Joint Oceanographic Institutions for Deep Earth Sampling

JOIDES Journal

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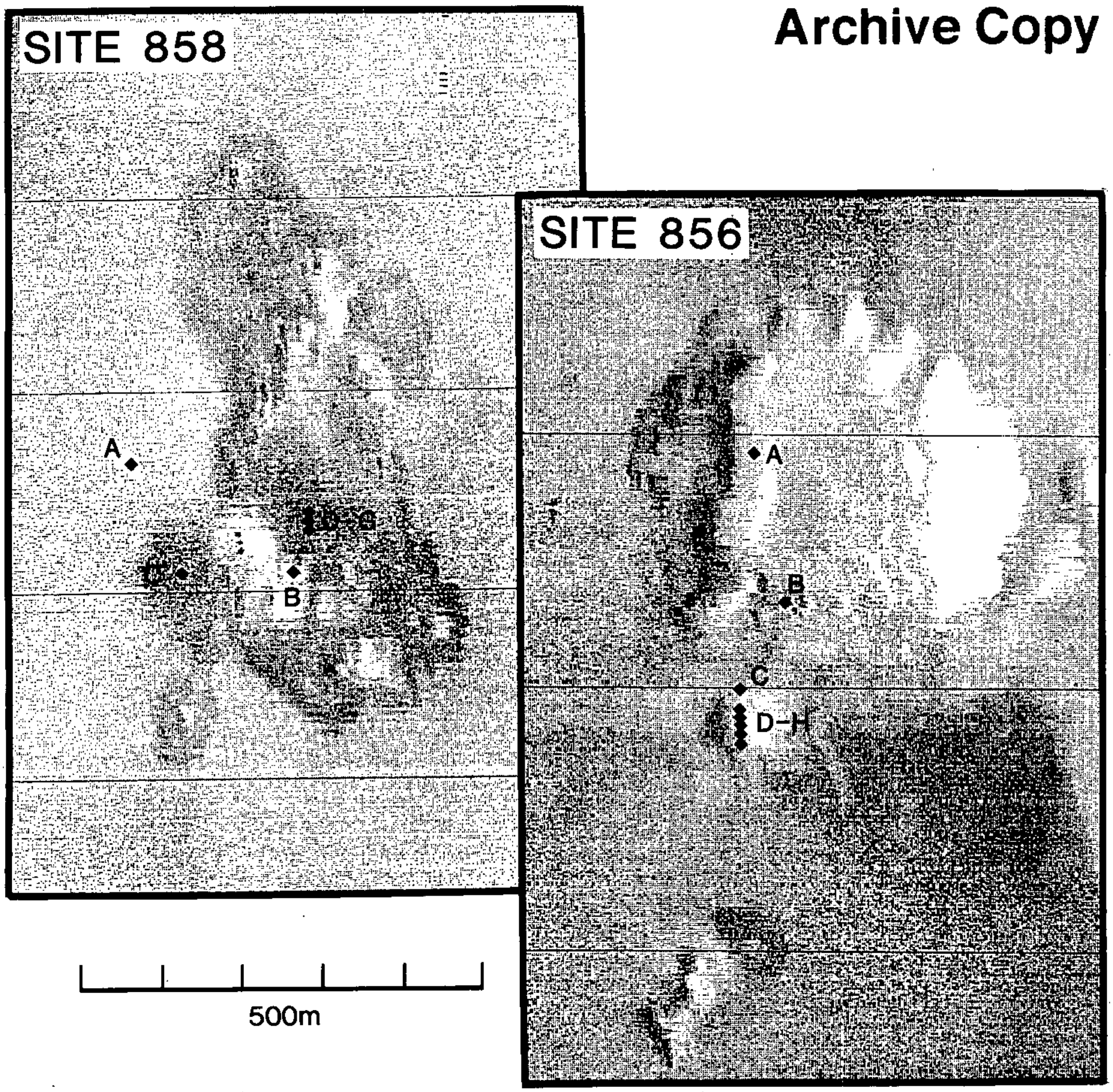

Front Cover:

Hydrothermal vents and massive sulfides in a sedimented rift

SeaMARC Ia side-scan acoustic images of the seafloor where sites 856 and 858 were drilled on Leg 139. Site survey done by Paul Johnson (University of Washington) and Jim Franklin (Geological Survey of Canada).

Site 856. Holes 856A and 856B penetrated just over 100 m of uplifted turbidites before intersecting a primitive intrusion that underlies the circular hill. Holes 856C-G all intersected massive sulfide and sulfide debris of a deposit that appears to predate the adjacent intrusion. Holes 856F and G penetrated 64 and 95 m, respectively, of massive sulfide before dense cuttings and hole failure prevented further penetration. A thermal anomaly is centered over the small hill in the lower (southern) part of the image, where sulfides and current hydrothermal activity have been observed. Site 856 lies ~7km east of the axis of Middle Valley sedimented rift.

Site 858. Holes at this site were drilled in the vicinity of, and within, an active hydrothermal vent field. The field is situated over a buried extrusive volcanic edifice which was intersected by Holes 858 F and G at 258 mbsf. Sediment in the surrounding area is typically 500 m thick. Light areas are the acoustic shadows of hydrothermal mounds; hydrothermal chimneys and rubble produce strong discrete reflections. Hole 858B was drilled into the flank of one mound, about 10 m away from a vent. The hole itself later became a vent. Re-entry Hole 858G was sealed and instrumented with a thermistor string, a pressure transducer, and a fluid sampling port, and will be monitored for up to 2 years. The first 3 weeks of data were successfully recovered during a recent *Alvin* diving program in the area.

See the preliminary report (p. 8) for further information on Leg 139.

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Focus

Greetings from (still) sunny (but not quite so warm) Texas! Fall 1991 finds the JOIDES scientific advisory structure busy absorbing the weighty (1.75 inches/4.5 cm thick, double-sided!) "North Atlantic Prospectus" recently produced by the JOIDES Office. The "NAP" is a compendium of highly ranked (i.e., in spring 1991) drilling programs proposed for the North Atlantic and adjacent seas from which the core of Fiscal Year 1993 (~January, 1993-October, 1993) drilling activities will be drawn. Thematic panels will be re-ranking these programs at their fall meetings, and also considering new competition from "North Atlantic" programs submitted to the JOIDES Office since last spring. The FY93 drilling schedule will actually be constructed in December, at the Annual Meeting of PCOM and Panel Chairs here in Austin.

In my continuing series of perambulations among the international partners as "sparkle meister" in pursuit of ODP renewal, I have just returned from a truly delightful trip to Victoria, British Columbia, to add to the festivities surrounding the conclusion of Leg 139. My congratulations go to John Malpas and Stuart Deveau of the Canadian Secretariat for a well-organized port-call meeting, run against the backdrop of a spectacular success at Middle Valley. Among its other notable achievements (see front cover and article, p. 8), the inaugural phase of the Sedimented Ridges program drilled into and sampled a commercially viable (at least if it were discovered on dry land) massive sulfide deposit! (The line to buy stock forms to the left.)

Furthermore, I have just heard from Earl Davis (co-chief for Leg 139) and Keir Becker that the first *Alvin* dives to retrieve data from holes sealed by CORKs ("circulation obviation retrofit kits" - ah, our love of acronyms!) have been successful. We all look forward to continuing revelations about Middle Valley as Leg 139 and follow-on data are analyzed and integrated.

As this is being written, the Leg 140 crew have just succeeded in removing most of the Leg 137 junk left in Hole 504B. The successful Diamond Core Barrel extraction followed a number of fruitless attempts. In fact, the "double dog" fishing run which snagged the DCB was to be the last one before pulling up stakes for Hess Deep. Once again, the 504B Phoenix has apparently risen from the ashes. Perhaps the last obstacle has been removed *en route* to Layer 3. Let's hope so.

The University of Texas JOIDES Office just celebrated its first anniversary. Craig, Peter, Kathy and I have all enjoyed our first year, during which ODP has reached some important scientific and technical objectives. I trust that our second year can only be better!

Jamie

James A. Austin, Jr.

Planning Committee Chairman

Science Operator Report

Leg 138: Eastern Equatorial Pacific

ODP Leg 138 drilled and cored eleven sites (844-854) in two drilling transects across the complex oceanographic circulation system of the equatorial Pacific (Fig. 1). This leg represents the fifth expedition of ODP and DSDP to examine evolution of global climate change during the Late Cenozoic through high-resolution studies of tropical ocean sediments. A record 5537 m of core were recovered during Leg 138, with an average core recovery of 99.9%.

Eastern Transect

Site 844

[7°55.28'N, 90°28.85'W; Water Depth: 3430 m]

Site 844 is located in the Guatemala Basin (Figs. 1, 2). The oceanographic setting of the site is within the eastward-flowing North Equatorial Countercurrent (NECC) and in the region known as the Costa Rica dome, where wind-induced doming of the thermocline produces surface upwelling and associated high, open-ocean productivity.

Four holes were drilled. Hole 844A, a missed mud-line core, was dedicated to detailed physical properties and interstitial water geochemistry. Hole 844B was APC-cored to 185 mbsf, where excessive pull-out necessitated switching to the XCB for coring to basement at 291 mbsf. Hole 844C was APC-cored to 181.5 mbsf. Coring in Hole 844C was guided by real-time acquisition, in the sediment laboratory, of magnetic susceptibility and GRAPE-measured sediment density to assure recovery of a complete stratigraphic section. This procedure also indicated that a section of Hole 844B had been double-cored. To rectify this problem, one core was recovered between 24 and 33.5 mbsf in Hole 844D. Three logging runs were made in Hole 844B using the standard lithostratigraphic string, geochemical string, and formation microscanner (FMS).

By means of magnetic susceptibility, GRAPE density and color spectral data from a newly developed core color scanning instrument, it can be shown that holes 844B-D recovered a continuous sequence of the upper 185 m of section.

The sediment sequence can be divided into three lithologic units. Unit I (0-22 mbsf; Pliocene-Pleistocene) is clay-rich biogenic silica ooze with minimal carbonate. Unit II (22-74.9 mbsf; late Miocene to early Pliocene) is an alternating carbonate and silica-rich biogenic ooze. Unit III (74.9-291 mbsf; late early Miocene to late Miocene) is dominated by biogenic calcium carbonate with lithologies ranging from diatom nannofossil ooze to foraminifer nannofossil ooze.

Calcareous nannofossils, radiolarians and diatoms are generally present throughout the sequence, providing a well-constrained biostratigraphy. Planktonic foraminifers are rare to absent in the upper 75 m, but are common to abundant through the remaining cored interval.

Paleomagnetic results show that a continuous, unambiguous paleomagnetic stratigraphy characterizes the upper Miocene to Pleistocene section. All magnetic events, except for a short normal event at the base of Chron C4, have been detected. The relatively good preservation of many fossil groups, combined with the paleomagnetic results, will make Site 844 an important stratigraphic reference section.

Site 845

[9°34.95' N, 94°35.45'W; Water Depth: 3729 m]

Site 845 is also located in the Guatemala Basin (Figs. 1, 2). The site is in an area affected by both the westward-flowing North Equatorial Current (NEC) and the eastward-flowing NECC. The primary paleoceanographic objectives of Site 845 were to collect a continuous late Neogene high-resolution record of paleoclimatic and paleoceanographic variability and to take advantage of the expected significant terrigenous component to calibrate equatorial biostratigraphies with the paleomagnetic record.

Three holes were drilled. Hole 845A was APC-cored to 207 mbsf, where excessive necessitated switching to the XCB for coring to basement at 291.6 mbsf. Hole 845B was APC-cored to 202.6 mbsf. The interval between 20 and 48.5 mbsf was APC-cored again (Hole 845C) in order to recover overlapping sections in an interval missed by holes 845A and 845B. Compilation of magnetic susceptibility, GRAPE density, and color spectral reflectance shows that a continuous section from the upper 207 mbsf was recovered. Three logging runs were made in Hole 845B using the standard lithostratigraphic string, geochemical string, and FMS.

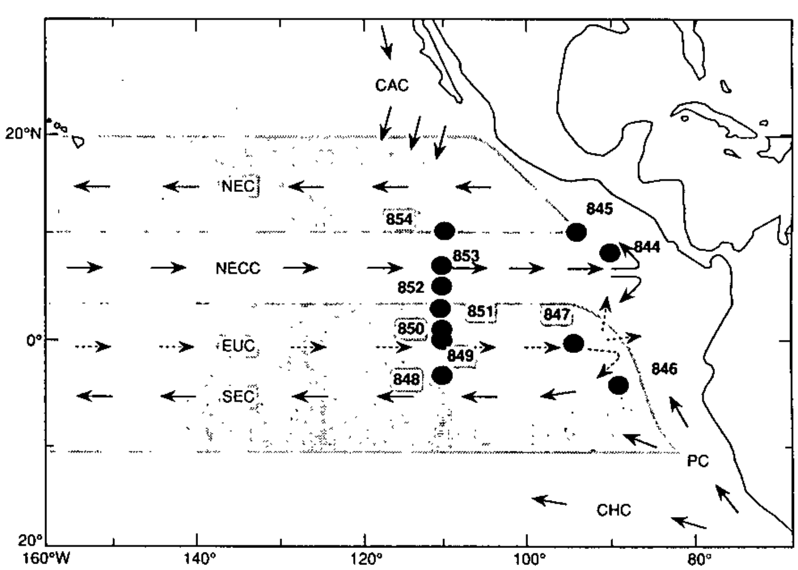

Figure 1. Site location map. CAC, California Current; CHC, Chile Current; NEC, North Equatorial Current; NECC, North Equatorial Countercurrent; EUC, Equatorial Undercurrent; SEC, South Equatorial Current; PC, Peru Current.

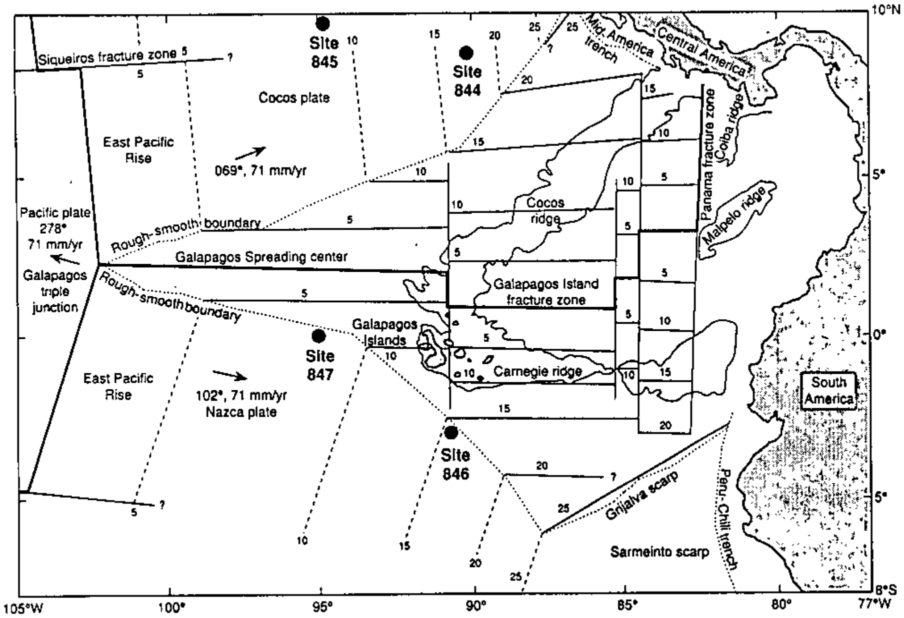

Figure 2. Eastern transect: plate tectonic setting.

The sediment sequence can be divided into two lithologic units. Unit I (0-136 mbsf; late Miocene to Pleistocene) is diatom-clay and radiolarian-clay with only one isolated occurrence of pelagic carbonate. Unit II (136-291 mbsf; middle Miocene to late Miocene) is mainly nannofossil ooze with a distinctive transitional siliceous-carbonate interval, including clay- and iron- rich horizons at its top and a thin sequence of metalliferous sediments above basaltic basement.

The continuous sedimentary section spans the time interval from late Pleistocene to early Miocene. Calcareous nannofossils, radiolarians and diatoms are generally present throughout the sequence, providing a well-constrained biostratigraphy. Planktonic foraminifers are rare to absent in the upper half of the section, but are common to abundant through the remaining cored interval. Calcareous nannofossils are dissolved in the Pliocene-Pleistocene, but show good preservation in the lower to middle Miocene.

Paleomagnetic results from Site 845 show that a continuous, unambiguous paleomagnetic stratigraphy was recovered from the interval between 50 and 200 mbsf, representing a period from middle Miocene (~13.4 Ma) to middle Pliocene (~2.7 Ma). In the upper 50 m, magnetization was too weak to be interpretable (possibly due to relatively high organic carbon content, which may result in dissolution of magnetic minerals). For the middle Miocene, however, Site 845 provides a high-resolution polarity record showing three short, normal polarity features (chrons C3A, C4, and C4A) that have not been recognized by currently accepted magnetic polarity time scales.

The 17-Ma basement age is significantly older than that estimated from subsidence modelling or calculated spreading from the East Pacific Rise. Recently published plate reconstructions suggest a basement age of <15 Ma for this site. Basement age estimates from DSDP Site 495 and results from Site 845 suggest early Miocene spreading rates of up to 81 mm/yr for this sector of the eastern Pacific. If the Beranga Rise is a fossil spreading center, then the estimated age of extinction is ~15 Ma.

Site 846

[3°05.77'S, 90°49.08'W; Water Depth: 3320 m]

Site 846 is located ~300 km due south of the Galapagos Islands (Figs. 1, 2). It is situated within the region of interaction between the South Equatorial Current (SEC) and the Peru Current (PC). Drilling at this site was designed to examine the detailed history of the PC, its interaction (or lack thereof) with the SEC, and linkages between the history of these currents and global climatic change.

Four holes were drilled. Hole 846A was a single APC mudline core dedicated to whole-round geochemical and physical property measurements. Hole 846B was APC-cored to 197 mbsf, where excessive overpull (140,000 lbs) made necessary the switch to the XCB for coring to basement at 420 mbsf. The last core recovered 1.5 m of basalt. The APC section was repeated in Hole 846C (to 192.5 mbsf) and Hole 846D (to 163.3 mbsf) to ensure complete recovery of the section. Hole 846D was continued with XCB to a final depth of 249.5 mbsf. Three logging runs were made in Hole 846B using the standard lithostratigraphic string, geochemical string and FMS.

The sedimentary sequence can be divided into two lithologic units. Unit I (0-317 mbsf; middle Miocene to Pleistocene) alternates between carbonate (mostly nannofossil) ooze and siliceous (both diatom and radiolalarian) ooze. Unit II (317.0-419.2 mbsf; early Miocene to middle Miocene) is composed mostly of nannofossil ooze. The upper portion has minor siliceous constituents but contains several cherty intervals; the lower part is a nannofossil chalk with foraminifers; siliceous microfossils are virtually absent. A thin sequence of metalliferous sediments lies immediately above basaltic basement.

The continuous sedimentary section spans the time interval from the Quaternary to the early Miocene with a 300-m thick, expanded sequence from the Pleistocene through the upper half of the Miocene. Sedimentation rates during this interval were >40 m/m.y. The lower half of the sequence is more condensed, with the upper to lower Miocene represented by ~120 m of section. A marked change in sedimentation rate occurred at ~7.1 Ma with the interval spanning the middle/late Miocene boundary accumulating at ~12 m/m.y. The base of the sequence is assigned to lower Miocene calcareous nannofossil zone CN3, ~16.5 Ma.

Radiolarians and diatoms are abundant from the upper Miocene to the Pleistocene; in the middle Miocene they begin to show signs of dissolution and in the lower-middle Miocene and lower Miocene they are absent. Calcareous nannofossils are generally abundant and well-preserved throughout the section, with the exception of the lowermost upper Miocene, where they are rare and poorly preserved. Planktonic foraminifers are common in the Pleistocene and Pliocene, but their abundance and preservation deteriorate down section.

The paleomagnetic signal at Site 846 was very weak; it was impossible to determine directions reliably. A weak, "soft" remanence was observed, but will have to await shorebased work for evaluation. The susceptibility record, while of very low amplitude, appears to be correlative from hole-to-hole.

Interstitial water sampling shows the influence of diagenesis, recrystallization and basalt alteration. A mildly reducing environment is indicated by profiles of alkalinity, sulfate, ammonia and the smell of H_2S. Calcium, silica, and strontium indicate ongoing recrystallization, most pronounced in the Miocene. Alteration of basement rocks is shown in downhole profiles of magnesium, calcium, potassium, lithium, and strontium and the first appearance of chert is dramatically indicated by a decrease in interstitial silica.

Site 847

[0°11.59'N, 95°19.20'W; Water Depth: 3346 m]

Site 847 is the equatorial divergence site of the eastern transect (Figs. 1, 2). The site, located 21 km from the equator and ~380 km west of the Galapagos Islands, was selected to provide a detailed record of equatorial divergence near the eastern boundary of the Pacific in a region where the Equatorial Undercurrent (EUC) surfaces and interacts with surface waters. The backtrack path for this site indicates that it has remained within the equatorial divergence zone for its entire history.

Four holes were drilled. Hole 847A was a single APC mudline core dedicated to whole-round geochemical and physical property measurements. Hole 847B was APC-cored to 139 mbsf, where excessive overpull made necessary a switch to the XCB for coring to 251 mbsf. There XCB penetration was stopped and small amounts of chert were recovered. The silica yields on geochemical logs suggest that a layer containing significant chert was at least 4 m thick. Hole 847B terminated at this layer. Hole 847C was drilled with the APC to 125 mbsf, and then continued with the XCB to 232 mbsf. The overlapping XCB section demonstrates the high quality of recovery by the XCB in pelagic sediments of this region; the cored section will allow continued study of high-resolution paleoceanographic and paleoclimatic processes well into the Miocene. A fourth hole, Hole 847D, was drilled to 130 mbsf with the APC system to further ensure that a continuous APC section was recovered and to provide the volume of material necessary for high-resolution paleoceanographic studies.

The sedimentary sequence can be described by one lithologic unit dominated by nannofossil and diatom nannofossil ooze, representing continuous sediment accumulation during the last 6.8 million years. There are two intervals (1.5-1.9 Ma and 4.3-4.6 Ma) when the section is dominated by diatom ooze. Sedimentation rates average ~30 m/m.y., with a maximum rate of >50 m/m.y. during the early Pliocene.

The paleomagnetic signal at Site 847 was very weak; it was impossible to determine directions reliably. Radiolarians and diatoms are abundant from the upper Miocene to the Pleistocene. Calcareous nannofossils are generally abundant and well-preserved in the Pliocene and Pleistocene. Planktonic foraminifers are common in the Pleistocene, but their abundance and preservation deteriorate down section.

High-resolution GRAPE and sediment color reflectance records obtained from the overlapping APC section, combined with initial biostratigraphy, show that Milankovitch orbital frequencies are preserved in these sedimentary properties. Initial analysis suggests that it may be possible to tune these records to at least 5 Ma, and thus provide a very high resolution chronostratigraphic framework for paleoceanographic studies.

Early Miocene (~22 Ma) nannofossils were found in the lower part of the section, as well as associated with the recovered chert. The age of this material presents a fundamental dilemma regarding the tectonics of this region. Reconstructions suggest crustal ages of <9 Ma, and thus would preclude a source for 22 m.y. old sediments.

Interstitial water chemistry shows the influence of diagenetic processes and possibly upward fluid advection. Profiles of alkalinity, ammonia, and sulfate indicate modification by advection, as do convex-upward profiles of sodium and chloride. This evidence for fluid advection, as well as the relatively high temperature gradients recorded (~0.076°C/m), provide an explanation for the presence of chert at relatively shallow depth.

Western Transect

Site 848

[2°59.63'S, 110°28.79'W; Water Depth: 3866 m]

Site 848, is the southernmost site of the western transect (Fig. 1). This transect, situated along 110°W, was designed to sample various elements of the equatorial circulation system in an area far removed from the influence of the eastern boundary of the Pacific. The transect also serves as the eastern end-member of a series of studies (legs 85 and 130) aimed at understanding regional and global responses of the equatorial Pacific to climatic change.

Four holes were drilled. Hole 848A was a single APC mudline core dedicated to whole-round geochemical and physical property measurements. Hole 848B was APC-cored to 93.3 mbsf, where the APC struck basement; small amounts of basaltic glass were recovered in the core catcher. One XCB was attempted in basement, but it returned empty. The section was repeated in Hole 848C (APC to 91 mbsf, one XCB to 94.2 mbsf) and Hole 848D (93.9 mbsf) to assure continuous recovery and to provide the volume of material needed for high-resolution paleoceanographic studies. A single logging run using the geochemical tool was made in Hole 848B.

The sedimentary sequence can be described as a single lithologic unit dominated by foraminifer nannofossil ooze; carbonate contents are typically >60%. Siliceous microfossils are present in minor amounts throughout the section. However, thin layers of diatom nannofossil ooze with radiolarians (containing up to 30% diatoms and increased radiolarian and clay percentages) are rhythmically interbedded throughout the sequence. Near the bottom of the section, sediments are characterized by an increase in reddish-brown semi-opaque oxides, representing the influence of hydrothermal deposition near the ridge crest.

Radiolarians and diatoms are abundant, with moderate to good preservation from the upper Miocene to the Pleistocene, though the lower 10 meters of the section is barren of diatoms. Calcareous nannofossils are generally abundant, with good to moderate preservation that allowed zonation of the entire section. Foraminifers are abundant in the upper Pleistocene, with their abundance and preservation deteriorating down section.

The paleomagnetic signal at was variable; polarity reversals are resolvable in the upper 47 mbsf (0-4.7 Ma) and in the interval from 72 mbsf to basement (6.8-10.5 Ma). The upper zone contains every major polarity chronozone and subchronozone between the Bruhnes and the Thvera. At these low latitudes, polarity reversals are primarily identified by declination pattern. Success of the multishot tool in providing core orientation is directly responsible for providing this extremely rare, deep-ocean, equatorial Pacific magnetic reversal record.

The continuous sedimentary section spans the time interval from the Quaternary to the middle Miocene. Excellent biostratigraphic and magnetostratigraphic control has resulted in a fairly detailed sedimentation rate curve in much of that section. Sedimentation rates are relatively low (~5 m/m.y.) in the early late Miocene and Pliocene and are elevated (>15 m/m.y.) in the late Miocene and Pleistocene.

Interstitial water sampling shows that the influence of diagenesis is restricted to the top of the sediment column by low sedimentation rates. Calcium, silica, strontium and lithium indicate that, while there is some recrystallization within the sediment column, it is very limited. There is, however, evidence for alteration of basaltic basement in profiles of sodium, chloride, alkalinity, magnesium, potassium and silica, though it is restricted to the bottom of the hole.

Site 849

[0°10.99'N, 110°31.18'W; Water Depth: 3850 m]

Site 849, <20 km from the equator (Fig. 1), is presently located within the equatorial-divergence zone. Four holes were drilled. Hole 849A was a single APC mudline core dedicated to whole-round geochemical and physical-property measurements. Hole 849B was APC-cored to 120.7 mbsf, before excessive over-pull required switching to the XCB for coring to basement at 350.5 mbsf. After completing three logging runs in Hole 849B, Hole 849C was APC-cored to a depth of 104.5 mbsf. Hole 849D was APC-cored to 108.5 mbsf and then continued with the XCB to a total depth of 326.7 mbsf, when the time allocated for completion of operations at Site 849 was reached. Three logging runs were completed, including the geophysical and geochemical tool strings and FMS.

The sedimentary sequence can be described as a single lithologic unit composed primarily of diatom nannofossil ooze with minor intervals of diatom ooze. The sediment is characterized by a very high degree of variability that is best described by the high-frequency changes in GRAPE density (which primarily reflects calcium carbonate content) and in color reflectance. These signals show a remarkable correlation with other Leg 138 sites, indicating the degree to which these data sets may provide high-resolution stratigraphy. The correlation is so strong that it is possible to use correlations from Site 846 (>1900 km east of Site 849) to resolve gaps between successive XCB cores in Site 849.

Magnetic intensities were too low at this site to provide a magnetostratigraphy. Radiolarians and diatoms are abundant, with moderate to good preservation from the upper Miocene to the Pleistocene, though the lower 10 meters of the section is barren of diatoms. Calcareous nannofossils are generally abundant and well preserved throughout the Pleistocene and Pliocene, with slight etching of some placoliths and moderate to strong overgrowth of discoasterids in the Miocene. Foraminifers are common in the Pleistocene and late Pliocene and rarer in the rest of the section. Preservation of foraminifers is, however, poor throughout the sequence.

Sedimentation rates at this site are relatively high during the late Pliocene and Pleistocene, ranging from 25 to 35 m/m.y. During the late Miocene and early Pliocene, rates are extremely high, ranging from 55 to as much as 100 m/m.y., providing a greatly expanded section. The lowest sedimentation rates in the section (~15 m/m.y.) are found in the oldest sediment (between 8 and 10 Ma).

The chemistry of interstitial water at Site 849 is influenced by recrystallization and diagenesis. Diffusive transport of some constituents is disrupted by a layer of diagenetic carbonate found at ~235 mbsf (~6.2 Ma). This layer effectively seals off the bottom 100 m of the sediment column, disrupting diffusive communication between the material above and below. The effect of this layer is seen in profiles of alkalinity, sulfate, ammonia, calcium, and strontium; above the layer these profiles are controlled by diagenesis, below they are controlled by diffusion.

Site 850

[1°17.83'N, 110°31.29'W; Water Depth: 3798 m]

The combination of good fortune and the combined skills of the SEDCO and ODP crews put us in the enviable position of being able to consider drilling an additional site beyond those outlined in the original scientific program. After careful consideration, we selected Site 850 at 1°17'N (Fig. 1) in order to increase the spacial resolution along the western (110°W) transect. Oceanographic and biologic studies in this region have shown that the equatorial divergence zone exhibits very strong and narrow (±1° of latitude) gradients, especially in surface production.

The selection of Site 850 was based on seismic data collected during the Venture site survey cruise on the RV *Thomas Washington*. Because of limited time, only two holes were drilled. Hole 850A was APC-cored to a depth of 74 mbsf. Hole 850B was APC cored to 98 mbsf, when excessive pullout required switching to the XCB for coring to basement at 399.9 mbsf. Three logging runs were completed, including the geophysical and geochemical strings as well as the FMS. While double APC coring, in conjunction with realtime monitoring of GRAPE, susceptibility and color-reflectance profiles have assured complete coverage of the upper 75 m, experience has shown that the section that contains only one APC and XCB will inevitably have some gaps. We hope to be able to determine the extent of these gaps by correlation of the continuous GRAPE record with nearby sites.

The sedimentary section at Site 850 spans the upper middle Miocene to Pleistocene and can be represented as a single lithologic unit of nannofossil ooze with varying proportions of other microfossil constituents. The uppermost 76 m (0-3.4 Ma) is richer in foraminifers and radiolarians than the average for the rest of the section. Between 76 and 255 mbsf (3.4-6.8 Ma), the section is dominated by diatom nannofossil ooze with interbeds of nannofossil diatom ooze. Between 255 and 395 mbsf (6.8-10.5 Ma), the sediment is radiolarian and diatom nannofossil ooze. In this lower interval, there are several distinctive layers of laminated nannofossil diatom ooze and very thinly-bedded chert. The 5 m above basement (10.6 Ma) is iron-oxide rich metalliferous sediment.

Based on results at other near-equatorial sites, we expected very little paleomagnetic signal. We were quite pleasantly surprised when an interval from 55-69 mbsf (2.9-3.4 Ma) showed a strong and coherent pattern, with five reversals spanning the Keana subchron to the Gauss/Gilbert boundary. The origin of the strong magnetic signal in this interval is, at present, not understood. The interval has neither anomalous sedimentation rates nor a change in redox conditions. Whatever its cause, the presence of an equatorial high-sedimentation rate interval with good magnetostratigraphy is unique and an important addition to the stratigraphic framework being developed for Leg 138 sites.

Preservation of calcareous nannofossils, radiolarians, and diatoms is generally moderate to good, with the exception of the lowermost 10 m (10.6 Ma) which lacks diatoms. Preservation of foraminifers is moderate down to about 65 mbsf (3 Ma) and poor through the rest of the sequence.

Sedimentation rates show a pattern similar to those at Site 849, with the highest rates being found in the late Miocene and early Pliocene. However, there are important differences reflecting steep gradients within the equatorial region. Rates are lower during the Pliocene and Pleistocene, compared to Site 849. Based on backtrack paths, the gradient in sedimentation rates switches only during the brief period that Site 850 passes under the equatorial-divergence zone. Thus, even over long time scales, gradients observed in surface ocean processes of the equatorial Pacific are recorded in the sediment record.

As at nearby Site 849, the presence of chert layers appears to divide the section into two distinct zones with respect to interstitial water chemistry. Above the cherts, microbial degradation of organic matter consumes sulfate, generating concave-downward and concave-upward profiles of sulfate and alkalinity, respectively. Below the cherts, both sulfate and alkalinity return to seawater values. Ammonia decreases 22-fold across this boundary, while potassium is invariant. Magnesium and calcium decrease downhole and silica increases with depth, consistent with reaction with biogenic silica.

Site 851

[2°46.22'N, 110°34.31'W; Water Depth: 3772 m[

The present location of Site 851 is at the northern edge of the westward-flowing SEC (Fig. 1). The site was selected to provide the latest Neogene history of the oceanic conditions within this highly productive region.

Site 851 is located ~860 km west of the East Pacific Rise, on crust generated about 11-12 Ma. The backtrack path of the site is straightforward, constrained only by movement of the Pacific Plate. Poles of rotation of the Pacific Plate have been estimated based on hot spot traces and also using the age distribution of sediments from DSDP sites along the equatorial sediment bulge. Depending on which of these rotation schemes is used, the equatorial crossing of Site 851 differs by as much as 2 m.y.

From an original ridge crest depth of ~2800 m, the site has subsided to its present depth of 3772 m and, in so doing, has intercepted a regionally and temporally variable lysocline. Throughout its history, Site 851 has been above the CCD. The combination of triple APC and double XCB, in conjunction with the realtime monitoring of continuous core logs (GRAPE, susceptibility, and color reflectance), assured almost continuous recovery of the 320 m-thick section. The sedimentary sequence spans the interval from the uppermost middle Miocene to the Pleistocene, and can be described as a single lithological unit composed of varying mixtures of foraminifer nannofossil ooze and diatom nannofossil ooze.

The pattern of sedimentation is typical of pelagic sediments within this region. The first sediment to accumulate was a nannofossil ooze containing substantial iron-oxides and clays. Initial sedimentation rates are ~50 m/m.y. As with many sites in the equatorial region, sedimentation rates drop after 10 Ma. Sedimentation rates during the time interval 10-8 Ma are ~35 m/m.y. This rate is higher than that of Site 849, which should have been south of the equatorial divergence region at this time, but about the same or possibly lower than that at the nearest southerly site, Site 850. Based on pole rotation for the Pacific Plate, Site 850 would be a little more than a degree from the equator during this time period. This interval of reduced sedimentation rate is characterized by increased dissolution of calcium carbonate, which coincides with a similar event seen at all Leg 138 sites that seems to represent a major dissolution event. The record is thus a complicated interplay of large-scale temporal changes in ocean chemistry superimposed on more local responses to surface current regimes.

At ~7 Ma, there is an increase in sedimentation rates to ~65 m/m.y., which is reflected in an increase in mass accumulation rates of calcium carbonate, organic carbon and non-carbon material. As at other sites drilled during Leg 138, the latest Miocene and early Pliocene are marked by high sedimentation rates, though not as high as previous sites drilled along the 110°W transect. While these rates are relatively high, they are ~40% less than those at sites 849 and 850. During the Pliocene and Pleistocene, sedimentation rates decrease to a relatively constant 20 m/m.y. Again, this decrease is paralleled by decreases at more southerly sites. However, as expected from productivity gradients in the modern Pacific, recent sedimentation rates at Site 851 are less than those estimated for sites 850 and 849.

In many aspects, Site 851 continues trends in sediment, porewater and physical gradients defined along the 110°W transect: Sedimentation rates are relatively high, but lower accumulation rates of organic carbon are reflected in less reducing porewaters, better preservation of calcium carbonate, and the presence of a stable magnetic signal for at least the last 4 million years.

Site 852

[5°17.55'N, 110°4.53'W; Water Depth: 3872 m]

Site 852 is presently located at the seasonal boundary between the westward-flowing SEC and eastward-flowing NECC (Fig. 1). Four holes were drilled. Hole 852A was a single APC mudline core dedicated to whole-round geochemical and physical property measurements. Hole 852B was APC-cored to 113.4 mbsf before the final APC core struck what was assumed to be basement. Hole 852C was APC-cored to 110.5 mbsf and one XCB core was attempted to sample the interval not penetrated by Hole 852B. Hole 852D was then APC-cored to 116.0 mbsf. A single logging run using the geochemical tool was completed in Hole 852D. Analysis of continuous GRAPE, susceptibility and color-reflectance measurements showed that 100% of the section was recovered.

The sedimentary sequence at Site 852 spans the interval from uppermost middle Miocene to Pleistocene and can be described as a single lithologic unit. Pliocene and Pleistocene sediments are characterized by a mixture of foraminifer nannofossil ooze and nannofossil foraminifer ooze with common oxide-rich beds, underlain by Miocene and lower Pliocene radiolarian nannofossil ooze.

Sediments from the upper 79 m and in the interval from 110 mbsf to the base of the section display stable magnetic remanence. In the upper interval, the Brunhes chron through the top of chron C3A can be identified, providing chronostratigraphic control for the past 5 to 6 m.y. The lower interval can be correlated to the paleomagnetic time scale as the upper part of chron C4A to the upper part of chron 5.

Calcareous nannofossils are abundant and display good or moderate preservation throughout the section. Planktonic foraminifers are abundant or common, but poorly preserved in the Pleistocene and upper part of the Pliocene. In the lower part of the section, their preservation is poor and barren zones are observed. Radiolarians are common, with moderate to poor preservation in the Pleistocene and Pliocene. They are more abundant and better preserved in the upper and upper middle Miocene. Diatom abundances varies throughout the section, being rare to few in the Pliocene and rare to abundant in the Miocene.

Sedimentation rates during the late Pliocene and Pleistocene are relatively constant, averaging ~12 m/m.y. As seen at all other sites along the 110°W transect, rates during the late Miocene and early Pliocene (8 to 4 Ma) are higher than during the younger interval. Rates during this period range from 15 to ~23 m/m.y. Within this interval of generally higher rates, the interval from 6.5 to 7.5 Ma shows a marked decrease to 12 m/m.y. Sedimentation rates at the base of the site, between 8 and 10 Ma, reach the lowest levels observed. The overall reduced sedimentation rates throughout the history of Site 852 are consistent with estimated paleolatitudes, which suggest that Site 852 was never within the equatorial high productivity region.

Site 853

[7°12.65'N, 109°45.07'W; Water Depth: 3726 m]

Site 853 is located in the eastward-flowing NEC (Fig. 1). The objective of drilling was to provide a record of the late Neogene history of the NEC, as well as a record of accumulation resulting from transport of eolian sediments in the northern hemisphere trade winds.

Five holes were drilled. Hole 853A was a single APC mudline core dedicated to whole-round geochemical and physical property measurements. Hole 853B was APC-cored to 72.4 mbsf before the final APC core struck what was assumed to be basement. The core cutter in the last core sacrificed itself with recovery of basalt. Hole 853C was APC-cored to 66 mbsf and one XCB core was drilled to basement. Hole 853D was APC-cored to 68.8 mbsf. Finally, two APC cores were taken in Hole 853E to sample an interval where the collapse of a core liner in a previous hole resulted in a damaged section and some uncertainty in the construction of a complete composite section.

Bad weather during drilling operations caused significant heave, and for the first time on Leg 138 it was difficult to control overlap in adjacent APC-cored holes. Even with the number of holes drilled, a short gap is present in the section. For the first time since Site 844, an interval was re-cored by successive APC cores. Thus, even with a large heave compensator such as on the *JOIDES Resolution*, ship motion can result in difficulties in recovering continuous records for paleoceanographic study.

Sediments in the 73-m section are dominated by calcareous microfossils, with minor amounts of clay, foraminifers and oxides. Siliceous microfossils are present in minor amounts in the upper few meters and rare or absent throughout the rest of the sequence.

Stable magnetic remanance was measured throughout the entire section. With the exception of three short intervals, polarity direction could be defined. Magnetic reversal pattern could be correlated to the magnetic polarity time scale for all events from Chron C4A through the Brunhes.

A well-constrained biostratigraphy was obtained primarily from calcareous nannofossils. Comparison of paleomagnetic and nannofossil stratigraphies provides new biochronologic data for calibration of nannofossil events. Foraminifers are poorly preserved and abundant only in the Pleistocene and Pliocene. Radiolarians and diatoms are rare and poorly preserved in the younger interval and present as scattered fragments in the Miocene.

Sedimentation rates, based on the excellent paleomagnetic results, are ~15 m/m.y. in the late Miocene, decrease to ~8 m/m.y. in the Pliocene and to 4-5 m/m.y. in the Pleistocene. Superimposed on this general decrease in sedimentation rates are short intervals of increased rates in the latest Miocene and early Pliocene, similar in pattern to changes seen at other sites drilled during Leg 138. The overall reduction in sedimentation rates throughout the history of Site 853, and the marked decrease in siliceous microfossils, are consistent with reduced productivity associated with the more northerly position of this site.

Site 854

[11°13.43'N, 109°35.65'W; Water Depth: 3772 m]

Site 854 is presently located within the westward-flowing NEC (Fig. 1) and in an area of relatively thin sediment cover. The objective was to provide a record of eolian sedimentation in a region influenced by northern hemisphere trade wind circulation, with minimal direct influence of southern hemisphere trade winds.

Three holes were drilled. Because of thin sediment cover and limited time available, Hole 854A was first APC-cored to 28.7 mbsf. To prevent damaging the APC core by striking basement and possibly forcing a pipe-trip, a single XCB core was tried, and then Hole 854A was drilled to basement at 46.5 mbsf. This depth was in close agreement with an estimate based on 3.5 kHz records collected during the pre-site survey. Holes 854B and 854C were then APC-cored to 45.4 and 46.0 mbsf, respectively.

Dominant lithologic components in the 46-m sedimentary sequence are clay, nannofossils, foraminifers and metalliferous oxides. The upper 22 m consist of alternating foraminifer ooze, nannofossil ooze, and clay. Between 22 and 32 mbsf, the sediment is a more homogeneous oxide-rich clay with lesser amounts of nannofossils and minor amounts of zeolites. Nannofossil content again increases in the interval between 32 to 38 mbsf. Below 39 mbsf, black metalliferous clay and clayey metalliferous sediment high in iron and manganese oxide were recovered. This black metalliferous sediment was not recovered at any of the previous sites.

All major fossil groups are found in the upper Pliocene and Pleistocene section. With the exception of foraminifers, which exhibit poor preservation, the chief microfossil groups exhibit moderate to good preservation. Calcareous nannofossils indicate the first hiatus detected on Leg 138. This hiatus is marked by a Mn-rich "hard ground" layer and extends from nannofossil zones CN12 to CN9b. Below this hiatus, foraminifers and siliceous microfossils are generally absent, and calcareous nannofossils are generally poorly preserved.

Magnetic remanence is very stable throughout. Even though the multishot camera could not be used, the continuously recovered section in the three holes, together with a stable inclination pattern, enabled reasonably unambiguous polarity selections. Nannofossils and radiolarians in the upper 19 m and nannofossils in the lower section provide sufficient time control to constrain the magnetostratigraphic sequence. Above the hiatus, all magnetic events spanning the Brunhes to the base of the Gauss could be identified. Below the hiatus, all magnetic events from the top of C3A to the top of C5 were identified.

Excellent magnetostratigraphy allows a detailed set of sedimentation rate estimates. As expected from the thin sediment cover, sedimentation rates are low, averaging ~5 m/m.y. from ~0 to 3 Ma. The interval between 3.5 and 5.3 Ma is one of very reduced sedimentation and represents the hiatus described above. Sedimentation rates are highest during the interval from 6.5 to ~7.5 Ma, reaching values of ~15 m/m.y. The basal metalliferous sediments accumulated at rates of ~5 m/m.y.

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Leg 139: Sedimented Ridges I

Leg 139 objectives included characterization of fluid flow and geochemical fluxes within a sedimented rift hydrothermal system, and investigation of processes involved with hydrothermal discharge and associated alteration and mineralization.

Site 855

[48°26.56'N, 128°38.27'W, Water Depth: 2456 m]

Site 855 is located along a normal fault that forms the eastern topographic boundary of the sedimented rift valley, Middle Valley, of the northern Juan de Fuca Ridge (Figs. 1, 2). Throw on the fault of ~115 m is greater than the local sediment thickness of ~90 m, so that basement is exposed along the seafloor scarp. Four holes were drilled to form a transect across the hanging wall block. Individual holes were located 40 m (Hole 855B), 70 m (Hole 855A), and 125 m (holes 855C and 855D) from the base of the scarp. Precise estimates of these ranges were obtained from a Mesotech scanning sonar image made of the scarp from the bottom of the drill string prior to spudding the first hole.

Objectives of this transect were to define the cross-sectional geometry and hydrologic nature of this rift-bounding fault, and to determine the nature and rate of fluid flow where seawater may be drawn into basement either along the fault outcrop or through the thin sediment section.

All holes intersected basalt, two in the footwall (855A and 855B) and two in the hanging wall (855C and 855D). Offsets from the scarp and depths to basalt (determined by depths at which drilling rate abruptly dropped) at holes 855A (74 m) and 855B (45 m) constrain the geometry of the fault, which appears to dip at ~45°; depths to basalt at holes 855C (98 m) and 855D (108 m) are consistent with reflection time to basement (120 ms) and acoustic velocities determined for the section.

Drilling conditions and recovery in basalt were poor, with binding and hole collapse typical at all holes. The objective of reaching the normal fault zone at a level of basalt/basalt contact, estimated to be ~35 m sub-basement, was not possible. Operations were terminated after 3, 18, 9, and 11 m of basement penetration at holes 855A, 855B, 855C, and 855D, respectively. Small pieces of basalt were recovered at each hole, with recovery rates averaging 8%. Given the simple fault geometry inferred, this disposition of basement samples may allow the basaltic section to be characterized at three levels: top of basement (holes 855C and 855D), ~60 m sub-basement (Hole 855B), and 100 m sub-basement (Hole 855A). Samples range from porphyritic basalts with large phenocrysts of plagioclase and olivine to basalts containing only sparse plagioclase phenocrysts. Relatively fresh glassy margins are present on many samples, although most samples show various degrees of low-temperature alteration. No systematic spatial or depth variations are evident.

RCB cores in the unconsolidated sediment section were mechanically disturbed and core recovery averaged only 39%. A single lithologic unit was defined, consisting of dark green to gray clay, silty clay, and quartz-plagioclase sandy silt and silty sand, comprising fining-upward turbidite sequences throughout the cored interval. These sequences range in thickness from 13 to 131 cm; Hole 855C cored 28 of them in 98 m. They are readily detected in magnetic susceptibility traces obtained on the multi-sensor track, in which positive peaks correspond with coarse sediments at the bases of turbidites.

Pore waters squeezed from sediments and collected *in situ* with the water-sampling temperature probe (WSTP) indicate that fluids in basement at all four holes are nearly identical to sea water. Chlorinity, alkalinity, calcium, and sulfate all display maxima or minima within the sediment section and then return to seawater values near basement. Coupled with low heat flow found in Hole 855C, these data indicate that sea water is being drawn down into the basalt layer along the outcrop at the fault scarp.

Site 856

[48°26.20'N, 128°40.84'W, Water Depth: 2406 m]

Site 856 is situated over a small hill in the eastern part of Middle Valley (Fig. 2). The structure of this hill is characteristic of others in this and other sedimented rifts. It is roughly circular, ~500 m in diameter, and stands ~60 m above the floor of the valley. Previous studies in this and other areas have indicated that these hills form by uplift of the sediment section above sub-sedimentary intrusions, and are often associated with hydrothermal massive sulfide mineralization. Drilling addressed the origin of these structures, extent and nature of associated hydrothermal

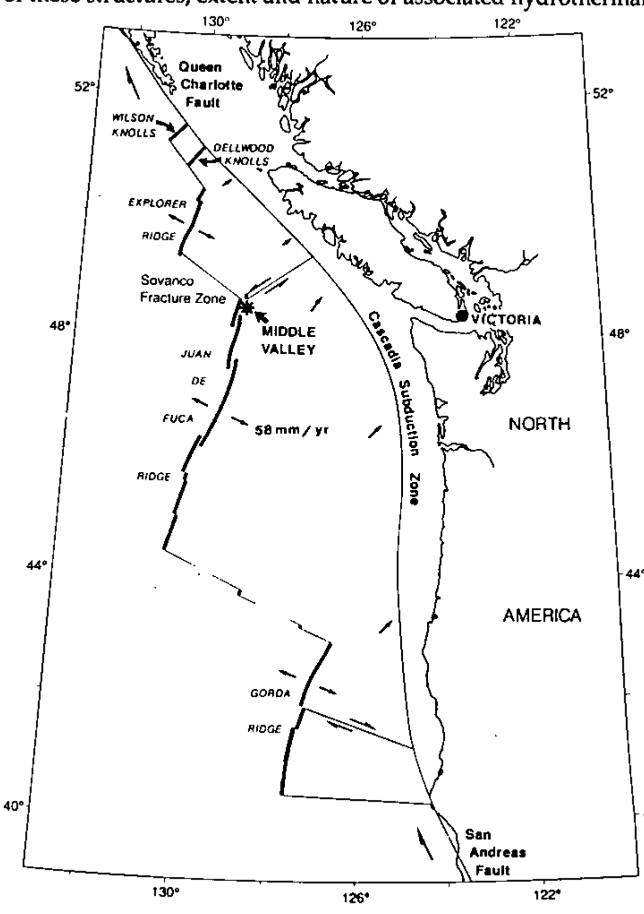

Figure 1. Plate tectonic setting of Middle Valley.

alteration and mineralization, and difficulties of drilling massive sulfides with existing ODP drilling technology.

Operations began with a north-south transect of APC/XCB holes. Holes 856A and 856B were located at the center and southern edge of the top of the hill. Coring recovered basalt from the top of a thick sill at depths of 112 and 120 mbsf, respectively. Overlying sediment is an undisturbed section of semi-indurated turbidites, ~20% less porous throughout than the section sampled at Site 855. Heat flow was found to be 0.60 W/m^2 in Hole 855A and 1.52 W/m^2 in Hole 855B. Although high, these values do not reflect conditions that existed when the hill was formed and was hydrothermally active. Temperatures at the top of the sill are only 50°C in Hole 856A and 150°C in Hole 856B. Porewater compositions suggest that currently there is no flow vertically through the sediment section, although absence of a Pleistocene chlorinity anomaly suggests that seawater has flushed through the sediment at some time during the past 10,000 years. Coarse clastic layers of massive sulfide interbedded with fine sand to silt turbidites were encountered at a depth of ~30 m in Hole 856B. Semi-indurated sediment near the bottom of Hole 856B was weakly overprinted by hydrothermal alteration and mineralized by disseminated barite, pyrrhotite, chalcopyrite and sphalerite.

The transect continued with APC/XCB holes 856C through 856E, distributed over a distance of 60 m across the southern flank of the hill. Massive sulfide, sulfide sand, and sulfide mud were encountered at or immediately beneath the sea floor in all of these holes. This material was difficult to penetrate or recover with either the APC or XCB systems; a final attempt (856F) resulted in no recovery and a bent APC barrel. Having thus defined the minimum extent of this massive sulfide outcrop, it was decided to continue operations with a standard RCB bit, to test this technology in massive sulfides, and to explore the nature and extent of this hydrothermal deposit at depth. RCB drilling was very successful, and the hydrothermal deposit proved to be thicker than expected. Hole 856G penetrated 65 m of massive sulfides with 33% recovery before the bit became inextricably jammed by falling rubble. Hole 856H was then started using a section of drill-in casing and a mini re-entry cone and drilled to 95 mbsf, again through apparently continuous massive sulfides, before hole fill prevented further penetration. Core recovery was 21%.

Recovered massive sulfide is composed predominantly of pyrite and pyrrhotite with subordinate amounts of chalcopyrite ($CuFeS_2$) and sphalerite (Zn,FeS). Late-stage alteration has locally formed magnetite and hematite in some samples and apparently resulted in removal of some sphalerite from the upper part of the deposit. Magnetite and hematite alteration decreases down-hole, resulting in increasing amounts of primary mineralization with higher zinc and copper contents. Only rare fragments of altered sediment are contained in the massive sulfide, suggesting that most or all of it was deposited above the sea floor. The lack of minerals rich in elements such as Pb, As, and Sb, which are typically enriched in sediment-hosted sulfide deposits, suggests that the major source of metals is basaltic basement.

Though shallow, Hole 856H was logged because of its unique character. Logging involved several temperature runs, neutron geochemical log, sonic velocity, and induction electrical resistivity. Results indicate clearly that no sedimentary or volcanic material remained unrecovered (i.e., the sulfide is truly massive). As expected, geochemical logs indicate high iron and sulfur, and low calcium and silicon contents. Resistivities are low, ranging between 0.1 and 0.2 ohm m. The upper 70 m of the hole remained very cool, <2.5°C warmer than bottom water at all times during the logging program, indicating down-hole flow of water into the formation. Temperatures at greater depths increase systematically to ~25°C at 80 m. The bottom of the drilled hole could not be reached because of accumulation of fill. The temperature gradient defined between this point and the sea floor, combined with the typical value of thermal conductivity measured on the sulfide core material (>5 W/m°C), yielded a heat flow that is similar to that measured at the sea floor and in Hole 856B, indicating that the thermal regime before drilling was probably conductive.

Total penetration in massive sulfide at both holes 856G and 856H (up to 95 m) extends to depths (up to 70 m) below the local level of the sedimented valley floor. This suggests that either the hydrothermal deposit fully replaced the sediment in which it lies, or it was constructed by near-seafloor precipitation during sedimentation. The massive nature of the sulfide suggests the latter. Clearly, a large volume of fluid has been involved in producing the deposit. This is presumably common in sedimented rift environments, where inherently low-permeability, nearly continuous sediment cover causes hydrothermal discharge from underlying igneous crust to be highly-focused and long-lived.

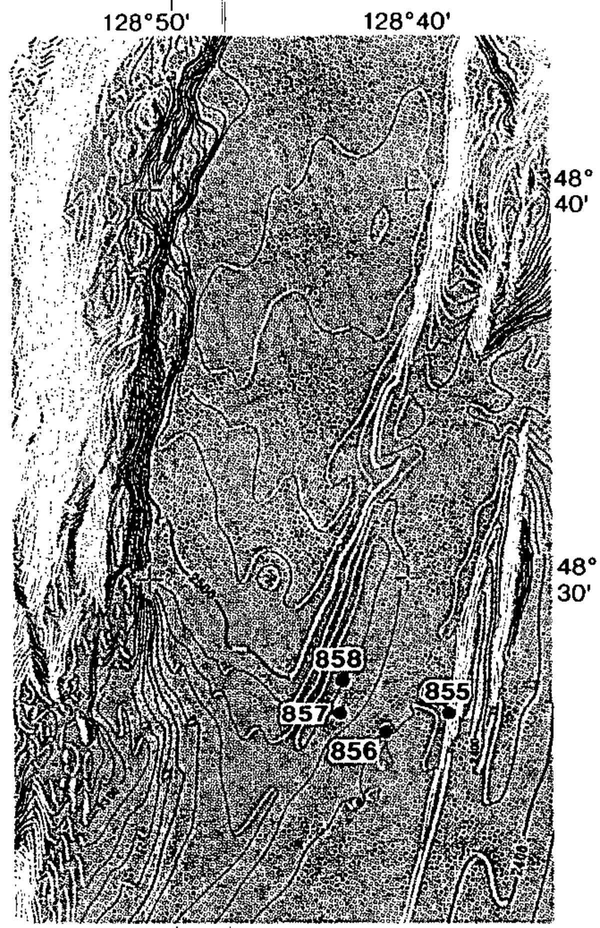

Figure 2. Side-lit bathymetry of Middle Valley showing Leg 139 drill sites. Turbidite sediments enter the valley from the north. The contour interval is 10 m.

SITE 857

[48°26.5'N, 128°42.6'W, Water Depth: 2433 m]

Site 857 is located 5.2 km west of the normal-fault scarp (see Site 855), and ~1.5 km east of the sediment-buried fault that forms the current structural boundary of the central rift (Fig. 2). The primary objective was to penetrate "hydrologic basement" at a point well away from areas of either recharge or discharge, in order to: 1) test the hypothesis that there is a thermally and chemically well-mixed hydrothermal "reservoir" beneath the sediments of the valley, 2) characterize the physical and chemical nature of water-rock interaction within high-temperature basement, and 3) determine how efficiently fluids can be delivered to seafloor vents several kilometers away.

Site 857 lies over a major thermal anomaly, where seafloor heat flow exceeds 0.8 W/m^2 over an area extending 10 km in a rift-parallel direction. Heat flow increases north of the site, toward a hydrothermal vent field 2 km away (near Site 858) where heat flow exceeds 4 W/m^2 and fluids discharge at the seafloor at temperatures up to 286°C.

Operations began with APC/XCB Hole 857A, which was drilled (to 112 mbsf) slightly west of the peak of the heat-flow anomaly to avoid intersecting a bright reflector, inferred to be a sill, at 400 ms in seismic reflection records. An adjacent APC Hole 857B was drilled to 30 mbsf to provide additional temperature data within the upper sediment section. Data from these holes showed that heat flow at this location is conductive at a value of about 0.71 W/m^2, somewhat lower than targeted for this deep-penetration site. For this reason, RCB exploratory Hole 857C was offset 180 m to the east. The conductive temperature gradient measured over the upper 80 m of Hole 857C indicates a heat flow of 0.80 W/m^2. Coupled with the thermal conductivity measurements made on core samples, this heat flow suggests a temperature of over 300°C at the bottom of the hole (568 mbsf).

The sediment section consists of interbedded hemipelagic mud and turbiditic silt and sand that are increasingly indurated with depth. Induration is caused by the high thermal gradient and accompanying diagenetic alteration and metamorphism. At depths less than ~250 mbsf, carbonate concretions and diagenetic pyrite are common. This assemblage gives way with depth to carbonate-cemented clastics, then to pervasively cemented fine and coarse-grained sediment, and ultimately to ferroan carbonate. Below 400 mbsf, detrital feldspars are altered to clay minerals, and magnetite is pyritized by H_2S. At shallow depths, magnetic susceptibility is highly variable, but correlates well with magnetite concentrated in the basal part of turbiditic sands. A 3-5 meter-thick hemipelagic unit at 15 mbsf bearing distinctively low susceptibility is similar to one at Site 856 and may represent an interglacial period characterized by low rates of turbidite sedimentation. Susceptibility decreases from 150 to 250 mbsf, and remains low at greater depths because of increasing alteration of magnetite to iron sulfides.

The first of a series of sills, interbedded with indurated sediment, was penetrated at a depth of 471 mbsf in Hole 857C. The sills are basaltic in composition, with plagioclase and pyroxene phenocrysts set in a fine-grained, hydrothermally altered groundmass, and are properly described as metadiabase. The dominant alteration assemblage consists of chlorite, epidote, and actinolite. The sills are vertically fractured and cut with veins of epidote, chlorite, carbonate, pyrite, chalcopyrite, and sphalerite. Remanent magnetic intensities of igneous rocks are low, from 5 to 30 mA/m, and there is some tendency for remanence to decrease with depth.

Physical properties indicate that the sediment is highly indurated. Porosity decreases systematically with depth, from normal values of ~65% near the seafloor to values as low as 25% at 450 mbsf, and there is a corresponding increase in seismic velocity over this same depth interval, from ~1550 m/s to 3000-3500 m/s. Velocity in the igneous units ranges from 4400 to 4600 m/s. Both indurated sediment and igneous rock are seismically anisotropic; transverse velocities are higher than vertical velocities by 10-15% in igneous units and by up to 20% in sediment (horizontal values are quoted above). Intrinsic porosity of the igneous rock is low, typically <5%, although mineralized and open sub-vertical fractures are present in cored material.

Based on variations in drilling rate, it was inferred that thick intervals of sediment were interbedded with the intrusive igneous rocks, but recovery in these intervals was poor. However, induction, porosity, lithodensity, sonic and natural gamma logs run in Hole 857C are of superb quality and reveal lithologic structure clearly. Six igneous units were intersected that range from 5 to 8 m in thickness; the sedimentary interbeds are from 2.5 to 18 m thick. *In situ* sonic log velocities agree well with vertical-component velocities measured on samples. Electrical resistivities of sediments range from ~0.4 to 0.6 ohm m, and of igneous layers from 3 to 6 ohm m. Resolvable differences are also present from unit to unit, with a tendency for values to decrease with depth. Despite probable high formation temperatures, temperatures measured during logging runs were low, never exceeding about 100°C. This suggests that the lower part of the section is sufficiently permeable to allow thermally significant rates of induced down-hole flow.

In spite of low porosities, pore waters were squeezed from all parts of the section, including one of the more highly altered and porous metadiabase sills. Profiles of composition vs. depth reflect mainly reaction and diffusion; there is no evidence for vertical flow of water through the sediment section. All major dissolved species show large changes from seawater composition with depth. Below 200 to 370 mbsf, most species reach concentrations that become constant with increasing depth, at values very close to those in the vent water that is discharging at up to 286°C at Site 858 2 km to the north.

The initial phase of operations at Site 857 ended after a reentry cone was successfully set with 568 m of grouted-in casing at Hole 857D. The hole was left to re-equilibrate thermally during the time of initial operations at Site 858. Before leaving the site, Hole 857C, which had been left with a free-fall funnel, was reentered. A temperature log was run, then the hole was plugged with cement in order to eliminate any hydrologic, chemical, or thermal influence this hole might have on nearby Hole 857D. Hole 857C in fact appeared to be collapsing and sealing itself, and as a result, the temperature log was only partially successful. A temperature of 230°C was recorded in fill at 472 mbsf, the deepest point reached.

Hole 857D was reoccupied and deepened to a total depth of 936 mbsf, toward the goal of reaching purely igneous "basement," at which point excessive bit wear resulted in termination of the hole. The sequence of interbedded sills and sediment continued to the bottom of the hole. As before, it was inferred from variations in drilling rate that thick intervals of sediment are interbedded with intrusive igneous rocks, but recovery in sedimentary intervals was systematically poor. Induction, porosity, lithodensity, sonic, and natural gamma logs run in holes 857C and 857D revealed lithologic structure clearly and confirmed this inference. Numerous igneous units are imaged clearly in all logs; these range from 1 to 25 m in thickness. The range of thickness of sedimentary interbeds is similar, and volumes of igneous and sedimentary rocks are roughly equal. Electrical resistivity of igneous layers ranges from 3 to 20 ohm m, and there is a tendency for resistivity to increase into the interiors of the thicker sills. Extremely low resistivity, very close to that of seawater, was observed in two thin zones where a loss of circulation pressure during drilling indicated flow into the formation. A run with the formation microscanner (FMS) was also completed in Hole 857D, revealing fracturing throughout the igneous units and in parts of the sedimentary interbeds.

Following logging runs with seismic-stratigraphy and FMS tools, a pipe trip was completed to retrieve the FMS, which had jammed in the bottom of the pipe, and to install the packer bottom-hole assembly. The packer/flow meter experiment went smoothly, and provided excellent constraints on the hydrologic regime in Hole 857D. Slug and steady injection tests were attempted with the packer set in casing; permeability was so high that virtually all of the pressure losses occurred in the pipe and through the packer itself. Formation pressures rose little, even at the maximum rate of injection the drillship's pumps could supply (3000 l/min, 150 strokes/min). Formation pressures measured while the packer was seated confirmed the low pressures that were indicated previously, when circulation was lost; pressure in the formation at the level of the most permeable zone at 614 mbsf is over 1 MPa lower than that in the cold hole. Additional flow-meter tests were completed with the packer element not set. This allowed the full differential pressure between the cold hole and the formation to be applied; flow rates of nearly 10,000 l/min were estimated, with the majority of this flow going into the permeable zone at 614 mbsf, and some going into a zone deeper in the section. This rate of down-hole flow is over 2 orders of magnitude higher than that measured in any other DSDP or ODP borehole. With the hole well-cooled by the flow, a final formation test was carried out with the packer set at 756 mbsf, just below the lower permeable zone. Results from this test also indicate a low relative formation pressure, but in this case the formation could be successfully pressurized with the drillship's pumps, and permeability will be resolvable from the injection and slug tests that were done. Pipe was pulled out of the hole after completing a log through the packer bottom-hole assembly with the litho-porosity tool string.

Final operations at Hole 857D involved setting an instrumented CORK (Circulation Obviation Retrofit Kit), which included a 300 m-long, ten-thermistor temperature-sensor string, a pressure sensor, and plumbing for fluid sampling.

Site 858

[48°27.34'N, 128°42.54'W, Water Depth: 2420 m]

Site 858 is located 1.8 km north of Site 857 (Fig. 2), over an active hydrothermal vent field that extends several hundred meters along and across the strike of Middle Valley. The regional structural setting is similar to that at Site 857; they are both situated ~6 km east of the axis of the rift valley over an uplifted but fully buried basement fault-block. Sediment thickness in the vicinity of Site 858 ranges from 400 to 700 mbsf. The vent field lies above what appears to be a local basement high; several shallow (<300 mbsf), bright reflectors are seen in both single-and multi-channel seismic profiles beneath the site. The seafloor reflection over the vent field is two to three times stronger than that from surrounding sea floor. Heat flow through the seafloor in the region surrounding the vent field is typically ~1.0 - 1.5 W/m², somewhat higher than at Site 857. Measured heat flow in the vent field itself ranges from 4 W/m² to over 20 W/m².

A total of seven holes (858A-858G) were drilled in an array crossing the field and onto the flank of the associated thermal anomaly in an attempt to document local fluid-flow and thermal regimes, and associated sediment alteration beneath and around the vent field (holes 858A - 858D). Holes 858E and 858F were drilled in the immediate vicinity of Hole 858D. A deep reentry hole (Hole 858G) was drilled approximately in the center of the vent field to characterize deeper hydrothermal and geologic structure in the upflow zone and in upper igneous crust beneath the vent field.

Hole 858A was continuously APC-cored to 62.5 mbsf and XCB-cored to 339 mbsf. Drilling ended when penetration rate and recovery dropped below acceptable levels. The hole is located ~100 m west of the vent field area (as defined by seismic, 3.5 kHz, and acoustic side-scan data), and ~150 m west of the nearest currently-active vents. Temperatures measured in the upper 110 m of the hole show the thermal regime to be conductive; the thermal gradient is 1.7°C/m. Preliminary observations of cored material and interstitial fluid indicate that the sediment is highly indurated, but in general has experienced little pore-fluid flux, despite proximity to the vent field. Pore-fluid composition approaches that of active vents below ~240 mbsf, where dissolved calcium reaches concentrations of 70 to 80 mmol/kg. Temperature near the bottom of the hole was estimated to be near 300°C, and the deepest sediment recovered was highly silicified.

Hole 858C was drilled within the distal part of the vent field area (again, as defined by high acoustic backscatter and locally depressed topography) 70 m west of the nearest known vent. Temperature measurements define a temperature gradient of ~3°C/m. APC/XCB cores were collected to 93 mbsf, by which point penetration rate and core recovery had become so poor that the hole was terminated. No indications of focused fluid flow were observed, although a considerable amount of dispersed pyrite and some brecciation were encountered.

Hole 858B was drilled 140 m east of Hole 858C and only a few meters away from a hydrothermal vent where a seafloor vent temperature of 286°C had been measured. A temperature of 197°C was measured with the WSTP at 19.5 mbsf, indicating that the flow feeding the nearby vent is very localized. Pore water of similar composition to that venting was recovered from only 20 mbsf, compared with 240 mbsf in Hole 858A only 260 m to the northwest. The hole was drilled to a depth of 39 mbsf, where core recovery and rate of penetration dropped below acceptable levels. Highly silicified sediment was again encountered where estimated formation temperatures had reached ~300°C.

Holes 858D-858F were drilled in the center of the vent area, ~70 m northeast of the nearest vent (at Hole 858B). APC coring recovered 29 m of sediment in Hole 858D; a temperature of 208°C was measured with the WSTP at a depth of 18.5 mbsf. Hard drilling and low XCB core recovery began at ~30 mbsf, although no silicified rock was recovered, and drilling was terminated at 41 mbsf. Following a jet-in test that led to an aborted Hole 858E, Hole 858F was started 10 m to the south. Together with a deep re-entry hole planned for this location (Hole 858G), its objective was to penetrate through the zone of upflow and eventually into upper igneous crust beneath the vent field. Hole 858F was washed to 26 mbsf; below that, an interval of hard sediment (inferred to be silicified from the very low drilling rate of 70 minutes per core) was penetrated before relatively ... able mud and indurated ...

averaging 1 to 5%. Recovery improved to 5 to 10% below 256 mbsf, where highly altered igneous rock was encountered. Coring of igneous rock continued to 297 mbsf to provide a hole sufficiently deep to permit logging through the sediment/basalt contact.

Logging operations began in Hole 858F with the Sandia dewared high-temperature tool. The tool disengaged from the wireline but was later successfully fished. The LANL tool was used to collect a water sample at 104 mbsf, which turned out to be mostly bottom water. A temperature log using the JAPEX temperature-pressure-flowmeter tool measured a maximum temperature of only 104°C, suggesting that seawater was flowing down into the hole.

Penetration of basalt flows continued in re-entry Hole 858G to a total depth of 432.6 mbsf.

Sediment in all holes is hydrothermally altered, as reflected in mineral assemblages, bulk chemical composition, and physical and magnetic properties. Degree of alteration varies laterally and with depth in a manner consistent with the thermal structure defined by surface heat flow and downhole temperature measurements. The lateral boundary of the upflow system is very sharp, and upward flow of pore fluid at a rate that can be detected thermally or geochemically is limited to the area beneath the vent field itself. Conditions are thermally conductive, and chemically diffusive or reactive, in holes 858A and 858C. Within the vent field, it is inferred that the section is virtually isothermal and chemically dominated by advection deeper than a few tens of meters. Lateral flow appears to be significant at various levels in all holes. Extreme alteration may have resulted in formation of a cap of indurated sediment intersected at 30 mbsf in holes 858B, 858F, and 858G. This cap may represent a fundamental hydrologic unit beneath the field. Unfortunately, very little of this material was recovered. Electrical resistivity logging in Hole 858F imaged a sequence of turbidite layers that correlates well with a similar sequence logged in Hole 857C, 1.6 km distant. This is remarkable, in light of the vast difference in thermal and chemical regimes at the two sites, for two reasons: the porosity signature of the turbidite layers has survived hydrothermal induration, and the section has been vertically compressed by <10% in the process. Correlations can also be drawn between sections at Hole 858A and holes 857A and 857C, based on lithologic and biostratigraphic boundaries.

Igneous basement at Site 858 comprises a relatively uniform sequence of basalt flows. Units are defined primarily on the basis of textural variation. Low core recovery limited the degree to which individual flow units could be recognized, although typically one to two chilled margins were recovered in a given core. Chemical analysis indicates that the flows may be genetically related to the sills drilled at Site 857. The rocks are highly altered, but vein- and dispersed-mineral assemblages show little indication of the passage of high-temperature (>380°C) hydrothermal fluids. Injection tests showed that this basaltic basement is highly permeable. Measurements with a flow-meter in Hole 858G during a steady injection test showed that most of the flow entered the formation in a discrete layer. Temperature measurements showed clear evidence that downhole flow, forced "naturally" by cold, high-density water in the hole, entered the formation at the same depth and cooled it. Temperature measurements in Hole 858G indicate as well that drawdown into the sediment section may have been stimulated where Hole 858F penetrated the cap rock.

After completion of all operations, an instrumented hydrologic seal (CORK) was installed to obviate downhole circulation and to monitor temperature and pressure as the formation returns to equilibrium. The CORK includes a 400 m-long, 10-thermistor temperature sensor string, a pressure sensor and plumbing for fluid sampling. This CORK, and the one left in Hole 857D, will be visited in several weeks by scientists in the submersible *Alvin*, at which time data and fluid samples will be extracted.

Leg 140 Prospectus: Deepening Hole 504B/Hess Deep

During Leg 140 (16 September to 12 November 1991), *JOIDES Resolution* will return to deepen Hole 504B in the eastern equatorial Pacific, the deepest hole ever drilled into oceanic crust. The primary purpose of this leg is to deepen 504B through the dike/gabbro and/or layer 2/3 transition.

Hole 504B presently extends over twice as deep into oceanic crust as any other hole, and is the only DSDP/ODP borehole that unequivocally penetrates through extrusive lavas into sheeted dikes (Fig. 1). It therefore is perhaps the most important reference hole for the structure and composition of "normal" oceanic crust, and represents the best opportunity for sampling the transition between sheeted dikes and underlying gabbros in the context of a complete crustal section.

Leg 140 will be the seventh DSDP/ODP expedition to occupy Hole 504B. The hole was originally spudded during Leg 69, and was then deepened and/or logged during parts of five other DSDP/ODP legs: 70, 83, 92, 111 and 137.

Although previous coring, logging, and geophysical programs at Hole 504B achieved unprecedented scientific success, its operational history 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. They were a particular problem during Leg 111, which experienced several premature bit failures, an overall core recovery rate of <13%, and loss of a large-diameter diamond coring assembly. Lack of time and proper equipment forced the temporary abandonment of the hole before the lost junk could be removed.

Recently, Leg 137 achieved its primary objective: to clean Hole 504B of the junk lost at the end of Leg 111 (see *JOIDES Journal*; Vol. XVII, No. 2, June 1991). Operations throughout the leg showed no indication of supposed problems with the casing, although a borehole televiewer inspection during the last day on site showed flaws with the lower 30-40 m of casing. Leg 137 succeeded in demonstrating that Hole 504B can be advanced to the layer 2/3 transition.

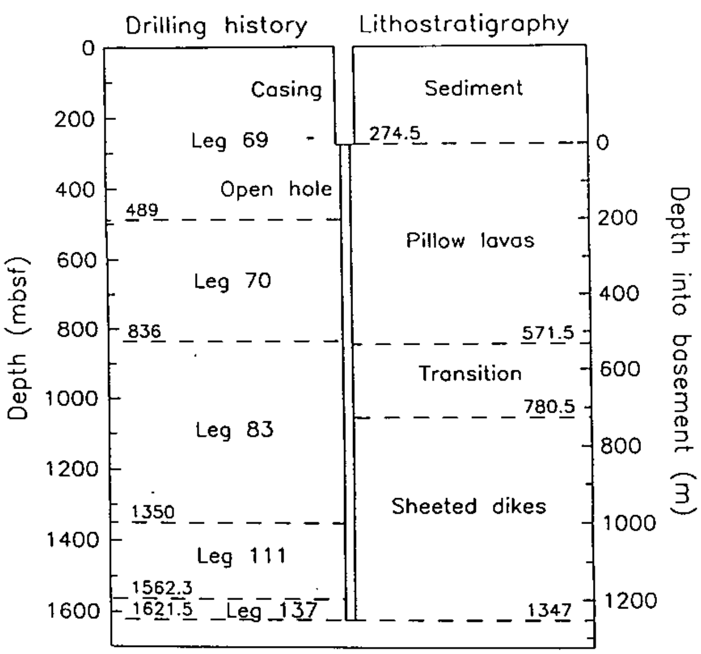

Figure 1. Hole 504B drilling history and lithostratigraphy.

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 be fished with the proper tool. An attempt will be made to do that at the beginning of Leg 140.

Summary of DSDP/ODP Results from Hole 504B

Hole 504B is located in 5.9-m.y.-old crust about 200 km south of the Costa Rica Rift, and presently extends through 274.5 m of sediment and 1347 m of basement, a total penetration of 1621.5 m. Basement penetration is more than twice that of Hole 332B in the Atlantic (583 m). Hole 504B is the only basement hole to have penetrated through extrusive pillow lavas and into underlying sheeted dikes, a transition predicted from studies of ophiolites. The 1347 m of basement cored consists of 571.5 m of pillow lavas and minor flows, underlain by a 209-m zone of transition into 566.5 m of sheeted dikes and massive units. The lithostratigraphy has been determined from core recovery averaging only ~20% (25% in pillows, 10-15% in dikes); it is generally corroborated by an extensive suite of geophysical logs, except that the logs suggest a sharper transition between pillows and dikes. To date, the lithostratigraphy sampled in Hole 504B is the best direct verification of the ophiolite model of oceanic crust. However, this verification is only partial, as the lowermost 3-4 km of oceanic crust have never been sampled *in situ*.

Site survey seismics, heat-flow measurements, downhole temperature, porosity, and permeability data indicate that the crust at Site 504 is at a particularly interesting stage in its evolution: at a relatively young crustal age, thick, even sediment cover has mostly sealed basement against pervasive hydrothermal circulation, and crustal temperatures vary closely about values consistent with predicted, conductive plate heat transfer. Recent detailed heat flow work and numerical simulations indicate that convection still occurs in the permeable, uppermost 500 m of basement beneath the impermeable sediment cover, partly controlled by the presence of isolated basement faults and topographic highs.

Basement rocks recovered are fine- to medium-grained, plagioclase-olivine + clinopyroxene + chrome spinel, phyric basalts, with aphyric types more abundant with depth. All recovered basalts are mineralogically and chemically altered to some extent. Detailed studies of downhole variation of secondary minerals and mineral assemblages document the existence of three major alteration zones:

1. An upper alteration zone in pillows (274.5-584.5 mbsf) displaying typical effects of oxidative alteration commonly observed in DSDP holes.
2. A lower alteration zone in pillows (584.5-836 mbsf) presumably produced by reactions with low-temperature suboxic to anoxic solutions at low water/rock ratios. This zone is

characterized by smectite and pyrite.

3. A high-temperature alteration zone (898-1621.5 mbsf) that produced the first *in situ* samples of ocean floor basalt containing greenschist-facies alteration minerals.

Pronounced changes in alteration mineralogy observed from 836 to 898 mbsf are interpreted to have resulted from a steep gradient between low-temperature (<100°C) alteration solutions circulating in pillow lavas and very high-temperature fluids (>300°C) that affected the lower portion of basement at the site. The transition between pillow lavas and underlying dikes corresponds closely to the transition from low- to high-temperature alteration, because bulk permeability and porosity of the dikes are orders of magnitude lower than in the pillows.

In the deepest 200 m of dikes, the recovered core is only slightly altered, and actinolite and magnetite become relatively more abundnat. Plagioclase is less altered than pyroxene, which is frequently recrystallized to actinolite, in contrast to the dikes above where plagioclase is more extensively recrystallized than clinopyroxene. These observations suggest that temperature of alteration may have been higher in the deepest 200 m, where conditions may have approached "lower actinolite facies."

Despite effects of alteration, primary composition and variation of recovered basalts can be reliably established. Lavas and dikes recovered are remarkably uniform in composition. Their high MgO contents (up to 9.8 wt.%) and very low abundances of K (0.02%) classify these basalts as olivine tholeiites. Judging from their high Mg-values (0.60 to 0.75%), these basalts appear to have undergone only limited high-level crystal fractionation.

Hole 504B has been surveyed with the most extensive suite of *in situ* geochemical and geophysical experiments for any submarine borehole. Geophysical data indicate that *in situ* physical properties of the crust change dramatically across the transition from pillow lavas to sheeted dikes: sonic and seismic velocities and electrical resistivity increase sharply, while bulk porosity and permeability drop by orders of magnitude. These measurements demonstrate that the velocity structure of layer 2 at the site is controlled by variations in porosity with depth. Sonic and seismic data are generally consistent with a sharp layer 2B/2C boundary at the top of the sheeted dikes. Sonic data, but not the much longer-wavelength seismic data, indicate a thin layer 2A, consisting of the uppermost 100-200 m of highly porous pillow lavas. This layer corresponds to a highly permeable, under-pressured zone into which ocean bottom water has been drawn since the hole was drilled. Layer 2B comprises the lowermost 500 m of pillows, in which original porosity has been partially sealed by alteration products.

A vertical seismic profile conducted during Leg 111 indicates that the next major transition, 100-300 m deeper than the hole now extends, is that between sheeted dikes of seismic layer 2C and gabbros of seismic layer 3, which has never been sampled *in situ*. Drilling this boundary may be within reach of Leg 140 operations.

Leg 140 Operations Plan

Leg 140 is scheduled to leave Victoria, B.C., on 16 September 1991 and return to Panama City on 12 November 1991. The schedule includes a 17-day transit to Hole 504B, ~1 week to clean out Leg 137 junk, 3-4 weeks to core ahead 300-400 m, 4 days of logging, and a 2-day transit to Panama. In the event that Hole 504B cannot be cleaned out, the alternate program is to go to a Hess Deep site (4.5 days transit), install a guide base, core as time permits, and transit to Panama (6.0 days).

The primary objective of Leg 137 was to prepare Hole 504B for coring during Leg 140 by cleaning out fill and junk left in the hole during Leg 111. After milling, the hole was reamed and drilled 9 m to 1570 mbsf using a tricone bit. Coring with both rotary (RCB) and Christensen (large-diameter diamond bit) systems further deepened the hole to 1621.5 mbsf. Unfortunately, when the last Christensen core barrel was pulled from the hole, the outer barrel and attached diamond bit were left in the hole. In an attempt to retrieve this fish, part of the overshot grapple broke off and was left like a collar around the outer core barrel. Attempts to retrieve this compound fish were unsuccessful because of time limitations and the absence of necessary fishing equipment.

The part of the overshot grapple that was retrieved indicates that the top of the outer core barrel is smooth and flat, and should therefore be recoverable within 7-10 days of fishing and/or milling.

Leg 137 demonstrated that Hole 504B can be cored using RCB bits at a penetration rate of 1.0-1.5 m/hr, with recovery in the range of 10-15%. Although recovery was better (50%) using the Christensen core barrel and diamond bits, penetration with the Christensen core barrel was limited to 2 m per round trip of the drill string. Cores cut using these core barrels are retrieved by pulling the entire drill string back on board; cores are not retrieved by wireline. Diamond bits used with the Christensen core barrel were made of the hardest matrix material available, but were worn smooth after only 2 hr of rotation.

For Leg 140, the RCB system will be used exclusively. Operations on Leg 140 will employ RCB bits specially hardened to increase rotating time from 15 to 20-30 hr per bit. In this way, we plan to core continuously 300-400 m deeper in the time available, with acceptable levels of core recovery inferred from past experience.

Contingency Plan: Hess Deep

If unforeseen circumstances should require abandonment of work at Hole 504B, Leg 140 will pursue a program of drilling deep oceanic crust exposed at Hess Deep. In Hess Deep, 1.2-Ma East Pacific Rise (EPR) lower crust has been exposed by the westward propagation of the Costa Rica Rift. These exposures offer a unique opportunity to sample lower ocean crust and shallow mantle formed at a fast spreading ridge and to test differing models for the igneous and tectonic evolution of ocean crust. As a consequence, a long-term program of drilling at Hess Deep has been proposed to sample a crustal section, from lavas down to shallow mantle, formed at the fast-spreading EPR. This would be accomplished by drilling partial offset sections within various tectonic blocks exposing different levels of ocean crust and mantle in and along the walls of the deep. While a number of sites have been identified to fulfill this objective based on *Nautile* and *Alvin* dives, an initial visit by the drill ship has more limited objectives: (1) obtaining the first long continuous core of gabbroic layer 3 formed beneath a fast-spreading ridge for comparison to gabbroic layer 3 drilled at the slow-spreading Southwest Indian Ridge (Hole 735B), (2) testing drillability of tectonic blocks in Hess Deep, and (3) drilling a hole through the gabbroic layer 3/mantle boundary (petrologic MOHO).

Prospective Drill Sites

A 5-6 km long, 15-20° slope separates Hess Deep and the

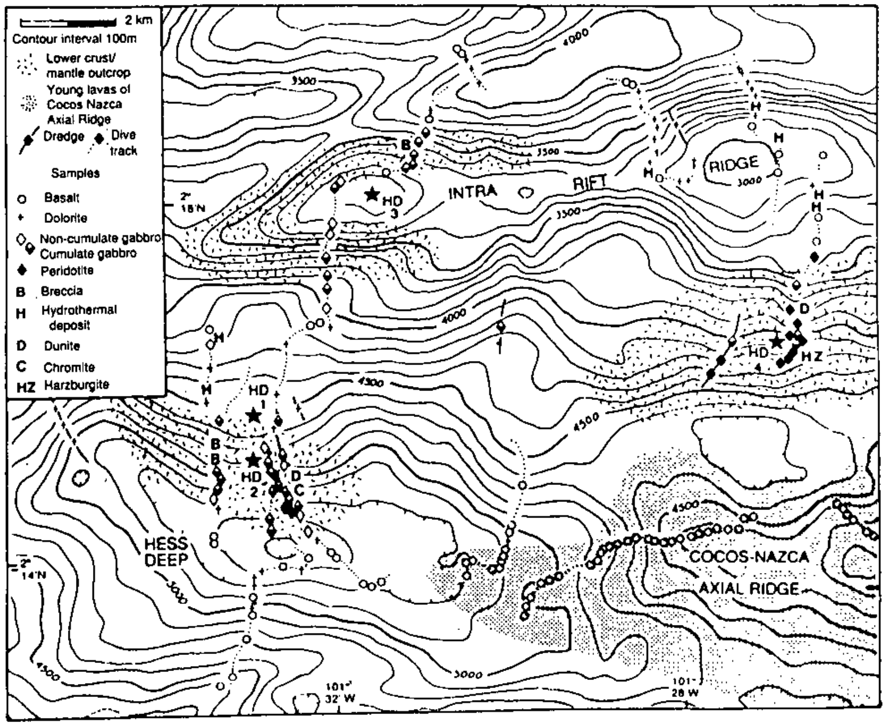

Figure 2. Geologic and bathymetric map of Hess Deep rift valley. Geology is based upon the *Nautile* dive series and dredge results from *F/S Sonne* and *Atlantis II* (modified from Francheteau et al., in press). The stars indicate the locations of the four proposed drilling sites (HD-1, HD-2, HD-3 and HD-4).

intra-rift ridge. Along this slope, there is a consistent change in lithology, which suggests that this slope is a coherent, tilted fault block. At ~4500 m depth, there is a change in lithology, with basalts and diabases exposed to the north and plutonic and ultramafic rocks to the south. Plutonic and ultramafic rocks include isotropic, two-pyroxene gabbros, layered olivine gabbros, and serpentinized peridotites. Some samples are mylonitized and locally the distribution of rock types is mixed.

Three sites have been proposed for drilling: HD-2, HD-3 and HD-4 (Fig. 2). HD-2 (2°15.2′N, 101°33′W; 5000 m water depth) is located south of the intra-rift ridge and north of Hess Deep, but south of HD-3. Massive, subhorizontal gabbro outcrops are exposed along a 15-20° slope and are 100-200 m in size. Plutonic rocks should be relatively unfractured and drillable; it is possible that the MOHO is structurally complicated and may be difficult to drill. A bare-rock guidebase is required.

HD-3 (2°18′N, 101°31.6′W; 3075 m water depth) is located on the crest of the intra-rift ridge. The crest is relatively flat and large enough to facilitate placement of the required bare-rock guidebase. It may be difficult to drill basaltic rubble that covers the ridge; plutonic rocks should be relatively unfractured and drillable.

HD-4 (2°16.8′N, 101°26.6′W; 4100 m water depth) is located south of the intra-rift ridge and north of the Cocos-Nazca ridge. Plutonic and ultramafic rocks are exposed between 4500 and 3500 m depths along a gentle slope that is locally <10°. Dunites with Cr-spinels and serpentinized foliated harzburgites (up to 50% serpentinized) crop out in subhorizontal ledges that dip to the north. Continuity of peridotite outcrops observed during a *Nautile* dive indicates that this slope is an intact block (scale of kilometers) of the shallow mantle. Abundance of dunites in the section, by analogy to similar regions in ophiolite complexes, and their proximity to gabbros, suggests that these dunites represent the critical transition zone to mantle at the base of the crust.

Drilling Strategy

In the event that part of Leg 140 is devoted to operations at Hess Deep, the ship will proceed to the primary proposed drill sites (HD-3 and HD-2; Fig. 2) and deploy the underwater television camera to do a mini-survey. Based on this survey, a test hole will be attempted using the mud- motor. Following a successful test hole, a bare-rock guidebase will be deployed, and drilling will proceed at the site until the end of the leg. If a hole deeper than 200 mbsf is achieved, a standard suite of logs will be run at the end of drilling prior to departure. In the event that the initial test hole is unsuccessful, the ship will move to the other of these two sites, to conduct an additional mini-survey and test hole. In the event that the second test hole is unsuccessful, the ship will proceed to HD-4, where another mini-survey and test hole will be made. It is anticipated, from the success in drilling serpentinites during Leg 109 and visual descriptions of near-continuous massive blocky outcrops of peridotite in this area, that drilling at the last site is unlikely to fail. Based on submersible surveys, however, abundant dunite exposed in the region suggests that drilling would begin below the seismic MOHO, rather than above it, but within the petrologic transition zone between crust and mantle. For that reason, HD-4 has been assigned the lowest priority of the three Hess Deep sites proposed for Leg 140.

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Leg 141 Prospectus: Chile Triple Junction

The primary objective of ODP Leg 141 is to investigate processes associated with subduction of an active spreading ridge along the margin of Southern Chile, including: 1) rapid uplift and subsidence of the arc and forearc, 2) high levels of regional metamorphism and elevated thermal gradients, 3) a hiatus in arc magmatism, 4) anomalous near-trench and forearc magmatism, and 5) localized subsidence and extensional deformation of the forearc in the region of the collision. Alteration, diagenesis, and mineralization of forearc materials can be expected, driven by hot fluids venting from the subducting spreading ridge.

A secondary objective of ODP Leg 141 is to investigate physical properties and geochemistry of gas hydrates in oceanic sediments. Bottom Simulating Reflectors (BSRs), likely produced by frozen gas hydrate layers in the shallow subbottom, are common on seismic reflection profiles from the region.

Background and Regional Setting

The Chile triple junction (CTJ) represents the only presently active ridge-trench collision where the overriding plate is composed of continental lithosphere. Hence, this region provides the only active modern example of the geological results of ridge subduction along continental margins, a process that has dramatically affected the geology of Tertiary western North America, among other places. Regional plate-tectonic reconstructions for CTJ are well constrained by marine magnetic anomaly studies, so detailed relationships between plate motions and continental-margin geology can be effectively studied there. These reconstructions show that the Chile Ridge first collided with the Chile Trench ~14 Ma near the latitude of Tierra del Fuego. A long ridge segment was subducted between Tierra del Fuego and the Golfo de Penas between ~10 and 14 Ma, another ridge segment was subducted adjacent to the Golfo de Penas (and perhaps partially overlapping with the Taitao Peninsula) ~6 Ma, and a short ridge segment was subducted adjacent to the Taitao Peninsula ~3 Ma.

Relative plate-motion vectors change considerably following the passage of the triple junction along the margin. Prior to ridge collision, the Nazca plate was being subducted at a rapid rate (~80 mm/yr for the past 3 m.y., and as fast as 130 mm/yr during the late Miocene) in a direction slightly north of east. Following passage of the triple junction, the Antarctic plate is subducted at a much slower rate, ~20 mm/yr for the past 15 m.y., in a direction slightly south of east.

The Nazca/Antarctic plate boundary comprises the Chile Ridge spreading center, which intersects the Chile Trench at 46°12'S, forming a ridge-trench-trench triple junction. Swath bathymetric data delineate present-day geometry and location of the ridge-trench collision. North of ~46°12'S, the Nazca plate is being subducted beneath the South American plate. South of that latitude, the Antarctic plate is being subducted beneath South America. The spreading ridge strikes nearly parallel to the trench, resulting in a highly oblique ridge-trench collision, while fracture zones associated with the Chile Ridge spreading system trend within ~20° perpendicular to the trench. The CTJ region appears to have formed the southern limit of coseismic rupture during the great 1960 Mw = 9.1 Chile earthquake.

On-land geology of southern Chile, while not mapped in detail, is reasonably well-known at a regional level. Local areas near CTJ have been the subject of recent field work. Exposures in the area are dominated by four principal lithologies: 1) pre-Late Jurassic metamorphic rocks, forming pre-Andean South American basement, 2) the largely Mesozoic Patagonian batholith, 3) Mesozoic and Cenozoic volcanic rocks associated with the Patagonian batholith, and 4) Neogene sedimentary and igneous rocks. Additionally important, but areally limited, rock types include an unusual suite of young (Pliocene to Pleistocene) granodioritic plutons in and around the Golfo Tres Montes within ~20 km of the trench axis and ~150 km seaward of the main axis of the Quaternary Andean volcanic arc, and a tilted but apparently coherent Pliocene ophiolite sequence on the Taitao Peninsula.

Scientific Objectives

Drilling objectives for the southern Chile margin are focused on effects of ridge-crest subduction. Geophysical studies suggest that the major effect of collision is that gradually accelerating tectonic erosion, manifested by rapid subsidence of the forearc, dominates processes acting along the margin before the ridge crest arrives at the trench, culminating in a period of rapid tectonic erosion when the ridge is subducted, followed by a period of subduction accretion that "rebuilds" the forearc. Basic objectives of the drilling program are to: 1) test this model of "accelerated subduction erosion", and 2) explore mechanisms responsible for subduction erosion.

The basic strategy that serves as the foundation of proposed CTJ drilling closely follows a "dual approach" strategy: 1) to determine the time-space distribution of materials in the forearc to constrain their geometry and kinematics, and 2) to make *in situ* measurements of physical, chemical, and geological parameters to provide information about processes operating in the forearc.

Specific questions to address in the CTJ region include:

1) What are the timing, rates, amplitude, and regional extent of vertical motion within the forearc that result from ridge/trench collision?
2) Where is the seaward limit of continental crust along the Chile margin forearc in the vicinity of the ridge/trench collision?
3) What are the nature, petrology, distribution, and chemical affinities for near-trench volcanism associated with ridge-trench collision?

Drilling Strategy

Drill sites have been selected so that two transects of the ridge/trench collision zone are planned for drilling: a downdip transect along CDP Line 745 consisting of three sites (SC-1, SC-2, and SC-3), and a strike transect along the base of the trench slope (SC-3, SC-4, and SC-5). The combination of these five sites should provide a three-dimensional perspective on effects of ridge subduction at the Chile margin. Sites SC-1, SC-2, SC-3, and SC-5 are scheduled for drilling (Table 1); sites SC-4 (along the base of the trench slope) and SC-6 (on the Taitao Ridge) if time permits (Figures 1 and 2).

A second downdip transect, consisting of Sites SC-7, SC-8, and SC-9, with alternate sites SC-7' and SC-9', is located along CDP

Table 1. Summary Site Information

Site	Latitude	Longitude	Water Depth (m)	Penetration (m) Sediment	Basement	Drilling (hrs)	Logging (hrs)	Total (days)
Priority sites								
SC-1	45°51.0'S	75°41.3'W	1700	1150	50	291.0	44.0	14.0
SC-2	45°52.0'S	75°45.0'W	2200	900	0	239.5	40.0	11.6
SC-3	45°53.7'S	75°51.3W	2850	450	50	167.5	65.0[1]	9.7
SC-5	46°14.0'S	75°46.0'W	2475	700	0	138.0	44.0[2]	7.6
					Totals:	836.0	193.0	42.9
Contingency sites								
SC-6	46°31.0'S	75°49.0'W	1280	100	50	35.5	21.0	2.3
SC-4	46°08.4'S	75°48.2'W	2320	765	0	132.0	45.0[2]	7.4
SC-7	47°29.5'S	75°44.0'W	1875	650	0	153.0	36.0	7.9
SC-7'	47°30.5'S	75°47.0'W	2100	1150	50			
SC-8	47°31.2'S	75°53.3'W	2250	1200	0			
SC-9	47°33.0'S	76°00.0'W	1200	400	0			
SC-9'	47°33.5'S	76°04.0'W	1725	550	0			

[1] Logging time estimate includes time for VSP experiment and logging run with high-temperature logging tool.
[2] Logging time estimate includes time for logging run with high-temperature tool.

Line 769, south of the present location of the triple junction (Fig. 2). This transect is designed to determine the extent to which subduction erosion truncated this segment of the margin; it will be drilled if time remains on the leg after completing operations at SC-1 through SC-6.

Sites SC-1, SC-2 and SC-3 are all located in areas where Bottom Simulating Reflectors (BSRs) are imaged by seismic reflection profiles. Sites at the base of the trench slope, SC-3, SC-4, and SC-5, are located in regions of high geothermal gradients, and may encounter temperatures of approximately 200°C at T.D.

No sites are planned as reentry holes, but the ability to deploy mini-cones to provide for bit replacement is an important available option.

Site Descriptions

1) East-West Transect of the Collision Zone

Three sites are located along Line 745 (Fig. 1): near the base of the trench slope (Site SC-3), in the mid-slope region (Site SC-2), and on the upper slope of the margin (Site SC-1). Basic drilling objectives at each site include: 1) determining lithologies and depositional environments of sediment sequences, and 2) determining vertical-motion history. In addition, at Site SC-3, we expect to sample lithologic units that have been modified by hydrothermal circulation and near-trench volcanism and to see structural fabrics and deformation caused by close proximity to the ridge axis.

2) Sites Near the Rift Axis

Two sites are positioned on the lowermost trench slope adjacent to the rift axis. Site SC-4 is situated in the rift contact zone immediately adjacent to the rift axis, while Site SC-5 is situated

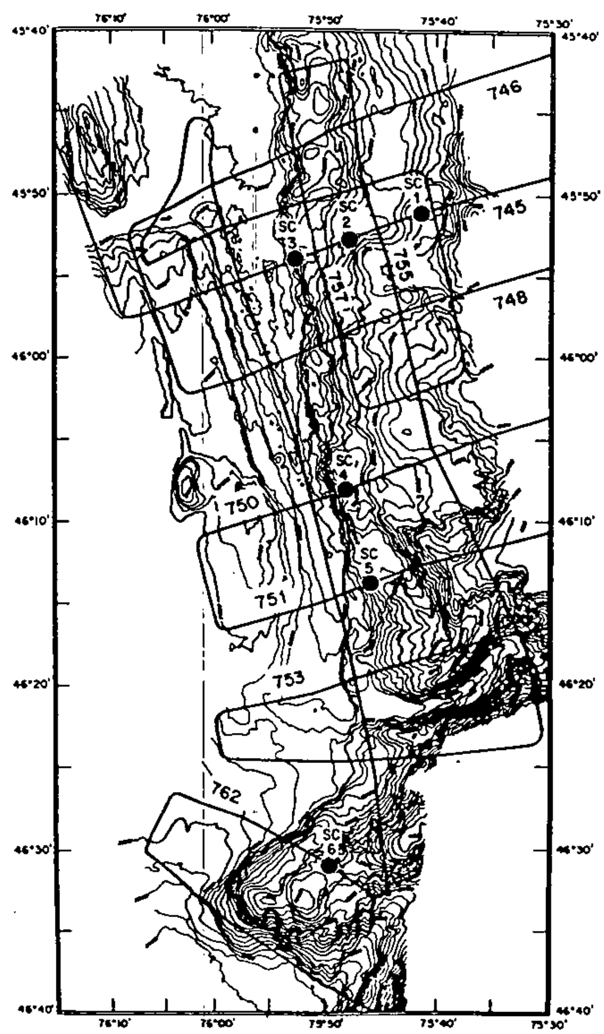

Figure 1. Locality map showing the main bathymetric features of the northern region of the Chile triple junction and proposed drill sites SC-1 through SC-6. Bathymetry in meters.

over the rift axis in the subducted rift zone. The objective at both SC-4 and SC-5 is to sample lithologies that have been modified by hydrothermal circulation from the ridge axis. An additional objective at Site SC-4 is to verify the extent of tectonic erosion by drilling into the prominent interpreted basement reflector beneath the site. At Site SC-5, an additional objective is to determine age and nature of accreted material above the subducted ridge axis.

3) Ophiolite Obduction at the Taitao Ridge

Site SC-6 is located on the crest of the Taitao Ridge (Fig. 2). The objective at this site is to determine the relationship between this feature and the Taitao ophiolite. If the Taitao Ridge is simply an offshore extension of the ophiolite exposed on land, we expect to find both geochemical and stratigraphic similarities between the two. If the Taitao Ridge is an independent fragment of oceanic crust being emplaced into the margin, we can investigate timing and mechanisms of ophiolite emplacement using the Taitao Ridge as an example.

4) Development of the Outer-Arc High

Sites SC-7, SC-8 and SC-9 are located along Line 769 (Fig. 2). These sites are intended to sample materials involved in the oldest part of the accretionary complex that has developed following ridge/trench collision. SC-9 and SC-9' will determine physical properties of the deforming accretionary prism, as well as date the onset of deformation there. In addition, SC-7 and SC-7', located on the upper slope of the margin, will determine age and nature of the interpreted basement reflector along this section of the margin. SC-8 will sample the sediment sequence that might represent the seawardmost remnant of the forearc prior to ridge/trench collision.

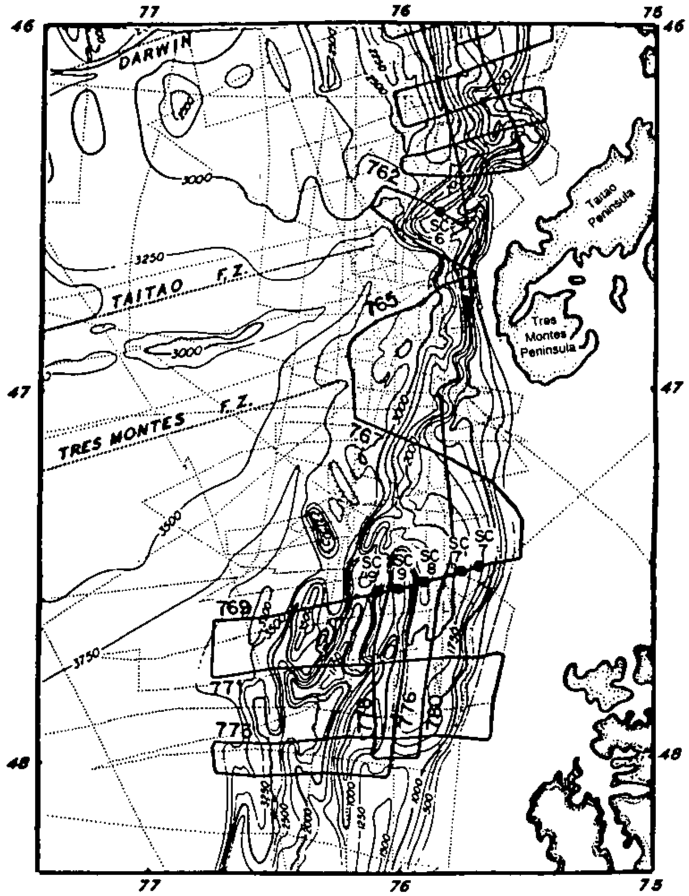

Figure 2. Locality map showing the main bathymetric features of the southern region of the Chile triple junction and proposed sites SC-6 through SC-9'. Bathymetry in meters.

Downhole Measurements and Logging

To characterize the margin fully, we plan to carry out a downhole logging program and several downhole experiments. The standard logging suite (seismic stratigraphy string, geochemistry string, formation microscanner [FMS]) will be run at each site. All logging times are budgeted to include use of the side-entry sub (SES). In addition, special downhole experiments are planned at some sites, which include the following:

1) A Vertical Seismic Profile (VSP) to allow detailed seismic profile/drill-hole stratigraphic correlation at SC-3.

2) Analysis of *in situ* fluids encountered within the forearc, including a series of pressure core sampler (PCS) samples at one site (SC-3), at least.

3) Temperature logs collected with a high-temperature logging tool at sites SC-3, SC-4 and SC-5.

Operational Plan

JOIDES Resolution will leave Panama on 17 November 1991. The drilling area will be reached after a transit of 13 days. Four sites (SC-1, SC-2, SC-3, SC-5; Table 1) are included in the detailed operational plan below. A schedule for operations is given in Table 2. The remaining sites (SC-6, SC-4, SC-7, SC-7', SC-8, SC-9, SC-9'; Table 1) will be drilled in descending order of priority, if time is available after completion of the main program.

A survey for Sites SC-1, SC-2 and SC-3 will be carried out using the Global Positioning System (GPS). To help in locating these sites, Line 745 will be resurveyed using shipboard single-channel seismic equipment. After dropping beacon(s), three holes will be drilled at Site SC-3. Hole A will be drilled and cored as an APC/XPC hole to 400 mbsf. The WSTP tool will be deployed for downhole-temperature measurements and fluid sampling before, during, and after penetration of the Bottom Simulating Reflector (BSR). After plugging Hole A the drillship will offset a short distance to spud and wash Hole B to 150 mbsf. During this operation, several WSTP runs will be made, and several PCS cores will be taken. Hole C will be washed to 400 mbsf and cored to 500 mbsf using an RCB bottom-hole assembly. After the bit is dropped and the hole conditioned, logging will begin with temperature measurements with the high-temperature tool, followed by seismic-stratigraphy, geochemistry, and FMS tool strings. Finally, VSP experiments will be carried out.

Upslope at Site SC-2, three holes will again be spudded in close proximity, following the strategy outlined for Site SC-3. Hole A will be APC/XCB-cored to 600 mbsf. Hole B will be washed to 150 mbsf, with retrieval of several PCS cores and several WSTP runs. Hole C will be drilled with an RCB bottom-hole assembly, washed to 600 mbsf, and then cored to 900 mbsf. After the hole is conditioned, logging will be undertaken using seismic-stratigraphy, geochemistry, and FMS tool strings.

At Site SC-1, three holes will be spudded in close proximity, again following the strategy outlined for Site SC-3. Hole A will be

Table 2. Drilling Schedule

Leg 141 begins with port call in Panama on 12 November, 1991, with a scheduled departure on 17 November, 1991.

	Time on site (days)	Transit time (days)	Cumulative time (days)
Transit from Panama to SC-3		13.1	
Arrive SC-3, 30 November	9.7		
Leave SC-3, 09 December			22.8
Arrive SC-2, 09 December	11.6		
Leave SC-2, 20 December			34.4
Arrive SC-1, 20 December	14.0		
Leave SC-1, 03 January			48.4
Arrive SC-5, 03 January	7.6		
Leave SC-5, 10 January			56.0
Transit from SC-5 to Valparaiso		3.4	
Totals	42.9	16.5	59.4

Total days planned: 59.4

Total Days available: 57.0

(Transit time assumes average speed of 10 kt.)
Leg 141 ends in Valparaiso, Chile on 13 January, 1992.

APC/XCB cored to 600 mbsf. In order to address gas-hydrate-related objectives, Hole B will be washed to 150 mbsf, with retrieval of several PCS cores and several WSTP runs. Hole C will be drilled with an RCB bottom-hole assembly, washed to 600 mbsf, and then cored to 1200 mbsf. After the hole is conditioned, logging will be undertaken using seismic-stratigraphy, geochemistry, and FMS tool strings.

JOIDES Resolution will then transit to proposed Site SC-5. After a pre-site survey and dropping the beacon, one hole will be APC/XCB-cored to 700 mbsf. In the section to be cored by APC (upper 150 mbsf), several WSTP runs will be attempted. After the bit is dropped and the hole is conditioned, logging will be started with the high-temperature temperature tool, followed by runs of seismic-stratigraphy, geochemistry, and FMS tool strings.

Operations will be terminated when drilling time for Leg 141 is exhausted. *JOIDES Resolution* will steam for Valparaiso, Chile, arriving there after a transit of 3 to 4 days on the morning of 13 January 1992.

Special Operations and Safety Considerations

Special operations are focused on achieving recovery of both solid and fluid materials necessary for quantitative analyses of gas hydrate and other interstitial-fluid geochemical systems at several sites. Interstitial fluids will be collected with the WSTP tool at sites SC-1 through SC-5. In addition, core samples will be collected with the PCS at sites SC-1 through SC-3.

CTJ is an area of elevated geothermal gradients, with sufficient sediment thicknesses to have thermogenic oil and gas present. Furthermore, CTJ is a region of widespread occurrences of BSRs indicating the likely presence of gas hydrates, perhaps overlying some quantity of free gas. CTJ drilling will be the first occasion where the JOIDES Pollution Prevention and Safety Panel (PPSP) has approved drilling through BSRs.

All three sites along CDP Line 745 transect in the collision zone (Sites SC-1, SC-2, and SC-3) are loci of BSRs and were relocated during PPSP review to avoid highs on BSRs and deeper, potentially trapping configurations. Furthermore, an order of drilling was specified by the PPSP so that the deepest, safest site would be drilled first and the shallowest and potentially most hazardous site last, with the understanding that if free gas, in dangerous quantities, is encountered in an earlier-drilled site, drilling is to be suspended. Approved sites scheduled for drilling in their specified drilling order are as follows: SC-3, SC -2, and SC-1 (Table 1a). Two additional sites, SC-4 and SC-5, more or less analogous to SC-3 near the toe of the landward-trench slope, were also approved.

Site SC-6 was approved on the offshore extension of the Taitao Ridge. This ridge is composed of ophiolitic material onshore, and its seismic and magnetic character offshore indicate that it is either ophiolitic or oceanic crust. This site received PPSP approval over a range of locations along CDP Line 762.

PPSP approved the following sites on Line 769 and specified their drilling order as follows: 1) SC-7, 2) SC-7', 3) SC-9', 4) SC-9 (the only site on this transect with a BSR), and 5) SC-8 (moved by PPSP to get farther downdip on a wedge of sediment that possibly contains updip pinchouts. Updip pinchouts can still occur in the site's approved, structurally lower, location. PPSP felt that at the new, structurally lower location, this site is reasonably safe if drilled last, as specified).

Leg 142 Prospectus: Engineering Tests at the East Pacific Rise

ODP is developing a high-speed, slim-hole Diamond Coring System (DCS) designed for deployment in deep water from the *JOIDES Resolution*. Use of high-speed, narrow-kerf, slim-hole diamond coring techniques by the mining industry has been demonstrated to be very effective in land drilling operations in coring fractured, highly unstable, crystalline rock formations. In those operations, significant reduction in hole size, coupled with the technique of grinding rock at high speed and low bit weight, rather than crushing the rock, have resulted in high recovery rates (typically 90 percent or better), less core jamming, and improved hole stability over that achieved with conventional rotary drilling. DCS Phase I tests were conducted during ODP Leg 124E in the Luzon Straits, and DCS Phase IIA tests were conducted on the Bonin Ridge during Leg 132 (see *JOIDES Journal*, June, 1991, issue for summaries of these engineering tests). Leg 142 (Engineering Leg III) is scheduled to conduct engineering tests of the DCS Phase IIB system on the East Pacific Rise (EPR) (Fig. 1). Details of the Phase IIB DCS that will be tested were summarized in the *JOIDES Journal* June, 1991, issue.

Leg 142 will depart Valparaiso, Chile, on January 18, 1992, and arrive in Honolulu, Hawaii, on March 19, 1992. (Total transit time for the leg is estimated at 25.1 days.) Operations will take place entirely on the young, unsedimented EPR at approximately 9°30.8 N. Assembly and rig-up of the DCS will take place during the 12.5-day transit from Valparaiso to EPR; rig-down and off-loading shipping preparations will take place during the 12.6-day transit from the drill site to Honolulu. The remaining 35.9 days will be available for on-site operations.

Engineering Objectives

The primary engineering and operational objective for Leg 142 is to maximize coring time with the DCS. To accomplish this task, it will be necessary to deploy a refined version of the "mini" hard rock guide base (HRB) and to anchor it by drilling in the first stage of a new nested drill-in-BHA system (DI-BHA). Depending upon hole stability through the upper 50 to 60 m (interpreted to be rubble), it may be necessary to deploy the second stage DI-BHA assembly, and then resume DCS coring operations.

Coring with the DCS is anticipated to continue until the system has proven to be a viable coring system in fractured crustal formations, or until excessive borehole temperatures require that operations be curtailed for the safety of personnel working on the elevated DCS platform. A minimum penetration of 100 m into fractured young crustal material, with a minimum 50% recovery, is the goal.

Once DCS coring capabilities have been demonstrated, remaining time will be spent testing other ancillary, but complementary, developmental systems. Secondary objectives include: (1) evaluating deployment of slim-hole temperature/caliper logging tools in DCS holes; (2) evaluating reaming a nominal 4 in DCS hole out to 7-1/4 in; (3) evaluating maintenance of adequate hole stability in a reamed DCS hole, allowing the deployment of conventional temperature/caliper logging tools; (4) evaluating deployment of a second stage DI-BHA through the upper unstable "rubble" hole; and (5) evaluating potential of a developmental 7-1/4 in diamond core barrel (DCB) coring system.

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Scientific Objectives

Scientific objectives of the planned multi-leg EPR drilling program are to investigate magmatic, tectonic, and hydrothermal processes that result in the formation of ocean crust at fast-spreading ridges. The East Pacific Rise Detailed Planning Group (EPR-DPG) developed a drilling strategy and made recommendations to achieve these objectives (see *JOIDES Journal*, February, 1991). In essence, the strategy calls for an L-shaped array of moderately deep (200-500 m) holes with one deep (~1.5 km) hole, near the EPR axis to approach or penetrate the seismically interpreted subaxial magma reservoir. Sites within ~1 km of the axis would be useful for studying: 1) physical structure and composition of "zero-age" crust; 2) nature of fluid-rock interactions; 3) the nature of hydrothermal flow; 4) temporal variability of lava compositions; and 5) a natural laboratory for interpreting remote sensing data available for larger portions of the EPR.

Within this context, the purpose of Leg 142 is to use DCS to establish and deepen one or more of the near-EPR axis sites. Leg 142 represents the first attempt to use the DCS at an active ridge crest. As such, it represents an important test of the system's capabilities and limitations, as well as an opportunity to obtain initial scientific returns of the multi-leg effort.

Both proposed drill sites (EPR-1 and EPR-2; see following section) are located near the EPR at 9°30'N. This area of the EPR

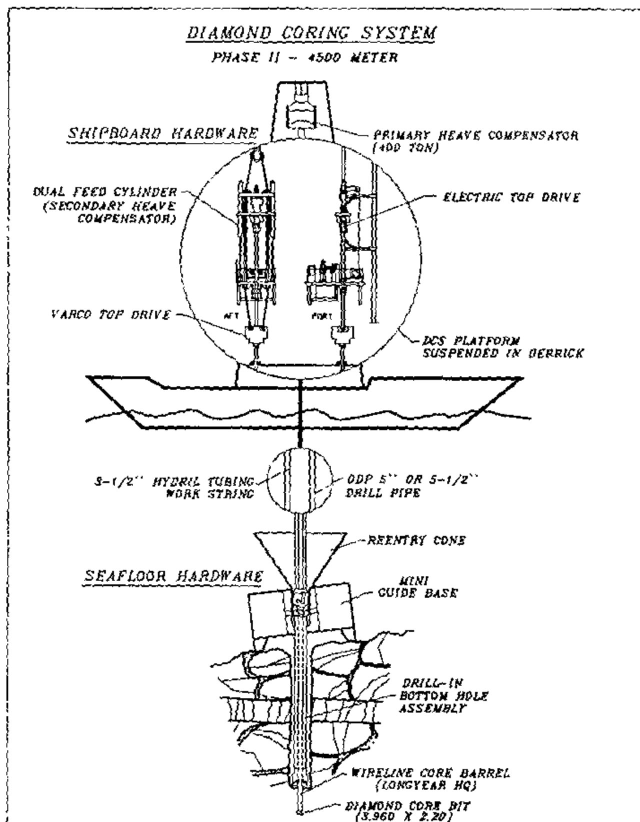

Figure 1. Diamond Coring System, Phase II

is particularly well-studied, so scientific results of drilling should provide data which can be interpreted within a broader regional context from numerous mapping, geophysical, and sampling studies already completed or in progress. Multichannel reflection and seismic tomography show the location of an interpreted axial magma chamber beneath the EPR at 9°30'N. Detailed deep-tow mapping by ARGO, plus ongoing studies of hydrothermal activity, allow flow-by-flow mapping in the vicinity of the drill sites and a much better understanding of the hydrothermal flow pattern and fluid-rock interaction occurring at depth. Previous and ongoing petrologic studies shed light on questions of magmatic plumbing systems and magma chamber processes. Very recent near-bottom seismic refraction studies provide high-resolution views of the seismic velocity structure in the uppermost levels of the oceanic crust in the vicinity of 9°30'N.

Given this wealth of existing knowledge, proposed drill sites are ideally sited to provide definitive answers to questions about the origin of EPR-generated ocean crust. Leg 142 is planned to provide the first new rock samples and other information (e.g., from downhole logging) needed to answer these questions and to formulate new ones.

Engineering Test Sites

Site EPR-2 is the primary drill site identified for Leg 142 operations (Fig. 2). Alternate sites have been identified as possible drilling locations should EPR-2 prove inadequate to achieve the engineering objectives of the leg.

Primary site EPR-2 is located at 9°30.8'N, 104°14.6'W, at a water depth of 2590 m in the axial summit graben. Recent high-resolution bottom-seismic-refraction studies show that EPR-2 has 50-60 m of low-velocity (~2.0 km/s) material (called "rubble") at the surface. This rubble layer overlies basalt with a velocity of ~5.5 km/s, interpreted to be massive and highly drillable. The geology of the site is well-known from ARGO surveys and *Alvin* studies conducted in March-April, 1991.

Site EPR-1 (9°30.2'N, 104°15.1'W; water depth 2600 m) is an alternate site for Leg 142. This site is located ~1 km west of EPR-2. Near-bottom seismic refraction studies show that EPR-1 and other off-axis sites consistently have thicker surface rubble layers (typically 150-200 m thick) overlying basalt with velocities of 4.2 to 4.7 km/s. The geology of EPR-1 and its surroundings is well known from Alvin submersible studies.

Both EPR-1 and EPR-2 are key sites for the multi-leg EPR drilling program outlined in the reports of the EPR Working Group (EP-WG) and EPR-DPG. Because of its thinner rubble layer and higher velocity below the rubble, EPR-2 will be drilled first; the primary goal of Leg 142 is to start a hole at EPR-2 and to drill to a depth of at least 100 m with 50% recovery.

Engineering and Drilling Operations Test Plan

The engineering and drilling operations test plan for Leg 142 is simpler than that of previous engineering legs. A great deal of time and energy has gone into the selection of a drilling target on the EPR that will yield the best opportunity for success in spudding and deepening a hole on a young crustal spreading center.

During *Alvin* Dive 2358 of the EPR site survey, an extensive ponded lava flow was observed. This relatively flat area, located at ~9°30.8N and 104°14.6W, was identified as an excellent location to deploy a mini-HRB and attempt a DCS penetration into the ridge crest. Given this location, the Leg 142 engineering and drilling operations test plan is as follows:

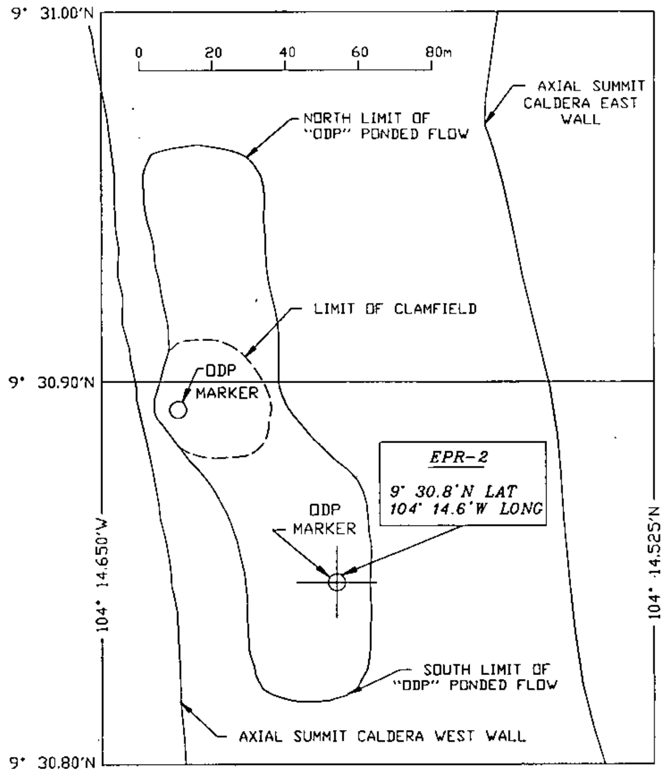

Figure 2. *Alvin* Dive-2358 survey of East Pacific Rise crest (site survey for ODP bare rock drilling). EPR-2 is to be the primary drill site for Leg 142.

(1) Deploy the newly refined hex-sided mini-HRB with its counter-balanced righting system and 8-ft-diameter reentry cone.

(2) Un-jay and remove the running tool. Re-enter the HRB with the first stage (primary) DI-BHA. Drill-in the first stage DI-BHA system to ~4 or 5 m below sea floor and back-off in the HRB casing hanger assembly. (Note: This may be done with a 12-1/2 in TCI roller cone bit or an 11-1/4 in diamond core bit.)

(3) Lower tensioning sub and re-enter HRB with the bit guide. Latch-in and tension-up against the HRB, then release the bit guide via wireline. Deploy the DCS and attempt coring out the bottom of the ponded lava flow, through the rubble zone anticipated to be 50 to 60 m in thickness, and into the more structurally sound (?) basaltic formations below. The minimum desired penetration is 100 mbsf, temperature gradients permitting. (Note: If unstable hole conditions are prevalent in the rubble zone, the second-stage DI-BHA may be deployed prior to attempting to achieve the DCS depth objective. Upon setting the second-stage DI-BHA, DCS coring operations may be continued to the original depth goal.)

(4) Upon achieving or exceeding the DCS depth objective (as qualified by the note above), and prior to removing the DCS tubing string from the hole, a slim-hole caliper log will be attempted. If this is successful, then a slim-hole

temperature log will be conducted (Logging Plan below.).

(5) After slim-hole logging operations have been completed, an attempt will be made to ream the 3.9-in DCS hole out to 7-1/4 in using a special piloted diamond bit and center bit assembly.

(6) If the reaming operation is successful (without unreasonable hole stability problems) and time is available, three conventional logging tool runs may be attempted in the 7-1/4 in open hole. Run number one would consist of a resistivity/density/gamma suite; number two a velocity/gamma suite; and number three either a FMS or BHTV tool.

(7) Once all efforts at reaming and/or logging the 7-1/4 in hole have been completed, the secondary stage DI-BHA will be deployed and backed-off inside the back-off nut from the primary stage DI-BHA.

Logging Plan

The proposed logging plan for Leg 142 is as follows:

(1) Upon completion of initial DCS coring operations, commence logging with a slim-hole caliper tool to measure the gauge of the bore hole and to provide input into the feasibility of slim-hole logging of DCS holes.

(2) Following the caliper logging run, attempt a slim-hole temperature log to provide information on bore hole temperatures.

If the 4-in DCS bore hole is successfully reamed out to 7-1/4 in, and the hole is stable, several logging runs may be attempted with standard tools. These runs have lower priority than other identified engineering objectives. These logging runs will be designed to gain information that is most useful for evaluating the DCS drilling/reaming effort and which cannot be obtained through the second-stage DI-BHA. Three deployments are anticipated in the reamed hole to evaluate fracturing of the rock and to define actual hole size. The following "standard" logging tools are listed in order of priority. Three distinct logging runs are recommended because the penetration below sea floor is likely to be shallow and the standard tool strings will take up a significant portion of the hole.

Run No. 1: Resistivity/density/gamma ray—resistivity will yield fracture porosity data, density also has a high quality caliper tool for verifying hole size, and natural gamma activity should help to determine flow boundaries.

Run No. 2: Velocity/gamma—velocity information can be used to compare the cored hole to appropriate site survey information, and the neutral gamma data will help to depth-correlate the different runs.

Run No. 3: FMS or BHTV—these tools provide images of the formation and of drilling-induced damage, as well as orientation of the bore hole.

Ancillary Engineering and Science

It is unlikely that any time will be available for coring or logging operations beyond those described above. DCS coring, sea floor, and DI-BHA systems described above are still in the developmental stage, and it is impossible to make accurate time estimates for the various operations.

However, should all primary Leg 142 objectives be completed, with time to spare, then the following ancillary engineering and science options will be considered:

(1) Deployment of a second mini-HRB to allow evaluation of the Diamond Core Barrel (DCB) coring system.

  (a) Consideration will be given to deployment of the second HRB, either adjacent to the first HRB, where the most definitive comparison of 4 in versus 7-1/4 in diamond coring can be made, or

  (b) in the "clam field" area identified during the RV *Atlantis II* site survey where warm water is venting at the sea floor.

  (c) A third option is to move off-axis and attempt DCB coring through the thicker (150-200 m ?) low velocity zone. This may help to provide engineering and operational data relating to attempted ~200 m penetrations into such low velocity "rubble" zones elsewhere along the EPR.

(2) Should a 7-1/4 in hole be available, there is scientific interest in conducting a vertical seismic profile (VSP). The VSP would prove useful in locating a possible magma chamber deeper in the section.

(3) If the primary hole is deepened and reamed further, or a second deeper hole is drilled, there is interest in logging the deeper hole with the complete ODP logging suite.

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The Selection of Co-Chief Scientists

Timothy J.G. Francis, Deputy Director, Ocean Drilling Program, Texas A&M University

Introduction

Under the terms of the Memorandum of Understanding between the U.S. National Science Foundation and participating countries, responsibility for the selection of scientific participants for ODP legs rests with the Science Operator, ODP-TAMU.

The JOIDES Planning Committee (PCOM) recommends scientists for consideration by ODP-TAMU as Co-Chief Scientists. The names of these individuals are published in the PCOM Minutes. At the meetings themselves, PCOM is more explicit about its preferences, but good manners prevent the publication of a "pecking order." After all, nothing would be achieved by gratuitously insulting the very people on whose enthusiasm and ability the program depends. The names put forward by PCOM can be regarded as a shortlist of candidates for each leg. However, it is sometimes necessary for ODP-TAMU to add further names to the shortlist later, in order to maintain an appropriate international balance. The PCOM members of the countries concerned are asked for advice on this, by PCOM and by ODP-TAMU.

Criteria for Co-Chief Selection

The next step in the process of reducing the shortlist to the two Co-Chiefs required for each leg is to find out as much as possible about everyone on it. Curriculum vitae of most of the candidates will already be on file at ODP-TAMU. Referees will be asked, in confidence, for their views; members of the ODP-TAMU staff are consulted—some may have sailed with a candidate on an earlier leg. However, because of differences of language, culture and means of communication between the various partner countries, it is impossible to get a uniform level of information about all candidates.

The qualifications of the candidates are then compared to a list of criteria which ODP-TAMU tries to satisfy. As a general rule, the criteria at the top of this list are more important than those lower down:

1. Where possible, a Co-Chief should be a proponent of the science of the leg for which he/she is selected.
2. The national balance identified in the MOU between NSF and the international partners needs to be observed. The MOU is not rigidly interpreted on a year-by-year basis, but is averaged over several years and the life of the program.
3. A Co-Chief must be an outstanding scientist in his/her field.
4. A Co-Chief must have the ability to lead an international team of 25-30 scientists.
5. At least one of the Co-Chiefs must be fluent in both written and spoken English.
6. The expertise of the two Co-Chiefs should be complementary.
7. New blood should be encouraged where possible.

Few people would disagree with the criteria listed above. Many of them have been in effect since the IPOD phase of the Deep Sea Drilling Project began in 1975. However, scientific ocean drilling has become a bigger, more complicated operation than it was a decade ago and these changes have complicated the process of Co-Chief selection. For example, the scientific and technical parties are now twice as large as they were on the *Glomar Challenger*. Laboratory instrumentation and computing systems are vastly more sophisticated on the *JOIDES Resolution*, and increase in complexity every year. ODP is in the throes of a shipboard data explosion. As a result of these changes, Co-Chief Scientists have both greater managerial responsibilities and a heavier editorial burden than was formerly the case.

Early in the program, ODP was criticized as being a "closed shop," controlled by a clique of scientists from the days of DSDP. However misguided this criticism may have been, one of the ways in which the JOIDES PCOM responded was to encourage new blood wherever possible—on JOIDES panels and working groups, and on the drillship. Hence the seventh criterion.

Complicating Factors

1. Ever since it began, ODP has been gradually evolving. Two ways in which it has changed have a particular impact on Co-Chief selection:
   a) It has become more international as time has gone by. Japan and the UK joined in 1985, the ESF consortium in 1986, and in 1991 the USSR became a full member. All participant countries have signed the same MOU with NSF, which will remain in force until the end of the present phase of the program at the end of September 1993. There are now 7 international partners, each expecting to be represented by Co-Chiefs.
   b) Since 1989, there has on average been one engineering leg per year for which only one Co-Chief Scientist is appointed. The other Co-Chief on an engineering leg is an engineer from ODP-TAMU.
2. ODP has dropped its early regional orientation and become a thematically-driven program. Most legs now have several proponents; some are put together by a Detailed Planning Group from a number of separate proposals. A consequence of this is that being a successful proponent is not a guarantee that one will be invited to be a Co-Chief. The chances are that one proponent will be invited; more will be disappointed.
3. About 10% of the individuals invited to be Co-Chiefs decline the invitation. Their reasons for doing this are usually personal and cannot be discussed at an open forum like PCOM. This puts an element of chance into the selection process and may, for example, result in two U.S. Co-Chiefs being appointed when the original intent was to have one U.S. and one international partner. The national balance would in that case have to be corrected later.
4. Selecting Co-Chiefs takes time, not because decision-making processes at ODP-TAMU are slow, but because some invitees need time before they can accept. For example, many invitees need to consult with their university administration or institution director in order to ensure that they have the time to take on the major commitment of being a Co-Chief. By inviting someone, ODP-TAMU is effectively saying that ODP wants 1-1/2 years of their time over the next three years. The fact that the vast majority of universities and research institutes regard this as an appropriate way for their employees to spend their time is evidence of the high regard in which ODP is held.
   The time factor means that ODP-TAMU cannot work on Co-Chief invitations in series, waiting for Leg N to be settled before proceeding to Leg N+1. Rather, ODP-TAMU has to go out with invitations on two or three legs in parallel.

Conclusions

Being a Co-Chief Scientist in ODP is a position of great responsibility and prestige. It brings with it not just the opportunity to direct a major scientific project, but to influence the manning of that project as well. For most Co-Chief Scientists, it means more technical and human resources at their elbow than they have ever had before or will ever enjoy in the future. In some countries, it even opens the door to further personal or research grant funding.

Not surprisingly, therefore, there are many more scientists aspiring to the position than there are slots to offer them. Competition is intense. In an international program, however, it is important that this does not escalate into an unseemly public argument.

It is true that only very good scientists will be invited to be Co-Chief Scientists. The converse, however, is not true. It is not true that a candidate who is not selected is not a very good scientist. There are just far too many variables in the equation for that conclusion to be drawn. This fact should help unsuccessful candidates bear their disappointment with grace. Ultimately, what should motivate us all is the desire to see the science, which only ODP can do, being well and efficiently done.

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DPG Report

North Atlantic Rifted Margins Detailed Planning Group

(Executive Summary)

Copies of the complete report of the North Atlantic Rifted Margins Detailed Planning Group (NARM-DPG) are available from the JOIDES Office.

Introduction

The NARM-DPG proposes a first priority drilling program (Fig. 1; Table 1) requiring 8 two-month legs, based on approximately 25 legs of proposed drilling from 12 highly ranked drilling proposals. These proposals were forwarded to the NARM-DPG by PCOM with the mandate of specifying a science and drilling plan answering fundamental questions of continental breakup. The 18-member NARM-DPG has worked for 6 months and held two meetings. We believe that the NARM proposal is mature and fulfills PCOM's mandate.

Within the last decade, high quality MCS and other geophysical data, and DSDP/ODP drilling, have demonstrated deficiencies in our understanding of continental rifting and rifted margins. It has been demonstrated that developing rifted margin models by extrapolating continental rift models to higher degrees of crustal thinning is at best a gross oversimplification, and is in many cases wrong. Studies of large-scale volcanism along many rifted margins show not only magmatism exceeding that in most Phanerozoic continental rifts, but also crustal thickening at the ocean-continent transition (OCT) in contrast to the traditional view of particularly thin crust there. Furthermore, pure and simple shear models for continental rifts and basin formation do not fully account for crustal and tectonic asymmetries, and for mantle exposures on non-volcanic rifted margins which closely resemble advanced continental rifts. Recognition is growing that different structures, mantle temperatures, strain rates (which can vary by at least two orders of magnitude), and perhaps other unidentified parameters may have existed prior to and during rifting and led to the highly diverse margin types observed today.

These recent and revolutionary observations, substantiated through late DSDP and early ODP drilling, have already resulted in new models for rifting, breakup, and lithospheric deformation, and have forced reexamination of plate driving forces. Following COSOD-II recommendations, the NARM-DPG proposes to constrain and test these new models through a combination of advanced and extensive geophysical characterization, and deep sediment and basement drilling across selected margins, including conjugate margin pairs, which show large variations in breakup processes. An important objective of the NARM program is to compare quantitative results on deformation style and rate, early volcanic productivity and spreading rate, mantle temperatures and magmatic melt histories, and subsidence rates and histories from the two most contrasting types of rifted margin formation: (1) the thick-crusted volcanic margin, and (2) the thin-crusted, multi-rift, non-volcanic margin. Proposed drilling therefore falls into two main categories: (1) volcanic margin drilling on the conjugate East Greenland/northwestern European margins, and (2) non-volcanic margin drilling on the Iberia Abyssal Plain/Newfoundland Basin conjugate margins. The two subprograms are of approximately the same size and are highly integrated. Because of the very condensed nature of the proposed drilling program, all sites within an individual transect are essential. Hence, the drilling order assigned to transects and legs reflects the optimum sequence of drilling rather than significant variations in scientific priority. A synchronous and balanced approach to drilling the two programs is recommended.

Volcanic Rifted Margins

Volcanic margins and their continental counterparts, continental flood basalts (CFBs), are among the planet's large igneous provinces. The Northeast Atlantic volcanic margins and CFBs are estimated to comprise as much as $2x10^6$ km^3 of mainly basaltic extrusives. Only about 5%, which have been thoroughly studied, are exposed onshore, and thus high potential exists for expanding our understanding of the breakup history and fundamental processes by extending studies offshore. One tectonic feature of volcanic margins, the huge, seaward-dipping and offlapping

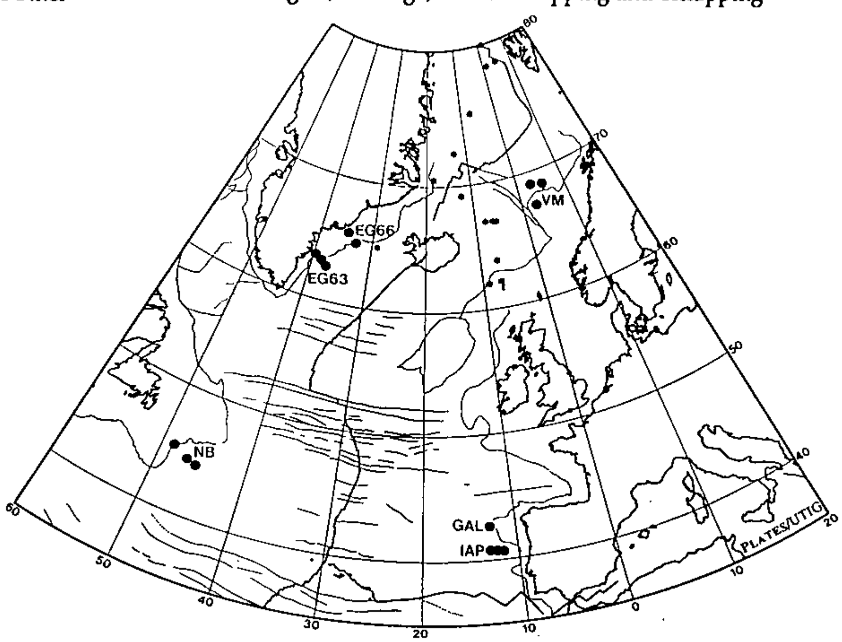

Figure 1. Compilation of all high priority drillsites selected by the NARM-DPG (filled circles; see Table 1 for detailed information); and all high priority drillsites south of 80°N selected by the NAAG-DPG (asterisks). Abbreviations and corresponding proposal numbers are: EG, East Greenland, 310 & 393; GAL, 334; IAP, Iberia Abyssal Plain, 365; NB, Newfoundland Basin, 365; VM, Vøring Margin, 358. Continental outlines and mid-ocean ridge axes are indicated by heavy lines; shelf breaks by light lines. Digital map courtesy of PLATES/UTIG (M. Coffin and L Gahagan).

Table 1. Proposed drillsites, drilling order, and estimated drilling times

Drilling Order	Site	Water Depth (m)	Penetration (m) Sed.	Basmt.	Total	Days[1] on Site
Volcanic Margins						
1.1	EG63-1	520	440	500	940	20
1.2[2]	EG63-2	1875	1220	500	1720	48
2.1	VM-3	1370	470	800	1270	23[5]
2.2	VM-5	3180	470	400	870	17
2.3	VM-6	3370	600	50	650	9
3.1[3]	EG63-3	2095	1420	50	1470	24
3.2[3]	EG63-4	1840	1180	100	1280	24
4.1	EG66-1	280	10	500	510	16
4.2	EG66-2	1565	620	100	720	17
Non-Volcanic Margins						
1[4]	IAP-4	5400	680	100	780	15
	IAP-2	5200	850	100	950	19
	IAP-3B	5500	850	100	950	19
	IAP-3	5500	1120	100	1220	25
	IAP-5	5000	900	100	1000	20
2	NB-4A	3940	2250	200	2450	~45
3	IAP-1	5200	2500	50	2550	~50
ANY	NB-7A	4200	1600	100	1700	36
	NB-1	1200	1650	0	1650	19
	GAL1	4500	550	100	650	11

[1] including logging time
[2] later deepening, if required by results of initial 500 m basement penetration
[3] contingent on the results of first three sites
[4] only 2 to 4 of this group of sites should be drilled. The order and number of sites drilled depends on the outcome of the early drilling. See Section 4.3.4 for further explanation.
[5] no logging time added

basaltic wedges along the margins, expose at their surface a complete stratigraphic record of volcanism at the margin. This record will be sampled both coarsely, by drilling the youngest, oldest, and intermediate parts of the wedge, and finely, by deep basement drilling through many successive flows. Drilling at volcanic rifted margins will address questions regarding deformation of the lithosphere (particularly flexural deformation); the mechanism of magma emplacement including the role of apparent magmatic underplating; syn- and post-constructional subsidence of the seaward-dipping reflector sequence and earliest oceanic crust; timing of the entire rifting and breakup process; and the role of mantle plumes in continental breakup. Major and minor trace elements and isotopic data from the basalts drilled will provide information about the effects of the Iceland plume on rifted margin formation, and will help to assess the relative roles of competing plume models.

A multi-transect strategy is required to sample breakup development at different offsets from the plume center and within each of the two major lithosphere types overlying the plume head. We therefore propose drilling three transects, with drilling to proceed in the order specified in Table 1: (1) one complete margin transect off Southeast Greenland, a region of apparent structural simplicity, cratonic lithosphere, and conjugacy to the DSDP drilled Rockall-Hatton margin, to form a conjugate margin study, (2) one transect in a different lithosphere setting, across the Vøring margin, to build from earlier, highly successful DSDP/ODP drilling, and (3) a second transect off Southeast Greenland, to sample the basalt wedge at an offset from the plume different from the first Southeast Greenland transect and building on DSDP data from the western Reykjanes Ridge south of Iceland (Fig. 1; Table 1). The proposed volcanic rifted margins program can be completed in 4 two-month drilling legs.

The main Southeast Greenland transect consists of four sites designed to constrain timing of breakup; lithospheric deformation; magmatic processes; flexural deformation rates; emplacement mechanisms; geochemical and volumetric development of magmatism; spreading rate development prior to formation of magnetic isochrons; syn- and post-constructional subsidence of the volcanic carapace; and continuing subsidence of the spreading ridge. The transect is located within cratonic lithosphere with a roughly symmetric conjugate margin development, partly drilled during Leg 81, and is offset ~550 km from the present center of the Iceland plume source. Site EG63-1 will sample, through deep basement penetration, the initial volcanism, which is likely to show large variations with stratigraphic level. Sites EG63-2 and EG63-4 will sample the central part of the excessive volcanic phase in an area of interpreted steady-state wedge formation, where it is seismically well-imaged. Site EG63-2 is planned as a deep basement site in order to recover more rift-proximal deposits, cyclicities, and lava stratigraphy, which will bear on emplacement models, and to study flexural deformation and associated strain rates in detail. Site EG63-3 will sample the phase of waning volcanism and increased subsidence at about C24/C23, and is planned as a shallow basement hole. Sites EG63-1 2, and 3 will provide a complete margin subsidence profile across a margin showing simple topography. Geochemical data from the Reykjanes Ridge at its intersection with the transect flow line (61°N) will be used as a reference.

The Vøring margin transect was, at the time of formation, offset to the north of the Icelandic plume center a distance similar to that which the main Southeast Greenland transect was to the south, but lies in lithosphere affected by the Caledonian orogeny and subsequent pre-breakup rifting. This transect thus has the potential to study plume and lithosphere asymmetry and the effect of preexisting, shallow lithosphere structures on the plume. ODP Site 642, which was drilled through the innermost part of a seaward-dipping reflector wedge during Leg 104, forms a key element of the transect. Three more sites, VM-3, VM-5, and VM-6, are proposed. Site VM-3 is located on the outer part of the same (main) seaward-dipping reflector sequence as Site 642, with the goal of sampling the younger part of the volcanic wedge in order to complete the geochemical characterization of the wedge, and to constrain timing of the transient excessive volcanism at this margin segment. Site VM-3 is planned as a deep basement site for correlation with seismic data, to provide access to more rift-proximal deposits, and to increase stratigraphic coverage. Site VM-5 is located on the outer part of a second and slightly younger (anomaly 23/22) seaward-dipping reflector sequence exhibiting a different style of dipping reflections. This younger wedge is north of a small margin transform fault separating the two wedges, and drilling into this wedge will test geochemical and constructional differences across the margin. Site VM-6 is a reference hole sampling basement in an area of interpreted normal oceanic crust. The site will be located within the flow sector through VM-3 and VM-5 on crust of anomaly 23/21 age. The VM sites will provide important subsidence data on a structurally more complex margin, and together with industry data from the shelf, provide a complete margin transect.

The second Southeast Greenland transect consists of two sites closer to the plume center and clearly within the Neogene/Quaternary plume source range documented by Leg 49 drilling. Site EG66-1 will sample, with deep basement penetration, the initial volcanism and rift environment, and provide stratigraphic data for correlation with nearby CFBs. Site EG66-2 will sample excessive volcanism close to its apparent termination ~C22, and provide stratigraphic data for correlation with Leg 49 sites as well as serve as a reference to the similarly aged "young" dipping reflector wedge on the Vøring Margin. The Southeast Greenland and Vøring transects, together with existing DSDP/ODP sites, will sample the breakup event at offsets of ~250 km, ~550 km, and ~900 km from the plume center and will follow the temporal development in spreading and geochemistry from the initially anomalous period of excessive volcanism toward present conditions. Differentiating between thermal and compositional effects of the plume on the Southeast Greenland margin will add importantly to our understanding of general plume structure.

Non-Volcanic Rifted Margins

We propose to concentrate most of the drilling on non-volcanic margins into a single transect across the Newfoundland Basin and the conjugate Iberia Abyssal Plain (Fig. 1; Table 1). We also propose one site on Galicia Bank, the margin segment adjacent to the Iberia Abyssal Plain. The entire non-volcanic rifted margin program can be drilled in 4 two-month legs. Drilling on each of the margins will include sites that would sample significant sections of basement with minimum sediment penetration, and sites which would sample thicker and stratigraphically more complete sequences of post- and syn-rift sediment. The program is designed to allow assessment of the degree of symmetry in the structures and evolution of the conjugate margins. Geophysical data suggest that seafloor exposures of mantle peridotite at Galicia Bank to the north of our transect extends southward into the Iberia Abyssal Plain. If present, which the proposed drilling will test, then it is clearly a feature of more than local significance. Identification of crustal type within a wide zone of thin continental or oceanic crust in the Newfoundland Basin and Iberia Abyssal Plain, and the position and nature of the OCT on the two margins, are important drilling targets. Sites designed to sample syn-rift sequences will constrain timing of rifting and breakup, rift environment, and possibly significant anomalous elevation and/or subsidence asymmetries strongly indicated by recent seismic data. Subsidence histories of the conjugate margins will help determine the relative importance of lithosphere-scale pure and simple shear extension mechanisms. One drill site on Galicia Bank north of the transect is proposed to study the nature of rocks overlying the "S" reflector, thought to be a crustal detachment fault. If the rocks can be shown to be the original hanging wall continental basement, this site offers the exciting future drilling opportunity of penetrating the main detachment fault on this rifted margin.

The sites in the Newfoundland Basin, NB-1, NB-4A and NB-7A, span the zone of thin crust that has been variously identified as oceanic and thin continental. Site NB-1 is located at the landward side of the thin crustal zone and would provide information about pre-breakup setting, timing of rifting and breakup in the basin, and vertical position of the crust, before, during, and after rifting. Site NB-4A is located roughly in the center of the zone of thin crust, and would sample post-rift sediment, the breakup unconformity, syn-rift sediment, and basement. Basement samples should resolve the question of the character, oceanic or continental, of the thin crust. Data from the sediment will constrain timing of rifting and breakup, and vertical movements of the crust. Site NB-7A is located on a basement ridge just landward of the J-Anomaly Ridge, both of which are thought to be oceanic.If NB-7A is oceanic and the zone of thin crust is continental, this will date the oldest oceanic crust along the transect. If continental, we will have precisely bracketed the OCT between this ridge and the J-Anomaly Ridge. Possible drilling surprises could include drilling a serpentinized peridotite ridge similar to that on Galicia Bank which is thought to continue southward into the Iberia Abyssal Plain, conjugate to the Newfoundland Basin. This would have an important impact on our thinking regarding the mechanism by which these peridotite ridges are exposed at the seafloor.

The sites proposed for drilling in the Iberia Abyssal Plain, IAP-1, IAP-2, IAP-3, IAP-3B, IAP-4, and IAP-5, are concentrated in the middle and outer parts of the zone of thin crust, and fall into two groupings. The first group, sites IAP-2, IAP-3, IAP-3B, IAP-4, and IAP-5, are part of a strategy to locate the OCT in the Iberia Abyssal Plain, to determine the extent of peridotite exposure in the basement, and to constrain the subsidence history of the margin. The first site, IAP-4, would sample the geophysically identified peridotite ridge and provide basement samples for microstructural and geochemical studies of its emplacement and melting history. Drilling would follow at site IAP-2, landward of IAP-4, to sample the last, tilted continental block. In the absence of major surprises, we would then proceed to site IAP-3B, just oceanward of site IAP-4, to drill what we interpret to be the oldest oceanic crust. Our objective is to define the OCT, constrain vertical movements of the crust, and understand the geochemistry of the early volcanism. If, however, peridotite is not encountered in IAP-4, then we would propose stepping either landward, if oceanic material were recovered, or oceanward, if continental material were recovered. Two sites landward of IAP-4 (IAP5 and IAP-2), and two sites oceanward of IAP-4 (IAP-3B and IAP-3) may be used in this strategy. The second group of sites, actually one site, IAP-1, is located over the wide zone of transitional crust analogous to that in the Newfoundland Basin. The site would probably require an entire leg to drill through post-rift sediment, the breakup unconformity, and syn-rift sediment to basement. The objectives of the site, like those for NB-4A, are to confirm geophysical identification of crustal character in the transitional zone, constrain timing of rifting and breakup, and determine syn- and post-rifting vertical movements of the crust.

We also propose drilling one site in Galicia Bank, GAL-1, which has a high probability of proving a concept, and which may lead to an exciting drilling opportunity. The "S" reflector in the Galicia Bank is interpreted to be a low-angle detachment fault penetrating to at least mid-crustal depths. Our proposed site, GAL-1, lies where a reflector thought to be correlatable to "S" is shallow enough to drill. Questions have been raised, however, about whether the "S" reflector at that place is covered by continental basement of the hanging wall, and is therefore pristine, or whether it is covered by sediment, and therefore may have suffered erosion. Site GAL-1 is planned, with a modest amount of drilling, to sample the seismic unit overlying the "S" reflector to determine if it is continental basement or sediment, and could help achieve our high priority, long-term, goal of drilling the "S" reflector.

Level of Required Effort

Two of the proposed sites exceed 2000 m penetration, the deepest being proposed to 2550 m, pushing the present capability of the JOIDES *Resolution* to its limit. These targets are ambitious, in terms of technology, drilling time required to reach the stated objectives, and level of scientific commitment required to commit scarce resources to a long-term program. However, substantial progress in resolving the fundamental processes of plate separation and deformation of the lithosphere at rifted margins depends on such new data. In terms of scientific rationale and maturity, the time is right for conducting such a program consistent with the goals for deep drilling and basement penetration set out by the recent ODP Long Range Plan (1990).

JOIDES Committee Reports

Planning Committee Meeting Summary

The 1991 Summer Meeting of JOIDES Planning Committee (PCOM) was held at Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany. The following motions were passed.

Supplemental Science

- Upon evaluation of the three supplemental science proposals we have received, PCOM ranks the potential science return of S-3 (OSN-2) the highest. Therefore, PCOM will consider only S-3 for scheduling in FY92.
- In order to decide at the Annual Meeting whether to reserve a maximum of 10 days during Leg 145 for drilling a re-entry hole, OSN-2, paired with NW-1A (Supplemental Science Proposal S-3), PCOM asks the thematic panels and co-chiefs for Leg 145 to determine which sites would be modified or dropped to accommodate up to 10 days at OSN-2. *[Note: Consensus]*
- PCOM moves that the supplemental science proposal S-2 (to log Hole 801C) be incorporated in the prospectus of legs 143/144 (Atolls and Guyots) as an alternate site, and that the appointed co-chief scientists consider logging at Hole 801C, which has a considerable scientific merit as recognized by the thematic panels and by PCOM, if time is available.
- PCOM moves to discontinue the practice of accepting "supplemental" science proposals (as defined by its motion and consensus of December 1990). However, continued submission of proposals requesting less than 1 leg of drilling is encouraged. Such proposals will be ranked in accordance with normal ODP review procedures.

See "Proposal News" (p. 32) for further information.

OPCOM ("Opportunity Committee")

- PCOM endorses the plan for allocation of incremental funding recommended by OPCOM, as modified by PCOM [see minutes for 21 August 1991]. To make the funds available in a timely manner, PCOM recommends that the spending plan be passed to BCOM for their consideration prior to their scheduled meeting [i.e., early 1992].

Short-Term Planning (i.e., FY92 in the Pacific)

- PCOM endorses the concept of drilling one rotary core site in the lagoon at Enewetak Atoll for the purpose of testing the drilling capability of *JOIDES Resolution* in shallow water. The duration of this test, including deviation from the proposed [legs 143/144] track, should not exceed 60 hours.
- PCOM reaffirms the critical importance of the development of GEOPROPS, or tool of comparable capability, as an integral part of scientific planning. PCOM further recommends that OPCOM funds be made available as soon as practicable to further this aim. PCOM anticipates that a suitable tool could be tested on Leg 146.

"Statute of Limitations" on ODP Proposals

- PCOM recommends that proposals which have not been updated for three full calendar years before the present calendar year (i.e., January 1, 1988 for 1991 activities, to roll to January 1, 1989 on January 1, 1992 for 1992 activities) be declared formally "inactive". Thematic panels will be given the directive by the JOIDES Office not to review inactive proposals formally, but rather to initiate submission of proposal updates (as per revised Proposal Submission Guidelines, published in the June 1991 *JOIDES Journal*) from proponents if there is sufficient panel interest. The community will be informed about this change in policy through the *JOIDES Journal* (see additional documentation in the August minutes).

See "Proposal News" (p. 32) for further information.

Consensus

- PCOM thanks Erwin Suess, who is leaving the chairmanship of the youngest thematic panel of ODP (SGPP), for his dynamic, intelligent and dedicated leadership.

Sedimentary and Geochemical Processes Panel Meeting Summary

SGPP met at Lamont Doherty Geological Observatory, on June 4-6, 1991. The meeting was dominated by the joint session with DMP during the second day; this session was preceded and followed by regular SGPP business. Highlights of the numerous agenda topics follow.

1. Red Sea Drilling

SGPP supports revival of Red Sea drilling as initiated by LITHP and requests PCOM to inquire with the appropriate authorities and/or other connections. SGPP regrets that no geochemist has been appointed co-chief for Leg 146 (Cascadia) but urges ODP staffing of the shipboard scientific party should take this situation into account. SGPP suggests that the organizers of the Gas Hydrate Workshop consider expanding the existing report and perhaps submit an article for publication in addition to publishing the WG-Report in the *JOIDES Journal* (see p. 29). SGPP has formulated a request for proposals to drill a dedicated gas hydrate leg; this request will appear in the *JOIDES Journal* (see p. 29)and in *EOS* and results from a lack of current proposals on SGPP's highest ranked theme.

2. Joint Session with DMP

The discussion during the joint session with DMP was initiated by seven questions formulated to express SGPP's thematic needs:

1) What is the accuracy of geochemical logging tools including uses of new logging tools?
2) What are the logging characteristics and log interpretation of gas hydrates?
3) How to make maximum use of sealed bore holes and collect samples at *in situ* temperature and pressure?
4) What are the problems anticipated with the deployment of downhole tools in Cascadia and Barbados drilling?
5) How to put together a special logging program for SGPP?
6) How can fluids be sampled?
7) How should money be spend on Long-Range Objectives?

Highlights from this session were:

(a) Mg is a key element for SGPP. The minimum Mg concentration required for wireline identification of specific minerals is that which is visible on the GLT log. KTB logs have revealed relatively poor statistics at very low Mg concentrations, but it is believed that this situation can be improved. The key question is "Where is it really critical from a geological viewpoint to know whether Mg is present at, say, 0.5% or 1.5%?" Once this question has been answered, a logging program can be designed.

(b) SGPP needs a specialised gas hydrate logging suite. The discussion concluded with the observation that the existing logging suite should provide a good deal of useful information about hydrate occurrence and composition. Logging might provide more answers if the tools were recalibrated. DMP should finalize its views on the optimum logging suite for investigating gas hydrates. This suite could be tested during Leg 141 (Chile triple junction).

(c) SGPP is most interested in sealed boreholes. The meeting concluded that the borehole seal initiative had considerable merit and should be pursued. However, there remains the possibility of scientific competition with wireline reentry.

(d) Other special logging programs for SGPP's themes are comprehensive geochemical data from logs, e. g. to measure chemical changes in carbonates where core recovery is poor. The elemental data should include Na (to improve the wireline-derived mineralogy) and Mg; therefore, a high-spectral-resolution tool is desirable. The required geophysical logs include FMS, magnetometer, V_p, V_s, porosity, density, fluid sampling, pore water pressure and permeability through a combination of LAST, GEOPROPS, or similar tools.

(e) Fluid sampling continues to be a top SGPP priority. The meeting noted that many future ODP legs require high- or low-temperature pore-fluid samples. The technology must be developed to allow this to happen. Substantial engineering input is needed in a brainstorming session as a prelude to an engineering feasibility study of the best option(s). The JOIDES working group meeting on *in situ* Pore-fluid sampling, scheduled for 23 August 1991 in Houston, will address the first stage.

(f) Priorities for remedial technologies discussed during the joint session strongly echoes those developments anticipated in the SGPP White Paper. SGPP consensus, after discussion of deep drilling, is that for moderately deep drilling (1-2 km), the Somali Basin sites are typical of the sort of drilling SGPP could support, although they would not necessarily be of very high priority. For still deeper drilling (i.e., 4-8 km holes), SGPP is unlikely to lend any support at present to sites such as those anticipated for Middleton Island or other deep subduction zone.

3. OPCOM Budget priorities.

Priority 1: Develop capability for fluid sampling and measurement of*in situ* fluid properties:

(a) for free-flowing water in hot rock (testing system);

(b) for pore water sampling/measurement (Pressure Core Sampler - phase II).

Priority 2: Develop capability for recovering unconsolidated sand/rubble without extensive loss or damage to cores.

Priority 3: Use of alternative platforms for sea level/sediment architecture objectives (e.g., New Jersey transect, coral Islands, Global Change Programs, etc).

Priority 4: Deep-drilling for SGPP objectives (e.g., Somali Basin).

Priority 5: Diamond Coring System.

Priority 6: High-latitude support.

Priority 7: ODP staffing costs.

Gas Hydrate Drilling

Gas hydrate layers, marked by prominent Bottom Simulating Reflectors (BSRs) at continental margins, trap a significant proportion of global methane. The occurrence, modes of formation, stability, composition, and physical properties of clathrates are of interest to a broad spectrum of geoscientists. The Sedimentary and Geochemical Processes Panel (SGPP) of ODP considers the genesis and characteristics of gas hydrate layers to be so important that the panel has ranked the concept of a dedicated drilling program to study hydrates at the very top of its priority list. SGPP invites scientists to submit proposals for such a dedicated program to the JOIDES Office, following procedures outlined elsewhere in *JOIDES Journal*. Please remember that the *JOIDES Resolution* will leave the Pacific for the Atlantic and adjacent seas in early 1993, where it will remain until at least the middle of 1994. For further details on SGPP hydrate objectives, contact:

In Europe: Judith McKenzie (SGPP chair) In North America: Roger Flood

Gas Hydrates and Ocean Drilling

Workshop organized and chaired by Keith Kvenvolden and Erwin Suess

Introduction

The workshop *Gas Hydrates and Ocean Drilling* was held in conjunction with the meeting of the Sedimentary and Geochemical Processes Panel (SGPP) at College Station, Texas, on March 5 - 6, 1991. In attendance were panel members and invited participants, totaling about 35 individuals. The purpose of the Workshop was to review the geological, physical-chemical, and geophysical aspects of gas hydrates in oceanic sediments in order to provide guidance to ODP for drilling, coring, and testing the gas hydrates that will be encountered on future ODP legs.

Discussion Topics

The discussion centered around six main topics, with selected speakers addressing each of the topics and goals as follows:

1. Gas hydrates and the global methane budget.

Purpose: discuss the role of gas hydrates in global change and define the place of ODP in the Global Change program.

Focus: stability and reservoir size of gas hydrates in sediments of the Arctic shelf and of outer continental margins.

2. Physical-chemical characteristics of gas hydrates.

Purpose: examine the fundamental properties of gas hydrates and consider the conditions leading to hydrogen sulfide hydrates occurring separately or syngenetically with methane hydrates in continental margins and/or sedimented ridge crests.

Focus: physical chemistry of gas hydrates; evidence for hydrogen sulfide gas hydrates on the Cascadia margin; safety measures needed by ODP to cope with hydrogen sulfide hydrates.

3. Geophysical characteristics of gas hydrates.

Purpose: consider the arguments of free gas vs. no free gas at the base of the gas hydrate zone and examine the assumptions for the system: sediment-water-free gas-gas hydrate in seismic models of BSRs.

Focus: percentages of pore space filled with gas hydrate; gas hydrate formation from "undersaturated" methane solutions; ODP safety standards with regard to drilling of gas hydrates.

4. ODP Pressure Core Sampler.

Purpose: examine the status of the PCS and particularly of the development for phase II to achieve scientific goals formulated by SGPP.

Focus: discuss capabilities for recovering sediment at *in situ* temperatures and pressures for analysis of gas hydrates, pore fluids and gases, and microbial activity; for preserving sediment structures, through-wall imaging of internal structures, fabric analyses, and physical properties measurements; for transfer of gases, fluids, and solids through pressure ports; and for calibration of well logs.

5. Safety procedures for ocean drilling.

Purpose: revise safety procedures for drilling gas hydrates.

Focus: formulate recommendations for PPSP.

6. Gas hydrate objectives of ODP for FY 1992.

Purpose: reexamine objectives and sites of Leg 141 (Chile triple junction) and Leg 146 (Cascadia margin) to emphasize gas hydrate objectives.

Focus: discuss thermogenic vs. biogenic sources of methane and the role of fluid movement in active margin settings; consider other possible gas hydrate objectives for future drilling legs.

Summary of Remarks

Kvenvolden set the stage for considerations of the global importance of gas hydrates by pointing out that a lack of knowledge leads to wide-ranging speculation concerning the role of gas hydrates and the size of the methane hydrate reservoir. Decomposing gas hydrates may currently contribute 2 - 4 Mt/yr of methane carbon to the atmosphere. This contribution is minor compared to other known sources of atmospheric methane. However, increasing temperatures may increase the flux of methane from gas hydrates.

Brooks described gas hydrate which occur at subbottom depths of <6 m at water depths ranging from 400 to 2,400 m in the Gulf of Mexico. The methane in these gas hydrates was either from biogenic or thermogenic sources based on molecular and isotopic compositions. Seismic wipe-out zones, hummocky and pockmarked surfaces are associated with the gas hydrate occurrences. Shallow biogenic gas hydrates were also observed in the Eel River Basin offshore northern California.

Paull discussed the methane record in ice cores for the past 20,000 years, during which atmospheric methane concentrations changed from 320 ppbv to 600 ppbv ~18,000 years ago. He suggested that this change might be related to gas hydrate decomposition caused by sea level lowering of 100 m at that time. The gas hydrates would destabilized from the bottom up with an estimated release of 1.8×10^{-4} Gt/km^2. Thus 1 Gt of methane would be released for each 5,600 km^2. Because the gas hydrate reservoir is so large, this released methane (a greenhouse gas) could affect global climate; the methane release could also cause sediment instability and submarine slumps.

Sloan presented an historical review of gas hydrates, which were first discovered in the laboratory in the early 1800s. In gas hydrates, water molecules form a structural framework of cages that contain gas molecules. The size of the cages is fixed and can include only gas of specific molecular diameters. Two crystalline structures are possible. In Structure I, the vertices of the cages are joined, whereas in Structure II the faces of the cages are joined. Methane hydrates are Structure I, but with ~1% propane the geometry of the cages will shift to Structure II. Eight heuristics of gas hydrates led to nine applications: (1) biogenic methane, carbon dioxide, and hydrogen sulfide form Structure I, but with propane form Structure II; (2) Structure II has greater stability field than Structure I; (3) hydrogen sulfide hydrates are uniquely stable; (4) 1 m^3 hydrate contains 160-180 m^3 gas; (5) thermogenic gas hydrates should have similar heat transfer properties; (6) gas hydrates can exist with only one other phase; (7) in deep water drilling, hydrates can occur when water-based drilling fluids are used; (8) hydrate crystal morphology dictates strength of structure; and (9) metastability will exist only over short time scales (i.e., days).

Boulegue considered hydrogen sulfide and its role in the formation of hydrate. He had observed hydrogen sulfide on platinum and noticed that the ratio was similar to that found in fully saturated hydrogen sulfide hydrates. There was a concern that hydrogen sulfide hydrates would pose a problem for ODP. Discussion led to the conclusion that hydrogen sulfide hydrate formation or decomposition should not be a major problem, but that hydrogen sulfide should be monitored during the drilling operation.

Claypool posed five questions of importance to gas hydrate drilling: (1) what are pressure-temperature conditions that control methane hydrate stability; (2) how much methane is necessary to stabilize the hydrates; (3) is free gas present; (4) can gas hydrate act as a seal to high pressure gas; and (5) what procedure should be used to estimate the drilling depth to the base of the zone of gas hydrate stability. To answer these questions, he proposed that a new equation ($P = \exp[46.74 - 10{,}748/T]$, where P is in kPa, and T is in °K) be used to define the methane-water-hydrate system and that hydrostatic, not lithostatic, pressure be used. He concluded that gas hydrate formation requires 80 - 150 mM methane and that free gas at the base of gas hydrate cannot be at high pressure, i. e., cannot exceed hydrostatic pressure, if water is present.

von Huene reviewed the geophysical results of gas hydrate occurrences observed on DSDP legs 76 and 84 and on ODP Leg 112. He noted that a BSR is not always observed where gas hydrates are present. Reprocessing seismic records shows that what may first appear as a continuous seismic reflector may in fact be patchy in occurrence. Low amplitude BSRs may indicate absence of free gas. An increase of gas hydrates with depth will give rise to stronger reflections. Some gas is needed to get reflectivity. Synthetic seismograms showed 60% porosity and 10% gas hydrates. A three hole experiment, proposed for offshore Peru, was suggested for offshore Chile in order to evaluate the relationship between the BSR and the occurrence of gas hydrate.

Hyndman discussed a model for gas hydrate formation in subduction zones where accreting sediments are expelling fluids upward. Upward fluid flow also occurs where there is rapid sediment loading. In this model, the BSR represents a layer of gas hydrate formed through the sweeping upward of biogenic methane. The hydrate builds upward in the stability field, and the BSR occurs where fluid expulsion is high. This model contrasts with the conventional view of *in situ* gas hydrate formation. Both models have problems, which were discussed. The new model was applied to the Cascadia margin. Analyses of seismic data suggest that the gas hydrate occupies ~1/3 of the pore space and that the gas hydrate base is 5 to 50 m thick. There is little gas below the BSR. Conclusions reached were: (1) no increase in BSR reflector strength over structural highs; (2) no flat spots at base of hydrate; (3) no reflections at base of gas layer; (4) no attenuation of underlying reflectors by gas; (5) velocity-depth shows increase through BSR; (6) AVO best fit indicates no free gas; and (7) gas hydrate permeability more like snow than ice.

Worthington reviewed the logging characteristics of gas hydrates. Logs used conjunctively can yield quantitative assessment of gas hydrates. A comparison was presented between various logging devices and the theoretical and measured responses to gas hydrates and gas and water. Results were shown for gas hydrates recovered from the NW Eileen State No. 2 well in Alaska and DSDP Site 570 offshore Guatemala. Information about gas hydrates from cross plots was demonstrated: (1) density vs. neutron porosity; (2) sonic velocity vs. neutron porosity; and (3) density vs. sonic velocity. A recommended logging program included the following: temperature and pressure, density and neutron activation; sonic wave form, gamma ray, dual lateralog, carbon and oxygen (geochemical log), caliper log, and spherically-focussed log.

Pettigrew After an historical review of the Pressure Core Barrel by Kvenvolden and a review of guidelines for the PCS, Pettigrew described the current status of the PCS, which is 42 ft. long, has a 6 ft. pressurized section, and 2 fluid sampling ports. The core is recovered at near *in situ* pressure and bottom hole pressure is trapped. The PCS has been tested five times, three times on Leg 124 and twice on Leg 131, with various degrees of success. Questions were raised concerning temperature control, fluid transfer, and contamination by drilling fluid. A calculation was made showing that the maximum pressure that could result from a trapped gas hydrate would be about 3,000 psi, which is well within the 5,000 psi design range of the tool.

Dunlap described the TAMU pressure sampling system that was designed and used several years ago. This device was deployed in shallow water and was opened in a hyperbaric chamber where engineering properties of the sediment were measured, and samples were taken for gas analyses. There is a concern about gas hydrates affecting the foundations for oil-well platforms in deep water. A system is being designed to push a probe ahead of the drill to measure properties related to gas hydrates, such as shear strength, pore pressure, resisitivity, thermal conductivity, sediment density, and temperature. A core penetrometer is being considered to determine type of sediment and pore-water pressure. A device is also being constructed to make gas hydrates in the laboratory to measure physical properties.

Ball reiterated the concerns of the PPSP and indicated that this panel would consider proposals, on a site-by-site basis, that request drilling through BSRs. Guidance from this workshop will be useful.

von Breymann reviewed ODP objectives in gas hydrate drilling. The next ODP legs with gas hydrates are 141 (Chile triple junction) and 146 (Cascadia margin). It is important to look at questions of gas hydrates when designing a leg proposal. Legs may be readjusted to answer gas hydrate questions. The possibility of thermogenic hydrocarbons must be considered. Phase I development of the PCS requires an operational tool that at a minimum can recover gases and liquids. A gas manifold needs a lead person to interface with ODP. Logging of gas hydrate occurrences is essential. Model testing of gas hydrates needs at least shorebased interest. The following measurements are important for gas hydrate research: (1) composition and quantity of gas; (2) presence and absence of free gas; (3) porosity/velocity calibrations; (4) amount of gas hydrate as percent of porosity; (5) permeability of gas hydrate layer; (6) concentration of methane above and below BSR; and (7) source of methane and other gases - local source vs. migration.

Lewis discussed the scientific rational and objectives of ODP Leg 141 (Chile triple junction). This leg involves a complex migrating triple junction and ridge crest subduction. Of interest in gas hydrate research is Line 745, where three holes will be drilled. Along this line, the BSR is quasi-continuous; two holes will penetrate the BSR if approved. In addition, one hole will be drilled near the toe of the slope on Line 750, and one hole will penetrate the region of the triple junction on Line 751.

Hyndman reviewed briefly Cascadia margin drilling (Leg 146) to define fluid expulsion and physical properties. Sites will be drilled offshore Vancouver to test diffuse fluid flow and offshore Oregon to test focused fluid flow. One fourth of the leg will be devoted to gas hydrates. The gas hydrate objectives are: (1) calibrate BSR pressure-temperature conditions; (2) measure velocity, porosity, permeability and estimates of heat flow; (3) calibrate seismic data interpretation; (4) test gas hydrate formation model; and (5) evaluate diagenetic associations of gas hydrates.

Recommendations

From the above presentations and the accompanying discussion, the following conclusions and recommendations were made. There was a general consensus that gas hydrates are an important research topic in ocean drilling. Even though more than 20 years has passed since gas hydrates were first recognized as naturally-occurring substances, much remains to be learned about these intriguing materials. ODP provides an important platform for the study of gas hydrates occurring in oceanic sediments. Current drilling practices of ODP are capable of recovering partially decomposed samples of gas hydrate. To make the study of gas hydrates quantitative, there is an immediate need for use of a functional PCS which is capable of recovering gas and liquids at *in situ* pressures. Such a device will provide not only information about gas hydrates, but also about the composition and concentration of fluids within and below the zone of gas hydrate stability. In order to gain new knowledge about gas hydrates, the following specific recommendations are made by SGPP:

Predictive equation for depth of gas hydrate stability field

The temperature and pressure regime below the seafloor determines the stability field of pure methane and mixed gas hydrates. SGPP concurs with the recommendations by the 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 stabilities, be developed for use aboard the *JOIDES Resolution* to improve safety measures.

Pressure Core Sampler

1. Manifold for extracting free and hydrated gases

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

2. "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 the internal pressure of the sample chamber to self-squeeze pore waters from the center of the core, thereby eliminating possible contamination by drilling fluid. SGPP concurs with the recommendations of the workshop participants that design, construction, and operation of the harpoon be completed with input from the shipboard geochemists of legs 141 and 146.

3. Exchangeable pressure chamber.

The 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 gas 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: 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 turnaround time for close sample spacing downhole, eliminates 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 should be made of titanium; if gases, dissolved metabolites, or major sea water ions are to be measured, the less costly stainless steel version is adequate.

Gas hydrate leg

Understanding 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 this workshop recommend that a dedicated gas hydrate leg be planned and drilled similar to the one previously proposed for the Peru Margin (355A). SGPP and PPSP, outside proponents and investigators should design such leg with drilling opportunities in the Atlantic or the Pacific oceans.

Proposal News

"Supplemental Science": the end of an experiment

PCOM, at its August 1991 meeting in Hannover, decided to discontinue the recently instituted practice of considering "Supplemental Science" (S) proposals.

The "supplemental science" concept was originally discussed at the 1990 Annual Meeting of PCOM with Panel Chairs in Hawaii. At that time, PCOM thought that incorporating high-quality, short (i.e., < 1 leg) drilling proposals into the FY 92 drilling schedule might open up ODP to a broader scientific community. PCOM passed 2 motions and a consensus concerning supplemental science, which described timing for submission of S-proposals, and stipulated that PCOM would consider scheduling up to 10 days of such science during legs 141 to 147. This policy was later advertised in the February 1991 issue of the *JOIDES Journal* and the February 5 1991 issue of *Eos*.

Three S-proposals (S-1, S-2, S-3) were received at the JOIDES Office for legs 141 to 147. All had some measure of thematic panel support. At the Hannover meeting, PCOM discussed these S-proposals at length. As a first step, PCOM prioritized the submitted S-proposals, and passed the following motion:

Motion: *Upon evaluation of the three supplemental science proposals we have received, PCOM ranks the potential science return of S-3 (OSN-2) the highest. Therefore, PCOM will consider only S-3 for scheduling in FY 92.*

Difficulties with the concept became apparent when PCOM considered scheduling supplemental science against scheduled science that it would replace. (For contractual reasons, leg lengths stipulated in the FY 92 schedule could not be substantively modified.) PCOM finally decided that this complex task could not be completed without further advice from thematic panels. PCOM arrived at the following consensus:

Consensus. *In order to decide at the Annual Meeting whether to reserve a maximum of 10 days during Leg 145 for drilling a re-entry hole, OSN-2, paired with NW-1A (Supplemental Science Proposal S-3), PCOM asks the thematic panels and co-chiefs for Leg 145 to determine which sites would be modified or dropped to accommodate up to 10 days at OSN-2.*

PCOM went on to consider the philosophical issue of continuing the S-proposal experiment. Ensuing discussion emphasized that adding "supplemental science" meant subtracting previously highly-ranked science from scheduled legs, while adding time to scheduled legs (as well as planning "mini legs") to accommodate S-proposals would have serious operational, logistical and staffing disadvantages. Eventually, PCOM decided to abandon "supplemental science", and passed the following motion:

Motion: *PCOM moves to discontinue the practice of accepting "Supplemental Science" Proposals (as defined by its motion and consensus of December 1990). However, continued submission of proposals requesting less than 1 leg of drilling is encouraged. Such proposals will be ranked in accordance with normal ODP review procedures.*

Therefore, PCOM will not issue a call for S-proposals for the North Atlantic (FY 1993) and subsequent drilling schedules.

Statute of limitations, JOIDES drilling proposals: When does a proposal submitted to ODP become "inactive"?

At its April 1991 meeting, PCOM began to discuss instituting a ~3-year limit beyond which ODP proposals (without additional input from proponents) would be considered "inactive". Such a designation would preclude further action (i.e., review or re-review by thematic panels, scheduling by PCOM) on that proposal by the advisory structure. This discussion occurred as a response to the growing perception by ODP thematic panels and PCOM that there are now too many proposals in the JOIDES system to keep in collective memory, particularly with substantive panel memberships changes occurring over ~3 year periods. In April, PCOM decided to defer action on such a statute until a master list was prepared by the JOIDES Office summarizing all ODP proposals submitted and their fates. That list was completed in early August.

From the master list, it is apparent that thematic panels, in the process of generating their spring 1991 global rankings, considered proposals with submission dates primarily later than early 1988. Such a "natural" phasing out of older proposals from consideration for drilling is believed to be a function in part of the lack of corporate panel memory beyond ~3 years. In August, PCOM formally recognized this phenomenon by implemented a statute of limitations for proposals older than ~3-4 years:

Motion: *PCOM recommends that proposals which have not been updated for three full calendar years before the present calendar year (i.e., January 1, 1988 for 1991 activities, to roll to January 1, 1989 on January 1, 1992 for 1992 activities) be declared formally "inactive". Thematic panels will be given the directive by the JOIDES Office not to review inactive proposals formally, but rather to initiate submission of proposal updates (as per revised JOIDES Proposal Submission Guidelines, published in the June 1991 JOIDES Journal) from proponents if there is sufficient panel interest. The community will be informed about this change in policy through the JOIDES Journal (see additional documentation in the August minutes).*

PCOM further agreed that the new statute of limitations should take effect on January 1, 1992. Based upon the new policy, the following is a summary of proposal status as it will be assessed by the JOIDES Office beginning on that date:

A proposal is "active" if:

1) it is in review (generally done only once by thematic panels),
2) it has been ranked (a policy specific to each thematic panel),
3) it has not been ranked, but was submitted after January 1, 1989.

A proposal is "inactive" if:

1) it has been replaced by a revision (see below),
2) it has been forwarded to a DPG, for incorporation into a drilling prospectus (however, if for some reason a DPG does not consider a proposal sent to it, that proposal can be re-ranked by thematic panels.),
3) it has not been drilled and has not been updated (see below) by one or more proponents since January 1, 1989.

Standard policy requires that the JOIDES Office provide thematic panels automatically with all new proposals and updates (see below) for review, and with reviewed, "active" proposals on request. From January 1, 1992 on, if a panel is interested in "inactive" proposals, it must either approach proponents directly for action by them, or take action internally on updating the proposal.

The JOIDES Office keeps all old proposals, as it is the proposal archive for ODP.

In August, some PCOM members argued that certain scientifically important proposals should remain active beyond the statute of limitations if there is continued thematic panel interest but the ship has not been in the area covered by that proposal for the specified period. PCOM consensus was that in such cases proponents should be encouraged, if necessary by thematic panels, to update those proposals, even if only minor modifications are possible. Resubmission of an updated proposal guarantees that it is brought to the attention of new thematic panel membership through the formal review process.

In order to keep a proposal "active", proponents must submit an "update" no later than ~3-4 years after its initial submission. Such an "update" may be either an addendum or a revision (see Proposal Submission Guidelines, June 1991 *JOIDES Journal*). Minimum requirements are proponent responses to thematic panel comments on the original proposal, and an introductory note identifying the new submission as either an addendum or revision of an original proposal. Typically, updates also include new site survey data and/or refined drilling strategies, if those are available. Revised proposals can be submitted to the JOIDES Office at any time.

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 four weeks before the first of the thematic panel meetings of either the fall or spring review period. Note that each proposal is forwarded to all four thematic panels, a practice that has proven necessary and successful during the past few years. 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.

ODP Site Summary Form

The Site Summary Form on the next page can be copied and used for proposals to be submitted to the JOIDES Office. The form is a *Microsoft Word* table (Macintosh), and can be requested from the JOIDES Office on a floppy diskette.

Listing of Recent Proposals

Received at the JOIDES Office from June through September, 1991.

Ref.No	Received	Abbreviated Title	Contact	Status
253-Rev	06/19/91	Deposition of organic carbon-rich strata, ancestral Pacific	Sliter, W.V.	**Ranked 1991**
346-Rev2	08/14/91	Ivory Coast - Ghana transform margin	Mascle, J.	**Ranked 1991**
348-Add	08/30/91	Uppper Paleogen to Neogene U.S. mid-Atlantic transect	Miller, K.G.	In Review
400----	09/03/91	Mass balance/def. mech., Middle Am. Trench/Costa Rica	Silver, E.A.	In Review
401—	09/05/91	Evolution of a Jurassic Seaway, SE Gulf of Mexico	Buffler, R.T.	In Review
388-Add	09/06/91	Add. to Neogene deep water circ. and chem., Ceara Rise	Curry, W.B.	**Ranked 1991**
369-Rev	09/09/91	Generation of oceanic lithosphere, MARK area	Casey, J.F.	**Ranked 1991**
402----	09/09/91	Geochemical anomaly in MAR basalts between 12°-18°N	Sobolev, A.V.	In Review
403----	09/09/91	KT boundary in the Gulf of Mexico	Alvarez, W.	In Review
330-Add2	09/10/91	Accretionary prism in collisional context, Med. Ridge	Cita-Sironi, M.B.	**Ranked 1991**
NARM	09/10/91	North Atlantic Rifted Margins DPG Report	Larsen, H.C.	**Ranked 1991**
404----	09/11/91	Neogene paleo. from W North Atlantic sediment drifts	Keigwin, L.D.	In Review
380-Rev2	09/12/91	VICAP, Gran Canaria	Bednarz, U.	**Ranked 1991**
391-Add	09/12/91	Formation of sapropels, eastern Mediterranean	Zahn, R.	**Ranked 1991**
405----	09/12/91	Amazon fan growth and climate, denudation, sea-level	Flood, R.D.	In Review
369-Add	09/16/91	MK2: deep hole in oceanic upper mantle	Mevel, C.	**Ranked 1991**
376-Rev	09/16/91	Layer 2/3 boundary and vertical tectonics, VEMA F.Z.	Mevel, C.	**Ranked 1991**
406----	09/16/91	North Atlantic climatic variability	Oppo, D.	In Review
407----	09/16/91	North Atlantic shallow mantle at geochemical anomaly	Dick, H.J.B.	In Review
408----	09/16/91	Testing two new interpretations, N Nicaragua Rise	Droxler, A.W.	In Review

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:		

Bulletin Board

ANNOUNCEMENTS

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 (please note new deadline):

Shorebased Work (regardless of leg) 12/15/91

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 deadline 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:

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.

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.

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 Established 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 are available from JOI.

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.

ODP Long Range Plan

The ODP Long Range Plan portfolio is 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

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 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.

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.

Micropaleontological Reference Centers

Located at eight sites on four continents, the Micropaleontological Reference Centers (MRC) provide scientists around the world an opportunity to examine, describe, and photograph microfossils of various geological ages and provenance. The collections contain specimens from four fossil groups—foraminifers, calcareous nannofossils, radiolarians, and diatoms—selected from sediment samples obtained from the Deep Sea Drilling Project (DSDP). The processing of samples from DSDP legs 1 through 82 has been overseen by John Saunders, Supervisor of the Western Europe Center, and William Riedel, Supervisor of the facility on the US West Coast. These samples have been prepared, divided into eight identical splits, and distributed to each MRC. Future plans include the addition of samples from the later legs of DSDP, and from the Ocean Drilling Program (ODP) as well.

All fossil material maintained by MRCs remains the property of the US National Science Foundation and is held by the MRCs on semipermanent loan.

The establishment of identical paleontological reference collections around the world will help researchers to unify studies on Pelagic biostratigraphy and paleoenvironments, and to stabilize taxonomy of planktonic microfossils. Researchers visiting these centers may observe the quality of preservation and the richness of a large number of Microfossils, enabling them to plan their own requests for either ODP or DSDP deep-sea samples more carefully. Visitors to MRCs also may compare actual, prepared faunas and floras (equivalent to type material) with figures and descriptions published in DSDP *Initial Reports* or ODP *Proceedings* volumes.

Facilities at MRCs

All MRCs maintain complete, identical collections of microfossil specimens. In addition, the following materials and equipment are available for visitor use:

- secure storage and display areas
- binocular microscope and work space
- reference set of DSDP *Initial Reports* and ODP *Proceedings* volumes
- lithologic smear slides accompanying each fossil sample
- microfiche listings of samples available.

For more information about MRCs, or to schedule a visit, contact the supervisor on site.

Locations of MRCs

US East Coast
Lamont-Doherty Geological Observatory
Palisades, NY 10964
Supervisor: Ms. Rusty Lotti
Phone: (914) 359-2900
Telex: 7105762653 LAMONTGEO

US National Museum
US National Museum of Natural History
Dept. of Paleobiology
Smithsonian Institution
Washington, D.C. 20560
Supervisor: Dr. Brian Huber
Phone: (202) 786-2658
Telex: 264729
Fax: (202) 786-2832

US Gulf Coast
Texas A&M University
Dept. of Oceanography
College Station, TX 77843
Supervisor: Dr. Stefan Gartner
Phone: (409) 845-8479

US West Coast
Scripps Institution of Oceanography
La Jolla, CA 92093
Supervisor: Dr. William Riedel
Phone: (619) 534-4386
Telex: 910337127 IUC WWD SIOSDG

Western Europe
Natural History Museum
CH-4001 Basel
Switzerland
Supervisor: Mr. John Saunders
Phone: 061-29-55-64

USSR
Institute of the Lithosphere
Staromonet 22
Moscow 109180, USSR
Supervisor: Dr. Ivan Basov
Phone: 231-48-36

Japan
National Science Museum
Dept. of Geology
3-23-1 Hyakunin-cho
Shinjuku-ku
Tokyo, 160, Japan
Supervisor: Dr. Y. Tanimura
Phone: 03-364-2311
Telemail: 03-364-2316

New Zealand
New Zealand Geological Survey
PO Box 30368
Lower Hutt, New Zealand
Supervisor: Dr. Tony Edwards
Phone: (04) 699059
Fax: (04) 691479

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, Jr., 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.

Geochemistry Progress and Opportunities, Miriam Kastner and Garrett Brass, Conveners.

Proceedings of a Workshop on the Physical Properties of Volcanic Seafloor, G.M. Purdy and G.J. Fryer, Conveners.

ODP BIBLIOGRAPHY AND DATABASES

ODP Science Operator

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

Cumulative Index to 96 DSDP Volumes Now Available

A cumulative index to all 96 volumes of the Initial Reports of the Deep Sea Drilling Project is now available from ODP/TAMU. The index is presented in two formats: an electronic version on CD-ROM, and a printed version. Both are packaged together in a sturdy slipcase.

The index is in three parts: (1) a subject index, (2) a paleontological index, and (3) a site index. The three parts reflect the interwoven nature of the marine geoscience subdisciplines.

The electronic version of the index is the more complete of the two, containing up to eight hierarchies of entries. The 1072-page printed index volume contains three hierarchies of entries and was condensed from the electronic version. Both versions of the index were prepared by Wm. J. Richardson Associates, Inc.

The CD-ROM containing the electronic index was manufactured under the auspices of the Marine Geology and Geophysics Division of the National Geophysical Data Center, National Oceanic and Atmospheric Administration, and U.S. Department of Commerce. In addition to the three-part index, the CD-ROM contains (1) a bibliography of authors and titles, (2) citations to DSDP exclusive of the Initial Reports, (3) proposals to DSDP, (4) site-summary information, (5) an inventory of DSDP underway geophysical data, (6) an inventory of downhole-logging data, and (7) data-documentation files.

Many persons contributed to the indexing project, including those at Scripps Institution of Oceanography and Texas A&M University. The U.S. National Science Foundation funded preparation and publication.

Index sets can be obtained from the Publications Distribution Center, Ocean Drilling Program, 1000 Discovery Drive, College Station, Texas 77845-9547, U.S.A. (telephone, 409-845-2016). The price is US $50.00 postpaid.

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	118	July 91
Leg 119	119	Sept 89	119	Sept 91
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	124	Sept 91
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	131/132	June 91		
Leg 132	131/132	June 91		
Leg 133	133	Sept 91		

Scientific Prospectuses and Preliminary Reports

	Prospectuses		Prelimin. Rpts.	
	Vol.	Published	Vol.	Published
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		
Leg 140	40	June 91		
Leg 141	41	Aug 91		

Engineering Prospectuses and Preliminary Reports

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

Technical Notes

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

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

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)

No. 14: A Guide to Formation Testing using ODP Drillstring Packers (1990)

No. 15: Chemical Methods for Interstitial Water Analysis on *JOIDES Resolution*

No. 16: Hydrogen Sulfide-High Temperature Drilling Contingency Plan (1991)

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

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)

Brochure: On Board *JOIDES Resolution*

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

Sample Distribution

The twelve-month moratorium on cruise-related sample distribution is complete for Ocean Drilling Program legs 101-133. 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. 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. Anyone may request a search. 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	No. Weeks Processing	Total No. Samples
ECR	6	9,785
GCR	2	10,442
WCR	2	3,375

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 National Geophysical Data Center (NGDC)

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 (see table below). 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.

AVAILABLE DATA

Data Available	Data Source	Description	Comments
1. LITHOLOGIC and STRATIGRAPHIC DATA			
Visual Core Descriptions			
-Sediment/sedimentary rock	Shipboard data	Information about core solor, sedimentary structures, disturbance, large minerals and fossils, etc.	
-Igneous/metamorphic rock	Shipboard data	Information about lithology, texture, structure, mineralogy, alteration, etc.	
Smear slide descriptions	Shipboard data	Nature and abundance of sedimentary components.	
Thin section descriptions	Shipboard data	Petrographic descriptions of igneous and metamorphic rock. Includes information on mineralogy, texture, alteration, vesicles, etc.	
Paleontology	*Initial Reports, Proceedings*	Abundance, preservation and location for 26 fossil groups The "dictionary" consists of more than 12,000 fossil names.	
Screen	Processed data	Computer-generated lithologic classifications. Basic composition data, average density, and age of layer.	
2. PHYSICAL PROPERTIES			
G.R.A.P.E. (gamma ray attenuation porosity evaluator)	Shipboard data	Continuous whole-core density measurements.	
Grain Size	Shore laboratory	Sand-silt-clay content of a sample.	Legs 1-79 only
Index properties: bulk and grain density, water content, and porosity	Shipboard data	Gravimetric and volumetric measurements from a known volume of sediment	
Liquid and plastic limits	Shipboard data	Atterberg limits of sediment samples.	
Shear-strength measurements	Shipboard data	Sediment shear-strength measurements using motorized and Torvane instruments.	
Thermal conductivity	Shipboard data	Thermal conductivity measurements of sediments using a thermal probe.	
Velocity measurements	Shipboard data	Compressional and shear-wave velocity measurements.	
Downhole measurements			
-Heatflow	Shipboard data	*In-situ* formation temperature measurements.	
-Pressure	Shipboard data	*In-situ* formation and hydrostatic pressure.	
3. SEDIMENT CHEMICAL ANALYSES			
Carbon-carbonate	Shipboard data, shore laboratory	Percent by weight of the total carbon, organic carbon, and carbonate content of a sample.	Hydrogen percents for Legs 101,103, 104, 106-108; nitrogen percents for Legs 101, 103, 104, 107, 108.
Interstitial water chemistry	Shipboard data, shore laboratory	Quantitative ion, pH, salinity, and alkalinity analyses of interstitial water.	
Gas chromatography	Shipboard data	Hydrocarbon levels in core gases.	
Rock evaluation	Shipboard data	Hydrocarbon content of a sample.	
4. IGNEOUS AND METAMORPHIC CHEMICAL ANALYSES			
Major element analyses	Shipboard data, shore laboratory	Major element chemical analyses of igneous, metamorphic, and some sedimentary rocks composed of volcanic material.	
Minor element analyses	Shipboard data, shore laboratory	Minor element chemical analyses of igneous, metamorphic, and some sedimentary rocks composed of volcanic material.	
5. X-RAY MINERALOGY			
X-ray mineralogy	Shore laboratory	X-ray diffraction	Legs 1-37 only
6. PALEOMAGNETICS			
Paleomagnetics	Shipboard data, shore laboratory	Declination, inclination, and intensity of magnetization for discrete samples and continuous whole core. Includes NRM and alternating field demagnetization.	
Susceptibility	Shipboard data	Discrete sample and continuous whole-core measurements.	
7. UNDERWAY GEOPHYSICS			
Bathymetry	Shipboard data	Analog records of water-depth profile	Available on 35-mm continuous microfilm
Magnetics	Shipboard data	Analog records and digital data.	Available on 35-mm continuous microfilm
Navigation	Shipboard data	Satellite fixes and course and speed changes that have been run through a navigation smoothing program, edited on the basis of reasonable ship and drift velocities, and later merged with the depth and magnetic data.	Available in MGD77 exchange format
Seismics	Shipboard data	Analog records of sub-bottom profiles and unprocessed signal on magnetic tape	Available on 35-mm continuous microfilm
8. SPECIAL REFERENCE FILES			
Leg, site, hole summaries	Shipboard data initial core descriptions	Information on general leg, site, and hole characteristics (i.e. cruise objectives, location, water depth, sediment nature, drilling statistics).	
DSDP Guide to Core Material	*Initial Reports,* prime data files	Summary data for each core: depth of core, general paleontology, sediment type and structures, carbonate, grain size, x-ray, etc.	Legs 1-85 only
AGEPROFILE	*Initial Reports,* hole summaries	Definition of age layers downhole.	
COREDEPTH	Shipboard summaries	Depth of each core. Allows determination of precise depth (in m) of a particular sample.	
9. AIDS TO RESEARCH			
ODASI	A file of ODP-affiliated scientists and institutions. Can be cross-referenced and is searchable.		
Keyword Index	A computer-searchable bibliography of DSDP- and ODP-related papers and studies in progress.		
Sample Records	Inventory of all shipboard samples taken.		
Site Location Map	DSDP and ODP site positions on a world map of ocean topography.		
Thin Section Inventory	Inventory of all shipboard thin sections taken.		

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 May 1, 1991 and August 31, 1991. For additional information on the ODP Data Bank, please contact Mr. Carl Brenner at Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964.

- From G. Moore (U. of Hawaii): Multichannel seismic lines OR4-10, 22, 23 and 37-41, along with bathymetric base map, from Oregon Margin survey of the Cascadia area.

- From E. Davis (PGC, Canada): DIGICON multichannel seismic lines 89-12, 89-13 and 89-14, along with corresponding navigation, from the Middle Valley area.

- From J. Franklin (Geol. Surv. Canada): SeaMARC 1A images of the Middle Valley area, in support of Leg 139 drilling.

-From D. Scholl (USGS, Menlo Park): Processed *Farnella* lines, with corresponding navigation and bathymetric base map, in the Detroit Seamount area.

-From D. Fornari (LDGO): Computer plots of hydrothermal mineral deposits, high- and low-temperature vents and biological communities in the East Pacific Rise area, along with cruise report from the ALVIN program carried out in April, 1991.

-From C. Brenner (LDGO): Final topographic base map with magnetic anomaly locations in the Pigafetta and East Mariana Basin area, for Leg 129 post-cruise studies.

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:
Dr. Nobuaki Niitsuma* (Shizuoka Univ., Japan)
Dr. Warren Prell* (Brown Univ.)
Dr. Kay-Christian Emeis** (Kiel Univ., F.R.G.)
Dr. Phil Meyers*** (Univ. of Michigan)

Leg 118:
Dr. Paul T. Robinson* (Dalhousie Univ., Canada)
Dr. Richard P. Von Herzen* (WHOI)
Dr. Amanda P. Julson** (ODP/TAMU)
Dr. Paul J. Fox*** (URI)

Leg 119:
Dr. John Barron* (USGS, Menlo Park)
Dr. Birger Larsen* (Technical Univ. of Denmark, Denmark)
Dr. Jack Baldauf** (ODP/TAMU)
Dr. John B. Anderson*** (Rice Univ.)

Leg 120:
Dr. Roland Schlich* (Institut de Physique du Globe, Strasbourg, France)
Dr. Sherwood W. Wise, Jr.* (Florida State Univ.), Chairman
Dr. Amanda Palmer Julson** (ODP/TAMU)
Dr. Ellen Thomas*** (Wesleyan Univ., Connecticut)

Leg 121:
Dr. John Peirce* (Petro Canada, Calgary)
Dr. Jeffrey Weissel* (LDGO), Chairman
Dr. Elliott Taylor** (Univ. of Washington, Seattle)
Dr. Jeffrey Alt*** (Washington Univ., St. Louis)

Leg 122:
Dr. Bilal Haq* (National Science Foundation, Washington, DC)
Dr. Ulrich von Rad* (Bundesanstalt fur Geowissenschaften und Rohstoffe, FRG), Chairman
Dr. Suzanne O'Connell** (Wesleyan Univ., Conn.)
Dr. Robert B. Kidd*** (University College of Swansea, U.K.)

Leg 123:
Dr. Felix Gradstein* (Bedford Institute of Oceanography, Canada), Chairman
Dr. John Ludden* (Univ. of Montreal, Canada)
Dr. Andrew Adamson** (ODP/TAMU)
Dr. Wylie Poag*** (USGS, WHOI)

Leg 124:
Dr. Eli Silver* (UC Santa Cruz),
Dr. Claude Rangin* (Univ. Pierre et Marie Curie)
Dr. Marta Von Breymann** (ODP/TAMU)
Dr. Martin Fisk*** (OSU)

Leg 125:
Dr. Patricia Fryer* (Univ. Hawaii)
Dr. Julian Pearce* (Univ. Newcastle-Upon-Tyne, U.K.)
Dr. Laura Stokking** (ODP/TAMU)
Dr. Patrick*** (Cottesloe, Western Australia)

Leg 126:
Dr. Brian Taylor* (Univ. Hawaii), chairman
Dr. Kantaro Fujioka* (Univ. Tokyo, Japan)
Dr. Thomas Janecek** (ODP/TAMU)
Dr. Charles Langmuir*** (LDGO)

Leg 127:
Dr. Kensaku Tamaki* (Univ. Tokyo, Japan), chairman
Dr. Kenneth Pisciotto*(El Cerrito, CA)
Dr. James Allan** (ODP/TAMU)
Dr. John Barron***(USGS, Menlo Park, CA)

Leg 128:
Dr. James Ingle* (Stanford Univ.)
Dr. Kiyoshi Suyehiro* (Univ. of Tokyo, Japan)
Dr. Marta von Breymann** (ODP/TAMU)
Dr. Michael McWilliams*** (Stanford Univ.)

Leg 129:
Dr. Roger Larson* (Univ. of Rhode Island)
Dr. Yves Lancelot*(Univ. Pierre et Marie Curie)
Dr. Andrew Fisher** (ODP/TAMU)
Dr. Edward L. Winterer***(Scripps Inst. of Oceanography, UCSD)

Leg 130:
Dr. Loren Kroenke* (Univ. Hawaii)
Dr. Wolfgang Berger*(Univ. Bremen, West Germany)
Dr. Thomas Janecek** (ODP/TAMU)
Dr. William Sliter***(USGS, Menlo Park, CA)

Leg 131
Dr. Asahiko Taira* (Univ. Tokyo, Japan)
Dr. Ian Hill* (Univ. of Leicester, U.K.)
Dr. John Firth** (ODP/TAMU)
Dr. Peter Vrolijk*** (Exxon, Houston, TX)

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

ODP/JOIDES Directory

Membership Lists

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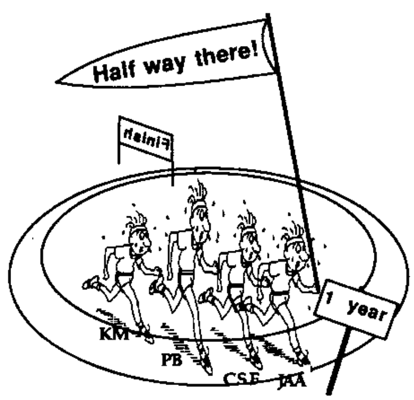

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Special Issue No. 4: Guide to the Ocean Drilling Program, September 1985 (Vol. XI)
Special Issue No. 4: Guide to the Ocean Drilling Program, Suppl. One, June 1986 (Vol. XII)
Special Issue No. 5: Guidelines for Pollution Prevention and Safety, March 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	Transit	Days On Site	Total	In Port
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

JOIDES Meeting Schedule

Date	Place	Committee/Panel
1991		
October 01-03	Yamagata, Japan	OHP
October 08-10	Tokyo, Japan	SSP
October 09-11	Nicosia, Cyprus	LITHP
October 09-11	Nicosia, Cyprus	TECP
October 14-17	Halifax, Nova Scotia	SMP
October 15-17	Halifax, Nova Scotia	DMP
October 23-25	La Jolla, California	PPSP
November 04-06	La Jolla, California	SL-WG
November 08-09	Zurich, Switzerland	SGPP
December 03	Austin, Texas	Panel Chairs
December 04-07	Austin, Texas	PCOM
1992		
January 14-16	Bonn, Germany	EXCOM
April 21-23	Corvallis, Oregon	PCOM
August 18-20	Canada	PCOM
Nov/Dec	Bermuda	PCOM