.K.		03/08/91
S-2	Downhole measurements Jurassic crust, Hole 801C	Larson, R.L.	US	03/20/91
346-Add	Complementary information on data status	Mascle, J.	F	03/25/91
NARM	North Atlantic rifted margins DPG Report	Larsen, H.C.		03/27/91
356-Rev	Oceanogr./climatic changes, North Greenland Sea	Smolka, P.P.	G	05/01/91
365-Add	Geothermal measurements, Newfoundland/Iberia transects	Louden, K.E.	C-A/F	05/28/91
S-3	Cased re-entry hole for deployment of OSN observatory	Dziewonski, A.	US/J	05/31/91

Global Ranking of Proposals by Thematic Panels, April 1991

Subdivision at ranks 5, 10 and 15 correlates with categories 3, 2, 1 and 0 on histograms of global map.

Rank	LITHP	OHP	SGPP	TECP	Map histo-grams
1	387-Rev Hess Deep	NAAG-DPG N Atl./Arctic gateways	355-Rev2 Gas hydrate	NARM-DPG N Atl. rifted margins	3
2	361---- TAG hydro.	348---- New Jersey sea level	391---- Med. sapropels	323-Rev Alboran Basin/gateway 330---- Med. Ridge	
3	EPR-DPG East Pacific Rise II	339---- Benguela Current 354---- SE Atl. upwelling	SR-DPG Sedimented Ridges II	362-Rev2 Chile Triple Junction II	
4	NARM-DPG N Atl. rifted margins (volcanic: 392-396)	388---- Ceara Rise	348---- New Jersey sea level	346-Rev Eq. Atl. transform	
5	SR-DPG Sedimented Ridges II	253---- Shatsky R. black shales	380-Rev VICAP Gran Canaria	GENERIC Hess Deep II (tectonic)	
6	376---- Vema FZ: layer 2/3 382---- Vema FZ: deep crust	347---- South-eq. Atl. paleo.	233-Rev3 Oregon acc. complex	343---- Caribbean crust	2
7	369---- MARK deep mantle	Bering Sea (Pac. Prosp.) Bering Sea history 390---- Shirshov Ridge	354---- SE Atl. upwelling	265---- Woodlark Basin	
8	NARM-DPG N Atl. rifted margins (non-volc.: 334, 365)	386-Rev California margin	059-Rev2 Sediment instability	378-Rev Barbados acc. wedge	

9	325---- Endeavour Ridge	345---- West Florida sea level	EPR-DPG East Pacific Rise II	334-Rev Galicia margin	
10	142-Rev Ontong Java Plateau	NARM-DPG N Atl. rifted margins	337---- New Zealand sea level	363---- GB-Iberia plume volc.	
11	368---- Hole 801C Return	296-Rev Ross Sea	360---- Valu Fa hydro.	GENERIC Slow offset drilling	
12	300---- 735B: layer 3/mantle	313---- Eq. Atl. pathways	388---- Ceara Rise	340---- N Australian margin	
13	374---- Oceanographer FZ		368---- Hole 801C Return	GENERIC Red Sea, Gulf of Aden	1
14	362-Rev2 Chile Triple Junction II		361---- TAG hydro.	Cascadia-DPG Cascadia Margin II	
15	252---- Loihi Seamount		340---- N Australian margin	379---- Med. drilling (Tyr. Sea)	
16	290---- Juan de Fuca axial smt.		330---- Med. Ridge	392---- Labrador Sea volc.	
17	379---- Med. drilling		378-Rev Barbados acc. wedge	333---- Cayman Trough	
18	323-Rev Alboran Basin/gateway		367---- S Australia margin	373---- Site 505 Return	0
19	373---- Site 505 Return		275-Rev Gulf of California	327---- Argentine cont. rise	
20	360---- Valu Fa hydro.		372---- N Atl. paleo.	367---- S Australia margin	
Plus	280-Rev; 331; 267; 319-Rev; 291; 390; 352; 333; 343				

Listing* of Proposals Ranked** by Thematic Panels During Early 1991 Meetings

* Sorted by 'Date Received at the JOIDES Office'; ** Priorities 1 - 20 of each panel

Proposal	Abbreviated Title	Contact	Priorities			
			LITHP	OHP	SGPP	TECP
252----	Loihi Seamount	Staudigel, H.	15	-	-	-
253----	Black shales in ancestral Pacific, Shatsky Rise	Sliter, W.V.	-	5	-	-
265----	Western Woodlark Basin	Scott, S.D.	-	-	-	7
290----	Deep drilling on axial seamount, Juan de Fuca Ridge	Johnson, H.P.	16	-	-	-
296-Rev	Drilling the Ross Sea, Antarctica	Cooper, A.K.	-	11	-	-
300----	Deep crustal drilling, Site 735B, SW Indian Ridge	Dick, H.J.B.	12	-	-	-
059-Rev2	Cont. margin sed. instability, drilling adjacent turbidites	Weaver, P.P.E.	-	-	8	-
313----	Major oceanographic pathway, equatorial Atlantic	Jones, E.J.W.	-	12	-	-
275-Rev	Drilling the Gulf of California	Simoneit, B.R.T.	-	-	19	-
142-Rev	Ontong Java Plateau	Mayer, L.	10	-	-	-
325----	High-T hydrothermal site, Endeavour Ridge	Johnson, H.P.	9	-	-	-
327----	Argentine continental rise	Hinz, K.	-	-	-	19
SR	Sedimented Ridges DPG Report	Detrick, R.	5	-	3	-
330----	Accretionary prism and collision, Mediterranean Ridge	Cita-Sironi, M.B.	-	-	16	2
337----	Tests of Exxon sea-level curve, New Zealand	Carter, R.M.	-	-	10	-
333----	Evolution of pull-apart basin, Cayman Trough	Mann, P.	-	-	-	17
340----	Tectonic, climatic, oceano. change, N Australian margin	Symonds, P.	-	-	15	12
343----	Window of Cret. volcanic formation, Caribbean Zone	Mauffret, A.	-	-	-	6
339----	Paleoceanographic transects, Benguela Current	Meyers, P.A.	-	3	-	-
345----	Sea level and paleoclimate, W Florida margin	Joyce, J.E.	-	9	-	-
346-Rev	Drilling equatorial Atlantic transform margin	Mascle, J.	-	-	-	4
347----	L. Cenozoic paleoceanography, south-equatorial Atlantic	Wefer, G.	-	6	-	-
348----	Paleogene/Neogene stratigraphy, U.S. Atlanic margin	Miller, K.G.	-	2	4	-
354----	Late Cenozoic upwelling system, Angola/Namibia	Wefer, G.	-	3	7	-
360----	Hydrothermal activity and metallogenesis, Valu Fa Ridge	Von Stackelberg, U.	20	-	11	-

361----	Active hydroth. system, slow-spread ridge, MAR 26° N	Thompson, G.	2	-	14	-
363----	Plume volcanism and rift/drift, Grand Banks-Iberia	Tucholke, B.E.	-	-	-	10
367----	Cool water carbonate margin, southern Australia	James, N.P.	-	-	18	20
368----	Jurassic Pacific crust: A return to Hole 801C	Larson, R.L.	11	-	13	-
369----	Deep mantle section, Mark area	Mevel, C.	7	-	-	-
372----	Cenozoic circulation and chem. gradients, N Atlantic	Zahn, R.	-	-	20	-
373----	Stress, hydrol. circul. and heat flow, Site 505 revisited	Zoback, M.D.	19	-	-	18
374----	Mantle heterogeneity, Oceanographer FZ	Dick, H.J.B.	13	-	-	-
376----	Layer 2/3 (and crust/mantle) boundary, Vema FZ	Auzende, J.M.	6	-	-	-
378-Rev	Growth and fluids evol., Barbados accretionary wedge	Westbrook, G.K.	-	-	17	8
379----	Scientific drilling in the Mediterranean Sea	Mascle, J.	17	-	-	15
EPR	East Pacific Rise DPG Report	Davis, E.E.	3	-	9	-
380-Rev	Volcanic island - clastic apron, Gran Canaria	Schmincke, H.U.	-	-	5	-
382----	Upper mantle - lower crustal uplifted section, Vema FZ	Bonatti, E.	6	-	-	-
386-Rev	Paleoceanography and deformation, California margin	Lyle, M.	-	8	-	-
Cascadia	Cascadia Margin DPG Report	Cathles, L.M.	-	-	-	14
233-Rev3	Fluids and structure of acc. complex, central Oregon	Moore, J.C.	-	-	6	-
355-Rev2	Formation of a gas hydrate	Von Huene, R.	-	-	1	-
387-Rev	Deep drilling of fast-spread crust, Hess Deep	Gillis, K.	1	-	-	-
Bering	Bering Sea history (Pacific Prospectus)	CEPAC	-	7	-	-
388----	Neogene deep water circ. and chemistry, Ceara Rise	Curry, W.B.	-	4	12	-
362-Rev2	Triple junction, southern Chile Trench	Cande, S.C.	14	-	-	3
390----	Drilling in the Shirshov ridge region	Milanovsky, V.E.	-	7	-	-
334-Rev	S reflector and ultramafic basement, Galicia margin	Boillot, G.	-	-	-	9
391----	Formation of sapropels, eastern Mediterranean	Zahn, R.	-	-	2	-
392----	Mantle plume origin, North Atlantic volcanic margins	Larsen, H.C.	-	-	-	16
323-Rev	Alboran basin and Atlantic-Mediterranean gateway	Comas, M.C.	18	-	-	2
NAAG	North Atlantic - Arctic gateways DPG Report	Ruddiman, W.F.	-	1	-	-
NARM	North Atlantic rifted margins DPG Report	Larsen, H.C.	4	10	-	1

JOI/USSAC Workshop

LARGE IGNEOUS PROVINCES WORKSHOP

M.F. Coffin, Convenor
4-6 November 1990
Woods Hole Oceanographic Institution

EXECUTIVE SUMMARY

Recent research has documented important temporal, spatial, and compositonal relationships among oceanic plateaus, volcanic passive continental margins, and continental flood basalt (CFB) provinces. Volcanic margins and oceanic plateaus comprise large extrusive constructions, which in some cases share temporal, spatial, and compositional characteristics with CFBs. Recognition of genetic similarities among these large igneous provinces (LIPs), which previously have been studied by different groups within the earth science community, prompted the JOI/USSAC-sponsored Workshop.

LIPs represent major global events, whose genesis and evolution are directly linked to mantle circulation. Large volumes of lava and associated intrusives are produced in short episodes. LIP emplacements may be related to changes in rate and direction of plate motion, and their episodicity is not well known. LIPs have potentially had, though as yet undocumented, major effects on global environment. The scale and timing of the large-scale outpourings of lava, gas, particulate matter,and heat may have caused severe regional and global environmental stress, affecting the chemistry and circulation of both the hydrosphere and atmosphere, and changing basin geometry which in turn modified ocean circulation, gateways, and sea level. Nonetheless, little quantitative information is available to constrain mantle and crustal processes, to reliably predict environmental effects of oceanic LIP formation, or to constrain LIP dimensions, duration and rate of emplacement, geochemical and petrological signature, crustal structure, and relationship to tectonism.

Oceanic plateaus and volcanic margins offer excellent laboratories to study internal processes and external consequences of LIP emplacements. Successful drilling critically depends on high-quality site survey and other preparatory work, but only drilling will substantially address many fundamental problems. The Workshop recommends that:

- Volcanic margin and oceanic plateau drilling become an integral part of future drilling programs using an approach reconciling the need for both exploratory and focused, problem-oriented sites. Transect drilling will be the principal strategy, supplemented by holes of "opportunity", and is compatible with magmatic, tectonic, and paleoenvironmental objectives. Significant advances will be made with present drilling technology integrated with comprehensive logging programs and vertical seismic experiments for deep holes.
- Each drilling transect sample key sedimentary, igneous, and metamorphic rock units, tied to off-LIP reference holes in normal oceanic crust and/or on the continental margin. Moderately deep (500-1000 m) basement penetration should be achieved to establish the igneous stratigraphy of each oceanic LIP. All other holes should penetrate ~150 m of igneous basement.
- Conjugate volcanic margin transects include arrays of closely-spaced holes across the margin (4-7 plus reference holes), augmented by single holes to evaluate along-strike variability, such as hotspot influence. North Atlantic margins are targets; areas with thin sediment would allow penetration deep into the extrusive pile.
- Hotspot/plume source evolution from a CFB across a volcanic margin to an oceanic plume be studied (≤10 holes) along the plume trail. Potential targets are the Greenland-Scotland Ridge, Walvis Ridge-Rio Grande Rise, and Deccan-Réunion hotspot tracks.
- One of the two huge oceanic plateaus, Kerguelen or Ontong Java, be drilled along longitudinal and latitudinal transects (10-15 sites plus reference holes) to examine variations in age and composition; and a purely oceanic plateau, e.g., Manihiki, Shatsky, or Hess, be drilled (~5 holes) to characterize the crustal composition of one LIP end member.
- Because optimal site density is now unknown, the first phase of drilling be focused on selected holes to estimate variability along the transect; further drilling would be contingent on initial results.

Bulletin Board

JOIDES MEETING SCHEDULE

Date	Place	Committee/Panel
1991		
09-11 July	San Diego, CA	EXCOM
16-28 July	Cardiff, Wales	ex-IOP & Co-Chiefs
August*	??	OD-WG
11-14 August*	Copenhagen, Denmark	NARM-DPG
20-22 August	Hannover, FRG	PCOM
03-05 September*	Tokyo, Japan	SSP
September*	Victoria, BC	TEDCOM
11-14 September*	Victoria, BC	IHP
01-03 October*	Yamagata, Japan	OHP
09-11 October*	Cyprus	LITHP
09-11 October*	Cyprus	TECP
14-17 October*	Halifax, NS	SMP
15-17 October*	Halifax, NS	DMP
23 October*	Houston, TX	DMP/fluid sampling
23-25 October*	Scripps, CA	PPSP
05-06 November*	Zurich, Switzerland	SGPP
07-09 November*	Scripps, CA	SL-WG
03 December	Austin, TX	Panel Chairpersons
04-07 December	Austin, TX	PCOM
1992		
14-16 January	Bonn, Germany	EXCOM
21-23 April	Corvallis, OR	PCOM
18-20 August	Victoria, BC	PCOM
Annual Meeting	Palisades, NY	PCOM

* Meeting not yet formally requested and/or approved

ANNOUNCEMENTS

Cenozoic Glaciation: The Marine Record Established by Ocean Drilling; A Supplement to Undergraduate Curricula

. Eugene Domack and Cynthia Domack, Hamilton College

A new course supplement, Cenozoic Glaciation: The Marine Record Establi shed by Ocean Drilling, will be available for use in the fall 1991 semester. The booklet, sponsored by JOI/USSAC, covers the results of five ODP high-latitude legs: two in the northern hemisphere (Legs 104 and 105) and three in the southern hemisphere (Legs 113, 119 and 120). Cenozoic Glaciation is intended for use as a supplement to regular class materials in courses such as oceanography, glacial geology, marine geology, and sedimentology, and is designed specifically for undergraduates. A coordinated color poster illustrating the core intervals described in the text is included.

Copies of the booklet and poster will be available from JOI in June 1991

If you would like a sample copy, contact Mary Reagan, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102; (202) 232-3900.

JOI/USSAC Ocean Drilling Graduate Fellowships

JOI/USSAC is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both two-year and one-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs and incidental travel, if any. Applications are available from the JOI office and should be submitted according to the following schedule:

ODP Cruise	Applic. Deadline
Leg 145 North Pacific Transect	9/1/91
Leg 146 Cascadia	9/1/91
Shorebased Work (regardless of leg)	1/1/92

JOI/USSAC Ocean Drilling Fellowship Program
Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102.
For additional information,call:
Robin Smith, 202-232-3900.

Applicants are reminded that staffing of ODP legs is arranged by the Manager of Science Operations at Texas A&M University 10-12 months before the leg sails. Fellowship applicants should not wait until the above deadlines to apply to be a shipboard scientist.

A fellowship application packet, with instructions, information on upcoming cruises, and an ODP Cruise Participant Application form is available from the above address.

Victoria Port Call, September 11-15, 1991

The Canadian ODP community has been busy organizing events for the port call of the *JOIDES Resolution* to Victoria, British Columbia.

The port call will center around a scientific symposium to be held on the afternoon of Friday, September 13. This will be held in the main auditorium of the Royal B.C. Museum, and will consist of four or five talks by ODP scientists. The theme will be "ODP in the Northern Pacific - preliminary results from Leg 139 and continued work on accretionary prism drilling (Leg 146)". The symposium is being organized by Chris Yorath and Roy Hyndman, both of the Pacific Geoscience Centre.

A public lecture will be held that evening (title to be confirmed later).

In addition to the talks and lectures, we hope to organize ship tours for those who will attend the port call (ie. senior scientific and industry personnel, schools, etc.), and set up numerous exhibits and displays either next to the ship or at the Royal B.C. Museum.

For more information, those interested can contact the Canadian Secretariat at:
Canadian Secretariat for ODP, Memorial University of Newfoundland, St. John's, NF, Canada A1B 3X5; Phone: (709)737-4708, Fax: (709) 737-4702, Bitnet: ODP@MUN

Funding for Site Survey Augmentation

JOI/U.S. Science Support Program has Site Survey Augmentation funds available to supplement drilling site data sets that are in all phases of planning. This program element includes support for:

- acquiring and/or processing data for sites being considered by JOIDES;
- mini-workshops that would bring together scientists to coordinate site-specific data for integration into a mature drilling proposal;
- "augmentation" surveys on ships of opportunity that would significantly enrich drilling-related science and/or acquire needed site survey data;
- U.S. scientists to participate in non-U.S. site surveys.

Site Survey Augmentation proposals may be submitted at any time. Priority will be given to augmentation of sites and/or themes that are high priority within JOIDES. As with all JOI/USSSP activities, it is important to clearly state how the work would contribute to U.S. plans or goals related to the Ocean Drilling Program. Note that the Site Survey Augmentation funds cannot be used to supplement NSF/ODP funded work.

Contact Ellen Kappel, JOI office, for further information and proposal guidelines: (202) 232-3900.

ECOD Workshop 1992, Copenhagen

Theme: Drilling towards the 21st Century: ODP in the Atlantic

Purpose: To create a "second wave" of drilling proposals, hopefully in the spirit of the ODP Long Range Plan, that are focussed on the Atlantic and aimed at the mid- to late 1990's.

Excursion 1:		Iceland 3 days (arrive 1 May, depart for Copenhagen 5 May).
6 May	9:00 AM:	Opening remarks and welcome by Danish Minister of Education and Science. Introduction by ESCO chairperson (M.B Cita). Pep talk by PCOM chairperson (J. Austin). Setting the thematic scene for future drilling: four, 30-minute talks by thematic panel chairpersons: Susan Humphris (LITHP). Nick Shackleton and/or new chair (OHP). Eldridge Moores (TECP). Judy McKenzie (SGPP).
	3:00 PM:	Split into four thematic working groups, chaired by ECOD thematic panel delegates (old/new).
7 May	8:30 AM:	Plenum talk by ODP Deputy Director (Tim Francis). Working groups continue.
	3:30 PM:	Excursion 2 to Stevns Klint (K/T boundary).
	Evening:	Dinner at Danish Country "Kro".
8 May	8:30 AM:	Talk by Yves Lancelot: new platform? Working groups continue.
	1:00 PM:	Presentation of working group highlights.
	3:30 PM:	Departure for ferry to Oslo.
	Evening:	Talk by Jorn Thiede: Nansen Arctic Drilling Program.
Excursion 3:		9-10 May, Oslo region. (Day 1 by ship, day 2 by bus.)

Workshop concludes following Excursion 3, at 5:00 PM, May 10. Participants may return by night ferry to Copenhagen. Report deadline: mid- autumn 1992, to be published by Danish Geol. Survey.

ODP Open Discussion via Bitnet

Recently ODP instituted a BITNET LISTSERVER. This is an open discussion service to which individuals subscribe *via* Bitnet. It permits exchange of information among all subscribers. Currently, the list administrator (Anne Graham of ODP Science Operations) sends a report of the previous week's shipboard scientific and operations activities to all subscribers. Site summaries are distributed as soon as they are received at ODP from the ship, usually the day after a site is completed. Periodically, an updated cruise schedule and brief descriptions of upcoming cruises are sent out. Any subscriber may send files to the list for distribution. A file sent *via* Bitnet to the list address (ODP-L@TAMVM1) will be distributed automatically to all subscribers.

Anyone with a Bitnet computer link can subscribe. At present there are subscribers in the U.S., Canada, Europe, Australia and Japan. There is no charge for subscribing to the listserver.

To subscribe, send a brief Bitnet command to LISTSERV@TAMVM1 consisting of the words "SUBSCRIBE ODP-L YOUR_NAME" (where YOUR_NAME really is your first and last names). For example, people on VAX/VMS systems using the JNET networking software will send a command that looks like this: $SEND LISTSERV@TAMVM1 "SUBSCRIBE ODP-L YOUR_NAME" but it may be different according to the command language your computer system uses. If you have any questions, your own friendly local system manager should be able to help. As a last resort, you may send a Bitnet message to Anne Graham (ANNIEG@TAMODP) requesting that you be added to the ODP-L subscription list.

ODP BIBLIOGRAPHY AND DATABASES

ODP Science Operator

Texas A&M University, 1000 Discovery Drive, College Station, Texas 77845-9547

Proceedings of the Ocean Drilling Program, Initial Reports and Scientific Results

	Initial Reports		Scientific Results	
	Vol.	Published	Vol.	Publ.
Leg 101	101/102	Dec 86	101/102	Dec 88
Leg 102	101/102	Dec 86	101/102	Dec 88
Leg 103	103	Apr 87	103	Dec 88
Leg 104	104	July 87	104	Oct 89
Leg 105	105	Aug 87	105	Oct 89
Leg 106	106/109/111	Feb 88	106/109	Jan 90
Leg 107	107	Oct 87	107	Feb 90
Leg 108	108	Jan 88	108	Dec 89
Leg 109	106/109/111	Feb 88	106/109	Jan 90
Leg 110	110	Apr 88	110	May 90
Leg 111	106/109/111	Feb 88	111	Dec 89
Leg 112	112	Aug 88	112	May 90
Leg 113	113	Sept 88	113	Aug 90
Leg 114	114	Nov 88	114	Feb 91
Leg 115	115	Nov 88	115	Sept 90
Leg 116	116	Jan 89	116	Sept 90
Leg 117	117	June 89	117	Feb 91
Leg118	118	May 89		
Leg 119	119	Sept 89		
Leg 120	120	Nov 89		
Leg 121	121	Nov 89		
Leg 122	122	Jan 90		
Leg 123	123	June 90		
Leg 124	124	June 90		
Leg 125	125	Aug 90		
Leg 126	126	Aug 90		
Leg 127	127	Sept 90		
Leg 128	128	Sept 90		
Leg 129	129	Dec 90		
Leg 130	130	Mar 91		
Leg 131	131			

Technical Notes

No. 1: Preliminary time estimates for coring operations (Revised Dec 86)

No. 3: Shipboard Scientist's Handbook (Revised 1990)

No. 5: Water Chemistry Procedures aboard the *JOIDES Resolution* Sept 86)

No. 6: Organic Geochemistry aboard *JOIDES Resolution*- An Assay (Sept 86)

No. 7: Shipboard Organic Geochemistry on *JOIDES Resolution* (Sept 86)

No. 8: Handbook for Shipboard Sedimentologists (Aug 88)

No. 9: Deep Sea Drilling Project data file documents (Jan 88)

No. 10: A Guide to ODP Tools for Downhole Measurement (June 88)

No. 11: Introduction to the Ocean Drilling Program (Dec 88)

No. 12: Handbook for Shipboard Paleontologists (June 89)

Publications Office, Fabiola Byrne
Phone: (409) 845-2016; Fax: (409) 845-4857
Bitnet: FABIOLA@TAMODP

Scientific Prospectuses and Preliminary Reports

	Prospectuses		Prelimin. Rpts.	
	Vol.	Published	Vol.	Published
Leg 129	29	Aug 89	29	Feb 90
Leg 130	30	Oct 89	30	May 90
Leg 131	31	Oct 89	31	June 90
Leg 133	33	May 90	33	Nov 90
Leg 134	34	June 90	34	Jan 91
Leg 135	No 35	Sept 90	35	May 91
Leg 136	36	Dec 90	36	May 91
Leg 137	No 37	Jan 91	37	May 91
Leg 138	38	Jan 91		
Leg 139	39	Mar 91		

Engineering Prospectuses and Preliminary Reports

	Prospectus		Prelimin. Rpts.	
	Vol.	Published	Vol.	Published
Leg 132	2	Nov 89	2	Sept 90

Other Items Available

Brochure: The Data Base Collection of the ODP - Database Information

Ocean Drilling Program brochure (English, French, Spanish, German or Japanese)

ODP Sample Distribution Policy

Micropaleontology Reference Center brochure

Instructions for Contributors to ODP *Proceedings* (Revised Oct 90)

ODP Engineering and Drilling Operations (New)

Multilingual brochure with a synopsis of ODP (English, French, Spanish, German and Japanese)

ODP Posters (Ship and coring systems posters)

ODP After Five Years of Field Operations (Reprinted from the 1990 Offshore Technology Conference proceedings)

Public Information Office, Karen Riedel
Phone: (409) 845-9322; Fax: (409) 845-0876
Bitnet: KAREN@TAMODP

ODP Data Available

ODP databases currently available include all DSDP data files (Legs 1-96), geological and geophysical data from ODP Legs 101-131, and all DSDP/ODP core photos (Legs 1-131). More data are available as paper and microfilm copies of original data collected aboard the *JOIDES Resolution*. Underway geo-physical data are on 35 mm microfilm; all other data are on 16 mm microfilm.

All DSDP data and most ODP data are contained in a computerized database (contact the ODP Librarian to find out what data are available electronically). Data can be searched on almost any specified criteria. Files can be cross-referenced so a data request can include information from multiple files.

Computerized data are currently available on hard-copy printouts, magnetic tape, or through BITNET.

Photos of ODP/DSDP cores and seismic lines are available. Seismic lines, whole core and close-up core photos are available in black and white 8x10 prints. Whole core color 35-mm slides are available.

The following are also available: (1) ODP Data Announcements containing information on the database; (2) Data File Documents containing information on specific ODP data files; (3) ODP Technical Note No. 9, "Deep Sea Drilling Project Data File Documents," which includes all DSDP data file documents.

Data Base Librarian
Phone: (409) 845-8495, Fax: (409) 845-0876
BITNET: DATABASE@TAMODP

Small requests can be answered quickly, free of charge. If a charge is made, an invoice will be sent and must be paid before the request is processed.

Data Available from the Geophysical Data Center

Computerized data from the DSDP are now available through NGDC in compact-disc read-only-memory (CD-ROM) format. The DSDP CD-ROM data set consists of two CD-ROMs and custom, menu-driven, access software developed by NGDC with support from JOI/USSSP. 500 complimentary copies of the DSDP CD-ROMs are being offered to U.S. researchers in academia and government, courtesy of JOI/USSSP. An additional 200 copies of the set are available on a cost recovery basis.

Volume I of the 2-disc set contains all computerized sediment/hardrock files, the Cumulative Index (Paleontology, Subject, and Site), bibliographic information, age and fossil codes dictionaries, an index of DSDP microfilm, sediment chemistry reference tables, and copies of DSDP documentation for each data and reference file.

Volume II contains all digital downhole logging data from the DSDP, including some data digitized for the CD-ROM set by the Woods Hole Oceanographic Institution under contract to JOI/USSSP. All of the data are in the Schlumberger Log Information Standard (LIS) format, some ASCII and Gearhart-Owen data have been translated to LIS by WHOI for the CD-ROM. All DSDP underway and geophysical data are on disc 2, including bathymetry, magnetics, and navigation in the MGD77 format (no data for Legs 1-3; navigation only for Legs 4, 5, 10, 11; SEG-Y single channel seismic data not included). Volume II also contains the DSDP Core Sample Inventory and color/monochrome shaded relief images from several ocean views.

DSDP data files can be provided on magnetic tape according to user specifications. NGDC can also provide correlative marine geological and geophysical data from other sources. NGDC will provide a complimentary inventory of data available on request. Inventory searches are tailored to users' needs.

Information from DSDP Site Summary files is fully searchable and distributable on floppy diskette, as computer listings and graphics, and on magnetic tape. NGDC is working to make all DSDP data files fully searchable and available in PC-compatible form. Digital DSDP geophysical data are fully searchable and available on magnetic tape. In addition, NGDC can provide analog geological and geophysical information from DSDP on microfilm. Two summary publications are available: (1) *Sedimentology, Physical Properties, and Geochemistry in the Initial Reports of Deep Sea Drilling Project Vols. 1-44: An Overview,* Rept. MGG-1; (2) *Lithologic Data from Pacific Ocean Deep Sea Drilling Project Cores,* Rept. MGG-4.

Costs for services are: $90/2-disc CD-ROM data set, $90/magnetic tape, $30/floppy diskette, $20/microfilm reel, $12.80/copy of Rept. MGG-1, $10/copy of Rept. MGG-4. Costs for computer listings and custom graphics vary. Prepayment is required by check or money order (drawn of a U.S. bank), or by charge to VISA, Mastercard, or American Express. A $10 handling fee is added to all shipments ($20 for foreign shipments), and a $15 fee is added to all rush orders. Data Announcements describing DSDP data sets are available at no charge, as are inventory searches of correlative (non-DSDP) geological and geophysical data available from NGDC. For details contact:
Marine Geology and Geophysics Division, NOAA/NGDC, E/GC3, Dept. 334, 325 Broadway, Boulder, CO 80303; Tel (303) 497-6339; Fax 303-497-6513); Internet cjm@ngdc1.colorado.edu.

Sample Distribution

The materials from ODP legs 130 and 131 are now available for sampling by the general scientific community. The twelve-month moratorium on cruise-related sample distribution is complete for Ocean Drilling Program Legs 101-131. Scientists who request samples from these cruises are no longer required to contribute to *ODP Proceedings* volumes, but may publish in the open literature instead.

All sample requests received at ODP are entered into the Sample Investigations Database. Anyone may request a search. Some common types of searches include on-going research for particular holes or legs, current research in a specific field of interest, or publications resulting from DSDP or ODP samples. For details contact:
Assistant Curator, Chris Mato
Phone: (409) 845-8490, Fax: (409) 845-4857
Bitnet: CHRIS@TAMODP

Request processing (time from receipt of request by ODP-TAMU to sending of samples from repository to scientist) during the period 1 January 1991 through 1 May 1991:

Repository	Avg. No. Weeks Processing	Total No. Samples
ECR	7	7,333
GCR	3	5,768
WCR	7	1,643

Available from: Karen Riedel, ODP, Public Relations, Texas A&M University, 1000 Discovery Drive, College Station, TX 77840.

Coring Poster

ODP has a poster, "Scientific Coring Beneath the Sea," available for distribution. The poster features individual coring systems developed for scientific ocean drilling including the rotary core bit, advanced piston coring and extended core barrel. Eric Schulte of Engineering and Drilling Operations designed and produced the poster.

Brochures

Updated ODP brochures in English, French, Spanish, and German are now available. A brochure featuring engineering developments is also available.

Reprints

Reprints of the 1990 Offshore Technology Conference paper, *"The Ocean Drilling Program: After five years of field operations,"* is available from Karen Riedel. The paper, written by P.D. Rabinowitz, L.E. Garrison, et al., features the significant results of Legs 100-124. The paper also describes in detail Legs 124E-135. An ODP Operations Summary outlines the data from each cruise including number of sites, number of holes and percent recovery.

ODP Wireline and Logging Services

Lamont-Doherty Geological Observatory, Palisades, NY 10964.

Wireline Logging Manual (New Edition, Sept 1990)

ODP Site Survey Data Bank

Lamont-Doherty Geological Observatory, Palisades, NY 10964.

The JOIDES/ODP Data Bank received the following data between December 1, 1990 and April 30, 1991. For additional information on the ODP Data Bank, please contact Dr. Carl Brenner at Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964.

- From K. Becker (RSMAS): Single channel seismic reflection profiles from *Tully 8904* site survey of the Escanaba Trough region.

- From A. Cooper (USGS, Menlo Park): Copy of processed *JOIDES Resolution* seismic line, Prydz Bay area.

- From R. Hyndman (PGC, Canada): SeaMARC Ia image of the Vancouver Island margin deformation front.

ODP Long Range Plan

Get your own copy of the Long Range Plan. The ODP Long Range Plan portfolio is now available from the JOI office. If you would like to receive a copy, contact:
Jenny Granger, JOI, Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102
Phone: 202-232-3900, FAX: 202-232-8203

JOI/USSAC Workshops and other Reports

Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave. NW, Suite 800, Washington, D.C. 20036-2102, Tel (202) 232-3900

Scientific Seamount Drilling, Tony Watts and Rodey Batiza, conveners.

Vertical Seismic Profiling (VSP) and the Ocean Drilling Program (ODP), John Mutter and Al Balch, conveners.

Dating Young MORB?, Rodey Batiza, Robert Duncan and David Janecky, conveners.

Downhole Seismometers in the Deep Ocean, Mike Purdy and Adam Dziewonski, conveners.

Science Opportunities Created By Wireline Reentry of Deep-Sea Boreholes, Marcus G. Langseth and Fred N. Speiss, conveners.

Wellbore Sampling, Richard K Traeger and Barry W. Harding, conveners

South Atlantic and Adjacent Southern Ocean Drilling, James A. Austin, convener.

Measurements of Physical Properties and Mechanical State in the Ocean Drilling Program, Daniel K. Karig and Matthew H. Salisbury, conveners.

Paleomagnetic Objectives for the Ocean Drilling Program, Kenneth L. Verosub, Maureen Steiner and Neil Opdyke, conveners.

Cretaceous Black Shales, Michael A. Arthur and Philip A. Meyers, conveners.

Caribbean Geological Evolution, Robert C. Speed, convener.

Drilling the Oceanic Lower Crust and Mantle, Henry J.B. Dick, convener.

Role of ODP Drilling in the Investigation of Global Changes in Sea Level, Joel S. Watkins and Gregory S. Mountain, conveners.

Ocean Drilling and Tectonic Frames of Reference, Richard Carlson, William Sager and Donna Jurdy, conveners.

ODP Shipboard Integration of Core and Log Data, Kate Moran and Paul Worthington, conveners.

Drilling of the Gulf of California, Berndt Simoneit and J. Paul Dauphin, Conveners.

East Pacific Rise Petrology Data Base (Vols. I-III), Charles Langmuir, compiler.

Report of the Second Conference on Scientific Ocean Drilling (COSOD II), JOIDES, sponsor.

ODP EDITORIAL REVIEW BOARDS (ERB)

For each ODP cruise, an editorial board is established to handle review of the manuscripts intended for publication in the "Scientific Results" volume of the *Proceedings of the Ocean Drilling Program.* These boards consist of the Co-Chief Scientists (*) and the ODP Staff Scientist (**) for that cruise, one outside scientist (***) selected by the Manager of ODP Science Operations in consultation with the cruise Co-Chief Scientists, and an ODP Editor. These boards are responsible for obtaining adequate reviews and for making decisions concerning the acceptance or rejection of papers. The names of scientists serving on ERBs for Legs 117 through 131 are listed below.

Leg117:
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A chairman for each ERB, usually a Co-Chief Scientist, has been elected since Leg 120.

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F ....France	NL ......Netherlands	

Welcome to our collegues from the Soviet Union!

Please note that all ODP/JOIDES mail to Soviet members should go to the Office of N.A. Bogdanov. Also, our experience is that telex communication works better than FAX; numbers for some USSR institutes are on the telex list (last page of this directory).

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- Special Issue No. 3: Initial Site Prospectus, Supplement Two, June 1980 (Vol. VI)
- Special Issue No. 4: Guide to the Ocean Drilling Program, September 1985 (Vol. XI)
- Special Issue No. 4: Guide to the Ocean Drilling Program, Supplement One, June 1986 (Vol. XII)
- Special Issue No. 5: Guidelines for Pollution Prevention and Safety, March 1986 (Vol. XII)
- Special Issue No. 6: Guide to the Ocean Drilling Program, December 1988 (Vol. XIV)

JOIDES Resolution Operations Schedule

Leg	Program	Cruise Dates	Days			In Port
			Transit	On Site	Total	
138	E. Equatorial Pacific	06 May-05 July '91	22	38	60	San Diego, 05-09 July '91
139	Sedimented Ridges I	10 July-11 Sept. '91	6	57	63	Victoria, 11-15 Sept. '91
140	504B*/Hess Deep**	16 Sep.-12 Nov. '91	18	39	57	Panama, 12-16 Nov. '91
141	Chile Triple Junction	17 Nov.-13 Jan. '92	18	39	57	Valparaiso, 13-17 Jan. '92
142	Engineering, EPR	18 Jan.-19 Mar. '92	25	36	61	Honolulu, 19-23 Mar. '92
143	Atolls & Guyots A	24 Mar.-19 May '92	12	44	56	Majuro, 20-24 May '92
144	Atolls & Guyots B	24 May-19 July '92	12	44	56	Yokohama, 20-24 July '92
145	North Pacific Transect	24 July-21 Sept. '92	20	39	59	Victoria, 21-25 Sept. '92
146	Cascadia	26 Sept.-21 Nov. '92	6	50	56	San Diego, 21-25 Nov. '92
147	Engineering EPR***/Hess Deep	26 Nov. '92-21 Jan. '93	14	42	56	Panama into the Atlantic

* If cleaning operations on early leg are successful, Hole 504B will be advanced during all of Leg 140
** If cleaning operations on early leg are not successful, the drillship proceeds to Hess Deep
*** If DCS Phase III System is ready