JOIDES Journal

Joint Oceanographic Institutions for Deep Earth Sampling
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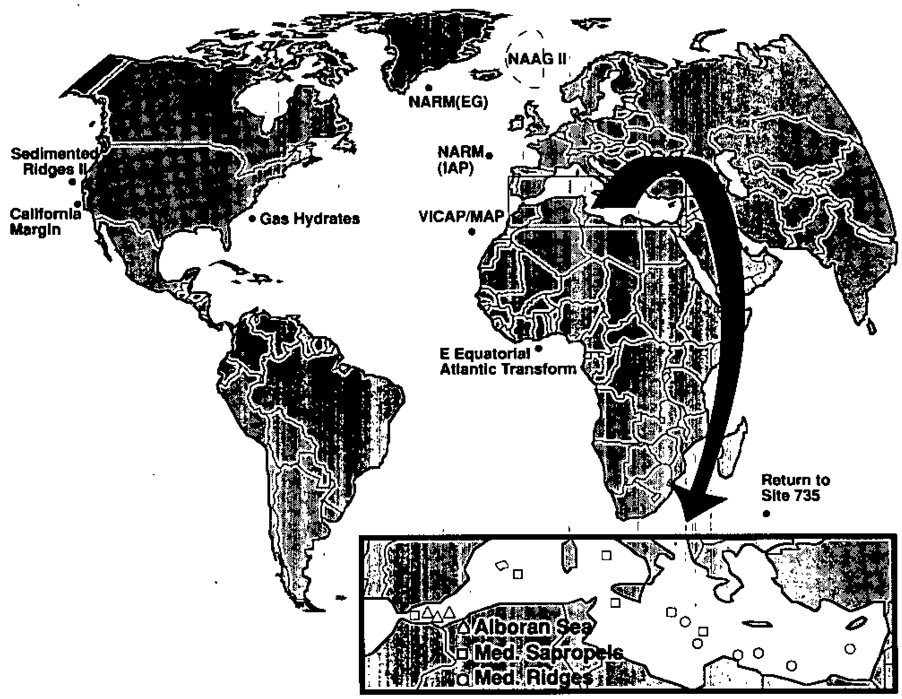
FY1995 Prospectus



JOIDES Planning Committee Looks Toward 1995 Drilling

Cover : At their August meeting in Brisbane Australia, the JOIDES Planning Committee selected twelve proposals for a FY95 Prospectus for drilling. These proposals, shown on the map with the abbreviated name of the program, were selected on the basis of panel priority, scientific maturity, site survey readiness and location (*for a key to the titles and proponents of these proposals see page 32*). The final decision on the FY95 schedule will be made at PCOM's December meeting in Miami. Map graphic furnished by Bill Collins, JOIDES Office.

The *JOIDES Journal* is edited by Karen Schmitt and the JOIDES Office staff—Bill Collins is the ODP Proposal News, ODP International News and Liaison Group News reporter, Sam Clark produces the ODP Directory. Comments, suggestions and contributions for the content of the *JOIDES Journal* should be directed to:

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JOIDES Journal

Joint Oceanographic Institutions for Deep Earth Sampling

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Japan: Ocean Research Institute, University of Tokyo

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Oregon State University, College of Oceanic and Atmospheric Sciences

University of Rhode Island, Graduate School of Oceanography

Texas A&M University, College of Geosciences and Maritime Studies

University of Texas at Austin, Institute for Geophysics

United Kingdom: Natural Environment Research Council

University of Washington, College of Ocean and Fishery Sciences

Woods Hole Oceanographic Institution

Table of Contents

THE OCEAN DRILLING PROGRAM IS ACCEPTING PROPOSALS FOR DRILLING . . . ANY OCEAN . . . ANY SEA

JOIDES PROPOSAL SUBMISSION

There are two options to get your ideas into the system.

LETTER OF INTENT

A Letter of Intent is a three to four page outline of your idea(s) for scientific ocean drilling. It may be submitted an alternative to a full proposal and will be forwarded to the panels for comment. Based on panel response, the preparation of a formal proposal may be recommended.

FULL PROPOSAL

An ODP drilling proposal must contain an abstract (400 words or less) and the following information to be accepted and forwarded to the four thematic panels for review :

- Scientific objectives preferably linked to COSOD or *ODP Long Range Plan.(LRP)* themes. (COSOD and ODP LRP documents are available from the JOIDES Office)
- Drilling sites that are tied to the stated scientific objectives and justified by appropriate site survey data.
- Completed ODP Site Summary Forms (blank forms are available from the JOIDES Office on disk or hard copy).

<u>In addition:</u>

Ten hard copies of the entire proposal must be sent to the JOIDES Office. The JOIDES Office would also appreciate receiving a copy of the proposal via electronic mail or on floppy disc .

JOIDES REVIEW AND PLANNING CYCLES

SITE SURVEY DATA PACKAGE

The JOIDES Office will ask proponents of proposals that have been highly ranked to submit a site survey data package to the ODP Data Bank at LDEO by a July or November deadline. The guidelines for submission of site survey data are available from the JOIDES Office at any time.

JOIDES PROPOSAL REVIEW DEADLINES

JANUARY 1

A proposal or letter of intent submitted for this deadline will be reviewed in the Spring. The JOIDES Office will return comments, recommendations, and data package requirements to proponents in April.

JULY 1

A letter of intent or proposal submitted for this deadline will be reviewed in the Fall. The JOIDES Office will return comments, recommendations, and data package requirements to proponents in October.

JOIDES PLANNING MILESTONES

APRIL

All "active" proposals (those submitted within the past 3 years) are considered and ranked by the Thematic Panels. A four year outlook is determined by the Planning Committee.

AUGUST

Based on proposal maturity and scientific priority, a short list of 10-12 proposals is compiled into a proposal prospectus by the Planning Committee.

DECEMBER

Following a review and ranking of proposals in the prospectus, and any other proposals added to the prospectus in the Fall by the Thematic panels, PCOM sets the drilling schedule for the next fiscal year.

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FOCUS

Brian Lewis
Planning Committee Chair

Budgets

In the last of these articles I described some of the budget problems that could have seriously jeopardized ODP operations beyond October 1993. Due in large part to actions at NSF, most of these impediments to renewal have evaporated. At its August 1993 meeting, PCOM was instructed by JOI to plan on the basis of a FY94 budget of $ 44.9 M. This allows planning to proceed as if there are six non-US partners and gives additional time for the Can-Aus Consortium to resolve its financial problems. However, the $ 44.9 M target is still well below the *Long Range Plan* (LRP) budget target, this means efforts to increase the budget must continue if all LRP program goals are to be achieved.

Core Repositories

In early 1992, the Executive Committee (EXCOM) endorsed the recommendations of the Dorman sub-committee identifying core repositories as an element of ODP that could be operated by the non-US partners. The goal was to achieve greater international participation in ODP during the 1993-1998 phase. After a few false starts, letters of interest were acquired from those partners and institutions wishing to operate an Atlantic core repository. These letters covered both the curation of new and old Atlantic cores.

In June EXCOM decided to establish an ODP repository at the University of Bremen once technical and financial details were worked out. At the August 1993 Planning Committee (PCOM) meeting there was strong support for establishing a repository at Bremen for housing new Atlantic cores, but there was little support for moving old cores. PCOM passed the following motion:

In light of the June 1993 EXCOM decision, re: moving the East Coast Repository (ECR), and after consultation with relevant constituent geologic communities and extensive discussion, PCOM endorses:

- **internationalization of ODP**
- **establishment of a new European repository at the University of Bremen, when space becomes available and programmatic details are resolved.**

However, given present advice from the JOIDES Advisory Structure, PCOM cannot endorse moving existing cores from LDEO if any chance remains of damage to those cores during transit to Europe. Before making a final recommendation, PCOM awaits the study of technical and financial aspects of moving the existing ECR cores safely, at present being carried out by ODP-TAMU.

PCOM also added the following consensus:

If an ODP repository is established in Bremen , PCOM recommends to JOI that Atlantic cores, from Leg 151 and following, be sent to this repository.

As of October 1, this issue is still under negotiation, in spite of the fact that new Atlantic cores are being rapidly produced...... "the devil that kills many a good intention is in the details".

Long-Range Planning

Long range planning was another item that PCOM addressed at its August 1993 meeting. There are two parts to this item. The first deals with focusing drilling objectives in the time period 1995-98 and the second with defining a program in the post 1998 period.

In the 1995-98 time period, the program should focus on targets-where drilling with the current technology can clearly resolve important earth science questions (***please note the call-for-proposals notice on the facing page***). One should do this with the concept in mind that no drilling beyond 1998 is assured, and that excellent results are the best basis for continuing the program. The thematic panels are revising their "White Papers" to include such high-priority targets and these will be an important component of the PCOM discussion in 1994.

For post-1998 planning there are two issues; the scientific goals and platforms to achieve these goals. Scientific reasons for deep drilling have always existed but really deep drilling has not been a feature of ODP, at least in part because scientific pressure on the drillship time for thematic and geographic reasons did not support multiple back-to-back legs on one hole. With multiple platforms of varying capability this option becomes viable if one of the platforms is capable of deep drilling with a riser. The Japanese have plans for such a deep-drilling vessel and discussion with JOIDES on the use of this vessel will be a major element of 1994 planning for a post-1998 program.

JOIDES Committee Reports

EXECUTIVE COMMITTEE (EXCOM)

COLLEGE STATION, TEXAS, JUNE 22 - 23, 1993

The June meeting of EXCOM was held June 23, 1993 at the Ocean Drilling Program facility on the campus of Texas A & M University, College Station, Texas. The following is a brief summary of the main items of business covered at the meeting.

LONG-RANGE PLANNING

PCOM's Long-Range Planning Efforts

EXCOM endorsed, with a motion, the PCOM consensus (PCOM 1993A-2) regarding long range planning and requested that PCOM present EXCOM with a status report on science planning and platform requirements at EXCOM's January 1994 meeting.

Japanese Proposal for the "New Era of Ocean Drilling"

In the second part of the long-range planning motion, EXCOM:

A. recognized the importance of the "New Era of Ocean Drilling" concept for the future of scientific ocean drilling,

B. recognized the need for close exchange/cooperation,

C. proposed to hold a workshop jointly with STA/JAMSTEC immediately following the next EXCOM meeting to investigate future modes of scientific ocean drilling with emphasis on cooperation.

It was suggested that, in addition to EXCOM, representatives from the JOIDES advisory structure, TAMU and LDEO be invited to attend this workshop.

ADVISORY STRUCTURE REVIEW COMMITTEE FINAL REPORT

EXCOM passed a motion to accept the Report of the Advisory Structure Review Committee (ASRC) and thanked the committee members and its Chair, Hans Dürbaum, for a most thorough and focused report.

Regarding the implementation of the ASRC, the following statements were adopted by consensus:

- EXCOM requested that PCOM examine each of the 12 subjects identified in the report and, where desirable, to implement immediately the recommendations.
- EXCOM recognized the need for discussion on some of the issues and, in those cases where PCOM had significant concern about specific ASRC recommendations, EXCOM requested PCOM review and evaluate the recommendations and prepare specific alternative motions for EXCOM's consideration at the January meeting.
- EXCOM requested the Chair of EXCOM to review these motions with the ASRC Chair and to present a summary at the next EXCOM meeting.

It was the wish of EXCOM to take final action on the recommendations of the ASRC and on PCOM's alternatives at its January meeting.

CORE REPOSITORY

EXCOM passed a motion requesting JOI advise TAMU to:

1. Definitize procedures for moving cores, with advice from PCOM and the panels.
2. Visit and enter negotiations with Universität Bremen regarding technical and financial aspects of establishing the ODP Atlantic repository in Bremen.
3. If technical and fiscal aspects of an ODP repository at Bremen are satisfactory, to contract for such services with Universität Bremen and conclude plans for core movement.
4. If discussions with Bremen did not conclude satisfactorily, accept the offer of LDEO.

APPROVALS AND POLICY UPDATES

FY94 Program Plan

EXCOM endorsed the FY94 Program Plan with a motion, but noted that the DCS test scheduled for FY94 may need to be postponed to 1995 for budgetary reasons.

Procedures for Contract Development, Specification and Review

EXCOM passed a motion stating that all ODP contracts let by JOI Inc. and its subcontractors should fully reflect the advice of the JOIDES Advisory Structure, particularly those that involve important new ODP program directions. To ensure that the interests of the JOIDES Advisory Structure are fully represented, the PCOM Chair, and as appropriate the EXCOM Chair, should be directly involved with JOI Inc. in the development of contracts that are determined (by JOI Inc.) to require Advisory Structure input. In those cases where RFPs are issued, PCOM Chair (and as appropriate the EXCOM Chair) should advise JOI Inc. on the specification of the RFP, on the proposal review process and the nomination of proposal reviewers.

The committee/panel reports in the *JOIDES Journal* are extracted from the minutes of the committee/panel meeting. Complete copies of the EXCOM, PCOM and other JOIDES panel minutes are available from the JOIDES Office. You can request them directly or obtain electronic versions via anonymous ftp on moby2.ocean.washington.edu (IP Number 128.95.252.41) (login: anonymous, password: your username, subdirectory: pub/JOIDES/Minutes).

PLANNING COMMITTEE (PCOM)

BRISBANE, AUSTRALIA, AUGUST 10 - 13, 1993

FY95 PROSPECTUS ACTION

At their August meeting in Brisbane, the JOIDES Planning Committee selected twelve proposals for an FY95 Prospectus for drilling. These proposals, shown on the map on the cover and on page 32 in the *Proposal News* section, were selected on the basis of panel priority, scientific maturity, site survey readiness and location. PCOM Watchdogs were assigned as follows:

Number	Proposal	PCOM Watchdog
300-Rev	Return to Site 735B	C. Mével
NARM-DPG	NARM Volcanic II (East Greenland)	Kiyoshi Suyehiro
SR-Rev2	Sedimented Ridges II	K. Becker
NAAG-DPG	NAAG II	Will Sager
(386/422) 386-Add	California Margin	Wolf Berger
423 /-Add	Gas Hydrates	J. Austin
391-Rev 2	Mediterranean Sapropels	Alan Mix
380-Rev 3	VICAP/MAP	R. Arculus
323-Rev 3	Alboran Sea	Brian Taylor
NARM-DPG	NARM Non-Volcanic II (Iberia)	John Mutter
346-Rev 4	E. Equatorial Atlantic Transform	Jeff Fox
330-Rev/ -Add3	Mediterranean Ridges I (shallow holes)	Rob Kidd

Logging Prospectus

PCOM tasked DMP with preparing a logging prospectus, based on ODP-LDEO recommendations, to complement the FY95 Prospectus for presentation to PCOM in December.

Alboran Safety Review

Since it was selected to be in the FY95 Prospectus, PCOM requested that PPSP re-prereview the proposed sites in the revised Alboran proposal at the October 1993 PPSP meeting. This would ensure that PCOM received PPSP's recommendations prior to the PCOM Annual Meeting in December.

Status of NAAG and NARM

To review the status of the DPG programs, PCOM requested that OHP present a review on the status of the NAAG program and TECP present a review on the status of the NARM-Non Volcanic program at the PCOM Annual Meeting in December.

EUROPEAN CORE REPOSITORY

Regarding the establishment of a European Core Repository, PCOM passed the following motion:

In light of the June 1993 EXCOM decision, re: moving the ECR, and after consultation with relevant constituent geologic communities and extensive discussion, PCOM endorses:

- **internationalization of ODP**
- **establishment of a new European repository at the University of Bremen, when space becomes available and programmatic details are resolved.**

However, given present advice from the JOIDES Advisory Structure, PCOM cannot endorse moving existing cores from LDEO if any chance remains of damage to those cores during transit to Europe. Before making a final recommendation, PCOM awaits the study of technical and financial aspects of moving the existing ECR cores safely, at present being carried out by ODP-TAMU.

PCOM added the following consensus statement:

If an ODP repository is established in Bremen, PCOM recommends to JOI that Atlantic cores, from Leg 151 and following, be sent to this repository.

As of October 1, PCOM is still reviewing the ODP-TAMU study of the technical and financial aspects of moving the cores from the ECR to Bremen.

ADVISORY STRUCTURE REVIEW COMMITTEE (ASRC) REPORT

EXCOM requested that PCOM examine each of the 12 subjects identified in the ASRC Report and, where desirable, to implement immediately the recommendations. After careful consideration of the ASRC Report, PCOM endorsed the ASRC proposals numbered 1, 2, 3, 6, 9 and 11 and recommended that EXCOM adopt these proposals.

EXCOM recognized the need for discussion on some of the issues and, in those cases where PCOM had significant concern about specific ASRC recommendations, EXCOM requested PCOM review and evaluate the recommendations and prepare specific alternative motions for EXCOM's consideration at the January EXCOM meeting. PCOM made the following recommendations to EXCOM regarding the remaining ASRC Report proposals.

ASRC Proposal 4

PCOM considers that the intent of ASRC Proposal 4 may be met best by modifying the existing system, rather than replacing it.

PCOM refers the issue of more rigorous proposal review to thematic panels and PANCH for comment. PCOM will consider revised guidelines for proposal review at its December 1993 Meeting. PCOM encourages all panels to be frank in their reviews, particularly if it is unlikely that a proposal will ever get drilled.

To prepare operational options for consideration at PCOM's annual (Dec) meeting, PCOM Chair will convene a one-day meeting of thematic-panel, SSP, PPSP and DMP chairs together with one representative each from TAMU & LDEO.

ASRC Proposal 5

PCOM accepts the ASRC's assertions on the important roles of SSP and PPSP in the assessment and augmentation of proposals for drilling but does not accept the Review Panel's recommendations for changes to the operations of the Panels.

New procedures to cope with early identification of highly-ranked proposals with possible safety issues have been approved by PCOM and are now in place between the two Panels.

PCOM sees major disadvantages in reducing either the size or frequency of meetings for SSP and believes it important that the task of helping proponents augment their survey packages remain with SSP "watchdog" specialists, rather than pass this role to JOIDES Office staff.

ASRC Proposal 7

Continue the RFP process every two years, alternating between the US and a non-US partner. Each non-US partner may submit only one bid to JOI Inc. for consideration. To gain experience, the PCOM-chair-elect should attend PCOM for a period of at least one year prior to his/her tenure.

ASRC Proposal 8

1. PCOM appreciates the comments of ASRC regarding the balance between long-range planning versus operational details. PCOM notes that long-range goals are defined by thematic White Papers and that actual legs ultimately stem from proposals from the scientific community. PCOM shall take strong interest in helping thematic panels in producing White Papers for 1995- 1998 and 1998 - 2003. PCOM takes the point that global problems require global drilling, and that the pursuit of global goals may not emerge automatically from proposal-driven programs.
2. PCOM agrees that information conveyed by liaisons and watchdogs may be less comprehensive than that received through panel chairs. PCOM recommends, therefore, that panel chairs routinely present proposals for scheduling at the annual PCOM meetings and answer questions regarding scientific and technical details, assisted by PCOM watchdogs. The liaisons and watchdogs should play a more proactive role, including contacting proponents of relevant projects. As in the past, PCOM members and panel chairs who are proponents cannot present their drilling program to PCOM.

ASRC Proposal 10

PCOM acknowledges and applauds the continuing and growing role of TEDCOM in helping the JOIDES Advisory Structure evaluate major engineering development programs like DCS and retractable-bit technologies.

In reference to ASRC's proposal 10 and in recognition of the continuing importance of such engineering development to both the present and future of ODP, PCOM recommends to EXCOM the following:

- that an external group designated to review the role of engineering development within ODP is not necessary at this time,
- that TEDCOM be augmented as follows:
    - by selection of new panel members from the academic ranks of engineering, to ensure that TEDCOM can give ODP the time required for effective input to ODP-TAMU and JOIDES on new and ongoing engineering development projects. These members should be nominated by PCOM in consultation with the existing members of TEDCOM and the ODP-TAMU engineering staff. However, PCOM does not advise that TEDCOM become much larger than its current complement of 16 members.
    - by appointment of the next Chair following a search among ODP partner nations for a slate of willing nominees representing the highest standards of engineering. The successful candidate should ideally have both academic and industrial background, but above all have both the dedication and the time to devote to ODP.

ASRC Proposal 12

PCOM will encourage panels and committees to delegate more work to members, subcommittees and Ad hoc bodies as appropriate.

PCOM recommends that no additional responsibilities be placed on the JOIDES Office without a suitable increase in resources. PCOM notes that the JOIDES Office had instituted or will be instituting a number of the suggestions of the ASRC such as, continuing development of proposal guidelines, providing a compendium of active proposal abstracts to all JOIDES Panel Members and the maintenance of a data base of proposals including proposal status, rating, and reviews.

To ensure that proposals falling outside Thematic Panel mandate receive due consideration, the JOIDES Office will flag proposals for possible review by PCOM.

For a copy of the ASRC Report, contact the JOIDES Office or obtain a copy from the anonymous ftp site.

THEMATIC PANEL WHITE PAPERS

After review of the process of White Paper revisions, PCOM requested that thematic panels, at their next meetings:

1. concentrate on sections identifying succinctly major results to-date and how they relate to stated thematic objectives
2. prioritize major themes for drilling utilizing realistic time estimates in the two periods FY1995-1998 and FY1999-2003
3. address the technology required to accomplish these scientific programs, including the requirements for platforms after 1998.

Concerns specific to each white paper will be conveyed to the panels by PCOM liaisons. The PCOM Subcommittee on White Papers will report back to PCOM in December, after the Fall thematic panel meetings, with their thoughts on the future development of the White Papers.

FY94 Program Plan Actions

Leg 157 (DCS Engineering Leg) Siting

PCOM decided that it would revisit the issue of candidate sites for DCS testing at the PCOM Annual Meeting in December. PCOM also decided to consider the issue of siting a HRB prior to the Leg 157 DCS test at the PCOM Annual Meeting in December.

Leg 158 (TAG) Scheduling

PCOM agreed that it would not move TAG from Leg 158. If DCS land testing was not successful, PCOM will find another program from among the FY95 Prospectus proposals to fill the Leg 157 slot and keep TAG as Leg 158.

Computer RFP

PCOM was in support of ODP-TAMU continuing its negotiations with the bidders for the ODP computer/database upgrade.

PCOM Endorsement of DMP Recommendation 93-3

PCOM endorsed the DMP recommendation for the formation of a group of self-supported experts, headed by Joris Gieskes, that will provide DMP and PCOM with documentation as to the feasibility and costs associated with the development and deployment of a fluid-sampling system.

Lithosphere Panel (LITHP)

LITHP Seeks Comments and Suggestions on Draft Revision of the LITHP White Paper

The Lithosphere Panel of the Ocean Drilling Program is rewriting the White Paper which defines the interests and goals of the lithospheric component of the Ocean Drilling Program. We are trying to develop a document which not only reviews important earth science problems which can be addressed using the drillship, but which also defines a list of high priority objectives which can realistically be achieved in the next phase of ocean drilling, through 2003. To that end, we would greatly appreciate any comments you have on this draft. Those comments can include suggestions for problems we have overlooked, problems we have given too little (or too great) an emphasis too, or bewilderment at our idea of priorities! We are writing the document from the point of view of scientific problems, rather than that of specific areas. Note also, that the priorities we have listed for 1993-1998 and 1998-2003 already constitute something like 1.5 times the amount of drilling that we can reasonably expect.

The document has two parts:

Part 1 reviews the goals of the panel, progress to date in reaching those goals, and a suggestions for specific goals to be accomplished by 2003.

Part 2 includes a more general review of scientific problems that can be addressed by scientific ocean drilling.

Any and all comments on this document are appreciated. Comments, additions, or corrections can be sent to Sherman Bloomer, either by mail or e- mail.

Copies of the White Paper are available from the JOIDES Office or from Sherman Bloomer, Chair of the Lithosphere Panel (Dept. of Earth Sciences, 675 Commonwealth Ave., Boston University, Boston, MA 02215; bloomer@crsa.bu.edu). The text of the White Paper can also be retrieved electronically via FTP. For those of you retrieving this document by e-mail the paper is broken into several pieces:

intro	background on the panel and goals
progress	significant drilling achievements to date
goals	high priority goals to 2003
ridges	problems concerning oceanic ridges
lips	problems concerning large igneous provinces
subduct	problems at convergent margins
Table 1	summary of objectives
Table 2	important results

The tables are in RTF format, as they are impossible to format correctly in ASCII. To access the files :

> ftp **crsa.bu.edu**
Name: **anonymous**
Password: **type in your e-mail address**
ftp> **cd pub/odp**
ftp> **binary**
ftp> **get lithp.tar.Z**
ftp> **quit**

While you're in crsa there is a readme file which can be examined using:

ftp> **get README |more**
(no space between | and more)

Once the file is transferred, to uncompress it:

> **zcat lithp.tar.Z | tar -xvf -**

this should make a directory odp and put seven or so files in the directory.

SHIPBOARD MEASUREMENTS PANEL (SMP)

Notice to Users of GRAPE Data

from Kate Moran, SMP Chair

The JOIDES Shipboard Measurements Panel (SMP) was contacted by one of the co- chiefs from Leg 138 and several members of the Leg 138 science party regarding the reliability of the gamma ray attenuation porosity evaluator (GRAPE) which is part of the multi-sensor track (MST). The scientists on Leg 138 suspected that the GRAPE was calculating a bulk density that was up to 10% too high. The offset between the discrete measurements and the GRAPE density was highest in high porosity materials.

Three potential problems were identified and evaluated: (1) the attenuation coefficient for the original Barium source may not have been changed to the appropriate Cesium coefficient when the source was changed at the beginning of ODP; (2) appropriate calibration calculations may not have been included in the software; and (3) a correction for pore water was not included in the software as recommended by Boyce (1976). It was determined that (1) and (2) did not occur and therefore did not cause the Leg 138 offset. The third possible problem was evaluated by running a distilled water standard through the GRAPE, measuring the maximum number of counts and calculating the bulk density, assuming the Boyce (1976) correction was not applied in the software. The resulting calculated bulk density for water was 1.1 Mg/m^3, the same value that was automatically output by the MST software. This bulk density is 10% higher than the actual density of distilled water. The Boyce (1976) equation was then applied using this GRAPE- measured density and the resulting corrected bulk density was 1.0 Mg/m^3. The applicability of the Boyce correction to low porosity materials was checked by applying the correction equation to the Aluminum standard. This resulted in a small change in bulk density (<0.5 %). Based on these tests, it was concluded that the Boyce correction was not included in the MST software and that this was the likely cause of the 10% error in bulk density for the high porosity sediment recovered during Leg 138. This was subsequently confirmed by the author of the software.

Consequently, all ODP GRAPE from Legs 101 to 152 must be corrected to account for this error.

Recommended Correction for GRAPE Bulk Density

The Compton mass attenuation coefficient can be assumed as a constant for most of the common minerals found in marine sediment and rock samples. One exception to this assumption is water, containing hydrogen (atomic number of 1). The Compton mass attenuation coefficient of water is approximately 10 percent different than that of common minerals. Most marine sediment are a two-component system of minerals and water. Consequently, a correction must be applied to marine sediment to account for this difference in mass attenuation coefficients in the two components. Boyce (1976) developed a correction for the GRAPE bulk density determination which accounts for the lower Compton mass attenuation coefficient of water. The equation is as follows:

$$\rho = \frac{(\rho_{bc} - \rho_{fc})(\rho_g - \rho_f)}{(\rho_{gc} - \rho_{fc})} + \rho_f$$

where:

ρ = true bulk density

ρ_{bc} = bulk density calculated from gamma counts assuming a mass attenuation coefficient for quartz

ρ_f = true fluid density

ρ_{fc} = fluid density calculated from gamma counts assuming a mass attenuation coefficient for quartz

ρ_g = true grain density

ρ_{gc} = grain density calculated from gamma counts assuming a mass attenuation coefficient for quartz

and have values as follows:

ρ_f = 1.024 Mg/m^3, ρ_{fc} = 1.128 Mg/m^3, ρ_g = 2.65 Mg/m^3, ρ_{gc} = 2.65 Mg/m^3 (assuming an attenuation coefficient for quartz).

References

Boyce R.E., 1976, *Initial Reports of the Deep Sea Drilling Project*, Volume 33. Definitions and laboratory techniques of compressional sound velocity parameters and wet water content, wet bulk density, and porosity parameters by gravimetric and gamma ray attenuation techniques, p. 931-951.

Lloyd, J. and Moran, K. (1992) ODP GRAPE evaluation; a report to the JOIDES Shipboard Measurements Panel **(available from the JOIDES Office as Attachment 3 to the SMP Minutes, Meeting 9)**

Wireline Services Report Leg 146

Wireline Logging on Cascadia Margin

Dr. Richard Jarrard **LDEO Logging Scientist**

Reports presented in the JOIDES Journal *are summaries. Complete reports are available from the Borehole Research Group, LDEO, Palisades, NY 10964 Internet: borehole@ldeo.columbia.edu*

Introduction

ODP Leg 146 examined the complex interplay of fluid flux and structural evolution that occurs at accretionary prisms. By drilling two locations each on the Vancouver and Oregon accretionary prisms, as well as a reference hole seaward of Vancouver prism, this leg achieved its two objectives. First, characterize and compare two end-member prism-dewatering regimes: diffuse fluid flow (Vancouver margin) vs. channelized flow (Oregon margin). Second, test models for the origin of bottom simulating reflectors (BSRs) and their relationship to methane hydrates. Downhole measurements were crucial for attaining these objectives. Many types of downhole measurements were employed on Leg 146 (e.g., ADARA and WSTP temperatures, drillstring packer, CORK, LAST II, and oblique seismic experiment); this report focusses only on Schlumberger logging measurements (standard logging and vertical seismic profile [VSP]) analyzed by the five shipboard logging scientists.

Figure 1, which shows some logs from reference Site 888, illustrates several features of Leg 146 logging:

- Sediments drilled on Leg 146 were mostly silty clay to sand. Here the gamma-ray log has been transformed into a continuous record of sand/clayey-silt variations, independent of core recovery problems.
- The close correspondence seen here between hole size and sand percentage is symptomatic of a problem that has frustrated most previous logging attempts on accretionary prisms: hole collapse in the sandier portions of hole degrades log quality, fills the bottoms of holes, and causes pipe sticking. Leg 146 was successful in logging all sites, because of a combination of several time-consuming techniques: washing holes for logging, using the side-entry sub, and alternating logging with hole conditioning.
- The neutron porosity log shown here is one of several porosity-sensitive logs used to determine changes in porosity with depth. Comparison of porosity/depth trends at reference and prism sites permits determination of the amount of intersite shortening-induced dewatering.
- The comparison of sonic (inverse of velocity) and porosity logs gives a transform from velocity to porosity. This transform can be applied to velocities determined from multichannel seismic data, in order to identify porosity changes along a seismic line.

At Site 888 (Figure 1) and most other shallow terrigenous-sediment locales, sands are higher-velocity and less porous than clay-rich sediments. In contrast, all sites on the Cascadia accretionary prism exhibit the opposite pattern (e.g., Figure 2): the gamma-ray log, a sand-shale indicator, shows that clay-rich sediments are higher in resistivity (i.e., lower in porosity) and higher in velocity than sandier units. Compression-induced differential compaction probably is the source of this pattern.

Log responses in the vicinity of the BSR at Sites 889 and 892 (Figure 2) illustrate the following scientific results:

- The exact depths of BSRs, as shown here on the logs, were determined by conversion between drilling depth and seismic time based on VSPs. The negative-polarity of the BSR implies a downhole decrease in velocity, density, or both at the BSR. This decrease has been hypothesized to result from high-velocity methane hydrates just above the BSR or low-velocity free gas just below the BSR.

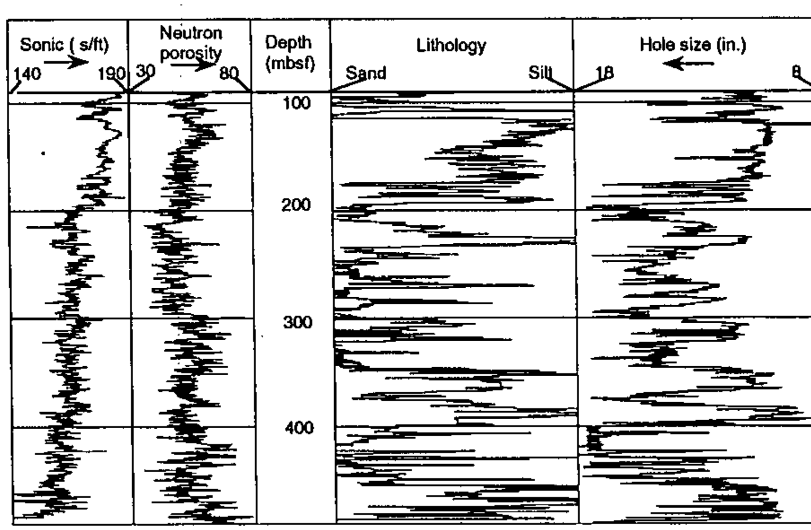

Figure 1. Several logs from reference Site 888, seaward of Vancouver accretionary prism.

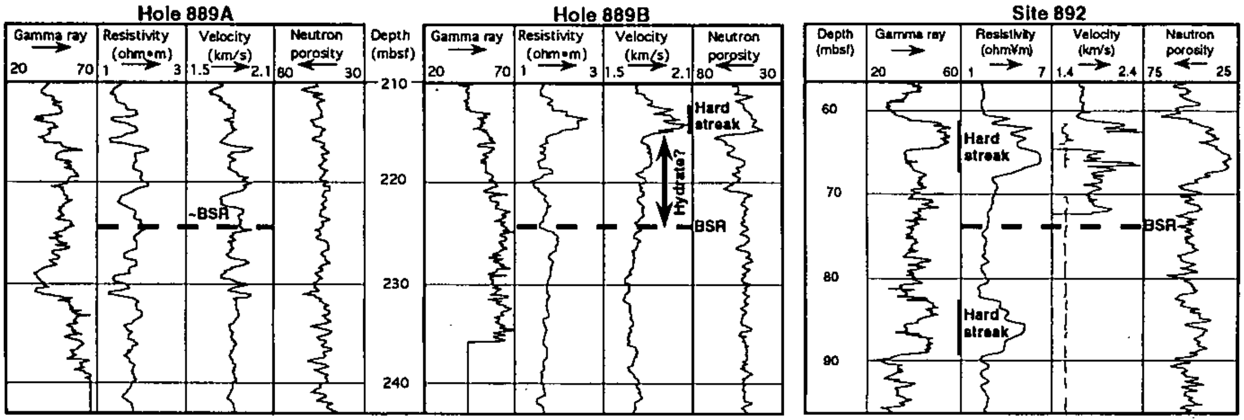

Figure 2. Log responses in the vicinity of the bottom simulating reflector (BSR) at Holes 889A and B and at Site 892.

- At Site 892, log velocities near and below the BSR are 1.5 km/s, the velocity of water; this pattern indicates that formation velocities are even slower than the compressional wave within the borehole water. Only free gas can lower formation velocities so dramatically. VSP-based formation velocities beneath the BSRs at Sites 889 and 892 are only 1.2-1.5 km/s, confirming that free gas causes these BSRs. This free gas could not be detected in the velocity logs from Holes 889A & B, because fluid pumping during drilling displaced pore fluids and pore gas away from the vicinity of the drillhole.
- Are the high-velocity, high-resistivity intervals at these sites massive hydrates? The neutron logs show that they are low-porosity "hard streaks", not hydrates; they exhibit low neutron porosity, whereas hydrate pore-filling causes high neutron porosity. Log responses indicate that massive hydrates are absent.
- The hard streaks at Site 892 are thought to have formed by strain hardening. They cap thin zones of channelized fluid flow, based on temperature measurements.
- The only hydrate detected by the logs is an 8-m thick interval at Hole 889B, where velocity is higher than would be expected based on resistivity and neutron logs, and where core-temperature measurements also indicate hydrate. The few percent hydrate here produces no velocity contrast at the BSR. Thus, hydrates cannot account for the BSR at these sites.

H_2S Hazard on ODP Leg 146

On ODP Leg 146 extremely high concentrations of hydrogen sulfide (H_2S) were encountered in cores acquired from the top 17 m of the sedimentary section at Site 892, in 674 m water depth off the coast of Oregon. The amount of H_2S given off by these cores on the deck of the drillship was sufficient to create a safety hazard and, if improperly handled, they could have administered a lethal dose. The purpose of this note is to warn the scientific community of the dangers in handling this naturally-occurring material.

The cores were several orders of magnitude richer in H_2S than any previously recovered by DSDP/ODP in 25 years of scientific ocean drilling. Gas hydrates were recovered from the same interval and it is possible that the H_2S may have been stored in a hydrate structure. The cores were split and allowed to degas in the open air before being taken into the ship's laboratory. ODP technical staff handling the cores wore breathing apparatus and used hand-held H_2S detector instruments. Key personnel on the drillship are regularly trained in he hazards of H_2S, which is commonly encountered in oil and gas drilling.

Other investigators may try to recover samples of this unique material in the future. Although the sea bed at Site 892 was sufficiently hard to require rotary coring with the Extended Core Barrel (XCB), it is possible that samples could be obtained by gravity corer, grab or dredge from much smaller vessel than the drillship. Training in the dangers of H_2S is strongly recommended before attempting such sampling. Breathing apparatus and H_2S detectors should be available on the ship before samples are brought on board.

During the course of ODP's operations at Site 892 there were also indications of high H_2S concentration in the water column immediately above the sea floor. The evidence for this was that detectable quantities of H_2S were given off by the TV camera frame for several minutes after its recovery to the deck of the drillship. It is not possible to translate these readings into specific concentrations of H_2S in the water column. But if these concentrations are present all the time and were not just a temporary disturbance due to the drilling operations, they could be sufficient to cause embrittlement and failure of the high-strength steel pressure vessels of submersibles and ROVs.

For further information, please refer to the Leg 146 *Initial Reports* volume which will be published about October 1993.. .... T.J.G. Francis, R. E. Olivas Ocean Drilling Program, Texas A & M University

Science Operator Report Leg 148

RETURN TO HOLE 504B

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Reports presented in the JOIDES Journal *are summaries. Complete* Preliminary Reports *are available from ODP, Texas A & M University, 1000 Discovery Drive, College Station, TX 77845-9547*

ABSTRACT

During Leg 148 of the Ocean Drilling Program, JOIDES Resolution deepened Hole 504B, already the deepest hole ever drilled into oceanic crust, to a total depth of 2111.0 m below the seafloor (mbsf). Located in 5.9-m.y.-old crust, Hole 504B represented the best opportunity for studying the transition between the sheeted dike complex and the underlying gabbros and its relationship to the seismic Layer 2/Layer 3 boundary. The newly drilled section is a continuation of the variably altered massive diabases that compose the sheeted dike complex drilled by previous legs. Sonic velocities logged in the sheeted dikes are in the upper range for seismic Layer 2, but the velocity recorded (6.8 km/s) in the lowermost 100 m of the hole is more typical of Layer 3. Deeper penetration was prevented because the drill string became stuck when a fault was encountered. Although the string was eventually freed, the equipment necessary to clean the hole was not on board, and coring was halted to avoid jeopardizing the hole. A partly milled drill bit and rubble remain at the bottom of the hole, which could be cleaned on a future leg.

Hole 896A, drilled into a basement topographic high and a heat-flow maximum, was a contingency hole drilled while awaiting the arrival of fishing equipment for Hole 504B. Massive basalt, pillow lavas, breccias, and two dikes were noted in the cores recovered. Lithological differences between the two sites include more abundant breccias and massive units in Hole 896A vs. a greater proportion of pillow units in Hole 504B. No detailed lithologic correlations yet exist between the two holes. The greater abundance of recovered breccias from Hole 896A, the thicker and more abundant smectite and carbonate veins in the upper half of Hole 896A, the lack of flow of bottom seawater down into Hole 896A (compared to the occurrence of such flow into Hole 504B in the past), all suggest that, although still permeable, the Site 896 section is more extensively sealed than at Site 504. This effect may be related to location of the site on a heat-flow maximum.

INTRODUCTION

Results from Leg 148 suggest that Hole 504B has now penetrated into the transition to Layer 3, but actual penetration into Layer 3 was stopped when drilling encountered a fault. Intriguing questions regarding exactly what kind of material makes up the fault zone and, more particularly, what lies on the other side of the fault at present remain unanswered.

Site 504 (Figure 1) is located 201 km south of the Costa Rica Rift, the easternmost arm of the Galapagos Spreading Center, in 5.9-m.y.-old crust. Hole 504B was spudded in October 1979 during DSDP Leg 69. Hole 504B was subsequently deepened and/or logged during parts of six other legs, including Leg 70 (1979), Leg 83 (1981-82), Leg 92 (1983), Leg 111 (1986), Leg 137 (1991), and Leg 140 (1992), as shown in Figure 2.

At the end of Leg 140, Hole 504B extended through 274.5 m of sediment and 1725.9 m into basement. The Hole 504B basement section consisted of 571.5 m of pillow lavas and minor flows, underlain by a 209-m transition zone of mixed pillow lavas, thin flows and dikes, and 945.4 m of sheeted dikes and massive units. Results from recent drilling in Hole 504B during Leg 140 near the end of 1991 plus seismic evidence suggested that at that time the bottom of the hole lay within the lower portion of the sheeted dike complex, close to the seismic Layer 2/Layer 3 boundary. Many believe that the Layer 2/Layer 3 transition coincides with the change downward from sheeted dikes to underlying gabbros as is observed in ophiolites, but this seismic transition may be a metamorphic boundary within gabbros or within the lower sheeted dikes. Although the transition from sheeted dikes to gabbros has been observed by submersible in tectonic exposures of both Atlantic and Pacific ocean crust, this transition has never been observed in-situ in undisturbed ocean crust, and its relation to the Layer 2/Layer 3 boundary remains unproven.

Site 896 was a contingency site initially occupied while awaiting the arrival of fishing tools for further work at Site 504. The first drilling objective at Site 896 was to examine local variability in volcanic stratigraphy, aerial extent of flows, and horizontal and vertical variations in igneous

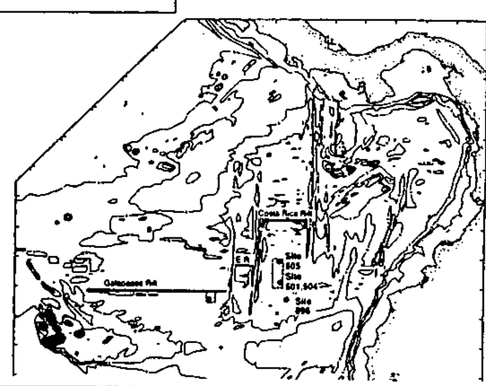

Figure 1. Location of DSDP/ODP Sites 501, 504, 505 and 896 south of the Costa Rica Rift in the eastern equatorial Pacific (from Hobart et al. 1985)

geochemistry. The second objective was to examine the effects of off-axis hydrothermal activity on the basement, relating the composition of upwelling fluids (determined on Leg 111 and from a Leg 111 site survey) in a high heat-flow area to alteration of basement rocks. Physical properties and hydrogeology of the site could also be examined to test models of off-axis convection. The third objective was to drill the second of a pair of deep basement sites. Hole 504B penetrates two possible faults (at about 800 mbsf in the lower volcanics and at 2111 mbsf in the lower dikes), whereas Site 896 is located on the inferred footwall, south of Hole 504B. Variations in alteration between uplifted and down-dropped basement and the possible role of the fault in alteration were examined, as well as the possible influence of the fault on volcanism and volcanic stratigraphy. The new site also provides the opportunity for future geophysical experiments between the paired Holes 896A and 504B.

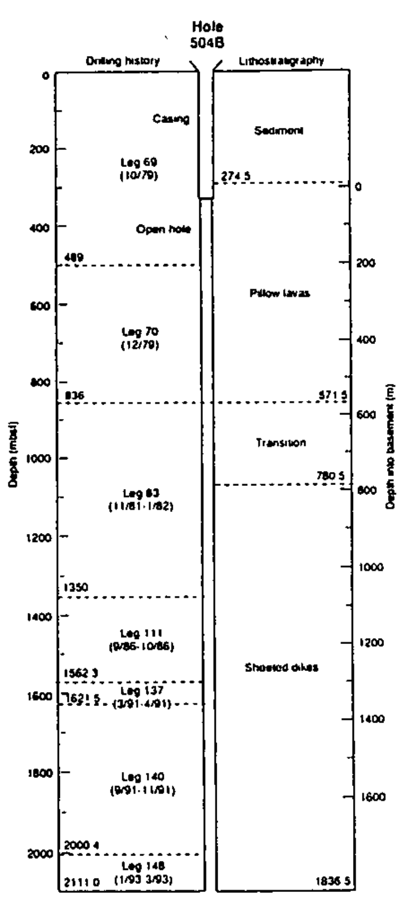

Figure 2. Generalized drilling history and lithostratigraphy of Hole 504B.

SITE 504

Site 504 is located at 1°13.611'N, 83°43.818'W, at a water depth of 3460 m. Upon reentering Hole 504B on 28 January 1993, temperatures were logged from seafloor to just above the total depth of the hole (2000.4 mbsf). The gradient through the cased section was close to the background value in the sediments, indicating that presently there is no downhole flow like that observed in the past. A slight dip in temperatures immediately below the bottom of casing is similar to that observed during Leg 140, indicating some hydrothermal activity in the uppermost basement. Deep in the hole, the gradient is generally linear and consistent with logs taken during Legs 137 and 140, and indicates a maximum temperature of about 180°C at the bottom of the hole.

Following temperature measurements, borehole waters were sampled on 28-29 January. Water was collected in 6 of 8 runs, at 560, 796, 1031, 1266, 1501, and 1970 mbsf. One sample (1501 mbsf) clearly displays chemical characteristics of seawater that has reacted with basalt at elevated temperatures, whereas the compositions of other samples are close to seawater. Following drilling operations, the hole was spiked with a NaBr tracer, so future water sampling can detect fluid movement from basement or overlying seawater into or out of the borehole.

Fifteen cores (148-504B-239R through -253R) were drilled from 30 January to 9 February, penetrating from 2000.4 to 2111.0 mbsf (110.6 m), for an average recovery of 10.4%. Twenty-five lithologic units were identified on Leg 148, for a total of 294 units in Hole 504B. The recovered rocks are massive diabases and are a continuation of the sheeted dike complex drilled on previous legs. Five chilled-dike contacts were found, and other units were identified by differences in mineralogy, grain size, and texture. All rocks are fine-grained, with average grain size ranging from 0.4 to 1.0 mm. Fourteen units are sparsely to moderately phyric plagioclase- olivine-pyroxene diabase; four units are sparsely to moderately phyric olivine-plagioclase - pyroxene diabase; three units are aphyric; and four units are sparsely phyric plagioclase-olivine diabase. A trace of chrome spinel is also present in about half the units. Intergranular material is primarily plagioclase and pyroxene, with opaque oxide minerals and olivine in small amounts. Titanomagnetite ranges from 0.02 mm up to 0.45 mm in size, and the larger grains contain exsolution lamellae of ilmenite. Plagioclase and pyroxene phenocrysts are generally 1.0-1.5 mm in diameter, but range up to 5 mm, and olivine phenocrysts are generally 1 mm in size. Coarse-grained glomerocrysts of plagioclase - clinopyroxene, olivine, magnetite, or spinel occur in many units, and some of these glomerocrysts have gabbroic textures.

Alteration of the rocks is heterogeneous. The diabases are affected by a pervasive slight to moderate background alteration (10%-40% recrystallized), with locally more intensively altered zones (40%-100% recrystallized) in centimeter- to decimeter-sized patches, and in centimeter-sized alteration halos around veins. Patches and halos make up a few percent of the recovered core. Actinolite (-magnetite) replaces interstitial material, and olivine is totally replaced by talc + magnetite, chlorite + quartz, and actinolite. Clinopyroxene is slightly to totally replaced by actinolitic amphiboles, whereas plagioclase is the least altered phase, and is partly replaced by secondary anorthite, chlorite, albite, actinolite, and rare epidote. Titanite(?) partly replaces igneous magnetite, but the ilmenite exsolution lamellae generally remain unaltered. Cr- spinel is partially altered to magnetite around the margins and along internal cracks.

Actinolite (-titanite) veins are the most common veins, and range from 0.05 to 3.0 mm in width. Dips of actinolite veins are variable, but maxima occur at 20°-25° and 85°-90°. Chlorite - actinolite forms thin (< 0.5 mm wide), mainly steeply dipping (75°-90°) veins. Single occurrences of chlorite + quartz + titanite, chlorite + quartz + pyrite, chlorite + laumontite, and epidote veins were also observed. There is an average of 21 veins per meter of recovered rock, and veins account for about 1.2 vol. % of the total recovered material. The abundance of alteration minerals continues depth trends noted during previous legs to Site 504, consistent with generally higher alteration temperatures in the lowermost 400 m of sheeted dikes.

Three oriented dike margins were recovered during Leg 148, and dip from 76° to 88°, similar to shallower dikes cored on previous legs. All diabase samples show well-preserved primary (igneous) characteristics, and no shape fabric or preferred orientation of grains related to crystal-plastic deformation were found. Observed structures include veins, microfaults, fractures, chilled margins and rare <1-mm-wide cataclastic zones. Vein orientations are similar to those recovered in shallower dikes, and are predominantly dike-parallel and dike-normal, the latter possibly shrinkage cracks that formed during cooling of the dikes. The morphology and the internal fabric of the veins suggest that they formed as extension fractures, possibly by the crack-seal mechanism. Subsequent compression of some veins is indicated by kinked actinolite and chlorite fibers. Shearing, possibly associated with formation of very fine-grained amphibole, appears to have affected some of the veins.

Magnetic measurements were made on 11 oriented minicores and were supplemented by measurements of natural remanent magnetization (NRM) and bulk susceptibility on 11 small unoriented samples. Magnetic susceptibilities average 0.018 - 0.013 SI units, similar to values for shallower dikes. The Leg 148 cores lack the steeply inclined drilling-induced remanence observed in shallower dikes. Instead, a relatively weak viscous component is observed, which is generally removed by AF demagnetization at 20 mT. As a result, natural remanent intensities (mean = 0.48 + 0.39 A/m) and Koenigsberger ratios (mean = 2.2) are lower, and mean destructive fields are higher, than those for shallower dikes. The saturation anhysteretic remanent magnetism is greater than the NRM, which suggests that the Leg 148 rocks may carry a chemical remanence rather than a thermal remanence. Measurements of anisotropy of magnetic susceptibility are consistent, despite low degrees of anisotropy. The observed fabric has a minimum axis which is horizontal and north, and a maximum axis which is horizontal and east (corrected using the stable remanence direction). This may be interpreted as horizontal, dike-parallel, flow at the dike margins and crystal settling at the dike center.

The wet bulk densities range narrowly from 2.88 to 3.05 g/cm^3, with most >2.90, and compressional wave velocities range from 5.4 to 6.0 km/s in response to slight variations in olivine abundance and alteration over the cored interval, consistent with values obtained for the immediately overlying dikes. The velocities are too low for rocks of this density, suggesting the opening of microcracks during decompression as the rocks were brought to the surface. Resistivities range from 80 to 250 ohm-m in response to changes in porosity (1%-5%) and alteration. The thermal-conductivity values range from 2.0 to 2.2 W/mK, within the limits observed throughout the overlying sheeted dikes.

Microfaults are common in Leg 148 cores, leading to an abundance of flat, platy-shaped fragments in the recovered cores. The microfaults are lineated and have steps, but are discontinuous and show no resolvable displacement in thin section. The microfaults are steeply dipping, and slickenlines suggest both dip-slip and strike-slip senses of movement. The penetration rate for the last core (148- 504B-253R) was very fast (7 m/hr), and after picking up the bit off bottom to retrieve the core, the drill string became stuck near the bottom of the hole. The high penetration rate for this core and the recovery of tabular rock pieces with microfaults and slickenlines in this core and most of the preceding cores indicate that drilling penetrated a fault.

Approximately 30 hr was spent in various efforts to free the string. When it became clear that we were making no progress in getting free, and in order to avoid damaging the drill string, it was backed off near the top of the bottom-hole assembly (BHA). Operations at Site 504 were discontinued to await arrival of fishing tools (fishing jars, mill bits), which took 9 days. After setting a reentry cone and coring at nearby Site 896, the fishing tools arrived on 20 February, and operations were continued in Hole 504B. The stuck drill string was freed using the fishing jars, and all of the string was recovered on deck except the drill bit, which had broken off and remained at the bottom of the hole. Mill bits were then run to grind up the drill bit and clean the hole.

The second mill run encountered rubble filling the hole up to 19 m above the lost drill bit, and after we pulled out of the hole we discovered that the fishing jars had broken, leaving the mill bit, various subs, and a drill collar in the hole. This material was actually stuck in the hole, but the junk was ultimately successfully fished out using an overshot and the fishing jars. Because of the scientific value of the hole, the high probability of getting stuck again, and the lack of any usable fishing jars, it was decided to log Hole 504B at this time rather than attempt cleaning the rubble and milling the lost drill bit without any means to free a stuck drill string. Four days were spent logging Hole 504B in two parts: the geophysical, FMS, and magnetometer logs were run over the entire length of basement, and two unsuccessful attempts at the VSP were made 25-27 February; the VSP was finally run successfully on 4 March.

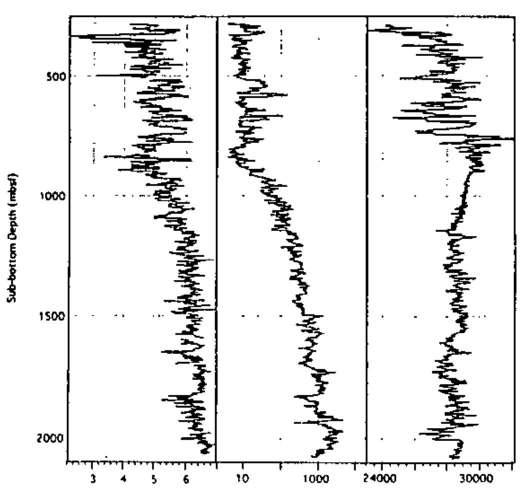

Figure 3. Hole 504B logging results.

The various logs give a consistent and clear picture of the Hole 504B basement section (Figure 3). Sonic velocities from the log generally fall between 4.5 and 5.5 km/s in the volcanic section and transition zone above 1100 mbsf, but are greater (6.0-6.5 km/s) in the dikes from 1200 to 1800 mbsf. Below this depth velocities drop slightly and then increase steadily to a value of 6.8 km/s at the lowermost depths measured (2060 mbsf). The velocities of the sheeted dikes fall in the upper range for seismic Layer 2, but the maximum velocity recorded (6.8 km/s) near the bottom of the hole is a typical Layer 3 velocity. Rocks recovered from this interval are fine-grained diabase dikes, suggesting the possibility that the transition to seismic Layer 3 may begin within sheeted dikes and may not necessarily correspond directly to the appearance of gabbros. For more information on the logging results on Leg 148 see the Wireline Services Report in this issue of the *JOIDES Journal*.

Results from Leg 148 suggest that Hole 504B has now penetrated into the transition to Layer 3, but actual penetration into Layer 3 was stopped when drilling encountered a fault. Intriguing questions regarding exactly what kind of material makes up the fault zone and, more particularly, what lies on the other side of the fault at present remain unanswered. A partly milled drill bit and some rubble lie at the bottom of the hole, but the hole can be cleaned on a future leg, given the proper equipment to stabilize the bottom of the hole and mill the remaining small amount of junk.

SITE 896

Site 896 is located 1 km southeast of Hole 504B at a water depth of 3439.8 m (1°13.006'N, 83°43.392'W). The site is situated on a bathymetric high overlying a basement topographic high. These coincide with a local heat-flow maximum where low-temperature hydrothermal fluids are upwelling through most of the 179-m sediment section, which was cored during Leg 111.

Site 896 was occupied 11-20 February while waiting for fishing tools to arrive for further work at Site 504, and then again 28 February to 4 March, and 6-7 March. Four days were devoted to setting a reentry cone and casing, 8 days for coring, and 3 days for logging.

Basement was first encountered in Hole 896A at 179 mbsf, where rubbly material was felt by the drill bit, and was cored from 195.1 to 469 mbsf (290 m into basement). Mainly pillow basalts and minor massive flows and breccias were recovered in 30 cores for an average recovery of 27.7% (73.68 m of rock). Igneous lithology and magnetic and physical properties suggest that the core can be divided into upper and lower sections.

Four types of volcanic units were identified: massive basalt, pillow lavas, breccias, and dikes. Massive units make up about 38% of the drilled section, and may be lava flows or possibly interiors of very large pillows. Two dikes, identified by steeply dipping (74w-78w) margins chilled against host rock, were identified in the material recovered. The dike margins are characterized by a lack of variolitic textures and exhibit a different series of quench crystallization textures than pillow margins. Pillow lavas make up approximately 57% of the drilled section.

Breccias make up 5% of the drilled section, and include several types: 1) Hyaloclastites formed on the seafloor by fragmentation of glassy pillow rims, and consist of clasts of volcanic glass in a matrix of smectite and altered glass. (2) A second type of breccia consists of millimeter- to centimeter-sized clasts of basalt - glass fragments, cemented by carbonate and/or smectite. Basalt clasts show evidence for alteration, oxidation, and vein development prior to cementation. Such breccias may have formed as talus at the base of a slope or within fissures in the basement. (3) The third type of breccia is characterized by a "jigsaw-puzzle" fabric where the various clasts can be fitted back together, and are cemented by carbonate and smectite matrix and veins. These breccias probably formed beneath the seafloor by fragmentation in the uppermost crust during extension.

The basalts are sparsely to highly phyric tholeiites. Fifty lithologic units were recognized, of which all but two are sparsely to highly phyric plagioclase-olivine basalts or olivine-plagioclase basalts, both commonly containing spinel. The two exceptions are moderately olivine-phyric basalts. The volcanic section can be divided into upper and lower sections: plagioclase-olivine phyric basalts make up 90% of the units in the upper basement (195.1-390.1 mbsf), whereas olivine-plagioclase phyric lavas make up 72% of the lower section (390.1-469 mbsf). Clinopyroxene is also present as a phenocryst phase from 353.1 to 392.1 mbsf. The basalts contain a variety of megacrysts and glomerocrysts, including plagioclase, plagioclase-olivine, plagioclase-clinopyroxene, and plagioclase- olivine-clinopyroxene.

Plagioclase phenocrysts range in size from less than 0.1 to more than 5 mm. Olivine phenocrysts range from less than 0.1 mm microphenocrysts to 5 mm megacrysts, and commonly contain inclusions of glass or spinel. Clinopyroxene phenocrysts range from less than 0.5 to 7 mm, and are partly resorbed. Spinel is a minor mineral, ranging in size from 10 to 200]m.

There are suggestions of cyclic variations in plagioclase and olivine phenocryst abundances through the core, and the overall abundance of phenocrysts appears to decrease up through the section. Such variations suggest cyclic and/or systematic changes in the magma chamber over the time that the basalts erupted. These changes can also be seen in the composition of the spinel as inferred from its color, in the type of glomerocrysts preserved in the lavas, and in the occurrence of clinopyroxene in some of the deeper units. All of these factors suggest derivation of basalts from increasingly higher temperature magmas upsection.

All of the rocks from Hole 896A are slightly (<10%) affected by low-temperature (<100°C) alteration except for pillow rims, where fresh glass is commonly present. A pervasive background (reducing) alteration is characterized by the gray color of the rocks, and by saponite and rare pyrite replacing olivine and filling pore spaces. Plagioclase is rarely slightly replaced by saponite. Oxidative alteration effects are characterized by dark gray to yellow and red alteration halos, up to 20 mm wide around smectite veins, and which are more common in the coarser grained massive lavas. The red and yellow colors are due to Fe-oxyhydroxides replacing olivine, filling interstitial space and staining the primary silicates.

Dark green and light green saponite are the most common veins in both pillow and massive lavas. Calcium carbonate, commonly aragonite, is present as a later phase following smectite. Analcite was observed in veins of several hand specimens, and one occurrence each of fibrous zeolite (possibly natrolite) and pyrite was observed. Most of the veins are less than 1 mm thick, but some range up to several millimeters in thickness, especially in the upper half of the core. Phillipsite is also present in the cement of the hyaloclastites, where it formed after saponite and before carbonate.

Two types of veins were characterized structurally: fibrous and nonfibrous. Veins filled with blocky carbonate and/or vermicular clay have characteristics suggesting growing of crystals into open spaces. The orientation of all nonfibrous veins are clearly nonrandom, with a tendency toward steeper dips. These veins are common in massive lavas, and may represent steeply dipping cooling joints. Fibrous veins are generally relatively late and formed after filling of cracks and voids by nonfibrous carbonate and clay. Extension occurred within the lava pile in virtually all directions, as indicated by complex vein geometry (especially fibrous veins). Textures of fibrous veins (and some breccias) indicate formation by the crack-seal mechanism, thus implying periods of relatively high fluid pore-pressures needed to cause hydraulic fracturing.

Magnetic properties suggest that Hole 896A can be divided into two sections. The boundary between the upper and lower sections at about 370 mbsf coincides with the top of a thick series of massive units.

In the upper part of the hole the intensity of natural remanence (J_o) is relatively high (11.9 - 4.0 A/m), the median destructive field (MDF) is high (22.6 - 12.9 mT), and the bulk susceptibility is high (0.015 - 0.008 SI units). Isothermal remanent magnetism (IRM) acquisition experiments indicate that the rocks generally saturate in fields less than 0.2 T, consistent with the carriers being very fine- grained single-domain (titano)magnetite and/or (titano)maghemite. These properties are common to both pillow and massive units. Stable inclinations in the upper part of the hole are consistent, with a mean value of -9.5a - 10.4a.

In the lower part of the hole, J_o is significantly lower (3.9 - 2.5 A/m), MDFs are lower (12.3 - 7.3 mT), and bulk susceptibilities are higher (0.033 - 0.014 SI units). Alternating-field demagnetization often isolates two components: a low-coercivity phase, probably carried by (titano)magnetite and/or (titano)maghemite, and a higher coercivity phase. The presence of a small proportion of high-coercivity material in these samples is also indicated by IRM acquisition experiments. Stable inclination data exhibit a high degree of variation, which may reflect large-scale disruption of the units cored in the lower part of the hole.

Anisotropy of magnetic susceptibility (AMS) measurements reveal weak (< 9%), dominantly prolate, magnetic fabrics. The maximum principal AMS axes are dominantly subhorizontal, toward 283a, but it is unlikely that this represents a flow fabric.

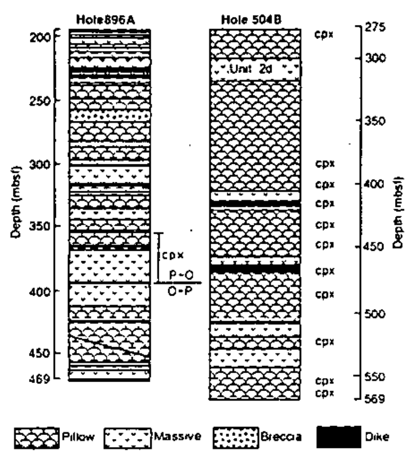

Figure 4. Lithostratigraphy of Holes 896A and 504B. 'Cpx' indicates the position of clinopyroxene phyric lavas. In Hole 896A, 'P-O' indicates the dominance of plagioclase-olivine phyric, and 'O-P' indicates the dominance of olivine-plagioclase phyric, lavas. 504B lithologies modified from Adamson (1985)

The physical properties of most of the samples from Hole 896A are typical of moderately altered basalt: bulk densities range for the most part between 2.80 and 2.95 g/cm^3; the porosities are moderately high (2%-10%); resistivities are low, ranging between 40 and 250 ohm-m; velocities are fairly low, ranging largely from 5.5 to 6.0 km/s; and thermal conductivities range between 1.6 and 1.8 W/mK. The unusual recovery of glassy pillow margins, interpillow hyaloclastic breccias, and flow breccias cemented by clays and calcite suggests that the crust at Site 896 is at least partially sealed by alteration products. While these materials have very low densities (2.2-2.7 g/cm^3), velocities (3.6-4.7 km/s), and resistivities (10-20 ohm-m), they are much higher than those of seawater (1.035 g/cm^3; 1.5 km/s; 0.2 ohm-m at room temperature) and will strongly affect the overall properties of the formation, causing V_p, density, and resistivity to rise; porosity to decrease; and heat flow to approach conductive values. There is a marked increase in scatter in V_p and thermal conductivity below 350 mbsf, which we attribute to increasingly variable alteration with depth.

Prior to the last bit run and following eight days of fishing and logging in Hole 504B, which allowed the borehole temperatures to recover from drilling somewhat, a combined temperature and geochemical log was run in Hole 896A . The measured temperature profile suggests a conductive heat flow of 275 mW/m2, and a temperature of about 50°C at the basement/sediment interface. These values are consistent with detailed surface heat flow measurements and modeling of off-axis convection in the region, and are not indicative of downhole flow as occurred when Hole 504B was first drilled.

Following drilling in Hole 896A, a series of logs, including the sonic density tool, dual laterolog, FMS, magnetometer, and a packer permeability experiment, were run in Hole 896A. Two passes were made with the FMS, which provided excellent images of the borehole walls down to 440 mbsf.

The BRG magnetometer was run to 438 mbsf in Hole 896A. The measured anomalies are generally large, ranging up to 5000 nT, but the bottom 30 m has rather small anomalies, <100 nT. Anomaly amplitudes imply reverse magnetization with negative inclinations, consistent with measurements on minicores and with location of the site within a reversed magnetic interval.

The packer was set at depths of 106 mbsf (in the casing), 233 mbsf, and 385 mbsf. The uppermost few tens of meters of basement appears quite permeable, much like in Hole 504B. Permeabilities decrease deeper in Hole 896A, but probably remain large enough to support off-axis circulation in the uppermost basement.

The most significant lithological differences between Sites 896 and 504 are the more abundant breccias and massive units in Hole 896A vs. the greater proportion of pillow units in Hole 504B (Figure 4). Clinopyroxene appears as a phenocryst phase only at depths greater than about 100 m into basement at both sites, but no detailed lithologic correlations yet exist between the two holes. Ponding of lavas could account for the thick massive units with cumulate olivine in Hole 896A, and such ponded units would not be expected to be laterally continuous over large areas. The possible presence of a fault between the two sites may have affected lava accumulation at the spreading axis, leading to further differences in lithostratigraphy. The greater abundance of recovered breccias from Hole 896A, the thicker and more abundant smectite and carbonate veins in the upper half of Hole 896A, the lack of flow of bottom seawater down into Hole 896A (compared to the occurrence of such flow into Hole 504B in the past), all suggest that, although still permeable, the Site 896 section is more extensively sealed than at Site 504. This effect may be related to the location of Site 896 on a basement topographic high and a heat-flow maximum.

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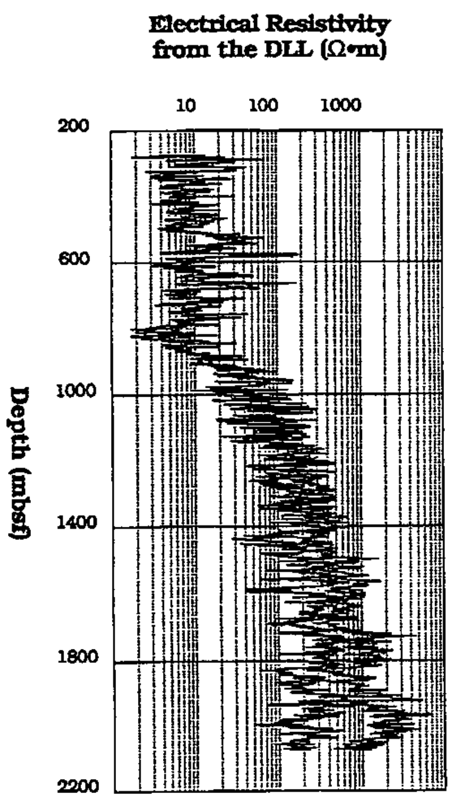
Hobart, M.A., Langseth, M.G., and Anderson, R.N., 1985. A geothermal and geophysical survey on the south flank of the Costa Rica Rift: Sites 504 and 505. *In* Anderson, R.N., Honnorez, J., Becker, K., et al., Init. Repts. DSDP, 83: Washington (U.S. Govt. Printing Office), 379-404.

Leg 148 Wireline Logging Report Figures

Figure 1. Electrical resistivity profile obtained in Hole 504B with the DLL. Both deep (LLd) and shallow (LLs) measurements are shown (LLd > LLs throughout). The large difference between LLs and LLd at the bottom of the hole is due to the presence of breakouts.



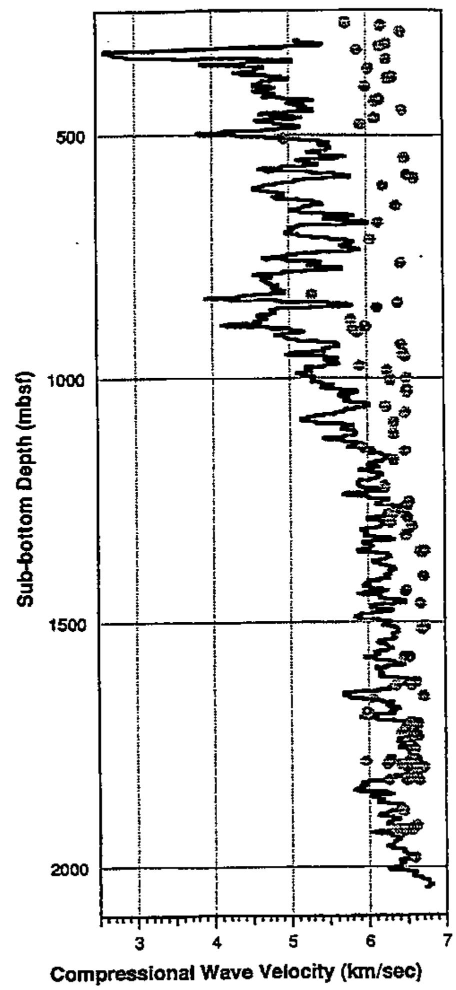


Figure 2. Compressional wave velocity log from Hole 504B. Individual dots are velocities measured in the laboratory at 100 MPa confining pressure.

Wireline Services Report Leg 148

RETURN TO HOLE 504B

DR. PHILIPPE PEZARD LOGGING SCIENTIST

Reports presented in the JOIDES Journal *are summaries. Complete reports are available from the Borehole Research Group, LDEO, Palisades, NY 10964 Internet: borehole@ldeo.columbia.edu*

INTRODUCTION

The Leg 148 program of downhole measurements in Hole 504B was conducted in two phases. The first phase occurred immediately after the initial reentry of the hole, and was aimed at recording a temperature log and sampling borehole fluids. The second phase was conducted after fishing operations, with the hole at a total depth of 2111 mbsf. The geophysical, FMS, and magnetometer logs were run over the entire length of basement. Due to instrumental problems, no BHTV images were recorded and three attempts were made to record the VSP before success was achieved. The time allocated for packer measurements was judged to be more effectively used at Hole 896A.

LOGGING AT HOLE 504B

Leg 148 represented a new opportunity to log equilibrium temperatures in Hole 504B, given that 14 months had passed since the last thermal disturbance to the hole during Leg 140. Unexpectedly high temperatures were observed from the seafloor to a depth of about 250 m into the sediment, which cannot be explained by the disturbance created by the single fluid sampler run, and would suggest a poor calibration of the sensor at these temperatures. Independently of this anomaly, the trend shown by the profile in this section is the same as that observed during Leg 140, indicating that the hole is still recovering from the cooling observed during Leg 137 and 140.

Below 400 mbsf, the measured temperatures closely resemble those measured during Leg 111 and 137, with a gradient of 116°C/km above 800 mbsf, and 61°C/km down to 1200 mbsf. Then the gradient decreases again to 49°C/km, producing a slight difference from the Leg 137 trend, possibly due to a relict of cooling due to drilling during Leg 140 (15 months earlier). The profile is linear down to the bottom where it reaches the temperature of 180°C.

Logging started with the geophysical combination consisting of the acoustic velocity array sonde (SDT) and the dual laterolog (DLL) electrical resistivity sonde. Data were collected throughout the hole. The resistivity data proved to be extremely repeatable with respect to those recorded during Legs 111 in the upper part of the hole, and the quality of the acoustic waveforms is excellent, for the first time in Hole 504B.

The resistivity data recorded with the DLL in the lower 500 m of the hole show a continuous increase of the electrical resistivity of Layer 2C basalts up to 6000 Ω•m near total depth (Figure 1). While the increase is somewhat gradual down to 1400 m, it tends to proceed in a step-like fashion underneath. In the lower 300 m of the hole, the large difference between the shallow (LLs) and the deep (LLd) measurements can be attributed to the contribution of the hole itself, mostly affecting the shallow value and due to the presence of breakouts as shown by FMS calipers.

Compressional wave velocity log data have been plotted with sample velocities measured in the laboratory at 100 MPa confining pressure (Figure 2). Below 1200 mbsf, the agreement between downhole and laboratory measurements is excellent. With exception of local excursions, velocities in basement generally fall between 4.5 and 5.5 km/s above 1200 mbsf. The behavior of the velocity log is fairly regular below, with velocity values varying within a narrow range of 6.0 to 6.5 km/s. A maximum value of 6.8 km/s is reached at 2060 mbsf, near the bottom of the hole.

The formation microscanner (FMS) was lowered next and high-resolution electrical images were recorded throughout the hole, along with size, shape, deviation from vertical, and drift azimuth of the borehole. From the top of the basement to the present total depth, 504B tends to drift to the north-east and the hole deviation from vertical is generally under 6.0 degrees. The hole size shows values beyond 15 inches in the upper part of the hole, and values under 12 inches below 1500 mbsf. In the latter interval, a few narrow intervals are characterized by the presence of breakouts, with similar azimuthal orientations at about N015 and N115 degrees, as that derived by Morin et al. (1990).

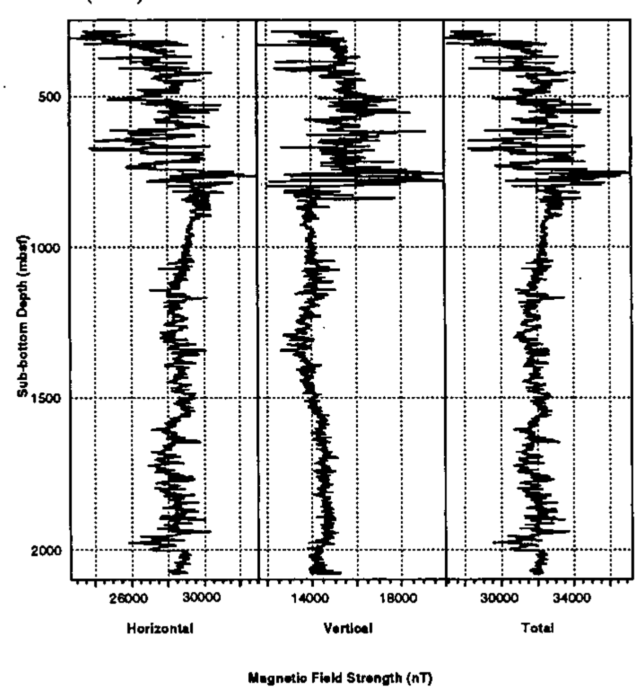


Figure 3. Horizontal, vertical, and total magnetic fields in Hole 504B.

The high-temperature-magnetometer of the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Germany, recorded the horizontal and vertical magnetic field components in Hole 504B throughout the hole. Figure 3 displays the horizontal, vertical, and total magnetic fields uncorrected for possible time and temperature drifts as well as daily variations of the Earth's field in Hole 504.

On the basis of the amplitudes of magnetic anomalies the profile can roughly be divided into three zones, the upper part from 275 to 850 mbsf with amplitudes of up to 5000 nT, the center part from 850 to 1000 mbsf with anomalies only smaller than 100 nT, and the lower part from 1000 mbsf to the bottom with anomalies of up to 1000 nT. These zones can immediately be correlated with lithological units.

The upper extrusive zone produces predominantly negative horizontal and positive vertical field anomalies interpreted to indicate reverse remanent magnetizations of the basalts. The few positive horizontal anomalies could be caused by normally magnetized rocks but they can also be a result of steeply dipping and non-cylinder-shaped source bodies. The largest anomalies with amplitudes of 5000 nT require rock magnetizations of at least 5 A/m and indeed maximum NRM intensities exceed 10 A/m.

After three unsuccessful attempts at deploying a 3-components high-temperature sensor, a vertical seismic profile (VSP) was conducted in 10-m increments from 1516 to 2076 m with the WSTA vertical-component seismic tool of Schlumberger. Data were recorded at 57 levels. With the 124 clampings made during Leg 111, the entire basement section is now covered under a consistent recording format. Preliminary analyses give interval velocities ranging from 5.5 to 7.0 km/s, with an average of 6.58 km/s for the lower interval which compares well with integrated transit-times from the sonic log.

Logging at Hole 896A

Site 896 is situated 1 km to the southeast of Hole 504B, on a bathymetric high overlying a basement topographic high. This location was chosen as it coincide with a local heat-flow maximum. The main scientific objectives at this site were to study local variability in volcanic stratigraphy and igneous geochemistry, aerial extend of flows, and to examine the effects of off-axis hydrothermal activity in a high heat-flow area.

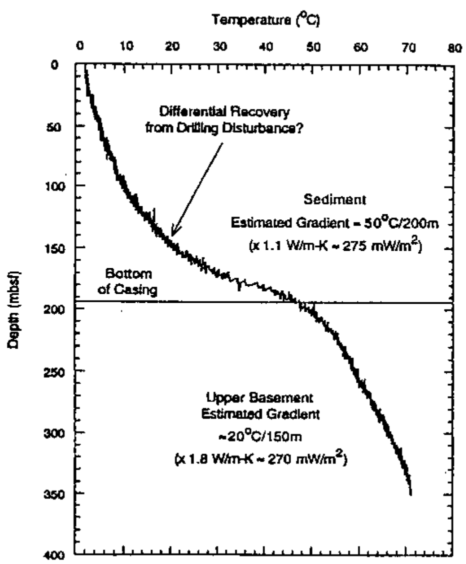


Figure 4. Temperature profile obtained in Hole 896A at re-entry before the second coring phase and 8 days after the end of the first one.

A full program of downhole measurements was conducted in Hole 896A, including LDEO temperature, Schlumberger and BGR magnetometer logs, as well as a packer experiment. As Hole 896A was cored in two phases, an opportunity to run the Schlumberger geochemical sensors (GLT) was provided when the hole was re-entered for the second coring phase. The LDEO temperature tool (TLT) was run in combination with the GLT in order to evaluate the thermal status of the hole 8 days after the initial drilling disturbance.

While excellent GLT data were recorded over 150 m at the top of the basement, the temperature profile (Figure 4) shows residual effects from drilling. Nevertheless, the measured data suggest a conductive heat-flow on the order of 275 mW/m^2, and an equilibrium temperature of about 50°C at the sediment-basement interface. This high-heat flow value is consistent with detailed heat-flow measurements and modeling of off-axis convection in the region. In addition, the data do not display through the cased section the depressed temperatures that would be indicative of downflow into the hole, as occurred in Hole 504B when it was initially drilled.

At the end of coring operations, the geophysical combination used in Hole 504B was run first in order to determine proper setting locations for the packer experiment. Both electrical resistivity and acoustic velocity data are excellent throughout the recorded section. Compressional velocities average 4.8 km/s (Figure 3), with a few excursions to lower values in the lower part of the hole. In general, higher values than those reported by Moos et al. (1990) in the upper part of Hole 504B were obtained, possibly in relation with the more important sealing of cracks and fractures observed in the core due to intense hydrothermal alteration at this high heat-flow site.

The electrical resistivity data average 10.0 Ω•m in the pillows and thin flows, which is similar to that obtained in the extrusive section of Hole 504B (Pezard, 1990). In the lower half of the hole, values as low as 3.0 Ω•m were measured were severe groundmass alteration was described in the core.

The formation microscanner (FMS) was lowered next and images recorded again throughout the hole, from 440 mbsf to the casing shoe. Two successful passes were made. The BRG magnetometer was run last in the hole, over the same interval. The measured anomalies are generally large, ranging up to 5000 nT, but the bottom 30 m have rather small anomalies, <100 nT. Anomaly amplitudes imply reverse magnetization with negative inclinations, consistent with measurements made on minicores and with the location of the Site. Finally, the packer was set at 106 mbsf (in casing), 233 mbsf, and 3865 mbsf. Preliminary analysis of the data gives a quite permeable uppermost basement, much like in Hole 504B, and the permeability appears to decrease deeper in the hole.

In conclusion, the new data recorded in the dikes as well as in the upper basement of Hole 504B are of excellent quality and should help to provide constraints on the lithostratigraphy, structure and stress environment encountered while drilling the lower part of the hole. In Hole 896A, the downhole measurements image an upper basement structure in many aspects different to that obtained in Hole 504B.

Science Operator Report Leg 149

Ocean-Continent Transition in the Iberia Abyssal Plain

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Reports presented in the JOIDES Journal *are summaries. Complete* Preliminary Reports *are available from ODP, Texas A & M University, 1000 Discovery Drive, College Station, TX 77845-9547*

Abstract

The principal objective of Leg 149 was to drill a transect of holes across the ocean-continent transition (OCT) off western Iberia to determine the changes in the petrologic and physical nature of the acoustic basement (Fig. 1). Three main sites (Sites 897, 898, and 900) were chosen on basement highs to enable penetration of basement to several hundred meters. The catastrophic loss of 3500 m of drill string at Site 898 led to the abandonment of that site and the occupation of a nearby alternate site (Site 899) where basement was within reach of the remaining drill string. Site 901 was drilled in the last 2 days of the leg over a tilted basement fault block the top of which is within 200 m of the seabed.

The OCT in the central Iberia Abyssal Plain segment of the margin has been located by seismic reflection and refraction profiles and by magnetic and gravity modeling. These independent measurements all support a single conceptual model of the crust and upper mantle within the OCT of the Iberia Abyssal Plain. In part, Leg 149 confirmed this model by finding serpentinized peridotite acoustic basement at Site 897 and thinned continental crust at Site 901 (Fig. 2). However, the presence and unusual mode of emplacement of the serpentinite breccias over serpentinized peridotite at Site 899, 19 km east of Site 897, and the metagabbros drilled at Site 900, 122 km east of Site 897, were unexpected. The geophysical and tectonic models of rifted margin formation will be revised to explain these new observations.

Introduction

The North Atlantic Rifted Margins Detailed Planning Group (NARM DPG) met in 1991 to plan a program of drilling to study the problems of rifted-margin formation and evolution. Leg 149 represented the first part of a program proposed by the DPG for the study of nonvolcanic margins. Leg 149 drilled five sites (Sites 897 through 901) on the Iberia Abyssal Plain with the principal objective of constraining the nature and age of the crust under the OCT (Figure 1). Each of the Leg 149 sites is over a basement high (Figure 2). Before the leg we believed that these highs were produced late in the rifting process, principally by rotation of faulted blocks of basement, and hence would be representative of the adjacent but deeper basement rocks.

The principal objective of Leg 149 was to drill a transect of holes across the ocean-continent transition (OCT) off western Iberia to determine the changes in the petrologic and physical nature of the acoustic basement.

Ocean-Continent Transition

The principal objective of Leg 149 was to establish the nature of the OCT beneath the Iberia Abyssal Plain by drilling a transect of holes. Identification of crustal type within a wide zone of thinned continental or thin oceanic crust and the position and nature of the OCT were important drilling targets. Geophysical data suggest that seafloor exposures of mantle peridotite on the western margin of Galicia Bank, to the north of our transect, extend southward beneath the sediments of the Iberia Abyssal Plain (Figure 1) (Beslier et al., 1993). If Leg 149 proved this hypothesis correct, then clearly the peridotite is of more than local significance. The objectives of establishing the nature of the upper crust and testing some of the predictions, made largely on the basis of geophysical observations, had to be tempered by the accessibility of the crust to the drill bit. Therefore, to achieve significant progress within a single leg, sites were drilled that lie on basement highs that are situated at critical points within the OCT (Figure 2). The detailed objectives of each site are outlined below. The general aim was to penetrate several hundred meters into the acoustic basement and to obtain cores and downhole logs in the basement to determine its origin and history. This was to be done by petrologic and chemical analysis, by microstructural examination, by examination of the mineralogy, by apatite fission track analysis and/or isotope dating of suitable core material, by velocity and magnetic measurements, by analysis of geochemical logs, by interpretation of the formation microscanner logs and other logs, and by whatever other means seemed appropriate.

Results

The Cenozoic sediment-accumulation history for all sites are shown together in Figure 3.

Site 897

Site 897 is situated in the Iberia Abyssal Plain over a north-south basement ridge within the OCT zone. Geophysical modeling had predicted that the ridge lay at, or close to, the ocean- continent boundary and might consist of serpentinized peridotite. Cores were obtained from three holes that penetrated up to 694 m of Pleistocene to Lower Cretaceous sediments and from two holes that penetrated up to 153 m of basement.

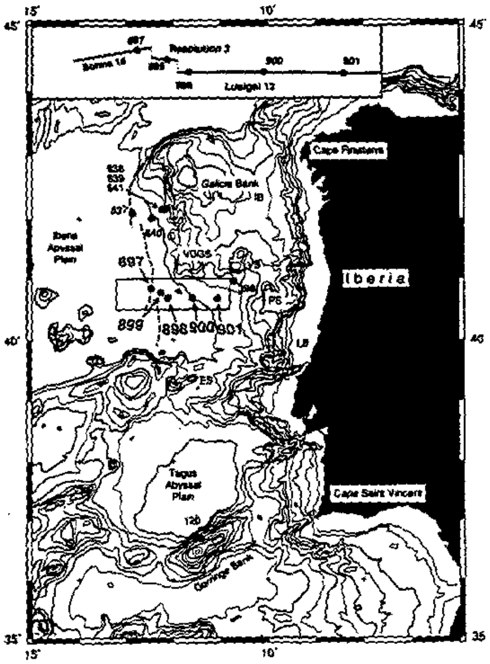

Figure 1. Bathymetry of the west Iberian margin (contours in meters; bold lines are at 1000-m intervals). Leg 149 sites are 897-901; other numbers are sites drilled on Legs 13, 47B, and 103. The bold dashed line is the predicted location of the peridotite ridge (Beslier et al., 1993). The top map shows the location (solid lines) of the seismic profiles used to construct the composite structural section in Figure 2. Labels are: IB, Galicia Interior Basin; VDGS, Vasco da Gama Seamount; VS, Vigo Seamount; PS, Porto Seamount; LB, Lusitanian Basin; ES, Estremadura Spur.

The basement is composed of serpentinized, relatively undepleted peridotite that originated in the upper mantle and was exposed at the seafloor during, or somewhat after, the time of continental breakup. A debris-flow unit containing early late Hauterivian to early Aptian sediments immediately overlies basement and contains fragments of peridotite and continental basement rocks. The unit could have been deposited in a single event or as multiple events. The sediments suggest that continental basement rocks and a source of land-plant debris were located upslope of the site.

A significant depositional hiatus starting in the middle Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Four lithologic units are identified at Site 897:

1. Unit I (0-292.0 mbsf) is a Pleistocene to lower Pliocene silty clay to clayey silt with nannofossil clay with graded silt and fine sand beds. The unit consists mainly of terrigenous turbidites.
2. Subunit IIA (292.0 -301.2 mbsf) is upper Miocene terrigenous turbidites.

   Subunit IIB (301.2-359.8 mbsf) is upper to lower Miocene calcareous turbidites.

   Subunit IIC (359.8-619.7 mbsf in Hole C; base at 622.4 mbsf in Hole D) is upper Oligocene to middle Eocene calcareous turbidites.
3. Subunit IIIA (619.7-639.4 mbsf in Hole C; 622.4-645.2 mbsf in Hole D) is an unfossiliferous pelagic/hemipelagic claystone deposited below the CCD that extends back in age to the Paleocene/Cretaceous.

   Subunit IIIB (639.4-648.7 mbsf in Hole C; 645.2-655.2 mbsf in Hole D) is an unfossiliferous Cretaceous conglomerate and claystone with clayey sandstone.
4. Unit IV (648.7-677.5 mbsf in Hole C; 655.2-693.8 mbsf in Hole D) consists of a post-Aptian(?) mass-flow deposit consisting of sandstone, dolomite, limestone, and calcareous claystone with peridotite clasts and megaclasts.

The sedimentary section provided a discontinuous fossil record from the Pleistocene through Early Cretaceous. Two unconformities in the Miocene together represent a 12-Ma hiatus from middle Miocene to early Pliocene time. An earlier hiatus in deposition occurred from Early Cretaceous to middle to late Eocene time.

The mass-flow deposit immediately above the basement, containing basement blocks and a variety of sediments of early late Hauterivian to early Aptian age, has several implications for the history of the peridotite ridge. The peridotite was exposed at the seafloor and contributed clasts to the debris flow(s) some time between the early late Hauterivian and the Paleocene. Either the ridge existed when the debris flow(s) occurred, and material was transported from the north along the north-south ridge itself, or the peridotite had not yet been fully uplifted to form a ridge when the debris flow(s) occurred and the non-peridotite material was transported from the north, east, or even west.

Holes 897C and 897D penetrated 95 and 153 m, respectively, of basement rock. The entire basement section consists of peridotite that has been almost completely serpentinized and partially brecciated during and after serpentinization. About 90% of the peridotite is undifferentiated harzburgite or lherzolite whose original composition was 70%-80% olivine, 15%-20% pyroxene, and 1%- 2% spinel. These rocks are heterogeneous, ranging from pyroxene- rich peridotite to dunite. The remaining 10% of the peridotite is plagioclase- and spinel-bearing and was originally composed of 50%-70% olivine, 20%-30% pyroxene, 15% plagioclase, and 1%-5% spinel. The coexistence of plagioclase and spinel suggests that these rocks last equilibrated at a low pressure, 900-1000 MPa (about 30 km depth). The wide variety of peridotite types and the locally high proportion of plagioclase (up to 40%), suggest that the peridotite may have experienced some melting and even magma mobility. The brecciation ranges from pervasive fracturing and serpentine and carbonate veining to the formation of gravel-sized serpentinized peridotite clasts embedded in a carbonate and serpentine matrix. Some brecciation shows a well-developed foliation associated with a late-stage shear deformation event. While the peridotites have experienced

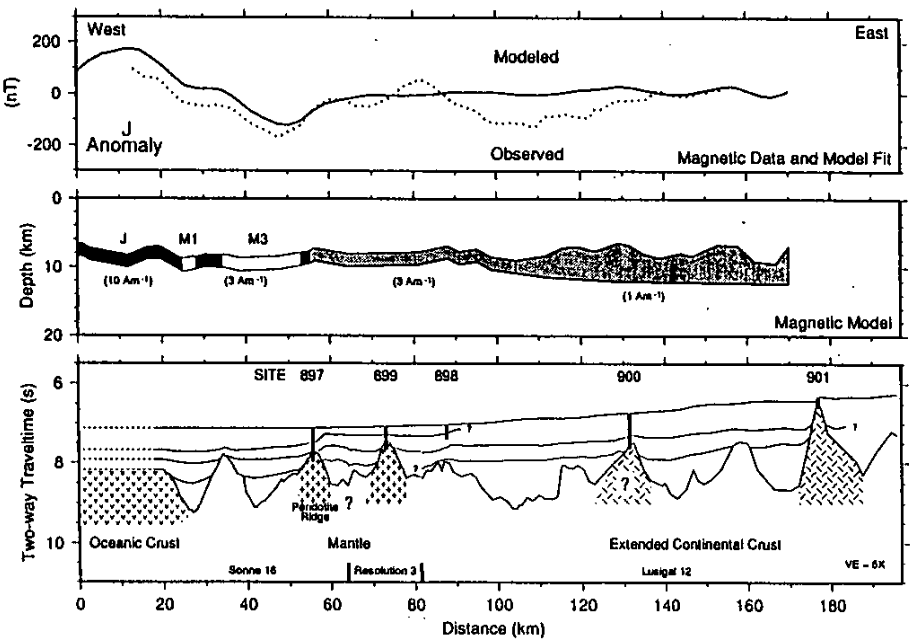

Figure 2. Composite east-west sediment and basement section through the Leg 149 sites. The composite section was assembled from parts of three seismic sections (see Figure 1 inset for locations). The magnetic profile is a composite from two tracks projected onto an east-west line (Whitmarsh et al., 1990). East of Site 897, over the peridotite ridge, the magnetic anomalies cannot be explained by seafloor spreading. Drilling results show that Sites 897 and 899 are underlain by serpentinized peridotite, which was part of the upper mantle exposed at the seafloor during rifting. Site 900 is underlain by amphibolite-grade metagabbro, possibly continental crust or syn-rift lower oceanic crust. Site 901 is underlain by Jurassic pre- or syn-rift sediments over extended continental crust. The crust under the J magnetic anomaly is considered to be unambiguous oceanic crust.

late, low- temperature deformation, they show no signs of high-temperature ductile deformation.

Acoustic formations 1A, 1B, and 2 have been widely recognized on multichannel seismic reflection profiles on the west Iberia margin and locally dated by previous drilling (Mauffret and Montadert, 1988). At Site 897, acoustic formation boundaries 1A/1B and 1B/2 correlate with the middle to late Miocene hiatus at 315 mbsf and with the top of a middle Eocene claystone and chalk at 590 mbsf, respectively.

Site 898

Site 898 is situated in the Iberia Abyssal Plain over a semi-elliptical basement ridge within the OCT zone. Geophysical modeling had predicted that the ridge lay within a part of the OCT, intermediate between thin oceanic crust to the west and thinned continental crust to the east, in which there is a large magnetic anomaly that cannot be modeled by seafloor spreading. APC and XCB cores were obtained from a single hole that penetrated 342 m of Pleistocene to upper Oligocene sediments. Coring and logging plans were terminated by the loss of 3500 m of drill pipe, which prevented us from reaching basement at this site.

Unit I contains approximately 260 turbidites that were deposited in the last 1.1 Ma; on average one turbidite was deposited every 4000 years. A significant depositional hiatus starting in the middle Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Two lithologic units are identified at Site 898:

1. Unit I (0-161.9 mbsf) is Pleistocene to Pliocene terrigenous turbidites.
2. Subunit IIA (161.9 -172.2 mbsf) is Pliocene to Miocene pelagic/hemipelagic sediments.

   Subunit IIB (172.2-341.5 mbsf) is Miocene to Oligocene calcareous contourites and terrigenous turbidites.

The sedimentary section provided a discontinuous fossil record of the Pleistocene through the late Oligocene. An unconformity in the Miocene represents a 10-m.y. hiatus from middle Miocene to late Pliocene time.

Site 899

Site 899 is situated in the Iberia Abyssal Plain within the OCT zone over a semi-elliptical basement ridge with a steep southern flank. Geophysical modeling had predicted that the ridge lay within a part of the OCT, intermediate between thin oceanic crust to the west and thinned continental crust to the east, in which there is a large positive magnetic anomaly that cannot be modeled by seafloor spreading. Rotary cores were obtained from two holes that penetrated 562.5 m of upper Pliocene to Upper Cretaceous sediment overlying an unusual serpentinite breccia and serpentinized peridotite with interbedded lower Aptian to upper Hauterivian claystone and siltstone. Coring was terminated when the drill string became temporarily trapped near the bottom of hole. Downhole logs were acquired from within acoustic basement in the interval 395 to 430 mbsf; deeper logging was prevented by bridges, and, when we tried to log from the base of the casing to the top of basement, bridges stopped the logging tools in that interval, too.

A 2.9-m.y. hiatus in the middle/late Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain. In addition, there is a major hiatus represents most of the Paleogene.

Acoustic basement is composed of a thick series of three serpentinite breccias overlying discrete sections of serpentinite, serpentinized peridotite, gabbro, and intercalated Lower Cretaceous claystones and siltstones with associated non-MORB basalts.

Four lithologic units are identified at Site 899:

1. Unit I (81.5-131.65 mbsf) is Pleistocene to Pliocene terrigenous turbidites.
2. Subunit IIA (131.65-206.6 mbsf) is a Pliocene to Miocene pelagic/hemipelagic sediments with scattered turbidites.

   Subunit IIB (206.6-228.6 mbsf in Hole 899A, 230.5-360.2 mbsf in Hole 899B) is a Miocene to Oligocene claystone to siltstone probably deposited above the CCD by contour currents and occasional mud turbidites.
3. Subunit IIIA (360.2-364.61 mbsf in Hole 899B) is an upper Eocene claystone deposited below the CCD.

   Subunit IIIB (364.61-369.8 mbsf in Hole 899B) is an Upper Cretaceous claystone with clay-rich conglomerate and sandstone deposited by a combination of hemipelagic and pelagic settling and by high density turbidites or sand-silt-clay debris flows.
4. Subunit IVA (369.8-484.2 mbsf in Hole 899B) contains three Cretaceous serpentinite breccias, 10 to 95 m thick, the two lowermost breccias are Aptian in age.

   Subunit IVB (484.2-549.9 mbsf in Hole 899B) was poorly recovered and includes serpentinite, basalt, gabbro, and claystone of early Aptian to late Hauterivian age.

A most unusual aspect of the sequence of rocks recovered is the three lithologies in Unit IV which consist of (a) serpentinite breccia units up to 95 m thick; (b) unbrecciated serpentinite, serpentinized peridotite, and gabbro; and (c) intercalated claystone, unconsolidated altered serpentinite, and minor siltstone associated with basalt fragments as individual pieces in the cores or as clasts within the sediment. The clasts in the breccia units are up to 1 m thick. At least 90% of these clasts are serpentinized peridotite, many of which display a fabric indicative of moderate temperature-high pressure ductile deformation, and the remainder are fragments of metamorphosed magnesium-rich igneous rock. The breccia units are structureless and unsorted. Rarely, flow structures and the sediment/breccia contact are seen near the bases of the breccia units. The matrix has a texture that, in a tectonic setting, indicates shear deformation under low normal stress typically due to high fluid pressures. Clasts of continental basement rocks, basalt, sediment, and gabbro are entirely absent. Below the breccia units, Subunit IVB is composed principally of unbrecciated boulder-sized blocks of serpentinite, but it also contains intercalated siltstones and claystones and intercalated clasts of basalt, microgabbro, and mylonite. Both subunits contain intercalated Lower Cretaceous sediments that suggest a normal stratigraphic upward-younging sequence.

Downhole logs were obtained from only the thick serpentinite breccia unit in the top of Unit IVA (395 to 430 mbsf). These showed a very low natural-gamma count (5-10 API units), low aluminum (1%-1.5 wt %), a high resistivity (mean 150 and maximum 1000 ohm-m), low porosity (0%-10%), and compressional and shear wave velocities of 3.81-4.85 and about 2.3 km/s respectively. Locally higher velocities, resistivities, and densities appear to correlate with blocks of serpentinized peridotite.

Site 900

Site 900 is situated in the Iberia Abyssal Plain within the OCT zone over an angular basement high that appears to be a tilted fault block. Geophysical modeling had indicated that this basement high lay within a part of the OCT with a very weak magnetization and therefore is probably thinned continental crust. Cores were obtained from a hole that penetrated 748.9 m of Pleistocene to Paleocene sediment, and 57.1 m of basement composed of mafic igneous rock. Coring was terminated when the rate of penetration came close to 1 m/hr and bit failure was imminent. A total of 385 m of sonic, resistivity, and FMS logs was acquired from three separate intervals in the sediments and basement.

Basement is composed of amphibolite-grade mafic igneous rocks. The history of these rocks is unclear at present, and they may have originated as Paleozoic basalt, cumulate gabbro from the lower crust, or pre-Mesozoic subcontinental mantle invaded by gabbro. In any case they were exposed at the seafloor prior to the late Paleocene, probably by the Early Cretaceous rifting.

A 4-m.y. hiatus in the middle/late Miocene, which began at 11.7 Ma, is correlatable with a regional angular unconformity on seismic reflection profiles and may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Two lithostratigraphic units are identified at Site 900:

1. Subunit IA (0.0-67.2 mbsf) is Pleistocene to upper Pliocene mud-dominated turbidites and hemipelagic/pelagic sediment.

   Subunit IB (67.2-96.0 mbsf) is an upper Pliocene to upper Miocene hemipelagic/pelagic sediment.

   Subunit IC (96.0-181.5 mbsf) is upper Miocene to upper lower Miocene mud-dominated turbidites and hemipelagic/pelagic sediment.
2. Subunit IIA (181.5-234.3 mbsf) is lower Miocene contourites and turbidites with pelagic/hemipelagic sediments.

   Subunit IIB (234.3-748.9 mbsf) is a lower Miocene to Paleocene sediments, possibly including turbidites, reworked by contour currents.

The sediments at this site reveal the history of development of the lower continental rise adjacent to the Iberia Abyssal Plain during the Cenozoic. The cores chronicle the deposition of silt and clay layers with laminated bases under the influence of bottom currents, which were probably contour-following currents and part of the general oceanic circulation. Mud turbidites were occasionally seen, too. These sediments were succeeded by carbonate-rich turbidites and then by mud-dominated turbidites as the abyssal-plain sediments built upward and sideways onto the rise.

Fifty-seven meters of fine- to coarse-grained metamorphosed mafic rocks was drilled in the basement. The rocks are highly deformed and brecciated and veined by later calcite, epidote, and clinozoisite. A porphyroclastic texture, with large porphyroclasts of plagioclase and clinopyroxene, is seen in thin section. Chemical analyses suggest that the rocks are relatively depleted in large ionic lithophile elements. These rocks may be (a) Paleozoic basalts that were accreted onto continental basement during the Hercynian orogeny, (b) cumulate gabbro from the lower crust, or (c) pre-Mesozoic subcontinental mantle invaded initially by a hot gabbroic component, stretched during the Mesozoic crustal extension and then retrogressively metamorphosed. In any case they were exposed at the seafloor prior to the late Paleocene, probably by the Early Cretaceous rifting.

The sonic, resistivity, and FMS logging strings were run over three separate parts of the hole, including 36 m of basement. Hole conditions made logging difficult and forced us to use the conical side-entry sub. Eventually, logging had to be abandoned due to persistent obstructions in the hole and damage to the logging cable and FMS tool. The most valuable data are likely to be the FMS images from the sediments at the base of the hole. They show clear evidence of dip within those sediments that correlate with the observation of dip within the cores. The FMS data will allow the azimuth of the dip to be determined.

Site 901

Site 901 is situated in the Iberia Abyssal Plain within the OCT zone over a basement high that has an angular shape on a single east-west seismic reflection profile and that appears to be a tilted fault block. The block has a west-dipping fault scarp and is capped by an acoustically transparent layer, clearly visible on a pre-stack migrated version of the seismic profile, several hundred meters thick. Geophysical modeling had indicated that this basement high lay within a part of the OCT with a weak magnetization and therefore is probably underlain by thinned continental crust. Site 901 was drilled during the last 48 hr of the leg. We drilled and washed down to 182.0 mbsf and cored intermittently down to 247.8 mbsf. Coring was terminated when we had to depart for Lisbon.

We obtained Upper Jurassic (Tithonian) black mud and sandstone containing significant terrestrial plant debris from the acoustically transparent layer capping the tilted fault block. This is the oldest sediment acquired during Leg 149, and it is from the pre- or syn-rift period. We recovered a section of Pliocene nannofossil clay or ooze, apparently unconformably overlying a thin film of Lower Cretaceous clay. The section below is apparently Tithonian and consists of black clay, silt, and sand. There are intervals of sandstone that make up about 10%-20% of the section. The sediments are black because they contain significant pieces of land- plant debris (some are as large as 1 cm) and pyrite.

The Tithonian, 152-146 Ma, is older than the time of initiation of seafloor spreading on this margin, 130 Ma. We do not know the time at which rifting began here, so this sediment could have been pre-rift or syn-rift. In either case, we conclude that this part of the margin is underlain by extended continental crust.

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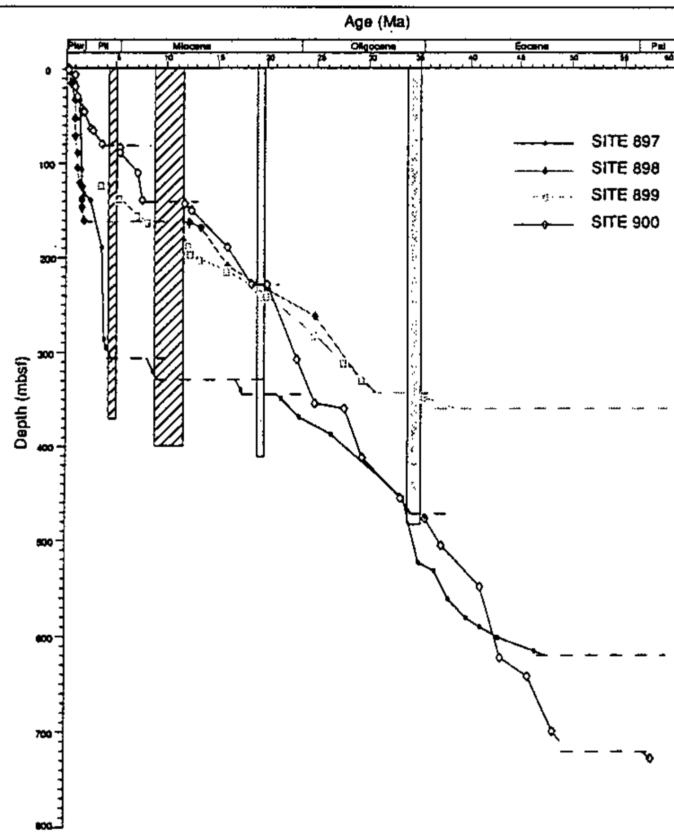
Figure 3. Summary sediment-accumulation-rate diagram for Leg 149 sites. Dates were obtained from calcareous nannofossils and planktonic foraminifers. The boxes with diagonal lines indicate hiatuses in deposition that can be correlated between all the sites. The shaded boxes indicate hiatuses that can be correlated between at least two or more sites.



Science Operator Prospectus Leg 152

EAST GREENLAND MARGIN

DR. HANS CHRISTIAN LARSEN CO-CHIEF SCIENTIST
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DR. PETER CLIFT ODP STAFF SCIENTIST

A complete Scientific Prospectus *for this leg is available from ODP, Texas A & M University, 1000 Discovery Drive, College Station, TX 77845-9547*

ABSTRACT

Leg 152 represents the second in an eight-leg program, proposed by the NARM-DPG, to investigate rifted margins. Four legs will be devoted to each margin type, volcanic and nonvolcanic. Leg 152, selected as first priority by the North Atlantic Rifted Margin Detailed Planning Group (NARM-DPG), will be the first leg to address processes at volcanic rifted margins by drilling a transect of proposed sites at 63°N, southeast Greenland. The southeast Greenland transect is located approximately 550 km south of the original center of the Iceland hotspot in a region of apparent structural simplicity, with a well-understood, simple plate kinematic history. Breakup took place within cratonic lithosphere, forming two conjugate margins, one in southeast Greenland and the other represented by the Rockall-Hatton margin, previously drilled by the Deep Sea Drilling Project (DSDP). This transect of a total of four proposed sites is designed to constrain a number of different features of the margin including the timing of breakup, the nature of the lithospheric deformation, magmatic processes, flexural deformation rates, emplacement mechanisms, geochemical and volumetric trends in the magmatism, spreading rates prior to formation of the first oceanic magnetic isochrons, syn- and post- constructional subsidence of the volcanic carapace, and the post-breakup subsidence of the spreading ridge.

INTRODUCTION

The North Atlantic Rifted Margin Detailed Planning Group (NARM- DPG) met in 1991 to plan a program to study the problems of rifted margin formation and evolution. Leg 152 is the first leg out of a total of four legs proposed by the NARM-DPG for the study of the tectono-magmatic development of volcanic rifted margins. The four legs planned by the DPG involve three margin transects (Figure 1). The first-priority transect is the EG63 transect offshore of southeast Greenland. Three transects have been chosen to provide comparable drilling data from margins or segments of margins in different lithospheric settings, with partly different structural development and with different offset from the supposed center of the Icelandic mantle plume. Within each transect the temporal evolution of the margin will be imaged.

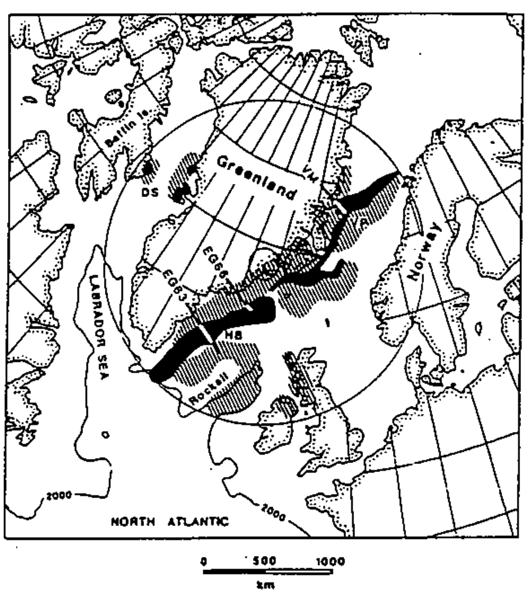


Figure 1. Map of the supposed location and distribution of the Iceland hotspot at the time of breakup (White and McKenzie, 1989). Also shown are the three proposed ODP transects: EG63, EG66, VM-VP.

The southeast Greenland transect EG63 was considered the highest priority transect by the NARM-DPG because of its simple and well-constrained setting and because of the conjugate Rockall- Hatton margin already drilled by DSDP Leg 81. To fully complete the four sites planned for the EG63 transect will require more than two legs of drilling. Leg 152 is planned to drill two sites along the transect, one at the landward end of the transect (EG63-1) and one within the central part of the transect (EG63-2).

VOLCANIC RIFTED MARGINS

Volcanic rifted margins (VRMs) are characterized by significant igneous-magmatic crustal accretion and substantial surface volcanism during continental breakup. During breakup, eruption occurs largely above sea level for some time after initiation of continental drift. Figure 2 shows the idealized zonation of a volcanic rifted margin into a three fold division: a landward zone of plateau basalts, sills, and dikes; a central zone of baselap-free, seaward-dipping, and offlapping lava-flow units (seaward-dipping reflector sequence, SDRS); and a seaward zone of seafloor- spreading crust generated at increasing water depth. In contrast to nonvolcanic rifted margins, volcanic rifted margins tend not to show a wide zone of crustal attenuation toward the ocean-continent transition (OCT). A fairly thick crust (20-25 km) with high seismic velocities in the lower crust is observed around the transition zone.

One of the major objectives of the EG63 transect and Leg 152 is to provide stratigraphically well- constrained sampling of the magmatic evolution associated with the development of the most striking feature of VRMs, the SDRS. These huge volcanic edifices belong to some of the largest igneous provinces (LIPS) known from Earth history.

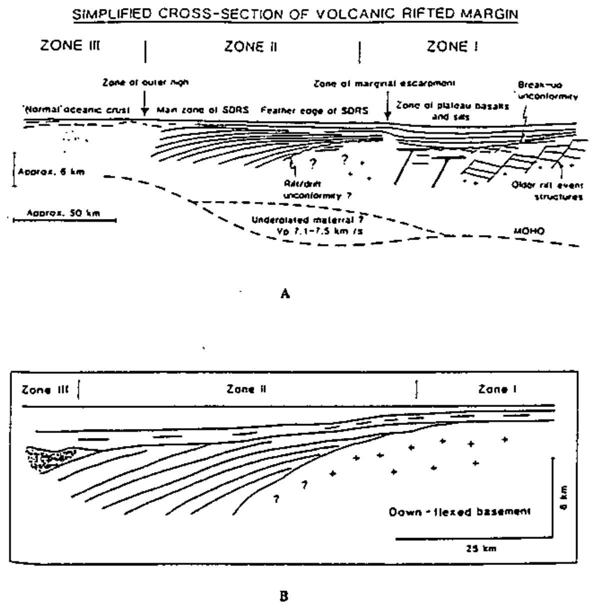


Figure 2. A) Idealized zonation of a volcanic rifted margin. Zone I may be a "sedimentary equivalent" to the Zone II volcanic edifice and may, or may not, be floored by older rift basins. SDRS = seaward- dipping reflector sequence. B) Schematic cross section of a volcanic margin development in a cratonic area. Continental flood basalts (CFB) may build up within Zone I. Note the differences from Figure 2A, most real examples show variations between these two different developments.

Several models attempt to explain the formation of large volumes of magma at rifted plate margins. These range from catastrophic plume "impact" models, where a plume ascending from the lower mantle impacts and initiates magmatism when it hits the base of the lithosphere (Richards et al., 1989), through the more passive plume "incubation" models, whereby a large plume head slowly incubates beneath a lithospheric cap (Kent et al., 1992) and releases melt only when the lithosphere is stretched (White and McKenzie, 1989). Other models imply no role for a plume, for example, the broad thermal anomalies of Anderson et al. (1992) and the convective overturn model of Mutter et al. (1982). Some of the key differences between the models are the degree of temperature anomaly within the asthenosphere, the shape and life length of the temperature anomaly and the role of "passive" plate drag and associated mechanical thinning of the lithosphere in the process of melting of the asthenosphere and the excessively strong generation of magmatic melts.

The EG63 transect and Leg 152 will investigate these variables by examining the temporal evolution of the magmatism from its start, through its excessive phase and into its waning stage and "normal" seafloor spreading.

SCIENTIFIC OBJECTIVES

Summary

1. To constrain the timing of, and tectono-magmatic variation across, an archetypal seaward-dipping reflector sequence (SDRS).
2. To determine and constrain volcanic emplacement mechanisms and investigate the nature of underplating.
3. To evaluate the relationship between the Iceland plume and the southeast Greenland volcanic rifted margin.
4. To understand the subsidence and oceanographic history of the Irminger Basin, Arctic bottom water overspill across the Iceland- Greenland Ridge, and the glaciation history of southern Greenland.

Tectono-Magmatic Objectives

A first-order objective is to determine to what extent rifting at a volcanic rifted margin is active or passive. In the active model, extension is driven by local forces acting on the plate, such as those produced by a buoyant mantle plume. With the passive model, the plate responds to remote plate forces. The relationship between rifting and magmatism at volcanic margins will vary, according to whether rifting is active or passive. If rifting is passive, we may observe significant stretching of the lithosphere before major volcanism (White and McKenzie, 1989), whereas if the rifting is active, hot plume mantle may rise to shallow levels, decompress, and melt without significant prior stretching of the lithosphere (Duncan and Richards, 1991). Data from drilling cannot alone resolve this fundamental issue. However, the whole array of drilling-derived data regarding the temporal evolution in magmatism, geochemically as well as plate-kinematically, coupled with the deformation rate of the lithosphere, will help considerably in resolving the controversy between active and passive rifting.

Timing of the SDRS

Constraints on the timing of magmatism (and subsidence of the margin) will be provided by a combination of radiometric dating of volcanic rocks, paleomagnetism, and high-resolution biostratigraphy of late Paleocene and early Eocene sediments. Timing and duration of volcanism can be constrained by radiometric dating of volcanic rocks. Paleo-secular variation of the magnetic field measured from oriented cores of rapidly accumulated basalts can, it is hoped, provide high-resolution relative dating on the order of 5-10 k.y. Late Paleocene and early Eocene biostratigraphy south of the Faeroe- Greenland Ridge should have a high potential for precise dating, and it is hoped that the drilling data will provide new avenues for refined correlation with the existing magnetic time scale.

Tectono-Magmatic Evolution

At the ocean/continent boundary, flexure rather than localized fault failure seems to prevail. The crustal flexure is associated with and caused by extreme differential and syn-formational subsidence of the order of perhaps 5 km/m.y. The deep (400 m) sampling of basement scheduled for Leg 152 can constrain both the overall timing of this deformation, as well as provide detailed imaging and high-resolution relative timing of local flexural response. In addition, the spreading rate during the early phase of spreading, prior to the first datable seafloor-spreading anomalies, can be established through drilling.

A major, transient thermal anomaly is likely to have been present during breakup to have produced the excessive amounts of magmatic melts. Modeling of major element variations such as Na content and CaO/Al_2O_3 ratios will be used to estimate extent and pressure of melting. In addition, Mg-rich picritic liquids, formed by extensive melting, may be common. Alkaline magmas formed by lower degrees of melting at great depth may also occur.

Because the parental magma of basalts in the different models originates at different mantle depths and follows a different time- temperature path, petrological and geochemical studies of drill-core samples and estimates of magma production rates will constrain the relative importance of the three models. Plume components from deep mantle sources in the volcanic rifted margin sequences can be identified and quantified by geochemical studies.

SDRS Emplacement and Magmatic Underplating

Emplacement history of the volcanic rocks and the possible role of underplating can be detailed and investigated by the scheduled deep basement drilling. The drilling data and calibrated seismic mapping in 3D will allow calculation of individual flow volumes, variations in magma production rates with time, and variations in residence time in shallow crustal magma chambers (primitive vs. fractionated magmas, aphyric vs. porphyritic). The data will be used to investigate possible cyclicities, to verify original flow directions, and to analyze for possible crust-magma anatectic reactions suggestive of underplating. This quantification of the volcanic system together with the deformation pattern of the lithosphere, will provide important, though indirect, information on the suggested processes of magmatic underplating.

Relationship of the Iceland Plume to the Volcanic Rifted Margin

One specific objective of Leg 152 is to obtain sufficient material from the SDRS, and in future legs from the "normal" oceanic crust distal to the volcanic margin, with which the composition of the basaltic magmas may be determined. Extrapolation of elemental and isotopic data will enable estimates of mantle compositions and temperatures to be made. These will be compared with existing data from Iceland and the Mid-Atlantic Ridge (MAR). This may enable us to determine whether the basalts represent melting of plume-heated MORB-like asthenosphere or melting of ancestral Icelandic plume mantle. It is hoped that this in turn may provide important information about the dynamics of the plume system.

Drilling Strategy

Transect EG63 is located close to 63°N, and is approximately 550 km south of the center of the syn-breakup, ancestral Iceland hotspot. The transect of four proposed sites, two of which (EG63-1 and EG63-2) are scheduled to be drilled during Leg 152, is in an area of cratonic lithosphere that underwent only limited tectonic stretching prior to breakup (Larsen, 1988, 1990). The drilling transect starts on the middle to outer part of the narrow shelf, only about 40 km offshore. The inner to mid-shelf is floored by basement rocks with a thin Quaternary cover (Figure 3). The outer shelf is floored by the landward feather edge of the southeast Greenland SDRS covered by up to 1.5-km-thick Paleogene and Neogene sediments. The planned drilling transect extends seaward across the wide southeast Greenland margin for about 150 km and terminates in oceanic crust of Anomaly 24 age close to the seaward end of the SDRS.

Figure 3. (facing page) Seismic line of the southeast Greenland transect to be drilled during Leg 152, showing location of sites EG63-1 through EG63-4. Both sites EG63-1 and EG63-2 will be drilled as reentry sites for possible later deepening following initial results. Q: Quaternary; N: Neogene; P: Paleogene; B: continental basement; SDRS: seaward-dipping reflector sequence; M: multiples.

The EG63 transect is located along the 61°N flowline (61°N at the Reykjanes Ridge), which, according to isotopic and LREE data, is within the distal portion of the source signature from the Icelandic plume. Formation of the SDRS wedge terminated between Anomaly 24B and 24A along this transect and flowline. The transect will show whether the source compositional anomaly extended farther south during breakup than it does at present and will provide important information about the spatial and temporal extent of the compositional vs. thermal-plume components during breakup.

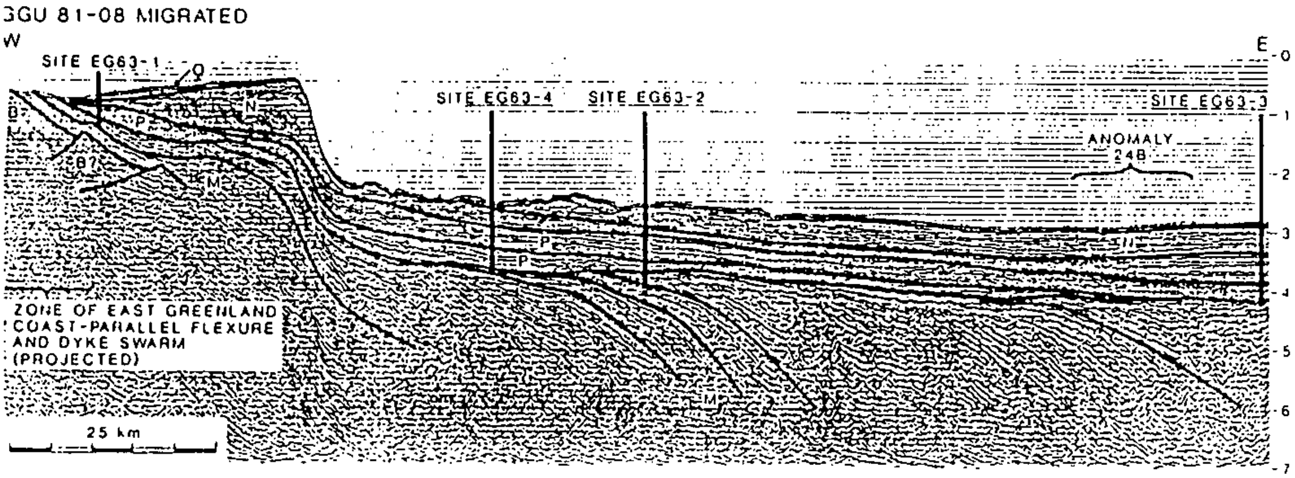
Proposed Sites

Proposed Site EG63-1

This site is located on the southeast Greenland continental shelf, on the oldest, landward edge of the SDRS (Chron 25N or older) in a water depth of 520 m (Figure 3). Approximately 440 m of sediment, probably ranging in age from Paleocene to Holocene, overlies the SDRS. Studies of the seismic reflection profiles suggest that three sedimentary units will be drilled: (1) 260 m of Holocene sediments, probably glacial tills, unconformably overlying (2) 80 m of Eocene to Miocene clastic shelf sediments, which in turn overlie (3) 100 m of Paleocene to lower Eocene terrigenous to shallow-water clastic sediments. The lowest part of the sedimentary succession may in part be volcaniclastic, with carbonates occurring above. This site is designed to optimize recovery of the older parts of the SDRS whilst also recovering the Paleocene to Miocene sedimentary successions. Basement penetration to 400 m is scheduled (Table 1).

Proposed Site EG63-2

Proposed site EG63-2 is located near the center of the SDRS outcrop on the upper continental rise in a water depth of 1875 m (Figure 3). Approximately 1220 m of upper Paleocene to Holocene sediments overlies basaltic basement. From seismic data the sedimentary succession probably comprises (1) 350 m of hemipelagic post-Miocene clastics, including possible contourites; (2) 520 m of post-lower Eocene sand/silt/clay turbidites; (3) 350 m of Paleocene/lower Eocene shelf sediments (shallow marine sands and carbonates grading down into terrigenous sediments with volcaniclastic deposits). This site is designed to optimize recovery of the thicker parts of the SDRS, younger than those recovered at site EG63-1, whilst also recovering the Paleocene to Miocene sedimentary successions. Basement penetration to 400 m is scheduled (Table 1). This site is the ideal place for a deep well into the SDRS, which is well developed and well seismically imaged here (including along-strike data). A steady-state magmatic development has clearly been established.



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DEADLINES FOR PROPOSAL SUBMISSION

1 January 1994 & 1 July 1994

Thematic panels will review new and revised proposals received at the JOIDES Office **not later than 1 January 1994** during their Spring meetings and rank those proposals within their mandate and interest. Highly-ranked proposals will be reviewed by the Site Survey Panel at its April 1994 meeting and monitored from then on.

Proposals (10 copies!) must be submitted to the JOIDES Office.

Proposals submitted directly to thematic panels are not reviewed.

Science Operator Prospectus Leg 153

DRILLING IN THE WESTERN WALL OF THE MARK AREA

DR. JEFFREY A. KARSON — CO-CHIEF SCIENTIST
DR. MATHILDE CANNAT — CO-CHIEF SCIENTIST
DR. D. JAY MILLER — ODP STAFF SCIENTIST

A complete Scientific Prospectus *for this leg is available from ODP, Texas A & M University, 1000 Discovery Drive, College Station, TX 77845-9547*

ABSTRACT

Leg 153 is scheduled to drill rocks believed to be representative of the lower crust and upper mantle created at a slow-spreading ridge. Two sites (proposed sites MK-1 and MK-2) have been selected in the MARK area (Mid-Atlantic Ridge near the Kane Transform) to achieve deep penetration into: 1) a gabbro massif (as well as a major detachment fault along which the gabbro has been unroofed); and 2) a serpentinized peridotite section along strike to the south of the gabbroic massif.

Both proposed sites are along the western rift-valley wall; gabbros and serpentinized peridotites are located 10 and 35 km south of the transform, respectively. Studies at these proposed sites will address a variety of tectonic, petrological, hydrothermal, and geophysical problems that are contingent upon the penetration of long continuous cores in deep crustal to upper mantle rocks in slow- spreading lithosphere. Major tectonic questions concerning the mechanisms responsible for deep crustal and upper mantle exposures along the rift-valley wall and the evolution of rift valleys may also be addressed.

INTRODUCTION

Two categories of data are critical to an understanding of oceanic spreading dynamics: 1) data on the magmatic processes which govern the formation of the oceanic crust (partial melting of mantle rocks, melt segregation and pooling, magmatic differentiation); and 2) data on the tectonic processes associated with the rise of new asthenospheric material, and with the stretching of the lithosphere in the axial domain. To understand the processes occurring in the lower crust and the mantle, direct information is essential and can be obtained from drill cores. Drilling can potentially provide relatively continuous cores and therefore may reveal the details of lithological and structural relationships. Drilled samples are also at least partially oriented with the axis of the core approximately vertical. The dip of the various sets of structures may be measured with respect to this reference line. In addition, there are ways to constrain the azimuth of the observed structures, either by using paleomagnetic data or by matching the cores with the images obtained with the FMS (formation microscanner) logging tool and by implementing the experimental hard rock orientation (HRO) system.

Recent studies of slow-spreading ridges suggest that magma chambers are not permanent. Investigations suggest that a complex interplay among magmatism, deformation, and hydrothermal processes may characterize seafloor spreading at slow-spreading ridges. Another characteristic of slow-spreading ridges is the common exposure of rocks of deep crustal and upper mantle origin (gabbros and serpentinized peridotites) in the axial valley walls and even within the axial valley. Different mechanisms have been proposed to explain the presence of peridotites cropping out on the seafloor, such as 1) relatively intense extension of the crust related to detachment faulting, 2) modest faulting of very thin crust created in areas of low magma budget, and 3) serpentinite diapirism related to penetration of seawater down to the mantle along major fault planes. In addition, the proximity of a major transform fault may also favor the exposure of rocks of deep origin by the formation of an intersection massif.

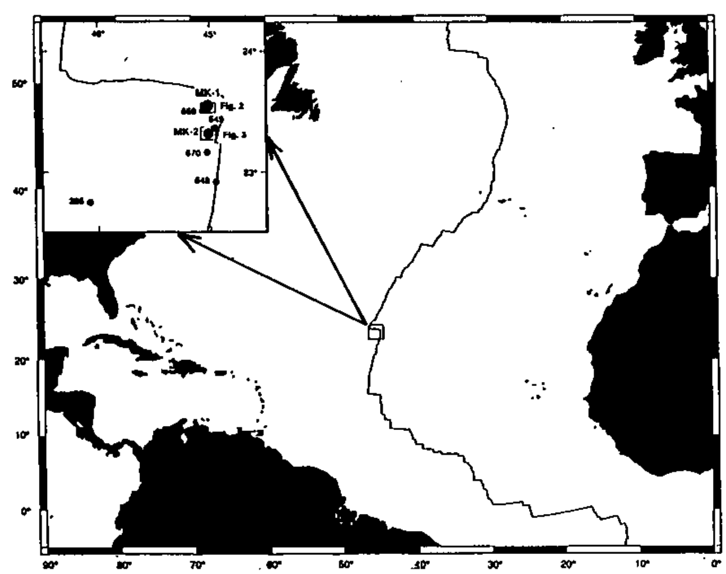

Figure 1. Location of the MARK area on the Mid-Atlantic Ridge. Inset shows Kane Transform, Site 395 (DSDP Legs 45, 78B, and ODP Legs 106 and 109), Sites 648 and 649 (ODP Leg 106), and Sites 669 and 670 (ODP Leg 109). Also shown are locations of proposed sites MK-1 and MK-2 (larger circles).

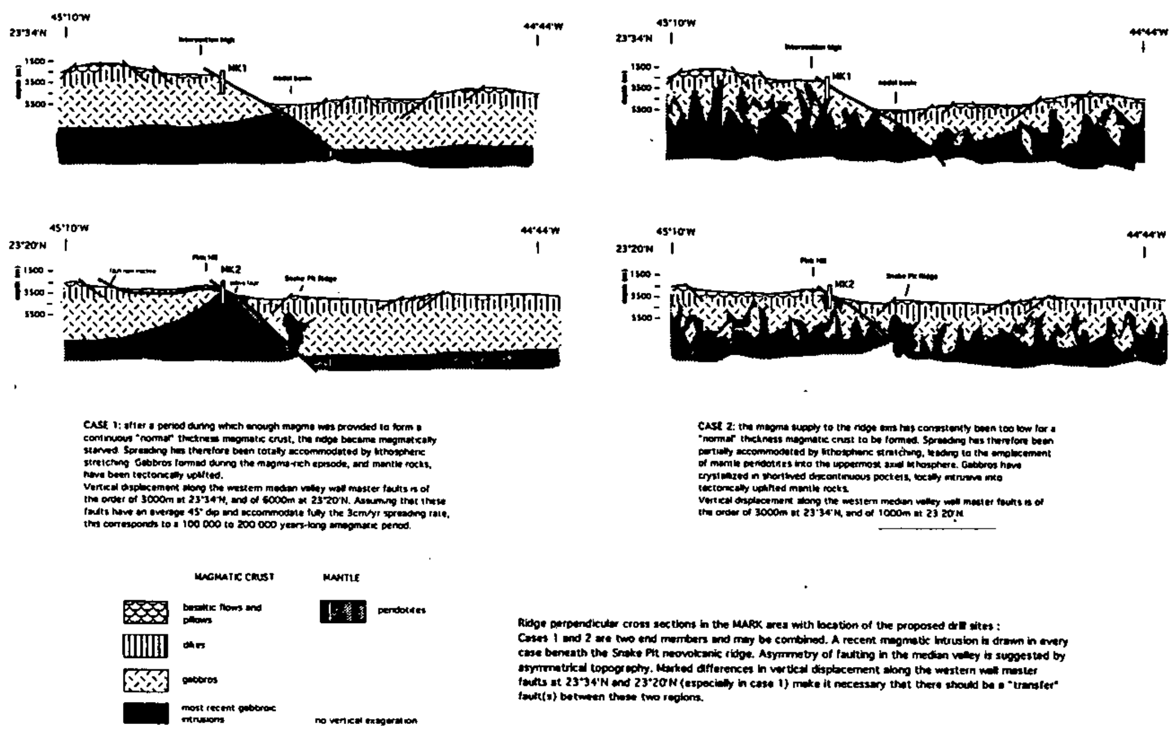

Figure 2. Alternative models for the crustal structure at proposed sites MK-1 and MK-2.

To better understand the processes involved in the formation and evolution of slow-spreading oceanic lithosphere, two holes have been proposed, one in rocks believed to be representative of the lower crust and one in rocks interpreted to be derived from the shallow mantle, exposed along strike in the western wall of the Mid-Atlantic Ridge (MAR) (Figures 1 and 2).

Study Area

Two drill sites (proposed sites MK-1 and MK-2) are proposed along the western wall of the MARK area (Mid-Atlantic Ridge at the Kane fracture zone) where detachment faults as well as gabbro and peridotite outcrops have been documented by both the *Alvin* and the *Nautile* dives.

South of the Kane Transform, the MAR is relatively linear with no major offset. The rift valley varies in width from 10 to 17 km. The inner floor deepens toward the north from 3500-4000 to 6100 m in the nodal basin marking the intersection with the Kane Fracture Zone. The ridge/transform intersection is characterized by a strong topographic asymmetry; the inside corner is a topographic high (1300 mbsl) contrasting strongly with the much lower outside corner (3500 mbsl).

Scientific Objectives

Whereas knowledge of the uppermost crust and basalt petrology is extensive at mid-ocean ridges, many of the hypotheses that have been proposed for the generation and evolution of basalts are conjectural and can be tested, and concepts fundamentally advanced, only by conducting detailed studies of long, continuous cores of cumulate mafic and cumulate and residual ultramafic rocks. Likewise, many of the alteration, structural, and physical properties studies rely on continuity of section. In addition to magmatic objectives, other general structural objectives require continuous core recovery. Very little information exists on the structural character of the lower crust. It is not known if the lower crust is penetratively or locally deformed, how strain is localized in the crust, how structures are oriented, or how structural style and orientation change with depth. Nor is there a clear picture of the relationships between fluid penetration and the evolution of ductile and brittle structures, the mechanism by which fluid penetrates into the ductile crust, or the general alteration state of the lower part of slow-spreading crust.

Drilling at proposed site MK-1 will allow sampling of a continuous section through a major detachment fault zone along which the deep-level gabbroic massif has been unroofed. The proposed drill site has been located by *Alvin* and visited by *Nautile*. It exposes a moderately dipping fault zone as well as gabbroic rocks and greenstones. Both rock types exhibit gneissic to cataclastic textures, developed under amphibolite to greenschist and lower metamorphic facies conditions. A continuous section drilled through this massif could identify the minimum thickness of the fault zone to determine if it is a likely candidate for dipping seismic reflectors. A single hole drilled into the gabbro exposed at the intersection massif will address major questions concerning the nature of the plutonic foundation of slow-spreading crust.

A hypothesis that could be tested at MK-2 concerns the structure and composition of the crust in areas of ultramafic exposures (Figure 2). Studies of peridotite and gabbro samples from the MARK area (Mével et al., 1991; Tartarotti et al., in prep.) and from the 15°N area of the Mid- Atlantic Ridge (Cannat et al., 1992) suggest that there may be gabbro pockets intrusive into the uplifted mantle peridotites. This arrangement is similar to that of some Western Alps ophiolites (Lagabrielle and Cannat, 1990) and differs significantly from the layered magmatic crust model suggested by marine seismic refraction studies and some ophiolite complexes. This model could be tested by a deep hole drilled into an axial valley peridotite outcrop. Implications of this model could also be examined at proposed site MK-1.

Drilling into exposed peridotites in a slow-spreading environment will also address the mode of uplift of upper mantle rocks in the axial region of the MAR. Leg 153 will examine if such properties allow for strain concentration and the development of detachment faults. The order of magnitude of deviatoric stresses and strain rates in the stretched axial region will also be examined and, in addition, the relative importance of the ductile- and brittle-strain domains which should vary as a function both of the rock rheology at the imposed strain rates, and of the temperature distribution in the axial lithosphere. Leg 153 will attempt to clarify the mechanisms by which water penetrates into the mantle (faults?), whether the rising mantle is serpentinized at great depths, and if serpentinite diapirism and swelling play a significant role in the uplift. Samples from proposed site MK-2 should allow petrographic paleo-deviatoric stress levels to be tested. Later investigations, such as borehole seismic experiments and possibly long-term in situ observations of seismicity and stress variations with time, could contribute to the understanding of tectonic processes operating near the spreading center.

Leg 153 also seeks to identify the source of magnetic anomalies. Gabbros and serpentinized peridotites form a significant part of the seafloor in slow-spreading environments, and the magnetic properties of these rocks, along with their ability to produce magnetic anomaly patterns, are an important aspect of the proposed project. Finally, proposed sites MK-1 and MK-2 will provide a data base for evaluation of ophiolites as samples of ridge-generated lithosphere, and for comparison with peridotites and gabbros from other environments such as the Hess Deep (ODP Leg 147), which was created at a fast-spreading center.

Drilling Plan/Strategy

Two drill sites are proposed (Figure 1 and 2) in the western wall of the rift valley, one through gabbros (MK-1) and the second through peridotites (MK-2). Each hole should be drilled to a depth of at least 200 m and as deep as possible within time constraints. These two holes should be drilled with the intent to be deepened on future legs to a depth of at least 500 - 1000 m in order to sample a representative section of the ocean crust and upper mantle at a slow-spreading ridge.

If drilling is successful, these two holes could be deepened and the MARK area could become a natural laboratory for the study of slow-spreading ridges. The two existing holes adjacent to the axial valley could be used for borehole seismic experiments to constrain the structure of the lithosphere and long-term observations, such as the variation of seismicity and stress with time.

The hole in the gabbros could be deepened. It has been suggested that the Moho is shallower in this region (Purdy and Detrick, 1986), and MK-1 may represent a hole that could potentially penetrate through gabbros to the seismic or petrological Moho at relatively shallow depths or, by later offset holes, eventually achieve full penetration of the gabbroic crust and penetrate these important petrological and/or seismic boundaries. If drilling proves successful, the potential exists for a long-term, multi-leg strategy of drilling a series of offset holes (or deepening existing holes) through the gabbros, starting in the proposed hole at MK-1.

Proposed Sites

Proposed Site MK-1

Proposed site MK-1 will be drilled through the major detachment fault in the gabbros to a depth of at least 200 m. During the *Alvin* and the *Nautile* dive programs near the ridge/transform intersection in the MARK area, gabbros have been observed on the east-facing slope between 6000 and 2200 mbsl. East-dipping (25°-45°) fault surfaces subparallel to surface slopes were observed along the western rift-valley wall. These faults exposed gabbroic rocks and greenstones. Gabbroic rocks sampled from these outcrops not only show brittle structures such as slickensides, veins, and microcracks, but also show ductile structures suggesting that this slope may represent a major detachment fault system along which footwall gabbroic massif has been unroofed. Some of these outcrops located during *Alvin* and *Nautile* dives and the particular drill site chosen have the added advantage of being at relatively shallow depths (2500 m).

Proposed Site MK-2

Proposed site MK-2 (Figs. 3 and 5) will be drilled in peridotites to a depth of at least 200 m. The second proposed drill site is located on the northern peridotite outcrop discovered with the *Alvin*. In this area, the summit of the western rift-valley wall forms a hill (the "Pink Hill"), which culminates at 2600 m. Morphologically youthful pillow basalts crop out at the top of this hill and in the median valley floor. The base of the slope, at about 3700 m, is talus composed of serpentinite and basalt fragments. Serpentinized peridotites crop out continuously from about 3500 to about 3200 m. The valley wall is a tectonically active slope, dominated by numerous east-facing normal faults. The actual fault planes are moderately to steeply dipping (40w to 70w). The contact between the serpentinized peridotites and the pillow basalts, which form the top of the wall, is concealed by talus. Two alternatives for the nature of this contact are likely. The basalts may conformably overlie the peridotites. Alternatively, basalts and peridotites may belong to two, tectonically juxtaposed blocks.

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Feature Article

Evolution of Downhole Measurement Systems

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The JOIDES Office wishes to thank Peter Lysne, DMP Chair, for letting the JOIDES Journal *publish the following article originally written as a contribution to the Continental Drilling Symposium held August 30 - September 1, 1993 in Potsdam, Germany*

Abstract

An often-cited example of the need for technology development arises from the lack of downhole tools suitable for use in thermal regimes. But a more general reason for development stems from the nature of scientific drilling in that work is conducted in regions of the Earth's crust that differ from the sedimentary regions of interest to the traditional logging industry. Thus, even well-established tools must be examined for data integrity and information content. Interactions between scientific drilling programs and industrial institutions can further this mission at a time when budgetary difficulties are manifest. These interactions will require guarantees that evolutionary systems are useful and practical; guidelines addressing such quality issues are under development within the Ocean Drilling Program.

Introduction

Thrusts in the geosciences are placing an ever-increasing demand on downhole measurement systems at a time when the potential for major strides forward are possible, but when contributions from the previously supportive hydrocarbon industry are almost non-existent.

The majority of downhole measurements used in scientific programs originated in the hydrocarbon industry where advances proceeded in a hand-over-hand fashion. The first documented measurements were made in 1927 when the Schlumberger brothers demonstrated that resistivity measurements could be used to make hole-to-hole correlations. Later, resistivity measurements were rendered quantitative when an empirical relation was established between the resistivity and porosity. Since porosity is of strategic importance, "Archie's Law" provided justification for the development of better downhole tools in the form of focused-electrode devices. But the resulting measurements revealed difficulties with Archie's interpretation, so shaley-sand models evolved. In turn, these models required input concerning clay content, and this need drove refinements in nuclear logging tools. This process of need-derived advancement continued until the severe depression of the hydrocarbon industry began in the early 1980s. Relatively few advances in downhole measurements have occurred in the past decade even though technological achievements make progress imminently feasible.

A transition in scientific thinking and energy-development strategies also occurred in the early 1980s. During this time, the Deep Sea Drilling Program was reborn as the Ocean Drilling Program, and strong continental drilling programs emerged in several countries. These programs moved away from the sedimentary basins of importance to the hydrocarbon industry, and soon it became apparent that common downhole tools and interpretive techniques were in need of modification. Concurrently, drilling into thermal regimes was initiated in the geothermal industry, and this drilling was advanced by several scientific endeavors. Unfortunately, the loose federation of geothermal and scientific interests was insufficient to sustain a thrust aimed at development of high-temperature tools. In fact, some advances made in the early 1980s have been lost due to an entrenchment of the high-temperature semiconductor industry. It is now apparent that funding constraints on scientific and industrial fronts are a major hurdle to understanding crustal matters, and that strong cooperative efforts must be initiated if momentum is to be gained.

The purpose of this paper is to assess downhole measurements as they pertain to scientific programs, and to note where collaborative efforts may be initiated. First, generic issues of tool response to formation and borehole conditions are addressed because they apply to all measurement systems. The paper then deals with the particular case of high-temperature tools because such tools are evolving, albeit slowly, in scientific and industrial programs. The next section puts forth the need for rules governing the development of measurement systems, and presents the set of governing conditions that were recently adopted by the Ocean Drilling Program. Finally, a view to the future is made.

Generic Issues

From the viewpoint of a logging specialist, physical properties fall into two categories: (1) primary properties that can be readily determined downhole, and (2) secondary properties that are of importance, but are difficult to measure directly using downhole instruments. The primary properties include quantities such as borehole shape, temperature, resistivity, sonic velocity, hydrogen content, and density. These properties often delineate quantities or features of interest, and they are used in hole-to-hole correlation. Furthermore, resistivity, sonic velocity, and density are necessary to calibrate surface geophysical studies. Secondary properties include porosity, permeability, mineralogy, oxidation state, and water saturation. These quantities may be determined from core, but core may not be available if drilling conditions are bad, if industry holes of opportunity are exploited for scientific purposes, or if budgetary constraints are over-riding.

Foundations for the measurement of primary properties are based on the defining equations of classical physics, on a knowledge of proper boundary conditions for the solution of the ensuing partial differential equations, and on a model for the material properties of the media surrounding the sonde. The material model contains one or more adjustable parameters that represent quantities of the first category. The adjustable parameters are obtained through routines that fit measured quantities (voltages, time differences, count rates, etc.) to the model. To illustrate these concepts, appropriate relations for four tools commonly used to determine porosity are listed in Table 1. Due to the importance of porosity to the hydrocarbon industry, resistivity, sonic, neutron, and gamma tools have received considerable attention in recent years. A cogent discussion of these and other tools has been published (Hearst and Nelson, 1985); a review of techniques used in scientific programs is also available (ODP, 1990).

The relevance of the material model plays an important role in evaluating a tool's response. For example, the response of a resistivity tool is based on Ohm's Law, a linear relation between the electric field and the current density. This material model is proper as long as the formation is isotropic and homogeneous on a scale that is large compared to characteristic volumes introduced in the solution of the differential equations that govern the tool's response. Similarly, the neutron tool used to measure hydrogen content is accurate as long as the porosity, the water saturation, and the amount of material with large thermal neutron absorption properties is constant within each characteristic volume. Such information is best obtained from core, although complete core is not needed. This situation illustrates that core and logs are complementary systems, and they should be used together to provide information at a minimum cost.

In the past, the solution of the differential equations governing a tool's response was tedious and often inexact due to the large characteristic volumes and symmetry constraints introduced to make the problem tractable (recall the problems that you did in graduate school). Thus, tools were calibrated in test pits designed to simulate the range of subsurface conditions that they were expected to encounter. This approach leads to the "dolomite", "limestone", or "sandstone" calibrations that are applicable to clean sediments, but of uncertain applicability to other materials.

Recently, fast computers using modern finite-element and Monte Carlo algorithms have mitigated the modeling problem since both very small characteristic volumes and three-dimensional geometries are tractable. Now the cost of evaluating a tool is far less than that encountered when test pits were a necessity, and the effect of subtle variations in the material models can be thoroughly explored *provided* knowledge of the interior workings of the tool are available. Unfortunately, some logging companies treat this information as proprietary. If cooperative companies cannot be found, re-development of an existing tool concept may be justified to insure a better understanding of important measurements.

Consider now the relations between primary and secondary properties. In principle, these relations are governed by basic physics, and appropriate relations could be found by following paths similar to those discussed above. However, geometrical issues are very complex and occur on a size commensurate with pore dimensions. Even the best computational techniques cannot solve such detailed problems. Perhaps statistical techniques will provide solutions. For the present, a major difficulty arises because correlations between primary and secondary properties are uncertain and ambiguous.

Table 1 lists several relations that have been used to tie primary properties to porosity. The ambiguity in these relations is emphasized by the over fifty variations of Archie's Law that have evolved over the years (a skeptic might note that Archie's Law is a linear fit on a log-log plot that implies no theoretical justification). Clearly, there is a need for a better fundamental understanding of relations between primary and secondary properties, and advances in the understanding of these relations will have a profound effect on both scientific and applied endeavors.

High-Temperature Tools

The issues that confront the geothermal industry present an illustration of the points raised in the previous section. An often-cited obstacle to downhole measurements in hot holes is that available tools are physically incompatible with the geothermal environment, and the cost of developing and maintaining a suitable tool suite exceeds the anticipated revenues from logging services. This point is certainly true. But a service industry can be supported only if its measurements are useful. Since interpretative techniques developed for hydrocarbon reservoirs are not proven in geothermal formations, a second obstacle is the general inability to relate log data to pertinent information. Thus the hand-over-hand evolutionary process is missing, and the development of a viable geothermal logging industry is impeded by the chicken-egg syndrome. Scientific programs can help overcome this impasse.

Hostile environment tools commonly found in the logging service industry are capable of operation up to 260° C so they are applicable to some, but not all, high-temperature formations. Furthermore, size constraints are imposed by the diamond coring techniques that are commonly used in scientific and geothermal exploration programs. Taken together, the temperature and the tool diameter provide criteria for the design of logging equipment. Given present needs and realistic technologies, a modern tool will be operable at the critical point of sea water (407° C , 289.5 bar), and it will be less than 50 mm in diameter so that it will fit through an "H" size coring bit and into an "N" size hole.

Conceptually, two classes of tools are able to meet these criteria. The first class utilizes a teflon (300° C maximum) or magnesium-oxide-insulated electrical wireline to transmit power and data between the tool and the surface. The second class is completely self-contained in that power is obtained from batteries, and data are stored in a memory system. Even though memory tools have been around for decades, they have not found common usage due to past limitations. This situation is changing rapidly due to improvements in digital technology.

Both classes of tools were used to make high-resolution temperature measurements in the VC-2B scientific corehole to 295°C, see Figure 1, and the results of this work had a major effect on the directions of tool development in the United States. While data were of equivalent quality, the tool using a teflon-insulated electric wireline failed about one-half of the time due to wireline or cable-head difficulties. Significantly, the memory tool has never experienced a data loss. This record includes the faithful recording of temperature excursions during fishing exercises made when the tool was twice dropped through 2.7 km of drill pipe during exercises on Leg 139. The

Tool	Underlying Physics	Bulk Material Model	Primary Property	Interpretive Model
Resistivity	Maxwell's Eqs.	Ohm's Law	resistivity	Archie's Law
Sonic	Newton's Eqs.	Hook's Law, density	sonic velocity	Wyllie's Law
Neutron	Boltzmann's Eq.	elemental composition of matrix, Z >	hydrogen content	ratio, pore water to 1bound water
Gamma	Boltzmann's Eq.	elemental composition of matrix	density	grain density

Table 1. Tools Commonly Used to Measure Porosity.

success rate, and the relatively low cost of memory tools has prompted the US Department of Energy and other US institutions to make a major thrust in their development.

While memory tools are inexpensive, logging scientists raise the issue that the memory concept is flawed by the lack of communication between the tool and the operator. The greatest concern is that a tool will fail, yet the logging run continue due to lack of information. Perhaps future tools will possess some means of communicating a failed condition to the surface. In any event, memory tools must possess reliability and quality to be credible.

In the same vein, logging strategies are often evolved on the basis of real-time data. Memory tools preclude this approach. This point is not as valid now as it was in the past since modern data-recording systems support languages that are "intelligent". Thus, a logging strategy that contains contingencies may be programmed into the tool. Finally, the power available in a battery operated tool is limited. This means that power-intensive measurements are constrained to short duration. Examples of instruments currently under development within the world community are: a precision pressure/temperature tool, a spectral gamma tool, a fluid sampler, a focused resistivity tool, and a fluid conductivity tool.

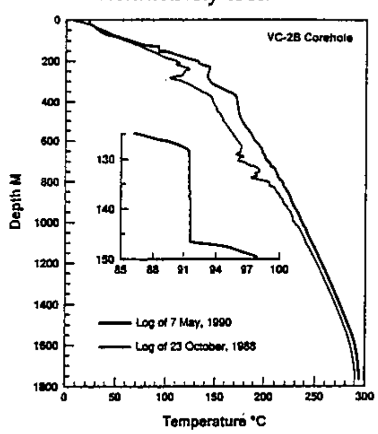

Figure 1. Temperature logs made in the VC-2B corehole, Valles Caldera, NM, USA. The log of May, 1990 was made shortly after circulation of drilling fluids was stopped, and it shows permeable zones of lost circulation that were candidates for fluid-sampling experiments. The insert illustrates the liquid-vapor interface after the fluid level in the hole had dropped to an equilibrium level, (Lysne, 1991).

ODP Guidelines for System Development

The Ocean Drilling Program (ODP) and associated institutions have maintained a modest effort in tool development for nearly a decade. While a few tools have been successful and have moved on into the industrial sector, many have languished due to an underestimation of the development difficulty and cost. Furthermore, engineering deficiencies in these "Third-Party" tools have resulted in inordinate expenditures of ship's time for a limited data return. Thus, the ODP has adopted a set of guidelines for tool development (ODP, 1992).

A feature of the ODP plan is that a *Principal Investigator* must be identified, and that this individual is the primary proponent for the development and use of the tool. Among other issues, this investigator must submit a plan that identifies development milestones, that makes provisions for land testing, that specifies the usefulness of the proposed measurements, and that contains a statement that the tool would be available for post-development deployment in the ODP. It is most important to note that Principal Investigator is tasked with leading the development of a measurement system, not just a tool.

An ODP tool development program follows a prescribed course consisting of three stages. A *Development Tool* is either a tool that is under development externally for use in the ODP or a tool that has been developed outside the ODP for other purposes, and is being considered for ODP deployment. Unlike tools in more advanced stages of development, the scientific success of a cruise cannot depend on a Development Tool.

After the development stage, the tool attains the status of a *Certified Tool*, and it may be an integral part of a scientific endeavor. The request for certification includes cost estimates for routine operation including data processing, details concerning spare parts, operating and maintenance manuals, and a demonstration of the usefulness of the data. A certified tool remains under the purview of the Principal Investigator.

Finally, a *Mature Tool* is an established tool that has become part of the ODP tool suite. Such a tool is effectively owned by the ODP.

The ODP guidelines for tool development are new and evolving. The tasks that are placed on the Principal Investigator are difficult, and require strong support from numerous scientific and engineering disciplines. This support will be costly. But the programmatic consequences of failed efforts are much more costly since failures stifle scientific innovation. It is not clear how the ODP will muster the necessary resources to support evolutionary efforts; it is clear that strong scientific rationale is necessary to justify their existence. The ODP, working through the entire JOIDES Panel structure, is forming a consensus regarding the evolution of downhole measurement systems. The resulting model will form the basis for a more general technology-development thrust that will influence all areas of the geological sciences.

Concluding Remarks

There is a clear need for new downhole measurement tools and interpretation techniques within the various scientific drilling programs. Furthermore, this need extends into institutions that are recovering resources from the crust, or using the crust as a repository for wastes. The depressed condition of the hydrocarbon industry precludes the strong advances that this sector offered to the science of downhole measurements in the past. However, the prevailing economic condition means that doors will be open for cooperation between the scientific and industrial institutions. It is proper and necessary for the scientific community to initiate cooperative ventures.

Acknowledgment

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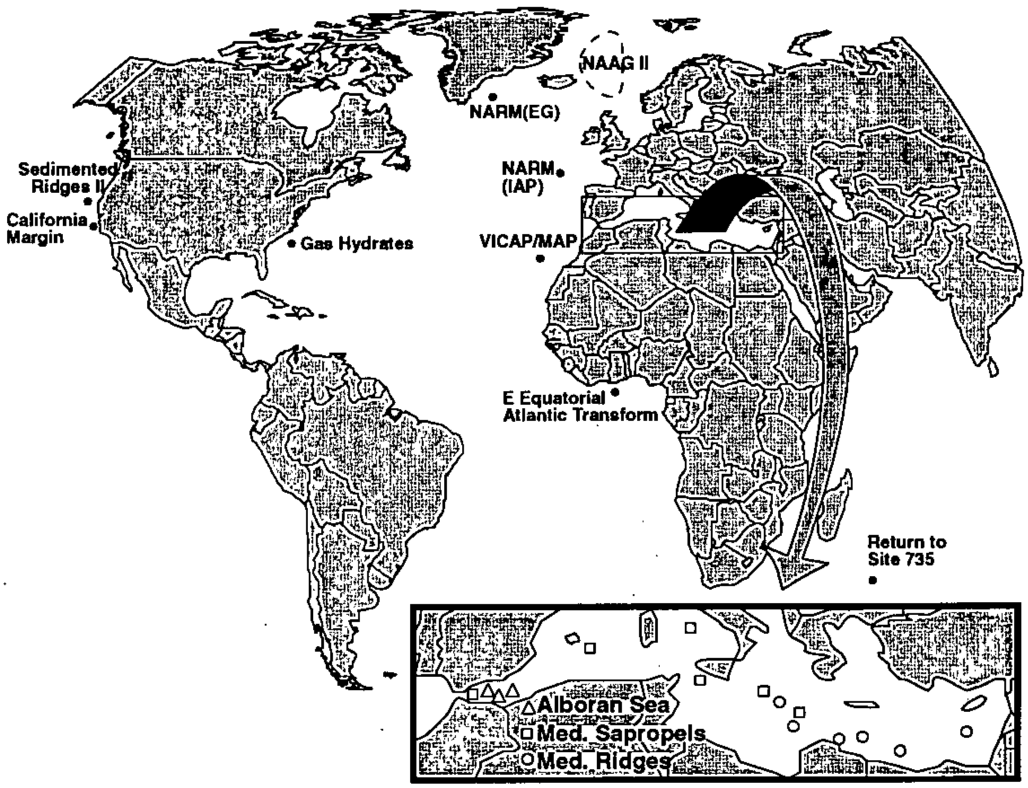
ODP Proposal News

PCOM Sets FY95 Prospectus

The first cut in the planning of science objectives for fiscal year 1995 was made at the PCOM meeting in August. A total of twelve potential legs were identified based on panel priority, scientific maturity, site survey readiness and location. The thematic panels, at their Fall meetings, may recommend other high-priority proposals be considered for scheduling The final decision on the FY95 schedule will be made at PCOM's December meeting.



Key	Proposal Title and Proponents (in italics)
Return to Site 735	**Return to Site 735: The Temporal and Spatial Variability of the Lower Ocean Crust at a Very-Slow Spreading Ocean Ridge** *H.J.B. Dick, S. Hart, J.H. Natland, P. Robinson, R. Stephen and R.P. Von Herzen*
Alboran Sea	**Tectonic Evolution of an Extensional Marine Basin in a Collisional Setting: The Alboran Sea** *M.C. Comas, A.B. Watts, V. García-Dueñas, R. Kidd, A. Maldonado, J. Platt, R. Stephenson and J. Woodside*
Med. Ridges	**Time Progressive Continental Collision: The Mediterranean Ridge Accretionary Complex in the Eastern Mediterranean (Phase 1 Shallow Drilling)** *A. Camerlenghi, E. Suess and M. Torres*
E Equatorial Atl.Trans.	**The Côte d'Ivoire Ghana transform (translational) margin (Eastern Equatorial Atlantic)** *J. Mascle, C. Basile, R. Scrutton, M. Moullade, and C. Ruppel*
VICAP/MAP	**Drilling into the Clastic Apron of Gran Canaria and the Madeira Abyssal Plain: Volcanic Island Evolution, Continental Margin Instability, Global Sealevel History and Basin Analysis** *H.-U. Schmincke, P. Weaver, P. Bogaard, S. Cloetingh, R. Cranston, J. Dañobeitia, A. Freundt, H. Hirschleber, K. Hoernle, I. Jarvis, R. Kidd, R. Rihm, M. Schnaubelt, R. Schuttenhelm, K. Stattegger, H. Staudigel, J. Thompson, A. Watts, W. Weigel, G. Wissmann and R. Zahn*
California Margin	**Ocean Drilling in the California Margin and Southern California Borderland** *M. Lyle, S.D. Stott and J. Barron*
Med. Sapropels	**Depositional History and Environmental Development During the Formation of Sapropels in the Eastern Mediterranean** *R. Zahn, M.B. Cita, G. de Lange, K-C Emeis and A. Cramp*

Gas Hydrate Sampling	**Gas Hydrate Sampling on the Blake Ridge and Carolina Rise: A Proposal to the Ocean Drilling Program** *C.K. Paull, W.P. Dillon, T. Collett, S. Holbrook, K.A. Kvenvolden, R. von Herzen, W. Ussler*
N Atl Arct. Gateways II	**North Atlantic - Arctic Gateways Detailed Planning Group Synopsis of February 1991 Meeting (Prepared by the North Atlantic-Arctic Gateways Detailed Planning Group, based on proposals 305----, 320---- and 336----)** *NAAG-DPG: W. Berggren, R. Heinrich, E. Jansen, L. Mayer, P.J. Mudie, W. Ruddiman (chairman) and T. Vorren*
N Atl. Rifted Margins	**North Atlantic Rifted Margins – Detailed Planning Group Report** *NARM-DPG members: G. Boillot, R. Buck, M.F. Coffin, M.C. Comas, O. Eldholm, G. Fitton, J. Hall, J. Hertogen, K. Hinz, D.R. Hutchinson, E.M. Klein, H.C. Larsen (co-chair), K.G. Miller, A.C. Morton, A, Saunders, D.S. Sawyer (co-chair), S.P Srivastava, and R.B. Whitmarsh.*
Sedimented Ridges II	**Sed Ridges II: Revision of the Sedimented Ridges Detailed Planning Group Drilling Strategy Based on Results of Leg 139 Drilling at Middle Valley** *J.M. Franklin and R.A. Zierenberg*

Proposals Received for the July 1 Deadline

The following is a list of the proposals received for the July 1 deadline. The proposals with numbers followed by four dashes indicate a completely new submission. These proposals will be reviewed by the Thematic Panels at their Fall meetings.

079-Rev2	**The Mesozoic Somali Basin: Tethys and the Birth of the Indian Ocean** *M.F. Coffin, A. Bosellini, J.E.T. Channell, W.W. Hay, H. Jenkyns, J.G. Ogg and P. Blum*
323-Rev3	**Tectonic Evolution of an Extensional Marine Basin in a Collisional Setting: The Alboran Sea** *M.C. Comas, A.B. Watts, V. García-Dueñas, R. Kidd, A. Maldonado, J. Platt, R. Stephenson and J. Woodside*
330-Add3	**Time Progressive Continental Collision: The Mediterranean Ridge Accretionary Complex in the Eastern Mediterranean (Phase 1 Shallow Drilling)** *A. Camerlenghi, E. Suess and M. Torres*
333-Rev2	**Cayman Trough: Ocean-Continent Boundary in a Transform Environment** *B. Mercier de Lépinay, P. Mann, U. ten Brink, E. Calais, and M.R. Perfit*
334-Rev3	**Galicia Margin S' Reflector** *G. Boillot, M.O. Beslier, D. Rappin, E. Banda and M.C. Comas*
346-Rev4	**The Côte d'Ivoire Ghana transform (translational) margin (Eastern Equatorial Atlantic)** *J. Mascle, C. Basile, R. Scrutton, M. Moullade, and C. Ruppel*
354-Add2	**Neogene History of the Benguela Current and Angola/Namibia Upwelling System** *G. Wefer, V. Spiess, U. Bleil, M. Breitzke, K. Gohl, R. Schneider and G. Ünzelmann-Neben*
372-Add2	**Cenozoic Evolution of Intermediate Water Circulation and Vertical Chemical Gradients in the North Atlantic** *R. Zahn*
386-Add	**Ocean Drilling in the California Margin and Southern California Borderland** *M. Lyle, S.D. Stott and J. Barron*
391-Rev2	**Depositional History and Environmental Development During the Formation of Sapropels in the Eastern Mediterranean** *R. Zahn, M.B. Cita, G. de Lange, K-C Emeis and A. Cramp*
400-Rev	**Determination of mass balance, fluid flow, and deformation mechanisms of the Middle America Trench and accretionary complex off Costa Rica** *E.A. Silver, K. McIntosh, M. Kastner, T. Plank, J. Morris, and T. Shipley*
406-Add	**North Atlantic Climatic Variability: Sub-Orbital, Orbital, and Super-Orbital Time Scales** *W. Broecker, G. Bond, D. Oppo, S. Lehmann, M. Raymo and T. van Weering*
408-Add	**Miocene Segmentation of the Carbonate Megabank covering the Northern Nicaragua Rise: Gateway Opening for the Initiation of the Carribean Current** *A.W. Droxler, A.C. Hine, P. Hallock, E. Rosencrantz, R. Buffler and A. Mascle*
412-Add2	**The Bahamas Transect: Neogene/Quaternary Sea-Level Fluctuations and Fluid Flow in a Carbonate Platform** *G.P. Eberli, D.F. McNeill and P.K. Swart*
415-Add	**Caribbean Ocean History, Ocean Plateau and the Cretaceous-Tertiary Boundary Impact Event: Multi-objective drilling in the Caribbean Sea** *H. Sigurdsson, S. Carey, S. D'Hondt, L.J. Abrams, T.W. Donnelly, R. Duncan and C. Sinton*
423-Add	**Gas Hydrate Sampling on the Blake Ridge and Carolina Rise: A Proposal to the Ocean Drilling Program** *C.K. Paull, W.P. Dillon, T. Collett, S. Holbrook, K.A. Kvenvolden, R. von Herzen, W. Ussler*
425-Rev	**Offset Drilling within the rift Valley of the Mid-Atlantic Ridge in the 15°20'N Region: Drilling of lower Crustal Gabbros, Mafic/Ultramafic Transition Zones, and Residual Mantle along Magma-starved Ridge Segments** *J.F. Casey, H.J.B. Dick, M. Cannat, H. Bougault, S. Silantyev and A. Sobolev*
427-Add	**High-Resolution Sequence Stratigraphy and Sea-Level History, South Florida Margin** *S.D. Locker, A.C. Hine, G.P. Eberli and E.A. Shinn*
432----	**A Deep Hole off Galicia to study the Mechanism of Continental Breakup: Sedimentary and Subsidence History and the Nature of the S Reflector** *T.J. Reston, G. Boillot, M.-O. Beslier, C.M. Krawczyk, and J.-C. Sibuet*
433----	**A Proposal to Test a new Theory of Orogeny by Drilling the Eastern Mediterranean Sea, especially the area in the Vicinity of the Eratosthenes "Seamount"** *K.J. Hsü, G. Udintsev, J. Makris, X. Le Pichon, Y. Mart and W. Ryan*
434----	**Late Quaternary climate variability in the tropical Caribbean/Atlantic region: A proposal for Ocean Drilling in the Cariaco Basin (Southern Caribbean)** *L.C. Peterson*
435----	**Crustal Fluxes into the Mantle at Convergent Margins: Nicaragua and Izu-Marianas Margins** *T. Plank, M.J. Carr and J.B.Gill*
NARM-Add	**NARM - Non-volcanic Transect I: Deep Drilling in the Northern Newfoundland Basin** *J.A. Austin, J-C Sibuet, S.P. Srivastava, B.E. Tucholke*
NARM-Add2	**Amendment to the North Atlantic Rifted Margin Detailed Planning Group Report (Narm-DPG): Volcanic Margin Transect East Greenland (EG63-transect)** *H-C Larsen, C.K. Brooks, K.G. Cox, and T.D.F. Nielsen*
SR-Rev2	**Sed Ridges II: Revision of the Sedimented Ridges Detailed Planning Group Drilling Strategy Based on Results of Leg 139 Drilling at Middle Valley** *J.M. Franklin and R.A. Zierenberg*

ODP International News

MOU's Signed !

In a process that began over two years ago, NSF and the JOIDES international partners have completed the first renewal of ODP. That is Britian, France, Germany, The European Science Foundation, and Japan have signed new Memorandimums of Understanding (MOU) which constitute a committment to the Program until at least 1998. The Can-Aus Consortium has signed an extension to the existing MOU and will have 7/12 of a full membership for the next year. This unusual arrangement will provide the Consortium with the opportunity to finding an additional partner.

JOI Has a New President

Joint Oceanographic Institutions Inc., the Prime Contractor for the Ocean Drilling Program, has a new President. He is Admiral James D. Watkins, US Navy (Retired). Admiral Watkins served for four years as US Secretary of Energy until January 1993; was Chairman of the Presidential Commission on the AIDS epidemic from 1987-88; and prior to that time was on active duty for thirty-seven years in the Navy, during the last four years of which he served in its highest position, Chief of Naval Operations. It was during this final Navy assignment that Admiral Watkins issued his strong, new policy regarding oceanography and the Navy in April 1984. At that time he reaffirmed the Navy's need for a strong and effective Naval Oceanography Program, stating: "The Navy must reassert to the Fleet and the Nation that we will maintain our preeminence and national leadership in oceanography." He also directed a seven-point action program to carry out the new policy which highlighted: graduate education in the multiple disciplines that constitute the oceanographic field; significantly enhanced career paths; programs to support modern, state-of-the-art platforms at sea; and augmentation of cooperative efforts with academia, industry, other federal agencies, and foreign governments.

His enthusiasm for the importance of basic science spilled over into both his AIDS Commission and his Department of Energy work. For example, as Secretary of Energy, he frequently expressed his concern that ocean science had not been sufficiently elevated to its proper place in national decision-making, particularly during debates on such important issues as global climate change and global environment. The JOI Board of Governors asked Admiral Watkins to take the Presidency of JOI and to help them institutionalize a new process by which the academic ocean science community might more effectively and efficiently participate in establishing enhanced partnerships with the federal agencies and international entities involved in ocean research. The Admiral is looking forward to working with the international community to enhance participation in the Ocean Drilling Program. His broad experience and international connection will be a great benefit to the Drilling Program.

5th ECOD Workshop, Davos, Switzerland

September 18 - 20, 1994

Drilling Marginal Basins and Gateways Past, Present, and Future ODP Drilling

Organizers:: Judith A. McKenzie & Helmut Weissert, Geological Institute, ETH-Zentrum, CH-8092 Zürich, Switzerland

The ESCO Secretariat is pleased to announce that an ECOD Workshop will be held in Davos, Switzerland, 18-20 September, 1994. The meeting will take place in Davos Dorf, a small town in southeastern Switzerland. The town is easily reached by train from Zürich airport (3 hours). The hotel/meeting place will be the Hotel Seehof located near the train station. The cost from Saturday night until Wednesday morning, including room, breakfast, dinner and mid-meeting fieldtrip will be ≈ SFr 450/person (≈ US $ 330) for single occupancy. Attendance is limited to 85 people.

The ECOD workshops are held biennially to provide a forum for communication among interested earth scientists representing the 12 member nations. The workshop will be built around two half-day morning scientific sessions, consisting of a mixture of invited talks and volunteered presentations. Afternoon sessions will address past, present, and future drilling proposals, including the most recent results reported by ESF shipboard scientists. Evening working group sessions will be devoted to development of new and pending ESF proposals. A one-day, mid-meeting field trip is offered for all participants to bring us together for "free-wheeling" discussions at the site of and exhumed fragment of Mesozoic Tethys ocean floor.

The 1st Circular on the ECOD Workshop, including registration form, is available upon request to Birgit Jorgensen or Naja Mikkelsen, ESCO Secretariat, Geological Survey of Denmark, Thoravej 8, DK-2400 Copenhagen NV, Denmark Fax: +45 31 19 68 68 e-mail: bj@dgu1.dgu.min.dk (internet)

Preliminary registration form must be submitted before 1st November, 1993.

Canadian Secretariat to Relocate

The Canadian Secretariat for the Ocean Drilling Program will have a new home later this year. The office has been at Memorial University of Newfoundland under the directorship of John Malpas since 1988. The new secretariat will be chosen following a bidding process which closes in October. The office of the Can-Aus Consortium will now move to the Australian ODP Office.

ODP European Logging School to be Held in Brussels, Belgium

DECEMBER 16 - 17, 1993

The ODP logging school will be held in Brussels in the EC Center December 16 - 17, 1993. The European Commission will collaborate in the organization of this meeting through the Human Capital and Mobility program. The logging school is intended primarily for scientists from the ESF Consortium interested in the Ocean Drilling program but scientists from other European countries are invited to attend. Participation is limited to fifty people and the school is free of charge but attendees must pay there own travel and lodging expenses.

The school will be arranged with a mixture of classes and demonstrations of software and hardware. The classes will be organized by the Lamont Doherty Earth Observatory (LDEO) logging group in cooperation with Schlumberger, Paris.

For information on the European logging school contact:
Professor Laust B. Pederson, Uppeala University, Dept. of Geophysics, Section of Solid Earth Physics, Villavaegen 16,S-752 36 UPPSALA, Sweden. Tel (+46)-18-182385, FXA (+46)-18-501110,
E-mail : lbp@geofys.uu.se

Please send your application to him as soon as possible if you attend to apply for the logging school. He will collect all applications and if necessary make a selection from amongst the participants. He will also keep participants informed about the school, preferably via E-mail. The application should contain your name, address, position, any ODP related work, etc.

ODP Logging School at American Geophysical Union Meeting

SUNDAY, DECEMBER 5, 1993

Tha Lamont-Doherty Earth Observatory's Borehole Research Group will hold an ODP Logging School in conjunction with the fall meeting of the American Geophysical Union. The school will be held in the Holiday inn Golden Gateway, 1500 Van Ness Ave., San Francisco. Attendance will be limited to fifty.

For more details on the logging school or to apply contact:
Katherine Rodway, Program Manager, Borehole Research Group, Lamont-Doherty Earth Observatory, Palisades, NY 10964, Tel: (914) 365-8672, fax: (914) 365-3182, Internet: rodway@ldeo.columbia.edu

Japanese ODP Workshop — "New Era of Ocean Drilling"

FEBRUARY 3, 1994

At the June meeting of the JOIDES Executive Committee (EXCOM), representatives from the Science and Technology Agency (STA) of Japan and the Japan Marine Science and Technology Center (JAMSTEC) presented a proposal entitled "New Era of Ocean Drilling". In essence, this is a proposal to construct and operate a new deep-sea research drilling vessel. The Program would be carried out through the shared resources of participating countries.

The proposal identified potential focal points such as Understanding the Structure of the Ocean Crust, Understanding the Dynamics of Plate Movement, and Understanding Changes in the Earth's Environment.

The preliminary design specifications for the drilling vessel include a drilling system having maximum capabilities of coring 2000 - 4000 mbsl in 7000m of water. The system would have the ability to drill into formations measuring 400°C while making downhole measurements to temperatures of 300°C.

In light of this proposal and the Planning and Executive Committee's commitment to steer the program into the next century, a workshop focusing on future platform requirements will be convened in Kyoto, Japan, on February 3, 1994. The workshop will be a cooperative effort between EXCOM and STA/JAMSTEC and take place immediately following the EXCOM meeting. *For more information please contact the JOIDES Office.*

Policy Update for Wireline Re-entry of DSDP and ODP Boreholes

At their January 1993 meeting, EXCOM amended their 1987 policy for wirelie re-entry of DSDP and ODP boreholes to the following (changes shown in bold):

The JOIDES Executive Committee actively encourages the use of the Deep Sea Drilling Project and Ocean Drilling Program boreholes for scientific purposes by both the D/V *JOIDES Resolution* and independent vessels through wireline re-entry. The drilling program has historically sought to maintain a catalog of hole conditions for those sites with installed re-entry equipment in order to facilitate scientific planning. In order to maintain such a list and to protect JOIDES interests in future use of these holes, the JOIDES Executive Committee requests that parties desiring to use any of these holes seek endorsement of the **Planning Committee, through the JOIDES Office**, prior to their use. In addition, a written report to the Science Operator on the state of the holes used is requested following the conduct of these experiments. We trust that all member institutions and governments will adhere to this agreement and will ensure that all announcements and reports are made in a timely fashion.

Liaison Group & Earth Science News

Fifth International Conference on Paleoceanography

October 10 - 14, 1995

The Fifth International Conference On Paleoceanography will be held 10 - 14 October, 1995 in Halifax, Nova Scotia, Canada. The theme of the conference is "**Linkages**" with special topics including:

Remote Sensing	Ice Core Records
Ocean - Atmosphere Linkages	The Arctic - The missing link
Continent - Ocean Linkages	High Latitude - Low Latitude Linkage

Seafloor- Seawater Linkages (JGOFS and Flux Records)
Physical Links Gateways and short-term tectonic events
Modeling - The link between the past, present and future
Tools and Proxies: Developments and Applications

Deadline for Abstracts is May 1, 1995

For more information on the Fifth International Conference On Paleoceanography please contact:
Larry Mayer or Frank Rack, Ocean Mapping Group, Dept. of Surveying Engineering, PO Box 4400 Fredericton, NB Canada E3B 5A3, Internet: larry@atlantic.cs.unb.ca or rack@atlantic.cs.unb.ca

or: David Piper, Atlantic Geoscience Centre, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, NS Canada B2Y 4A2, Internet: piper@agcrr.bio.ns.ca

Global Sedimentary Geology Program — 1992-1992 Activities

Research Project: Createceous Resources, Events and Rhythms

An *Atlas of Cretaceous Carbonate Platforms* consisting of some 40 case histories is being edited for a special publication of AAPG by Toni Simo (Wisconsin) and Robert Scott (Amoco). A second collection of papers on Paleoenvironmental Models of Platforms is being assembled by Jean Philip (France). The Carbonate Platform Working Group organized a workshop on platform sedimentation that was held in Tremp, Spain in August, 1992 and it also put on a half day session of papers at the AAPG-SEPM Convention in New Orleans in June 1993.

The Working Group on K/T held a workshop in Tunisia during the Spring of 1991 that attracted fifty participants. Two days were spent collecting closely-spaced samples from the Le Kef K/T section that is the proposed type section for the boundary. To settle a controversy over the interpretation of the extinctions of foraminifera across the boundary, splits of these samples are being analyzed by several micro-paleontologists.

Research Project: Albicore-Apticore

A new initiative on greenhouse climates and oceans of the mid-Cretaceous was sparked by a working group in our project Cretaceous Resources, Events and Rhythms. The working Group on Cyclostratigraphy headed by Alfred Fischer, first proposals a test of global synchronous sedimentations through a study of widely spaced cores of Albian carbonates. Subsequently, a connection developed between this Albian initiative and a proposal by Roger Larson to study the effect of volcanism on the climates in the Aptian. With the support from JOI/USSAC, Fischer and Larson organized a five-day Workshop held in Perugia, during early October, 1992 that attracted 74 scientists from 18 countries. The plan for assembling a global database to test ideas of greenhouse climates and Milankovitch rhythms is available free of charge from JOI Inc. (*see* JOIDES Journal *Bulletin Board*).

Research Project: Pangea

A second GSGP research project was developed during the week long workshop organized by George Klein (Illinois) and Benoit Beauchamp (GSC, Calgary) that was held in May 1992 at the University of Kansas. With the support of NSF, the co-conveners assembled 65 experienced researchers and 15 graduate students from 13 countries. The objectives of Project Pangea developed by the workshop are: 1) to understand global processes during the development and demise of the super continent Pangea; 2) characterize the special features of the global sedimentary record from Pennsylvanian to Middle Jurassic; 3) determine climatic variability during Pangenian time and seek explanations for it; 4) examine the relationships between extensions and the sedimentary records of environments, climates and sea level fluctuations.

GSGP was co-sponsor of the International Symposium on Pangea organized by the Canadian Society of Petroleum Geologists that was held in Calgary, August, 1993.

GSGP Program Development Committee

R. Ginsberg, USA (Chair)
P. Cook, UK
E. Flügel, Germany
V. Gostin, Australia
V. Kurnosov, Russia
A. M'Rabet, Tunisia
W. Schlager, Netherlands
S. Shu, China
L. Spalletti, Argentina

INTERRIDGE UPDATE

InterRidge has moved forward in several respects during the past few broadcast mailing, the Global component of the program selected the Indian Ridges and the Pacific-Antarctic Ridge for focused coordination efforts in the near term. An open meeting was held in Paris on April 8-9, 1993, to discuss next steps in coordinating research in these areas; the meeting report will be available from the InterRidge Office. Four major areas of interest were delineated: SW Indian Ridge, SE Indian Ridge, Pacific-Antarctic Ridge, and Arctic ridges. "Particular priority" should be focused on the Pacific-Antarctic Ridge.

The Meso-Scale Working Group, under the leadership of Martin Sinha, has focused its efforts into three components: (1) Segmentation at Mid-Ocean Ridges; (2) Crustal Accretion in Marginal Basins; and (3) Quantification of Fluxes at Mid-Ocean Ridges. Each of these subgroups is planning a workshop, as follows:

Ridge Segmentation -- Progress Toward Predictive Models (Symposium)

Convenors: Roger Searle, Jian Lin, and John Sinton
Dates: September 22-23, 1993
Location: University of Durham, UK

Segmentation Workshop

Convenors: Roger Searle, Jian Lin, and John Sinton
Dates: September 24-25, 1993
Location: University of Durham, UK

Fluxes Workshop

Convenors: H. Elderfield and C. Mével
Dates: September 24-25, 1993
Location: University of Durham, UK

Marginal Basins Workshop

Convenors: Julian Pearce and Kensaku Tamaki
Dates: October 11-13, 1993
Location: Seattle, Washington, USA

Please contact subgroup convenors for further information about the results of these workshops.

The Active Processes Working Group is currently being constituted under the leadership of J. Cann (Leeds); probable subgroups include (1) Ridge-Crest Observatory, including system design, power supplies, sensor development, and communications; and (2) Event Detection and Response, focusing on detection techniques, communications network, baseline surveys, and response conduct. A workshop will probably be convened in late 1993.

The roster of "official" InterRidge member countries is growing. Principal members include France, Germany, Japan, Spain, UK, and US. Canada, Iceland, and Portugal are likely to sign on as Associate members for 1993; Australia is likely to become an Associate member in 1994; and discussions are ongoing in other countries.

The InterRidge Steering Committee will probably meet in October-November 1993 to assess progress of the program to date. No venue has yet been selected for this meeting.

The next InterRidge General Meeting is likely to be held in early 1994. Germany has offered to host the meeting; details will be forthcoming.

CONTINENTAL SCIENTIFIC DRILLING

On August 30 - September 1, 1993 the Coordinating Committee on Continental Drilling (CC-4) on behalf of the International Lithosphere Program convened a symposium in Potsdam, Germany, to explore the establishment of an International Continental Drilling Program.

The goal of the Potsdam meeting was to make the case for scientific drilling to address key problems in the earth sciences irrespective of scientific discipline, the required depth of the boreholes, or the optimal location for drilling. Thus, like the COSOD (Conferences on Scientific Ocean Drilling) meetings of the Ocean Drilling community, the intent was to be as comprehensive as possible in the scope, concentrating on as many exciting research questions as possible that can be addressed through scientific drilling regardless of the location or depth of the required hole(s).

The symposium was subdivided into group sessions in the following themes:

Basin Evolution
Calibration of Crustal Geophysics
Ocean-Continent Margins and Continental Accretion
Earth History and Climate
Dynamics and Deformation of the Lithosphere
Volcanic Systems and Thermal Regimes
Crust/Mantle Interaction
Convergent Plate Boundaries and Collision Zones
Fluids in the Earth's Crust
Origin of Mineral Deposits
Impact Structures and Mass Extinctions
Current Drilling, Coring and Sampling Technology

The groups met separately and then in joint sessions with the goal of producing a report summarizing the key scientific questions that would be addressed throught scientific drilling and examples of the types of projects that could be carried out throught international cooperative efforts.

Following the Potsdam meeting, represenatitives of a number of countries met to discuss the nature of a possible ICDP. A resolution recommending establishment of such a program was broadly supported by the various national represeatatives and a steering committee was appointed to pursue this further..

For more information on Continental Scientific Drilling please contact either of the Co-Chairs:

Prof. Mark D. Zoback, Department of Geophysics, Stanford Univ., Stanford, CA 94305, Ph. 415-725-9295, Fax 415-725-7344, zoback@pangea.stanford.edu

Prof. Rolf Emmermann, GeoForschungsZentrum, Telegrafenberg A17, O-1561 Potsdam, Germany, Ph. 49-331-310310, Fax 49-331-22824

Bulletin Board

Funding for Site Survey Augmentation

JOI/U.S. Science Support Program has Site Survey Augmentation funds available to supplement drilling site data sets during any phase of planning. This program element includes support for:

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

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

Contact Ellen Kappel, JOI Inc. office, for further information and proposal guidelines: (202) 232-3900, Internet: ekappel@iris.edu.

JOI/USSAC Ocean Drilling Fellowships

JOI/U.S. Science Advisory Committee is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both one-year and two-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward the objectives of a specific leg or to broader themes.

Applications should be submitted according to the following schedule:

Shorebased Research (regardless of leg)	**12/1/93**
Shipboard Research (Legs 159 - 164)	**5/1/94**

For an application and descriptions of the upcoming legs contact:

JOI/USSAC Ocean Drilling Fellowship Program
Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102
Internet: joi@iris.edu

For additional information, call Andrea Leader (Tel: 202-232-3900, Fax: 202-232-8203)

Now Available!

APTICORE - ALBICORE
Global Events and Rhythms of the Mid-Cretaceous

APTICORE: Roger L. Larson, Elisabetta Erba, conveners
ALBICORE: Alfred G. Fisher, Isabella Premoli Silva, conveners

The report of the international workshop on the Cretaceous Greenhouse Coring Project is now available.

For a free copy of the report please contact:

JOI/USSAC, Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., NW, Suite 800,
Washington, DC 20036-2102 Internet: joi@iris.edu

ODP Promotional Material

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

Coring Poster

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

Brochures

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

Reprints

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

Norwegian-Greenland Sea Atlas

Co-editors: Kathy Crane & Anders Solheim
Co-Sponsors: JOI/USSAC & the Norwegian Polar Institute

Data contributions: side-looking sonar, multibeam bathymetry, gravity, magnetics, seismic reflection/refraction, etc.

Available in November 1993 from JOI Inc.

For a copy of the atlas please contact:
JOI/USSAC, Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., NW, Suite 800,
Washington, DC 20036-2102 Internet: joi@iris.edu

ODP Open Discussion Bulletin Board via Bitnet

The ODP BITNET LISTSERVER is a discussion bulletin board service to which individuals subscribe *via* Bitnet. It permits exchange of information among all subscribers. Currently, the list administrator, Linda Weatherford, 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 reviewed before being distributed.

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 message to Linda Weatherford (Weatherford@tamodp or Weatherford@nelson.tamu.edu) requesting that you be added to the ODP-L subscription list.

WINDOWS TO THE PAST

Discovering Earth's Future

A New Video from the Ocean Drilling Program!

"Windows to the Past: Discovering Earth's Future" introduces you to the Ocean Drilling Program (ODP), the world's largest basic research program in earth and ocean sciences. ODP scientists sail the world's oceans to learn more about Earth's processes locked in the sediment and rocks beneath the seafloor. Join them on this journey; their adventure has just begun. This video was produced by the Biomedical Communications Department, Texas A & M University Health Science Center in conjunction with the Ocean Drilling Program at Texas A & M University.

For copies of this 20 minute video contact:

Agatha Moy, Ocean Drilling Program, Texas A & M University Research Park,
1000 Discovery Drive, College Station, TX 77845-9547
Internet: moy@nelson.tamu.edu

ODP Science Operator

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

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

	Init. Reports		*Sci. Results*	
	Vol.	**Pub.**	**Vol.**	**Pub.**
Leg 101	101/102	Dec 86	101/102	Dec 88
Leg 102	101/102	Dec 86	101/102	Dec 88
Leg 103	103	Apr 87	103	Dec 88
Leg 104	104	July 87	104	Oct 89
Leg 105	105	Aug 87	105	Oct 89
Leg 106	106/109/111	Feb 88	106/109	Jan 90
Leg 107	107	Oct 87	107	Feb 90
Leg 108	108	Jan 88	108	Dec 89
Leg 109	106/109/111	Feb 88	106/109	Jan 90
Leg 110	110	Apr 88	110	May 90
Leg 111	106/109/111	Feb 88	111	Dec 89
Leg 112	112	Aug 88	112	May 90
Leg 113	113	Sept 88	113	Aug 90
Leg 114	114	Nov 88	114	Feb 91
Leg 115	115	Nov 88	115	Sept 90
Leg 116	116	Jan 89	116	Sept 90
Leg 117	117	June 89	117	Feb 91
Leg 118	118	May 89	118	July 91
Leg 119	119	Sept 89	119	Sept 91
Leg 120	120	Nov 89	120	May 92
Leg 121	121	Nov 89	121	Nov 91
Leg 122	122	Jan 90	122	Dec 91
Leg 123	123	June 90	123	May 92
Leg 124	124	June 90	124	Sept 91
Leg 125	125	Aug 90	125	Apr 92
Leg 126	126	Aug 90	126	Aug 92
Leg 127	127	Sept 90	127/128	Sept 92
Leg 128	128	Sept 90	127/128	Sept 92
Leg 129	129	Dec 90	129	Dec 92
Leg 130	130	Mar 91	130	Apr 93
Leg 131	131/132	June 91	131	Apr 93
Leg 132	131/132	June 91		
Leg 133	133	Sept 91		
Leg 134	134	Mar 92		
Leg 135	135	May 92		
Legs 136/137	136/137	Jan 92		
Leg 138	138	Sept 92		
Leg 139	139	Aug. 92		
Leg 140	140	Sept. 92		
Leg 141	141	Dec 92		
Legs 142/143	142/143	Apr 93		
Leg 144	144	Aug 93		
Leg 145	145	Aug 93		

ODP Bibliography & Databases

Scientific Prospectuses and Preliminary Reports

	Prospectuses		*Prelimin. Rpts.*	
	Vol.	**Pub.**	**Vol.**	**Pub.**
Leg 148	48	Oct 92	48	Apr 93
Leg 149	49	Nov 92	49	June 93
Leg 150	50	Mar 93		
Leg 151	50	Apr 93		
Leg 152	52	May 93		
Leg 153	53	July 93		

Technical Notes

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

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

No. 6: *Organic Geochemistry aboard* JOIDES Resolution- *An Assay* (1986)

No. 7: *Shipboard Organic Geochemistry on* JOIDES Resolution (1986)

No. 8: *Handbook for Shipboard Sedimentologists* (1988)

No. 9: Deep Sea Drilling Project data file documents (1988)

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

No. 11: *Introduction to the Ocean Drilling Program* (1988)

No. 12: *Handbook for Shipboard Paleontologists* (1989)

No. 13: *Stone Soup—Acronyms and Abbreviations used in the Ocean Drilling Program* (1993)

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

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

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

No. 17: *Design and Operation of a Wireline Pressure Core Sampler (PCS)* (1992)

No. 18: *Handbook for Shipboard Paleomagnetists* (1993)

No. 20: *Science Prospectus; FY93-FY94 Atlantic Program* (1993)

No. 21: *Design and Operation of a Drill-in-Casing System* (1993)

No. 22: *Safety Procedures o n board the* SEDCO/BP 471 (JOIDES Resolution) (1993)

Cumulative Index to 96 DSDP Volumes Now Available

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

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

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

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

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

Index sets (US$50), *Proceedings* (US$45 each, plus postage), *Prospectuses, Preliminary Reports* and *Technical notes* (free) can be obtained from:

Publications Distribution Center
Ocean Drilling Program
1000 Discovery Drive
College Station, Texas 77845
U.S.A.

Phone: (409) 845-2016;
Fax: (409) 845-4857;
Internet: Fabiola@nelson.tamu.edu

Sample Distribution

The materials from Legs 144 and 145 are now available for sampling by the general scientific community. This means that the twelve-month moratorium on cruise-related sample distribution is complete for Ocean Drilling Program legs 101 - 145. Scientists who request samples from these cruises are no longer required to contribute to *ODP Proceedings* volumes, but must publish in the open literature.

All requests received at ODP are entered in the Sample Investigations Database. Anyone may request a search. Some common types of searches include: on-going research from particular holes or legs, current research in a specified field of interest, or publications resulting from DSDP or ODP samples.

For details contact: Assistant Curator, Chris Mato
Phone: (409) 845-4819, Fax: (409) 845-4857
Bitnet: CHRIS@TAMODP
The Assistant Curator takes an average of 1.5—2 weeks to review each request.

Other Items Available

- Brochure: *The Data Base Collection of the ODP - Database Information*
- Ocean Drilling Program brochure (English, French, Spanish, German or Japanese)
- *ODP Sample Distribution Policy*
- Micropaleontology Reference Center brochure
- Instructions for Contributors to *Proceedings of the ODP* (Revised Oct. 92)
- *ODP Engineering and Drilling Operations* (New)
- Multilingual brochure with a synopsis of ODP (English, French, Spanish, German and Japanese)
- ODP Posters (Ship and coring systems posters)
- *ODP After Five Years of Field Operations* (Reprinted from the 1990 Offshore Technology Conference proceedings)
- Brochure: *On Board* JOIDES Resolution
- Brochure: *Downhole Measurements in the Ocean Drilling Program—A Scientific Legacy*

Contact: Karen Riedel
ODP Public Information Office,
Phone: (409) 845-9322; Fax: (409) 845-0876
Internet: Riedel@nelson.tamu.edu

Data Available from ODP

ODP data currently available include all DSDP data files (Legs 1-96), geological and geophysical data from ODP Legs 101-137, and all DSDP/ODP core photos (Legs 1-137). 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. 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 Macintosh- or PC-formatted disks, magnetic tape, hard-copy printouts, or through BITNET or Internet.

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

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

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.

Contact: Data Librarian *Phone: (409) 845-8495, Fax: (409) 845-0876*
BITNET: DATABASE@TAMODP *Internet: database@nelson.tamu.edu*

Data Available from the National Geophysical Data Center (NGDC)

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

Volume I of the set contains all sediment/hardrock files, the Cumulative Index, bibliographic information, age and fossil codes dictionaries, an index of DSDP microfilm, sediment chemistry reference tables, and documentation.

Volume II contains all digital logging data from the DSDP. All data are in the Schlumberger Log Information Standard (LIS) format. All DSDP underway and geophysical data are on disc 2, including bathymetry, magnetics, and navigation in the MGD77 format (no data for Legs 1-3; navigation only for Legs 4, 5, 10, 11; SEG-Y single channel seismic data not included). Volume II also contains the DSDP Core Sample Inventory and color/monochrome shaded relief images from several ocean views.

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

Information from DSDP Site Summary files and digital DSDP geophysical data are fully searchable and available. 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 are: $90/2-disc CD-ROM data set, $90/magnetic tape, $30/floppy diskette, $20/microfilm reel, $12.80/copy of Rept. MGG-1, $10/copy of Rept. MGG-4. Prepayment is required by check or money order (drawn of a U.S. bank), or by charge to VISA, Mastercard, or American Express. A $10 handling fee is added to all shipments ($20 for foreign shipments), and a $15 fee is added to all rush orders. Data Inventory searches of correlative (non-DSDP) geological/geophysical data available from NGDC are available at no charge.

For details on available NGDC data contact:
Marine Geology and Geophysics Division,
NOAA/NGDC, E/GC3, Dept. 334, 325 Broadway, Boulder, CO 80303
Tel (303) 497-6339; Fax 303-497-6513) Internet cjm@ngdc1.colorado.edu.

ODP Editorial Review Boards (ERB)

For each ODP cruise, an editorial board is established to handle review of the manuscripts intended for publication in the "Scientific Results" volume of the *Proceedings of the Ocean Drilling Program*. These boards consist of the Co-Chief Scientists (*) and the ODP Staff Scientist (**) for that cruise, one outside scientist (***) selected by the Manager of ODP Science Operations in consultation with the cruise Co-Chief Scientists, and an ODP Editor. These boards are responsible for obtaining reviews and for making decisions concerning the acceptance or rejection of papers. A chairman for each ERB, usually a Co-Chief Scientist, has been elected since Leg 120. The names of scientists serving on ERBs for Legs 130 through 147 are listed below.

Leg 132 (Engineering II):
Dr. J. Natland* (Univ. Miami)
Dr. F. Rack** (ODP-TAMU)

Leg 133:
Dr. P. Davies* (Univ. Sydney, Australia)
Dr. J. McKenzie* (ETH, Zurich, Switzerland)
Dr. A. Palmer-Julson** (ODP-TAMU)
Dr. R. Sarg*** (Midland, TX)

Leg 134:
Dr. G. Greene* (USGS, CA)
Dr. J. Collot* (Lab. Geod.,Villefranche, France)
Dr. L. Stokking** (ODP-TAMU)
Dr. T. Crawford*** (U. Tasmania, Australia)

Leg 135:
Dr. L. Parson* (Inst. Oceanog. Sci., UK)
Dr. J. Hawkins* (Scripps, UCSD), chair
Dr. J. Allan** (ODP-TAMU)
Dr. P. Weaver*** Sediment. (Inst. Oceanog. Sciences, UK)
Dr. J. Resig*** Paleontology (Univ. Hawaii)

Leg 136:
Dr. R. Wilkens* (Univ. Hawaii)
Dr. A. Dziewonski* (Harvard Univ.)
Dr. J. Firth** (ODP-TAMU)
Dr. J. Bender*** (Univ. N. Carolina)

Leg 137/140:
Dr. K. Becker* (Univ. Miami)
Dr. J. Erzinger* (Univ. Giessen, Germany), chair
Dr. H. Dick* (WHOI)
Dr. L. Stokking (ODP-TAMU)

Leg 138:
Dr. L. Mayer* (Univ. New Brunswick, Canada)
Dr. N. Pisias* (Oregon State Univ.), chair
Dr. T. Janecek** (ODP-TAMU)
Dr. T. van Andel*** (Univ. Cambridge, UK)

Leg 139:
Dr. E. Davis* (Pac. Geo. Centre, BC, Canada)
Dr. M. Mottl* (Univ. Hawaii)
Dr. A. Fisher** (ODP-TAMU)
Dr. J. Slack*** (USGS, Reston, VA)

Leg 140:
(See Leg 137/140)

Leg 141:
Dr. S. Lewis* (USGS, Menlo Park, CA)
Dr. J. Behrmann* (Univ. Giessen, Germany)
Dr. R. Musgrave** (ODP-TAMU)

Leg 142:
Dr. M. Storms* (ODP-TAMU)
Dr. R. Batiza* (Univ. Hawaii)
Dr. J. Allen ** (ODP-TAMU)

Leg 143:
Dr. W. Sager* (TAMU)
Dr. E. Winterer* (Scripps, UCSD)
Dr. J. Firth** (ODP-TAMU)
Dr. J. Sinton*** (Univ. Hawaii)

Leg 144:
Dr. J. Haggerty* (Univ. Tulsa)
Dr. I. Premoli-Silva* (Univ. Milan)
Dr. F. Rack** (ODP-TAMU)

Leg 145:
Dr. I. Basov* (Russian Acad. Sci.)
Dr. D. Rea* (Univ. Michigan)
Dr. J. Baldauf** (ODP-TAMU)

Leg 146:
Dr. B. Carson* (Lehigh Univ.)
Dr. G. Westbrook* (Univ. Birmingham)
Dr. B. Musgrave** (ODP-TAMU)

Leg 147:
Dr. K. Gillis* (WHOI)
Dr. C. Mevél* (Univ. Pierre et Marie Curie)
Dr. J. Allen** (ODP-TAMU)

Leg 148
Jeff Alt* (Univ. Michigan)
Hajimu Kinoshita* (Univ. Tokyo)
Laura Stokking** (ODP-TAMU)

Leg 149
Dale Sawyer (Rice Univ)
Robert Whitmarsh (Deacon Lab, Surrey, UK)
Adam Klaus (ODP-TAMU)

Leg 150
Greg Mountain* (LDEO)
Kenneth Miller* (Rutgers Univ.)
Peter Blum** (ODP-TAMU)

Leg 151
Annik Myhre* (Univ. Oslo)
Jörn Thiede* (GEOMAR)
John Firth** (ODP-TAMU)

Leg 152
Hans Christian Larsen* (Geol. Surv. Greenland)
Andrew Saunders* (Univ. Leicester)
Peter Clift** (ODP-TAMU)

Leg 153
Mathilde Cannat* (Univ. P. et M. Curie)
Jeffrey Karson* (Duke)
Jay Miller** (ODP-TAMU)

Leg 154
Bill Curry* (WHOI)
Nicholas Shackleton* (Cambridge Univ.)
Carl Richter** (ODP-TAMU)

Leg 155
Roger Flood* (SUNY-Stoney Brook)
Adam Klaus** (ODP-TAMU)

Leg 156
Tom Shipley* (UTIG)
Yujiro Ogawa* (Univ. Tsukuba)
Peter Blum** (ODP-TAMU)

Wireline Logging Manual (Latest Edition, Sept. 1990)

To receive a copy, please contact Larry Sullivan
(tel.914-365-8805 fax:914-365-3182) InterNet:sullivan@ldeo.columbia.edu
For inquiries about wireline tools in ODP contact:
Manager of Technical Operations, Borehole Research Group
Lamont-Doherty Earth Observ., Palisades, NY 10956
Ph: 914-365-8734, Fax: 914-365-3182, Internet: borehole@lamont.ldeo.columbia.edu

Guide to Third-Party Tools

Downhole Measurements in the Ocean Drilling Program: A Scientific Legacy

For copies of these documents and inquiries about all other downhole tools in ODP contact:
Dr. Philip D. Rabinowitz, Director, Ocean Drilling Program, Texas A & M University, 1000 Discovery Drive, College Station, TX 77845 USA
Phone: 409/845-2673, Fax: 409/365-3182, Internet: moy@nelson.tamu.edu

ODP Wireline Logging Services

Borehole Research Group, Lamont-Doherty Earth Observatory, Palisades, NY 10964.

ODP Wireline Log Database

The ODP Wireline Log Database comprises data from 49 legs, including both original and processed data, conventional Schlumberger logs and specialty tools (borehole televiewer, multichannel sonic, and temperature), borehole images and sonic waveforms. The entire database is catalogued through a Macintosh-based system which is updated routinely and which allows for the information about the logs recorded at each hole to be easily accessed. In addition, the data management program contains information on over 800 data requests fulfilled to date.

Wireline Log Data Distribution Policy

Data distribution onboard. All of the logging data acquired on each ODP leg are available onboard to each member of the scientific party. A form to request analog/digital data is distributed onboard or mailed to each scientist after the end of the leg.

Currently, digital data is available onboard in two formats: DLIS or ASCII. The latter is available for conventional logs (acoustic, nuclear, geochemical, electrical) which have been preliminary edited by the logging scientist(s) and transferred to the ship main Vax cluster for distribution through the network. In addition, processed Formation Microscanner data are made available as soon as possible after preliminary processing in a format (Portable Bit Map) compatible with a number of graphic applications on different computer platforms (Macintosh, SUN, VAX, IBM/PC). Starting with Leg 149 and the installation of MAXIS onboard, the DLIS format has replaced the LIS format; for those scientists who will not be able to read the new format, a conversion program will be available at LDEO-BRG to perform the translation.

Data distribution on-shore. The original logging data is available at the well log data repository about 3 weeks after the end of the cruise. Each data request must be made using the appropriate form, specifying log type and format.

Schlumberger Data. Schlumberger digital data include conventional (acoustic, nuclear, geochemical, electrical) and Formation MicroScanner logs. The original, unshifted and unprocessed data is available in LIS/DLIS format. The processed conventional logs are available in LIS (on magnetic tape) or ASCII format (on magnetic tape or 3.5" diskette). Schlumberger sonic waveforms are available in LIS/DLIS or binary format on magnetic tape. Conventional logs are also available in analog format on blackline at the metric scale 1:500.

The processed Formation MicroScanner/Dipmeter data are available in LIS (on DAT tape; legs 129-140 and 143 on), ASCII (on 3.5" diskette; legs 135-140 and leg 143 on), and PBM formats (on DAT tape; leg 139 and leg 143 on). Formation Microscanner/Dipmeter data are also available in analog format on blacklines at two different scales (metric 1:6 and 1:40).

Other Data. Multichannel Sonic data are available in BRG or binary format (on magnetic tape). Analog Borehole Televiewer data are available in analog form only (Xerox copies of original Polaroid photographs); Digital Borehole Televiewer data are available on TK50 cartridges. Most temperature data are available as ASCII files of temperature and pressure versus time.

CD-ROM. Starting with leg 143, the processed well log data is available on CD-ROM as well (a leg 139 CD-ROM will be soon available as well). The ODP-BRG CD-ROM includes:

- processed FMS data in LIS (Log Information Standard) format (leg 143 only)
- FMS image raster files in PBM (Programmable Bit Map)
- dipmeter data (ASCII format)
- conventional logs (ASCII format)
- BRG temperature tool data (ASCII format)
- text/information files (ASCII format)

Note that all of the above data are available free of charge to members of the scientific community. Any request, however, not conforming to the standards listed in the request form (ex. particular graphic presentation, multiple formats or media for the same dataset, etc.) will be subject to charge.

The scientific community at large has access to the logging data a year after the end of each leg. Interested scientists, however, can obtain the logging data before the 1-year moratorium upon approval of the co-chiefs and the shipboard party; like the rest of the shipboard party these scientists will have the obligation of submitting a scientific or data report for the ODP Scientific Results volume.

Data can be requested at the address indicated above or through electronic mail. Scientists who request duplication of a significant number of tapes are required to provide the tapes necessary for the duplication.

Any request of data from commercial firms (ex. oil companies, consulting agencies etc.) should be addressed to the National Geophysical Data Center in Boulder, Colorado, where the unprocessed data are sent after the one-year moratorium.

Wireline Log Data Requests and Communications via Electronic Mail

The Borehole Research group can receive data requests and queries electronically by two paths. The first path is through our mailbox on **OMNET**. The address of this mailbox is "borehole". It is checked every day. The second path is over **InterNet**. Lamont-Doherty has a T3 class connection to the Internet so data file transfer over the net is a practical option in addition to handling electronic mail. Data transfer via **ftp** can be arranged. The primary contact points for outsiders are the following:

- **borehole@ldeo.columbia.edu** (general purpose account)
- **chris@ldeo.columbia.edu** (Cristina Broglia, Data Services Supervisor, for database and log analysis related questions)
- **barnes@ldeo.columbia.edu** (Deborah Barnes, Database Assistant and CD-ROM Coordinator, for data requests and CD-ROM development/status)
- **beth@ldeo.columbia.edu** (Elizabeth Pratson, Senior Log Analyst, for log analysis related questions)
- **filice@ldeo.columbia.edu** (Frank Filice, Technical Operations Manager, for questions related to Schlumberger services, and specialty and third party tools).

ODP Site Survey Databank

Lamont-Doherty Earth Observatory, Palisades, NY 10964

The JOIDES/ODP Data Bank received the following data between May 1, 1993 and August 31, 1993. For additional information on the ODP Data Bank, please contact Mr. Dan Quoidbach at Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, Internet: daniel@ldeo.columbia.edu.

-From H. Bougault (IFREMER): Three bathymetry maps related to ODP proposal 425 "Drilling the lower crust and upper mantle at 15oN, Mid-Atlantic Ridge".

-From A. Camerlenghi (Osservatorio Geofisico Sperimentale): For ODP proposal 330-Rev (Mediterranean Ridge): position maps of all the site survey data available; 3.5 kHz records of Ban-91 lines 8 to 16, and Ban-89a lines 3 to 7 and 14; core logs and location of BAN-84, BAN-86, MD-69, BAN-88, BAN-89, and BAN-84; navigation map of PRISMED cruise of R/V NADIR that collected MCS lines on the Katia transect area; heat flow data and a paper describing the lithology and significance of the BAN-84 cores.

-From M. Cannat (Universite Pierre et Marie Curie): PAL video tape with a selection of *Nautile* dives images from the Faranaut cruise, relevant to the proposed drilling sites 1A and 1B (Mid-Atlantic Ridge area, proposal 425).

-From M. Comas (Instituto Andaluz de Geologia Mediterranea): MCS lines regarding the deep hole at the new proposed Site Alb-1 and alternate Site Alb-1A, as well as basement depth contour maps, bathymetry and navigation for Alboran, proposal 323-R.

-From W.B. Curry (WHOI): Core data for inclusion in the JOIDES proposal 388 - Leg 154 data sets (Ceara Rise).

-From A. Droxler (Rice University): Various SCS profiles for Northern Nicaragua Rise; proposal 408-R.

-From R. Flood (SUNY): In support of ODP proposal 404: plots showing locations of ship tracks on the Blake/Bahama Outer Ridge where there is GLORIA data; locations of ship tracks where LDEO collected seismic profiles and 3.5 kHz profiles and bathymetric map.

-From Geol. Surv. Greenland: nav. plot for NGT lines - Leg 151.

-From M. Hansen (The Geological Survey of Greenland): Copy of GGU seismic line GGU/80-13 and location map for Leg 151.

-From W. Hieke (Technische Universitat Munchen): Copies of 11 high resolution SCS lines Valdivia cruise no. 120 (MEDRAC) and page-size navigation. Med. Ridge area, proposal 330.

-From K. Hinz (BGR): EXPLORA BGR Line 79-201 for New Jersey Margin.

-From K. Hinz (BGR): Navigation, MCS profile of Line BGR-31 and a report regarding NAAG, Norwegian Greenland Sea, Jan Mayen, proposal 320.

-From K. Hinz (BGR): SONNE SO81/3 cruise report. Hess Deep - 1992.

-From Karl Hinz (BGR): For Leg 151 - East Greenland sites: Progress Report No. 9 - Evolution of North Atllantic Volcanic Margins; For Leg 151 - Fram sites: MCS profiles of line BGR-31 and navigation plot.

-From H.B. Hirschleber (U. Hamburg): List of latitude/longitude citations for Meteor 16.4 (beginning, ends and crossings only). For VICAP-MAP.

-From K. Kastens (LDEO): 3.5 kHz data for Med. Ridge; proposal 330.

-From K. Kastens and E. Bonatti (LDEO): Vema Fracture Zone 3.5 kHz data, navigation and bathymetry.

-From L. Keigwin (WHOI): Copies of navigation and SCS lines and one section of 3.5 kHz record from R/V KNORR 31 in support of JOIDES proposal #404, "NW Atlantic Sediment Drifts: Bermuda Rise/Blake Bahama Outer Ridge". Also a 3.5 kHz record.

-From D. Kempler (The Hebrew University of Jerusalem): Copy of contoured bathymetry map from Udintsev & Krashenninikov for Eratosthenes Seamount in Med. Ridge area.

-From R. Kidd (University of Wales): Navigation, P.D.R. echosounder, OKEAN sidescan, MCS and SCS profiles for various lines from cruise UN93L; 3.5 kHz and SCS sparker for Line BAN 89 for Med. Ridge (Eratosthenes Seamount) and Med. Sap. (MEDSAP 2B site) areas; proposals 330, 391-R.

-From S.D. Locker (USF): In support of JOIDES proposal 427, South Florida Margin, navigation and SCS sections. Eleven lines are digital records collected in 1992 aboard the R/V BELLOWS. One blueline copy is an analog graphic recording from the R/V SUNCOASTER in 1990.

-From M. Lyle (Boise State University): Site and line location on NOAA SeaBeam bathymetry maps; SCS and MCS profiles from Lee cruise L4-90, Farnella cruise F3-84 and others and selected data in support of JOIDES proposals 386/Rev2 and 422/Rev, "Ocean Drilling in the California Margin and Southern California Borderland".

-From S.B. Marstal (Geological Institute, Aarhus Universitet): Seismic sections from cruise METEOR 24; two shotpoint maps, one with all high-resolution reflection seismic profiles from the cruise and one with profiles processed in Aarhus with proposed drilling sites plotted re VICAP-MAP drilling proposal 380-Rev3.

-From G. Mountain (LDEO): Core data and 34 SCS profiles of lines from Ewing 9202 cruise (Ceara Rise area); proposal 388-R.

-From G. Mountain (LDEO): Navigation plot; 3.5 and SCS lines from EWING cruise 9009; EXXON MCS line 77-8; SeaBeam from ATLANTIS II cruise 120. Positions of oil wells and test wells drilled on the New Jersey Margin area. Also, navigation for East Coast USGS MCS lines 18 through 38. For New Jersey Margin.

-From A. Myhre (University of Oslo) and C. Marcussen (The Geological Survey of Greenland): Navigation plot for EGM site and navigation listings for Leg 151.

-From C. Paull (University of North Carolina, Chapel Hill): Navigation, heat flow and core data, MCS and SCS profiles for Blake Ridge/ Carolina Rise/ Gas Hydrates; proposals 423, 404.

-From C.K. Paull (The University of North Carolina at Chapel Hill): Lists of piston core sites and lengths and heat flow measurements made on the Carolina Continental Rise and Blake Ridge; 26 MCS profiles (various processes) and map of CDP lines in support of ODP proposal 423-Rev entitled "Gas Hydrate Sampling on the Blake Ridge and Carolina Rise: A Proposal to the Ocean Drilling Program".

-From R. Rihm (GEOMAR): Bathymetry, navigation and location maps; list of MCS profiles obtained during METEOR cruise nr. 24; MCS, SCS and Parasound profiles, from METEOR 24. and selected data in support of JOIDES proposal 380-R3, VICAP-MAP.

-From K. Sloth (Geological Survey of Denmark): Twenty-six MCS profiles from the Geological Survey of Greenland and the Geological Institute at the University of Aarhus, cruise GGU/EG92. In support of proposal 393, NARM, East Greenland.

-From J. Thiede (GEOMAR): MCS profiles for NAAG, North and South Iceland Faroe Ridge - Leg 151.

-From USGS, Woods Hole: Navigation data for BGR line 201. For New Jersey Margin area.

-From G. Wefer (Universitat Bremen): A seismic data report on the ODP site survey cruise (RV SONNE SO-86) with attached page-size seismics for proposal 354. Angola/Namibia area.

-From E. Weigelt (Alfred-Wegener-Institute fur Polar-und Meeresforschung): Page-size navigation plot and listings and AW1911 lines for Leg 151.

-From C.A. Williams (Cambridge U.): Geophysical Data Report of the Eastern Mediterranean Sea. RSS SHACKLETON cruises 3/72, 5/72, 1/74. For Med. Ridge.

-From J. Woodside (Free University, Amsterdam): Navigation for several SHACKLETON cruises (for seismics in East Mediterranean bound report).

-From R. Zahn (GEOMAR): For Med. Sap. and Med. Ridge: SCS tracks, MCS tracks, bathymetric map of Eratosthenes Seamount; R/V Tyro cruise report, SCS lines SC-1-SC-6 (Sicily Channel/Gela Bank); navigation, 3.5 kHz and airgun profiles along lines MR-1 through MR-6 (Menorca Rise); navigation, 3.5 kHz, sparker and echosounder profiles and location map plus core logs of various Bannock cores. Copy of the Initial Report for Site 116 (Hatton-Rockall Basin); proposals 330, 391-R and 372.

Micropaleontological Reference Centers

Micropaleontological Reference Centers (MRC)

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

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

Establishment of identical paleontological reference collections around the world will help researchers to unify studies on pelagic biostratigraphy and paleoenvironments, and to stabilize taxonomy of planktonic microfossils.

Researchers visiting these centers may observe quality of preservation and richness of a large number of microfossils, enabling them to plan their own requests for either ODP or DSDP deep-sea samples more carefully. Visitors to MRCs also may compare actual, prepared faunas and floras (equivalent to type material) with figures and descriptions published in DSDP *Initial Reports* or ODP *Proceedings* volumes.

Facilities at MRCs

All MRCs maintain complete, identical collections of microfossil specimens.

In addition, the following materials and equipment are available for visitor use:

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

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Selected Acronyms and Abbreviations

MC .... axial magma chamber
BGR .... Bundesanstalt fur Geowissenschaften und Rohstoffe
BGS .... British Geological Survey
BHA .... bottom-hole assembly
BHTV .... borehole televiewer
BMR .... Bureau of Mineral Resources
BRGM .... Bureau de Recherches Geologiques et Minieres
BSR .... bottom-simulating reflector
CSG .... Computer Services Group (ODP)
DCB .... diamond core barrel
DCS .... diamond coring system
DI-BHA .... drill-in bottom-hole assembly
DP .... dynamic positioning
DPG .... Detailed Planning Group
DRB .... DCS retractable bit system
ECOD .... ESF Consortium for Ocean Drilling
FMS .... formation microscanner
FY .... fiscal year
HRB .... hard rock guide base
HRO .... hard rock orientation
IFREMER .... Institut Francais de Recherche pour l'Exploitation de la Mer
InterRidge .... International Ridge Inter-Disciplinary Global Experiments
IRIS .... Incorporated Research Institutions for Seismology
JAMSTEC .... Japan Marine Science and Technology Center
JGOFS .... Joint Global Ocean Flux Studies
JOI-BOG .... JOI Board of Governors
KTB .... Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland
LAST .... lateral stress tool
LRP .... Long Range Plan
mbsf .... meters below seafloor
MDCB .... motor-driven core barrel
MOU .... memorandum of understanding
MOR .... mid-ocean ridge
MRC .... Micropaleontological Reference Center
MST .... multi-sensor track
NADP .... Nansen Arctic Drilling Program
NAS .... National Academy of Sciences
NERC .... Natural Environment Research Council (UK)
NGDC . National Geophysical Data Center
NSERC . National Science and Engineering Research Council (Canada)
OBS .... ocean bottom seismometer
ODPC .... ODP Council
OSN .... Ocean Seismic Network
PCS .... pressure core sampler
PDC .... poly-crystalline diamond compact (drilling bit)
PEC .... Performance Evaluation Committee
RFP .... request for proposals
RFQ .... request for quotes
RIDGE .... Ridge Inter-Disciplinary Global Experiments (US)
ROV .... remotely-operated vehicle
SCM .... sonic core monitor
SCS .... single-chan nel seismic
SES .... sidewall-entry sub
SOE .... Special Operating Expense
SOW .... Statement of Work
STA .... Science and Technology Agency (of Japan)
USSAC US Scientific Advisory Committee
USSSP .... US Science Support Program
VPC .... vibra-percussive corer
VSP .... vertical seismic profile
WG .... Working Group
WOB .... weight on bit

FY93 Science Programs:

504B	deepening Hole 504B (Leg 148)
NARM NV-I	North Atlantic Rifted Margins non-volcanic, first leg (Leg 149)
NJ/MAT	New Jersey / Middle Atlantic Transect (Leg 150)
NAAG-I	North Atlantic Arctic Gateways, first leg (Leg 151)

FY94 Science Programs::

NARM V-I	North Atlantic Rifted Margins volcanic, first leg (Leg 152)
MARK	Mid-Atlantic Ridge at Kane fracture zone (Leg 153)
Ceara Rise	Leg 154
Amazon Fan	Leg 155
N. Barbadoes Ridge	Leg 156
DCS-VE3	Diamond Coring System engineering leg at the Vema fracture zone (Leg 157)
TAG	Trans-Atlantic Geotraverse Hydrothermal Field (Leg 158)

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New JOIDES Office FTP Site on moby2.ocean.washington.edu IP number 128.95.252.41

The following information is now available from the JOIDES Office via anonymous FTP on moby2.ocean.washington.edu; FTP (File Transfer Protocol) is the primary method of transferring files over Internet, it is often the name of the program that implements the protocol. File transferring normally requires a user to have an id on the system they are transferring files to/from. However, with an anonymous FTP site, the JOIDES Office can make files publicaly available to anyone with FTP capabilities without the necessity for user ids. Editor's Note: If you want to find out more about FTP or the Internet, I would recommend *The Whole Internet* by Ed Krol (1992)

Acess via:	**ftp moby2.ocean.washington.edu**
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Subdirectory	Contents
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/pub/JOIDES/Meetings	JOIDES Meeting schedules
/pub/JOIDES/Minutes	JOIDES Panel minutes
/pub/JOIDES/Proposals	site summary forms and proposal submission guidelines

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The information contained within the *JOIDES Journal* is preliminary and privileged and should not be cited or used except within the JOIDES organization or for purposes associated with ODP. This journal should not be used as a basis for other publications.

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Special Issue No. 2: Initial Site Prospectus, Supplement One, April 1978 (Vol. III)
Special Issue No. 3: Initial Site Prospectus, Supplement Two, June 1980 (Vol. VI)
Special Issue No. 4: Guide to the Ocean Drilling Program, September 1985 (Vol. XI)
Special Issue No. 4: Guide to the Ocean Drilling Program, Suppl. One, June 1986 (Vol. XII)
Special Issue No. 5: Guidelines for Pollution Prevention and Safety, March 1986 (Vol. XII)
Special Issue No. 6: Guide to the Ocean Drilling Program, December 1988 (Vol. XIV)
Special Issue No. 7: Ocean Drilling Program Guidelines for Pollution Prevention and Safety, Oct., 1992 (Vol. 18)

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Logging information — Logging Schools

JOIDES Resolution Operations Schedule

Leg	Destination	Cruise Dates	In Port †	Total days	Transit	On Site
152	E. Greenland Margin	Sept. 29 - Nov. 24, 1993	Reykjavik, Sept. 24 - 28, 1993	56	6	50
153	MARK	Nov. 29 - Jan. 24, 1994	St. John's, Nov. 24 - 28, 1993	56	10	46
154	Ceara Rise	Jan. 29 - March 26, 1994	Barbados, Jan. 24 - 28, 1994	56	8	48
155	Amazon Fan	March 31 - May 26, 1994	Recife, March 26 - 30, 1994	56	8	48
156	N. Barbados Ridge	May 31 - July 26, 1994	Barbados, May 26 - 30, 1994	56	1	55
157	DCS Engineering	July 31 - Sept. 25, 1994	Barbados, July 26 - 30, 1994	56	8	48
158	TAG	Sept. 30 - Nov. 25, 1994	Barbados, Sept. 25 - 29, 1994	56		
	Drydock		Lisbon, Nov. 25 - Dec. 9, 1994			

† Although 5 day port calls are generally scheduled, the ship sails when ready

JOIDES Meeting Schedule

Date	Place	Panel
November 8-9, 1993	Palisades, NY	SSP
November 29, 1993	Miami, Florida	DRILLOPT
November 30, 1993	Miami, Florida	PANCH
December 1-4, 1993	Miami, Florida	PCOM
* January 25 - 27, 1994	Belairs Research Lab, Barbados	SMP
Jan. 31 - Feb. 3, 1994	Kyoto, Japan	EXCOM
* March, 1994	College Station, TX	IHP
March 7-9, 1994	Washington, DC	BCOM
* March 29-31, 1994	Amherst, MA	OHP
April 18-21, 1994	Cardiff, Wales	PCOM
June 27-30, 1994	Washington, D.C.	EXCOM

* Meeting not yet formally requested and approved