JOIDES Journal

VOL. XVI, No. 3, October, 1990

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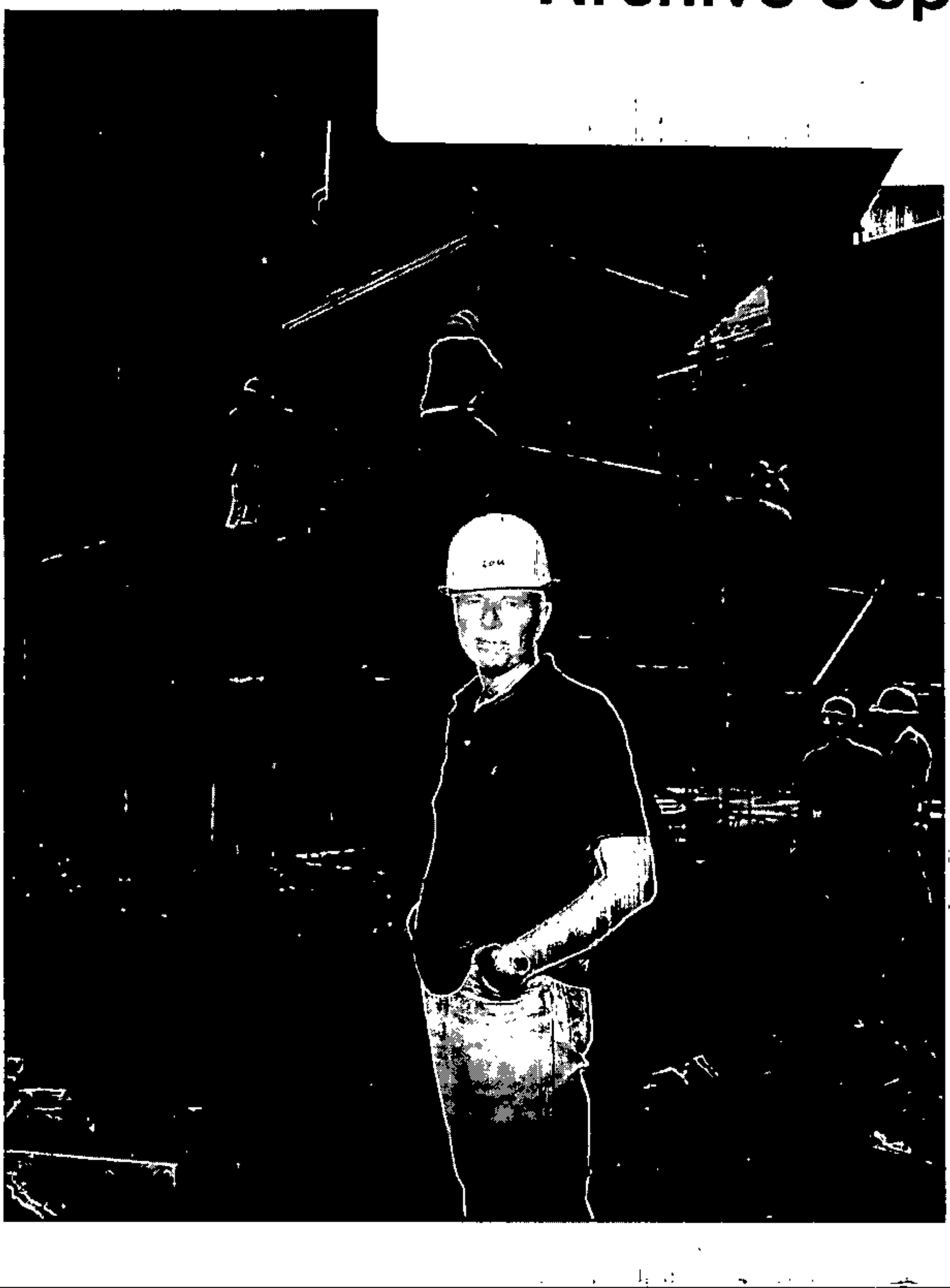

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FOCUS

As this office moves to Texas, I'll use this final opportunity in FOCUS to thank those in the JOIDES advisory structure who have aided ocean drilling for these past two years that Hawaii has hosted the JOIDES Planning Office. Basic to all, of course, has been the terrific support and cooperation afforded by the Science Operator at TAMU, by the Borehole Research Group and Data Bank at LDGO, and by the staff, officers, and Board of Governors of JOI. My thanks include those here in Hawaii: my secretary, Harriet Iwamura, the glue that held everything together; Guy Waggoner and Pat Cooper, for their work with PCOM, EXCOM and *JOIDES Journal*; and Laurent d'Ozouville, who maintained order in the potential chaos of proposals, revised proposals, and first, second, and third addendums to revised proposals. Laurent will be attached to the French Embassy in Canberra, and we wish him well. I've expressed my appreciation to fellow PCOM members and panel chairs, and now also thank panel members.

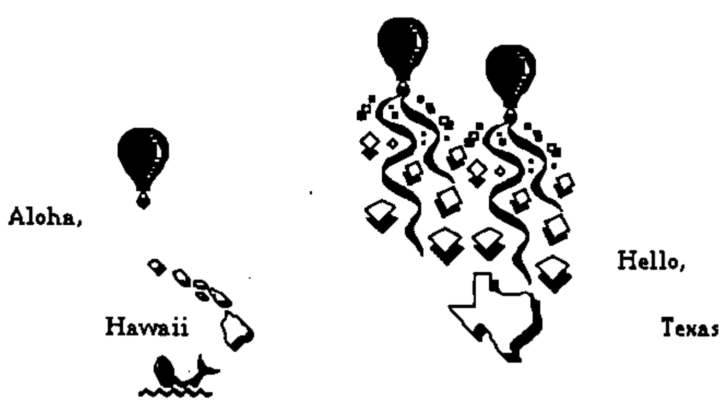
All of us in PCOM and many others in JOIDES are academic scientists, and I believe we are not fully appreciative of the immense contributions made by non-academic professionals who give so much of their time and expertise to the benefit of the Ocean Drilling Program. From my own duties I became most familiar with the members and activities of the Pollution Prevention and Safety Panel, but the Technical and Engineering Development Committee and the Downhole Measurements Panel are also filled largely with scientists and engineers of private and public industry and research laboratories. A few of these are also on other panels. The intense level of questions, the scrutiny of records, the depth of background knowledge, and the general seriousness of purpose show that we are well served. It is to these drilling engineers, exploration geophysicists, logging experts, and petroleum geologists, and to their companies that allow them their *pro bono* time, that I send my compliments and thanks for tasks well done.

Viva ODP!

Aloha to all in JOIDES,

Ralph

Ralph Moberly
Planning Committee Chairman



JOIDES RESOLUTION OPERATIONS SCHEDULE

LEGS 134 - 140

EG	AREA	DEPARTURE		ARRIVAL		IN PORT	DAYS AT SEA*
		LOCATION	DATE	LOCATION	DATE		
33	N.E. Australia	Guam	08/09/90	Townsville, Australia	10/11/90	10/11 - 10/15	62
34	Vanuatu	Townsville, Australia	10/16/90	Suva, Fiji	12/17/90	12/17 - 12/21	62
135	Lau Basin	Suva, Fiji	12/22/90	Suva, Fiji	02/18/91	12/18 (Crew Change)	58
136	Transit Oahu Pilot Hole	Suva, Fiji Honolulu	02/19/91 03/04/90	Honolulu Honolulu	03/01/91 03/21/91	03/01 - 03/03 03/21 (Crew Change)	10 17
137	Engineering 3A (504B)	Honolulu	03/22/91	Panama	05/01/91	05/01 - 05/05	40
138	E. Equatorial Pacific Neogene	Panama	05/06/91	Los Angeles	07/05/91	07/05 - 07/09	60
139	Sedimented Ridges 1	Los Angeles	07/10/91	Victoria, B.C.	09/11/91	09/11 - 09/15	63
140	Lower Crust at 504B or Eng./Science 4 at EPR	Victoria, B.C.	09/16/91	Panama	11/13/91	11/13 - 11/17	58

Revised 09/06/90

*Schedule subject to change pending detailed planning after Leg 134

A CHANGING OF THE GUARD

This summer, one "old salt" left the Ocean Drilling Program, and another experienced sailor was piped aboard. Dr. Louis E. Garrison, deputy director for the program since its inception, has retired, and Dr. Timothy Francis has assumed the number two slot in the Director's Office.

Lou Garrison

Lou takes with him a lifetime of geologic experience, a passion for ODP, and the love and respect of friends and colleagues worldwide. For the past six years, he lived the minutiae and machinations of drilling permits, the routine and drama of the ship's daily reports and the frustration and thrill of airline flight schedules and frequent flier plans.

Lou knew about scientific ocean drilling long before his May 1983 arrival in College Station. During Deep Sea Drilling Project days, he was a member of the Pollution Prevention and Safety Panel, and its chair for 10 years. When ODP became more than just a gleam in Dr. Philip Rabinowitz's eye, the call came...

"Phil asked me if I would be interested in becoming deputy director of the Ocean Drilling Program, should Texas A&M get the contract," Lou explained. "I thought for two whole seconds before saying 'yes.' ODP then consisted of Phil, Sylvi (Sylvia DeVoge), me and a secretary. At that time we weren't 100 percent sure that Texas A&M would get the program. So our days - and nights - were spent writing the proposal. By the spring of 1984, we had the proposal accepted. Texas A&M was chosen Science Operator and things really began to move," he said.

According to the plan, some yet-to-be-identified ship was to set sail January 1985. In less time than it takes to birth a baby, a ship had to be found and converted, a staff had to be interviewed and hired, and a program plan had to be written and accepted. After looking at drill ships around the world, the skeleton crew at ODP chose SEDCO/BP 471. "It was drilling commercially in the Gulf of Mexico," Lou said. "As soon as that contract was up in November, we sent it to Pascagoula for conversion. People like Barry Harding, Dan Reudelhuber and Vernon Grief really earned their keep during the conversion. The techs, too, put in untold hours to get the ship ready to sail."

"By now we had 20 to 25 people. We still had to buy the instruments for the ship, purchase and install the computers and find space for all these people who kept pouring in every day." The first priority was to equip the labs with the scientific instruments needed for a program of this scale. "Phil told us to list our ideal pieces of equipment; he wanted state of the art. He was truly visionary on this project. He knew the standards the equipment had to meet to survive ship's conditions, and the hundreds of users over at least 10 years," Lou said. Another huge project was to select the main computers for ship and office, as well as all of the personal computers. "The bill was humongous. I just wasn't used to dealing in these kinds of numbers," said Lou.

One of Lou's many responsibilities was to get the clearances for the first few cruises. Some, the ones needed to drill in the Bahamas on Leg 101, were pretty much under way, but others down the line needed his immediate attention. "I had never obtained a clearance in my life," he said. "This was truly on-the-job training." What he learned never could be explained in some imaginary clearance textbook. Clearances, like countries, are unique, and there's no cookbook formula to follow. "It's part instinct, part common sense, and a lot of luck," Lou observed.

State Department guidelines, for instance, don't tell you about dealing with the Saudi royal family, or how to get something from Italy during Christmas, or what to do when sulky officials turn stubborn at the flip of a site map.

The Saudi story centers on the illfated cruise in the Red Sea, which ultimately never took place. But it wasn't for lack of trying. Lou knew that the clearance was going to be tricky, so he started 18 months ahead to get blessings from Egypt, Saudi Arabia and Sudan. "Cairo had no problem with our drilling," Lou said. "And the competent Sudanese authorities immediately gave their permission. But we could get no acknowledgement from the Saudis."

So Lou got to work. Suzanne O'Connell, former staff scientist, had been the roommate of a Middle East specialist who then worked at the Brookings Institution. This person set up an interview between Lou and the nephew of a Saudi prince. In an elaborate social situation, Lou met the princeling for cocktails. Promises of favors given and favors returned ensued. Lou also went through a widow in London whose deceased husband had been a member of the royal family. She, too, promised to help, sending her young Saudi son to Prince Saud to intervene on behalf of ODP. After several months of this Tinkers-to-Evers-to-Chance gambit, permission was still not granted. Other problems, such as technological limitations and staffing, probably would have precluded to cruise anyway, but Lou ruefully remembers all the elaborate Machiavellian moves.

You never know when a clearance - or lack of one - will turn around and bite you. Leg 117 seemed a cinch. No problem. Four hundred miles offshore. International waters, no need for a permit. Lou was about to learn Chapter Two in Clearance Studies 101.

Lou had already flown to the port call in Sri Lanka when the agent informed ODP that they were indeed drilling in Sri Lankan waters. A permit was mandatory. And, the agent solemnly declared, these sorts of things take at least a year. Sri Lankan authorities basically contended that through some arcane section in the Law of the Sea, as incorrectly interpreted by a certain functionary at an oceanographic institute, the country's continental shelf extended 400 miles offshore. Ergo, ODP would be drilling in Sri Lankan waters. If ODP proceeded to drill, Sri Lanka would blacklist the organization with all third-world countries, which could play havoc with future permits, not to mention bad public relations for an international drilling program.

"The State Department wouldn't touch it. So I drew up a Memorandum of Agreement (MOU) between Texas and the National Agency of Sri Lanka. In it, ODP admitted that, yes, it was drilling in Sri Lankan waters, although we didn't believe that for a minute. We also agreed to take three of their scientists; two backed out. It was a lot of saber rattling, but I wanted to see the ship sail."

After a prolonged lunch at the hotel, the MOU sat unsigned on the table. Seems there were some minor corrections and the Sri Lankans wanted a clean copy. Certain parties to the agreement also wanted a tour of the ship. Lou finally got the lunch over, the bill paid and the official and his lawyers and public relations people to the ship. The Sri Lankan contingency not only got a redrafted MOU, but they also received the quickest ship's tour on record.

Seeing the ship sail gracefully into port - and sail out again on a new ODP leg - has been one of the highlights of Lou's career at ODP. "It fascinates me how such a complicated procedure works," he said. "No other drill ship in the world has the technical and logistical problems that the *Resolution* faces every two months. And despite all the millions of details, it works."

Lou hasn't severed his ties with ODP. He'll be called to consult from time to time. "My box of memories is jammed full," he said with a wistful smile. I've never worked with such a great bunch of people in my life. It amazes me how you can get such a concentration of young, talented people in one place. I feel privileged and fortunate to have been a part of this program. To end my career on a note like this ....
I couldn't ask for anything else."

Tim Francis

Dr. Timothy J. Francis has been appointed deputy director of the Ocean

Drilling Program. Dr. Francis was previously an independent consultant in ocean research and technology in the United Kingdom. His experience includes work for the Natural Environment Research Council and a term as Head of Geology and Geophysics at the Institute of Oceanographic Sciences in the United Kingdom. Dr. Francis has served as chief scientist on 10 oceanographic expeditions and has participated in 25 others. He has written, or co-written 60 scientific papers. His fields of interest have ranged from seismicity at mid-ocean ridges to the feasibility of disposing high-level radioactive waste in the sediments of the ocean floor. Currently, his primary interest is ridge-crest drilling. These formations, into which ODP will be drilling in 1991, will give scientists the opportunity to investigate a number of fundamental geologic processes including hydrothermal circulation, sulfide deposits, and the formation of oceanic crust.

Dr. Francis has been involved with ODP almost from its inception, and was instrumental in helping the United Kingdom become a full partner. Approximately 60 scientists from the United Kingdom have sailed as scientists or chief scientists with the program. Dr. Francis' duties as deputy director include ensuring the safety of selected drill sites, helping schedule upcoming cruises, and monitoring daily drilling operations and ship's activities.

LEG 131: NANKAI TROUGH PRELIMINARY REPORT

TECTONIC SETTING

The Nankai Trough is a topographic manifestation of the subduction boundary between the Shikoku Basin, a part of the Philippine Sea plate, which is moving about 4 cm/yr to the northwest (Seno, 1977), and the Honshu Arc, a part of the Japanese Islands, which extends approximately east-northeast to west-southwest. To the east, the trough converges with a major arc-arc collision boundary between the Honshu and Izu-Bonin arcs (Fig. 1).

The sediments that are being brough to the deformation zone are composed of two sequences: An upper turbidite layer and a lower hemipelagic layer (Kagami, Karig, Coulbourn, *et al.*, 1986). The turbidites have been transported laterally along the axis of the trough from the mountain ranges of the arc-arc collision zone (Taira and Niitsuma, 1986). The sedimentation rate in the trough is greater than 1 km/m.y. The thickness of the trench turbidite layer varies from place to place, chiefly owing to the configuration of the oceanic basin (Le Pichon, Iiyama, *et al.*, 1987).

The Shikoku Basin is a backarc basin formed behind the Izu-Bonin Arc by mostly east-west-directed spreading accompanied by a late-phase northeast-southwest spreading episode during the late Oligocene to middle miocene (25-12 Ma; Kobayashi and Nakada, 1978; Chamot-Rooke, *et al.*, 1987). The fossil spreading axis lies in the central part of the Shikoku Basin and has been subducted at the middle part of the Nankai Trough. Ridge-transform topographies produce a local ponding of turbidites in the trough by acting as "dams" for turbidity currents. Owing to the general shallowness of the Shikoku Basin, especially over the fossil spreading axis, the trench turbidite layer is thinnest in this area. The oceanic-basement configuration in the area of Site 808 is smooth and flat, which aided the creation of rather laterally continuous structural features at the toe region.

The entire sedimentary sequence in the central Nankai Trough is 1.1 seconds of two-way traveltime (s twt) thick; the hemipelagic portion of this sequence is about 0.3 s thick. The structure of the accretionary prism is well imaged by seismic sections. The deformation front is defined as the location of initiation of the incipient thrust with several meters of displacement, as identified on 3.5-kHz profiles. This is the proto thrust zone; it is followed by a series of imbricated thrusts that show a structure typical of thrust-fold belts. The décollement can be identified within the hemipelagic layer. The zone of imbricate thrusts extends landward (to the northwest) about 30 km with a master detachment surface, while the prism thickens to 1.9 s and is covered by lower-slope hemipelagic sediments. This zone then abruptly changes to a steep slope of vaguely defined internal structure.

A bottom-simulating reflector (BSR) is ubiquitous in this region. It first appears at the front of the imbricate thrust zone, about 0.15 s (one-way traveltime) below the seafloor, and steadily increases in depth below the seafloor landward, reaching a maximum depth of 0.3 s twt under the slope at about 3000 m water depth. The BSR becomes shallower toward the upper part of the slope. The anomalously shallow BSR at the toe region has been interpreted as resulting from high heat flux (Yamano *et al.*, 1982).

DRILLING OBJECTIVES

Drillsites in the Nankai Trough were occupied by *D/V Glomar Challenger* on DSDP Legs 31 (Karig, Ingle, *et al.*, 1975) and 87 (Kagami, Karig, Coulbourn, *et al.*, 1986). Leg 131 was a continuation of studies begun during Leg 87, but with a much stronger emphasis on physical properties, logging, and downhole experiments. The drilling location of Site 808 is positioned in the accreted and deformed sediments at the toe of the prism, where drilling planned to intersect both the frontal thrust and the décollement, and to recover basement.

The main objectives of Leg 131 scientific drilling included elucidation of the following thematic issues: (1) influence of pore fluids and the hydrogeology of the accretionary prism; (2) mechanical state and physical properties of deformed

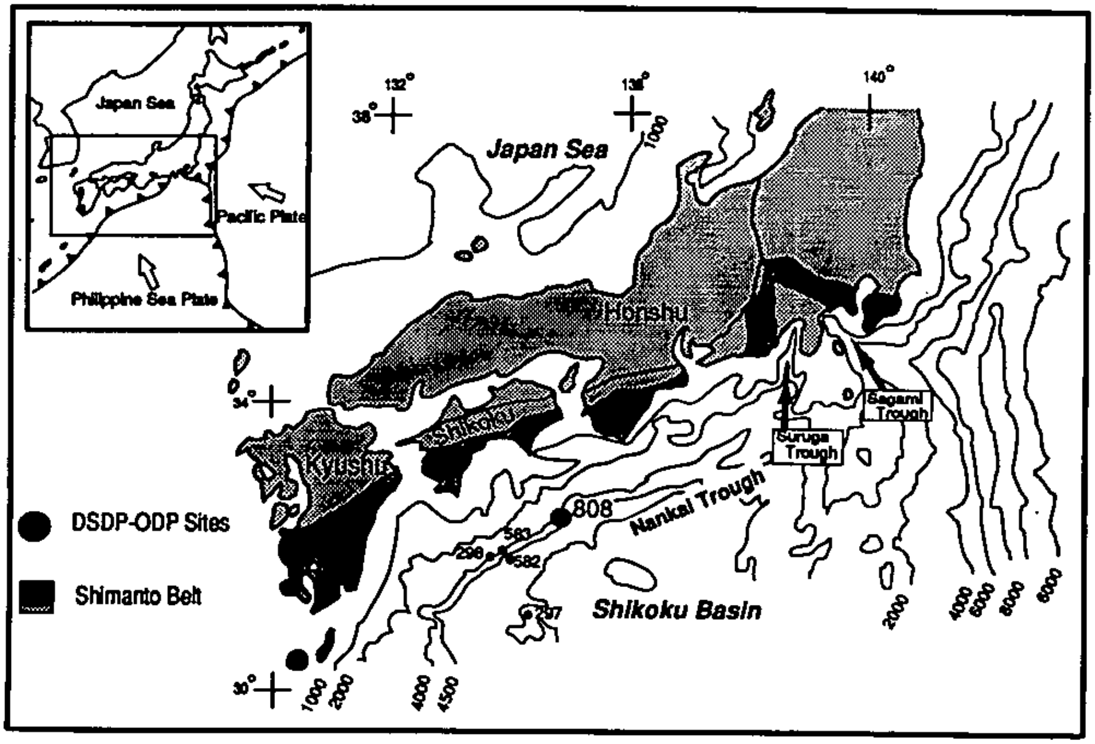


Figure 1. Map of the Nankai Trough, the Shikoku Basin, and Japan, showing bathymetry, DSDP and ODP sites, and the Shimanto Belt (ancient accretionary prism).

sediments; and (3) fabrics and structural styles of accreted sediments.

These objectives are closely interrelated and were studied by a variety of methods with a range of spatial scales, including downhole experiments (*e.g.* water sampler with temperature and pressure (WSTP), Lateral Stress Tool (LAST), wireline logging, and laboratory analyses of sedimentology, physical properties, and structural fabrics. These different measurements were combined to achieve a knowledge of seven primary aspects of accretionary prism development and evolution; (1) fluid flow; (2) porosity and density; (3) stress and strain; (4) elastic moduli; (5) sedimentology, structure, and fabrics; (6) geochemistry; and (7) stratigraphy.

DRILLING RESULTS

Leg 131 drilled 7 holes at Site 808 (proposed site NKT-2) in the toe of the Nankai accretionary prism (Figs. 1-3). The site was located at shotpoint 1720 on *R/VFred Moore* Line NT62-8. During the 67 days of Leg 131 operations, 56.3 days were spent on site whereas 6.8 days were spent underway.

Hole 808A penetrated 111.4 mbsf, with 79.6% recovery, but had to be abandoned prematurely when the unstable sand in the top 100 m collapsed, trapping the bottom hole assembly (BHA). This was severed with a back-off charge and the pipe recovered.

Hole 808B successfully penetrated to 358.8 mbsf using extended core barrel (XCB) drilling, but was stopped owing to slow rate of penetration. Core recovery was 24.1%. Attempts to log the hole using the sidewall-entry sub (SES) were terminated after only one log run when the lithoporosity tool jammed in the bit/bit sub. Part of the tool was lost while pulling out of the hole. Fishing attempts having failed, the hole was cemented and abandoned.

Hole 808C started with the first successful ODP deployment of 86 m of drill-in casing to prevent collapse of the sands from 19 to 105 mbsf. The hole was

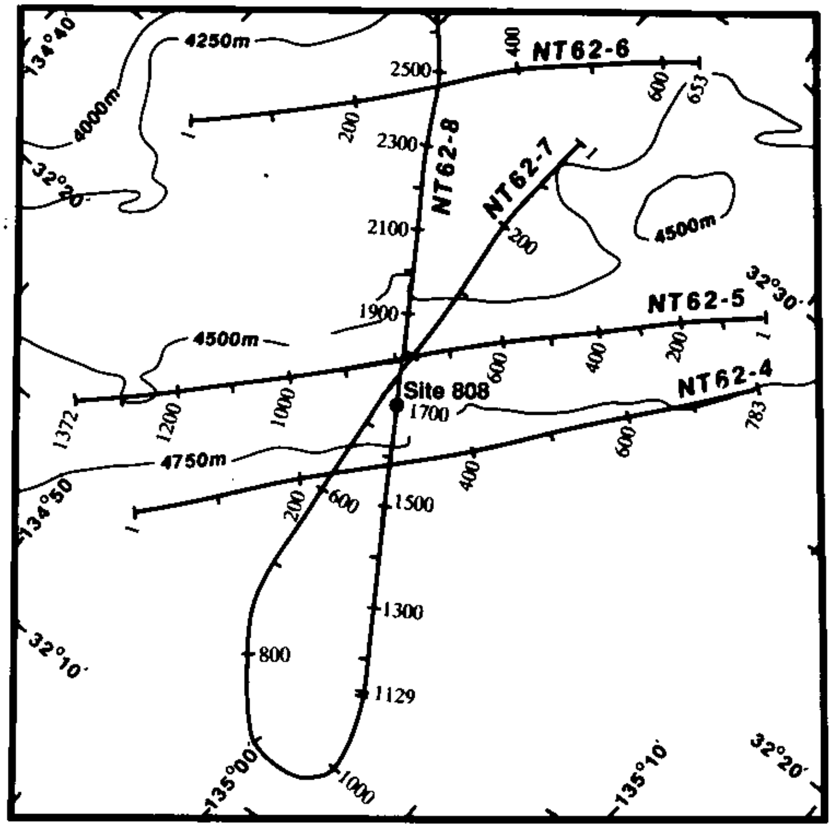


Figure 2. Location of ODP Site 808 with respect to *R/V Fred Moore* line NT62-8.

washed to 298.5 mbsf and rotary core barrel (RCB) cored to 1327.0 mbsf with 55.7% recovery. Attempts at wireline logging were frustrated by poor hole conditions despite numerous wiper trips. Through-pipe logs of lithoporosity and geochemical tools were obtained for the interval from about 750 mbsf to the seafloor.

Hole 808D was designed to be a deep penetration hole with reentry cone and casing to 750 mbsf. After 6 days of operations, the 750 m of 11-3/4" casing buckled during emplacement, and the hole was abandoned.

Hole 808E was a second attempt at the same operation, except that the casing length was only 540 m, the total length of remaining casing. This time the casing was successfully set, and the hole drilled ahead to 1200 mbsf for downhole measurements. Again, despite numerous wiper trips and heavy-mud and KCl treatment, the hole below the casing continued to show instability with swelling clays from 600-800 mbsf and collapse at the numerous fault zones. Attempts to obtain open-hole logs achieved only 100 m of log below the casing. A vertical seismic profiling (VSP) experiment was carried out from a depth of just over 600 mbsf to the top of the casing. The rotatable packer was deployed but failed to operate correctly on two attempts. The go-devil appeared to suffer damage in the pipe on deployment owing to drill-string vibration. The ONDO tool deployment was attempted repeatedly, but the landing pads would not pass through the BHA.

Hole 808F was designated for relatively shallow instrumental measurements to 300 mbsf using the WSTP, LAST and Pressure Core Sampler (PCS). This hole had to be abandoned at a depth of 140 mbsf after only a few measurements when the cutting shoe of the XCB tool failed and left debris in the hole. Hole 808G was respudded at the same ship's position and was used for instrumental

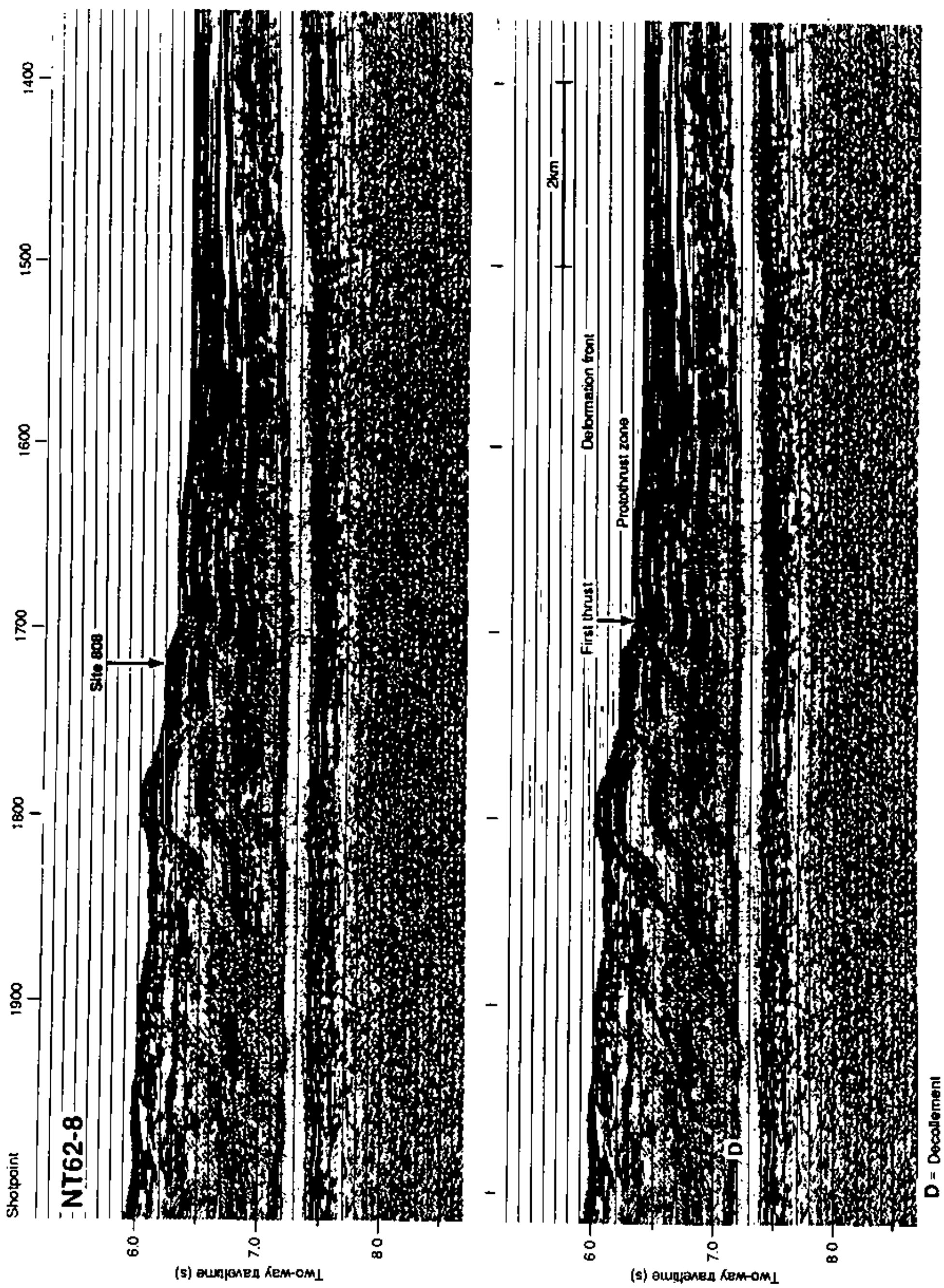


Figure 3. Section of seismic line NT62-8 showing location of Site 808.

runs until the pipe had to be pulled for the end of the leg. The LAST and PCS were successfully deployed in this hole.

The major lithostratigraphic units recognized in the sedimentary sequence are as follows:

➨Unit I: Lower slope apron (0-22.6 mbsf), Pleistocene. Interlayered clayey silt, fine-grained sand, bioturbated clayey silt, sandy clayey silt, and very thin ash layers. Gas expansion affected most of this unit. The fine-grained sands show typical Bouma T_{abde} sequences.

➨Unit II: Trench-fill deposits (20.6-556.8 mbsf), Pleistocene.
Subunit IIA: Upper axial-trench sandy deposits (20.6-120.6 mbsf), Pleistocene. Silty to very coarse-grained sands with variable bed thickness and internal structures. Beds show typical Bouma T_{abe} and rare T_{cde} sequences. Disseminated plant material in some intervals. Slide deposits occur near the base of this subunit.
Subunit IIB: Lower axial-trench silty deposits (120.6-263.4 mbsf), Pleistocene. The interval from 219 to 263.4 mbsf is duplicated below the frontal thrust from 365.0 to 409.5 mbsf. Subunit IIB comprises very thin- to thin-bedded very fine-grained sandstones, siltstones and mud, with minor ash; it has finer mean grain size and thinner mean bed thickness than Subunit IIA. The sandstones and siltstones show partial Bouma T_{bcde} sequences. A mudstone pebble conglomerate at 263.4 mbsf provides an important correlative deposit that is duplicated across the frontal thrust.
Subunit IIC: Outer marginal trench deposits (409.5-556.8 mbsf), Pleistocene. The interval from 409.5 to 511 mbsf is stratigraphically equivalent to the interval 263.4-365.0 mbsf above the frontal thrust. The major lithology is bioturbated clayey siltstone/silty claystone with interbedded, usually graded, thin-bedded, very fine-grained sandstones and coarse siltstones showing Bouma T_{cde} sequences.

➨Unit III: Trench to basin transitional deposits (556.8-618.5 mbsf), Pleistocene. Bioturbated clayey siltstone/silty claystone with thin ash/tuff layers. Unit III occurs from the first thick tuff bed to the last siltstone turbidite.

➨Unit IV: Shikoku Basin deposits (618.5-1243 mbsf), middle Miocene-Pleistocene.
Subunit IVA: Upper Shikoku Basin deposits (618.5-823.7 mbsf), Pliocene-Pleistocene. Interval from the last siltstone turbidite to the last occurrence of abundant ash/tuff layers. Characterized by abundant thin layers of tuff and volcanic sandstone intercalated within a thoroughly bioturbated mud succession rich in foraminifera tests.
Subunit IVB: Lower Shikoku Basin deposits (823.7-1243.0 mbsf), middle Miocene-Pliocene. A succession of thoroughly bioturbated clayey siltstones and silty claystones with traces of disseminated volcanic glass/tuff.

➨Unit V: Acidic volcaniclastic deposits (1243.0-1289.9 mbsf), middle Miocene. Very thin- (1-3 cm) to very thick-bedded (>100 cm) varicolored tuffs, including: (1) a thick quartz-rich acid tuff; (2) a gray to greenish gray altered tuff, (3) a varicolored tuffaceous mudstone; and (4) thin, dark olive-gray mudstones.

➨Unit VI: Basaltic basement (1289.9-1327.0 mbsf), middle Miocene. Basalt sills overlying pillow basalts, with some intercalated baked sediment containing age-diagnostic calcareous nannofossils.

The major surprise in this sequence is the appearance of beds of rhyodacitic tuffs (Unit V), reaching 4.5 m thick, over an interval of some 40 m just above the basalts. The source region for these is not clear.

Calcareous nannofossil stratigraphy proved useful for age assignments, and ties well with the paleomagnetic data. Of particular interest was a date of 13.6-16 Ma obtained from nannofossils in red mudstone recovered between basalts in the base of Hole 808C.

Most of the core proved to be satisfactorily stable for remanence determinations using the whole-core cryogenic system. With judicious use of the biostratigraphic ages as an initial guide, it was possible to provide considerable additional constraints on the age dating of the sediments. The agreement between the paleomagnetic and biostratigraphic data is very good.

From the age dating above, accurate sedimentation rates can be calculated. The turbidite sedimentation occurred with a deposition rate well in excess of 1 km/m.y. since 0.46 Ma, preceded by a slower and smoothly varying rate, averaging a little over 40 m/m.y. Extrapolation of this rate to the basalt surface gives an approximate age of 15.6 Ma.

The frontal thrust of the accretionary prism was penetrated at a depth of 365 mbsf and the décollement at 945-965 mbsf. Steep bedding and mesoscopic structures above the thrust have been oriented using paleomagnetics and imply a consistent northwest-southwest shortening direction. The thrust has developed as a rupture through an overturned fold, as evidenced by overturned bedding observed below the thrust plane. Pervasive deformation in the zone between the thrust and the décollement changes in nature with depth, with shear bands occurring mainly above 500 m and fault structures below that. A complete absence of vein structures, except in the basaltic basement, indicates a lack of concentrated fluid flow even at the faulted zones.

Analysis of interstitial water shows distinct chemical trends, marking several prominent boundaries. There are clear offsets in concentration trends of Ca, Mg, and Li at the thrust, and changes in gradients of Ca, Cl and silica at 560 mbsf correspond to the lithological boundary between the trench-fill turbidites (Unit IIC) and the transition zone (Unit III). At 820 mbsf changes in Ca, Mg, silica and sulfate correspond to the lithologic boundary at the base of the abundant ash/tuff layers (Unit IVA). A chloride minimum associated with the décollement may imply a past fluid-flow event. There is no clear evidence for presently active fluid flow.

Organic geochemistry reveals a pattern of anomalously high hydrocarbon maturity. Peaks in the abundance of thermogenic hydrocarbons, pentanes, butanes, and propanes in the depth ranges from 650 to 800 mbsf and from 1060 to 1280 mbsf suggest *in situ* formation at temperatures above those inferred from the present geothermal gradient.

First-order discontinuities in physical properties are observed at the thrust and décollement. Compaction trends have normal gradients above the thrust and below the décollement, but discontinuities appear in the compaction trends at these two structures. Porosity increases downward across the thrust from about 40% to 47%, and density correspondingly decreases from about 2.1 to 2.0 g/cm^2. This is taken to indicate that the sediments have not reequilibrated to the loading owing to the thrust displacement, confirming its young age. Across the décollement, porosity again increases downward from about 30% to 40%, and bulk density decreases. This evidence of relatively lower compaction below the décollement is taken to indicate higher pore pressures in this zone. Lithologic boundaries are also detected as changes in gradients of physical-property trends. Additionally, in the zone between the thrust and the décollement, seismic-velocity anisotropy decreases with depth.

Six WSTP temperature measurements in the depth range 91-346 mbsf give a combined gradient of 111°C/km, and, when combined with the thermal conductivity data, give a calculated heat flow of 126 mW/m^2. This value agrees well with the predictions of a purely conductive cooling model for oceanic lithosphere of the age observed at this site.

Owing to the poor hole stability, few open-hole logs were obtained. The limited data for the depth ranges 80-160 mbsf and 550-650 mbsf show good correlation with the recovered core. In the upper interval, where core recovery was poor, this will allow determination of lithology for unrecovered intervals. Lithoporosity and geochemical logs were obtained through combinations of casing and drill pipe for most of the interval from 50 to 750 mbsf. Results of these through-pipe logs require detailed correction for

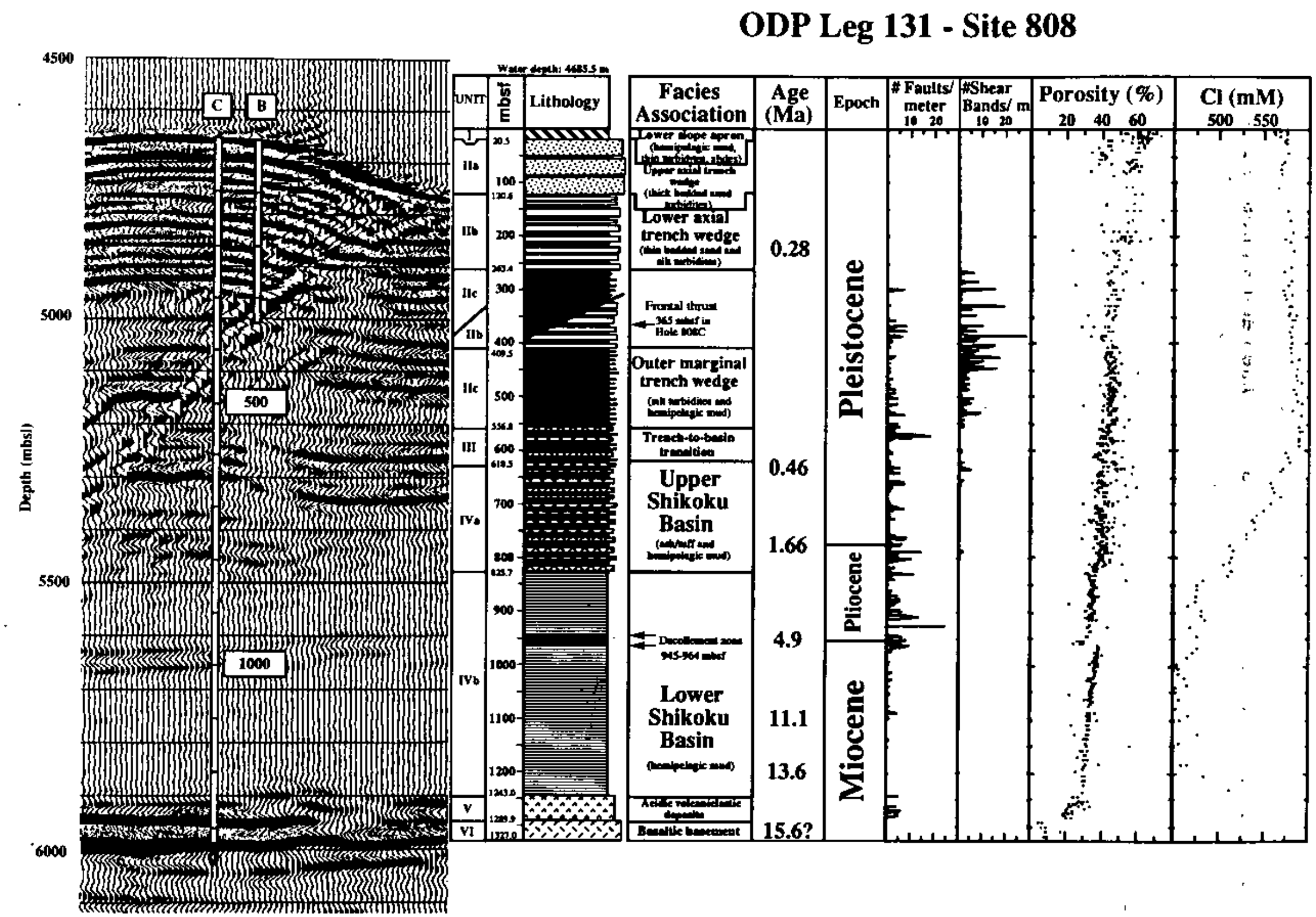


Figure 4. Summary figure for Site 808, showing Holes 808B and 808C relative to seismic section, lithstratigraphy, and age. Shear bands are most frequent from 300 to 600 mbsf; faults are more numerous from 600 to 1000 mbsf. Porosity shows a distinct shift at the décollement, and Cl has a large minimum around the décollement.

attenuation by pipe/casing and have not yet been analysed.

The PCS and LAST tools were both successfully deployed but the data await later analysis. While there was a high failure rate with these, this is always a high risk, especially with new tools.

SUMMARY AND CONCLUSIONS

Leg 131 investigated the hydrogeology, physical properties, and structural styles of deformed sediments in the toe of the Nankai accretionary prism. Initial results of Leg 131 show that:
(1) The Shikoku Basin basaltic basement in the Nankai region is middle Miocene (approx. 15.6 m.y.) in age, and is overlain by hemipelagic mudstones of middle Miocene to Pleistocene age. The onset of major turbidite deposition occurred less than 0.5 Ma.
(2) The first major thrust fault, intercepted at 365, occurs within an overturned fold and has a vertical stratigraphic throw of 145 m. The décollement zone, about 20 m thick, occurs from 945 to 965 mbsf within a lithologically homogeneous hemipelagic sequence.
(3) Structural style and orientations change with depth and age in the prism, with shear bands common in the shallower part of the section and small faults predominating at depth. The absence of vein structures throughout the sedimentary section indicates a lack of concentrated fluid flow.
(4) Physical-property data show major discontinuities at the thrust fault and décollement. A porosity increase below the décollement may indicate high pore pressures at this level. The first *in situ* stress and pore-pressure measurements in ocean drilling history were made, and should constrain the models for deformation and compaction in the accretionary prism.
(5) Interstitial pore-water geochemistry shows changes associated with lithologic boundaries but shows no evidence for active channeled fluid flow. A chloride minimum associated with the décollement may indicate a past fluid-flow event along this fault.
(6) *In situ* temperature measurements give a calculated heat flow of 126 mW/m^2, which agrees with conductive cooling models of the Philippine Sea lithosphere. However, hydrocarbon gas distributions suggest higher maturity levels than those expected from the present geothermal gradient.

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Table 1. Ocean Drilling Program Site Summary Report
Leg 131

Hole	Latitude (°N)	Longitude (°E)	Sea Floor Depth (mbsl)	Number of Cores	Interval Cored (m)	Recovered Core (m)	Percent Recovered	Interval Drilled (m)	Total Penetration (m)	Time (hrs)
808A	32° 21.12'	134° 56.67'	4676.0	13	111.4	88.7	79.6	0.0	111.4	60.0
808B	32° 21.09'	134° 56.61'	4674.2	28	247.8	59.7	24.1	111.0	358.8	211.0
808C	32° 21.17'	134° 56.66'	4674.6	108	1028.5	572.4	55.7	298.5	1327.0	394.8
808D	32° 21.14'	134° 56.58'	4672.7	0	0.0	0.0	0.0	780.0	780.0	153.8
808E	32° 21.11'	134° 56.61'	4672.9	0	0.0	0.0	0.0	1200.0	1200.0	461.5
808F	32° 21.15'	134° 56.76'	4684.3	4	61.0	2.4	3.9	79.0	140.0	31.5
		Not Including Wash Core:		3	11.0	0.0	0.0	129.0		
808G	32° 21.15'	134°56.76'	4684.3	12	99.6	12.8	12.9	113.4	213.0	50.8
		Not Including Wash Core:		11	64.6	11.3	17.5	148.4		
	Site and Leg Totals:			165	1548.3	736.0	47.5	2581.9	4130.2	1363.7
		Not Including Wash Core:		163	1463.3	732.1	50.0	2666.9	4130.2	

LEG 132: ENGINEERING II SITE REPORTS

ONDO Tool Deployment, Hole 808E

After leaving Pusan, Republic of Korea on 8 June 1990, Leg 132 first sailed to the Nankai Trough region east of Japan to complete the unfinished business of Leg 131. Three participants from Leg 131, including one of the co-chief scientists, remained on board to carry out the work. The principal objective was to lower a temperature probe (the "ONDO tool") into Hole 808E, which was drilled through the décollement of the Nankai Trough accretionary prism. Attempts to deploy this tool during Leg 131 were unsuccessful. Modifications were made during the Pusan port call, and the tool was emplaced in the hole on 11 June.

Site Summary, Site 809

Latitude: 31° 03.50'N
Longitude: 139° 52.72'E
Water Depth: 1802 m

Operations Summary

Leg 132 operations began at Site 809 (proposed site ENG-5; Fig. 1) on 13 June 1990, with a survey passing north-south over the crest of a line of small volcanic ridges to locate ourselves precisely within the HIG Seabeam bathymetric survey. Two short surveys of the sea floor were carried out using a Mesotech acoustic scanner and TV camera, one before each of the first two holes we drilled. The sea floor consists of slightly sedimented scoriaceous pillow lava, with pillow diameters ranging from less than 0.5 m to more than 2 m. The chosen site was within an area of flat sea floor, deemed suitable for setting of a guide base.

The beacon itself is located near a 10-m high flow front, but the flow is fairly flat upslope to the west. Thirty meters south and 34 m west of the beacon Hole 809A was spudded. The hole was drilled using the variable-displacement coring motor to test the capability of a newly-designed 11-5/8 inch bit/center-bit assembly in coring volcanic rock. Using the coring motor, and low weight on bit, the hole reached 8.3 meters below the seafloor in 7 hours, a rate of 1.2 m/hr. No cores were taken, but a tiny piece of very vesicular basalt scoria was retrieved in the core bit. Wear on the bit itself was negligible. The TV monitor revealed a crater about 2 m in diameter around the pipe, indicating that caving had occurred around the top of the hole. The caving was probably aggravated by the "whipping" action of the coring motor during the unsupported spudding operation.

The next test hole, Hole 809B, was drilled in the same manner with a smaller, newly-designed core bit 9-7/8 inches in diameter. The hole was about 100 m farther to the northwest, on a similar, but probably somewhat older, flow of pillow lavas with ponded sediment between the pillows. Closer to the presumed rift axis, smoother drilling conditions and even less basement relief were expected. The bit indeed produced a narrower hole with less caving, and reached 13.4 mbsf in 8.3 hr, a rate of 1.6 m/hr. Again, bit wear was negligible. Using the Mesotech acoustic scanner, we identified a particularly flat area away from local flow fronts or pillow ridges that produced backscatter shadows of 2-3 m at distances of 20-30 m on the display. The coordinates of the flat patch relative to the beacon were noted for reference during the guide-base operation. That was fortunate because the Mesotech scanning sonar failed during the guide-base lowering and has not functioned since.

The guide base was lowered to start Hole 809C, and reached the sea floor at 1100 hr on 16 June. Setting the base on the sea floor was done blindly, since the VIT frame holding the TV camera was too far above the guide base to see the bottom. With the weight of the base relieved from the drill string, the pipe was disconnected by rotating a jay-tool and backing out of the cone. The cone quickly lurched away from the camera to one side, and then leaned into one corner of the central cavity within the hard-rock base. Initially, it was feared that the basement surface was too steep, but examination of video tapes and subsequent operations established instead that the problem was likely insufficient syntactic foam to provide

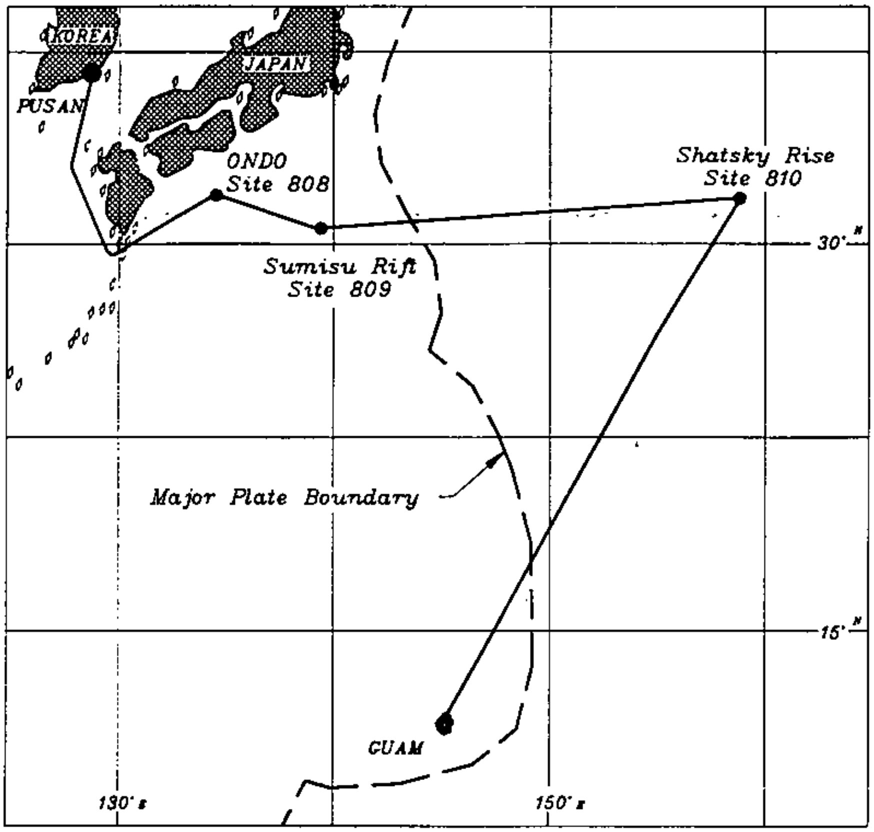

Figure 1. Leg 132 drill sites.

buoyancy to right the cone to the vertical above its gimbal assembly. With the jay-tool still down, a test reentry was performed, and, using the weight of the drill string plus the ship's dynamic positioning system, the cone was pulled upright.

With some reentry capability established, the pipe was retrieved and run in with a core bit and drill-in bottom-hole assembly (BHA). The design was intended to case off about 6 m of hole and thus provide sidewall stability at the outset of diamond coring operations, and simultaneously to lock the cone into a vertical position. After drilling 6 m, the pipe was to separate automatically from the BHA by means of a tapered back-off sub, leaving the casing in the hole below the jay-slot. Unfortunately, the back-off sub rotated free after only 4 m of penetration, leaving the top of the casing above the jay-slot. This was confirmed during our next re-entry with the jay tool. The pipe was tripped and a tool sent down to fish the casing. The reentry and fishing operation went smoothly, but the cone--freed of the supporting casing--once again fell to the south corner of the weighted base. This time it was decided to drill a "rat-hole," into which the same backoff system could simply be lowered without fear of premature operation of the back-off sub. However, on this reentry attempt, it was very difficulty to pull the cone upright. The throat of the cone was entered, but at an angle that did not allow the BHA to pass through the casing hanger to the sea floor. Reentry in such circumstances requires pivoting the cone to a nearly upright position, and then working the bit into the casing hanger. Alternatively, the string can be slid down one side of the inclined cone at an angle (produced by draping the pipe into the cone by means of offsetting the ship). The angle may come close to that of the gimbaled casing hanger. The risk is that such operations can produce strong excursions of the cone about the pipe as it rotates about its gimbal assembly. The situation was exacerbated by rocking of the weighted base itself on two legs as the cone swung and lurched into the sides of the box. This occurred because the four-legged base can only sit on three legs on an irregular basement surface. Bit weight on the sides of the cone applies moments to either side of the base which is centered on a line between the two stable legs. Thus it must wobble.

During one such pirouette on this re-entry attempt, the cone swung out of a pinned position and the drill string itself fell away, imparting a sharp lateral blow to the inner lower surface of the cone. This caused the cone to separate partially from its welded base and gusset support assembly where it joined the casing hanger. The cone could not safely be reentered in this condition, so it was pushed completely cff the casing hanger using the drill string. The cone fell to the sea floor upside down, confirming that the flotation was inadequate to support the cone even without that portion of the casing hanger above the gimbal.

The casing hanger itself, however, offered a small, 24-inch diameter opening through which reentries might be accomplished. The hanger would still have to be pulled to an upright position, but there was no reason not to attempt it. Regrettably, although the end of the string was placed in this tiny opening several times, and with more than one configuration of a BHA during two additional pipe trips, the drill-in BHA never was pushed past the jay-tool slots in the casing hanger successfully. Almost certainly, this was because the end of the string could not be held in the top of the hanger and to relieve enough weight to drag it into a vertical position. The rocking hard-rock base complicated these attempts.

At this point, discussions turned to abandoning the guide base and setting another one onto the sea floor. The flotation problem still existed, however. The only way to solve it was to retrieve the inverted cone with its flotation material from the sea floor and use it together with the flotation for the second guide base, all on one assembly. A fishing tool with four arms arranged like a moly-bolt was lowered to the sea floor and speared through the inverted opening at the cone's base. The simple tool worked well, and the cone was back on deck within a few hours.

Emboldened by this success, fishing operations for the guide base were begun. If it could be retrieved, then the site planned for the second guide base later in the leg would not be lost. A double jay tool was lowered on flexible 5-inch drill pipe. No other BHA components were used. The hard-rock base was located with the TV scanner, and the 24-inch opening in the casing hanger reentered. The hanger was pulled from the south to the north corner of the base by offsetting the ship to allow a maximum alignment of the flexible pipe with the tilted end of the hanger. After rotating the jay-tool with the coring motor, we finally found an orientation which allowed it to slip into the jay- assembly. Another partial turn engaged the tool, and we lifted the guide base from the sea floor to the moon pool.

The reincarnated guide base was then refitted by lightening the cone, doubling up the flotation material, and reattaching the cone to its base. A tilt beacon was constructed to ensure that the base would rest on sufficiently flat bottom, and added markings and inclinometers to the base to determine its orientation after we disconnected from the cone.

After lowering the reconstructed guide base to start Hole 809D, several additional difficulties with the sea-floor installation had to be overcome before we established a viable hole. At Hole 809D, although latching the drill-in BHA in the casing hanger and stabilizing the reentry cone was successful, a failure cf the jay-in tool left a 6-inch slab of metal in the throat of the guide base. The damaged tool was retrieved and the remaining tool on board strengthened. This was then tripped back down to the cone, jayed in, and then used to lift the base over the drill-in casing, leaving the casing embedded in the sea floor. The hard-rock base was moved a few meters to Hole 809E. Using the TV monitor, the metal slab was seen resting on the top of the drill-in BHA after we lifted the base.

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re. Hole 809E, after some hours attempting to drill in another BHA, operations eroded and undercut the basalt underlying one leg of the hard-rock base, causing the base to tilt beyond the 20° maximum allowed by the reentry-cone gimbal assembly. The casing was retrieved, tripped back to the cone, jayed in, and once again the base was moved across the sea floor to a new location, Hole 809F, where drilling in and latching a BHA to a depth of 5.9 meters below the sea floor (mbsf) was successfully accomplished.

There followed a period of assembly and testing of the diamond coring system (DCS), which is operated from a heave-compensated platform about 14 m above the rig floor. Several problems were discovered with the secondary heave compensation system, most of them having to do with noise imparted to controlling accelerometers mounted on the DCS platform. The most serious complications were resonance sent down the pipe (which was held in tension against the weight of the hard-rock base) and returned to the ship, and noise from the DCS platform's hydraulic feed cylinders. Both would change sometimes hourly as sea-state, wind, and ship's orientation changed. Eventually, the problem was overcome by shifting the sensor system to the ship's hull in the moon pool, thereby bypassing the fluctuating, high-frequency motions of the platform and hydraulic system. During most of the coring at Hole 809F, however, the full heave compensation system was not in use.

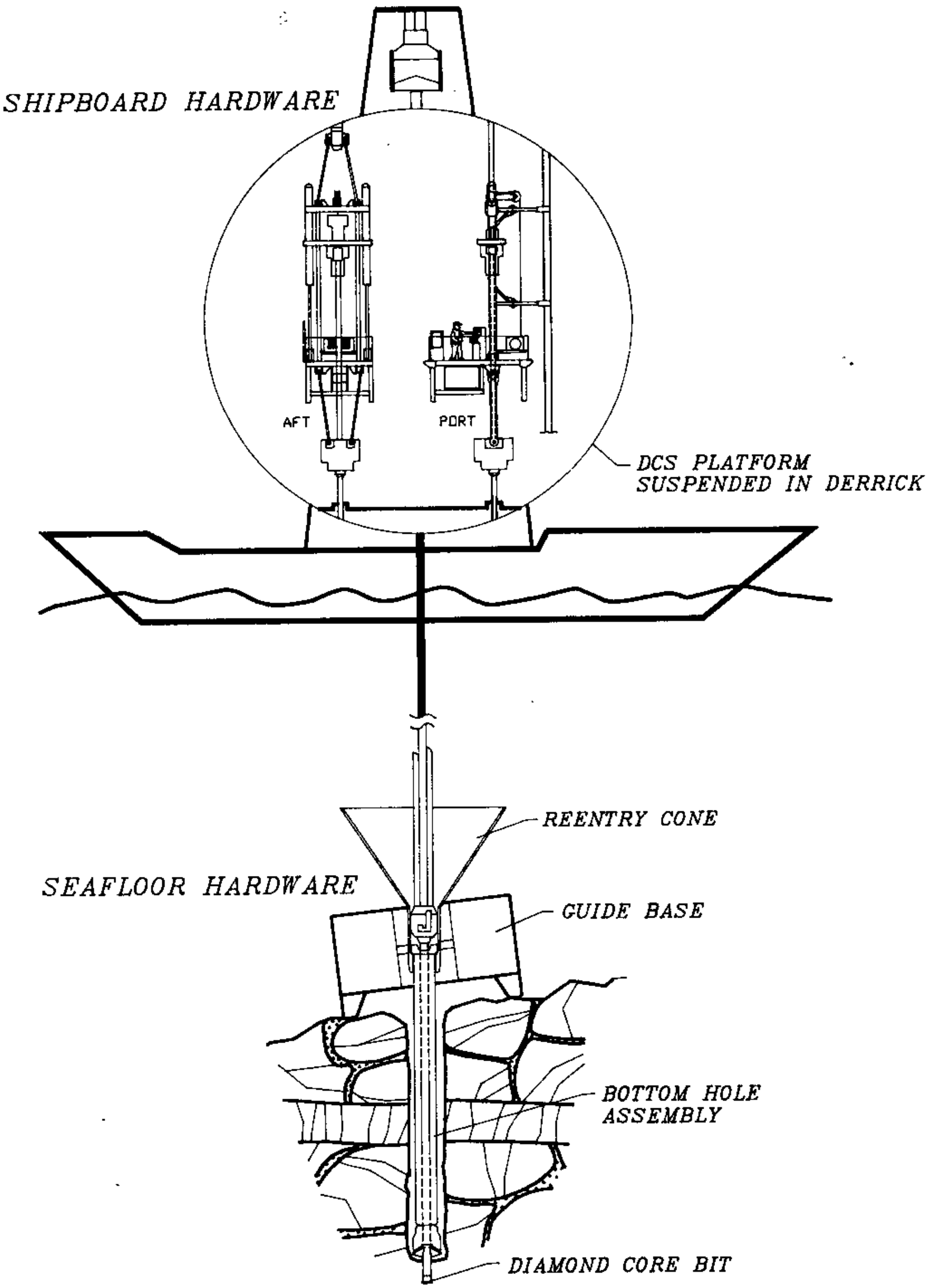
Coring with the DCS began on 6 July. Adjustments had to be made to put parameters in the controlling computer program, inasmuch as changes in weight-on-bit caused simply by landing the bit on the bottom of the hole were initially interpreted by the computer as break-throughs in the formation ("void"-hits). This triggered automatic pull-backs of the drill string. Also, about 2 m below the bottom of the casing, the bit encountered what is interpreted as a flow-top breccia which was extremely quickly drilled, and which took almost no ... Virtually none of this ...ntly

because it was either washed out ahead of the bit by down-the-pipe circulating fluids, or because it fell out of the core barrels as they were retrieved. Throughout this time, there were several indications of possible core jams, based on pressure readings of the fluid pumped down the tubing. At least one such reading may have been caused by aggregation of lumps of gel separated from the lubricant added to the drilling fluid. Also, some core barrels may not have latched in because of accumulated debris (lost core) lodged above the bit. We finally concluded that the core barrels indeed were functioning properly, but that the formation itself was too friable to be cored and retained.

Coring proceeded in harder formation, but soon stopped, unable to advance because of bit failure at 14.3 mbsf. The tubing was tripped, the drill string unjayed, the string suspended in the derrick, the DCS platform set back, and the DCS tubing tripped for a bit change. Reversing this sequence, drilling was resumed.

This second bit advanced through several highly vesicular basalt flows or pillows, with substantial recovery (64%) to a depth of 29 mbsf. Coring was fairly smooth and rapid.

Below 29 mbsf, unconsolidated formation was again encountered, and here the most significant weakness of the coring system was evident. For nearly 50 m of subsequent penetration, virtually nothing was recovered.Two or three small chips of basalt would occasionally arrive on deck, but otherwise all that could be discovered about the formation was based on particles of sand twice found in returned core barrels, and once on the chiseled face of a bit deplugger. The sand suggests the presence of crystal-vitric tuffs, but the small particle size is probably a consequence of drilling. The rate of advance was rapid; at times, there were abrupt drop-throughs of up to 1 m, possibly representing voids in the formation. For most of this interval weight-on-bit was low and impossible to sustain for much distance. Circulation was reduced to a bare minimum (at one ... at point to nearly half the minimum ... s



DIAMOND CORING SYSTEM

recommended by the bit manufacturer) and improvised traps were placed in the plastic core liners in an attempt to recover anything at all. But no amount of coaxing, no trick devised, could persuade material even to enter the core barrels. At one point, a center bit was lowered and, after drilling ahead for some meters, it was recovered without so much as a scratch on its painted surface.

With a limited degree of understanding, the problem is a combination of the design of the core catcher, the bit chosen for the coring, and the unconsolidated nature of the formation. First, the core catcher is designed to capture fractured but competent rock recovered at full round core diameter. It has a wide throat. There was no expectation that unconsolidated breccias of such thickness would be at this location, thus there was no core catcher on board with fingers to capture gravel-sized or smaller rock fragments.

Secondly, operations continuously pumped a viscous fluid combining sea water, weighted mud, and lubricant down the pipe while coring. The mixture passed through a narrow annulus at the base of the seated core barrel between it and the inner wall of the bit. The force of the spray was directed at the formation immediately ahead (1.5 cm) of the core barrel, evidently jetting the unconsolidated material away. That explains why not even the paint was removed from the center bit when it occupied the place of the core barrel.

Nonetheless, the bit eventually worked its way into more massive basalt flows once again, recovering a few fully cored pieces before the second bit expired at 79.2 mbsf. Probably, bit wear was accelerated or caused by a sand-blasting effect in the long interval of unconsolidated material we had just penetrated.

At this point, the DCS was set back on the platform, and rigged for logging through the DCS tubing. The slim-line combined caliper and gamma tool made it down the tubing, but did not pass an obstruction at the bit. The obstruction could not be cleared with the bit deplugger, so the tubing was retrived, revealing 34 cm of basalt tightly wedged just above the throat of the bit. Sandy particles coated some of the rocks. Once again, the logging tool was lowered, this time through the drill pipe, but another obstruction was encountered 2.3 m below the drill-in BHA. The logging tool worked this down to 13.7 mbsf, but no further. As the tubing string was no longer in place to drill out the obstruction, the site was abandoned after one month and five days of operations, leaving for Shatsky Rise.

In all, 79.2 m were drilled or cored , with 73.3 m of this using the diamond coring system. Although it took some days longer than planned, the full DCS eventually was brought completely on line, including the secondary heave compensation system, which operated well, keeping weight on bit to ±200-500 pounds. Operational efficiency and understanding of the system increased daily, and toward the end, the SEDCO drill crew was handling most of the operation. We learned a tremendous amount about how to place a hard-rock base on locally complex sea floor. Design modifications that are obvious now will make this a truly flexible and much simpler system for ridge-crest deployments in the future.

Although the recovery was disappointing, this was the first successful bare-rock coring of basalt in an active submarine volcanic field. The hole, though partly obstructed by a piece of basalt near the top, is still open for future drilling.

Science Summary

In Hole 809F, three chemically distinct basalt types were encountered in the 73.3 m of igneous formation penetrated by the diamond coring system below the casing shoe at 5.9 mbsf. Successively these are (1) fairly strongly fractionated ferrobasalt (Mg# = 0.43) from 5.9 to 21 mbsf; (2) moderately fractionated olivine tholeiite (Mg# = 0.60) from 21 to 29 mbsf, just above the 50 m interval with very low recovery; and (3) another moderately fractionated olivine tholeiite (Mg# = 0.60) from just below this interval in the last core obtained, between 78.9-79.2 mbsf.

The basalts are all extremely sparsely phyric, highly vesicular tholeiites similar to basalts dredged, drilled, and sampled by submersible from this incipient backarc rift. They are pillows or thin flows with glassy exteriors and more crystalline interiors. All the rocks are extremely fresh, with only minor oxidative alteration evident near some fractures. Most vesicles are partially lined with unaltered glass; only a few are lined with pale green clays or iron oxyhydroxides. The vesicles are a very prominent feature of these basalts. All the rocks contain myriad irregular to round pin-hole vesicles, but there are some very large vesicles (to 1-cm diameter) especially in the more evolved upper ferrobasalt. In this basalt, some of the larger vesicles are arrayed in trains across the rock face within pillow or flow interiors. Many of the larger vesicles are segregation vesicles, being partly filled with frozen melt, itself vesicular, which leaked into them as their walls ruptured during crystallization of the rock. One rock contains a fracture into which melt also leaked, annealing it completely. There is a good correlation between physical properties (velocity, density) and vesicle distribution in the basalts.

The basalts are glassy to spherulitic near quench margins, and more crystalline in the pillow/flow interiors. The less fractionated basalts carry minor olivine (no spinel) and have less abundant titanomagnetite than the ferrobasalt. There are a few rare plagioclase phenocrysts. Apart from the olivine, the crystallization sequence in all the basalts was the same: co-precipitating plagioclase and clinopyroxene were followed in intergranular spaces by spectacularly skeletal titanomagnetite and rare, tiny rods of ilmenite. Even tinier pyrrhotite spherules decorate the rims of the oxide minerals, thus segregated only during the very final stages of crystallization of the basalts.

The uppermost ferrobasalt and immediately underlying olivine tholeiite have the typical elevated K_2O (0.60 and 0.32%, respectively), Rb (10 and 5 ppm) and Ba (61 and 45 ppm) abundances, and the relatively low TiO_2 (1.7% at Mg# = 0.43; 1.2% at Mg# = 0.60), Zr (72 and 56 ppm) and Y (27 and 19 ppm) of many backarc-basin basalts. They are virtually identical to basalts previously sampled from this volcanic ridge. The lowermost basalt, obtained below the 50-m interval with virtually no recovery, is similar in most respects to the olivine basalt above the interval of low recovery, but it has somewhat lower K_2O (0.29%) and much lower Ba (19 ppm) contents. In these respects it resembles basalts from Site 791 drilled during Leg 126 which are interpreted to represent syn-rift basalts dating from the early stages of the opening of the Sumisu Rift.

We speculate that the interval of very low recovery represents highly vesicular and expanded basaltic glass similar to the basalt "mousse" recovered at Site 791. The rock compositions and stratigraphy suggest that we cored through a thin carapace of backarc basalts into syn-rift volcanic rocks deposited on subsided pre-rift basement, which projects on seismic profiler records to a shallow elevation at this location.

<u>Site Summary, Site 810</u>

Latitude: 32° 25.36'N
Longitude: 157° 50.73'E
Water Depth: 2634 m.

The principal objective of Site 810 (proposed site ENG-6) was to drill interbedded cherts and chalks of Mesozoic age on Shatsky Rise using the diamond-coring system (DCS). This objective was not achieved because of quality control problems with the modified reentry cone that was to be deployed on the seafloor, drill-in bottom-hole assembly (DI-BHA) problems, shortage of time toward the end of the leg, and approaching typhoons that made operations on the suspended DCS platform in the derrick too dangerous. Leg 132 cored a shortened section of Cretaceous (Maestrichtian)-Cenozoic nannofossil oozes with the advance piston corer (APC), and deployed a modified reentry cone before abandoning the site.

Operations Summary

Shatsky Rise was approached from the southwest, and the ship passed over previously drilled DSDP Sites 305 and

306 to link them to Site 810 with a continuous seismic reflection profile. Steaming from south to north, the profile traced the principal chert horizon to a point where the pelagic sediments capping it were only 0.07 s thick. A single APC core was obtained in Hole 810A. A wash-in test was conducted in Hole 810B to a depth of 60 mbsf to determine the length of conductor casing needed below the reentry cone. Hole 810C was continuously APC-cored from a precisely located mud line to the uppermost substantial chert horizon at 125 mbsf. One additional core was taken with the extended core barrel in Hole 810C before retrieving the drill pipe to deploy the reentry cone.

The principal difficulties with the reentry cone installation concerned latching casing in the casing hanger. Even before the reentry cone was lowered, one casing string was inadvertently dropped to the seafloor; evidently it became unthreaded while attempting to land the casing hanger. The hanger was removed and modified, but then became wedged in the cone on a test and could not be removed. No casing could be suspended from it. The cone was lowered as it was, with 14 drums of pig-iron ingots added to the skirt at the base of the cone in order to replace the weight the casing would have provided the assemble on the seafloor. This weight was required to tension the drill string properly during anticipated DCS coring operations.

After this cone was landed on the seafloor, it was difficult to seat a drill-in bottom-hole assembly (DI-BHA). When the drill string was retrieved for inspection, it was found that the mechanism had landed properly, but the key-slots that allow the DI-BHA back-off nut to unscrew had failed, thus preventing back-off. The DI-BHA was lowered again without tightening the back-off nut, so that with only a small amount of frictional resistance it would unscrew. Once again the mechanism did not work, and the DI-BHA became stuck. After freeing it and retrieving the drill string, it was discovered that a proper landing had occurred, but the backoff nut had fused or jammed into its landing shoulder, possibly by means of the frictional heat produced by rotation, or loads imposed by various seating attempts. This unintentional "weld" held the entire 45,000-pound DI-BHA on its trip back to the ship.

A final attempt to land the DI-BHA was made using a new beveled C-ring in the landing assembly. However, the landing shoulder was too narrow, and simply compressed the C-ring on the bevel, allowing the entire DI-BHA to slip through the cone and penetrate 25 m into the chert/ooze. Because this appeared to be a proper landing of the DI-BHA, the problem was only discovered while attempting to get a sinker bar to the anticipated bottom of the DI-BHA in order to recover the center bit. When the drill string was retrieved, the back-off nut again was found to be fused or wedged into the landing sleeve. Back-off had actually occurred, but this time the DI-BHA had fallen out of the cone. At this point there was no time left for DCS coring. As inclement weather approached, the DCS tubing was removed from the derrick and broken down into joints for storage on the riser hatch. Time remained to fish the DI-BHA. This was accomplished and all drill collars were on deck by 29 July 1990. All additional DCS hardware was then secured.

Since weather reports indicated that a day remained before departure would be mandatory, a seismic survey of a portion of the summit of Shatsky Rise was conducted.

Science Summary

At Holes 810A and 810C, 129.8 m of Cenozoic and Upper Cretaceous nannofossil ooze was recovered. The shortened section records hiatuses in the upper Miocene-lower Eocene, lower Eocene-upper lower Paleocene, and lower Paleocene-upper Maestrichtian. The oldest sediment recovered was early Maestrichtian. A complete Cretaceous-Tertiary boundary was not present. The hiatuses represent intervals of erosion and redeposition. Many of the sediments contain reworked foraminiferal assemblages and show structural evidence for the action of currents. Five lithologic units are distinguished as follows:

➡Unit I (0.0-4.2 mbsf): Pleistocene brown to dark gray nannofossil ooze with cut-and-fill structures, and evidence for mixing of cooler- and warmer-water faunas.

➡Unit II (4.2-76.0 mbsf): Lower Pliocene to Pleistocene light gray to white nannofossil ooze characterized by evidence for increasing dissolution and mixing downsection. This unit contains a number of thin and one thick (14 cm) ash beds and rounded puniceous dropstones derived from arc systems to the west.

➡Unit III (76.0-99.5 mbsf): Upper(?) Miocene to lower Pliocene pale tan to tan clayey nannofossil ooze and calcareous clay, with rhythmic color alternations corresponding to varying clay contents (highest estimated 70%). Foraminiferal assemblages show evidence for strong dissolution. The base of the unit is at a hiatus.

➡Unit IV (99.5-113.3 mbsf): Upper Paleocene and lower Eocene pale tan nannofossil ooze, separated by a hiatus. Paleocene foraminiferal assemblages are strongly reworked, and include some Cretaceous forms. There is evidence for slumping and size sorting.

➡Unit V (113.3-136.1 mbsf): Upper Cretaceous to upper Paleocene white nannofossil ooze with large coccolith plates and small chert nodules. The pale color and coring deformation in the lower 10 m makes the identification of structures difficult, but there is a hiatus across the Cretaceous-Tertiary boundary.

The excellent array of measurements for physical properties and magnetic susceptibility show strong correlations with cyclical lithologic variations in the sediments. Although the section is broken by hiatuses, the upper two lithologic units carry detailed information relating to the development of eolian transport from the Asian mainland during the climatic deterioration that occurred between the Pliocene and Pleistocene.

LEG 134: SCIENTIFIC PROSPECTUS VANUATU (New Hebrides)

INTRODUCTION

The New Hebrides island arc lies in the southwestern Pacific Ocean, marking the subduction zone of the Australia-India plate, which moves eastward beneath the North Fiji Basin and Pacific plate. The complex tectonics of this arc involves the d'Entrecasteaux zone (DEZ), which is an aseismic ridge that is colliding with the central New Hebrides arc, clogging the trench, deforming the arc, and providing an opportunity to investigate by drilling the processes governing such collisions. Other major geologic problems that can be investigated by drilling in this arc include (1) the processes involved in the evolution of an intra-arc basin located within the zone of influence of arc-ridge collision and (2) the magmatic evolution of arcs during major changes in tectonic environment, including arc-ridge collision and a possible change in the polarity of subduction.

REGIONAL GEOLOGIC SETTING AND TECTONIC EVOLUTION OF THE NEW HEBRIDES ARC

The New Hebrides island arc is part of a narrow, sinuous Cenozoic volcanic chain that extends from Papua New Guinea through the Solomon Islands, Vanuatu (New Hebrides), Fiji, Tonga, and the Kermadec Islands to New Zealand. The New Hebrides arc extends for a distance of 1700 km from the Santa Cruz Islands (eastern part of the Solomon Islands) in the north to the Matthew and Hunter islands (eastern part of the territories of New Caledonia) in the south. The territorial islands of Vanuatu extend for 1450 km from north to south (Chase *et al.*, 1988; Fig. 1).

The New Hebrides Trench trends northwest-southeast and marks the boundary between the Australia-India plate and the Pacific plate (Fig. 1). The maximum depth of this trench ranges from over 8000 m in the north, near the west-trending San Cristobal Trench of the Solomon Islands, to over 7500 m at its southern terminus near the east-trending Hunter Trench. The geomorphic trench is absent opposite Malakula and Espiritu Santo islands where the d'Entrecasteaux Zone (DEZ) abuts the west flank of the arc.

Relative motion between Australia-India and Pacific plates is about 10 cm/yr, with the Australia-India plate moving N 76°E (Minster and Jordan, 1978; Pascal *et al.*, 1978; Isacks *et al.*, 1980). Louat and Pelletier (1989) indicate that the convergence rate between the Australia-India plate and the New Hebrides island arc varies from 12 cm/yr near the southern part of the trench to 16 cm/yr near its northern termination and reaches only 9 cm/yr near the arc/DEZ collision zone.

Between the southern New Hebrides Trench and the Loyalty Ridge (to the west) lies the North Loyalty Basin where the ocean is about 4000-5000 m deep. The Deep Sea Drilling Project (DSDP) drilled into rocks of this basin (DSDP Site 286; Fig. 1) in 1973 and found that the basement consists of middle Eocene oceanic crust (Andrews, Packham *et al.*, 1975). The Loyalty Ridge trends northwest through this oceanic basin and includes volcanic and carbonate rocks that are presently being subducted at the southern New Hebrides Trench.

West of the Loyalty Ridge lies the New Caledonia Ridge, which extends northwestward and becomes the submarine ridge of the DEZ. The DEZ may have been a subduction zone in the late Eocene that was uplifted and exposed in Miocene time (Daniel *et al.*, 1981; Maillet *et al.*, 1983). The DEZ comprises horsts and grabens and is approximately 100 km wide. It extends eastward to end in the central New Hebrides Trench, where it is presently being subducted near Malakula and Espiritu Santo islands (Collot *et al.*, 1985). Near these islands, the DEZ comprises the high relief (2-4 km), east-trending North d'Entrecasteaux ridge (NDR) and the South d'Entrecasteaux Chain (SDC) which includes the Bougainville guyot. Paleogene MORB and volcaniclastic rocks were dredged from the NDR (Maillet *et al.*, 1983) and

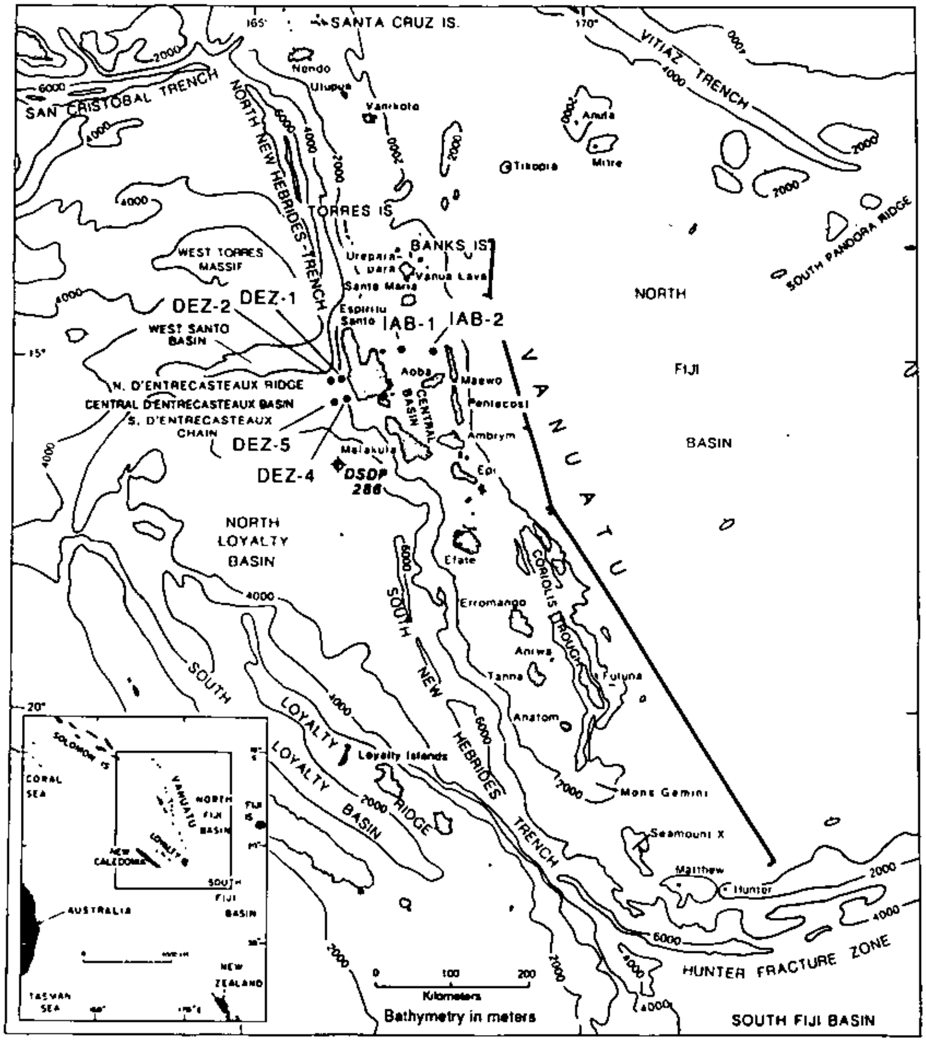


Figure 1. Regional bathymetry of the southwest Pacific showing approximate locations of drill sites proposed for Leg 134 (modified after Kroenke *et al.*, 1983).

andesites and carbonate rocks were dredged from Bougainville guyot. The NDR is being subducted beneath the arc with little noticeable disturbance of the arc-slope, but subduction correlates with a wide bulge of uplifted arc-slope rocks. The SDC largely deforms the arc-slope and generates well-developed compressive features in arc-slope rocks. The Bougainville guyot may be a piece of the SDC that is being subducted or obducted. The east-dipping Benioff zone is irregular but continuous despite the subduction of the DEZ (Pascal *et al.*, 1978; Isacks *et al*, 1980; Louat *et al.*, 1988; Macfarlane, *et al.*, 1988). North of the DEZ lies the oceanic West Torres Plateau, which has an unknown crustal affinity. Water depth over this plateau is as shallow as 750 m.

East of the New Hebrides arc lies the North Fiji Basin (Fig. 1), an active marginal sea of middle to late Miocene age (Malahoff *et al.*, 1982) that has evolved through four tectonic stages in the last 10 million years (Auzende *et al.*, 1988). It is a relatively shallow, open-ocean basin with water depths generally not greater than 3000 m. The basin is floored by oceanic crust that exhibits high heat flow (Larue *et al.*, 1982). The North Fiji Basin is bounded on the north by a ridge that supports the inactive volcanic islands of Mitre and Anuta,

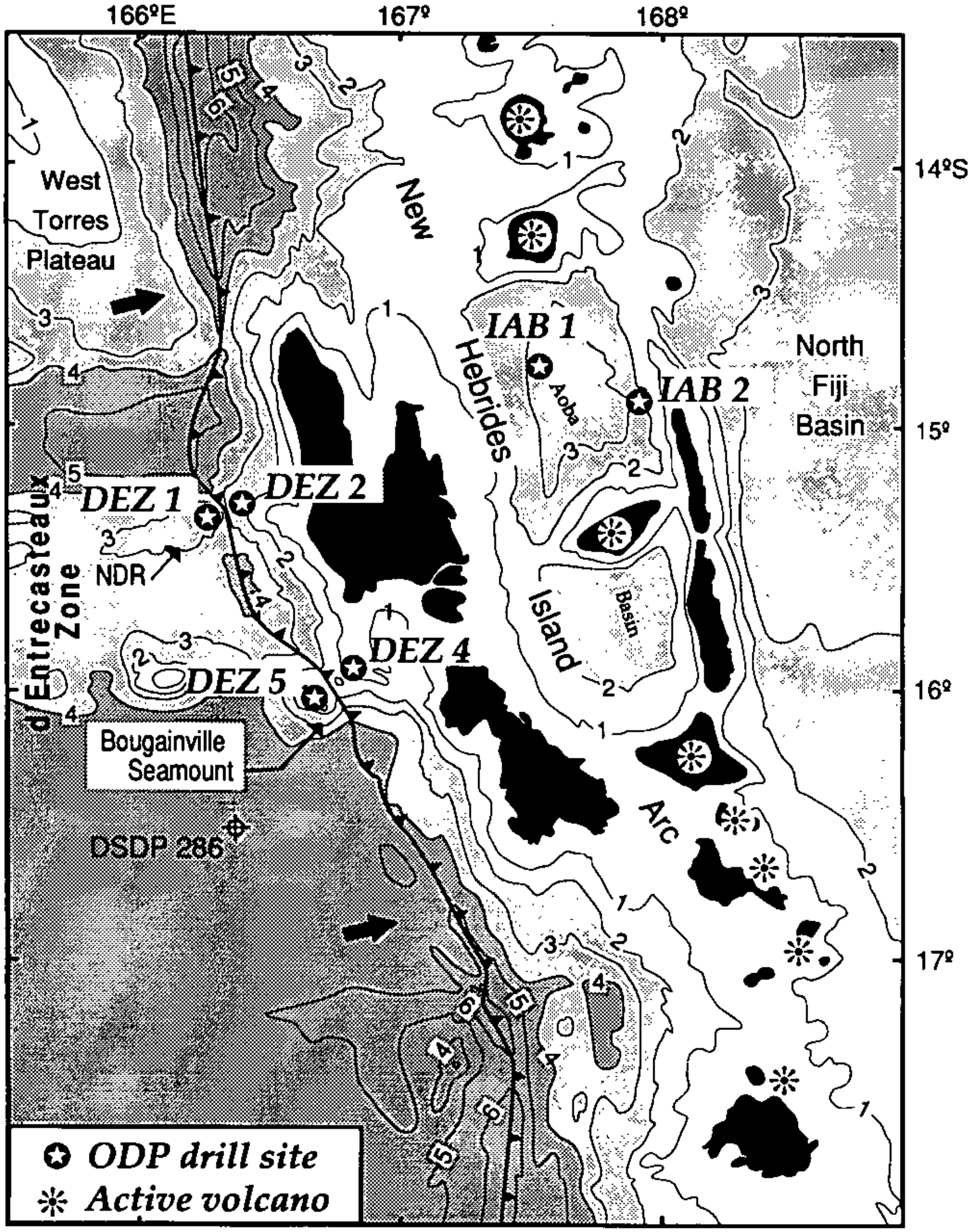


Figure 2. Geographic features of the New Hebrides island arc, DSDP Site 286, sites proposed for ODP Leg 134, and active volcanoes are shown. The barbed line indicates subduction.

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which may have been formed during Miocene southwestward subduction of the Pacific plate at the Vitiaz Trench (Jezek *et al.*, 1977). The North Fiji Basin is separated from the Oligocene South Fiji Basin by the northeast-trending Hunter fracture zone.

The forearc of the New Hebrides islands includes a flat-topped ridge, 100-150 km wide, from which Malakula, Espiritu Santo, and the Torres islands project. South of the island of Anatom (Aneityum), the forearc ridge is poorly developed, consisting primarily of a narrow ridge with sharp relief along the crest (Karig and Mammerickx, 1972; Monzier *et al.*, 1984). The volcanic arc lies east of the forearc area and consists of a chain of volcanoes, many of which are active. Most of the volcanoes lie 130-150 km east of the trench; however, volcanoes on Efate, Matthew, and Hunter Islands lie within 100 km east of the trench. The backarc area lies between the volcanic arc and the North Fiji Basin and includes an uplifted horst that supports the islands of Maewo and Pentecost. Also included in this area are the backarc troughs; a series of northern troughs that extends northward from Maewo (Charvis and Pelletier, 1989); and a (single) southern trough, the Coriolis Trough that trends southward from Pentecost Island (Karig and Mammerickx, 1972; Dubois *et al.*, 1975; Recy *et al.*, 1986). The volcanic islands Vot Tande and Futuna are perched on the steep western scarp of the Coriolis Trough.

The summit basins of Vanuatu were first described by Luyendyk *et al.*, (1974) who interpreted them as late-stage extensional features. These basins form a nearly continuous "median sedimentary basin" (Ravenne *et al.*, 1977). The North and South Aoba basins have greater bathymetric expression than does any other basin on the New Hebrides arc summit. Both basins are over 70 km wide and lie beneath 2000-3000 m of water. They are divided by the active volcano forming Aoba Island (Carney and Macfarlane, 1980; Katz, 1981). Carney and Macfarlane (1980) described these basins as asymmetric in east-west cross-section and containing thick deposits of Miocene to Holocene sediments. Seismic-refraction data suggest that both basins contain 5 to 6 km of sedimentary rocks (Holmes, 1988

Rocks exposed on the New Hebrides Islands show that three volcanic arcs were active in different areas (Carney *et al.*, 1985). The oldest arc yielded voluminous lower Miocene volcanic rocks that are exposed chiefly along the western chain of islands--Espiritu Santo and Malekula islands. During the late Miocene and Pliocene, the volcanic arc lay along the eastern island chain formed by Pentecost and Maewo Islands. The youngest volcanic arc, active during and since the Pliocene, has built the middle chain of islands that extends from Matthew and Hunter islands in the south to the Tinakula volcano in the Santa Cruz Islands to the north.

The evolution of the New Hebrides arc is poorly understood and many hypotheses have been advanced to explain formation of the forearc ridge, volcanic arc, and backarc (*e.g.*, Chase, 1971; Pascal *et al.*, 1978; Falvey, 1975; Coleman and Packham, 1976; Ravenne *et al.*, 1977; Carney and Macfarlane, 1977, 1980; Katz, 1988). In one hypothesis, a reversal of subduction polarity occurred in late middle Miocene time. Prior to this reversal, the Vitiaz Trench was an active subduction zone formed as a west-dipping slab of the Pacific plate that was being subducted beneath the Australia-India plate. The direction of subduction shifted to an east-dipping Benioff zone, with the Australia-India plate being subducted beneath the Pacific plate (Chase, 1971; Carney and Macfarlane, 1977, 1980; Carney *et al.*, 1985). In an alternative hypothesis, no shift in subduction direction occurred, and the present arc configuration is the result of a continuous east-dipping subduction zone (Luyendyk *et al.*, 1974; Carney and Macfarlane, 1977; Hanus and Vanek, 1983; Katz, 1988). On the basis of the distribution of earthquake foci along the New Hebrides Benioff zone, Hanus and Vanek (1983) concluded that two differently inclined slabs exist at intermediate depths. They argued that these slabs were [illegible] from two [illegible]

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of the same polarity and that these two cycles could explain the shifting volcanic axis and the formation of the North and South Aoba basins. Similarly, Louat *et al.*, (1988) concluded that there has only been eastward subduction, and that a steepening Benioff zone has been responsible for the migration of the volcanic axis.

SCIENTIFIC OBJECTIVES

Drilling in the central part of the New Hebrides arc will permit the investigation of the overall response of the arc to a wide variety of tectonic events within a small geographic area. Six sites forming two groups are proposed within the central part of this arc. The first group consists of four sites in the collision zone between the New Hebrides arc and the d'Entrecasteaux zone (DEZ sites in Fig. 2). The second group contains two sites in the intra-arc Aoba basin (IAB sites in Fig. 2). These two groups of sites will form a transect across the arc and will provide crucial information about the arc processes involved in arc-ridge collision, subduction-polarity reversal, and the formation of intra-arc basins.

The impingement of the DEZ against the arc has altered greatly the arc's morphology and structure in that near the impact zone, mountainous islands (Espiritu Santo, Malakula) have risen adjacent to the trench. A large, intra-arc basin (the Aoba basin), substantially deeper than any other basin in this arc, formed directly east of the impact zone. Furthermore, in the backarc area an extensional province that extends nearly continuously along the arc disappears abruptly, directly east of the collision.

Several marine geophysical cruises have been conducted aboard U.S. and French vessels over the eastern d'Entrecasteaux zone and the central New Hebrides island arc to locate the drilling sites. During the 1985 SEAPSO and 1987 MULTIPSO cruises of the *R/V J. Charcot,* Seabeam bathymetric data were obtained over both the DEZ-arc collision zone and the eastern flank of the Aoba basin. In 1982 and 1984, the *S. P. Lee* cruises (L6-82-SP and L5-84-SP) acquired high-quality multichannel seismic data over the entire Aoba basin and the accretionary complex of the collision zone. These data were augmented in 1987 by other multichannel seismic lines collected during the MULTIPSO site survey cru-4, - In addition to geophysical data, sever dives of the French submersible *Naut* were conducted in the DEZ-arc collisic zone during the 1989 SUBPSO cruise in the *R/V Nadir.*

Arc-Ridge Collision Sites: DEZ-1, -2, -4, 5.

Geological data suggest that the NDR e and the SDC of the DEZ differ greatly in morphology, genesis and lithology. These differences are mirrored by the contrasting arc-slope deformation caused by the collision of ridge and arc. Geophysical data indicate that across the accretionary complex, the slightly oblique (14°) subduction of the NDR has produced an asymmetric tectonic pattern which results in strong tectonic erosion (Collot and Fisher, 1989); in this collision zone, large mass wasting deposits formed across the arc slope instead of a bow wave of large anticline and thrust faults (Fisher *et al.*, 1986). The Bougainville guyot largely impinges the arc-slope (Daniel *et al.*, 1986) and generates well-developed compressive features in arc-slope rocks (Collot and Fisher, 1989). However, observations made during a recent deep-sea submersible survey (Collot *et al.*, 1989) revealed that the bedding of the arc-slope rocks, which generally slope trenchward in this collision zone (Fisher, 1986), dips steeply arcward near the contact of both colliding features. Rocks sampled during these dives indicate that, in the collision zone, the arc slope is primarily composed of volcanic and volcaniclastic rocks but also includes brownish clay or mudstone and some limestone. The proposed drill holes will help characterize the contrasting mechanisms of subduction and accretion by showing the composition, physical properties, and age of rocks in each ridge. Other holes will penetrate the arc-slope rocks, not only to determine their lithology but also to provide an estimate of the amount of ridge rocks that are incorporated into the accretio- wedge, and rocks form large blocks. The role of pore fluids in the development of collision structures will be determined by measuring pore-fluid pressure at these drill sites.

Sites within the collision zone are designed to determine what influence ridge composition and structure exert on the style of accretion and type of arc structures produced during collision. Sites DEZ-1 and DEZ-2 are located where the north ridge of the DEZ and the arc collide (Fig. 2). Site DEZ-1 will document the nature and age of the NDR and will provide a critical reference section of north-ridge rocks to enable recognition of these rocks in other drill holes. Information collected at this site will be used to determine the reaction of the accretionary wedge to the impact of the north ridge. Site DEZ-2 will penetrate the lowermost accretionary wedge, the interplate thrust fault, and the north ridge itself. This site will show whether north-ridge rocks have been accreted onto the arc and will also reveal the age and mechanical properties of rocks where, despite the great relief of the subducted ridge, the collision has caused little large-scale forearc deformation. Other objectives include stress analysis and the study of fluid circulation.

Proposed sites DEZ-4 and DEZ-5 are located where the Bougainville guyot has collided with the arc, causing considerable forearc deformation (Fig. 2). Site DEZ-4 will penetrate imbricated arc rocks to test whether these rocks are part of an uplifted old accretionary wedge, recently accreted guyot rocks, or island-arc basement. Other objectives include the study of stress orientation, fluid circulation, and Late Cenozoic uplift of the forearc. Site DEZ-5 will penetrate the platform of the Bougainville guyot and reach volcanic basement; this site will show the lithology, age, paleobathymetry, and mechanical properties of the guyot. This information will be used to determine the reaction of the accretionary wedge to the impact of the guyot.

Results obtained from drilling near the guyot will be contrasted with those obtained near the north ridge to determine why arc structures induced by the collision are so different. The rate of uplift of the accretionary wedge will be determined and compared to the rate at which onshore areas emerged; this emergence occurred synchronously with collision, and onshore areas rose at Holocene rates exceeding 5 mm/yr (Taylor *et al.*, 1987).

Intra-Arc Basin Sites: Sites IAB-1,-2.

The purpose of drilling in the Aoba Basin is to investigate how arc-ridge collision affected the development of the intra-arc basins and the evolution of the magmatic arc. In addition, volcanic ash within basin rocks may contain a record of the hypothesized reversal in arc polarity.

To investigate the evolution of intra-arc basins, two holes will be drilled in the summit basin, the North Aoba Basin. The crucial topic to be resolved is the age of a major discordance in the basin fill that appears to correlate temporally with the beginning of collision of the DEZ with the arc, providing one of the best estimates for the age of this event. This basin contains rocks of probable Miocene and younger age. The drill holes in the North Aoba Basin will show the provenance, age, paleobathymetry, and lithology of basin fill, from which the rate and timing of basin subsidence and filling can be derived.

The magmatic evolution of this island arc can be investigated using data from the proposed drill sites in the intra-arc basins. The main goals are to establish major compositional trends of volcanic ashes and the timing of volcanic pulses. An important facet of this study is to relate volcanic processes to the unsteady tectonic environment of this arc caused by the collision of the DEZ and the hypothesized Late Cenozoic flip in subduction polarity. The chronology and chemistry of volcanic ashes will be most useful when the results from sites near the collision zone of the DEZ are compared to results from the site away from this zone. If the polarity of subduction reversed, ash chemistry may show a distinct change that marked magma generation first from crust of the Pacific plate and later from crust of the Australia-India plate.

Proposed site IAB-1 is located within the center of the Aoba Basin (Fig. 2). Crucial information to be obtained at this site includes the age of a major unconformity that likely correlates with the onset of arc-ridge collision and will provide one of the better estimates of when this onset occurred. The chemistry of Quaternary volcanic ashes may show whether the magmatic arc has been affected by subduction of the DEZ.

Proposed site IAB-2 is located along the eastern flank of the Aoba Basin (Fig. 2), where basin rocks include two unconformities. The shallower one will show when the backarc area was deformed, possibly as a direct result of the collision. The deeper unconformity lies along the top of the oldest basin rocks, and drilling at this site will show the Late Cenozoic evolution of the magmatic arc. The chemistry of volcanic ash should show whether the magmatic arc was affected by arc polarity change.

OPERATIONS PLAN

Leg 134 is scheduled to depart Townsville, Australia, on 16 October 1990 after a five-day port call and arrive in Suva, Fiji, on 17 December 1990 after 62 operational days at sea. Six sites have been identified to meet the cruise objectives of Leg 134: four sites (DEZ-1, -2, -4, and -5) in the forearc and two (IAB-1 and -2) in the intra-arc basin.

Leg 134 will transit (4.3 days) to the Vanuatu region and core the DEZ sites first (Table 1). The first hole at DEZ-2 will be APC/XCB-cored to refusal (estimated at 500 m); the second will be washed to that depth, then RCB-cored to 800 m and logged. Standard Schlumberger, formation microscanner, and digital borehole televiewer data will be collected. Proposed site DEZ-1 will be APC/XCB-cored to 300 m, then logged using the standard Schlumberger suites and the formation microscanner. The first hole at proposed site DEZ-4 will be APC/XCB-cored to refusal (estimated at 500 m); the second will be washed to 500 m, then RCB-cored to 1000 m. Logging of the second hole will include the standard Schlumberger suites and the formation microscanner. Proposed site DEZ-5 will be RCB-cored to 750 m, then logged with the standard Schlumberger suites and the formation microscanner. APC cores will be oriented at proposed sites DEZ-2, -1, and -4.

Leg 134 will then transit (0.3 day) to the intra-arc basin sites. The first hole at each of the IAB sites will be APC/XCB-cored to refusal (estimated at 500 m at IAB-1 and 300 m at IAB-2), and the second will be washed to the refusal depth, then RCB-cored to total depth (700 m at IAB-1 and 1000 m at IAB-2). Logging at the intra-arc basin sites will include the standard Schlumberger suites and the formation microscanner.

Two new tools will be employed to log downhole magnetic properties (the natural remanent magnetization tool, or NRMT, and the magnetic susceptibility tool, or SUMT) at DEZ-5 and IAB-1. The tools, which meet Schlumberger requirements, have been developed by a French team (CAE-Total CFP). These logs will complement the paleomagnetic measurements performed on board and augment the knowledge of magnetic properties downhole.

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TABLE 1: LEG 134 PROPOSED DRILL SITES

Site Number	Latitude/ Longitude	Water Depth (m)	Penetration (sed)	(bsmt)	Time Estimates (days) Drill	Log	Total
DEZ-1	15°17.4'S 166°17.4'E	3200	300	---	3.3	0.8	4.1
DEZ-2	15°19.6'S 166°21.3'E	2650	790	10	8.5	2.2	10.7
DEZ-4	15°56.6'S 166°47.3'E	925	1000	---	7.9	1.4	9.3
DEZ-5	16° 01.1'S 166°40.6'E	1050	700	50	5.4	1.6	7.0
IAB-1	14°47.8'S 167°34.4'E	3098	700	---	8.1	2.1	10.2
IAB-2	14°52.4'S 167°53.0'E	2600	1000	---	11.5	1.6	13.1

WIRELINE SERVICES CONTRACTOR REPORT

Leg 130, Ontong-Java Plateau, had 3 objectives: (1) to describe the Neogene paleoceanography along a depth transect approximately parallel to the equator; (2) to determine the origin and subsequent tectonic movement of the Ontong-Java Plateau; and (3) to sample a deep-Pacific Mesozoic sedimentary section to determine paleoceanograpic trends and to search for basinwide anoxic events. Two deep holes (803D and 807C) were drilled to satisfy the basement and Mesozoic objectives, and a transect of sites (803 to 806) was drilled for Neogene paleoceanography.

All sites except Site 804 were logged, for a record-setting total of 3654 meters of open-hole logging data. High quality sonic velocity, density, and electrical resistivity logs were collected from each site, and good geochemical data were gathered for the natural gamma-emitting elements (K,U, Th) and Al. Due to an intermittent tool failure by the induced gamma-ray spectral tool, which measures Ca,Si, Fe, Ti, Cl, H, S, and Gd, only about 500 meters in two holes (805C and 806B) were logged. However, these will prove highly useful for the study of early to middle Miocene calcite deposition. The two basement holes (803D and 807C) were also logged with an imaging resistivity tool (the FMS or formation microscanner) to determine bedding in the sediments and structure in the basalts.

Neogene Paleoceanographic Transect
Paleoceanography has evolved from the important early broad-brush studies to more quantitative higher resolution approaches. The evolution of knowledge about the different geologic periods are growing at different rates, but primarily due to the efforts of ODP, knowledge about the changing Neogene oceans is increasing particularly rapidly. One of the important goals for the logging program on Leg 130 was to obtain high-resolution logs of the Neogene sedimentary section to determine climate-driven sedimentary cycles and to provide detailed depth ... between the different sites.

A secondary goal was to splice logging data with shipboard physical-properties data in order that *in situ* corrections could be developed for the shipboard data and to make complete physical properties profiles from the sea floor to the bottom of each hole. The profiles of density and sonic velocity are particularly useful for detailed correlation between the sedimentary section and seismic reflection profiles collected on the site survey.

To achieve high resolution studies, it is first necessary to demonstrate that the logging is capable of recording information at high resolution. Logging two holes at Site 807 (807A and 807C) provided the means to test the replicability of the logging, as shown in Fig. 1. This figure is a small part of the overlapped sonic velocity logs from the two holes. The primary difference between the two are minor depth shifts of velocity peaks and troughs caused by slightly different sedimentation rates in the two holes. The logs are reproducible on high resolution scales. Shore-based analysis of the Leg 130 logging data should greatly increase our understanding of sedimentary cycles on the Ontong-Java Plateau.

A comparison of the raw logs from sites on top of the Ontong-Java Plateau (Fig. 2) indicates that detailed stratigraphic correlations between sites on the Ontong-Java Plateau are possible, which will prove to be particularly helpful for examination of differential sedimentation between sites. Illustrated in Fig. 2 are sonic velocity logs from Site 586, drilled on DSDP leg 89, and Site 806, drilled on ODP leg 130. The two sites are both above 2600 m and are about 75 nautical miles apart on the cre of the plateau. An extremely good matq between the two logs can be achieved te the average sedimentation rate at Site 806 is slightly greater than at Site 586 as illustrated by the slightly offset dep scales on the figure. At the scale of rest figure 2 it is obvious that the two logs atch be easily correlated; correlations in ed if are also simple. In the depth transec ite

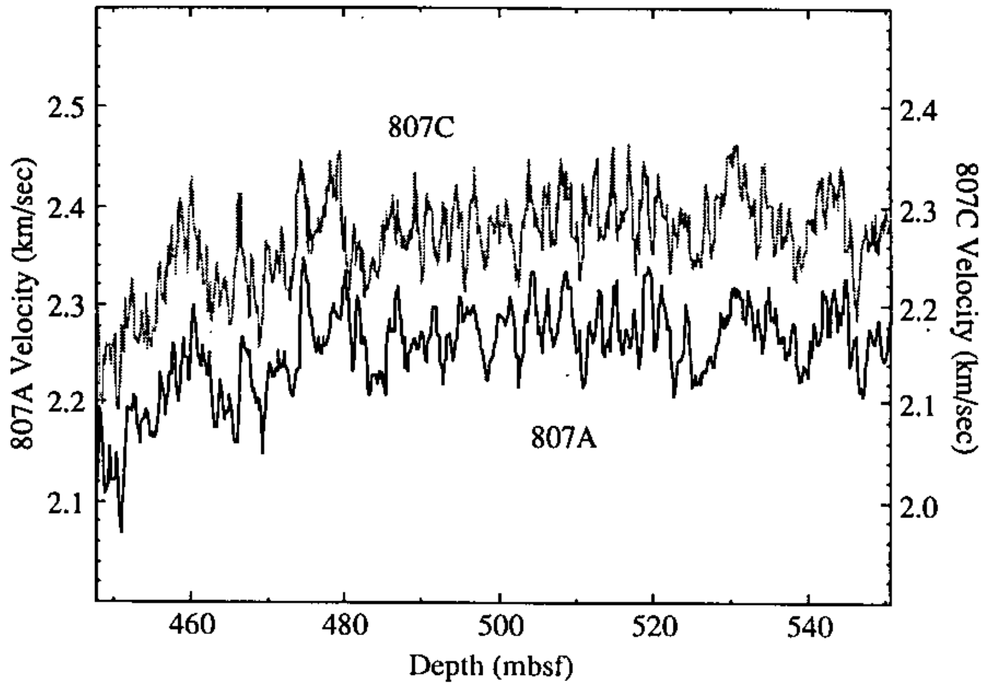

Figure 1. Comparison of sonic velocity logs from Holes 807A and 807C provided the means to test the replicability of the logging.

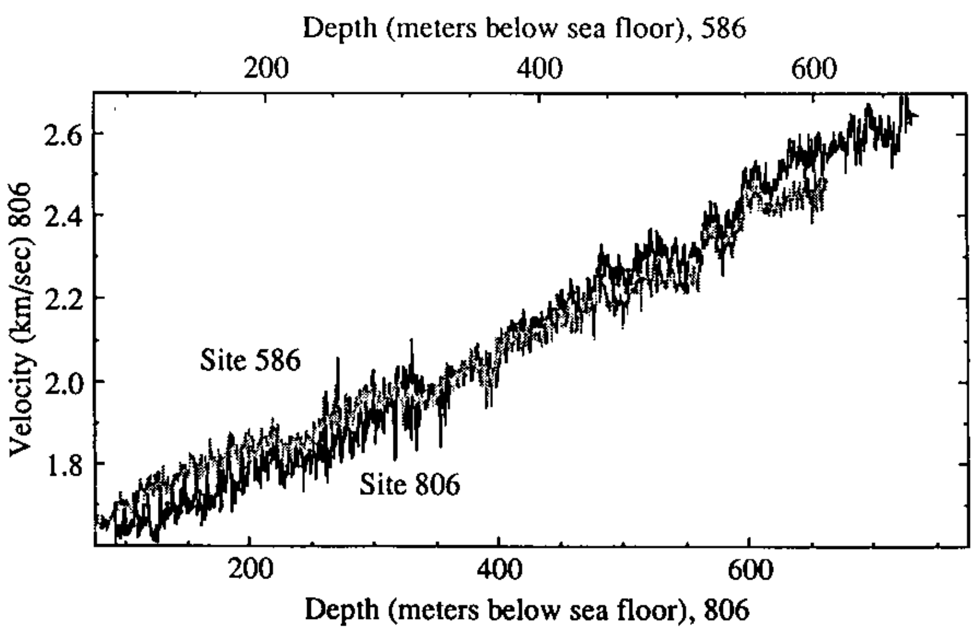

Figure 2. Sonic velocity logs from Site 586, drilled on DSDP leg 89, and Site 806, drilled on ODP leg 130. The two sites are both above 2600 m and are about 75 nautical miles apart on the crest of the plateau.

(Sites 803, 804, 805, and 806) it is more difficult to correlate features, but with the help of biostratigraphic tie points a high degree of correlation between holes can still be achieved.

Shipboard physical-properties measurements and the logging data were successfully spliced on Leg 130. The two are partly redundant, but shipboard core measurements are best and most abundant in the softest oozes near the surface, while logging data are particularly useful lower in the hole, where core recovery decreases and coring-induced artifacts increase dramatically. The redundancy has enabled the shipboard party to remove dubious sections of data from both data sets.

Deep Leg 130 Objectives

Logging data was particularly useful for delineating structure and sedimentation in the Paleogene-Mesozoic sedimentary sections and in basement of Sites 807 and 803, where core recovery was moderate to poor. The best set of logging data was from Hole 807C, where standard velocity and resistivity logs prove to be extremely useful for delineating chert horizons and chalk interbeds in the sediments. These logs, with density and chemical logging data, show flow boundaries and sediment interbeds in the basement. Resistivity images from the formation microscanner also show basement fractures and pillow basalts. In the sediments the formation microscanner images show both nodular and bedded cherts, as well as compaction structures around large chert nodules. The images also highlight clay-rich incipient solution features associated with diagenesis.

At Hole 803D (656 m total penetration) the logging was less successful primarily because a bridge that formed at 600 mbsf after the first logging run prevented a return to the deepest sediment section and basement. Nevertheless, the Paleogene section was logged with resistivity, density, sonic velocity, natural gamma ray, aluminum, and formation microscanner logging tools. Detailed comparisons can be made between this site, now at 3415 m, and 807C, now at 2820 m to discern Paleogene depth-related sedimentation trends.

PROPOSALS RECEIVED BY THE JOIDES OFFICE

May, 1990 through September, 1990

Ref. No.	Theme/Area	Author(s)	Country	Date Rcvd
383/A	Aegean Sea: Continent-Continent Collision	K.A. Kastens & al.	US/ESF	5/90
317/E Add-2	Seafloor bottom simulating reflectors, N. Cascadia	R.D. Hyndman	US	6/90
265/D Add.	Western Woodlark Basin	S.D. Scott & al.	CAN/AUS/PNG	6/90
384/A Rev.	Venezuela Basin and Aruba Gap	A. Mauffret & al.	FR/US	7/90
385/E	Paleomag., sed., stratig.: ODP Oahu Hole	B. Keating	US	8/90
385/E Add.	Paleomag., sed., stratig.: ODP Oahu Hole	C. E.Helsley	US	8/90
386/E Rev.	California margin drilling	M. Lyle & al.	US	8/90
233/E Rev-3	Central Oregon accretionary complex	J.C. Moore & al.	US	8/90
355/E Rev-2	Formation of a gas hydrate	R. von Huene & al.	FRG/US	8/90
387/E Rev.	Deep crustal drilling: Hess Deep	K. Gillis & al.	US	9/90
247/E Add.	Water mass conversion, Glac. Subarctic Pacific	R. Zahn & al.	CAN/US	9/90
286/E Add-2	Layer 2/3 transition in Hole 504B	K. Becker	US	9/90

PLANNING COMMITTEE MEETING SUMMARY

INTRODUCTION

The Summer Meeting of the Planning Committee was held 14-16 August, 1990 in La Jolla at the Scripps Institution of Oceanography. The discussions at this meeting centered around: reports of the recent engineering tests of the diamond-coring system (Leg 132); adjustments to the FY91 drilling schedule; ways to aid renewal of the Ocean Drilling Program; reports by the Joint Liaison Groups with FDSN and GSGP; and establishment of DPGs and WGs to facilitate planning for the drilling beyond FY 1992. At PCOM's next meeting (28 November-1 December 1990 in Kailua-Kona, Hawaii) the agenda will focus on preparation of the FY 1992 Program Plan from those programs in the Pacific Prospectus.

ENGINEERING LEG 132

Mike Storms reported on the results of the joint engineering development and science leg (Leg 132). The Diamond Coring System Phase II (DCS) had a thorough evaluation in the backarc, bare, fractured-rock environment. The system was not evaluated in interbedded chalks and cherts or shallow water atoll and guyot carbonates as originally planned.

Overall, the DCS system has proven itself for deployment from the *Resolution* and shown the capability to drill and core in bare, fractured rocks. The mini-hard rock guidebase design proved to be successful after minor modifications and the "pogo" concept worked very well. Two important unresolved questions for the EPR drilling are bit life and rates of advancement in fractured basalts.

Because of the uncertainty about the DCS performance at the EPR, a proposal was made to insert a leg at Loihi because of its location en route to the eastern Pacific, shallow depth, well-surveyed shallow summit of appropriate lithology, and scientific objectives. Counter arguments were that LITHP has higher priorities, and a major change in the present schedule might delay the vessel's appearance in the Atlantic. PCOM decided that the next test of the DCS will be at the East Pacific Rise.

ADJUSTMENTS TO FY 1991 PLANS

The need for a brief on-site survey to satisfy safety requirements for a Tonga forearc site led to a change in the order of drilling of the Lau-Tonga leg. PCOM also discussed several proposed "add-on" programs for the Oahu Pilot Hole. These include: 1) moving the site to south of Oahu for a coring program to study windblown ash deposits from the Hawaiian volcanoes, as well as paleomagnetism and physical properties of sediments and basement; 2) a test of the ODP reentry cone plug at the Oahu Pilot Hole; and 3) additional logging recommendations from DMP. PCOM approved the addition of 3 days for scientific coring, borehole seal test and logging; making a 17 day science leg.

The Science Operator recommended additional time be added to the planned engineering leg at Site 504B to improve the chances for success to clear the hole by fishing or milling and to explore options for drilling ahead. PCOM approved the addition of six days to Engineering Leg 137 at 504B. The thematic panels have been asked to prioritize various options for proceeding with the remaining time in the event the hole has to be abandoned.

PCOM also discussed the request by the Joint Global Ocean Flux Study (JGOFS) for non-interfering physical and chemical oceanography measurements and water sampling during the Eastern Equatorial Pacific Neogene Transect Leg. Since this work can be done without addition of time to the leg and represents studies complementary to the ODP goals, PCOM recommended their accommodation.

ADDITION OF INNOVATIVE SCIENCE

The absence of regional panels and the restricted mandates given to detailed planning groups has caused some concern that worthwhile scientific objectives are being missed if those aspects are not included in the original proposal being reviewed by a thematic panel or sent to a DPG. Moreover, there may be instances where an objective can be met along the transit between sites or to or from ports.

Most PCOM members believe that a mechanism for allowing some last-minute innovation is important for the future success of ODP, but there is a concern that "add-ons" are not being handled evenly. PCOM is asking the panels to help to inform the community that "add-ons" will be considered. The panel chairmen will also be asked to discuss the aspects of fairness, lateness, review, etc., and provide recommended guidelines for how PCOM should handle "add-ons" at the Annual Meeting.

FACILITATION OF RENEWAL OF ODP

An *ad hoc* committee to determine strategy to aid renewal had an excellent start, soliciting important supplemental information for the Long Range Plan (LRP) brochure, and obtaining a "ringing endorsement" of the Ocean Drilling Program by the JOI Board of Governors. A proposal was made to PCOM that 6 themes become a focus for future ocean drilling. After a lengthy discussion, PCOM decided that ODP will stick with the broader themes of the LRP.

PCOM members remain concerned that the objectives and phasing of the LRP may not succeed unless the advisory structure considers carefully how to carry it out. PCOM, therefore, charged the thematic panels to: 1) Identify the appropriate way to integrate existing individual proposals into the larger thematic programs identified by their global prioritization and by the LRP; 2) Plan to obtain proposals for themes or theme elements that are not presently represented; 3) Integrate interdisciplinary interests into the program effectively; and 4) Determine whether it is necessary to identify coordinators or proponents for the theme program.

JOINT LIAISON GROUPS

Members of the Liaison Groups with the Federation of Digital Seismic Networks (FDSN) and the Global Sedimentary Geology Program (GSGP) attended the meeting and exchanged views with PCOM. A Liaison Group with the Nansen Arctic Drilling Program (NADP) was established and its membership set.

FORMATION OF DETAILED PLANNING GROUPS AND WORKING GROUPS

In order to facilitate planning for the drilling beyond FY 1992, PCOM approved the formation of 2 Detailed Planning Groups and 2 Working Groups, made appointments, and set mandates for all four groups.

The North Atlantic Arctic Gateway DPG is to examine the three existing North Atlantic Arctic paleoceanographic gateway drilling proposals and provide a prioritized plan for a drilling program.

The North Atlantic Rifted Margin DPG is to examine the various proposals for drilling volcanic and non-volcanic North Atlantic rifted margins and recommend a prioritized plan for a drilling program, specifying the number of legs required to answer fundamental unanswered questions about these margins.

The Deep Drilling Working Group is to prepare a document that identifies technologies that exist or need to be developed to achieve scientific drilling goals in those areas that require deep penetration (*i.e.* greater than 2 km beneath the seafloor). The group will evaluate the alternatives identified in terms of likely costs and suggest long-term strategies for achieving a deep drilling program in the oceanic crust and deep sedimentary sections. In addition, the group will fulfill a long-term function in advising ODP on deep drilling.

The Sealevel Working Group is to formulate an approach for a worldwide attack on the problems of sealevel change utilizing the drilling capabilities of the *JOIDES Resolution*. A focussed drilling program should be formulated, specifying the number of legs required to answer fundamental questions about eustatic sealevel change and outlining the areas that will bring the greatest scientific return. A multi-disciplinary approach is recommended that incorporates lithospheric, ocean history, sedimentary, geochemical, and tectonic objectives.

CASCADIA MARGIN DETAILED PLANNING GROUP FINAL REPORT

INTRODUCTION

A series of proposals for drilling in the Cascadia margin (Fig. 1) have been presented and modified in response to thematic panel input. Vancouver Island proposals have addressed progressive diffuse regional fluid expulsion from the accretionary wedge. Oregon margin proposals have addressed fluid movements focused by fractures and permeable strata. Recognizing the tectonic and geochemical thematic interest of drilling the Cascadia Accretionary Prism, but lacking the information necessary to choose those parts of the proposals of highest purity, PCOM established a Cascadia Margin Detailed Planning Group (DPG) in January, 1990. PCOM charged the DPG to examine the Cascadia Accretionary Drilling proposals and provide a prioritized plan for drilling. If the highest priorities could not be addressed in one leg, PCOM instructed the DPG to make suggestions for later drilling.

The DPG met in Quinault, Washington during August 9-11, 1990 and developed, as reported below, a minimum one-leg drilling plan (Cascadia I) that addresses the highest priority scientific issues on the Cascadia Margin in a coordinated fashion. A follow-up leg (Cascadia II) was also planned that would greatly enhance the drilling program and build upon the accomplishments of the first leg.

THEMATIC GOALS

COSOD II gave high priority to drilling convergent margin accretionary prisms because of their importance to interpretation of ancient accretionary wedges now exposed on land; to understanding the coupling of tectonic processes and fluid flow and fluid overpressuring; and because of their geochemical contribution to the budget of greenhouse gases, the chemical balance of the oceans and arc volcanism. This interest has been iterated by the thematic panels. The Tectonics Panel (TECP) has identified drilling to determine deformation processes at convergent plate boundaries as a major theme and specifically noted the importance of fluid pressure and chemical reactions in influencing tectonic deformation and processes in this setting. TECP stressed the need to establish sediment and fluid budgets in a few selected regions and the benefits of establishing downhole observatories in these same areas. The benefits of concentrating efforts on a few end-member examples has also been noted by an ODP Working Group on Drilling to Understand the Fluid Regimes of Accretionary Wedges. The Sedimentary and Geochemical Processes Panel (SGPP) has identified the circulation of fluids as a high priority, and circulation in active margins as the highest priority over the next few years. SGPP has ranked drilling in the Cascadia margin as their highest priority for 1991 drilling; TECP has ranked Cascadia drilling as their third highest priority.

SCIENTIFIC OBJECTIVES

One of the major scientific problems may be reduced to several time-dependent mass balances or budgets. Inorganic and organic compounds and water enter the prism in water-saturated sediments riding on the subducting oceanic plate. As the sedimentary wedge thickens, the organic material in the sediments is transformed by bacteria or heat, or a combination of those two factors, and breaks down, producing methane and CO_2. Deformation, heating, and volatile generation propel and pressurize the pore fluids. The scientific problem consists of defining the budget and ultimate fate of sediment, water and dissolved chemicals. The problem is complicated by the non-linear nature of almost all of the interactions. For example, pressure exerts a strong non-linear influence on permeability as it approaches lithostatic values, which, in turn, exerts a tremendous influence on the direction, rate, and style of fluid flow. Chemical precipitation and dissolution affect the permeability in a power-law

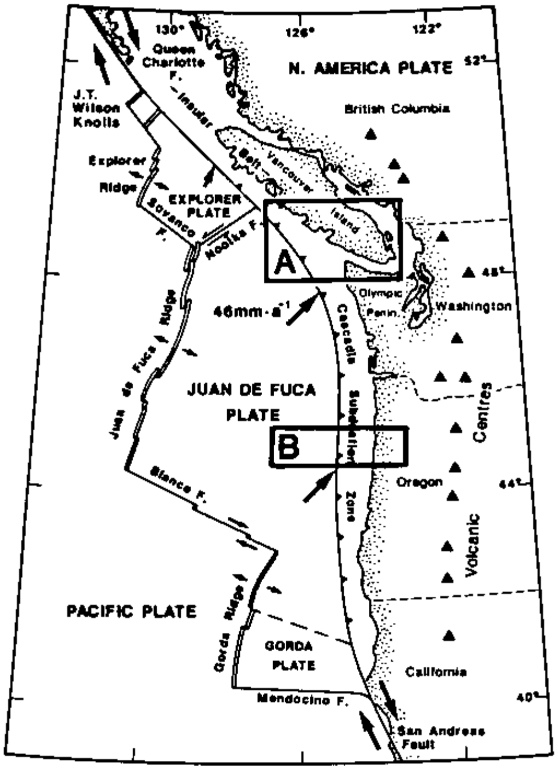

Figure 1. Continental margin of southwestern Canada and northwestern United States showing the plate-tectonic regime and main tectonic elements. (A) Vancouver Island margin and (B) Oregon margin study areas.

fashion, which can similarly affect chemical and fluid migration.

The synergistic changes in physical properties and consequent evolution of structural style caused by fluid flow is another critical scientific problem to be addressed in accretionary compexes. Porosity loss through consolidation and cementation reduces rock permeability and increases strength, which, in turn, alters the deformational style and leads to creation of alternate fluid conduits. This coupled structural-hydrogeologic system is ideally studied in accretionary prisms because in that region saturated sediments are presently being transformed to rock at high strain rates. Information gleaned from the analysis of drill cores taken from these active areas and determination of the pressure, temperature, and fluid composition conditions that pertain during deformation provides the best basis for interpretation of rocks in ancient accretionary prisms now subaerially exposed.

This DPG report describes a program that will substantially define the water and chemical mass balance, and the style of fluid movement within and through the Cascadia margin accretionary complex (Figs. 2, 3, & 5). The program will also define the synergistic structural and hydrogeologic evolution and cementation of the sediments. The Cascadia margin, as briefly summarized below, is an unusually active accretionary margin of particular societal interest and scientific accessibility. It has been particularly well surveyed in two areas from differing, but complimentary, scientific perspectives. Specifically, the coordinated program of drilling will:

(1) Measure the fraction of pore fluid expelled in a diffuse (*i.e.* not fracture-controlled) fashion (Fig. 2).

(2) Determine the source of fluids moving in fractures and determine the different geochemical consequences of the different fluid sources (Fig. 5).

(3) Determine, in a comprehensive way, how fluids control geotechnical properties and structural fabrics developed in association with the various expulsion processes.

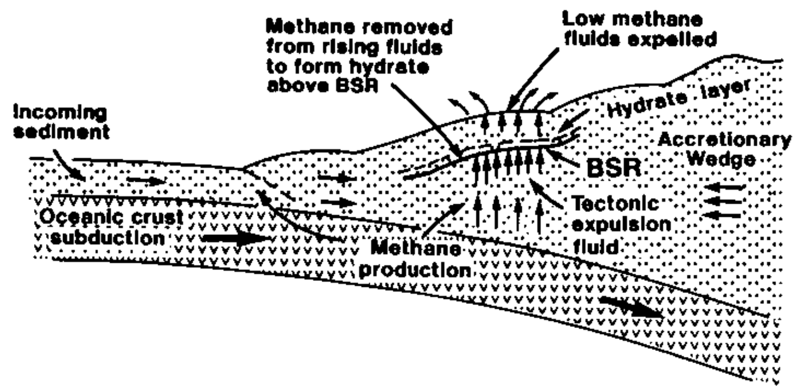

Figure 2. Schematic cross-section of an accretionary prism illustrating the fluid expulsion model for Bottom Simulating Reflector (BSR) hydrate formation.

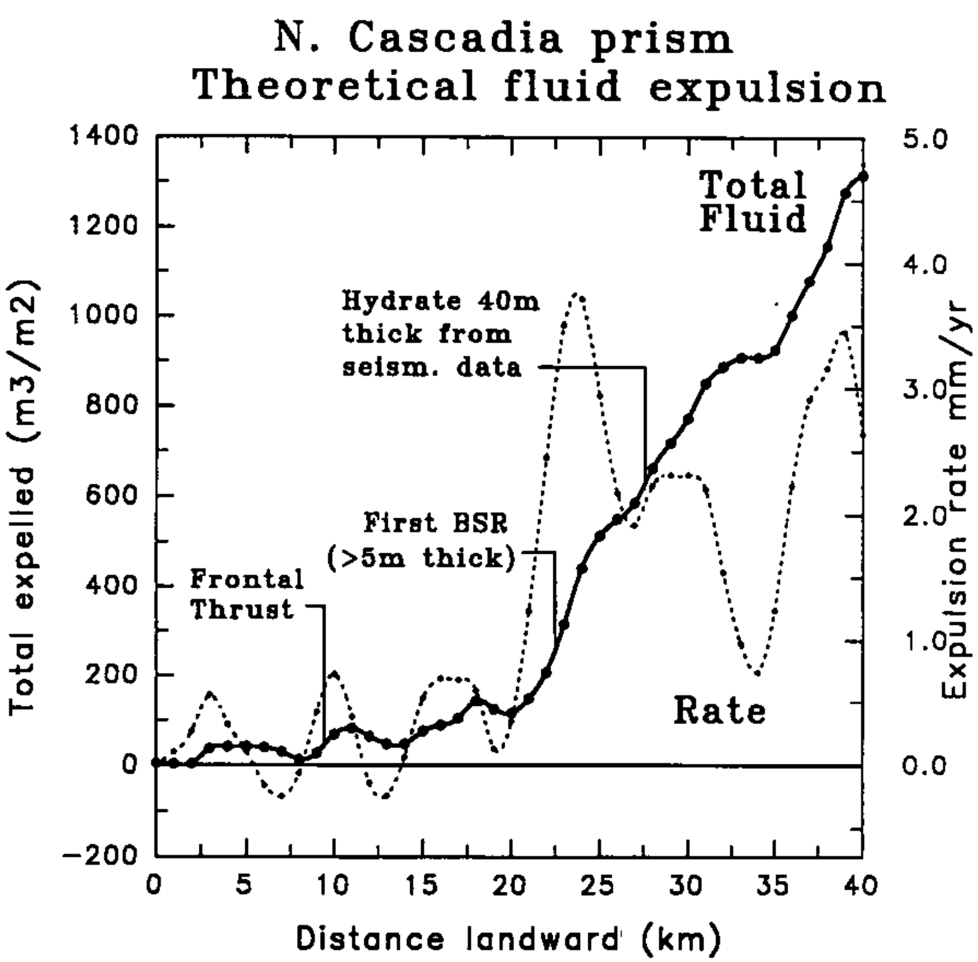

Figure 3. Simple theoretical model for progressive fluid expulsion landward across the northern Cascadia accretionary sedimentary prism. Note the inferred progressive thickening of the BSR hydrate layer.

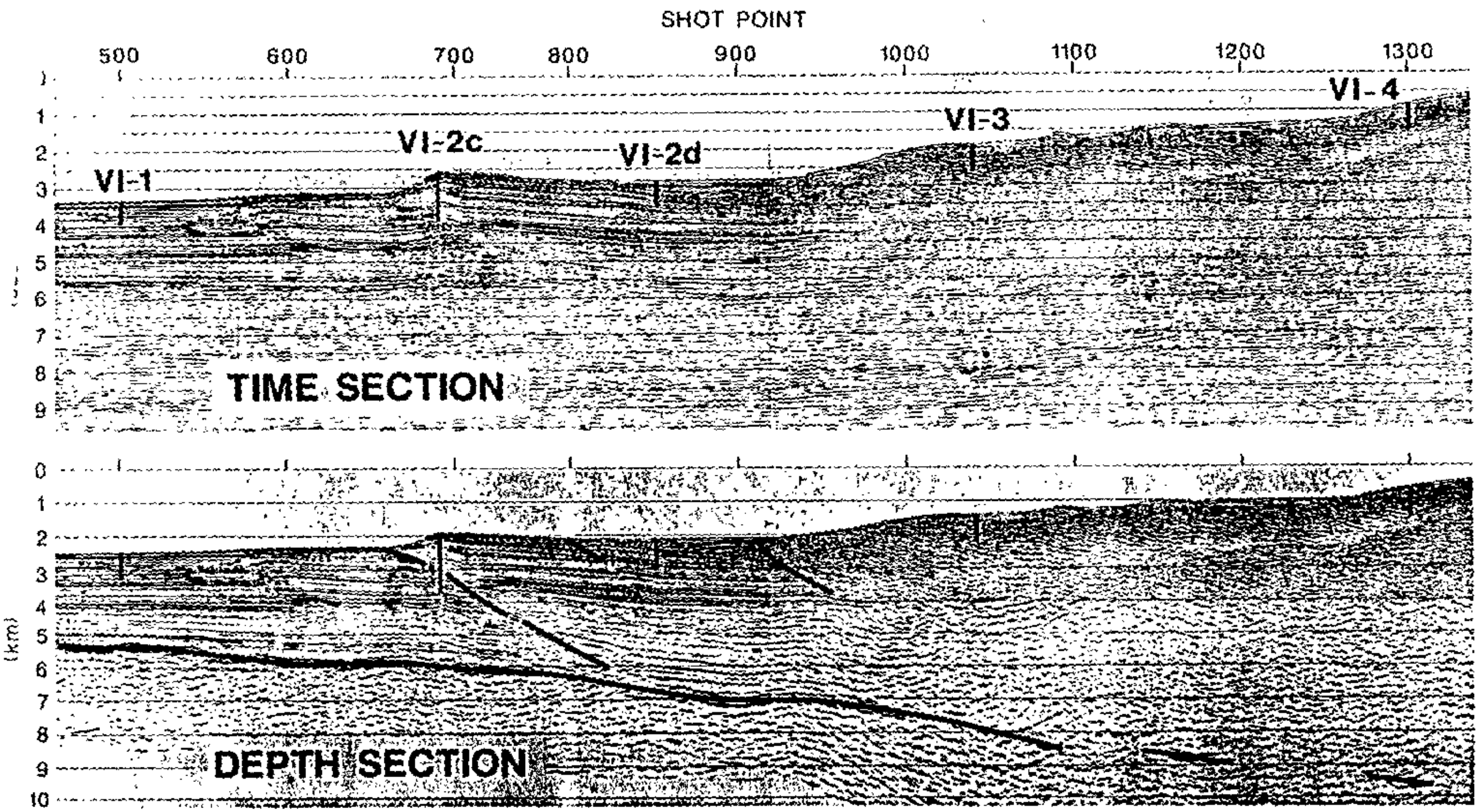

Figure 4a. Seismic section 85-01 across the northern Cascadia margin at Vancouver Island with the proposed drill sites VI-1, VI-2d and VI-3.

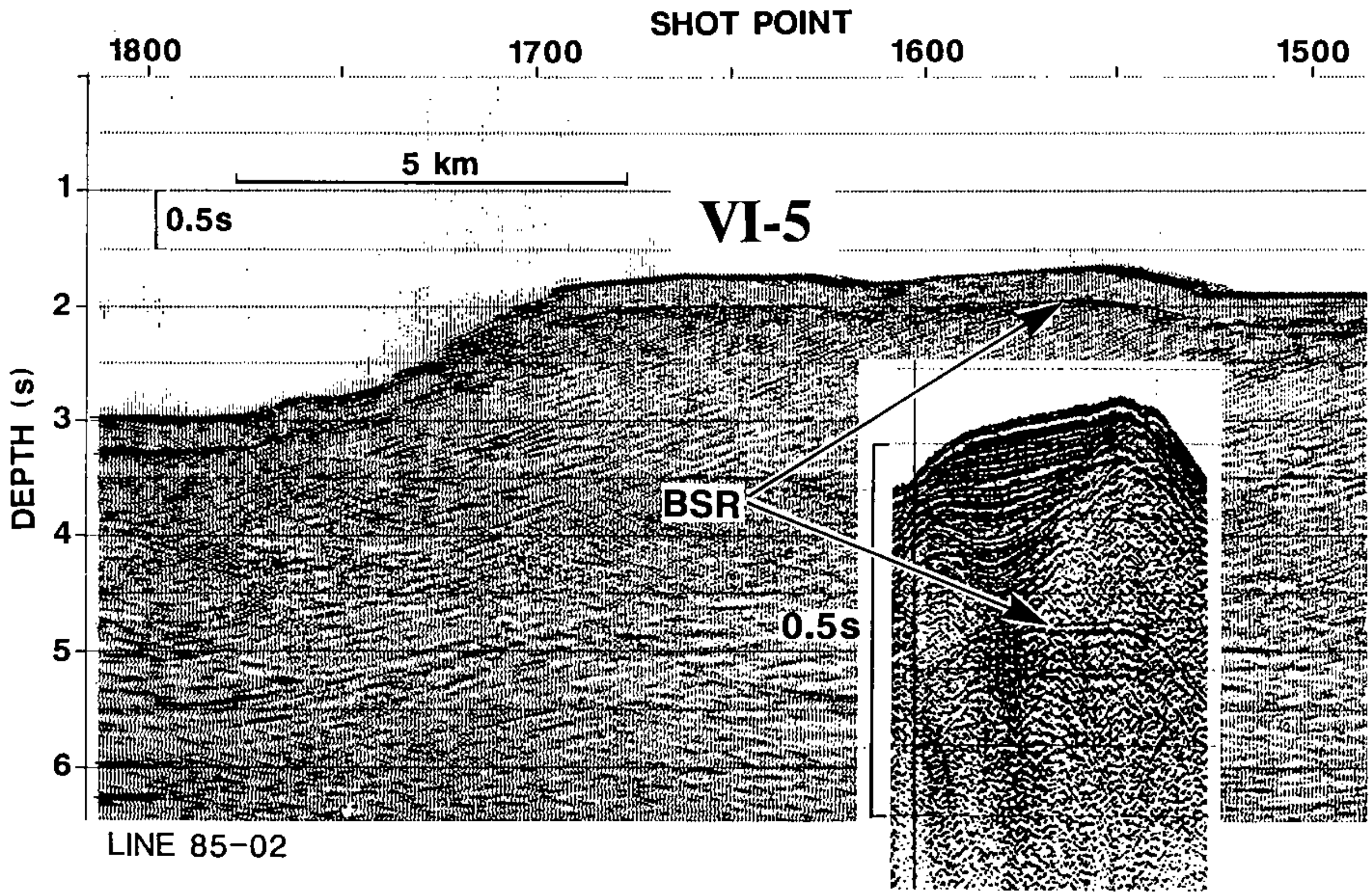

Figure 4b. Northern Cascadia seismic section 85-02 illustrating the BSR and drill site VI-5; the inset is from a single-channel seismic line.

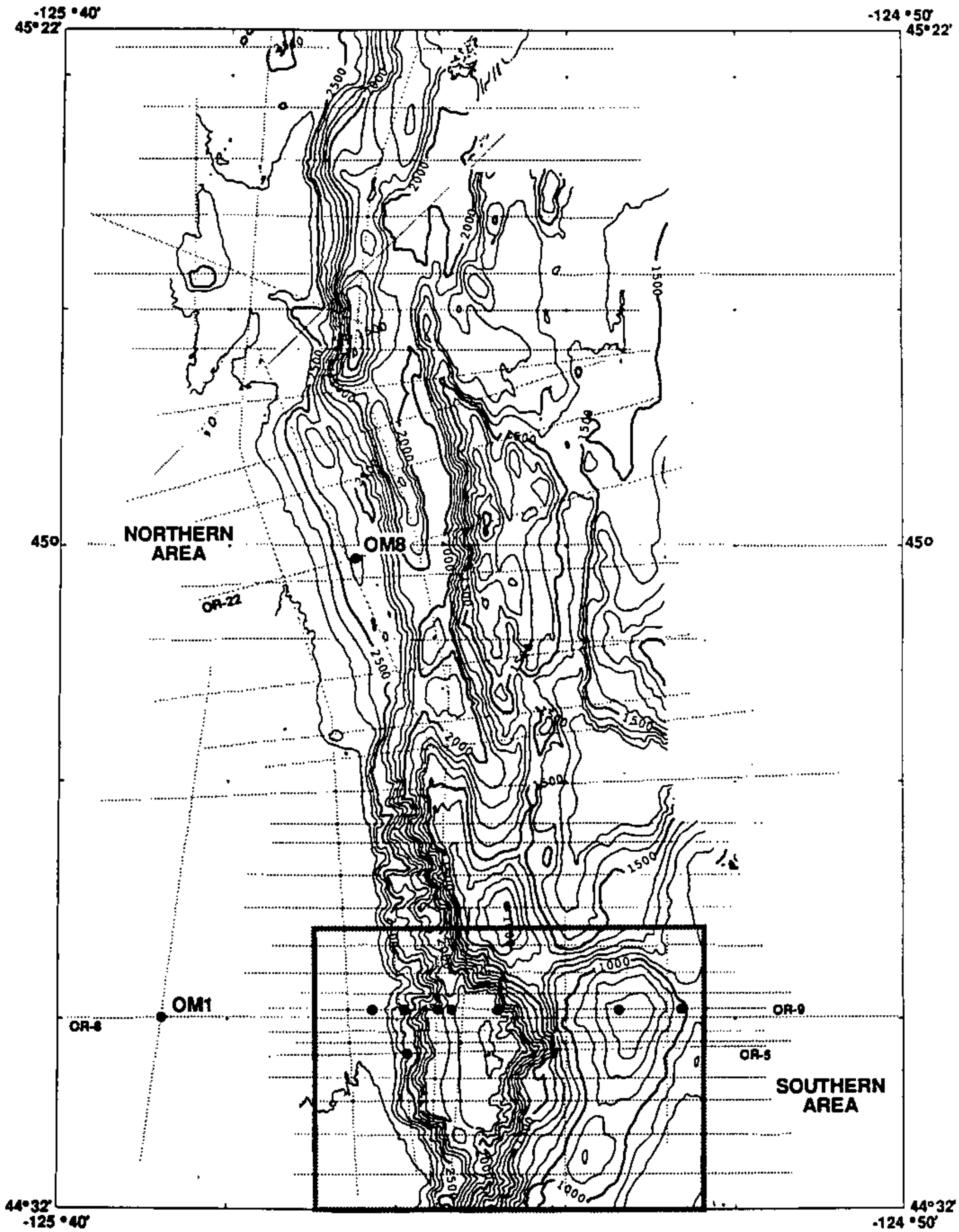

Figure 5. SeaBeam bathymetry with overlay of multichannel seismic survey (MCS) tracklines (dotted lines). Proposed drill sites indicated by OM-1 and OM-8 and solid dots inside lined box (see Figs. 7-9).

Many of the important scientific objectives of the Cascadia margin investigation can be achieved in one drilling leg. However, the DPG strongly recommends a second leg (Cascadia II) to retrieve instrumentation from the two initial observations (installed during Cascadia I), test new instrumentation in these holes, install seismic instrumentation, and, depending on the results of the long-term observatory experiments and the results of the first leg, carry out additional drilling and other critical and complementary experiments.

STRATEGY AND SCIENCE PLAN

The northern Cascadia transect drilling plan is directed at testing and calibrating three techniques for determining the progressive fluid loss and fluid mass balance across the accretionary prism. Information on the partitioning of fluid loss through diffuse expulsion and focused venting may also be obtained by the differences between the estimates that give total fluid loss and those that measure primarily diffuse loss. These essential data are required to constrain theoretical models of fluid expusion (Fig. 3). The three techniques are:

(1) The reduction in porosity landward in the wedge as inferred from seismic-velocity data. Calibration of the applicable porosity-velocity relation should be an important result. This technique gives the total fluid loss.

(2) The inferred downward decreasing temperature gradient from seafloor heat-probe data and the temperature at the hydrate bottom simulating reflector (BSR) from the hydrate stability field. Calibration of the BSR hydrate stability field should be an important result.

(3) The thickness of the hydrated sediment layer at the base of the stability field, estimated from seismic data, which is postulated to be proportional to the total fluid diffusely expelled upward. Drilling through the BSR will also provide a more general test of the new model for the formation of hydrate BSRs that depends on upward fluid expulsion (Fig. 2).

Preliminary application of this methodology of subtracting estimates of the diffuse flow (*i.e.*, over scales of several hundred meters; thermal profile, and hydrate thickness) from those of the total flow (porosity loss) suggests that at least half the water expulsion budget can be attributed to diffuse expulsion. The main outstanding uncertainties in the fluid expulsion estimates that can be addressed by drilling are: the applicable velocity-porosity relations, the true temperature-depth profiles, and thus the upward fluid advection, the temperature at the BSR, the thickness of the BSR hydrate layer, and the relation between fluid expulsion and hydrate layer thickness. The methane concentration in porewaters above and below the hydrate layer as a function of depth, the salinity and CO_2 content of the hydrate, and the amount of methane in the hydrate layer are all important additional objectives. Once the methodology is calibrated, high-resolution seismic data and heat-probe data may be employed to determine fluid expulsion over broad areas on the Cascadia margin, and on other accretionary wedges.

The second complimentary half of the Cascadia drilling program is the definition of fluid venting that is focused by fractures. Of particular interest is the fact that fluids of different origin (*e.g.* source, depth, *etc.*) appear to produce different styles of carbonate cementation with different isotopic signatures. If the pattern can be understood in the comparatively simple context of a currently active prism, much information on fluid movement and expulsion might be unlocked from the geologic record of older prisms - the classic uniformitarian geologic approach.

Preliminary results suggest that the fluid sources vary primarily as a function of distance into the prism and the type of focusing fault. For example, faults dipping toward the seaward side of the margin (landward vergent) sole just above the basaltic oceanic crust and appear to produce fluids with greater amounts of mantle helium. Vents along landward-dipping faults (seaward vergent) may tap fluids from the prism interior. Vents on the shelf (farther into the margin) appear to be more gas-rich

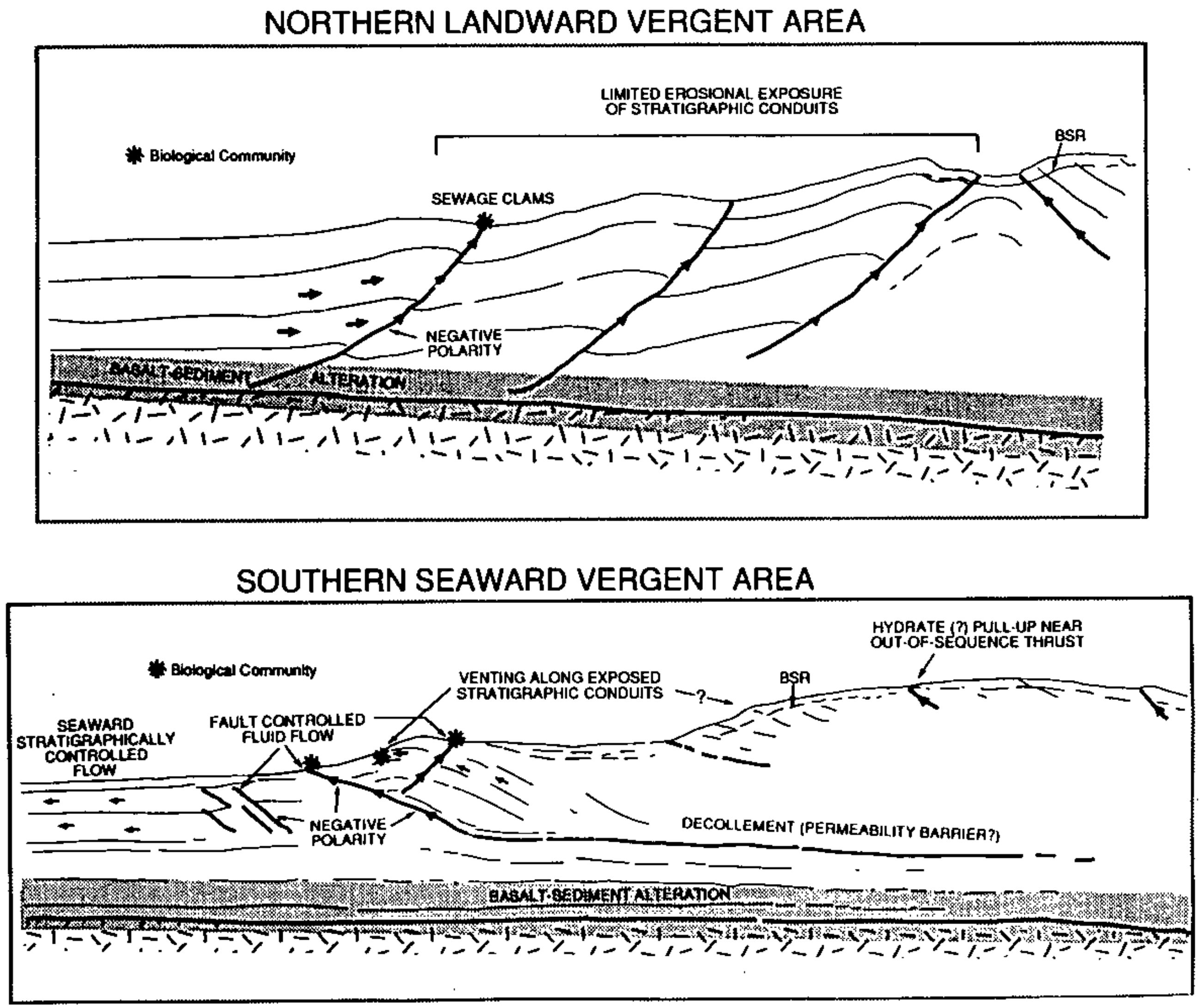

Figure 6. Conceptual cross-sections showing geologic setting and possible fluid expulsion scenarios for central Oregon margin.

TABLE 1. CASCADIA I DRILLING AND DOWNHOLE MEASUREMENT TIMES (DAYS)

Site	Priority	Location Latitude, Longitude	Water Depth (km)	Penetration (km) (days)	Drill[a] Time	STD[b] logs + FMS	WSTP 6 runs	CONE[c] PLUG	PACKER drill string	PACKER wire line	VSP	BHTV	TOTAL
VI-5	1	48°40'N 126°50'W	1350	600	3.1	1.5	0.3	4.5	0.7	0.7	1.5	0.3	12.6
VI-1	1	49°09'N 126°37'W	2500	600	4.5	1.6	0.3	-	-	-	-	-	6.4
VI-2d	1	28°16'N 126°24'W	2100	500	3.6	1.6	0.3	-	-	-	1.5	-	7.0
VI-3*	2	48°19'N 126°17'W	1350	500	3.1	1.5	0.3	-	-	-	-	-	-
OM-3	1	44°38.53'N 125°19.55'W	2655	540	3.5	1.7	0.3	4.5	0.7	0.7	1.5	0.3	13.2
OM-3A	2	44°40.37'N 125°19.55'W	2625	585	3.5	1.7	0.3	4.5	0.7	0.7	1.5	0.3	-
OM-7	1	44°40.38'N 125°07.34'W	668	300	1.6	1.2	0.3	-	-	-	-	-	3.1
OM-7A	2	44°40.38'N 125°03.12'W	1005	630	2.9	1.6	0.3	-	-	-	-	-	-
OM-8	1	44°59.55'N 125°22.22'W	2400	660	4.8	1.7	0.3	-	-	-	-	-	6.8
OM-4+	1	44°40.37'N 125°19.69'W	1020	700	4.6	1.7	0.3	-	-	-	-	-	6.6
OM-2+	1	44°40.37'N 125°21.58'W	2865	640	4.0	1.8	0.4	-	-	-	-	-	-
													55.7
												Total Time[d]:	57.7

[a] Estimates for single hole, using APC/XCB to TD or bit destruction
[b] Assumes SES
[c] Includes time to drill hole B to 500 m, set casing, and install plug
[d] Total time includes two extra days for additional downhole experiments (Geoprops/LAST)
* This site to be regarded as alternate to Site VI-5
+ Only one site between these two will be drilled, depending on results of previous sites

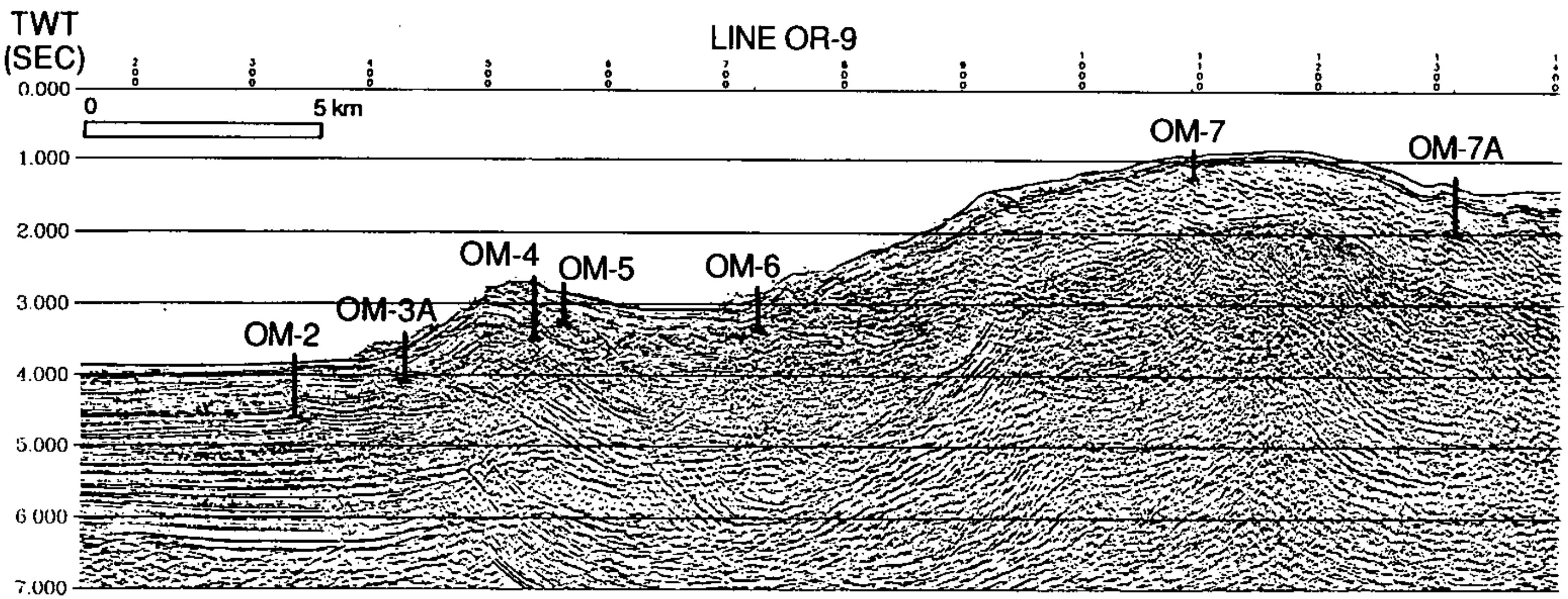

Figure 7. Multichannel seismic line OR-9 showing proposed drill sites OM-2, 3A, 4, 5, 6, 7 and 7A crossing the marginal ridge and second ridge.

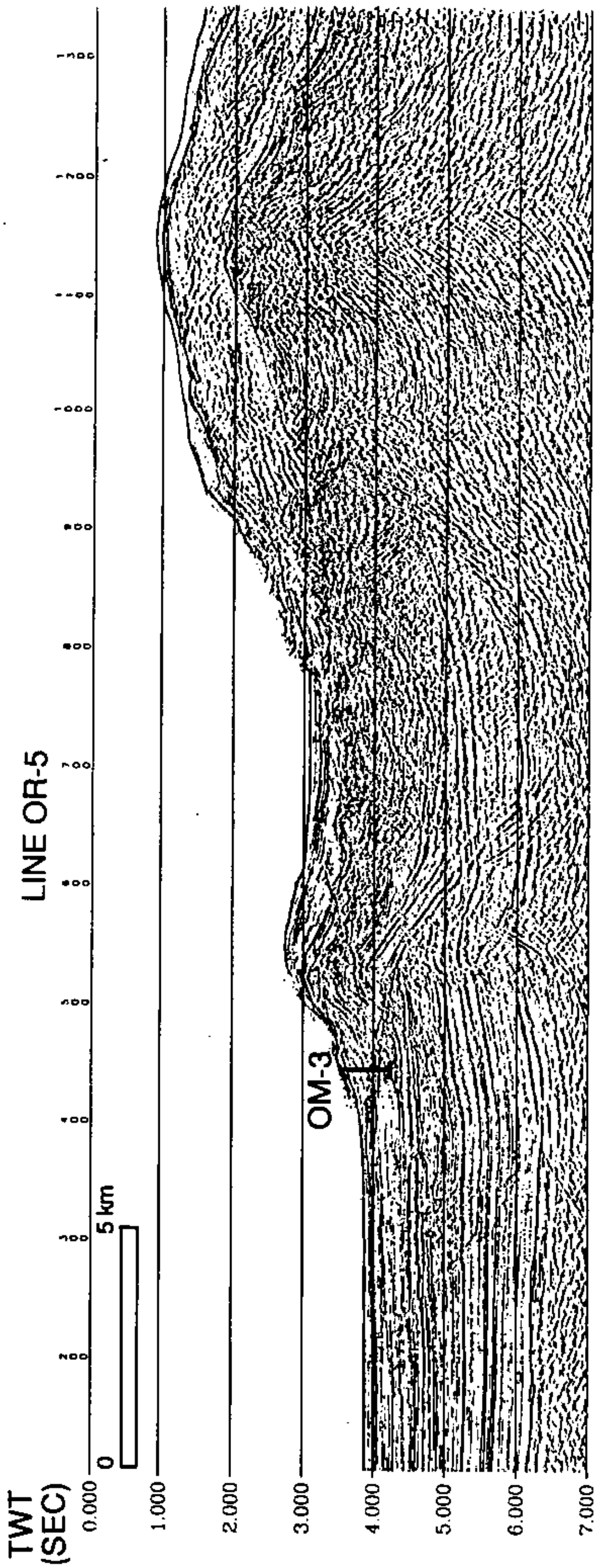

Figure 8. Multichannel seismic (MCS) line OR-5 showing proposed site OM-3 penetrating the frontal thrust.

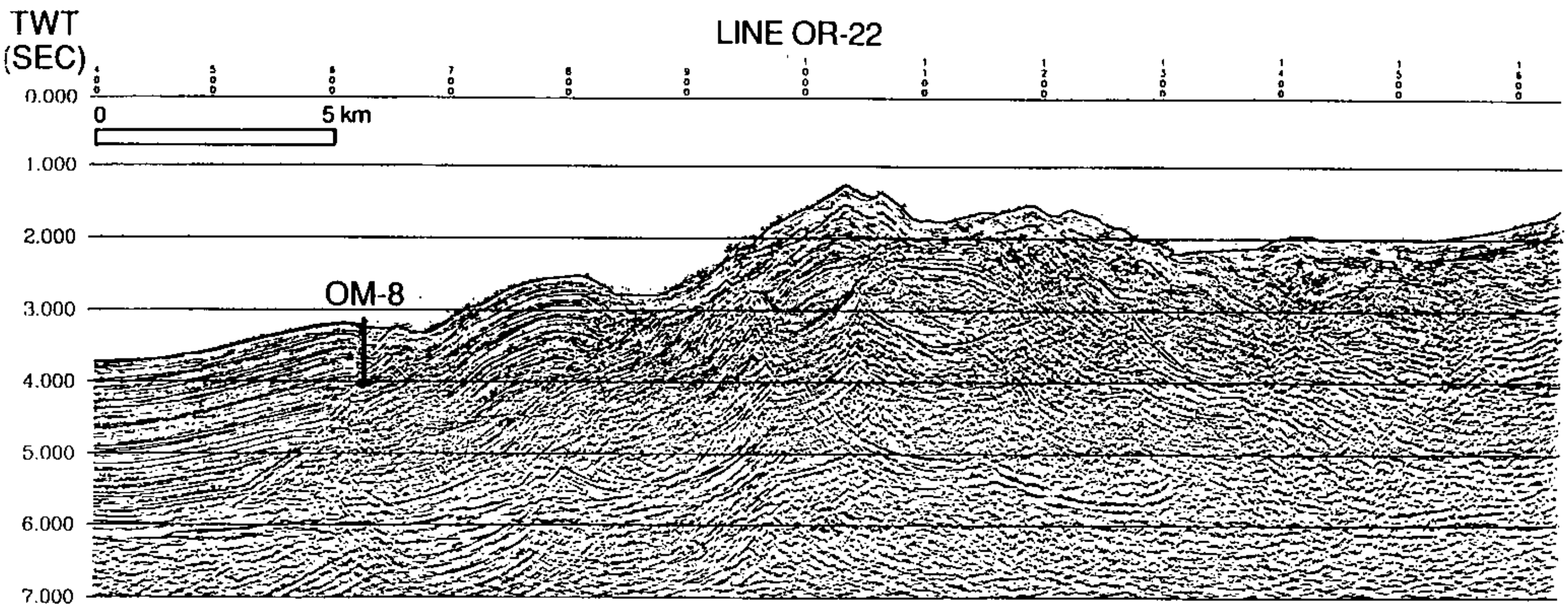

Figure 9. MCS line OR-22 showing landward-vergent structure characteristic of the northern area. Note the deeply rooting frontal thrust and reversal in vergence landward of shot point 1100.

and are characterized by periodic gas-bubble release, which builds chimneys.

The program will drill several end-member structures associated with active vents. Determination of the deep fluid chemistry, when combined with chemical-flux measurements from geochemical sampling barrels deployed by *ALVIN* at the vent sites, will allow direct measurement of the fluid flux. The approximate validity of this technique has been demonstrated by comparison to mechanical-flux measurements assuming a plausible deep-water chemistry. The technique needs to be calibrated by drilling.

In addition, core samples in the faults will sample cements that may record the history of fluid venting. Fabric analysis will reveal much about the history of fault movement, especially if the fabric can be related to cement paragenesis or otherwise dated.

The Cascadia I leg is proposed to start with the highest priority site on the Vancouver Island margin profile, the hydrate calibration hole (VI-5; Figs. 4a & b). This hole will be cased and fitted with a reentry cone for logging. Upon completion of the scientific work it will be plugged with an instrumented bore-hole seal to monitor long-term changes in pore pressure and temperature. The change in porosity in the area will then be addressed by drilling a reference hole in undeformed sediments and holes in the coherent and incoherent stages of sediment deformation.

After 26 days, regardless of the progress of this initial portion of the program, the ship will move south to the Oregon margin and emplace a similar observatory in the frontal thrust that taps the basal décollement (Figs. 5-7, & 9). The remainder of the leg will address a seaward dipping fault which extends to basement (Figs. 5, 8), a fault in an older portion of the prism (associated with a domed hydrate horizon), and venting associated with proto-deformation seaward of the prism toe. Although it is more difficult to assess the integrated rate of fracture venting because of the high variability, it is expected that the results will allow a first-order inventory. Areal mapping of the carbonate cements with GLORIA and SeaMARC-1A sidescan sonar profiling will assist the inventory. The history of venting inferred for deep cementation will be particularly important in this regard.

The overall result of the leg should be an excellent first assessment of the fluid and chemical budget of an important accretionary margin, and the installation of two observatories with the potential to indicate the temporal variability of margin hydrogeologic processes as well as carrying out long-term permeability experiments and obtaining fully equilibrated temperatures.

ADVANTAGES OF THE CASCADIA MARGIN

The Cascadia margin has several features that make the scientific studies required to assess the mass-balance relations particularly feasible.

(1) The margin is shallow. Water depths in the active accretion zone are less than 3 km, and in places less than 1 km. The shallow water depths significantly reduce drilling time, but more importantly allow stacking velocities from a normal-length seismic streamer to be used to determine the accurate sediment velocities and thus porosity. Also at the shallow depths of the Cascadia margin, the stability of the saline hydrates containing CO_2 that are likely to be found can be addressed with little extrapolation of laboratory data.

(2) In the critical areas, a uniform layer of hemipelagic sediment covers the margin, allowing unusually complete and high-resolution heat-flow surveys.

(3) The prism is one of the most intense in terms of fluid and volatile expulsion. This is because the mass flux of sediments into the prism is large and because, due to ocean upwelling at this eastern Pacific site, the organic content of the sediments is large. The large fluid and volatile flux increases all signals (for example, the thermal perturbation signal is resolvable), and thus reduces the errors in the mass-balance calculations.

(4) The Cascadia margin is unusual in its widespread carbonate cementation. These cements, which probably play an important role in the evolution of

permeability across the prism, also provide a historical record of fluid flow and composition.

(5) Potentially key variables differ along the strike of the margin. This feature may be particularly important for subsequent investigations. Convergence rate increases by a factor of 4 from south to north along the margin as the strike-slip component of convergent motion is reduced to nearly zero. Fault vergence changes from landward to seaward and back. Some faults penetrate to basement while others sole out in the sedimentary section.

(6) The margin is particularly close to major ports and oceanographic institutions. This is important for the servicing of observatory instrumentation, and increases the relevance of the monitoring and tectonic investigations that could relate to earthquake prediction.

(7) Parts of the Cascadia margin are exceptionally well surveyed with closely spaced seismic coverage, seismic refraction, heat flow, GLORIA and SeaMARC I and II coverage, and accurate high-resolution heat-flow surveys. More than 40 *ALVIN* dives to active vents (defined by biologic communities) off Oregon allowed definition and mapping of prevalent carbonate pavements associated with the vents.

(8) The main groups of proponents have addressed the margin from complementary perspectives. The DPG considers this healthy competition and difference in viewpoint a particular advantage.

Perhaps the most unique aspect of Cascadia compared to other siliciclastic accretionary margins is the measurable diffuse discharge. The diffuse expulsion, as contrasted to focused venting, is uniquely susceptible to quantitative measurement at Cascadia and appears to be a significant fraction of the total expulsion there. Once diffuse expulsion is determined, focused discharge can be obtained by subtraction from the total compactive expulsion. Quantitative determination of focused venting is difficult to estimate by local measurements because of its high areal and temporal variability.

DRILLING PLANS

Table 1 presents the plan for the Cascadia I drilling program. The holes are listed in order of priority for both the Vancouver and Oregon transects. After 26 days, the ship will transit from the Vancouver to the Oregon sites. The objectives of each drill hole are discussed below.

Vancouver Island Margin Progressive Fluid Expulsion Transect

Drilling along the Vancouver Island transect will concentrate on diffusive fluid flow through the accretionary prism and will test the gas hydrate model described in Figure 2. The proposed sites (Figs. 4a & b; Table 1) were selected from a list of sites described in the gas hydrate proposal recently submitted to JOIDES, and older JOIDES proposals 237/E, 317/E , and 317/E Addendum.

VI-1: Cascadia Basin deep-sea reference site

The operations plan specifies an approximately 500-m single-bit hole; coring, standard logging, good HPC and WSTP temperatures, and limited geotechnical measurements.

This site provides a reference for the velocity-porosity relation and the porosity-depth function of the incoming sedimentary section prior to accretion and deformation. It also gives the reference temperature-depth and heat-flow profile, and pore-fluid geochemistry.

VI-2d: Region of coherent seismic stratigraphy landward of main deformation frontal thrust

The operations plan specifies an approximately 500-m single-bit hole; coring, standard logging, good HPC and WSTP temperatures, and geotechnical measurements; a VSP is desirable. This site documents the porosity reduction and associated physical properties changes resulting from the initial "coherent" phase of deformation. In this zone there are well defined and separated thrusts that cut through most, if not all, of the sedimentary section. The porosity loss and temperature-depth data will document the total fluid loss and the rate of expulsion. Multichannel seismic velocity and velocity-porosity relations will be calibrated. Core and downhole measurements will determine the change in physical properties and pore pressures associated with the fluid expulsion.

VI-5: Hydrate Hole

The operations plan specifies an approximately 700-m hole with casing for long-term monitoring instrumentation and packer pore pressure measurement; coring, logging, good HPC and WSTP temperatures, detailed downhole geotechnical measurements, and VSP.

The three techniques for gephysically (remotely) determining fluid expulsion, *i.e.*, the porosity loss from velocity, the thermal technique and the seismically determined thickness of the hydrate layer should all be compared and calibrated in this hole.

The site is located in a region of incoherent deformation, where the prism has doubled its incoming thickness and where there is a continuous and clear BSR meeting drilling safety requirements. This site defines the distribution of hydrate associated with the BSR, determines the concentrations of methane, CO_2 and other pore fluid constiuents as well as differences in sediment diagenesis above and below the BSR, and calibrates seismic inferences about BSRs. This hole tests the fluid expulsion model for BSR hydrate formation. This is the top-priority hole in the Vancouver Island margin, and should be drilled first. After coring and measurement it will be sealed with the instrument to monitor downhole temperature and fluid pressure. It will then become one of the two downhole observatory holes to be established on the leg.

If the hole cannot penetrate the BSR for safety reasons, it should penetrate into the hydrate layer as close to the BSR as possible (<300 m, single bit) and VI-3 should penetrate to greater depth elsewhere in the incoherent deformation zone where there is no BSR, to meet the other fluid expulsion objectives.

VI-3: Region of incoherent deformation where prism has doubled its incoming thickness

The operations plan specifies an approximately 700-m hole, cased for long-term measurements, with coring, high-quality logging and downhole fluid sampling and measurement, good temperatures, geotechnical measurements, and VSP. This site documents the porosity reduction and associated physical-properties changes resulting from the phase of pervasive "incoherent" deformation. The porosity loss and temperature-depth data will document the total fluid loss and the rate of fluid expulsion, and calibrate the regional seismic-velocity and thermal techniques for expulsion monitoring. The hydrate objectives may be incorporated in this hole. If a BSR cannot be penetrated for safety reasons, this hole must be sited in incoherent deformation zone where the BSR is absent.

Oregon Margin Focused Fluid Expulsion Transect

Drilling spanning the Oregon margin will concentrate on conduits of focused fluid flow occurring principally along faults (Fig. 6). The overall goals of the program are to study the synergism of fluid flow and structural evolution and evaluate how flow may affect the geochemical cycle. The proposed drill sites will examine the frontal thrust in two areas, first, where it roots in a décollement beneath the accretionary prism and, second, where it verges landward and penetrates completely to the young, hot oceanic crust. The fluid and structural evolution in the frontal thrust will then be compared to up-slope sites through a backthrust in the hanging wall of the thrust and an out-of-sequence thrust 15 km landward. Every site will penetrate a conduit traced from a surface vent or a conduit that shows an acoustic signature consistent with high fluid content or fluid flow (negative polarities or upward deflection of a hydrate layer).

The proposed sites (Figs. 7-9; Table 1)

are selected from a more extensive list in the August, 1990 revision of the Oregon Margin drilling proposal, recently submitted to JOIDES, and older proposals 233/E and 233/E Revision-2. The sites are located in seaward and landward vergent areas of the, respectively, Southern and Northern Areas of Figure 6.

Sites OM-3 & 3A: Penetration of the frontal thrust and sources beneath the accretionary prism

Site OM-3 or OM-3A, penetrating the frontal thrust, will test whether it and the associated décollement provide a conduit for deeply sourced fluids (Figs. 7, 9). Site OM-3, on seismic line OR-5 (Fig. 9), has a high probability of encountering active fluid flow because the frontal-thrust zone in that region supports a vent biological community and a significant amplitude anomaly with probable reversed polarity is observed along the fault. Site 3A, on line OR-9, also shows a significant amplitude anomaly, but the frontal thrust was barren of biological activity in a 1984 *ALVIN* dive program, indicating no active fluid expulsion (Fig. 7).

Drilling will encounter the frontal thrust between 400-500 m. If active fluid flow is confirmed by geochemical or temperature anomalies, the hole will be cased through the thrust and a packer will be set in a perforated interval to determine fluid pressure and permeability in the thrust. Finally, the borehole will be plugged with the instrumented borehole seal.

Sites OM-7 & OM-7A: Fluid flow from older sources, out-of-sequence thrusts

Sites penetrating the out-of-sequence thrusts cutting the second ridge will examine the fluid flow and synergistic structural evolution from sources in the older, more structurally evolved portion of the accretionary prism (Fig. 7). On the second ridge, the principal drilling targets are two areas of very high back-scatter in SeaMARC-1A and GLORIA images that correlate with faults on the seismic lines. It is believed that back-scatter patterns may reveal carbonate deposits or winnowed sand around vents and, therefore, proposed sites OM-7 and OM-7A on Line OR-9 should penetrate the faults. The fault at OM-7 cuts the slope cover and is associated with a pull-up in the hydrate; this hydrate pull-up suggests active fluid flow which would bleed off any fluid trapped within the hydrate. Site OM-7 would be cored and logged.

Site OM-8: Fluid from the oceanic crust

Site OM-8, located on Line OR-22 (Fig. 8) penetrates the frontal thrust of the landward vergent area and would determine if fluids can have sources near the oceanic crust through a thick sedimentary section. In this region the frontal thrust roots within several tenths of a second above the oceanic crust under nearly 4 km of sediment. The oceanic crust is young (9 m.y.) and presumably hot, and probably still undergoing alteration at 200-300°C. The goal is to ascertain how these young, hot fluids alter and otherwise affect the structural evolution of the fault. The occurrence of clam beds along this fault and the high-amplitude reversed polarity reflections at depth both argue for active fluid flow. Total drilling depth is estimated at about 700 m. This site would be drilled and logged utilizing the GEOPROPS and LAST tools.

Site OM-4: Evolution of fluids in the hanging wall of the backthrust

Site OM-4, located on Line OR-9, is designed to evaluate the source depths for the fluids and to determine whether the fluids flow up the backthrust, perhaps from its anastomosing intersection with the frontal thrust (Fig. 5). From a geochemical perspective, the site would examine fluid evolution in the hanging wall of the frontal thrust. Additionally, site OM-4 could provide information on the permeability structure of the fault and ascertain how it might capture fluid flow from the adjacent stratified rocks.

The topographic slope marking the trace of the back thrust in the seaward vergent area supports several well developed active vents with biological communities, cabonates, and methane- or hydrogen sulfide-bearing fluids, or both. Site O[illegible] would involve [illegible] and logging. If GEOPROPS is available, pore pressure and pemeability measurements will be made.

DSDP Site 174: Reference Site

The Cascadia drilling program does not explicitly include a reference site. However, DSDP Site 174 is located along the transect (about 100 km seaward of the deformation front) on the Astoria Fan and will provide useful baseline data. Site 174 penetrated 879 m, nearly reaching the oceanic crust. The site includes basic physical-property measurements, as well as determinations of the isotopic composition of methane and carbon dioxide. If the Cascadia I leg demonstrates exciting results off Oregon, a complete reference site is anticipated in a follow-up leg (Cascadia II).

STRATEGY FOR CASCADIA I DOWNHOLE-MEASUREMENTS PROGRAM

Downhole Measurements

The downhole-measurements program at Cascadia has three major goals: fluid, dissolved gas, and methane hydrate sampling; (2) measurement of sediment physical and geotechnical properties; and (3) the contruction of temperature *vs* depth profiles under *in situ* conditions in the drillholes (Table 1). Many of the more important parameters are collected redundantly and are complementary to core measurements so that a single tool failure will not jeopardize the entire program.

Much of the *in situ* sampling will be carried out using the WSTP during drilling; together with the HPC-T recorder, these will be the primary tools used to measure subsurface temperatures. The pressure core barrel will be deployed during coring to bring back solid samples and hydrates for analysis. Additionally, the wireline packer will collect larger fluid samples from intervals of interest. All of these samplers retain *in situ* pressure so that dissolved gases can be studied.

The standard suite of ODP logging tools will provide high resolution profiles of the physical properties (sonic velocity, porosity, electrical resistivity, and density) and lithology (elemental composition) needed to assess the progressive dewatering and cementation of the accretionary prism. They will also be used to calibrate geophysical observations, especially for the velocity-porosity correlation, which provide the regional framework describing this margin. To further calibrate the reflection seismic profiles, the planning group recommends that vertical seismic profile experiments (VSP) be carried out at the two long-term monitor sites and at VI-2d. The planning group also recommends that all holes be logged with the Formation Microscanner (FMS) to image sedimentary structure and hole elipticity in general, but, in particular, to image the structure of the clathrate sections and fault planes. The high resistivity contrast between hydrates and normal deep-sea sediments and the stabilizing effect of hydrates on the borehole should make the imaging task simple to perform.

While the FMS is useful for imaging sedimentary structure and fracture, it cannot provide total coverage of the borehole. For this reason, the group recommends bore-hole televiewer (BHTV) logging of important intervals where structural orientation is of critical interest. A new digital BHTV is being tested on Leg 134, and should be available for Cascadia drilling.

The changes in geotechnical properties associated with progressive fluid loss will be measured *in situ* by the Lateral Stress Tool (LAST1 and LAST2) and the GEOPROPS probe, as well as through core measurements.

Changes in downhole heat-flow gradients and the regional pattern of heat flow on the Cascadia margin are extremely important for assessment of fluid expulsion rates and diffuse *versus* focused fluid flow. *In situ* temperature will be measured in each of the holes with the APC temperature shoe and the WSTP during the drilling phase. Temperature logs will be collected on each of the standard logging runs; the multiple temperature logs can be used to estimate equilibrium gradients in the sedimentary section. The high-resolution temperature profiles will also delineate zones of fluid flow into the borehole as distinct temperature anomalies.

Long-Term Monitor Sites

The long-term monitor sites are a major focus of the downhole measurements program. They will be loci of major logging and fluid-sampling efforts, and will also be used to measure geotechnical properties of the accretionary prism. Each monitor site will have a minimum 500-m-deep cased hole, to be perforated at zones of interest for fluid studies. During the first leg, each monitor hole will be packed off in casing for a hydraulic seal now being developed for use on the sedimented ridges drilling program, Leg 138.

The hydraulic seal will have an attached thermistor chain, differential pressure-measurement and fluid-sampling capability. The data and fluid samples can be collected by either the drillship or a submersible.

The pressure measurements will provide a long-term estimate of the permeability, based upon the recovery of borehole pressure through time in the sealed hole; while both temperature and pressure time series will provide information about long-term variation in fluid flow and also an estimate of fully equilibrated temperature and pressure.

TECHNICAL ASPECTS

Subduction complexes have proven to be difficult environments for drilling. Hole collapse has severely curtailed the downhole measurements program on several ODP and DSDP legs; this working group has designed the Cascadia drilling to minimize these problems. On Leg 131, the most recent subduction-zone drilling in the Nankai Trench, technical difficulties associated with hole stability were substantially increased because of drill-pipe "strumming" induced by the strong Kuroshio Current. The majority of downhole measurement failures were caused by instruments being vibrated apart while passing down the drill string. Nevertheless, hole closure was also a serious obstacle to the successful completion of the downhole measurement program; possible causes that resulted in hole collapse during Leg 131 included clay swelling, formation overpressure, and high formation stress.

Environmental conditions at Cascadia should be much better than at Nankai for two reasons. First, the surface currents off Cascadia are weak and variable, thus drilling in this margin will not face the formidable "pipe-strumming" problem that caused such damage at Nankai. Second, the lithology of Cascadia is much more favorable to hole stability. DSDP Site 174 in the Cascadia Basin and Site 175 on the Oregon subduction complex during Leg 18 both had good hole conditions, and showed no evidence of swelling clay problems. Unconsolidated sands hampered core recovery but did not affect drilling, as there seemed to be sufficient mud interbeds to maintain the hole. However, drill-in casing should be available on Cascadia drilling legs in case unconsolidated sands should prove to be a problem. This technique proved successful for stabilizing the upper 100 m of unconsolidated material at Nankai. Diagenetic carbonate cementation will also help stabilize the Cascadia drill holes: The lower unit of Site 175 (120-233 mbsf) is a firm mudstone cemented with carbonates; surface observations on core and exposed canyon outcrops on the Oregon margin indicate that cementation in the area is pervasive.

Hole closure at Nankai could also have been associated with formation overpressure. To maximize the potential for success, the first leg of drilling will be devoted to shallow objectives (300-700 mbsf) which present fewer technical difficulties and are less likely to be affected by formation overpressure. Packer experiments will be carried out in perforated casing at the two cased long-term monitoring sites (Table 1); the monitor program itself depends only upon the successful emplacement of the reentry cone and casing. The newly redesigned side-entry sub (SES) will also make logging operations safer and more efficient. More ambitious objectives have been left for a second leg of drilling which can be carried forward more easily based upon the results of the first leg.

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Given the above considerations, the Cascadia DPG believes that the proposed program has a high potential for success; however, it recognizes that the problems dependent upon hole stability in accretionary prisms are still realizable at Cascadia. While the planning groups knew of some technical means of stabilizing holes (*e.g.* the use, after drilling, of heavy mud and KCl), none of the members of the DPG are experts in hole stability. Thus the DPG endorses the recommendation of the DMP that a working group consisting of the co-chief scientists, TEDCOM members, and TAMU engineers continue to explore means to maximize hole stability well before drilling on Cascadia commences.

CASCADIA II DRILLING PROGRAM

The second Cascadia drilling leg will follow the first leg by about two years and will provide the opportunity to: (1) update and expand the downhole observatories; (2) conduct a comprehensive geotechnical program; and (3) establish reference sites for the fluid-geotechnical transect off Oregon. Cascadia II drilling will occupy 4-5 sites (Table 2).
A top priority for the second leg will be to reoccupy the downhole observatory sites, retrieve and redeploy the pressure-temperature instrument packages. Emplacement of downhole seismometers for long-term monitoring of subduction-zone seismicty is a high-priority objective. Downhole tiltmeters would also provide useful long-term information on local deformation. The GEOPROPS and LAST-2 instruments should be fully operational and reliable by the time of Cascadia II. Extensive use of these instruments is planned for the several new holes that would be drilled on the second leg, providing a comprehensive geotechnical measurement program. This program would yield high-resolution data on the vertical evolution of physical and mechanical properties at several sites. When integrated with data from the Cascadia I sites and seismic velocities, this data set will define, for the first time, the lateral gradients in physical and mechanical properties across an accretionary prism.

DSDP Site 174 undoubtedly will provi a useful seaward reference for the Cascadia I sites, but drilling a seaward reference site is of high priority for Cascadia II. This site will establish a baseline reference for physical- and mechanical-properties measurements across the Oregon prism.

The proposed drill sites for Cascadia II are as follows:

(1) A 1-km-deep hole will be drilled in the abyssal plain off Oregon (OM-1) to provide baseline data on fluid contents and physical and mechanical properties. Extensive use will be made of geotechnical instruments at this site.

(2) A 700-m-deep hole will be drilled into the proto-thrust zone off Oregon (OM-2) in order to sample fluids being expelled seaward of the frontal thrust and to document changes in physical and mechanical properties in the proto-thrust zone. This site would be a candidate for an additional downhole observatory.

(3) A second hole would be drilled near Cascadia I Site OR-3 which would penetrate the frontal thrust at a different depth. This hole would provide information on fluid-flow rates as well as additional structural and physical-properties data around the frontal thrust. The single-bit hole would be drilled to about 900 m.

(4) A second hole would also be drilled at the Vancouver BSR site (VI-5) to further test the diffuse-flow model for BSR formation. This hole would attempt to penetrate the hydrate zone in an area without a clear BSR for comparison to site VI-5, which will penetrate a strong BSR. This hole should be drilled to at least 1 km. The hole will provide additional structural data in the zone of incoherent deformation and directly evaluate the effect of hydrate on diagenesis.

(5) A landward reference hole will be drilled on the Oregon margin upper slope to document the subsurface geology in this region of poor seismic imaging, and provide a tie to extensive land geological studies. The hole would be drilled to about 1 km ...
cased ...

TABLE 2. CASCADIA II DRILLING AND DOWNHOLE MEASUREMENT TIMES (DAYS)

Site	Water Depth (km)	Penetration (km)	Drill Time (days)	STD logs + FMS	WSTP 6 runs	Cone Plug	Packer	VSP	Geop. LAST	BHTV	Objectives	Comments	Total
OM-2	2865	700	4.1	1.8	0.4	-	-	1.5	1.5	-	protothrust	one hole APC/XCB	9.3
OM-13	2050	900	9.9	2.0	0.4	0.5	1.0	1.5	1.5	0.3	downdip penetration of fault	two holes, one cased to 500 mbsf	17.1
OM-1	2900	1000	10.8	2.3	0.4	0.5	1.0	1.5	1.5	-	reference hole	two holes, one cased to 500 mbsf	18.0
OM-11	500	1000	7.6	1.5	0.4	0.5	1.0	1.5	1.5	0.3	landward site	two holes, one cased to 500 mbsf	14.3
VI-10	1350	700	3.4	1.8	0.4	-	-	1.5	1.5	0.3	complement to BSR site	one hole APC/XCB	8.9
												Total:	67.6

JOIDES/ODP BULLETIN BOARD

JOIDES MEETING SCHEDULE (09/01/90)

Date	Place	Committee/Panel
2-3 October, 1990	Villefranche, France	EXCOM
8-10 October, 1990	Basel, Switzerland	IHP
9-13 October, 1990	Townsville, Australia	SMP
11-13 October, 1990*	Tokyo, Japan	LITHP
11-13 October, 1990	Townsville, Australia	DMP
19-21 October, 1990*	Canberra, Australia	OHP
1-3 November, 1990*	Paris, France	TECP
2-3 November, 1990	Paris, France	SGPP
27 November, 1990	Kona, Hawaii	Panel Chairmen
28 Nov.-1 Dec., 1990	Kona, Hawaii	PCOM
5-6 March, 1991*	College Station, TX	SMP
23-25 April, 1991*	Narragansett, RI	PCOM
June, 1991*	San Diego, CA	TEDCOM
June, 1991*	Cardiff, Wales	ex-IOP & Co-Chiefs
June, 1991*	San Diego, CA	EXCOM
20-22 August, 1991*	Hannover, FRG	PCOM
22-23 October, 1991*	Halifax, Canada	SMP
3 December, 1991*	Austin, TX	Panel Chairmen
4-7 December, 1991*	Austin, TX	PCOM

* Tentative meeting; not yet formally requested and/or approved.

ODP/TAMU PANEL LIAISONS:

Downhole Measurements Panel - ANDREW FISHER
Information Handling Panel -RUSS MERRILL
Pollution Prevention & Safety Panel - TIM FRANCIS
Site Survey Panel - AUDREY MEYER
Technology & Engineering Development Committee - BARRY HARDING
Executive Committee - PHILIP RABINOWITZ
Planning Committee - TIM FRANCIS
Shipboard Measurements Panel - JACK BALDAUF & DENNIS GRAHAM
Sedimentary and Geochemical Processes Panel - MARTA VON BREYMANN
Ocean History Panel - TOM JANECEK
Tectonics Panel - LAURA STOKKING
Lithosphere Panel - JAMIE ALLAN

FUNDING FOR SITE SURVEY AUGMENTATION

The 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. Please contact Ellen Kappel at the JOI office for further information and proposal guidelines: (202) 232-3900.

A WORKSHOP ON PALEOGENE PALEOCENOGRAPHY

Lake Arrowhead, California
January 4-6, 1991
Sponsored by the JOI/US Science Support Program

Participants in the workshop will discuss and plan future scientific initiatives that focus on the Paleogene marine record and will require an integrated, multidisciplinary approach. Specialists in various fields of earth science will help to develop specific themes that will form the basis of future proposals for new deep-sea drilling and collaborative research. Applications are invited from indivuals in any field of earth science whose research focuses on global change and those specifically interested in the record of change during the Paleogene. Participants may apply for funds to defray the cost of travel and lodging. Applications should be sent to Dr. Lowell D. Stott, Dept. Geological Sciences, University of Southern California, University Park, Los Angeles, CA 90089-0740.

TAKE NOTICE

ODP has a new 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. Write to Karen Riedel, ODP Public Relations, for copies.

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.

Updated ODP brochures in French, Spanish, and German are now available from Karen Riedel.

WORKSHOP REPORTS AVAILABLE

The following reports are available. For copies please write to JOI/USSAC Workshop Report, 1755 Massachusetts Ave. NW, Suite 800, Washington, D.C. 20036-2102.

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

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

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

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

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

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

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

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

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

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

Caribbean Geological Evolution, Robert C. Speed, convener.

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

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

ODP OPEN DISCUSSION LIST *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 (ANNIE@TAMODP) requesting that you be added to the ODP-L subscription list.

BIBLIOGRAPHY OF THE OCEAN DRILLING PROGRAM

The publications below are available from ODP Subcontractors. Items from ODP/TAMU are available at 1000 Discovery Drive, College Station, TX 77840. Items from LDGO can be obtained from the Borehole Research Group, LGDO, Palisades, NY 10964.

ODP/TAMU, Texas A & M University

1. Proceedings of the Ocean Drilling Program, Initial Reports

   Volumes 101/102 (combined) Dec 86
   Volume 103 published Apr 87
   Volume 104 published July 87
   Volume 105 published Aug 87
   Volume 107 published Oct 87
   Volume 108 published Jan 88
   Volumes 106/109/111 (combined) Feb 88
   Volume 110 published Apr 88
   Volume 112 published Aug 88
   Volume 113 published Sept 88
   Volume 114 published Nov 88
   Volume 115 published Nov 88
   Volume 116 published Jan 89
   Volume 117 published June 89
   Volume 118 published May 89
   Volume 119 published Sept 89
   Volume 120 published Nov 89
   Volume 121 published Nov 89
   Volume 122 published Jan 90
   Volume 123 published June 90
   Volume 124E published June 90
   Volume 125 published Aug 90
   Volume 126 published Aug 90

2. Proceedings of the Ocean Drilling Program, Scientific Results

   Volumes 101/102 (combined) Dec 88
   Volume 103 published Dec 88
   Volume 104 published Oct 89
   Volume 105 published Oct 89
   Volume 108 published Dec 89
   Volume 111 published Dec 89
   Volume 106/109 published Jan 90
   Volume 110 published May 90
   Volume 112 published May 90
   Volume 113 published Aug 90

3. Technical Notes

   #1 Preliminary time estimates for coring operations (Revised Dec 86)
   #3 Shipboard Scientist's Handbook (Revised 1990)
   #5 Water Chemistry Procedures aboard the *JOIDES RESOLUTION* (Sept 86)
   #6 Organic Geochemistry aboard *JOIDES RESOLUTION* - An Assay (Sept 86)
   #7 Shipboard Organic Geochemistry on *JOIDES RESOLUTION* (Sept 86)
   #8 Handbook for Shipboard Sedimentologists (Aug 88)
   #9 Deep Sea Drilling Project data file documents (Jan 88)
   #10 A Guide to ODP Tools for Downhole Measurement (June 88)
   #11 Introduction to the Ocean Drilling Program (Dec 88)
   #12 Handbook for Shipboard Paleontologists (June 89)

4. Scientific Prospectuses

#27/28	(April 89)	Legs 127 & 128
#29	(Aug 89)	Leg 129
#30	(Oct 89)	Leg 130
#31	(Oct 89)	Leg 131
#33	(May 90)	Leg 133
#34	(June 90)	Leg 134

5. Preliminary Reports

#27	(Sept 89)	Leg 127
#28	(Oct 89)	Leg 128
#29	(Feb 90)	Leg 129
#30	(May 90)	Leg 130
#31	(June 90)	Leg 131

6. Engineering Prospectuses

   #2 (Nov 89) Leg 132

7. Engineering Preliminary Report

   #2 (Sept 90) Leg 132

7. Other Items Available
   - Brochure: The Data Collection of the ODP - Database Information

Bibliography of the Ocean Drilling Program, continued

- Ocean Drilling Program brochure (English, French, Spanish, German or Japanese)
- Onboard *JOIDES RESOLUTION* (new edition, 24 pp.)
- ODP Sample Distribution Policy
- Micropaleontology Reference Center brochure
- Instructions for Contributors to ODP Proceedings (Revised Oct 90)
- ODP Engineering and Drilling Operations
- Multilingual brochure with a synopsis of ODP (English, French, Spanish, German and Japanese)
- ODP Posters (Ship poster and corinmg systems poster)
- ODP After Five Years of Field Operations (Reprinted from the 1990 Offshore Technology Conference proceedings).

LAMONT-DOHERTY GEOLOGICAL OBSERVATORY

- Wireline Logging Manual (3rd Edition, 1988)

DATA AVAILABLE FROM THE NATIONAL GEOPHYSICAL DATA CENTER

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

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

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

Data are also available on magnetic tape, floppy diskette, or as computer listings. Costs for services are: $90/2-disc CD-ROM data set, $90/magnetic tape, $30/floppy diskette, $25/microfilm reel. Costs for computer listings and custom graphics vary. Prepayment is requires by check or money order (drawn on a U.S. bank), or by charge to VISA, Mastercard, or American Express. A $10 handling fee is added to all shipments ($20 for non-U.S. shipments), rush orders are extra. 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, call (303)497-6339 or write to: Marine Geology and Geophysics Division, NOAA/NGDC E/GC3, Dept. 334, 325 Broadway, Boulder CO 80303 (Fax 303-497-6513). Internet address cjm@ngdc1.colorado.edu.

DSDP AND ODP DATA AVAILABLE

ODP Data Available

ODP databases currently available include all DSDP data files (Legs 1-96), geological and geophysical data from ODP Legs 101-127, and all DSDP/ODP core photos (Legs 1-127). More data are available as paper and microfilm copies of original data collected aboard the *JOIDES Resolution*. Underway geophysical 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 #9, "Deep Sea Drilling Project Data File Documents," which includes all DSDP data file documents.

To obtain data or information contact: Kathe Lighty, Data Librarian, ODP/TAMU, 1000 Discovery Dr., College Station, TX 77845-9547, Tel: (409) 845-8495, Tx: 792779/ODP TAMU, BITNET: %DATABASE@TAMODP, Omnet: Ocean.Drilling.TAMU 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 National Geophysical Data Center (NGDC)

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/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 surcharge 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. For details, call (303) 497-6339 or write to: Marine Geology and Geophysics Div., Natl. Geophys. Data Center, NOAA E/GC3 Dept. 334, 325 Broadway, Boulder, CO 80303.

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 attentuation 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,	Minor element chemical analyses of igneous, metamorphic, and	

AVAILABLE DATA (Continued)

Data Available	Data Source	Description	Comments
4. IGNEOUS AND METAMORPHIC CHEMICAL ANALYSES, CONT'D.			
	shore laboratory	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 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 other 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 116 through 127 are listed below. Please note that: *indicates Co-Chief Scientist; **indicates Staff Scientist; ***indicates Outside Scientist.

Leg 117:
Dr. Nobuaki Niitsuma* (Sizuoka 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)
Dr. Wylie Poag*** (USGS, WHOI)

Leg 122:
Dr. Bilal Haq* (National Science Foundation, Washington, DC)
Dr. Ulrich von Rad* (Bundesanstalt fuer 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)

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. 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)

* indicates Co-Chief Scientist
** indicates Staff Scientist
*** indicates Outside Scientist.

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

ODP SAMPLE DISTRIBUTION

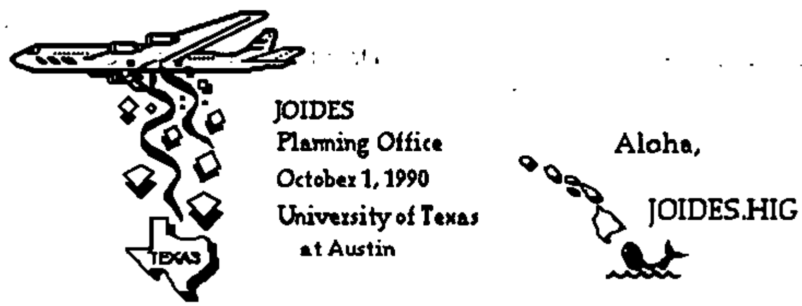
The materials from ODP Leg 126 and 127 are now available for sampling by the general scientific community. The twelve-month moratorium on cruise-related sample distribution is complete for Ocean Drilling Program Legs 101-127. Scientists who request samples from these cruises are no longer required to contribute to ODP Proceedings volumes, but may publish in the open literature instead.

All sample requests received at ODP are entered into the Sample Investigations Database. Anyone may request a search. Some common types of searches include on-going research for particular holes or legs, current research in a specific field of interest, or publications resulting from DSDP or ODP samples. At present, the most efficient way to access this database is to request a search by contacting the Assistant Curator of ODP.

Request processing (number of weeks to receive samples) during the period April 1989 through March 1990:

Repository	Avg. No. Weeks Processing	Total No. Samples
ECR	11	13,954
GCR	8	11,424
WCR	8	4,171

☞ Notice



The JOIDES Office rotated 1 October 1990 to the Institute for Geophysics at the University of Texas at Austin. The new chairman of the Planning Committee is James A. Austin. The rest of the staff is: Peter Blum, Non-US Liaison; Craig Fulthorpe, Science Coordinator; and Kathy Moser, Office Coordinator. The staff of the Hawaii JOIDES Office wishes everyone *Aloha*.

For communications with the UTIG JOIDES Office use the following:

JOIDES Planning Office	Phone: (512) 471-0471
The University of Texas at Austin	Fax: (512) 471-0999
Institute for Geophysics	Tmail: JOIDES.UTIG
8701 Mopac Blvd., Room 300	Email: joides@utig.ig.utexas.edu
Austin, TX 78759-8345	Telex: 7408994 JOID UC

A REMINDER - In order to help speed up communications, FAX numbers have been included in the Directory section of the JOIDES Journal. If we do not have your Fax number and would like it included, please let us know. As always the editorial staff of the JOIDES Journal appreciates your help in keeping the Directory listings up-to-date. Please send any revisions or corrections to: JOIDES Planning Office, The University of Texas at Austin, Institute for Geophysics, 8701 Mopac Blvd., Room 300, Austin, TX 78759-8345, USA

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Baker, J.*	JOI	(202)232-3900	7401433/BAKE UC
Ball, M.*	PPSP	(303)236-5784or5722	910 2504346/PETROL D Q
Balling, N.	DMP	(45)6-161666	64767/AAUSCI
Baragar, R.	LITHP	(613)995-4864	not available
Barron, E.*	OHP	(814)865-1619	not available
Barnes, C.	EXCOM	(613)992-5265	not available
Batiza, R.*	LITHP	(808)948-5036	7238861/HIGCY HR
Becker, K.*	LITHP,FPAPWG,SRDPG	(305)361-4661	317454/VOFM RSMAS MIA
Behrmann, J.	TECP	(49)641-702-8367	482956/UNI GI D
Beiersdorf, H.	CEPDPG,EXCOM,PCOM	(49)511-643-2412	923730/BGR HA D
Bell, S.*	DMP	(403)284-0336	03825686/ISPG CGY
Berger, W.	OHP	(619)534-2750	9103371271/UCWWD SIO SDG
Berggren, W.*	OHP	(508)548-1400	951679/OCEANIST WOOH
Biju-Duval, B.*	EXCOM,ODPC	(33)1-47-23-55-28	610775/IFREMER F
Blum, Peter	JOIDES	(512)471-0450	9108741380/UTIG AUS
Bonnasse-Gahot, J.	TEDCOM	(33)1-47-44-45-46	615400/ELFA F
Bosellini, A.	ODPC	(39)532-35968	510850/UNIV FE I
Bostrøm, K.	LITHP	(46)8-31-74-09	8105199/S
Boulegue, J.	SGPP	(33)1-43-36-25-25	200145/UPMC SIX F
Bourgois, J.	CEPDPG, TECP	(33)1-43-36-25-25	200145/UPMC SIX F
Bowman, J.*	ODPC	(44)793-411500	444293/ENVRE G
Bralower, W.*	OHP	(305)554-3085	not available
Brass, G.*	PCOM	(305)361-4690	317454/VOFM RSMAS MIA
Brenner, C.	LGDO	(914)359-2900X542	7105762653/LAMONTGEO
Briden, J.*	EXCOM	(44)793-411500X501	444293/ENVRE G
Brocher, T.*	LITHP	(415)329-4737	not available
Broglia, C.	LGDO	(914)359-2900X671	7105762653/LAMONTGEO
Brooks, K.	WPDPG	(45)1-11-22-32	19066/GGUTEL DK
Browning, P.*	LITHP	(44)223-333416	81240/CAMSPL G
Brumsack, H-J.	CEPDPG	(49)551-393-981	96703/UNI GEO D
Bryan, W.	SRDPG	(508)548-1400X2582	951679/OCEANIST WOOH
Buck, R.*	TECP	(914)359-2900X592	7105762653/LAMONTGEO
Burns, A.	JOI	(202)232-2900	7401433/BAKE UC
Caldwell, D.	EXCOM	(503)754-3504	5105960682/OSU COVS
Carson, B.	DMP	(215)758-3660	7106701086/LEHIGH UNIV UD
Cassano, E.	PPSP	(39)-2-5205826	310246/ENI
Cathles, L.	LITHP	(607)255-7135	6713054/WUI
Chapman, D.	SRDPG	(801)581-6820	not available
Chase, R.*	CEPDPG	(604)228-3086	0454245/GEOP UBC VCR
Chenevert, M.*	TEDCOM	(512)471-7270	9108741305/UTINTERNAT AUS
Christ, R.*	TEDCOM	(61) 3-5653402	not available
Christie-Blick, N.	SGPP	(914)359-2900	7105762653/LAMONTGEO
Cita-Seroni	PCOM	(39)-2-236998240	312800/PP MI I
Claypool, G.	PPSP	(214)851-8460	205638/MDRL DAL
Cloetingh, S.	LITHP	(31) 20-548-4741	10399/INTVU NL
Coffin, M.	SMP	(61) 62-499634	not available
Collin, R.	TEDCOM	(33)1-47-44-45-46	615400/ELFA F
Collins, W.	ODPC	(709)737-4708	0164101/MEMORIAL SNF
Cotten, W.	TEDCOM	(713)230-2650	9108814851/CHEVRON GT HOU
Cowan, D.*	PCOM	(206)543-4033	9104740096/UW UI
Crawford, T.*	PCOM	(61) 2-202470	AA58150
Crocker, H.*	DMP	(61) 9-3259155	not available

Cronan, D.	WPDPG	(44)1-589-5111	261503/IMPCOL G
Dalziel, I.*	TECP	(512)471-0431	9108741380/UTIG AUS
Davies, P	OHP	(61) 062-499111	not available
Davies, T.*	EXCOM	(512)471-0409	9108741380/UTIG AUS
Davis, D.	TECP	(516)632-8217	5102287767/SUNNADMIN S
Davis, E.*	CEPDPG,SRDPG	(604)356-6453	0497281/DFO PAT BAY
Delaney, J.	SRDPG	(206) 543-4830	not available
Delaney, M.*	OHP	(408)429-4736	7607936/UCSC UC
Delas, C.	PPSP	(33)42-91-40-00	615700/F
Dennis, B.	TEDCOM	(505)667-5697	660495/LOS ALAMOS LAB
Detrick, R.*	SRDPG	(401)792-6926	257882/DETR UR
Deutsch, U.	TEDCOM	(49) 5323-722450	953813/TU ITE D
Dorman, C.*	EXCOM	(508)548-1400X2500	951679/OCEANIST WOOH
Dreiss, S.*	SGPP	(408)429-2225	7607936/UCSC UC
Droxler, A.	OHP	(713)527-4880	not available
Duce, R.	EXCOM	(401)792-6222	257580/KNAU UR
Duennebier, F.*	SSP	(808)948-8711	7238861/HIGCY HR
Duncan, R.	PCOM	(503)737-2296	258707/JOID UR
Dürbaum, H.	EXCOM	(49)511-643-3247	923730/BGR HA D
Eade, J.	WPDPG	(679)381139	2330/SOPACPRO FJ
Elderfield, H.*	SGPP	(44)223-333406	81240/CAMPSL G
Engebretson, D.	TECP	(206)676-3581	not available
Erzinger, J.	LITHP	(49)641-702-8390	482956/GRIWOTY UNIGI D
Etheridge, M.*	TECP	(61) 62-499745	not available
Exon, N.*	WPDPG	(61) 62-499347	not available
Eystein, J.*	OHP	(47) 5-213491	8441023/UIBTA N
Falvey, D.*	PCOM	(61) 62 499327	not available
Fisher, A.	ODP/TAMU	(409)845-2197	62760290/ESL UD
Flower, M.	CEPDPG	(312)996-9662	253846/UNIV ILL CCC CGO
Floyd, P.	CEPDPG	(44)782-62-1111	36113/UNKLIB G
Forster, C.	SRDPG	(801)750-1247	3789426/UTAHSTATEU LOGAN
Fortier, M.	PPSP	(613)993-3760X328	0534366/EMR RMCB OTT
Foucher, J-P.*	DMP	(33) 98-22-40-40	940627/OCEAN F
Francheteau, J.	CEPDPG,SRDPG	(33)1-43-54-13-22	202810/VOLSISM F
Franklin, J.*	LITHP,SRDPG	(613)995-4137	0533117/EMAR OTT
Fratta, M.	ODPC	(33)8835-3063	890440/ESF F
Fricker, P.	ODPC	(41)31-24-54-24	912423/CH
Frieman, E.*	EXCOM	(619)534-2826	9103371271/UCWWD SIO SDG
Froelich, P.*	SGPP	(914)359-2900X485	7105762653/LAMONTGEO
Fujii, T.*	LITHP	(81)3-812-2111X5751	25607/ORIUT J
Fujimoto, H.*	SRDPG,TEDCOM	(81)3-376-1251	25607/ORIUT J
Garrison, L.*	ODP/TAMU	(409)845-8480	62760290/ESL UD
Gibson, I.*	SMP, IHP	(519) 885-1221X2054	06955259/U OF W WTLO
Gieskes, J	DMP	(619)534-4257	9103371271/UCWWD SIO SDG
Gill, J.	WPDPG	(408)429-2425	7607936/UCSC UC
Goldhaber, M.	SGPP	(303)236-1521	9109370740/GSA FTS LKWD
Golovchenko, X.	LDGO	(914)359-2900X336	7105762653/LAMONTGEO
Gradstein, F.*	SGPP	(902)426-4870	01931552/BIO DRT
Granger, J.	JOI	(202)232-3900	7401433/BAKE UC
Grassick, D.	TEDCOM		
Green, A.	PPSP	(713)965-4172	9108813649/USEPR TEX HOU
Green, D.*	LITHP	(61) 2-202476	AA58150
Grout, R.	ODP/TAMU	(409)845-2144	62760290/ESL UD
Harding, B.	ODP/TAMU	(409)845-2024	62760290/ESL UD
Harrison, C.*	EXCOM	(305)361-4610	317454/VOFM RSMAS MIA
Haseldonckx, P.	PPSP	(49)201-726-3911	8571141/DX D
Hay, W.*	SGPP	(303)492-7370	not available
Hayes, D.	EXCOM, PCOM	(914)359-2900X470	7105762653/LAMONTGEO
Heath, G.	EXCOM	(206)543-6605	9104740096/UW UI
Hedberg, D.	IHP	(46)-8-151-580	13599/RESCOUN
Hedberg, J.D.*	SSP	(713)973-3240	774
Hinrichs, D.*	NSF,ODPC	(202)357-7837	
Halsley, C.*	EXCOM	(808	
Hai			
Has			

Hey, R.	SSP	(808)948-8972	7238861/HIGCY HR
Hertogen, J.	SRDPG	(32) 16-201015	23674/KULEUV B
Hinz, K.	TECP	(49)511-643-3244	923730/BGR HA D
Horn, D.	PPSP	(49)201-726-3905	8571141/DX D
Hovland, M.	PPSP	(47) 4-80-71-30	73600/STAST N
Howard, S.*	SRDPG	(409)845-2265	62760290/ESL UD
Howell, E.	DMP	(214)422-6857	794784/ARCO PLNO
Huchon, Ph.	WPDPG	(33)1-43291225	not available
Humphris, S.*	LITHP	(508)548-1400X2523	951679/OCEANIST WOOH
Hutchinson, M.*	DMP		not available
Hyndman, R.*	WPDPG,FPAPWG	(604)656-8438	0497281/DFO PAT BAY
Ignatius, H.	ODPC	(358)0-469-31	123185/GEOLO SF
Ingersoll, R.	IHP	(213)825-8634	3716012/UCLA LSA
Ito, M.*	SGPP	not available	25607/ ORIUT J
James, N.	SGPP	(613) 545-6170	not available
Jansen, E.*	OHP	(47)05-21-3491	8441023/UIBTA N
Jarrard, R.*	LDGO	(914)359-2900X343	7105762653/LAMONTGEO
Jenkyns, H.	PCOM	(44)865-272023	83147 Attn. EARTH
JOIDES Office		(808)948-7939	7407498/JOID UC
Jones, E.	SSP	(44)1-387-7050	28722/UCPHYS G
Jones, M.*	IHP	(44)051-653-8633	628591/OCEANB G
Jung, R.	DMP	(49) 511-643-2857	923730/BGRHA D
Kappel, E.	JOI	(202)232-3900	7401433/BAKE UC
Karig, D.*	DMP,FPAPWG	(607)255-3679	6713054/CORNELL ITCA
Kasahara, J.	TEDCOM	(81)3-812-2111X5713	not available
Kastens, K.*	SSP	(914)359-2900X236	7105762653/LAMONTGEO
Kastner, M.*	PCOM	(619)534-2065	9103371271/UCWWD SIO SDG,
Katz, B.*	PPSP	(713)954-6093	not available
Kent, D.*	OHP	(914)359-2900X544	7105762653/LAMONTGEO
Kidd, R.	SSP	(44)0792-295149	48358/UCSWAN G
King, J.	SMP	(401)792-6594	257580/KNAU UR
Kinoshita, H.*	DMP	(81)3-472-51-1111	25607/ORIUT J
Kobayashi, K.	EXCOM, PCOM	(81)3-376-1251	25607/ORIUT J
Korsch, R.*	CEPDPG	(61) 62-488178	not available
Kristjansson, L.	ODPC,SRDPG	(354)1-213-40	2307/ISINFO IS
Kroenke, L.*	CEPDPG	(808)948-7845	7238861/HIGCY HR
Kudrass, H.	WPDPG	(49)511-643-2787	0923730/BGR HA D
Ladd, J.	NSF	(202)357-7543	7401424/NSFO UC
Lancelot, Y.	PCOM	(33)1-43-362525X5155	200145/UPMC SIX F
Langseth, M.*	PCOM	(914)359-2900X518	7105762653/LAMONTGEO
Larsen, B.	SSP	(45)2-884022X3210	37529/DTHDIA DK
Larsen, G.	ODPC	(45)6-12-82-33	15652/DK
Larsen, H-C.	TECP	(45)1-118866	19066/GGUTEL DK
Larson, R.*	PCOM	(401)792-6165	7400188/LARS UC
Last, A.	PPSP	(44)1-588-8000	884614/TRIOIL G
Laughton, A.*	EXCOM	(44)42-879-4141	858833/OCEANS G
Le Pichon, X.	FPAPWG	(33)1-14-31-84-88	842202601/ENULM F
Lee, C-S.	IHP	(61)062-499240	AA 62109
Leinen, M.*	PCOM	(401)792-6268	257580/KNAU UR
Levi, S.	PCOM	(503)754-2296	5105960682/OSU COVS
Lewis, B.	EXCOM	(202)543-7419	9104740096/UW UI
Lewis, S.	SSP	(415)856-7096	171449/PCS USGS MNPK
Louden, K.*	SSP	(902)424-3557	01921863/DALUNIVLIB HFX
Loughridge, M.*	IHP	(303)497-6487	258169/WDCA UR
Loutit, T.*	OHP	(713)966-6114	not available
Lyle, M.	SRDPG	(503)754-2749	5105960682/OSU COVS
Lysne, P.*	DMP	(505)846-6328	169012/SANDIA LABS
Macdonald, K.	SRDPG	(805)961-4005	258976/KMAC UR
MacKenzie, D.	PPSP	(303)794-4750	not available
Magnusson, M.	ODPC	not available	not available
Maldonado, A.	FPAPWG	(34)3-310-64-50	59367/INPB E
Malfait, B.*	NSF	(202)357-9849	7401424/NSFO UC
Malpas, J.*	PCOM	(709)737-4708	0164101/MEMORIAL SNF

Manchester, K.*	TEDCOM	(902)426-3411	01931552/BIO DRT
Maronde, D.	ODPC	(49)228-885-2327	17228312/DFG
Marx, C.	TEDCOM	(49)5323-722239	953813/TU ITE D
Maxwell, A.*	EXCOM	(512)471-4860	9108741380/UTIG AUS
Mayer, L.*	SGPP	(33)1-43-29-61-84	200145/UPMC SIX F
McClain, J.*	LITHP	(916)752-7093,0350	9105310785/UCDAVIS
McKenzie, J.	SGPP	(41)1-256-38-28	817379/EHHG CH
McLerran, A.	TEDCOM	(619)481-0482	not available
Merrell, W.*	EXCOM	(409)740-4403	not available
Merrill, R.	ODP/TAMU	(409)845-9324	62760290/ESL UD
Mevel, C.	LITHP,SRDPG	(33)1-43-36-25-25	200145/UPMC SIX F
Meyer, A.	ODP/TAMU	(409)845-9299	62760290/ESL UD
Meyer, H.	SSP	(511)643-3128	0923730/BGR HA D
Michot, J.	ODPC	(32)2-642-22-36	23069/BODPC
Mienert, J.	SGPP	(49) 431-720-0249	not available
Millheim, K.	TEDCOM	(918)660-3381	284255/CDFTU UR
Mix, A.*	OHP	(503)754-2296	5105960682/OSU COVS
Moberly, R.*	PCOM,EXCOM	(808)948-8765	7238861/HIGCY HR
Moore, G.*	WPDPG	(808)948-6854	7238861/HIGCY HR
Moore, J.C.	FPAPWG	(408)429-2574	not available
Moore, T.C.*	IHP	(313)747-2742	not available
Moores, E.	TECP	(916)752-0352	not available
Moran, K.*	SMP	(902)426-8159	1931552/BIO DRT
Morin, R.*	DMP	(303)236-5913	not available
Moss, M.*	EXCOM	(619)534-2836	not available
Motti, M.*	SMP,SRDPG	(808)948-7006	7238861/HIGCY HR
Mutter, J.*	LITHP	(914)359-2900X525	258294/MCSP UR
Natland, J.*	WPDPG	(619)534-5977	9103371271/UCWWD SIO SDG
Nemoto, T.*	EXCOM, ODPC	(81)3-376-1251	25607/ORIUT J
Nobes, P.*	DMP	(519)885-1211X6109	06955259/U OF W WTLO
Normark, W.	SGPP	(415)856-7045	171449/PCS USGS MNPK
Nowak, J.	IHP	(49)511-643-2615	922739/GFIZ D
NSF (ODP)		(202)357-9849	7401424/NSFO UC
Nuti, E.*	FPAPWG	(39)50-41503	502020/IRGCNR I
ODP/TAMU		(409)845-2673	62760290/ESL UD
ODP Databank	LDGO	(914)359-2900X542	7105762653/LAMONTGEO
Ogawa, Y.*	TECP,SGPP	(81)92641-1101X4320	25607/ORIUT J
Okada, Hakuyu*	CEPDPG	(81)92641-1101X4301	25607/ORIUT J
Okada, Hisakate*	OHP	(81)23631-1421X2585	25607/ORIUT J
Orcutt, J.*	LITHP	(619)534-2887	9103371271/UCWWD SIO SDG
Ottosson, M-O.	EXCOM, ODPC	(46)8-15-15-80	13599/RESCOUN S
Pascal, G.*	DMP	(33)98-46-25-21	940627/OCEAN F
Pautot, G.*	SSP	(33)98-22-40-40	940627/OCEAN F
Paxton, A	TEDCOM	(44)224-574555	739721/BRTOIL G
Pearce, J.	LITHP	(44)91-374-2528	53654/UNINEW G
Pedersen, T.	OHP	not available	not available
Perfit, M.	LITHP, SRDPG	(904)392-2128	not available
Peters, P.	JOI	(202)232-3900	7401433/BAKE UC
Peveraro, R.	DMP	(44)41-226-5555	777633/BRTOIL G
Phipps-Morgan, J.*	LITHP	(617)253-5951	not available
Powell, T.*	PPSP	(61) 62-499397	not available
Prahl, F.*	SGPP	(503)754-4172	5105960682/OSU COVS
Pratt, L. M.	OHP	(812)855-9203	272279/Indiana Ubloom
Premoli-Silva, I.	OHP	(39)2-23698248	320484/UNIMI I
Puchelt, H.	LITHP	not available	not available
Purdy, G.M.*	TECP	(508)548-1400X2826	951679/OCEANINST.WOOH
Pyle, T.*	JOI	(202)232-3900	7401433/BAKE UC
Rabinowitz, P.*	ODP/TAMU	(409)845-8480	62760290/ESL UD
Raleigh, B.*	EXCOM	(914)359-2900X345	7105762653/LAMONTGEO
Rea, D.*	CEPDPG	(313)936-0521	not available
Renard, V.	SSP	(33)98-22-42-26	940627/OCEAN F
Reynolds, R.	LDGO	914-359-2900X671	7105762653/LAMONTGEO
Rhodes, J.M.	SMP	(213)545-2841	not available
Richards, A.	SMP	(31) 2977-40012	20000/MCC NL

Riddihough, R.*	TECP	(613)995-4482	0533117/EMAR OTT
Riedel, K.	ODP/TAMU	(409)845-9322	62760290/ESL UD
Riedel, W.*	IHP	(619)534-4386	not available
Rischmüller, H.	TEDCOM	(49)511-654-2669	923730/BGR HA D
Roberts, D.	PPSP	(44)1-920-8474	888811/BPLDNA G G
Robertson, A.	TECP	(44)31-667-1081	727442/UNIVED G
Rutland, R.	EXCOM,ODPC	(61) 062 499111	not available
Sager, W.*	IHP	(409)845-9828	258781/GRITUR
Saito, T.*	OHP	(81)236-311421X2585	25607/ORIUT J
Sancetta, C.*	CEPDPG	(914)359-2900X412	7105762653/LAMONTGEO
Sartori, R.	SSP	(39)51-22-54-44	511350/ I
Sawyer, D.*	TECP	(713) 285-5106	62013673
Saunders, R.	IHP	(41) 61-295564	not available
Schaaf, A.	IHP	(33)76-898124X3810	UCB 330 208
Schilling, J-G.	EXCOM	(401)792-6628	257580/KNAU UR
Schlanger, S.	CEPDPG	(312)491-5097	not available
Schrader, H.	CEPDPG	(47)5-21-35-00	42877/UBBRB N
Schuh, F.	TEDCOM	(214)380-0203	794784/ARCO PLNO
Scott, S.	WPDPG	(416)978-5424	0623887/GEOLOGY TOR
Sengör, A.	CEPDPG, ODPC	(90)1-1433-100	23706/UTU TR
Shackleton, N.*	OHP	(44)223-334871	81240/CAMSPL G
Shipley, T.*	PCOM,FPAPWG	(512)471-6156	9108741380/UTIG AUS
Simoneit, B.	SRDPG	(503)754-2155	5105960682/OSU COVS
Sliter, W.	CEPDPG	(415)329-4988	171449/PCS USGS MNPK
Small, L.	EXCOM	(503)754-4763	5105960682/OSU COVS
Smith, G.*	LITHP	(314)658-3128	550132/STL UNIV STL
Smith, R.	JOI	(202)232-3900	7401433/BAKE UC
Solheim, A.	SMP	(47)-2-123650	74745/POLAR N
Sondergeld, C.*	DMP	(918)660-3917	200654/AMOCO UR
Spall, H.*	IHP	(703)648-6078	160443/USGS UT
Sparks, C.	TEDCOM	(33)1-47-52-63-95	203050/IFP A F
Spencer, D.	EXCOM	(508) 548-1400	951679/OCEANIST WOOH
Spiess, V.	IHP	(42)1-218-3387	not available
Stanton, P.	TEDCOM	(713)940-3793	9108815579/USEPRTX HOU
Stein, R.	OHP	(49)641-702-8365	482956/GRIWOTY UNIGI D
Stel, J.*	ODPC	(31)370-440780	not available
Stephansson, O.	DMP	(920)91359	not available
Stephen, R.*	DMP, SRDPG	(508)548-1400X2583	951679/OCEANIST WOOH
Storms, M.	ODP/TAMU	(409)845-2101	62760290/ESL UD
Strand, H.	TEDCOM	(47)-4-678066	not available
Stow, D.	SGPP	(619)265-5498	not available
Suess, E.	SGPP,FPAPWG	(49)431-720-020	not available
Sutherland, A.	NSF	(202)357-9849	7401424/NSFO UC
Suyehiro, K.*	SSP	(81)3-376-1251	25607/ORIUT J
Svendsen, W.	TEDCOM	(612)331-1331	210685/LYHQ UR
Symonds, P.*	SSP	(61) 62-499490	not available
Taira, A.*	PCOM	(81)3-376-1251X256	25607/ORIUT J
Tamaki, K.*	IHP,WPDPG, CEPDPG,LITHP,TECP	(81)3-376-1251	25607/ORIUT J
Taylor, B.*	WPDPG	(808)948-6649	7238861/HIGCY HR
Thierstein, H.	PCOM	(41)1-256-3666	53178/ETHBI CH
Thomas, E.*	SMP	(203)347-9411	not available
Tokuyama, H.*	SMP	(81) 3-376-1251	25607/ORIUT J
Tsunemasa, S.*	OHP	(81) 236-311421X2585	25607/ORIUT J
Tucholke, B.*	PCOM	(508)548-1400X2494	951679/OCEANIST WOOH
Valet, J-P.	SMP	(33) 1-69-82-3558	601137/F CNRS GIF
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van Weering, Tj.	WPDPG	(31)02226-541	not available
Veis, G.	ODPC	(30)1-777-36-13	215032/GEO GR
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Weigel, W.	SSP	(49)40-4123-2981	214732/UNI HH D
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Westgaard, L.	EXCOM,ODPC	(47)2-15-70-12	79913/NAVF N
Whitmarsh, R.	SMP	(44) 42-879-4141	858833/OCEANS G
Wilkens, R.*	DMP	(808)944-0404	7238861/HIGCY HR
Winterer, E.*	PCOM	(619)534-2360	9103371271/UCWWD SIO SDG
Wortel, R.	TECP	(31)30-53-50-86	40704/VMLRU NL
Worthington, P.*	DMP	(44)9327-63263	296041/BPSUNA G
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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, Supplement One, June 1986 (Vol. XII)

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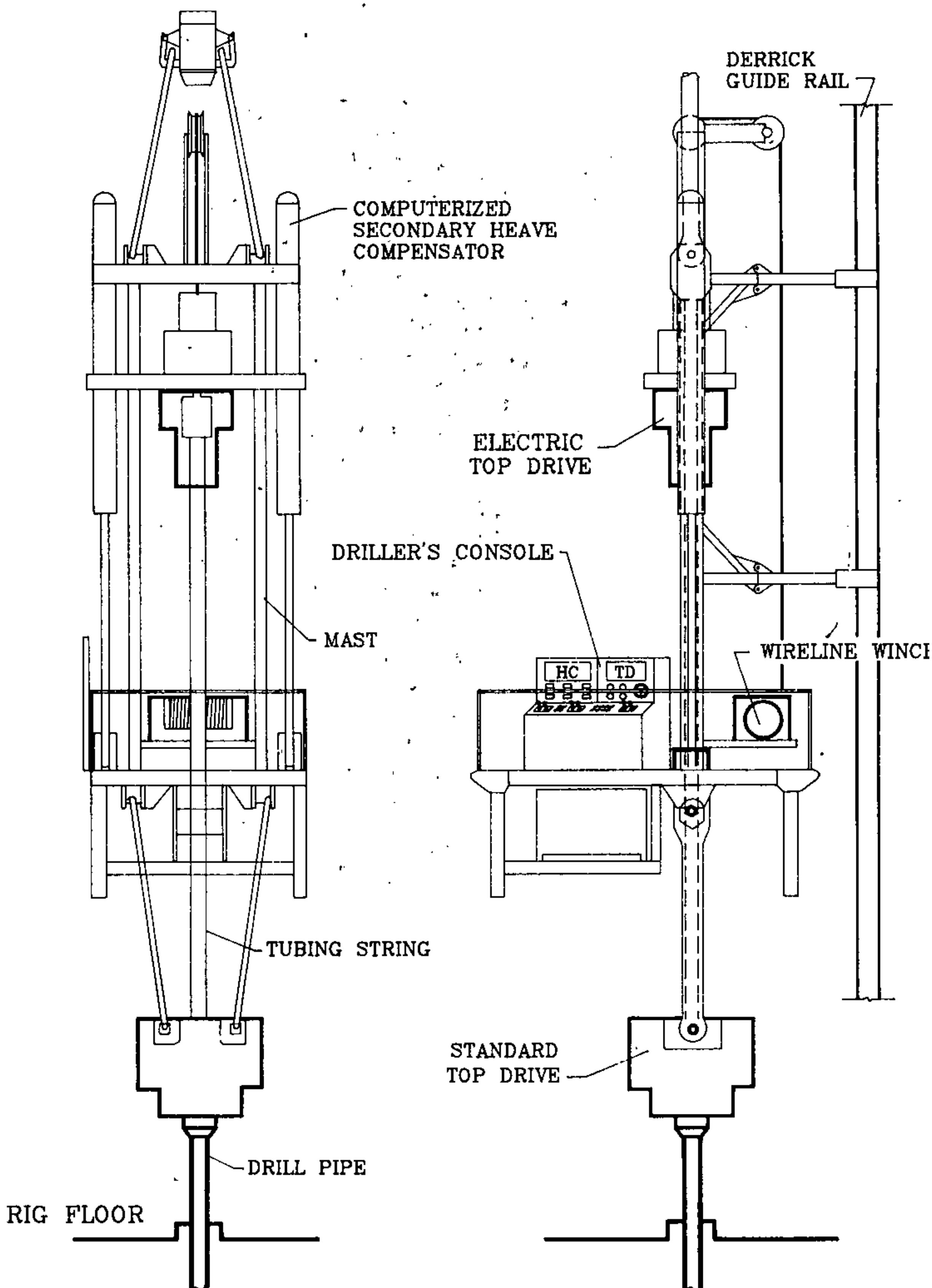

PLATFORM CONFIGURATION