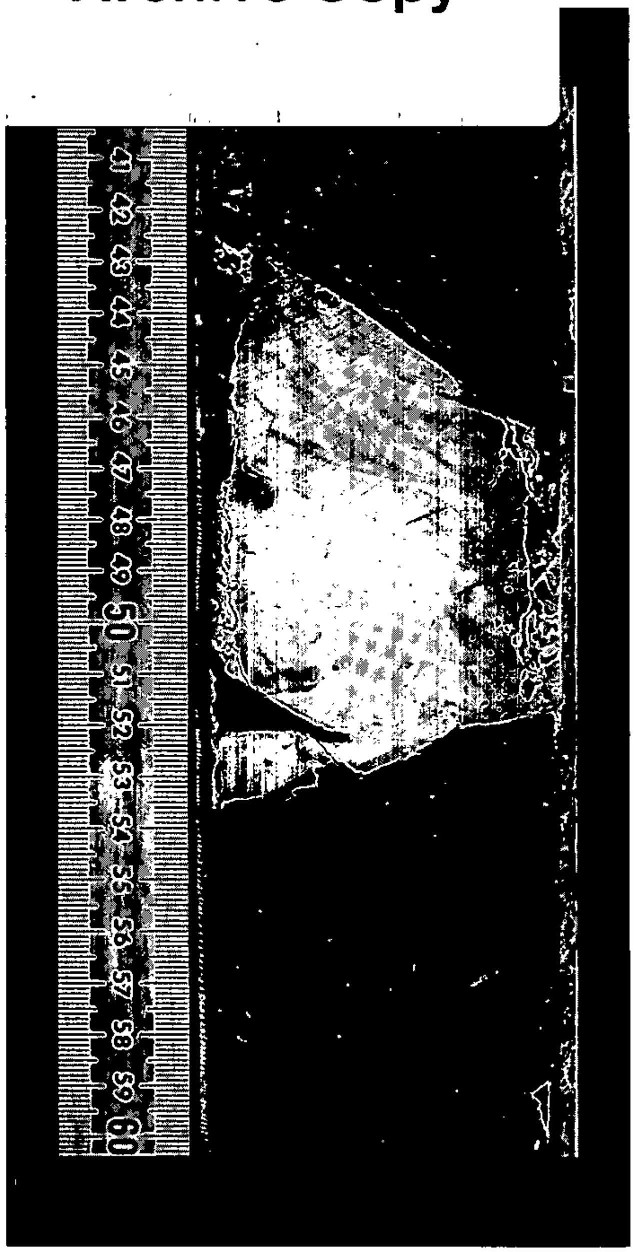
JOIDES Journal

Joint Oceanographic Institutions for Deep Earth Sampling
Volume 20, Number 1, February 1994



Mass Transport on the New Jersey Margin

See inside cover for information on 1995 ODP legs and how to apply for participation...

Cover: Core photo of Miocene mass-transport deposits from the New Jersey continental rise recovered on Leg 150 (Hole 905A, Core 74, Sect. 6, 40-60 cm). The deposit indudes a fault-bounded white Eocene chalk clast. The primary goal of Leg 150 was to date major Oligocene to Holocene unconformities on the New Jersey margin and to evaluate their correlation with glacio-eustatic age estimates obtained from the $\delta^{18}O$ record. The principal result from rise drilling is the finding that mass wasting has intermittently been a volumetrically important depositional agent on the upper continental rise, although deep-sea currents were important also (see the Leg 150 report in this issue).
Photo provided by Peter Blum, Leg 150 Staff Scientist.

The *JOIDES Journal* is edited by Karen Schmitt, 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:
JOIDES Planning Office
University of Washington, HA-30
Seattle, WA 98195
Tel: (206) 543-2203
Fax: (206) 685-7652
Internet: joides@ocean.washington.edu

Changes of address, requests for additional copies of the current issue and available back issues should be requested from:
Joint Oceanographic Institutions Inc.
1755 Massachusetts Ave., NW Suite 800
Washington, D.C. 20036-2102
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: joi@brook.edu

ODP Sets 1995 Drilling Objectives - see p. 2

ODP is currently staffing Legs 159 onwards. Shipboard participation is by invitation from ODP's science operator at Texas A&M University. Information and applications can be obtained by contacting the Ocean Drilling Program, Texas A&M University, 1000 Discovery Drive, College Station, TX 77845-9547 or phone (409) 845-2673, fax (409) 845 -4857, Internet: baldauf@nelson.tamu.edu.

Leg 159 Return to Site 735

The purpose of this leg is to return to ODP site 735, on the southwest Indian Ridge, and deepen hole 735B to a nominal depth of 2 km mbsf. The principle objective of this proposed leg is to understand the nature of the processes involved in the generation of the lower crust, and the put some constraints on the lower crustal stratigraphy at the slowest end of the spreading spectrum.

Leg 160 Eastern Eq. Atlantic Transform

The key issues to be addressed by drilling include an evaluation of the tectonic and sedimentary processes involved in the creation of the main morpho-structural features generated at the Côte d'Ivoire-Ghana Transform Margin. Results should provide data on the timing, rate and degree of vertical motion (subsidence and uplift) of the Côte d"Ivoire-Ghana Transform Margin.

Leg 161/162 Mediterranean I & II

The proposed two legs of drilling in the Mediterranean will address three main objectives: the Alboran Basin (Western Mediterranean), drilling on the Mediterranean Accretionary Complex (Eastern Mediterranean), and an E-W transect across the Mediterranean Sea to sample and study organic-rich layers called Sapropels.

Leg 163 N. Atlantic Arctic Gateways

This is the second of two North Atlantic-Arctic Gateways (NAAG) legs. The first leg, ODP Leg 151 was drilled August - September of 1993. The scheduled second leg of NAAG drilling will focus on the same goals as NAAG I but will also collect cores to try and resolve millennial scale climate variability and provide links to ice core data.

Leg 164 Gas Hydrates

Gas hydrates are a solid phase composed of water and low molecular weight gases (predominantly methane) which form under conditions of low temperature, high pressure, and gas saturation; conditions that are common in the upper few hundred meters of rapidly accumulating marine sediments. The main objectives of the proposed leg are to investigate the in situ characteristics of gas hydrates.

Leg 165 Test of the DCS

Throughout the past six years the Ocean Drilling Program has expended considerable effort on the design and development of a Diamond Coring System (DCS). The Planning Committee has tentatively scheduled an engineering leg during which the prime objective will be a test of the diamond coring system and in particular the secondary heave compensation system.

Table of Contents

JOIDES Journal

Joint Oceanographic Institutions for Deep Earth Sampling

University of California, San Diego, Scripps Institution of Oceanography

Canada-Australia Consortium

Columbia University, Lamont-Doherty Earth Observatory

European Science Foundation: Belgium, Denmark, Finland, Greece, Iceland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey

France: Institut Francais de Recherche pour l'Exploitation de la Mer

Germany: Bundesanstalt für Geowissenschaften und Rohstoffe

University of Hawaii, School of Ocean and Earth Science and Technology

Japan: Ocean Research Institute, University of Tokyo

University of Miami, Rosenstiel School of Marine and Atmospheric Science

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

The Process of Updating the LRP

1. **Agree to adjust the timing of the Phases to fit with MOUs and other known timelines.**

   Therefore:

   Phase I = FY89-FY93

   Phase II = FY94-FY98

   Phase III = FY99-FY02

   Phase IV = FY03-FY08

2. **Input from TEDCOM, DMP, IHP, SMP**
   - review of technology development in Phase I
   - projection of technology developments for Phases II-IV

3. **Input from Thematic panels**
   - review of accomplishments to present
   - scientific foci based on technological feasibility

     — Phase II FY93-FY98

     — Phase III FY99-FY02

     — Phase IV FY03-FY08

4. **Input from other programs, e.g. NAD, PAGES, InterRidge, ION**

5. **Input from ODP Partners**

6. **PCOM's job**

   Based on steps one through five, PCOM will formulate an updated LRP, including:
   - science focus in each phase
   - phased technology development plan
   - budget projections

Updating the ODP Long Range Plan

Focus

Brian Lewis
Planning Committee Chair

Each person appointed to a JOIDES panel receives a copy of the *Ocean Drilling Program (ODP) Long Range Plan (LRP)* as part of an information package. The LRP specifically outlines 16 major scientific ocean drilling objectives that the program wants to address in the 1989-2002 time period. These scientific objectives were distilled from a four-year scientific planning process that included workshops and panel discussions as well as two major international conferences—Conferences on Scientific Ocean Drilling I and II, (COSOD I and II).

The LRP adopts a three-phase implementation strategy to achieve its scientific objectives. Phase I is the period 1989-1992, Phase II is 1993-1996, and Phase III is 1997-2002. Included in the description of the scientific objectives to be pursued during each phase of the LRP are plans for acquiring or developing the necessary technology to achieve the scientific goals. In addition, a budget is included for each year to estimate how much funding will be necessary to realize these goals.

Phase I was implemented with the help of a "Strategy Committee", an ad hoc subcommittee of the Planning Committee. This group identified six of the sixteen LRP scientific objectives as high-priority for Phase I, set up formal Liaison Groups with other earth science research groups in the US and abroad and tried to develop a framework for scientifically monitoring progress toward LRP objectives.

The LRP implementation strategies for both Phase II and III were predicated on the assumption that the planned technological developments in Phase I would be achieved. Unfortunately, due to technological and fiscal difficulties (see *JOIDES Journal*, June 1993, Vol. 19, no. 2), two of the primary technological accomplishments planned for Phase I were not realized—DCS and deep drilling. The resulting technological limitations have, in turn, restricted the scientific objectives that were be addressed in Phase I to those not requiring DCS and/or deep drilling capabilities. In addition, ODP is now in the second year of Phase II of the LRP and it has become obvious that the budgetary assumptions upon which LRP strategies and implementation plans were based are no longer valid. The LRP is in need of an overall revision in order to continue to serve the program's long-range planning needs.

PCOM, in combination with the Thematic and Service Panels, has begun the process of updating the LRP. The most important aspects of the revision process will include: (a) identifying the main scientific and technological accomplishments of Phase I, (b) determining realistic timetables for ongoing technology development, (c) refocusing the scientific goals for Phase II and III in the light of recent scientific and technological results, and (d) forecasting realistic budgets for the Phase II and III implementation plans. In addition, a new phase, Phase IV, must be added to allow for achieving the deep drilling objectives that will not be realized in Phases II and III, and to iclude new objectives generated by recent discoveries.

An important step in the revision of the LRP was the jointly-sponsored EXCOM-STA/JAMSTEC workshop on ***Scientific Ocean Drilling in the 21st Century*** held February 3 - 4, 1994 in Kyoto, Japan.

At this workshop issues involving future platforms for scientific ocean drilling were discussed. The results of the workshop will be incorporated into the LRP revision process.

The major conclusions of the workshop were:

1. It is the unanimous opinion of the participants in the workshop, the representatives of JOIDES, the partner countries and STA- JAMSTEC, that scientific ocean drilling will be an essential component of earth sciences in the 21st Century.
2. The ocean drilling scientific community should make every effort to convince the leaders of their countries of the necessity for further development of ocean drilling in the 21st Century.
3. From the viewpoint of the experiences of ODP, it will be necessary to increase core recovery rates and to have better capability for drilling in geologically-difficult areas. To this end it will be essential to have a drilling platform equipped with a riser.

   In addition, riser drilling will allow us to advance our understanding of processes such as the following:
   - processes at convergent margins, including earthquake generation
   - processes at divergent margins
   - the process of formation of ocean crust
   - the role of fluid circulation
   - sea-level changes and sedimentary processes on continental margins

   The ultimate target of the riser capability should be to drill to depths of about 5 km in water depths up to 4 km. To achieve this we will have to overcome significant technological and financial barriers with further reinforced international cooperation.

   A phased approach to development of the riser capability may be necessary from a technological and financial viewpoint.
4. Although the scientific goals in the 21st Century include deep objectives requiring riser drilling, there are also many equally important scientific objectives that do not require riser drilling.

   Examples of these are:
   - research into climate change
   - global tomography studies and sea-floor observatories
   - the study of earth processes using drilling to depths of about 1 km
   - the role of the Arctic Ocean in earth's climate

Therefore there is also a clear and strong requirement in the 21st Century for access to drilling time on platforms which are capable of achieving these objectives.

JOIDES Committee & Panel Reports

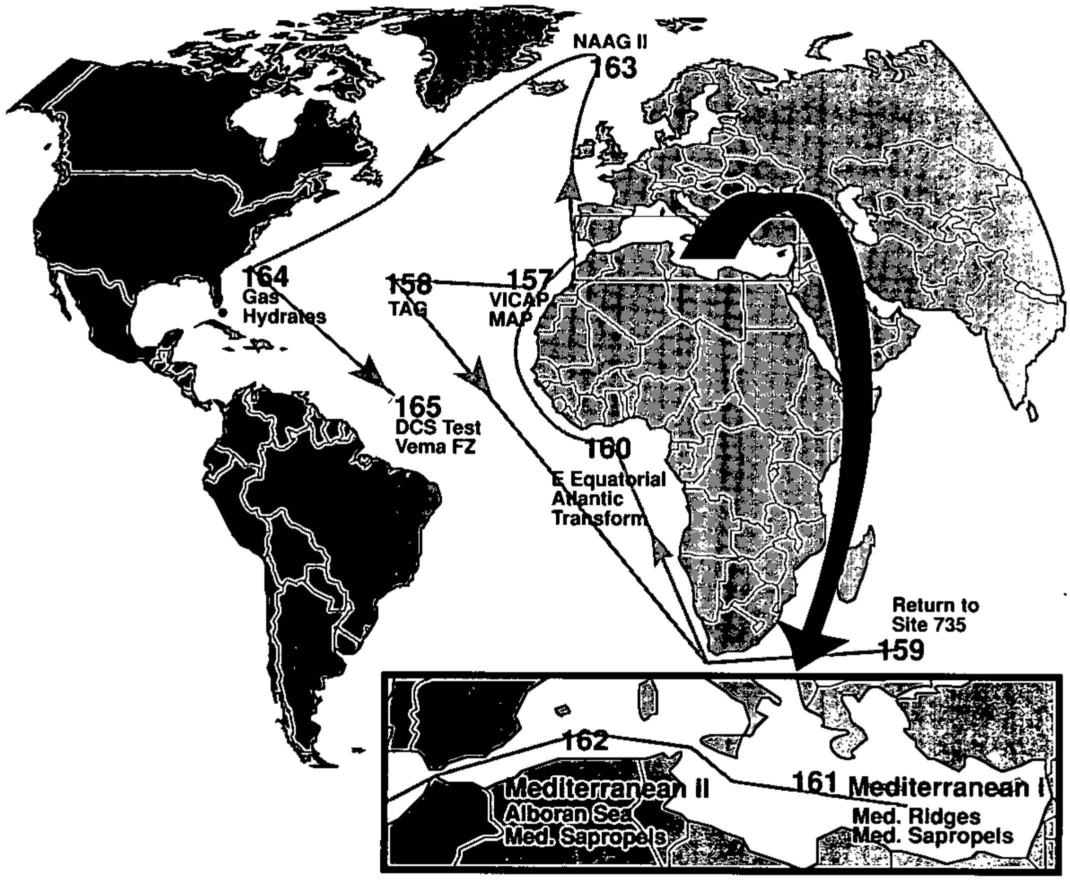
Planning Committee (PCOM)

Miami, Florida, December 1 - 4, 1993

PCOM met for their annual meeting in Miami, Florida. The PCOM meeting was preceded by the annual meeting of the JOIDES Panel Chairs (PANCH) and the new Drilling Options Committee (DRILLOPTS). The following report is a brief summary of important decisions and actions from the PCOM meeting.

1995 Science Plan

The most important task for PCOM at this meeting was to determine the 1995 Science Plan. After presentation of the rankings of the FY95 Prospectus proposals by the thematic panel chairs, and a review of the new Drilling Options Committee (DRILLOPTS) recommendations, PCOM voted to adopt the following schedule:



The schedule for ODP Legs 157 through 165 will be:

157 - VICAP/MAP (380-Rev3/Add3)
158 - TAG
— *Drydock - South Africa*
159 - Return to Site 735 (300-Rev)
160 - Equatorial Atlantic Transforms (346-Rev4)
161 - Mediterranean I
162 - Mediterranean II
163 - North Atlantic Arctic Gateways II
164 - Gas Hydrate Sampling (423-Rev/Add)
165 - DCS Sea Test

Addenda

1. This schedule presumes the drydock to occur in South Africa. Should this prove unacceptable to SEDCO/FOREX, and the drydock be scheduled elsewhere, PCOM should re-examine the schedule at the earliest opportunity.
2. The two Mediterranean legs will consist of elements of the following three proposals (in alphabetical order) - (1) Alboran Sea (323-Rev3), (2) Mediterranean Ridge (330-Rev/Add3), and (3) Mediterranean Sapropels (391-Rev).
3. The stated order of Mediterranean legs is preferred, but may be changed to accommodate the necessary weather window for the North Atlantic Arctic Gateways II leg.
4. The preferred location for the DCS sea test is on the Vema Transverse Ridge.

Mediterranean Program

The two Mediterranean drilling legs shall include

Med. I — MedSap 2B, 3, 4, Eratosthenes Seamount sites for sapropel and tectonic objectives, MedRidge (Ionian transect) 1, 2, 3 and the Mud Volcano 1.

Med. II — MedSap 5, 6, 7 and Alboran 2, 3,4

FY94 Budget Priorities

After extensive discussion, PCOM identified two priorities for additional expenditure of FY94 "funds":

1. a broad review of engineering development within ODP, per ASRC Proposal 10 (estimate $50-100K), and
2. logging-while-drilling (LWD) as part of Leg 156 (estimate $200K). As a consequence, PCOM recommended that JOI, Inc.
   a. support initiation of the engineering review as soon as possible (subject to EXCOM approval), and
   b. endeavor to locate LWD funds for Leg 156 prior to the ODP-TAMU operational deadline of 15 January 1994.

Regardless of the outcome of LWD for Leg 156, PCOM recognized the potential scientific importance of LWD for ODP, and encouraged proponents to incorporate this technology, as required, into their future proposals to the program.

FY95 Budget Prioritization

Priority 1

PCOM confirmed that the computer and data base upgrades were of the highest priority. PCOM endorsed the PANCH recommendation that the Computer RFP Evaluation Committee continue to work closely and frequently with ODP-TAMU to monitor and advise on the implementation of the upgrades.

Priority 2

DCS. PCOM endorsed the continued testing of DCS through 1995.

Priority 3

- Downhole measurements lab. PCOM supported ODP-TAMU's proposal to upgrade and expand the downhole measurements facility on the *JOIDES Resolution* ($400K).
- Shallow water gas hazards surveys. PCOM recommends to JOI that ODP-TAMU include funds in the FY95 budget for shallow water gas hazards surveys.

Priority 4

BHTV (≈ $ 100 K). By consensus, PCOM endorsed the PANCH recommendation that DMP explore the most efficient means of maintaining the capability to measure in situ stress on a routine basis, in appropriate holes, and return a recommendation to PCOM in April 1994.

SMP equipment list, progress as feasible.

Shallow Water Drilling Working Group Report

PCOM approved the *Shallow Water Drilling Working Group Report*, subject to minor editorial revisions and the addition of wording that states that funding will be from ODP commingled funds and that ODP-TAMU will be responsible for contracts and quality control. PCOM then thanked and disbanded the Shallow Water Drilling Working Group.

Copies of the SWDWG Report are available from the JOIDES Office upon request.
Contact Brian Lewis, PCOM Chair
Internet: joides@ocean.washington.edu

Hazard Survey for the NJ-MAT Program

Given the high priority of the New Jersey Mid-Atlantic Transect sites 4 through 9a by the relevant panels, PCOM placed a high priority for drilling these sites at the earliest possible date commensurate with completion of the required surveys, processing and interpretation as outlined in the Shallow Water Drilling Working Group's guidelines. PCOM requested JOI investigate ways of obtaining operational funds for ODP-TAMU to contract for these surveys and services.

Computer Upgrade RFP

- PCOM reaffirmed its commitment to upgrade ODP computer and information systems.
- PCOM recognized that this will entail significant expenditure of funds during FY94, FY95, FY96.
- PCOM advised JOI to continue a computer database upgrade advisory committee to advise ODP-TAMU and monitor progress on a regular basis during the entire project.
- PCOM advocated that end-user input be sought to insure timely and appropriate development of suitable products.

Thematic Panel White Papers

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

a) concentrate on sections identifying succinctly major results to-date and how they relate to stated thematic objectives

b) prioritize major themes for drilling utilizing realistic time estimates in the two periods FY1995-1998 and FY1999-2003

In addition, PCOM requested that the thematic panels provide a vision of science objectives beyond FY2003

Advisory Structure Review Committee Report

ASRC Proposal 4

PCOM adopted the revised *JOIDES Proposal Submission Guidelines*, *JOIDES Panel Meeting Schedule*, and *Proposal Review Guidelines* endorsed by the PANCH at the PCOM December Annual Meeting.

ASRC Proposal 8

PCOM's consensus was that the Thematic Panel Chairs not attend the April or August PCOM meetings except on a case-by-case basis as determined by the PCOM Chair.

ASRC Proposal 10

PCOM acknowledgeed and applauded 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 recommended to EXCOM that an external group be designated to review the role of engineering development within ODP, including the relationship between ODP-TAMU, TEDCOM, PCOM, and the Advisory Structure, and that this review occur as soon as possible.

Other Actions and Items

Backup Drilling Sites

PCOM endorsed the SSP recommendation that PCOM and ODP-TAMU require all legs—including barerock and offset drilling legs—plan appropriate contingency site(s), in addition to their primary sites, for drilling in the event of technical failure or other unforeseen problems.

NAD Design Study

PCOM heartily endorsed the Nansen Arctic Drilling Program undertaking a preliminary design study for an ice-strengthened drilling barge.

Core-Log Integration White Paper

PCOM agreed to institute the CLI advisory panel (CLIPAN) and recommended that BRG do everything possible to rearrange their budget to accommodate the need for CLIP on Leg 154.

PCS/PPCS

PCOM recommended that C. Paull, other SGPP members and J. Geiskes work with ODP-TAMU, TEDCOM and G. Brass to develop a plan to modify the existing PCS system and/or construct a new one (i.e. PPCS) to meet the needs of the scheduled gas hydrate leg and future legs that must recover gases and gassy sediments. The plan, together with a cost estimatewill be presented to PCOM in April 1994.

Tectonics Panel (TECP)

Corner Brook, Newfoundland, Sept. 19-21, 1993

TECP's meeting in Corner Brook was a joint meeting with SGPP. The following is a condensed version of the Executive Summary of the TECP minutes.

Prospectus Rankings

Rank	Proposal	Score (/4)
1	346 Rev 4 Equatorial Atlantic	3.08
2	330 Add 3 Mediterranean Ridge	2.45
3	323 Rev 3 Alboran Sea	2.08
4.	NARM Non-volcanic II (IAP new package)	1.67
5	NARM Volcanic (NARM Add2)	0.92

Assessment of NARM Drilling

After considering results of the NARM Leg 149 drilling, TECP recommended:

1. That the second leg of NARM volcanic drilling be the proposal NARM Add 2 (Larsen), rather than the second leg as outlined in the NARM DPG report.
2. The conjugate approach to the Newfoundland-Iberia transect was still valid.
3. Problems still existed with the siting of the deep Newfoundland basin site, as outlined in the comments on NARM Add, and it needed further study.
4. The second leg of NARM Non-volcanic drilling should be on the Iberian Abyssal Plain. Because of complications arising from the Leg 149 results, more documentation is needed from that area concerning the three-dimensional nature of basement highs, the possible dip of faults, and the regional distribution of basement.

   TECP recommended a pause, some re-survey, and a new package of approved drilling targets possibly involving extending Leg 149 sites 898, 900 and 901 further into basement, drilling either the S' reflector(item III.A.2 above), or site 3 of the NARM DPG report. TECP appointed a sub-committee of R. Von Huene (Chair), S. Agar, U. Ten Brink, T. Reston, and D. Sawyer to assemble a new package from existing drilling proposals. This package was submitted to PCOM at the December annual meeting.
5. The deep IAP sites need further study before committing drilling time to them. IAP 1 needs an advocate, currently lacking.

Other TECP Recommendations:

1. A wealth of structural information should be present in DSDP and ODP cores. TECP recommended a comprehensive structural-tectonic survey of all DSDP and ODP cores to glean whatever information exists. This would be perforce a "salvage job", because most cores were collected without regard to the structures that may have been present. Because of the delicate nature of many of the microstructures that may be preserved, TECP believed that any disturbance of the cores before this survey has been made potentially will destroy a great source of information about plate dynamics and/or kinematics. Thus, TECP urged the completion of such a survey before any cores are moved.
2. TECP was concerned about the lack of routine collection of structural information on ODP legs, in view of the apparent widespread presence of such features. TECP had received reports, for example, that structural features were encountered on such legs as Sedimented Ridges (Leg 139), the North Pacific (Leg 145), despite the fact that no structural geologist was aboard the *JOIDES Resolution*. TECP also noted that no structural geologist had been included on Leg 152, despite that it was on a rifted margin and was highly ranked by TECP. TECP urged that the routine collection of structural information be implemented ASAP, and that each Leg include a structural geologist as part of the scientific party.

   On tectonic drilling legs there was commonly a lack of sufficient applicants. Land geologists with appropriate thematic or regional experience can be better integrated into the ODP system. We suggest broader advertising in journals such as *GSA Today, Geotimes, Science, Nature,* etc. Advertisements should include a brief abstract and a list of positions available, etc. Ads should appear with as long lead time as possible before the pre-cruise meeting so that staffing can be completed by that time. Basically, cruises should be advertised as soon as scheduled. This expansion of the ODP participant base would help expand awareness of ODP activities and achievements, as well as improve support throughout the earth science community.
3. In its evaluation of drilling proposals for studies of processes in oceanic lithosphere, TECP noteed that several important geologic tools are notably lacking. TECP urged the development and implementation of tools to achieve these scientific objectives.

Sedimentary and Geochemical Processes Panel (SGPP)

Corner Brook, Newfoundland, Sept.ember 19-21, 1993

The following is a condensed version of the Executive Summary of the Sedimentary and Geochemical Processes Panel minutes.

Prospectus Rankings

The panel elected: (1) to add Proposal 412/-Add/-Add2 to the FY95 Prospectus and (2) to rank all the proposals. Non-proponent panel members gave a rank from 13 (highest rank) to 1 (lowest rank) to all proposals, with the possibility of averaging ranks for equally favored proposals. Proponents ranked 12 proposals, omitting their own proposal. Scores were assigned by normalizing the rank totals according to the number of votes cast (i.e., members minus proponents).

Ref. No.	Proposal	Score	Std. Dev.	Ranking
423/ -Add	Gas Hydrate Sampling	11.00	2.13	1
412/-Add2	Bahamas Transect	10.91	2.39	2
391-Rev2	Med. Sapropels	10.18	1.33	3
SR-Rev2	Sedimented Ridges II	9.58	2.89	4
380Rev3/059	VICAP/MAP	8.58	1.88	5
330Rev/Add3	Med. Ridge I	8.25	2.14	6
386/422/386-Add	California Margin	7.25	2.80	7
323-Rev3	Alboran Sea	4.83	2.12	8
NARM-DPG	NARM Non-volcanic II	4.67	3.58	9
NARM-DPG	NARM Volcanic II	4.08	2.75	10
300-Rev	Return to Site 735B	3.75	1.91	11
346-Rev4	E. Eq. Atl. Transform	3.58	3.06	12
NAAG-DPG	NAAG II	3.42	1.78	13

The top 2 proposals, Gas Hydrate Sampling and Bahamas Transect, can be considered to have a nearly equivalent ranking, a reflection of the balanced composition of the panel between geochemical and sedimentological interests. The distinct break in the scores between positions 7 and 8 marked the boundary of SGPP thematic interests.

Evaluation of PCS, PPCS, and VPC

SGPP strongly endorsed both the recent modifications to the PCS and the development of the PPCS. SGPP urged that precedence be given to further testing and improvement of the PCS in parallel with the development of the PPCS. Development of both tools is imperative for achieving SGPP high-priority objectives. Both tools should be made compatible for use with the same BHA's and sampling manifolds. The PCS will be a more appropriate tool for sandy sediments, whereas the PPCS has the potential to provide better samples in muddy lithologies. Simultaneous availability of the both tools will provide flexibility to obtain samples at sites with variable lithologies. SGPP also strongly endorsed efforts to acquire an operational VPC tool. The VPC will allow sampling of unconsolidated coarse sediment critical to thematic objectives of sea level and sediment architecture. SGPP considered the development of these tools so important to its thematic objectives that it planned to hold its Spring, 1994 meeting at ODP-TAMU and will devote a half-day to meet with the engineers to discuss tool development and testing.

Revision of SGPP's White Paper

In preparation for revising SGPP's White Paper and in accord with PCOM's request that the panel discuss major accomplishments to date and prioritize themes for the two periods FY95-98 and FY99-2003, the panel chose to focus efforts into three broad thematic areas: (1) sea level and facies architecture, (2) fluid flow and geochemical fluxes and (3) geochemical budgets and carbon geodynamics. Panel members were assigned to each of these topics to prepare draft revisions of the White Paper, emphasizing what can be accomplished with drilling during the specified time periods.

Ocean History Panel (OHP)

Bremen, Germany, October 6-8 , 1993

The Ocean History Panel held its fall 1993 meeting October 6-8 in Bremen, Federal Republic of Germany, hosted by Gerold Wefer. The following is a condensed version of the Executive Summary of the OHP minutes. The NAAG II planning session met October 4, 1993 in Bremen.

North Atlantic and Arctic Gateways Drilling Results

The panel heard a 30 minute presentation by Annik Myhre, Co-Chief Scientist, of the initial results of Leg 151 (NAAG, Leg 1). Myhre discussed important findings of the leg, as well as logistical issues.

The panel reviewed and endorsed the recommendations of the NAAG II planning session. Primary sites include ones from the NAAG-DPG report, with several sites from proposals 372-Rev/372-Add/372-Add2 and 406/406-Add in order to give high resolution carbonate records for monitoring rapid climatic events (Heinrich-Bond cycles) and for recording mid-depth water mass characteristics over glacial-interglacial times. The ideal weather window for reaching the northerly sites is late August and September, and will be critical for the success of the leg.

Caribbean Initiatives

OHP constructed a hypothetical one-leg drilling program addressing high-resolution Quaternary, Neogene, and Paleogene-Cretaceous objectives of OHP interest from existing proposals of high interest (415-Rev/415-Add with 408-Rev/408-Add and 434). OHP intends to request permission to hold a one-day planning session just prior to its Spring 1994 meeting to formalize plans for such an effort prior to spring global ranking.

Prospectus Ranking

Eight proposals from the FY95 Prospectus were considered by OHP as being of some interest to the panel and were included in the ranking; the other proposals are of no OHP interest. Discussion of the proposed drilling plan for 391-Rev2 (Mediterranean sapropels) showed that, excluding a poorly-chosen Alborán Sea site, the present plan (excluding logging) takes only 14-16 days drilling time. The panel therefore combined this half-leg program with a high-priority half-leg program, proposal 404 (Neogene West Atlantic sediment drifts) that will have complete site survey data after a December 1993 cruise. This combination favorably influenced 391-Rev2's standings in the rankings. The California margin program is unlikely to have complete site survey data by 1

November, and this influenced its standings in the ranking.

Rank	Proposal #/title	Score	Fraction
1	NAAG-II	6.66	0.95
2	391-Rev2+ 404, Med. Sap. & W.N. Atl.	5.92	0.84
3	386-Rev2/422-Rev/386-Add, Cal. Margin	5.00	0.71
4	346-Rev4, E. Eq. Atl. Trans.	3.21	0.45
5	323-Rev3, Alboran Sea	2.35	0.33
6	NARM Non Volcanic Leg II	2.14	0.30
7	423/423-Add, Gas Hydrate	1.42	0.20
8	380-Rev3, VICAP/MAP	1.07	0.15

White paper draft

The panel broke into topical working groups to prepare draft sections for a new White Paper. Each group was asked to evaluate the success of ODP drilling to date in addressing ocean history objectives, to identify exciting new targets for drilling, and to propose new strategies or technologies that will be needed by ODP to achieve success in these thematic objectives in the future. Discussion by the entire panel followed brief presentations by each group. OHP will have a working written draft for circulation in the near future.

Lithosphere Panel (LITHP)

Santa Fe, New Mexico, October 12 - 14, 1993

The Lithosphere Panel met jointly with Downhole Measurements Panel in October in Santa Fe. The following report was condensed from the Executive Summary of the LITHP minutes.

Joint LITHP/DMP Meeting

The joint LITHP/DMP meeting on October 12 heard liaison reports from NSF/JOI, PCOM, TECP, SGPP, TEDCOM, and OHP. Herzig and Humphris gave a review of the TAG drilling program, followed by a review of high temperature tool development and availability. The TAG logging prospectus was presented and the repairs to the BHTV were discussed.

One of the conclusions of the joint meeting was that stress measurements in the lithosphere are an important objective of LITHP and the BHTV remains the best way to quantify breakouts in boreholes. LITHP and DMP were pleased to see the work the BRG had put into repairing the BHTV and encouraged PCOM to support them in this effort.

Peter Lysne reviewed the status of borehole fluid sampling and the third-party tool requirements. It was clear to the group that future tool development was going to have to come with participation from outside the program. The joint meeting concluded with a discussion of the progress of the DCS test and the requirements for core-log integration.

Prospectus Ranking

Rank	Proposal:	Score	Stan. Dev.
1	Return to 735B	6.50	0.82
2	Sed. Ridges II	5.07	1.38
2	VICAP-MAP	5.00	1.37
4	NARM-Volc. II	4.75	1.24
5	East. Eq. Transform	3.25	1.29
6	Calif. margin	2.13	1.15
7	Alboran Sea	1.81	1.05

(ranked NARM proposal is the Vøring margin transect, not continuing East Greenland)

Caribbean Proposals

The panel reviewed the status of the Caribbean proposals, particularly in light of OHP's intent to construct a leg or two focusing on paleoceanographic objectives. The consensus of the panel was that LITHP needed to take a lead role in helping to develop a combined plan of drilling to address the K-T impact story and the origin of the Caribbean LIP. The availability of new site survey data (to be collected in April) and the results of shore-based studies of the LIP basalts by Duncan's students showing strong evidence for near-synchronous volcanism have changed the panel's opinion about the Caribbean as an appropriate site for a LIP study.

White Paper

The panel revised its list of short-term (1993-98) and long term (1998-2003) objectives and assigned editing responsibilities to prepare a final draft by mid-November, for discussion at the PCOM meeting in December.

Downhole Measurements (DMP)

Santa Fe, New Mexico, October 12 - 14, 1993

The Downhole Measurements Panel met jointly with Lithosphere Panel in October in Santa Fe. The following report was condensed from the Executive Summary of the DMP minutes.

DMP has instituted a policy of focusing attention on legs that present difficult downhole measurement scenarios. In view of the importance of TAG to the Lithosphere Panel, a joint session was held on October 12 to discuss the status of special, high-temperature instrumentation required for downhole measurements (see LITHP report above). These discussions carried over into DMP sessions occurring on the last two days of the proceedings.

Downhole Measurements at Barbados and TAG

The DMP recognized that downhole measurements at Barbados could provide a significant definition of an accretionary prism beyond that which is currently available, and that measurements in a producing hole at TAG would be truly a unique scientific experience. However, Barbados and TAG require instrumentation that is costly. Thus, the DMP felt that it would be remiss if it did not provide PCOM a prioritization of downhole measurement thrusts, however painful this prioritization may be. After considerable discussion, the DMP made the following recommendations involving measurements at Barbados and TAG:

1. Tool Deployment at TAG

DMP recommended that the Logging Contractor inform Schlumberger that the standard suite of tools will be deployed at TAG to the limit of their temperature specifications, and that the tools should be capable of such operation. The BRG and Schlumberger should work together to insure that these conditions are met.

2. Memory-Temperature Tool for Use at TAG

The DMP recommended that, subject to the availability of funds, the ODP rent or purchase a memory-temperature tool for use at TAG. The purchase cost of the tool is estimated to be $ 50 K.

The use of these tools requires the availability of a high-temperature logging cable, and some are third-party tools that must be proven in land-tests. Memory tools do not suffer from a cable restriction, and they are under development at Sandia and other institutions. The use of the Sandia tools will require an agreement between the ODP and the US Department of Energy. All tools will be reviewed by the DMP at its spring meeting, and recommendations for deployment may be made.

3. Logging While Drilling for Barbados

The DMP recommended plans for Logging While Drilling (LWD) for Barbados be progressed subject to the availability of funds. The cost of the necessary services is estimated to be $ 195 K.

TAG/LWD Budget Prioritization

DMP recommended that, should there be financial conflict, the use of LWD technology at Barbados be accorded priority over the use high-temperature instrumentation at TAG. The rationale is based on probabilities. It is judged more probable that LWD instruments will be necessary to achieve downhole measurement objectives in the unstable environment at Barbados than high-temperature instruments will be necessary to attain similar objectives at TAG where downflow is expected.

Information Dissemination

DMP recognized that the success of the Downhole Measurements Program is contingent upon the use of generated data to advance scientific efforts, and DMP always invites comments on how to advance this thrust. Furthermore, DMP recognized that some measurement issues are technically complex, yet the basic principles of the measurements and what they mean needs to be disseminated throughout the ODP. Thus, DMP has instituted the development of brochures describing the measurements currently used within the ODP. The first two brochures will be on the geochemical logging tool, and the neutron porosity tool. Finally, to further the dissemination process, a representative of the BRG will be available to the thematic panels for consultation on a one-meeting-per-year basis. DMP recognized and commended the BRG for its efforts to promulgate the Downhole Measurements Program.

Technology and Engineering Development Committee (TEDCOM)

Reykjavik, Iceland, September 23 - 24, 1994

The principal objectives of the TEDCOM meeting were to review (a) DCS development, (b) ODP operational tools development, (c) the role of the TEDCOM within ODP (closed session with representatives of PCOM, ODP-TAMU and the ASRC).

DCS Review

Given the information available at the meeting, TEDCOM recommended against proceeding with the seatest of Leg 157. Unacceptable delays of several months in the development of hardware had delayed the essential mechanical simulation tests and the land tests had not been carried out on schedule.

TEDCOM recommended that a subcommittee be formed to assist ODP-TAMU with the definition and assessment of simulation tests and land tests. TEDCOM recommended that the sub-committee (SC) be supported in terms of travel to work with ODP-TAMU staff to:

- Ensure that the Paul Munroe (subcontractor) control system will work.
- Specify requirements, and particularly results requirements, of the simulation tests and land tests.
- Monitor the mechanical simulation tests in Salt Lake City and land testing in Midland.
- Ensure that the influence of water depth on DCS control/behavior is included in simulation studies. Following assessment of the latter and the land tests, the SC with ODP-TAMU will recommend an optimal water depth for the next DCS seatest.

Operational Tools Review

After review, TEDCOM recommended to PCOM that ODP-TAMU prepare detailed tables of ODP development projects, including expenditures to date, as well as planned budget and engineer-months to completion.

ODP Engineering Developments

TEDCOM strongly supported the ASRC recommendation that an external group be nominated to review the Engineering Drilling Operations department within ODP and requested that PCOM reverse its decision not to recommend this review. The group should review the organization and operation of ODP-TAMU and TEDCOM and the interaction between them.

TEDCOM membership.

TEDCOM welcomed the idea of an enlarged TEDCOM membership, which would create a pool of expertise available to ODP. Engineers with additional expertise in the following areas would be particularly welcome:

- drill bits
- hole stability
- soil mechanics (related to coring/drilling)
- coring systems and fluids
- industry experience of tool development.

Not all member of the pool would have to attend all TEDCOM meetings.

In order to improve TEDCOM/PCOM interaction, TEDCOM requested that PCOM support the ASRC recommendation that the TEDCOM Chair be invited to attend all PCOM meetings, or to send a delegate, and that a technical representative from ODP-TAMU should attend all PCOM meetings.

Site Survey Panel (SSP)

Palisades, New York, November 8-9, 1993

Site Survey Guidelines for Tectonic Windows into Oceanic Crust ("Offset section drilling") -- SSP, November 18, 1993

1.	Deep penetration SCS	No
2.	High-resolution SCS	May be required [1]
3.	Multichannel seismic	3 or 5a recommended [2]
4.	Grid of seismic lines	See data type [3]
5a.	Refraction (surface source)	3 or 5a recommended [2]
5b.	Refraction (near-bottom source & receiver)	May be useful [3]
6a.	3.5 kHz echo sounder or equivalent	May be required [1]
6b.	12 kHz echo sounder	No
7.	Swath bathymetry	Required
8a.	Side-looking sonar (shallow towed)	Recommended
8b.	Side-looking sonar (near-bottom towed)	Recommended, but may be required for specific sites
9.	Photography/video	Required [4]
10.	Heat flow	No
11a.	Magnetics	Required [5]
11b.	Gravity	Recommended
12.	Sediment core	May be required [1]
13.	Rock sampling	Required [6]
14.	Water current data	May be required [7]
15.	OBS microseismicity	May be useful [8]

1 Shallow penetration, high-resolution single-channel seismic data and 3.5 kHz data will be required if sites are proposed to spud into sediment pockets. If a re-entry site is planned in a sediment pocket, a core near the site is required to verify the conditions for setting the re-entry cone.

2 A regional MCS or OBS-refraction survey is recommended to determine the regional crustal structure before dismemberment. It is not important to have crossing seismic lines exactly over the proposed site.

3 Near-bottom source/near-bottom receiver seismic refraction is a new experimental technique that holds great promise as a site survey tool for tectonic windows. SSP is following the development of this technology with great interest, and may upgrade this data type to "recommended" or "required" at a future date.

4 Visual observations (submersible, towed still camera, towed video camera) are required to determine the detailed geological setting of the site, and to select a site for emplacing a bare-rock drilling guidebase.

5 A regional magnetic survey is required to determine the age of the oceanic crust and the plate kinematic history of the site.

6 A closely-spaced, precisely positioned suite of samples is required in the immediate vicinity of the drill sites, as well as a less-dense suite of samples over a broader region. Samples must be analyzed for geochemical/petrological and structural characteristics.

7 Data on water currents will be required for sites in shallow water of wherever swift currents are anticipated.

8 Microseismicity determined from ocean bottom seismometers is useful in regions where the faults that form the tectonic window are still active.

The committee/panel reports in the *JOIDES Journal* are extracted from the minutes of the committee/panel meetings. Complete copies of the PCOM and other JOIDES panel/committee 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).

Science Operator Report Leg 150

New Jersey Continental Slope and Rise

Dr. Gregory Mountain Co-Chief Scientist
Dr. Kenneth G. Miller Co-Chief Scientist
Dr. Peter Blum ODP Staff Scientist

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

After a 10-year hiatus, Ocean Drilling Program Leg 150 returned to offshore New Jersey to evaluate the effects of global sea-level change on clastic sediments of a passive continental margin. Initial efforts by Legs 93 and 95 of the Deep Sea Drilling Project (DSDP) together with studies by oil companies paved the way for a focused sea-level study on the New Jersey margin by Leg 150 and related drilling. We used industry seismic and well data to plan a multichannel seismic (MCS) survey in 1990 that ties continental shelf sections into the continental slope. By drilling at four holes tied to our MCS grid, we dated numerous sequence boundaries traced from the continental shelf. Leg 150 drilled a transect of four sites on the slope in water depths of 444 m, 811 m, 913 m, and 1123 m (Sites 903, 902, 906, and 904, respectively; Fig. 1). Site 905 was located on the continental rise in 2698 m water depth. Recovery was excellent (88%) with a total of 4034.5 m of sediments brought on board.

Introduction

The primary goal of Leg 150 was to date major Oligocene to Holocene unconformities on the New Jersey margin and to evaluate their correlation with glacio-eustatic age estimates obtained from the $\delta^{18}O$ record. Secondary goals were to determine ages of major Eocene "Doubthouse" unconformities and to evaluate the relative importance of along-slope vs. downslope sediment- transport processes and evaluate their links to eustatic variations.

Site 902

Site 902 is in ~811 m of water on the upper continental slope off the shore of New Jersey. It is located 2 km north of, and slightly upslope from, the COST B-3 well. The primary objective was to core and log a post-lower Eocene section containing seismic reflections that can be traced to sequence boundaries beneath the adjacent continental shelf.

Six lithostratigraphic units are recognized at Site 902. They are numbered so that designations for correlating units correspond among the four Leg 150 slope sites (Sites 902-904 and Site 906). Units I and III through V are primarily siliciclastic upper Pleistocene to upper Oligocene sediments, consisting of clays and silts with sporadic interbeds of quartz and glauconitic sands. Unit VII is a biogenic carbonate interval without significant terrigenous influence. Preliminary seismic correlations indicate that the boundaries between these subunits correspond to reflections, and that several other reflections match glauconitic sand layers within various subunits. The units include:

Unit I (0-124 mbsf), Holocene to uppermost Pleistocene sandy silty clays with several thin slump units at Hole 902C.

Unit III (124-153 mbsf), poorly fossiliferous upper Miocene silty clays with scattered layers of glauconite sands.

Unit IV (153-404 mbsf), upper and middle Miocene silty clay and clayey silt with occasional siderite nodules/bands and abundant plant/wood fragments. Calcareous fossils are generally absent, diatoms and dinoflagellates provide stratigraphic control.

Unit V (404-595 mbsf), middle middle to lower Miocene glauconitic clays and silts, clayey siltstone and sandy silts with glauconitic sand beds.

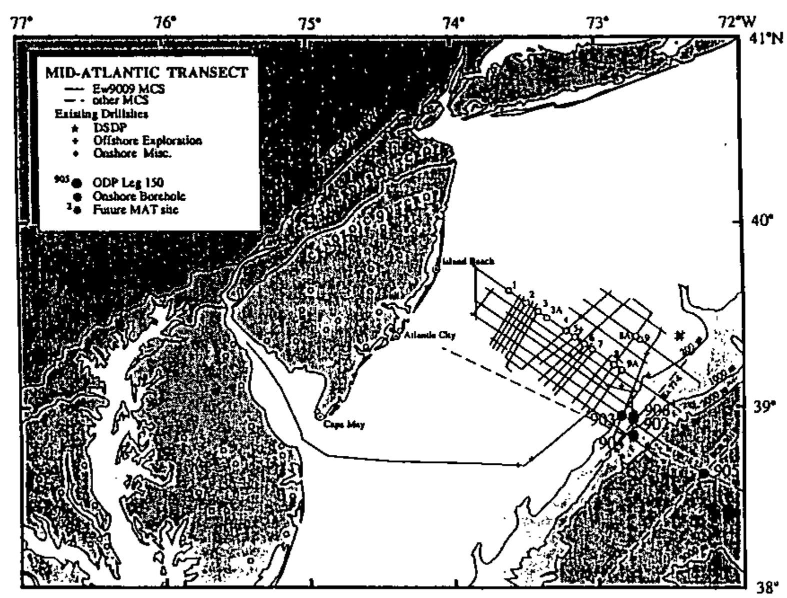


Figure 1. Generalized bathymetric location map of the Mid-Atlantic margin showing *Ewing* 9009 MCS seismic grid (solid lines), other MCS profiles (dashed lines), proposed shelf sites (stippled circles), onshore drill sites (open circles), and Sites 902- 906 (large closed circles) drilled by ODP Leg 150.

Unit VI (595-682 mbsf), lower lower Miocene to upper Oligocene silty clays, nannofossils and diatoms common.

Unit VII (682-736 mbsf), upper Eocene siliceous nannofossil clayey chalks containing foraminifers. The striking lithologic contact between this and the overlying unit corresponds to an unconformity between the uppermost lower Oligocene and the upper Eocene. This boundary marks a significant change in depositional regime from pelagic, carbonate-dominated deposition during the Eocene to predominantly terrigenous deposition in the early Oligocene.

Bulk density varies cyclically downhole, and values determined with GRAPE are used for Pleistocene correlations to the SPECMAP time scale; they also show significant variations in the Miocene section. Magnetic susceptibility peaks are associated with GRAPE maxima in the Pleistocene section. Water content and porosity vary inversely with bulk density, but closely mirror trends in bulk density. This relationship suggests that most variations in bulk density are the result of variations in porosity.

Calcareous microfossils are abundant to common in the Pleistocene and lower Miocene to Eocene sediments, and in these intervals they provide good biostratigraphic resolution. In contrast, calcareous microfossils are generally absent from the upper and middle Miocene silty clays; diatoms and dinoflagellates provide stratigraphic control for these sections. Dinoflagellates provide the only zonal control in cores barren of calcareous microfossils and nonsignificant diatom assemblages. Rich benthic foraminiferal assemblages indicate transport of material from the shelf during the Pleistocene, with little in situ fauna found; they also indicate a shallowing from late Eocene (middle bathyal; 600 to 1000 m) to early Miocene (upper bathyal; 200 to 600 m).

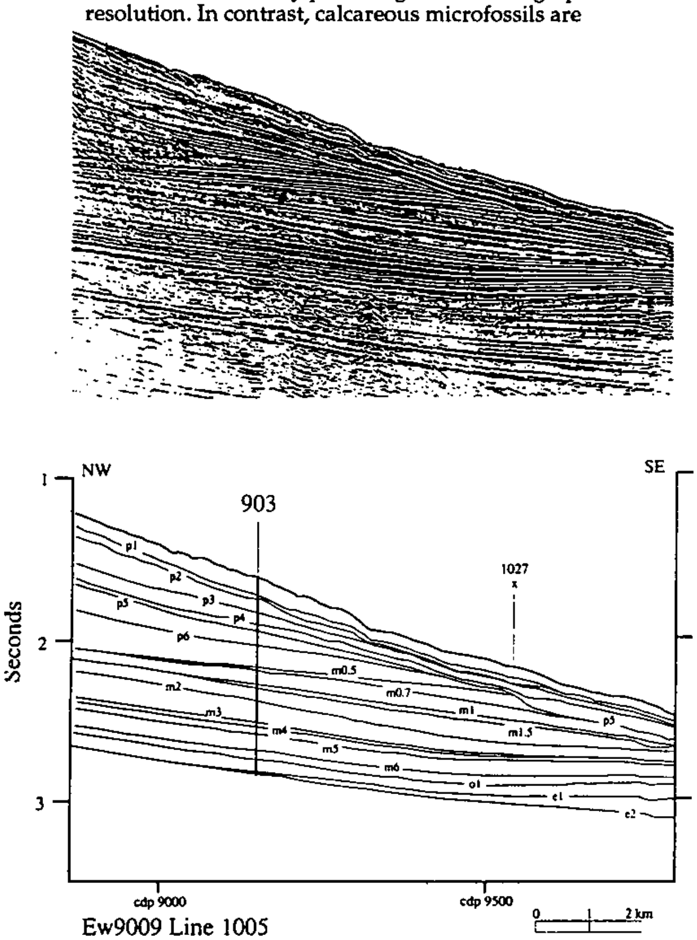


Figure 2. MCS profile EW9009 1005 crossing Site 903. Intersection with profile 1027 is shown. Top panel is processed data; bottom panel is line-drawing interpretation. Vertical scale is two-way traveltime (s). Reflector terminology and ages are given in Table 1.

The principal result from Site 902 is that sequence boundaries traced from beneath the shelf to the slope can be recognized as stratal surfaces and dated at Site 902 (Table 1). Numerous (~17) potential sequence boundaries are observed within the Ew9009 MCS grid on the shelf. Some of these were originally defined by Greenlee and Moore (1988) and refined by Greenlee et al. (1992) based on studies of a grid of seismic data acquired by Exxon Production Research. Others have been added based on an ongoing study of data collected by Lamont-Doherty Earth Observatory (Mountain, Miller and Christie-Blick, in prep.). To avoid the possibility of having to re-assign correlations between these two parallel and evolving data sets, we adopt a strictly local set of reflector names tied to the Leg 150 cores (Table 1).

Site 903

Site 903 was drilled in ~445 m of water on the upper continental slope of offshore New Jersey, 4.4 km upslope of Site 902 (Fig. 1). Site 903 is the shallowest of four sites on a slope transect designed to sample post-lower Eocene sequence boundaries (Fig. 2).

Six lithostratigraphic units are recognized at Site 903 that can be correlated with similar units at Site 902, with the exception of Unit II, which is absent from the latter. At both sites, the upper five units are siliciclastic and the lowermost unit is carbonate:

Unit I (0-273.9 mbsf), middle to upper Pleistocene silty clay with fine sand layers containing a thick succession of slumps and debris flows below 221.5 mbsf.

Unit II (273.9-358.9 mbsf), lower to middle Pleistocene nannofossil silty clay and coarse sand.

Unit III (358.9-522.9 mbsf), upper and middle Miocene alternations of silty clays and glauconitic sands, distinguished from the unit above by abundant glauconite.

Unit IV (522.9-733.1 mbsf), middle Miocene diatomaceous silty clay to clayey silts with generally lower abundance of glauconite than above.

Unit V (733.1-974.4 mbsf), lower to middle Miocene glauconitic, diatomaceous, organic-rich silty claystone distinguished from above by higher organic content.

Unit VI (974.4-1064.1 mbsf), lowermost Miocene to upper Oligocene silty claystone, distinguished by minor glauconite, common nannofossils, and rare diatoms.

Unit VII (1064.1-1149.7 mbsf), upper Eocene clayey nannofossil chalk.

Integration of magnetic susceptibility, density, and biostratigraphic data provides a remarkably good time scale for the Pleistocene section. Preliminary correlations indicate an apparently continuous section from oxygen isotope stage 5.5 through stage 15.1 (~120-574 Ka). Calcareous microfossils occur at irregular intervals in the Pliocene to upper middle Miocene, where biostratigraphic subdivision relies primarily on dinoflagellates and diatoms. Uppermost Pliocene strata appear at 358.9 mbsf

(Zone NN15), whereas the first evidence for Miocene strata appears at 363 mbsf. The placement of the upper/middle Miocene strata is uncertain; foraminiferal evidence indicates that it is as high as 510 mbsf and dinoflagellates as low as 625 mbsf. Nannofossils, diatoms, and dinoflagellates provide excellent control for the lower middle and lower Miocene section. Nannofossils and planktonic foraminifers provide good control on upper Oligocene and upper Eocene strata. Transported benthic foraminifers from the shelf are ubiquitous in the Pleistocene and common in the Miocene, while evidence for transport is minimal in Oligocene and Eocene benthic foraminiferal assemblages. Eocene to lowermost Oligocene assemblages indicate that the paleodepth was >600 m, shallowing to 200-600 m by the Miocene. Overall shallowing and increased downslope transport accompanied the progradation of clinoforms from a location 90 km landward of Site 903 in the early Miocene to less than 20 km landward in the Pleistocene.

The principal result from Site 903 is that sequence boundaries traced from beneath the shelf to the slope can be recognized and dated. Excellent logs were obtained from Hole 903A, and preliminary synthetic seismograms constructed from log data are encouraging. Precise correlations for some sequence boundaries will require additional shore-based studies, especially to obtain a magnetochronology for weakly magnetized lower upper Miocene and older sediments. Nevertheless, shipboard studies provide excellent correlations for several boundaries:

1. Reflector m2 (Yellow-2) is associated with a reversed magnetozone tentatively correlated to Chron C5Ar and has an age estimate of approximately 12.4 Ma;
2. We precisely dated the reflector m5 (Green) sequence boundary for the first time. This reflector correlates with an interval spanning the boundaries between the middle/lower Miocene, Zones NN4 and NN5. It has an estimated age of 16.2 Ma;
3. At both Sites 902 and 903, the reflector m6 (pink-3) sequence boundary separates the lower lower Miocene from the uppermost Oligocene;
4. At both Sites 902 and 903, the o1 (green-2) sequence boundary separates uppermost lower Oligocene from uppermost Eocene strata.

Reflector	Color	Correlation	
p1	yellow	oxygen isotope stage 7/6 transition***	middle Pleistocene
p2	blue	oxygen isotope stage 9/8 transition***	middle Pleistocene
p3	green	oxygen isotope stage 10 hiatus; stage 11/10 transition***	middle Pleistocene
p4	purple	oxygen isotope stage 12.4/12.3 transition***	middle Pleistocene
p5	orange	oxygen isotope stage 13/12 transition***	middle Pleistocene
p6	indigo	disconformity separating stage 15*** & upper Pliocene	middle Pleist./upper Plio.
m0.3	yellow	near base of C4n	middle upper Miocene
m0.5*	Red	C4Ar?	middle upper Miocene
m0.7	blue	below is C4Ar?	lower upper Miocene
m1*	Tuscan	C5r?	upper middle Miocene
m1.5**	orange	C5r?	upper middle Miocene
m2*	Yellow-2	C5Ar?	upper middle Miocene
m3*	Blue	older than C5Ar, NN7, & FO *G. fohsi fohsi*	middle middle Miocene
m4*	Pink-2	?near NN5/NN6 boundary	middle middle Miocene
m5*	Green	near Zone NN4/NN5 boundary; possibly upper NN4	near lower/middle Miocene boundary
m5.2**	ochre	?unconformity NN2/NN4?	lower Miocene
m5.4**	sand	within Zone NN2	lower Miocene
m5.6**	true blue	within Zone NN2	lower Miocene
m6**	pink-3	unconformity NN2/NP25	near Oligocene/Miocene boundary
o1**	green-2	unconformity NP23/NP19-20	middle Oligocene/upper Eocene
e1	yellow	unconformity NP16/NP19-20	middle/upper Eocene boundary
e2**	red-3	middle part of Zone NP15	top lower middle Eocene porcellanites

* Possibly equivalent to the shelf reflectors of this color (Greenlee et al., 1992).
**Possibly equivalent to the shelf reflectors of this color (Mountain et al., unpublished).
***Based on GRAPE and magnetic susceptibility correlations to SPECMAP oxygen isotope time scale.

Table 1. Tentative correlation of seismic reflectors, New jersey contimemtal margin.

Site 904

Site 904 was drilled in 1123 m of water on the upper continental slope, offshore New Jersey, 7.5 km south and slightly downslope from Site 902 (Fig. 1). This is the deepest of four sites on a slope transect designed to sample post-lower Eocene sequence boundaries traced from the adjacent continental shelf. The primary objective of Site 904 was to sample a Miocene succession where its downdip location relative to the other Leg 150 sites suggests that it is more fossiliferous due to less destructive pore water dissolution. An additional objective was to drill through and sample a relatively thick upper and middle Eocene section, and continue down across a diagenetic boundary near the middle/lower Eocene boundary.

Four lithostratigraphic units are recognized at Site 904:

Unit I (0-106.2 mbsf), Holocene to middle Pleistocene silty clay; slump deposits of poorly sorted sand and lithic clasts make up the base of this unit.

Unit IV (106.2-223.9 mbsf), upper to middle Miocene diatomaceous silty clay to clayey silts with carbonate and pyrite nodule.

Unit V (223.9-296.5 mbsf), lower to middle Miocene glauconitic, diatomaceous silty clay with abundant diatoms.

Unit VI (296.5-341.2 mbsf), lower Miocene to upper Oligocene silty clay with minor glauconite, common nannofossils, and rare diatoms.

Unit VII (341.2-576.7 mbsf), upper to middle Eocene clayey nannofossil chalk with diatoms, radiolarians, and foraminifers. A microtektite layer occurs 8 m above the upper/middle Eocene boundary, as determined by nannofossils; this layer is part of a 15 cm laminated interval containing well sorted silt- to sand-sized particles.

Density, magnetic susceptibility, and biostratigraphic data provide good correlations of the Pleistocene section to the SPECMAP time scale; this site contains a record of part of the middle Pleistocene back to stage 12. The middle Pleistocene is underlain by lower upper Miocene strata. Considerable uncertainties surround placement of the upper/middle Miocene boundary, with planktonic foraminifers and nannofossils indicating a disconformable contact over 20 m below that indicated by diatoms and dinocysts. The upper middle Miocene section contains a spotty record of calcareous plankton, and shipboard biostratigraphy of this section is uncertain. The lower middle Miocene to upper Oligocene section has reasonable calcareous biostratigraphic control, and at least two possible hiatuses were detected (NN5/NN7 and NN2-3/NN4). As at Sites 902 and 903, most or all of the early

Oligocene is not represented, with possible hiatuses near the Oligocene/Miocene boundary and in the late Oligocene. Eocene biostratigraphic control is good. Preliminary biostratigraphic studies of a microtektite layer show that it is lower upper Eocene.

The principal result from Site 904 is that we recovered a lower Miocene section with calcareous microfossils. There is great potential for improved integration among biostratigraphic, Sr- isotopic, and magnetostratigraphic chronologies crucial to the objectives of Leg 150. In addition, Site 902 recovered the thickest upper Eocene section yet found in this region. Definitive age estimates of seismic reflectors require further study; the interpretations completed thus far are consistent with the ages of reflectors traced from the continental shelf and dated at Sites 902 and 903.

Site 905

Site 905 was drilled in 2698 m of water on the upper continental rise of offshore New Jersey, 33 km from the foot of the continental slope (Fig. 1). This is the deepest water depth of the five sites drilled during Leg 150, and constitutes the most seaward member of the New Jersey Sea Level Transect. The immediate goal at Site 905 was to determine the deep-sea expression of Oligocene to Holocene eustatic changes resolved in the other Leg 150 sites drilled on the New Jersey slope. This sea-level history is to be compared with any evidence we may find of deep-water circulation at Site 905 in order to establish temporal relationships between downslope and along-slope sediment transport processes.

Four lithostratigraphic units are recognized at Site 905:

Unit I (20-215 mbsf), lower Pleistocene conglomeratic clay; all but parts of 2 cores are mass transport deposits containing clasts of clay, silt and sand-sized sediment, pebbles and shell fragments; terrigenous components dominate.

Unit II (215-537 mbsf), lower Pleistocene to upper Miocene homogeneous silty clay with uniformly low terrigenous composition; diatom abundances increase downward.

Unit III (537-680 mbsf), at least five upper to middle Miocene units of conglomeratic clay; polycyclic mass transport units indicated by clasts within clasts, by clasts composed of two or more sediment types in sharp contact, and by clasts composed of indurated sandy matrix with flow structures and folds (see cover photo).

Unit IV (680-911 mbsf), upper middle Miocene homogeneous silty clay, and like Unit II with uniformly low terrigenous composition and abundant diatoms.

Biostratigraphic studies show that the 910.6 m of lower Pleistocene to lower middle Miocene section may be subdivided into four main units bracketed by unconformities. The upper unit, 218.7 m thick, is lower Pleistocene nannofossil Zone NN19 (1.37-1.45 Ma). This unit overlies a thin (~55 m) interval of upper Pliocene hemipelagic silty clays (224-279 mbsf); a late Pliocene-early Pleistocene hiatus separating these units encompasses about 0.6 m.y. (nannofossil Zones NN19 to the upper part of Zone NN17 are not represented). A ~278 m thick, apparently continuous lower Pliocene to upper Miocene section constitutes a third unit extending from 290.4 to 568.3 mbsf; an intra-Pliocene hiatus encompasses about 1 m.y. (nannofossil Zones NN14 and NN13 are not represented). The lowest unit, (576.49 to 909.66 mbsf) is poorly understood at this time. Dinocyst and diatom stratigraphies indicate that this is an essentially continuous middle Miocene section. Alternatively, there are suggestions from calcareous nannofossil stratigraphy that abnormal stratigraphic successions occur. The hiatus associated with the boundary between the upper and middle Miocene is at least ~2 m.y. (calcareous nannofossil Zones NN10 and NN9 and possibly NN8 are absent).

The principal result from Site 905 is that mass wasting has on occasion been a volumetrically important depositional agent on the upper continental rise. The lower Pleistocene mass flow unit, roughly 200 m thick, can be traced in profiles for tens of kilometers along the rise parallel to the margin, as well as an equal distance seaward from Site 905. Furthermore, middle Miocene mass transport deposits comprise many tens of meters in the middle of the interval recovered at Site 905. Remarkably uniform, homogeneous hemipelagic sedimentation prevailed for most of the time since the middle Miocene, punctuated by bottom current erosion at roughly 9.5 Ma and 4 Ma.

Site 906

Site 906 was drilled in 923 m of water on the middle continental slope of offshore New Jersey, 0.6 km north of Site 902 (Fig. 1). We located Site 906 in the thalweg of modern Berkeley Canyon in order to minimize upper Neogene sediments and to penetrate a buried Miocene canyon. We conducted a detailed seismic survey of the buried canyon structure on approach in order to map its geometry. Scientific objectives at Site 906 were:

1. To compare the depositional history of a site on an interfluve of an extinct middle Miocene canyon (Site 902) with that of a site in the thalweg of the buried canyon (Site 904);
2. To evaluate the timing and mechanism of sediment deposition in both environments; and
3. To determine the timing of canyon cutting and sedimentation changes with respect to global sea-level change.

Several of the lithologic units penetrated at slope Sites 902-904 are represented at Site 906, and we maintained the same lithologic unit designations among the slope sites. Units II and III are not represented at Site 906. However, the canyon fill penetrated at Site 906 between 361.8 mbsf and 478.2 mbsf contains lithologies that are very different from the coeval Unit V at Sites 902-904, and we designated three subunits of Unit V for these canyon fill deposits at Site 906.

Unit I (0-55.4 mbsf), Holocene to upper Miocene silty clay with mudclasts.

Unit IV (55.4-279.2 mbsf), upper and middle Miocene diatomaceous silty clay to clayey silts with siderite and pyrite nodules. Gravity flow deposits occur in the middle and base of the unit.

Unit V (279.2-478.2 mbsf), middle Miocene canyon fill divided into three subunits (laminated silty clay, thinly bedded fine quartz sand, silty clay interspersed with mud-clast conglomerates).

Unit VI (478.2-563.8 mbsf), upper Oligocene silty claystone and clayey siltstone with abundant glauconite, common nannofossils, clastic sills, and microfaults.

Unit VII (563.8-602.4 mbsf), upper to middle Eocene clayey nannofossil chalk.

The Pleistocene section at Site 906 is thin (43 m) and younger than the *Pseudoemiliania lacunosa* LAD (<474 ka). The upper Miocene section at Site 906 contains Zones NN9-10 and N16-17, and is thus lower upper Miocene (8.2-10.4 Ma). The boundary between the upper and middle Miocene is not recognizable using biostratigraphic criteria.

Stratigraphic interpretation of the middle Miocene section recovered at Hole 906A is the least constrained of any of the slope sites because of a thick interval (~90-420 mbsf) barren of calcareous fossils and an interval of wide ranging zonations in the mass flow deposits below this interval. The only stratigraphic control currently available for the interval between 90 and 420 mbsf is provided by diatoms, which indicate assignment to the middle Miocene *R. barboi* Zone. All of the canyon fill at Site 906A is assigned to the *R. barboi* Zone (older than about 11-0.5 Ma). The mud clast conglomerate found at the base of the canyon fill (421.1-478.2 mbsf) contains both lower Miocene (Zone N6) and middle Miocene fossils (*R. barboi* Zone). We assume that the older ages are due to reworking of older clasts, and that the canyon fill is middle middle Miocene and younger (< about 15 Ma). The Oligocene section is assigned to Zones NP25 and P22 (upper part) and undifferentiated Zones NP24/25 (lower part). Calcareous plankton indicate that a ~66 m section of upper Oligocene glauconitic silty clay (Zones NP24-NP25 and P22) overlies an upper Eocene nannofossil clayey chalk (Zones NP19/20 and P15- 17).

The principal result from Site 906 is that we recovered a remarkable history of a middle Miocene canyon. The canyon was cut between about 12.5 and 15 Ma. We previously traced reflector m3 (= shelf Reflector Blue of Greenlee et al., 1992) as the base of the canyon. This reflector dates to about 13.5 Ma, consistent with its being the surface of canyon incision. This event may correlate with an inferred glacio-eustatic lowering that is part of the middle Miocene $\delta^{18}O$ increase, although additional chronostratigraphic studies are needed to document this. Subsequent to the cutting of this canyon, it rapidly filled first with debris from the canyon walls, then with turbiditic sands as it served as a conduit for sands carried downslope. The demise of the canyon was marked as it rapidly filled with 100 m of laminated mud in less than about 1 m.y.; this period of lamination marked an unusual interval of low oxygen noted not only at Site 906, but also at other slope sites. The entire birth and demise of the canyon took less than about 2 m.y.

Overall Results

Leg 150 was successful in attaining its primary scientific goal: sequence boundaries traced from beneath the shelf to the slope were recognized as stratal surfaces and dated at slope Sites 902-904 and 906. We traced seismic reflectors from the continental shelf to the slope using the Ew9009 MCS seismic grid, including the following Oligocene-Miocene reflectors of Greenlee et al. (1992): Red, Tuscan, Yellow-2, Pink-2, and Green. In addition, we traced the informal ochre, sand, true blue, pink-3, and green-2 reflectors of Christie-Blick, Mountain and Miller (unpublished), and several reflectors identified on Leg 150. However, there are uncertainties in some correlations of the shelf reflections due to problems with downlapping, erosion, and masking of reflectors. Therefore, we established a local alphanumeric scheme (Table 1) that is tentatively correlated with the shelf reflections.

Shipboard age estimates of the sequence boundaries on Leg 150 compare favorably with other proxies for sea-level change. For example, reflector m3 can be traced to the continental shelf, where it is recognized as the distinct Green sequence boundary on the basis of onlap, downlap, and erosional truncation. At Site 903, we correlated reflector m3 with the Zone NN4/NN5 boundary, with an age of about 16.2 Ma. This apparently correlates with an oxygen isotope increase that is inferred to be a glacio-eustatic lowering (i.e., the Mi2 $\delta^{18}O$ increase that began ~17 Ma and culminated at 16.1 Ma; Miller et al., 1991).

At Site 906, we recovered a middle Miocene submarine valley fill. The valley, which may represent a slope canyon, formed and was infilled between about 15 and 12.5 Ma. This event may correlate with an inferred glacio-eustatic lowering that is part of the middle Miocene $\delta^{18}O$ increase. The demise of the canyon was marked by rapid infilling with 100 m of laminated mud, representing an interval of low bottom-water oxygen noted not only at Site 906, but also at other slope sites.

Physical properties data (GRAPE density, index properties, magnetic susceptibility) allowed good correlations to the Pleistocene SPECMAP time scale (Imbrie et al., 1984). The strata recovered at the four slope sites apparently represent a complete record of stages 12 to 5.2 (474-122 ka). Pleistocene mass wasting events tended to correlate with transitions from interglacials to glacials, i.e., during glacio-eustatic lowerings.

High surface water productivity in the early to middle Miocene is indicated by diatom blooms, supply of abundant organic matter, and locally reducing conditions. Terrigenous supply greatly increased in the late middle to late Miocene, resulting in increased terrestrial organic carbon, generation of biogenic methane, reduction of pore water pH, formation of pyrite, and dissolution of calcareous microfossils. Salinity increases abruptly at the top of the Miocene at all slope sites and continues to increase with depth, suggesting evaporite deposits at depth. A microtektite layer in the upper Eocene at Sites 903 and 904 correlates with a similar layer at Site 612 and records an impact of the extraterrestrial body.

The principal result from rise drilling is that mass wasting has intermittently been a volumetrically important depositional agent on the upper continental rise, although deep-sea currents were important also, as evidenced by bottom current erosion at roughly 9.5 Ma and 4 Ma.

References

Greenlee, S.M., and Moore, T.C., 1988. Recognition and interpretation of depositional sequences and calculation of sea level changes from stratigraphic data-offshore New Jersey and Alabama Tertiary. *In* Wilgus, C.K., Posamentiew, H., Ross, C.A., and Kendall, C.G.St.C, Sea Level Changes: an Integrated Approach. SEPM Spec.Pub., 42:329-353.

Greenlee, S.M., Devlin, W.J., Miller, K.G., Mountain, G.S., and Flemings, P.B., 1992. Integrated sequence stratigraphy of Neogene deposits, New Jersey continental shelf and slope: Comparison with the Exxon Model., *Geol. Soc. Am. Bull.*, 104:1403-1411.

Imbrie, J. I., et al., 1984. The orbital theory of Pleistocene climate: Support for a revised chronology of the marine $\delta^{18}O$ record. *In* A.L. Berger et al., eds., Milankovtich and Climate, Part I, D. Riedel, Hingham, Mass., 269-305.

Miller, K.G., Feigenson, M.D., and Wright, J.D., 1991. Miocene isotope reference section, Deep Sea Drilling Project Site 608: An evaluation of isotope and biostratigraphic resolution. *Paleoceanography*, 6:33-52.

Science Operator Report Leg 151

North Atlantic Arctic Gateways

Dr. Annik M. Myhre — Co-Chief Scientist
Dr. Jörn Thiede — Co-Chief Scientist
Dr. John Firth — ODP Staff Scientist

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

ODP Leg 151 drilled seven sites in the Norwegian-Greenland Sea and the Arctic Ocean, recovering over three km of core, which ranges in age from middle Eocene to Quaternary. Site 907 on the Iceland Plateau recovered a middle Miocene to Quaternary sequence overlying basement basalts with calcareous microfossils only in the upper Pliocene to Quaternary, but with a middle to upper Miocene biosiliceous-rich interval indicating high-productivity conditions. Site 908 in the Fram Strait documents a late Oligocene age for the biosiliceous-rich pre-rifted strata on the Hovgård Ridge microcontinent. Nearby Site 909 penetrated 1061.8 m into the Fram Strait basin, which acts as the corridor for deep-water flow between the Arctic Ocean and Norwegian-Greenland Sea, and recovered an upper Oligocene?/lower Miocene to Quaternary sequence high in organic matter and hydrocarbons but virtually absent of calcareous and siliceous microfossils. Sites 910, 911, and 912 on the Yermak Plateau consist of Pliocene to Quaternary glacio-marine sediments with abundant dropstones and high organic carbon content. An overcompacted zone in the upper 20 to 50 m at these sites may indicate ice-sheet loading on the plateau during past glacial advances. Ice-rafted dropstone occurrences are as old as late Miocene at Site 907 (6.4 Ma), and at least as old as 3.5 Ma in the Fram Strait and Yermak Plateau; however, relative increases in abundance occur consistently at about 2.5 Ma at most drill sites. Site 913 on the East Greenland Margin drilled a thick section of Pliocene to Quaternary glacio-marine sediments with abundant dropstones, overlying a middle Eocene to lower Oligocene and middle Miocene sequence of clays and silty clays. A biosiliceous-rich interval occurs in the upper Eocene to lower Oligocene.

Introduction

The Arctic and subarctic seas exert major influences on global climate and ocean systems. Understanding the causes and consequences of global climatic and environmental change is an important challenge for humanity. The high northern latitude oceans are of high relevance for this task, since they directly influence the global environment through the formation of permanent and seasonal ice covers, transfer of sensible and latent heat to the atmosphere, deep-water renewal, and deep-ocean ventilation, which control or influence both oceanic and atmospheric chemistry. Thus, any serious attempt to model and understand the Cenozoic variability of global climate must take into account these paleoenvironmental changes in the Arctic and subarctic deep-sea basins.

Leg 151 drilled a series of sites (Fig. 1) in four remote geographic, partly ice-covered locations (the northern gateway region, i.e., Yermak Plateau, Fram Strait, the East Greenland Margin, and the Greenland-Norway Transect, i.e., the Iceland Plateau) with the aim of reconstructing the temporal and spatial variability of the oceanic heat budget and the record of variability in the chemical composition of the ocean. Leg 151 also undertook a study of circulation patterns in the pre-glacial, relatively warm polar and subpolar oceans, and of the mechanisms of climatic change in a predominantly ice-free climatic system. In addition, the drilling recovered a collection of sequences containing records of

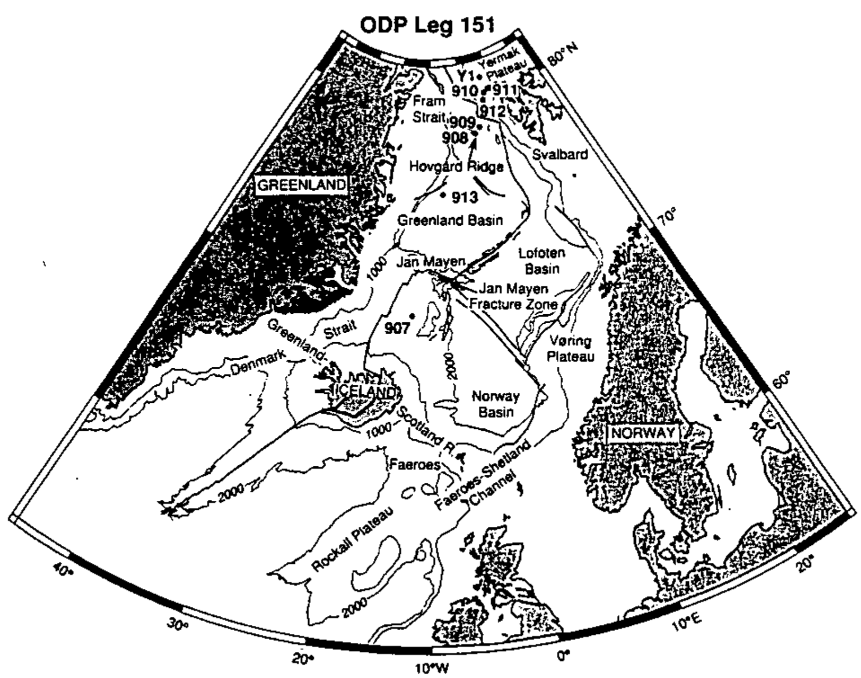


Figure 1. Location of Leg 151 drill sites. Y1=proposed site YERM-1.

biogenic fluxes ($CaCO_3$, opal, and organic carbon) and stable-isotopic carbon and oxygen records that will address aspects of facies evolution and depositional environments as well as the carbon cycle and productivity. The drilling approach focused on rapidly deposited sediment sequences to be used for high-resolution, Milankovitch-scale paleoclimatic analysis and rapid sub-Milankovitch-scale climate changes. The drill sites are arrayed as either broad north-south and east-west transects to monitor spatial paleoclimatic variability (i.e., Sites 907, 913, and the Fram Strait/Yermak Plateau sites) or closely spaced suites of cores across a range of depths to monitor vertical variability (i.e., Sites 910, 911, and 912 on the Yermak Plateau). Other approaches included sites drilled to better constrain the time of opening of Fram Strait, and sites placed to monitor downstream sedimentological effects of deep flow through narrow gateway constrictions (i.e., Sites 908 and 909).

The age and nature of basement rocks in several regions were also of interest; however, this objective was reached only at the Iceland Plateau (Site 907). Time constraints, pollution prevention and safety constraints, and ice conditions prevented basement from being reached in the East Greenland Margin, Fram Strait, and Yermak Plateau regions, respectively. The sites to the north of Svalbard (Sites 910, 911, and 912) also constitute the first drilling to be conducted in the Arctic Ocean proper.

Summary of Objectives

Cenozoic Paleoceanography of the Nordic Seas

1. To study the timing and history of deep and shallow water exchange between the Arctic Ocean and the Norwegian-Greenland Sea via the Fram Strait (northern gateway).
2. To study the timing and history of deep and shallow water inflow and outflow between the Norwegian-Greenland Sea and the North Atlantic across the Greenland-Scotland Ridge.
3. To investigate water-mass evolution, particularly addressing the initiation and variability of east-west and north-south oceanic fronts in surface waters, the initiation and variability of northern-source deep-water formation, and the history of vertical physical and chemical gradients.

Cenozoic Evolution of Climate in High Northern Latitudes

1. To investigate the timing and development of polar cooling and the evolution of low to high latitude thermal gradients in the northern hemisphere.
2. To establish the temporal and spatial variation of sea-ice distribution, the glacial history of the circumarctic, Greenland, and Northern Europe, and the history of IRD sedimentation in the Arctic.
3. To investigate variations in climatic zonality and meridionality through time as response to tectonic forcing.
4. To establish the history of the higher frequency components of the climatic and glacial evolution of the Arctic and subarctic areas.
5. To identify ocean-atmosphere interactions associated with Northern Hemisphere deep-water formation and the interhemispheric couplings and contrasts in climatic evolution.

Sediment Budgets

1. To investigate fluxes of biogenic carbonate, opaline silica, organic matter, and nonbiogenic sediment components through time.
2. To study bathymetric variability through time of the CCD and lysocline.
3. To establish the spatial and temporal history of silica preservation.
4. To investigate Arctic and subarctic oceanic influence on global biogeochemical cycles.

Results

Site 907

Site 907 is located on the eastern Iceland Plateau in the southwestern part of the Norwegian-Greenland Sea. Site 907 represents part of the western extension of a paleoenvironmental transect from the Norwegian (ODP Leg 104) to the Greenland continental margin, as well as one of the southern tie points of a north-south transect through the North Atlantic-Arctic gateways. Site 907 was also located on a relatively shallow part of the Iceland Plateau, providing access to an undisturbed, flat-lying, pelagic sediment sequence.

Five sedimentary lithostratigraphic units were recognized at Site 907 (on top of the basalt encountered at 216.3 mbsf):

Unit I: (0-16.8 mbsf) This unit consists of Quaternary clayey silts, silty clays, and foraminifer-bearing silty muds, with minor amounts of biosilica-bearing silty carbonate ooze.

Unit II: (16.8-56.3 mbsf) This unit consists of Quaternary to Pliocene clayey silts and silty clays, characterized by the absence of biogenic carbonate and the abundance of silt- and sand-sized siliciclastic grains.

Unit III: (56.3-118.1 mbsf) This unit is characterized by Pliocene to upper Miocene clayey silts and silty clays, with biogenic silica, an increase in volcanic glass content, and a decrease in the percentages of quartz and feldspar. Dropstones are found throughout.

Unit IV: (118.1-197.3 mbsf) This unit is characterized by upper to middle Miocene dark greenish gray to dark gray ash- and biosilica-bearing silty clays and clayey silts, with pervasive greenish gray color bands.

Unit V: (197.3-216.3 mbsf) This unit consists of middle Miocene dark olive gray clayey mud and silty clay, which is distinguished from Unit IV by its high quartz and clay and low biosilica contents.

The micropaleontological studies of the recovered sediment sequence at Site 907 demonstrated that it consists of Pliocene to Quaternary hemipelagic deposits, upper and middle Miocene biosiliceous oozes, and middle Miocene ash-rich muds. Most major pelagic microfossil groups have contributed to a detailed biochronology, which is supported by an excellent magnetostratigraphy. Correlation to previous micropaleontological studies of DSDP Legs 38 and 94 and ODP Legs 104 and 105 proved difficult because of a number of factors: location of the new site under different water masses, better coring techniques, scarceness of calcareous materials, variable preservation of siliceous species, and high percentages of endemic species.

Site 907 siliceous microfossil assemblages suggest highly productive surface waters during most of the Neogene, whereas the decline of the pelagic habitats as indicated by the increased presence of ice-rafted materials since the late Pliocene led to the deposition of overlying, mostly terrigenous sediments typical for the glacial depositional environments.

The sedimentary sequence rests on top of acoustic basement which consists of nearly aphyric basalts. Each of the recovered units is homogeneous and massive, distinguished by glassy tops and bottoms with abundant vesicles on either side of the glass. They indicate that the cooling units are pillow basalts.

In summary, Site 907 fulfilled its objectives insofar as we collected a more or less complete Neogene and Quaternary paleoenvironmental section as the southern part of the North Atlantic-Arctic gateway problem. However, it did not fulfill our expectations either of a particularly high stratigraphic resolution section or of extensive carbonate sedimentation in the Neogene and Quaternary on the Iceland Plateau.

Site 908

Site 908 was drilled on Hovgård Ridge, which marks the northern boundary of the Boreas Basin. The site on top of Hovgård Ridge was drilled to determine the age and lithology of sediments in basins on the ridge crest to establish timing and sedimentary processes immediately postdating the opening of Fram Strait and the subsidence of the ridge. It was also planned as a shallow-water site to investigate the history of water-mass exchange between the Arctic Ocean and the Norwegian-Greenland Sea. The age of the sedimentary units on top of the ridge was unknown.

Two major lithologic units are distinguished, the boundary between lithologic Units I and II is placed at 185 mbsf, where the biosilica content sharply increases.

Unit I: (0-185 mbsf) Except for a few intervals of foraminifer-bearing mud, which occur in the two uppermost cores, and three distinct ash layers, this unit consists entirely of Quaternary to Pliocene siliciclastic sediments.

Unit II: (185-344.6 mbsf) Unit II is distinguished by the appearance of biosilica and distinctly greater sediment lithification. The sediments consist primarily of upper Oligocene to early Miocene? silty clays. Diatoms are the dominant biogenic component and typically constitute 8%-20% of the bulk sediment.

Microfossils recovered reveal a discontinuous stratigraphic sequence of Pliocene to Quaternary and upper Oligocene to possibly lowermost Miocene sediments. An unconformity separates relatively unfossiliferous Pliocene and Quaternary hemipelagic from upper Oligocene diatom-rich muds. Miocene sediments are absent at Site 908.

The sediments of Unit I are representative of the glacial Pliocene and Quaternary depositional regime in the southern Fram Strait, with little documentation of the glacial and interglacial faunas and floras. Below Core 908A-20X the section is fossiliferous, consists of very dark gray mud(stones), and contains upper Oligocene siliceous microplankton (diatoms, rare radiolarians) and deep neritic benthic foraminifers. The entire section is also rich in terrestrial organic material. Methane increased at 90-100 mbsf, and the C_1/C_2 ratios decreased at 120 mbsf, but these were not considered a serious problem because they stabilized below 275 mbsf. This section of fully marine Oligocene sediments without indications of a sea-ice cover is at present unique for the Arctic and subarctic Northern Hemisphere.

Site 909

Site 909 had been planned as the deep-water location in Fram Strait on a small abyssal terrace which is located immediately to the north of Hovgård Ridge. This terrace comprises the sill between the Arctic Ocean and the Norwegian-Greenland Sea and it is protected against the influx of turbidites by channels or depressions to the west, east, and north. Shallow gravity cores from the terrace had demonstrated the existence of a hemipelagic fossiliferous sediment section with an undisturbed, easily-dateable upper Quaternary stratigraphy. Since the central part of the Fram Strait was ice-free, the westernmost of the locations proposed for the FRAM-1 site was selected.

The entire sedimentary sequence can be subdivided into three lithologic units:

Unit I: (0-248.8 mbsf) This unit consists of Quaternary to Pliocene interbedded clays, silty clays, and clayey muds with varying amounts of dropstones with diameters of >1.0 cm. Dropstones do not occur beneath 240 mbsf.

Unit II: (248.8-518.3 mbsf) This unit consists of Pliocene to Miocene silty clays and clayey silts with common pyrite. Some of the clays are carbonate-rich.

Unit III (518.3-1061.8 mbsf) Based on sedimentary structures, this Miocene to Oligocene unit can be subdivided into two subunits. The upper subunit (518.3-923.4 mbsf) consists of silty clays, clayey silts, and muds, and some is carbonate bearing. The lower subunit (923.4-1061.8 mbsf) comprises silty clays, clayey silts, and clayey and silty muds which are characterized by several intervals of commonly folded and otherwise deformed bedding.

Microfossil assemblages comprise mostly palynomorphs as well as agglutinated benthic foraminifers. Dinoflagellates suggest a nearly complete Miocene section. Other microfossil groups are virtually absent, with the exception of rare calcareous nannofossils in the upper 50 m and from 700 mbsf to the base. The benthic foraminifers suggest an older age (early Oligocene), indicating unusual diachrony of this group, possibly caused by the migration of benthic habitats. Siliceous microfossils were virtually absent, but dissolved silica in pore waters in the upper part of the section was present in high enough quantities to suggest their original presence. However, in the lower part of the section, dissolved silica was so low that the original sediments must have been opal-free.

Site 910

Site 910 is located in 556 mbsl on the central inner Yermak Plateau. Its objectives were to study the Neogene evolution and glacial history of the Arctic, to investigate the history of influx of North Atlantic waters into the Arctic Ocean, and to form the shallow member of a bathymetric transect of depth gradients of sediment properties and accumulation.

The 507.4-m-thick sequence recovered at Site 910 consists of very firm, nearly homogeneous silty clays and clayey silts, predominantly very dark gray. It is highly consolidated in the surface layers. Sediment texture and mineral components exhibit variations of 20%-30% throughout the sequence, but show few major trends. Dropstone frequency reaches 1-3 dropstones per meter (0-208.7 mbsf), whereas frequencies are less than 1 per meter below (208.7-507.4 mbsf). The drilled sequence comprises a single silica-rich lithologic unit, which is subdivided into three subunits, based on dropstone frequency and variations in siliciclastic abundance. The recovered sequence suggests variations in the siliciclastic influx to the Yermak Plateau throughout the time interval documented in these cores, and an increase of ice-rafting at approximately 208.7 mbsf, possibly an indicator of the intensification of Northern Hemisphere glaciation.

The biostratigraphy of this site is based on calcareous nannofossils and planktonic foraminifers. The upper part of Hole 910C, down to 64.2 mbsf, contains Quaternary microfossils, but the position of the Quaternary/Pliocene boundary is not clear because of the poor core recovery in the upper part of the holes. The occurrences of small specimens of the calcareous nannofossil *Gephyrocapsa* and the foraminifer *Neogloboquadrina dextral* in Sample 910C-11R-CC indicate that the Quaternary/Pliocene boundary may be situated close to this zone. Below 112.4 mbsf the nannofossil assemblages change abruptly and are dominated by Pliocene species. The unusually consistent occurrence of benthic foraminifers in the entire sequence provides a basis for ecologic and oceanographic interpretations of the bottom conditions. Terrestrial plant material and palynomorphs are common throughout the section.

The outstanding geotechnical properties of this site with its highly overconsolidated upper part of the penetrated sequence resulted in our decision to devote a dedicated D hole to an in-depth post-cruise study of the physical properties. The drilled sequence could be subdivided into two geotechnical units, determined by the marked increase in shear strength observed at 19 mbsf in Hole 910A and between 9 and 18 mbsf in Hole 910C. Sharp increases in sediment strength (from <100 kPa to >300 kPa) and wet bulk density (from 1.7 g/cm^3 to 2.2 g/cm^3), and a sharp decrease in porosity (from 50% to 35%) between 0 and 20 mbsf, indicate that the shallow sediments are overconsolidated. Below 150 mbsf, where core recovery is better, the sediments show more normal distributions of index properties and strength. The overconsolidation of shallow sediments at this site may result from ice-loading.

Site 911

Site 911 is located in the shallow southern part of the Yermak Plateau (Fig. 2), at a moderate distance northeast of Site 910. It was intended to drill a thick blanketing sequence of Neogene and Quaternary sediments whose upper part we hoped to study for the glacial history of the Arctic Ocean, the influx of Atlantic surface water into the Arctic, and as a shallow member of a bathymetric transect which had the aim of studying depth gradients in sediment accumulation. Three holes were drilled, the first to a maximum depth of 505.8 mbsf.

The sediments recovered at Site 911 (Holes 911A, 911B, and 911C) consist primarily of unlithified, homogeneous clayey silts and silty clays of Quaternary and Pliocene age. A single lithologic unit has been defined, which can be subdivided into two subunits, primarily based on variations in dropstone abundances.

Subunit IA: (0-380.4 mbsf) This Quaternary to Pliocene subunit is distinguished by an increase in dropstone abundance to peak values of about six per core, with siltstones, sandstones, and shales as dominant lithologies.

Subunit IB: (380.4-505.8 mbsf: Pliocene). By comparison with Subunit IA, Pliocene Subunit IB is defined by a smaller content of dropstones. The dropstones are also smaller in diameter (average 1.3 cm) and consist mostly of plutonic rocks and sand/siltstones.

The three holes recovered a Quaternary and Pliocene sequence of ice-rafted sediments with scattered calcareous microfossils. Glacial sediments contain rare to common Quaternary and Pliocene benthic and planktonic foraminifers and calcareous nannofossils. The boundary between the Pliocene and Quaternary is recognized only in the deepest hole, Hole 911A, between the final occurrence of the planktonic foraminifers *Neogloboquadrina*

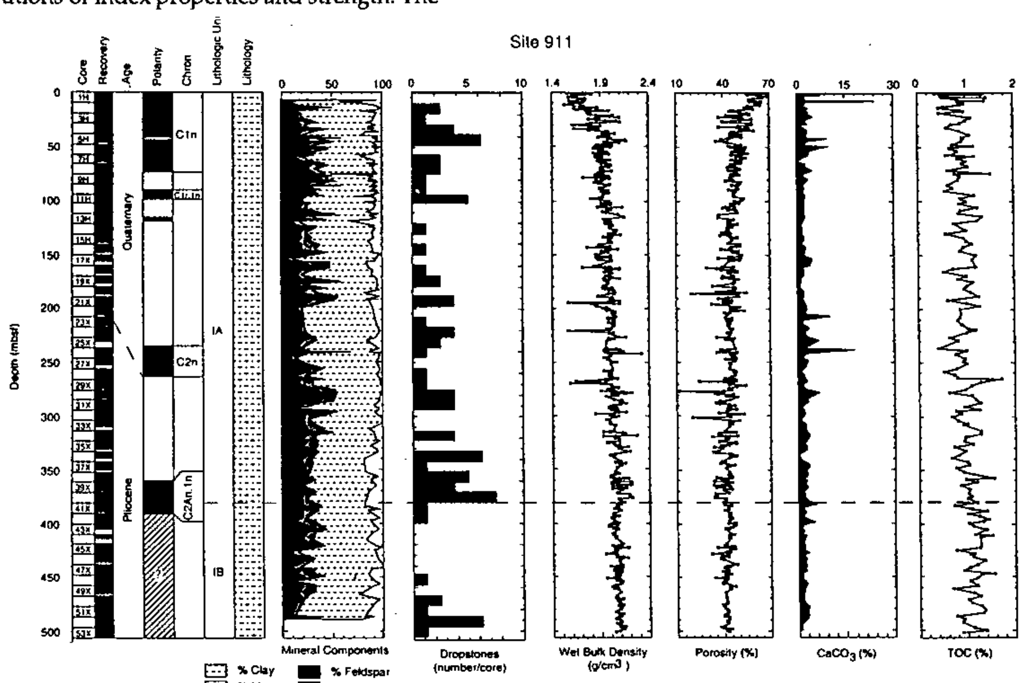


Figure 2. Summary of core recovery, age, lithologic units, sediment components, physical properties, and chemistry of Site 911.

atlantica sinistral (Pliocene) (409.3 mbsf) and the first occurrence of *N. pachyderma* sin. (Quaternary) (351.9 mbsf). Siliceous microfossils are absent, with the exception of rare recrystallized and reworked specimens. Reworked planktonic and benthic foraminifers, probably ice-rafted, occur in the lower part of Hole 911A.

Site 912

Site 912 is located on the shallow southwestern edge of the Yermak Plateau. It was selected to study trends in Neogene and Quaternary sediment accumulation on the Yermak Plateau and to investigate the glacial history of the Arctic gateway. It had been planned for penetration through a thick sedimentary section of Quaternary and Neogene age with evidence for the glacial history of the Arctic and the history of the North Atlantic (West Spitzbergen Current) water influx into the Arctic.

Sediments recovered at Site 912 are predominantly unlithified, slightly to moderately bioturbated silty clays and clayey silts of Quaternary to Pliocene age. A single lithologic unit was defined at Site 912, based on the relative uniformity in sediment type, texture, and mineralogy. The unit is characterized by higher abundances and greater sizes of dropstones as compared to Sites 910 and 911 on the inner Yermak Plateau. Most of the dropstones consist of silt-, sand-, and mudstones, but metamorphic and igneous rocks are also common. Two lithologic subunits were defined on the basis of changes in dropstone abundance, with the Subunit IA/IB boundary placed at 40 mbsf (within the Quaternary). The uphole increase in dropstone abundance at about 40 mbsf indicates an enhancement of glacio-derived sediment transport potentially related to an intensification of Northern Hemisphere glaciation.

Site 913

Site 913 is located in the deep Greenland Basin on crust slightly older than magnetic anomaly 24B; it is the northernmost of the drill sites planned along the East Greenland Margin. The original scientific objectives were aimed at describing the onset and evolution of the East Greenland Current, monitoring the deep-water formation in the Greenland Basin, and deciphering the history of the input of coarse ice-rafted debris. The poor recovery of the upper part of the drilled sequence has prevented fulfillment of most of the previously defined scientific objectives, but after penetrating a several-hundred-meter-thick sequence of Quaternary and Pliocene glacio-marine sediments with large ice-rafted components, we succeeded in reaching Oligocene to Eocene fossiliferous pelagic deposits. These deposits contain lithologies documenting a stratigraphic interval which had not been covered on previous DSDP and ODP legs.

Sediments in Hole 913A and the shallow part of Hole 913B (to 307.2 mbsf) are, in large part, glacially influenced. Individual dropstones are particularly prevalent in the upper 131 mbsf; their lithology is diverse and includes a variety of sedimentary (quartz sand-, silt-, and limestones), igneous (gabbros, granites), and metamorphic (quartzites, amphibolites, gneisses, and schists) lithologies.

Four lithologic units were defined:

Unit I: (0-3.2 mbsf) Sediments consist of Quaternary interbedded clays, silts, and sand, and biocarbonate-bearing clay and silty mud, and few dropstones.

Unit II (3.2-378.7 mbsf) is divided into two subunits. Subunit IIA (3.2-143.8 mbsf) consists of Quaternary to Pliocene interbedded clayey mud and silty mud with minor gravelly or gravel-bearing layers, defined by the presence of abundant large dropstones of various lithologies. Subunit II B (143.8-378.7 mbsf) comprises middle Miocene to Pliocene predominantly silty clay, clayey silt, and silty mud, with very few dropstones.

Unit III (378.7-770.3 mbsf) is divided into four subunits. Subunit IIIA (378.7-462.0 mbsf) consists of middle Miocene to late Miocene interbedded, massive and laminated silty clay and clay. Subunit IIIB (462.0-490.7 mbsf) contains early Oligocene to late Eocene biosilica-bearing clay, biosiliceous to silty clay, and clayey and silty siliceous ooze. Subunit IIIC (490.7-674.1 mbsf) consists of middle Eocene to early Oligocene massive and laminated clays, minor silty clays, and muds.

Subunit IV (674.1-770.3 mbsf) comprises middle Eocene laminated clays, silty clays, and massive silty clays, as well as clayey and silty muds in fining-upward sequences. In the lower part, some layers of well-cemented calcareous sandstone and siltstone have been penetrated; their presence is the probable cause of the reduced recoveries from the bottom of Hole 913B.

The uppermost sequence at Site 913 consists of poorly recovered Quaternary to Pliocene sediments containing planktonic and benthic foraminifers and nannofossils to a depth of 288.4 mbsf. Sediments in the interval 288.4-375.2 mbsf are either barren of microfossils or of indeterminate age due to poor recovery. Diatoms, radiolarians, and benthic foraminifers recovered at 423.5 mbsf suggest an age of middle to early late Miocene for the overlying washed section. Sediments at 471.6 to 490.7 mbsf comprise lower Oligocene to upper Eocene radiolarians, diatoms, and benthic foraminifers; radiolarians and diatoms are particularly well preserved and abundant through the upper part of this interval, providing a first look at a Paleogene siliceous sequence along the East Greenland margin. Diatoms are absent with the exception of pyritized forms at 558.1 mbsf. Radiolarians are reduced, but continuous from 490.7 to 558.1 mbsf, and co-occur with sporadic appearances of *Bolboforma* and planktonic and benthic foraminifers. Combined data from 500.3 to 558.1 mbsf indicate middle to upper Eocene sediments. Samples from 548.8 to 587.1 mbsf are barren of microfossils with the exception of agglutinated benthic Eocene foraminifers at 567.7 mbsf. The lower part of the hole has been marred by poor recoveries, but sediments are fossiliferous, and, based on agglutinated foraminifers and *Bolboforma*, seem to belong to the middle Eocene, several million years younger than oceanic basement under Site 913.

Summary and Conclusions

During the Arctic summer of 1993, *JOIDES Resolution*, accompanied by the Finnish icebreaker MSV *Fennica*, recovered the first scientific drill cores from the eastern Arctic Ocean, including material which records the earliest history of the connection between the North Atlantic and Arctic oceans, the onset of glacial climate in the Arctic and the inception of abundant sea-ice formation and sediment ice rafting, and evidence for massive ice caps on the Arctic Ocean margin during certain glaciations.

The oldest sediments recovered, middle Eocene at Site 913, contain the highest abundances of terrigenous organic matter recovered during Leg 151 and indicate the close proximity of a continental source during this initial phase of seafloor spreading in the Greenland Basin. Episodes of laminated sediment deposition suggest a lack of infaunal activity and bioturbation during the middle Eocene. The dissolved-silica level is extremely low, suggesting an absence of biosiliceous deposition and hence indicates a restricted basin or basins receiving nutrient-depleted surface water over shallow sills, well above the mid-water nutrient maxima common in modern oceans. During this time, Fram Strait remained closed to deep-water flow. Productivity increased throughout the middle Eocene, and Site 913 remained below the CCD.

At Site 913, there was a renewed influx of terrigenous organic carbon in the late Eocene, coinciding with the first appearance of preserved biogenic silica. Upsection the preservation and abundance of siliceous microfossils increases. The siliceous intervals were formed during times of high productivity, resulting in high sedimentation rates and high abundances of marine organic carbon. Nevertheless, ventilation of the deep waters was poor, resulting in lamination and probably causing the accumulation of CO_2 in deep water, which dissolved carbonate.

The late Oligocene to earliest Miocene interval from Site 908 on the Hovgård Ridge suggests moderately well-mixed oceanic conditions in the Norwegian-Greenland Sea. The sediments record relatively high but variable surface-water productivity, well demonstrated by the most highly variable organic carbon of any Leg 151 site (0.75% to 2.0%). High productivity is also indicated by the abundance of siliceous microfossils. This site was below the CCD during this time, and the intermediate waters were poorly ventilated. Extensive bioturbation suggests at least intermediate bottom-water oxygen levels, but thin, poorly bioturbated and laminated intervals suggest episodes of very low oxygen content. Laminated-sediment intervals continued until about the middle/late Miocene boundary (Site 907, Site 909, Site 913) and provide evidence for restricted circulation in the early Miocene Greenland-Norwegian Sea. Deep-water flow from the Arctic or production in the Nordic Seas did not occur before this time.

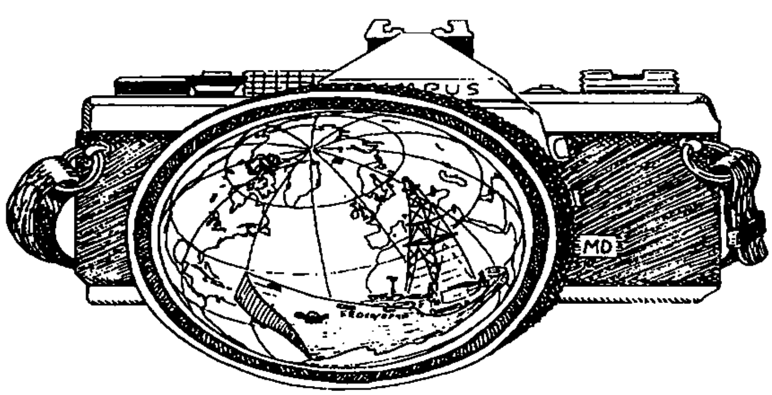
The late Miocene time interval is represented only at two sites. Site 909 is characterized by a paucity of microfossils, while Site 907 is rich in siliceous microfossils, which began prior to the middle/late Miocene boundary but ended by about 7 Ma, suggesting that deep-water formation began to better mix the Nordic Seas, but that true North Atlantic Deep Water (NADW) was not formed until the latest part of the Miocene. The disappearance of anoxic indicators marks the start of deep mixing in the Greenland Basin, while the presence of siliceous production on the Iceland Plateau shows that the southern part of the Nordic Seas still had net upward transfers of nutrients from deeper waters to the surface, unlike modern conditions. The gradient from north to south reflects either the beginning of inflow of Arctic deep waters into the Nordic Seas or the development of a strong temperature gradient in surface waters and the beginning of basinal deep-water formation in the north.

At all sites, the Pliocene and Quaternary interval is marked by evidence of ice, with significant quantities of dropstones appearing near the late Miocene/Pliocene boundary, with a marked increase at about 2.5 Ma.

Pliocene and Quaternary sediments on the Yermak Plateau at the southern edge of the Arctic Ocean are extremely thick, deposited either by the melting of a sediment-laden pack ice transported to the region by Arctic surface circulation or during interglacials as ice melted from a massive Barents Sea ice sheet or an ice cap centered on Svalbard. The former scenario seems more likely, because the melting ice edge now supports high productivity, which could cause the observed high levels of marine organic carbon deposition. The summer edge of Arctic pack ice must then have been near the Yermak Plateau for most of the Plio-Pleistocene interval.

Site 910 was marked by a highly overconsolidated interval, beginning at about 25 m depth in the sediment column. No such interval was found at the deeper water Site 912 (south) or Site 911 (north, Fig. 2). At Site 912, sedimentary evidence of the ice sheet was recorded for the same time interval. The consolidated interval was traced along the Yermak Plateau with seismic reflection profiles. This consolidation possibly indicates that an ice lobe of the Barents ice sheet reached well out to sea in the late Pleistocene and was grounded on the top of the Yermak Plateau. These event(s) may have occurred prior to the last glacial maximum at 18 ka. Evidence for the extension of the Barents ice sheet westward will provide important constraints for Pleistocene ice models.

HIGH RESOLUTION



LEG 151 - Atlantic Arctic Gateways
St. Johns's to Reykjavik
July - September 1993

Wireline Logging Report Leg 151

Wireline Logging in the Arctic Ocean

Dr. James Bristow ODP-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*

During the late summer of 1993 the *JOIDES Resolution* recovered the first drilled deep-sea cores from the Arctic Ocean. The drilling vessel, accompanied by the Finnish icebreaker *Fennica*, drilled sites first on the Iceland Plateau (Site 907) and Fram Straits (Sites 908 and 909), and then on the Yermak Plateau to the north-west of Svalbard at about 80°N (Sites 910, 911 and 912; see Fig. 1 on p. 14). A final site (913) on the east Greenland Margin was drilled after the vessel was forced south by advancing ice.

Downhole measurements were obtained at five of the seven sites drilled on Leg 151 (907, 908, 909, 910 and 911). These measurements provide invaluable information pertaining to the objectives of the leg, which principally were to study the Cenozoic paleoceanography and climatic evolution of this important gateway region. The sediments recovered on Leg 151 record the earliest connection between the North Atlantic and Arctic Oceans through the Nordic Seas, the onset of glacial climate in the Arctic, and the inception of abundant sea ice formation and sediment ice rafting.

The results outlined below are derived from analysis of the raw logging data. Much of the logging data recorded needs to undergo post-cruise processing to remove artifacts caused by environmental factors, such as borehole size; some logging data, such as those gathered by the formation microscanner (FMS) and the geochemical tool, require extensive reprocessing before detailed analysis can be performed.

At Hole 907A on the Iceland Plateau a full suite of four Schumberger tool strings were deployed: the seismic stratigraphic (natural gamma-ray, induction, and sonic velocity tools), lithoporosity (natural gamma-ray, density, and neutron porosity tools), formation microscanner, and geochemical (measuring potassium, thorium, uranium, silica, calcium, iron, sulfur, titanium, and gadolinium) combinations. The logged interval covering the middle Miocene to early Pliocene sediments consisted predominantly of clay with significant biosilica content, which distinguishes this hole from the other logged holes The higher opaline content results in very high log porosities of 75-80%, reflected in the low resistivity and density readings and the relatively low gamma-ray values in comparison to the other logged sites.

The quad combination tool string, consisting of the natural gamma-ray, density, induction, and sonic velocity tools, along with the FMS were run in the Hole 908A, located in the Fram Strait: The most prominent feature in Hole 908A is the angular unconformity occurring at about 185 mbsf, which is well defined in all of the logging data (Fig. 2). The Pliocene sequence above the unconformity is predominantly clay with quartz and feldspar, with log porosities of ~50% and average bulk densities of ~1.85g/cm^3. The upper Pliocene sequence has a well defined cyclic nature best exhibited in the resistivity log. Post-cruise analysis will confirm whether this is of Milankovitch frequencies. Lithologic Unit II below the unconformity is characterized by higher log porosity (60%) and lower bulk density and gamma-ray counts, due to the presence of a significant biosiliceous component in this (probable) upper Oligocene sequence. Fig. 3 shows the excellent correlation of porosity measurements calculated from the deep resistivity log with shipboard porosity measurements from core material.

Logging at Hole 909C was enabled by use of the sidewall entry sub (CSES). The interval logged by the quad combination and FMS tool strings covered almost the entire drilled sequence. Sonic velocity shows a remarkably linear trend downhole, with velocities increasing from 1.5 km/s at the top to 2.6 km/s at 1010 mbsf. The log porosities show a similar trend, with a range from 45% at the top to 30% at the bottom of the hole.

The lower portion of the hole is characterized by the presence of a few more sandy units and tightly

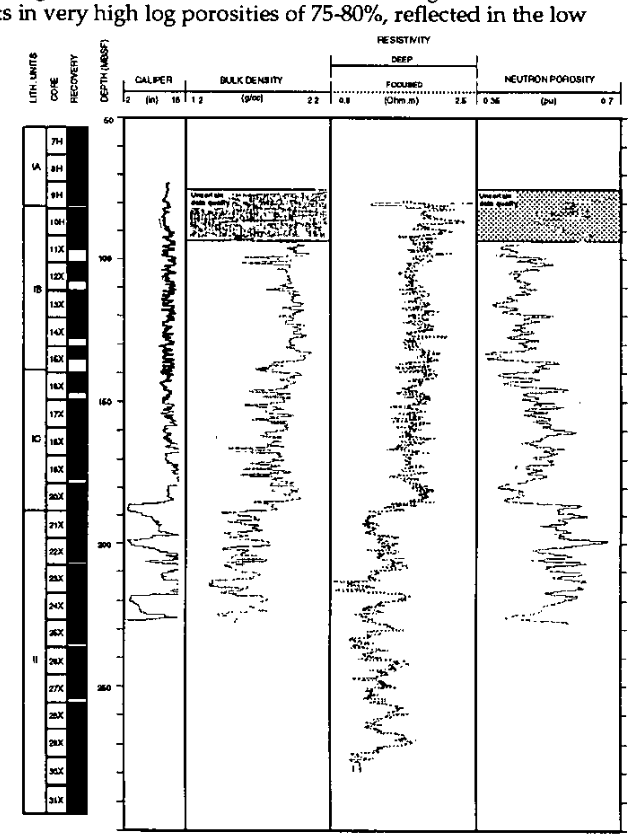


Figure 2. Hole 908A physical logs summary plot. Orthogonal caliper data from the formation microscanner shown with bulk density, deep phasor induction, and neutron porosity.

folded beds, interpreted as slump structures. Core recovery in this unit is very poor, but the coverage of the logs clearly delineate the occurrence of the sandier units. The raw FMS images show disturbed beds, interpreted as slumping, in the intervals 1005-998 mbsf and 966-969 mbsf, which correspond well to the lithological descriptions of core material. The post-cruise processing of the images will allow for enhanced delineation of the slumps and will supply directional information.

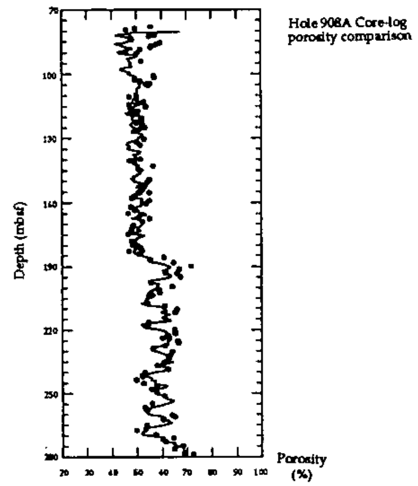


Figure 3. Porosity derived from the deep phasor induction log compared with porosity measurements on discrete core samples (solid dots) for Hole 908A.

The FMS also provides important information about the azimuth and the degree of deviation of this hole, which was marked. The deviation from vertical increases almost linearly from about 13° at 590 mbsf to 26° at the base of hole (1010 mbsf), and the direction of deviation was consistently to the north-east. As the direction is constant, one can easily use the apparent dip of the bedding within cores to orient samples for detailed anisotropy studies of sediment fabric or magnetic properties. The hole is probably following the direction of minimum stress within the sediments, though whether this direction corresponds to the regional tectonic pattern has yet to be determined.

Hole 910C, the first site drilled on the Yermak Plateau, suffered from poor core recovery (57.8%). The data recorded from the quad combination and seismic stratigraphic tool strings, however, provide valuable information over several intervals of poor recovery. The Pliocene sequence covered by the logs is dominated by clay with subordinate quartz and feldspar. The total gamma-ray count is high as a result. Log porosity is fairly constant (45%) downhole. Velocity increases fairly linearly with depth, though it jumps in the bottom part of the hole where the abundance of quartz and feldspar components increase in the core material.

Hole 911A, the second hole logged on the Yermak Plateau, was covered comprehensively with the logging tools. The Pliocene to Quaternary sequence that Hole 911A represents is also dominated by an unlithified, dark-gray, silty-clay lithology. The logs, exhibiting no major variations downhole, reflect the homogeneous nature of the sediment. Log porosity is a fairly constant 50% downhole, and log velocity increases linearly from 1.6 to 1.9 km/s in the interval 110-460 mbsf.

Apparent in the recovered cores throughout the hole were iron sulfide nodules, usually infilling burrows in bioturbated sections. These nodules were observed to be commonly 0.5 to 1.5 cm across, and due to their highly conductive nature, they appear on the FMS images as black (conductive) spots (Fig. 4). These spots are consistent between and repeated in the two passes of the FMS. Fig. 4 also shows the individual resistivity traces from one of the FMS pads dropping sharply at the occurrence of the sulfide nodules. Shore-based processing of the FMS data should enable a more accurate delineation of the abundance of these nodules in the hole.

Despite the fact that the logs from Hole 911A show no major trends downhole, they exhibit a marked cyclicity, particularly well defined in the resistivity data. Preliminary spectral analysis shows it to be of Milankovitch frequencies. Extracting paleoclimatic information from logs is often compromised by low accumulation rates, limiting the temporal resolution of the logs. At Site 911 the sedimentation rates are particularly high, reaching 193 m/my as calculated from preliminary paleomagnetic constraints. This gives the logs a temporal resolution on the order of 1 Ky. Preliminary spectral analysis over the interval 1.1-1.8 Ma (~110-240 mbsf) show strong spectral power at ~43 Ky and to a lesser extent at 100 Ky. The dominant 43 Ky peak is probably a climatic expression of the 41 Ky orbital obliquity cycle. It is uncertain at this stage what the cyclicity represents in terms of varying physical components in the formation. Given that resistivity is proportional to the inverse square of porosity, these porosity changes may relate to grain size variations, which are in turn driven by fluctuations in ice cover.

The logging data will be an important aid in finer-scale lateral correlation of the individual sites drilled at the Fram Strait and Yermak Plateau. Due to the homogenous nature of the sediments and to uncertainty about the abundance of unconformities, such correlation proved difficult aboard ship. Much of the logging data exhibit cyclical behavior, and it is hoped that more accurate post-cruise paleomagnetic constraints will allow for finer-scale correlation between the sites based on the logging data.

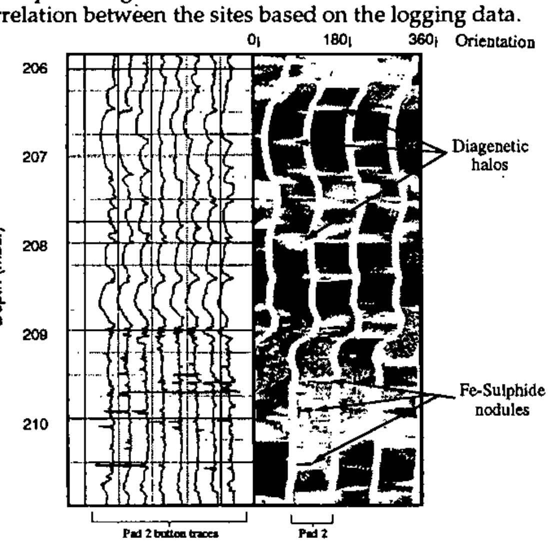


Figure 4. Data from the formation microscanner (FMS) for the interval 206-211 mbsf, Hole 911A. On the right side of the figure are the oriented microresistivity traces from the four orthogonal pads of the FMS -- the lighter the color, the more resistive the beds. On the left-hand side the microresistance traces from eight of the individual buttons on pad number 2 are shown, with resistance decreasing to the left. The Fe-sulfide nodules, which appear as small dark spots in the microresistivity images, correspond to sharp decreases in resistance on the traces from the individual buttons.

Science Operator Report Leg 152

East Greenland Margin

Dr. Hans Christian Larsen — Co-Chief Scientist
Dr. Andrew D. Saunders — Co-Chief Scientist
Dr. Peter Clift — ODP Staff Scientist

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 objectives of Leg 152 were to sample the basalts of the seaward-dipping reflector sequences (SDRS) on the continental margin of southeast Greenland and in the adjacent Irminger Basin (Fig. 1). The leg aimed to achieve deep penetration (400 m) at one site on the feather-edge of the SDRS and another deep site in the center of the sequence. Drilling of the cover sediments was aimed at recording the subsidence history of the margin and the paleoceanographic development of this part of the North Atlantic. Four sites (914- 917) were drilled on the shelf in 500 m of water (Fig. 3), and two on the continental rise in 1868 m (Site 918) and 2088 m (Site 919) of water (Fig. 2). Deep penetration (779 m) into the earliest basalts of the SDRS was achieved at Site 917, recording the nature of some of the earliest volcanism and the nature of the breakup unconformity and immediate substrata. Three lava series were identified, an Upper Series of picrites and high Mg-basalts, a Middle Series of dacites and evolved basalts and a Lower Series of basalts and rare olivine basalts. The Middle and Upper Series are separated by thin fluvial sandstones. Flow thicknesses decrease systematically upsection. All three series appear to be derived by melting of a normal MORB-like depleted upper mantle. Contamination of the lavas by continental lithosphere was recognized in the trace element composition (high Ba, K, Sr) of the two lower series.

Further basalt drilling at Site 918 showed that a MORB source was the source of all the magmatic melts during SDRS eruption. No evidence was found to implicate the presence of a chemically less-depleted mantle plume, similar to that underlying the modern Icelandic hotspot, although the presence of large volumes of magma and picritic basalts clearly indicates the need for a thermally anomalous mantle source. Weathering horizons and intercalated sediments demonstrate that the lavas were erupted in a subaerial environment. Penetration of the basal breakup unconformity moreover indicates that the Greenland crust had been stretched, subsided and then uplifted into a subaerial environment prior to SDRS volcanism. Eruption rates were very high, with the whole 150-km-wide SDRS apparently having been produced during magnetic Chron 24r (latest Paleocene to early Eocene), spanning only 2.7 m.y. Gradual thermal cooling of the margin has resulted in gradual subsidence since that time. Sites 914-917 have remained at shelf depths probably due to buoyant underlying continental crust, while Site 918 subsided rapidly, as it lies east of the sharp ocean- continent transition. An influx of terrigenous turbidites in the Irminger Basin during the late Oligocene may reflect both a fall in eustatic sea level and the start of (flexural) uplift of the Greenland margin. Ridge-push from the Reykjanes Ridge may have instigated the uplift and is seen in the shape of boreholes measured by caliper logging tools. Development of glauconitic hardgrounds within middle Miocene chalks indicates a start to the flow of the cold North Atlantic Deep Water (NADW) at 13-11 Ma into the Irminger Basin over the subsiding Iceland-Greenland Ridge. Microfauna suggest a warm climate up to this time. The first occurrence of ice-rafted debris is in marine silts of 7 Ma (late Miocene). The provenance of dropstones clearly points to a previously unrecorded early glaciation of southern Greenland. The date predates other estimates of North Atlantic glaciation by about 3-4 Ma and may indicate that the later widespread North Atlantic glaciation nucleated in this area.

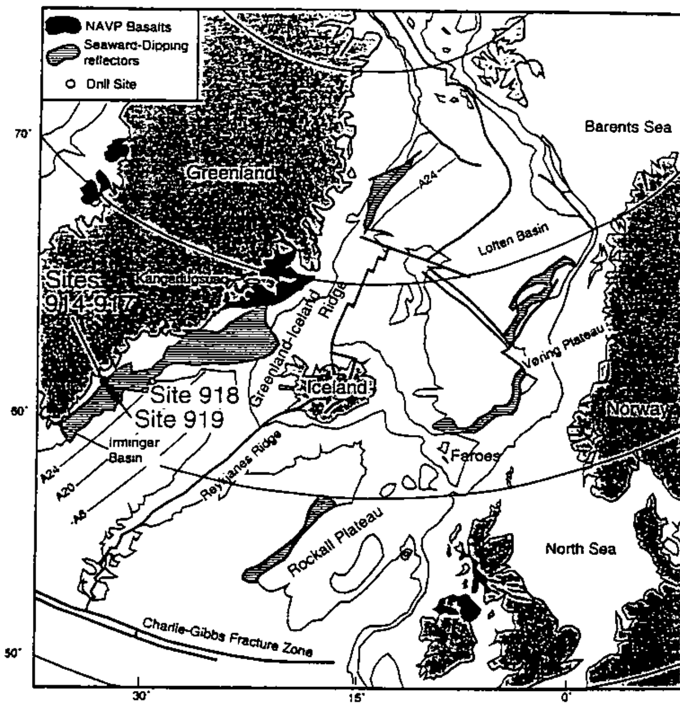


Figure 1. Map of the North Atlantic region, showing the location of dipping reflector sequences, basalt and sill complexes, and Sites 914-919 drilled during Leg 152. Thin gray lines define seafloor magnetic anomalies. The seaward-dipping reflectors along the EG63 transect were all erupted during Chron 24r times. NAVP = North Atlantic Volcanic Province.

Introduction

Divergent rifted margins are among the most prominent topographic features on our planet. One type of divergent rifted margin that was discovered barely 10 years ago, the so-called volcanic rifted margin, is now recognized as perhaps the most common style developed along the Atlantic margins.

The southeast Greenland transect is located approximately 600 km south of the original center of the ancestral Iceland hotspot in a region of apparent structural simplicity, with a well-understood, simple plate kinematic history (Fig. 1). 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 Deep Sea Drilling Project (DSDP) Leg 81.

Drilling Objectives

By drilling a transect of a total of six sites (914-919; Fig. 2) on the East Greenland Shelf and adjacent Irminger Basin, Leg 152 hoped to address the following goals:

- To constrain the timing of, and tectono-magmatic variation across, an archetypal seaward-dipping reflector sequence (SDRS).
- To determine and constrain volcanic emplacement mechanisms and investigate the nature of underplating.
- To evaluate the relationship between the Iceland plume and the southeast Greenland volcanic rifted margin.
- 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.

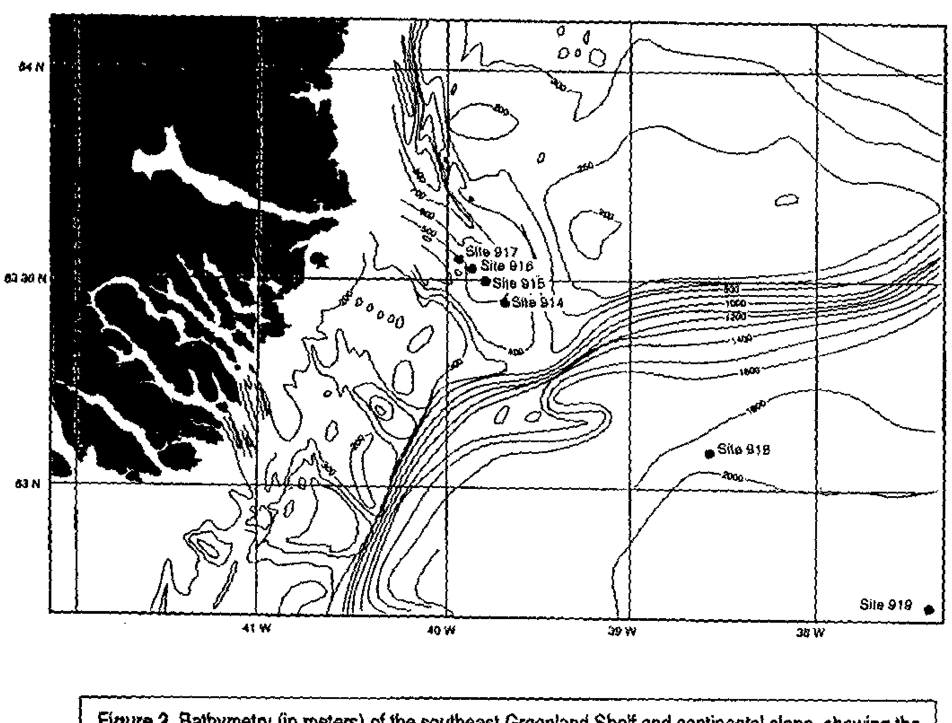


Figure 2. Bathymetry (in meters) of the southeast Greenland Shelf and continental slope, showing the location of Sites 914-919. Bathymetric data are from GEBCO 1:1,000,000 series.

Site 914

Site 914 is located on the East Greenland Shelf, approximately 60 km from the coast (Fig. 2). The site was selected to penetrate a representative sequence of Quaternary and Tertiary sediments commensurate with deep penetration (400 m) of the feather-edge of the seaward-dipping reflector sequences (SDRS). The primary objectives of this site are the Quaternary and Holocene glacial history of the margin, the Paleogene sedimentation and subsidence history, and the composition, age and eruption environment of the SDRS.

Unit I (0 - 158.5 mbsf) comprises Holocene glaciomarine sandy silt and mud with dropstones (lithologic Subunit IA; 0 to 5 mbsf), Quaternary compacted diamicton (Subunit IB; 5 to 14 mbsf), and glaciogenic sediment with gravel clasts (Subunit IC; 14 to 158.5 mbsf).

Unit II (187.2 to 245.0 mbsf; base not recovered) is characterized by massive, bioturbated, greenish black sandy silts. Overall, the fine grain size and bioturbation in Unit II suggest a mid- to outer- shelf environment of deposition. Lithologic Unit II has been dated by nannofossils as latest Eocene to early Oligocene (32-35 Ma). Benthic foraminifers indicate paleo- water depths of between 100 and 250 m for the lithologies in Unit II.

The benthic foraminifer assemblage indicates a transition from a glacial to an interglacial environment in the upper 30 cm of the recovered sediments. Locally, the diamictons show high shear strengths, consistent with subglacial compaction.

Principal Findings at Site 914

1. The presence of diamicton confirms that wet-based glaciers advanced to at least this point on the shelf, some 60 km east of the present ice sheet. The tephra found in the uppermost part of the core will enable us to determine whether the advance predates the latest (Weichselian) glaciation.
2. The benthic and planktonic foraminifers in the Quaternary and Holocene sediments illustrate changes in climatic conditions during glacial and interglacial periods.
3. The oldest sediment recovered at this site is of latest Eocene- early Oligocene age, and confirms that marine shelf conditions existed at that time. Benthic foraminifers indicate water depths of between 100 and 250 m at that time, thus providing a datum point for the subsidence study of the margin.
4. A marked hiatus exists between the lower Oligocene strata and the Quaternary glaciomarine deposits.

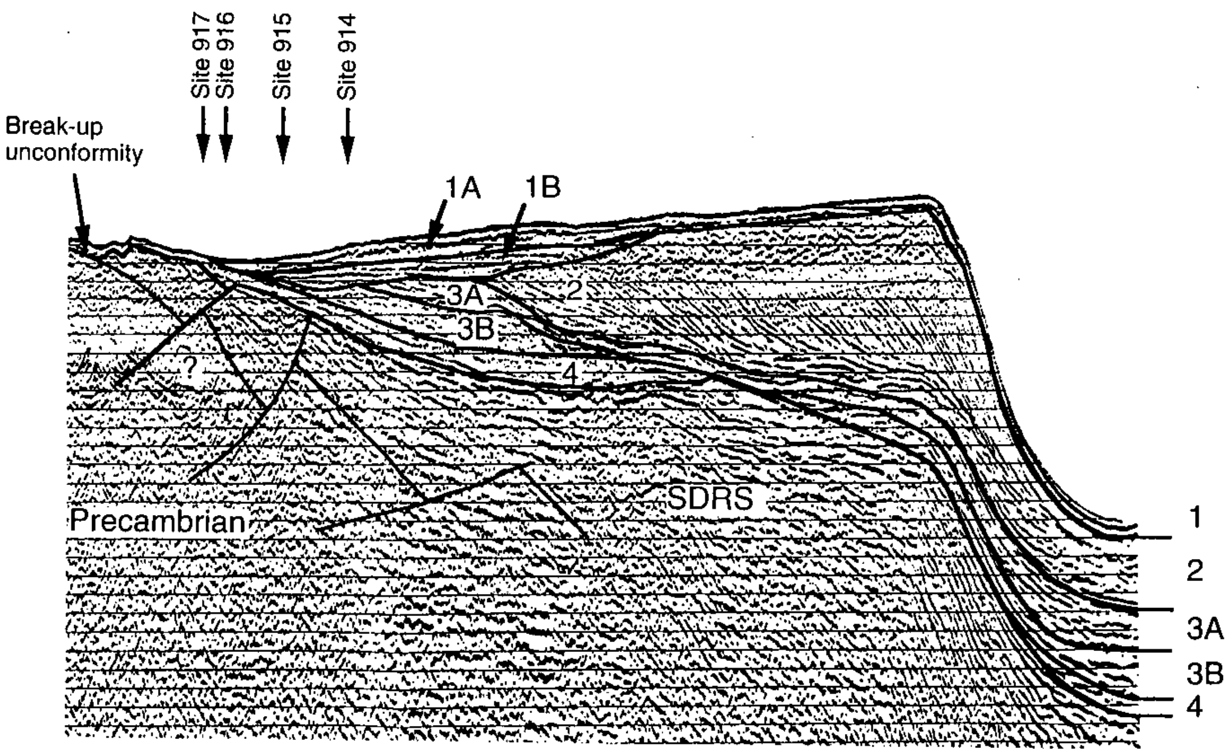


Figure 3. Sites 914-917 are located at the landward feather-edge of the SDRS wedge where it onlaps to down-flexed continental basement. Penetration of >800 m into the SDRS wedge was achieved at Site 917. Units are seismic stratigraphic units, correlated with lithological data from the drill sites.

Site 915

Site 915 is located on the East Greenland Shelf, approximately 58 km from the Greenland coast (Fig. 2). The primary objectives of this site are the same as at Site 914, namely: Quaternary and Holocene glacial history of the margin, the Paleogene sedimentation and subsidence history, and the composition, age and eruption environment of the seaward- dipping reflector sequences (SDRS).

Unit I was divided into two subunits. Subunit IA (0-2.2 mbsf) is Pleistocene to Holocene glaciomarine silty sand and silty mud with dropstones. Subunit IB (2.2-93.7 mbsf) is presumed to be a diamicton with gneiss, basalt, metasediment and granitic pebbles and cobbles. The age is presumed to be Quaternary, on the basis of stratigraphic position and lithological correlation with other areas.

Unit II (93.7 to 187.1 mbsf) comprises late Eocene volcaniclastic silty sandstone and sandy siltstone with interbeds of calcareous mudstone and sandstone. Sedimentary facies and benthic foraminifers are consistent with having been deposited in shallow water at shelf or upper slope depths.

Unit III (187.1-189.3 mbsf) comprises a heterolithic conglomerate with gravel, sands and silts. The conglomerate clasts are predominantly basalt, and the unit overlies a red, weathered basalt. The unit was probably deposited in a subaerial environment, possibly an alluvial fan.

The diamictons recovered at Site 915 are heavily consolidated, with shear strengths greater than the range covered by hand-held penetrometers. This suggests that these sediments have been in contact with ice sheet(s) on the East Greenland Shelf.

The igneous succession (189.3-209.4 mbsf) consists of two basalt units: an upper, 1.05-m-thick, highly oxidized basalt flow, and 4 m of slightly altered, vesicular basalt. The two flows are separated by several basalt cobbles, indicating that they are not contiguous. The lower basalt contains glomerocrysts of olivine, plagioclase and pyroxene. The composition of the basalts, especially the high Zr/Nb ratios, indicates derivation from a depleted, mid-ocean-ridge basalt mantle source.

Principal Findings at Site 915

1. Drilling at Site 915 demonstrated the presence of basaltic basement beneath sediments of late middle Eocene age.
2. The basalt has been extensively weathered, probably in a subaerial environment, and the immediately overlying sediments (Unit III) appear to be alluvial in origin.
3. The predicted age of the basalts (early Eocene) is considerably older than the sediments, and this will require confirmation by Ar-Ar dating of the basalt; suitable feldspar-rich basalt has been recovered.
4. The recovery of Eocene sediments will provide important data for studies of the subsidence history of the shelf.
5. The presence of diamicton confirms that wet-based glaciers advanced to at least this point on the shelf, some 55 km east of the present ice sheet.

Site 916

Site 916 is located on the East Greenland Shelf, approximately 50 km from the coast (Fig. 2). This site was selected to penetrate a representative sequence of Quaternary and Tertiary sediments, commensurate with deep penetration of the feather-edge of the seaward-dipping reflector sequences (SDRS). The primary objectives of this site are the Quaternary and Holocene glacial history of the margin, the Paleogene sedimentation and subsidence history, and the composition, age and eruption environment of the SDRS.

Unit I (0 to 60.4 mbsf maximum thickness) comprises glaciomarine sediments and diamicton. The lower part of the diamicton gives a Quaternary age, based on foraminifers.

Unit II (78.6 to 96.7 mbsf) is dominated by volcaniclastic sandy silt with interbeds of silty sand. Basalt is the dominant volcanic clast in these rocks. The absence of marine microfauna, and the abundance of woody fragments, indicate that the sediments were deposited in a nearshore environment.

Unit III (96.7 to 101.7 mbsf, TD) is a volcanic breccia with olivine-rich basalt present as in situ layers or large clasts of local origin. The breccia may represent a lahar or volcanic mud flow.

Principal Findings at Site 916

1. Basaltic basement occurs at the depth predicted by the sharp reflector observed on seismic profiles.
2. The basalt was emplaced as a lava flow and probably weathered in a subaerial environment.
3. The basement is overlain by sediments with high volcaniclastic and organic matter components, and were deposited in either a nearshore, a lagoonal, or a lacustrine environment.
4. Although it was not possible to determine the age of the lower sedimentary units, it is anticipated that they will yield diagnostic microfossils (e.g., palynomorphs) during shore-based studies. These will be required to determine the minimum age of the last volcanic rocks and the subsequent subsidence history of the margin.
5. As with Sites 914 and 915, the presence of diamicton confirms that wet-based glaciers advanced to at least this point on the shelf, some 53 km east of the present ice sheet.

Site 917

Site 917 is located on the East Greenland Shelf, approximately 50 km from the coast (Fig. 2). The site was selected to penetrate deeply into the feather-edge of the seaward-dipping reflector sequences (SDRS). The primary objectives at this site are a determination of the Paleogene sedimentation and subsidence history; the composition, age and eruption environment of the SDRS; and the nature of the rock types beneath the SDRS.

Unit I (0-28.7 mbsf) is a thin layer of Quaternary, glaciomarine silt with dropstones. The compacted diamicton recovered at Sites 914-916 to the east is absent from the thin Quaternary succession cored at this site.

Unit II (28.7-37.7 mbsf) consists of upper middle Eocene marine, micaceous sandy siltstones with a high content of volcanic glass and basalt fragments. The benthic foraminiferal assemblage within Unit II indicates a paleo-water depth of less than 200 m. The Quaternary rocks of Unit I unconformably overlie Unit II.

Unit III (37.7 to 41.9 mbsf) is a basal volcaniclastic conglomerate lies between Unit II and the basaltic flows. Volcaniclastic sandstones are found intercalated with the basalt(183.0 mbsf), and thin clay-rich zones occur throughout the volcanic sequence. These, like Unit III, are barren of calcareous nannofossils, indicating that they were not deposited under open marine conditions.

Hole 917A reached basaltic basement at 41.9 mbsf. A total of 91 flow units, plus 1 intrusive sheet, have been recognized in the recovered core. The volcanic succession has been divided into three stratigraphic series: an Upper (41.9 to 183.4 mbsf), Middle (184.1 to 376.7 mbsf) and Lower Series (376.7 to 821.06 mbsf). The Upper and Middle Series are separated by a thin (67 cm recovered) fluvial sandstone interval. The lavas of the Upper Series are predominantly olivine basalts and picrites; those of the Middle Series are more evolved basalts and dacites; and the Lower Series comprises basalts with scattered olivine basalts. Pyroclastic units occur within the Middle Series.

The entire sequence was erupted subaerially, as evidenced by the common presence of red, oxidized flow tops and fewer reddened soil horizons. Morphologically, both aa and pahoehoe flow types are present, with the more massive aa flows predominating in the Middle and Lower Series. Flow thickness tends to increase downhole; the average flow thicknesses are 4.2 m (Upper Series), 8.1 m (Middle Series), and 12.7 m (Lower Series). Several flows exceed 30 m in thickness, and one is more than 50 m thick.

The lower 280 m of the volcanic sequence is highly fractured and faulted; one fault (at 576.5 mbsf) is marked by a mylonite zone. Structures within the basalts and intercalated sediments indicate that the lavas dip at approximately 25° relative to the drill core; this is consistent with the seismic profiles that show a seaward dip. Geopetal structures in half-filled amygdules, however, consistently show a shallower dip of about 5° suggesting that hydrothermal activity continued after regional flexuring.

The Upper Series lavas are predominantly olivine basalts and picrites; the main phenocryst phase is olivine. The sequence of phenocryst phases in the Middle and Lower Series is olivine, olivine + plagioclase, olivine + plagioclase + augite (=B1 magnetite), plagioclase + augite + magnetite (in the dacite). Three dacite flows at the base of the Middle Series contain basalt xenoliths, some with lobate margins, and disequilibrium phenocryst assemblages. These suggest that magma mixing has occurred. The dacites are not peraluminous.

The majority of the lavas have high Zr/Nb ratios (18 to 50), although six flows from the Middle and Lower Series have ratios less than 15. The high Zr/Nb ratios are comparable with values for depleted mid-ocean-ridge basalt (MORB), indicating derivation from a MORB-like source. The Upper Series also has low Ba contents and low Ba/Zr ratios, similar to MORB. The Lower and Middle Series, however, have high Ba/Zr ratios, indicating interaction between the magmas and continental lithosphere. The Upper Series lavas show no evidence for such contamination.

Underlying the lavas is a thin layer of quartzose, coarse-grained sandstone of possible fluviatile origin (lithologic Unit V; 821.06 to 821.20 mbsf) of unknown age. Beneath the sandstone we encountered steeply inclined, low-grade metamorphic, carbonaceous, pyrite-bearing mudstones and sandstones (lithologic Unit VI; 821.2 to 874.9 mbsf). Poorly preserved fossils, possibly foraminifers, indicate a marine origin. Trace fossils (Chondrites) also indicate deep water (outer shelf?) conditions; bottom conditions may have been euxinic. The petrography and bulk-rock composition indicate that the rock is, at least in part, of volcanic (basaltic) origin. The steep inclination of the bedding (30° to vertical, with some beds showing overturning) may be related to tilting and slumping associated with pre-SDRS rifting.

Principal Findings at Site 917

1. Lava sequence recovered at Site 917 could be readily divided into three series, based on the flow morphology, thickness and geochemistry. All lavas appear to have been erupted subaerially.
2. Trace element chemistry suggest continental crustal contamination of the Lower and Middle Series. The more picritic Upper Series are derived by simple asthenospheric melting. There is no evidence of any involvement of a chemically undepleted source, such as that sourcing the modern Iceland volcanism.
3. Pre-volcanic sediments of Unit VI are strongly tilted and may suggest large degrees of extension and block rotation prior to eruption of the seaward-dipping lavas. The sand of Unit V indicates uplift and subaerial erosion prior to eruption.

Site 918

Site 918 is located near the center of the seaward-dipping reflector sequences on the upper continental rise of the SE Greenland Margin, approximately 130 km from the Greenland coast (Fig. 2). The site was selected to study the age and emplacement environment of the SDRS, the history of the East Greenland glaciation, the subsidence history of the Irminger Basin, and the early formation of the North Atlantic Deep Water.

Unit I (0-600.0 mbsf; Holocene to Miocene) is predominantly dark gray silt with both volcanogenic and continentally derived components. It has been divided into five subunits, depending on the presence of turbidites and the proportion of ice-rafted debris.

Unit II (600.0 to 806.5 mbsf; upper Miocene to lower Miocene) is 288.5 m thick, composed of nannofossil chalk and silt, and is moderately to heavily burrowed. Common micritic and glauconitic hardgrounds occur at the base and top of this unit.

Unit III (806.5-1108.2 mbsf; lower Miocene to upper Oligocene) comprises sand, silt and nannofossil chalk. A layer of unconsolidated gravel occurs at the base of Unit III.

Unit IV (1108.2-1157.9 mbsf; middle to lower Eocene) is 49.7 m thick and comprises interbeds of nannofossil chalk and volcaniclastic silt with nannofossils.

Unit V (1157.9-1189.4 mbsf; lower Eocene) is 31.5 m thick and consists of glauconitic sandy silt with interbeds of calcareous sand. Lower Eocene benthic foraminifers indicate a paleo-water depth between 75 and 200 m for the interval between 1160 and 1168 mbsf.

Basalt was first encountered at 1168.2 mbsf. Although only 2.8 m was recovered, this unit could be as much as 12 m thick. It comprises dark gray, holocrystalline basalt with glomerocrysts of plagioclase and clinopyroxene. Compositionally, the rock is an evolved tholeiite. The high Zr/Y (6.7) and low Zr/Nb (6.5) ratios of this basalt indicate affinities with Icelandic tholeiites. The unit may represent a sill or a flow; there were no recovered contacts. Below this unit there is a further 9.3 m of sedimentary rocks, above the main basaltic basement.

Hole 918D reached basaltic basement at 1188.5 mbsf. Deep (17.7 m), subaerial weathering has affected the top three flow units, which have been completely oxidized and altered to clay. The first rock preserving any original mineralogy was encountered at 1206.0 mbsf. From there to the bottom of the hole, 18 flow units were identified. All of the flow units consist of aphyric tholeiite with very little mineralogical or compositional variation. No evidence for submarine eruption was found, although the upper flow units may have been erupted into shallow water or across a wet substrate.

Principal Findings at Site 918

1. Dropstones in glaciomarine sediments indicate that ice-rated debris was being deposited in the Irminger Basin as early as 7.0 Ma (late Miocene)
2. Glauconitic hardgrounds in chalks suggest that strong erosive bottom water flow of the North Atlantic Deep Water, overspilling the Iceland/Greenland Ridge was affecting the Greenland continental rise area at 11-13 Ma.
3. Eruption of the seaward-dipping basalt lavas was subaerial. Subsidence below sea level, following strong weathering, took place in the early Eocene.

Site 919

The sediment column at Site 919 (Fig. 2) is assigned to one lithologic unit, which is at least 147 m thick. The dominant lithology comprises clay and silt in various proportions, and nearly 200 distinct beds or packages of beds were identified in the sediment sequence. Many of the beds show fining-upward and sharp basal contacts, indicating deposition from turbidity currents. Other beds have more irregular contacts and more poorly-sorted interiors, which may result from deposition from melting icebergs and subsequent reworking by mass flow and bottom currents on the seafloor. Dropstones occur throughout the sediment column, but they are smaller and less common than those found at the other Leg 152 sites.

The nannofossils recovered from Hole 919B indicate that the oldest sediments are of late Pliocene age. An extended Quaternary sequence (about 93.5 m) has been recovered from Hole 919A. Planktonic assemblages are abundant and well preserved throughout; temperate to warm water conditions are indicated by increased species diversity and a range of warm-water species in the Pliocene sediments. Siliceous microfossils, such as radiolarians and sponge spicules, are generally common to abundant. The location of the boundary between nannofossil Zones CN14 and CN13, the Pliocene/Pleistocene boundary, is in Core 152-919B- 6H, between 120 and 125 mbsf.

Principal Findings at Site 919

1. An expanded Quaternary-Pliocene section provides a complete biostratigraphic and magnetostratigraphic section of this time interval, during which ice-rafting of debris from East Greenland was common.

Leg 152 represents the second in an eight-leg program, proposed by the NARM-DPG, to investigate rifted margins and is the first leg to address processes at volcanic rifted margins by drilling six sites along a transect at 63°N, southeast Greenland.

Logging the Seaward-Dipping Reflectors on East Greenland Margin

Dr. Herve Cambray ODP-LDEO Logging Scientist

Wireline Logging Report Leg 152

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*

The Leg 152 program of downhole measurements was conducted in Hole 917A to characterize the series of basaltic Seaward-Dipping Reflectors (SDRs) along the East Greenland margin. For this purpose, a combination of geophysical sensors and the FMS were run along a 360-m-long interval. The geophysical combination consisted of the temperature (TLT), the electrical resistivity (DIT), the lithodensity (HLDT), the acoustic velocity array (SDT), and the natural gamma ray (NGT) sensors. Over the logged interval, the borehole is slightly elliptical with an average diameter of 11 inches. The borehole shape and conditions were favorable to downhole experiments and the data recorded in Hole 917A are of excellent quality (Fig. 1).

The natural gamma-ray data in Hole 917A proves to be particularly useful to identify the magmatic nature of the basaltic flows. The most differentiated rocks yield high gamma ray values, owing to their important K_20 and uranium contents (320.0-380.0 mbsf). Such a correlation is assumed because the electrical resistivity data does not seem to be affected by K-rich alteration, which is often the controlling factor of gamma ray variation. Gamma ray measurements made on cores are in good agreement with that from logs.

The density data are correlated with the electrical resistivity and acoustic data throughout. Density readings have to be corrected for hole size effect, especially from 320.0 to 360.0 mbsf, where occasional enlargements can be important. The velocity profile was computed to eliminate occasional "road-noise". Acoustic data distinguished by variability are however extremely well correlated with electrical resistivity data (high resistivity corresponding to high velocity). The velocity and the electrical resistivity profiles can be split into three major intervals: 181.0-260.0 mbsf (3.5 km/s and 10.0 Ω.m), 260.0-320.0 mbsf (5.0 km/s and 50.0 Ω.m) and 320.0 mbsf-bottom (4.5 to 6.0 km/s and 10.0 to 80.0 Ω.m). The sharp fluctuations observed in the lower part of the hole are due to a bimodal structure within each single flow, where the scoriaceous upper part is opposed to the massive lower part.

The real time display of FMS images on the MAXIS 500 unit, clearly confirmed the main features of SDRs, such as boundaries between flows and scoriaceous upper horizon within. Shore-based processing of the FMS data will allow a detailed description of tectonic features within and between basaltic flows. Differences between the two calipers of the FMS allows one to monitor the elliptical shape of borehole (Fig. 2). The presence of a steady elliptical borehole shape is generally interpreted in terms of breakouts, with the long axis of the borehole pointing toward the minimum horizontal stress direction. The two caliper measurements obtained with the FMS tool show a distribution of enlargements, with azimuthal orientation of elongations at about 015°N (Fig. 2). This constrains the maximum horizontal stress within the basaltic SDRs of Hole 917A, which is, to a first order, in accordance with the direction of motion of the North American Plate in this area.

Four logging units were defined in Hole 917A based on log responses. The boundaries between adjacent logging units were identified from simultaneous inflection points on at least several of the logs (Fig. 1). Also, synthetic seismogram from density and sonic data convolved with an appropriate wavelet was used to confirm the limits of logging units (Fig. 3). The main synthetic reflectors, compared with the seismic line from site survey, are

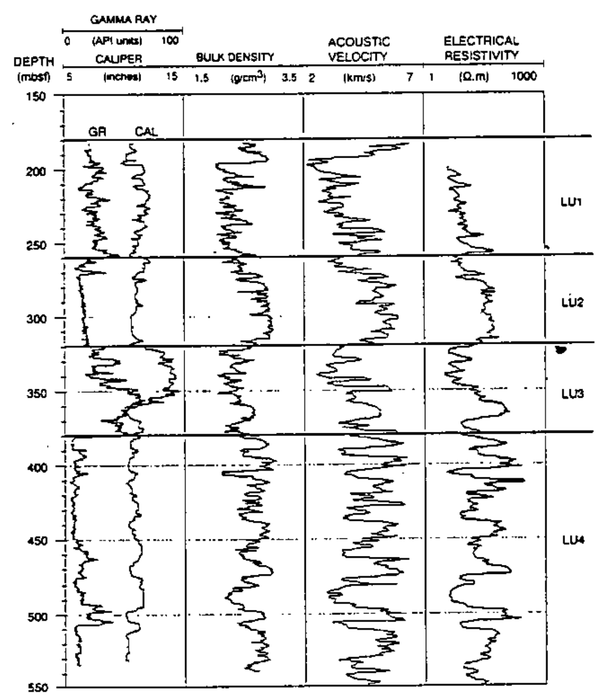


Figure 1. Summary log of Hole 917A from NGT (gamma ray), HLDT (density), SDT (acoustic) and DIT (electrical resistivity).

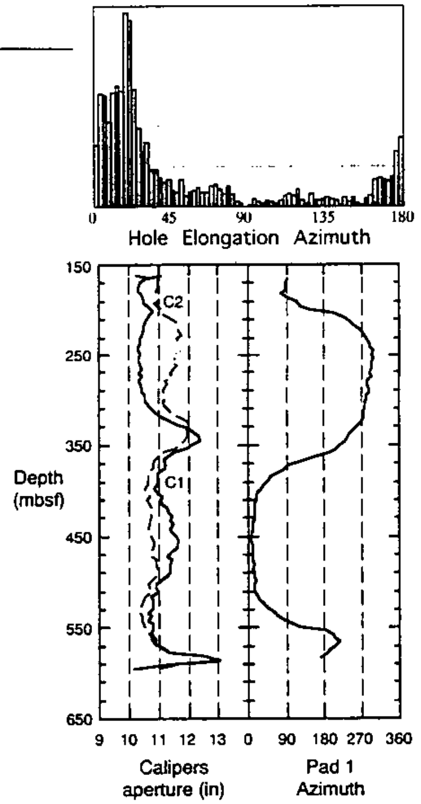


Figure 2. Charts illustrating the constant hole elongation direction as observed with FMS calipers in the basaltic SDRs. The tool rotated 90° at 350.0 mbsf. The largest hole diameter remains oriented close to the north-south axis.

correlated at 216 and 245 ms with the limits of dacitic level marked by hyaloclastic breccias.

Logging Unit 1 (180.0-260.0 mbsf) - LU1 is characterized by intermediate gamma ray values (30 API), produced by the high uranium content (3 ppm), K_20 being low at about 1 %. Acoustic velocity increases slightly from 2.5 to 3.5 km/s in this unit, and covary with resistivity data (from 5.0 to 10.0 Ω.m). The mean density is 2.2 g/cm^3. LU1 corresponds to a succession of aphyric basaltic lava flows, which are overlain by picritic olivine basalt. The medium-to-high gamma ray values are related to the differentiated nature of these basaltic flows.

Logging Unit 2 (260.0-320.0 mbsf) - LU2 is characterized by a noticeably constant increasing profile of gamma ray with increasing depth, interpreted as differentiation trend in the thick lava flow and, by an abrupt increase of density (2.8 g/cm^3.), velocity (5 km/s) and resistivity (50 Ω.m). LU2 corresponds to a massive and single flow of aphyric olivine basalt. The continuity of lithology in this depth interval readily explains the stability of the logging parameters.

Logging Unit 3 (320.0-380.0 mbsf) - Spectroscopy measurements of gamma ray show a high K_20 (3.5 %) and uranium (3 ppm) content. Density is low at about 2.2 g/cm^3. Velocity and resistivity are well correlated, with peaky profiles. LU3 corresponds to the occurrence of dacite within the basalt flows. The chemical signature of this differentiated formation is well marked by sharp increases in K_2O and uranium so that, gamma ray spectrometry is a key to defining this logging unit.

Logging Unit 4 (380.0 mbsf-535.0 mbsf) - The average density is about 2.8 g/cm^3. Acoustic and resistivity data are also well correlated with higher amplitudes. Gamma ray values are low and uniform, except for a few peaks. LU4 correspond to less differentiated basaltic flows. The succession of the flows is well recorded by velocity and electrical resistivity : sharp peaks correspond to the lower massive part of a single flow sandwiched between lower resistivity, scoriaceous upper and lower horizons. The scoriaceous horizons often contain an increased proportion of vesicles. The structure of vesicular basalt is less coherent and less continuous than non-vesicular basalts. These two characteristics explain the low acoustic velocity recorded in the scoriaceous level. High electrical conductivity at the same level is due to conductive alteration minerals within the vesicles.

In conclusion, a complete suite of downhole logs was successfully recorded at Site 917A, resulting in the identification of four distinct logging units. These logging units are well correlated with major lithologic changes defined from core. With a remarkable recovery for basement in this hole (above 50%), Hole 917A provides a good opportunity to accurately calibrate logging parameters. Results of such a study could be very helpful for log interpretations in future legs devoted to volcanic passive margins.

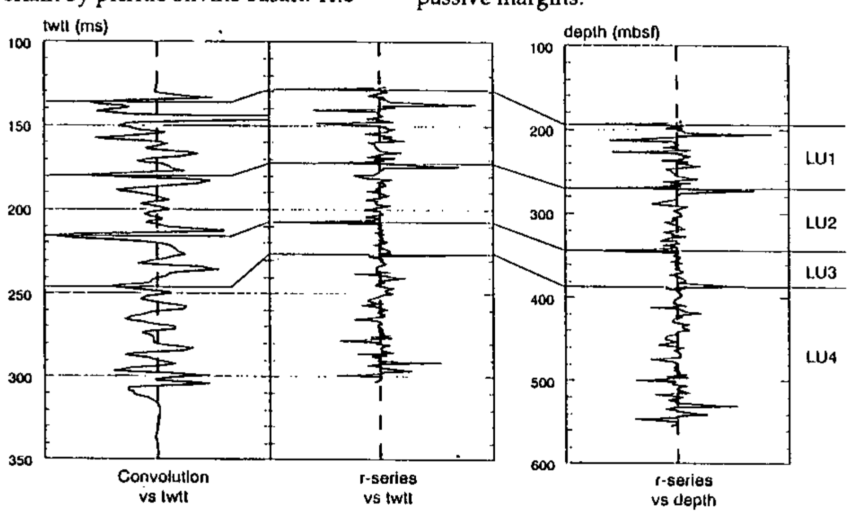


Figure 3. Synthetic seismogram from logging data for Hole 917A.

Science Operator Prospectus Leg 154

Ceara Rise

Dr. William B. Curry Co-Chief Scientist
Dr. Nicholas J. Shackleton Co-Chief Scientist
Dr. Carl Richter 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

The Ceara Rise in the western equatorial Atlantic provides an ideal target for constructing a bathymetric transect of drill sites. The Ceara Rise is located in the main flow path of the two principal water masses in the oceans. Mixing between these water masses creates the initial chemical and physical properties for deep water in the eastern basins of the Atlantic and for the Indian and Pacific oceans. Therefore it is imperative to understand the history of deep water circulation and chemistry in this region in order to evaluate the changes in deep water chemistry and carbonate preservation that are observed in other ocean basins.

The objective of Leg 154 will be to construct a transect of coring sites distributed down the northeastern flank of Ceara Rise from 2901 m to 4373 m. Several questions of paleoceanographic significance can be addressed by a depth transect of this type:

1. What was the history of deep water flow in the Atlantic during the Cenozoic? What has been the relationship between deep water circulation, chemistry, and Earth's climate?
2. What was the history of carbonate production and dissolution in the equatorial Atlantic during the Cenozoic? How have changes in carbonate production and dissolution been affected by changes in deep circulation and in Earth's climate?
3. What has been the Cenozoic history of surface water and climate in the tropics? How have the $\delta^{13}C$ of nutrient-depleted surface water and oceanic $\Delta\delta^{13}C$ varied throughout the Cenozoic?

The five highest priority sites will produce a late Cenozoic depth transect down the northeastern flank of Ceara Rise. In addition, three of these sites will sample the Paleogene sediment column at present water depths of 3037 m, 3602 m, and 4373 m.

Introduction

During the last several years, a coring and drilling strategy has been employed by the Ocean Drilling Program to recover bathymetric transects of Advanced Piston Cores (APC) and Extended Core Barrel (XCB) cores in order to reconstruct the Cenozoic history of deep water chemistry, carbonate production and dissolution, and deep water circulation. This strategy has followed a successful research strategy used for the reconstruction of late Quaternary deep water chemistry and sedimentation history and for pioneering Deep Sea Drilling Project (DSDP) transects for reconstructing Neogene and Paleogene sedimentation history (e.g., DSDP Leg 74). The research strategy invokes the basic assumption that the principal source of carbonate in the sediments is from surface water production, with little or no downslope or lateral input. If this assumption is true, then carbonate accumulation in the shallowest sites, if they are always above the lysocline, approximates the carbonate productivity of the overlying surface water. If the sites are located close together, and not near any sharp regional gradients in productivity, then the input rate of carbonate in all sites in the bathymetric transect should be equal. Then the difference in carbonate accumulation between shallow and deep sites is a quantitative indicator of the amount of carbonate lost to dissolution. With similar bathymetric transects, gradients in deep water chemistry can be reconstructed from the chemistry of benthic foraminiferal shells. Since

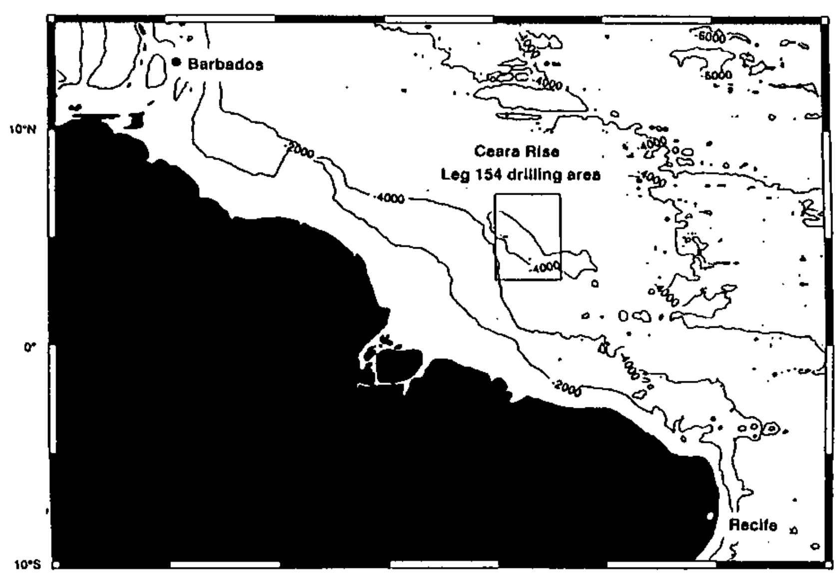


Figure 1. Location of the Ceara Rise in the Atlantic ocean. A detailed map of the marked area and the proposed drilling sites are shown in Fig. 2. Bathymetry in meters.

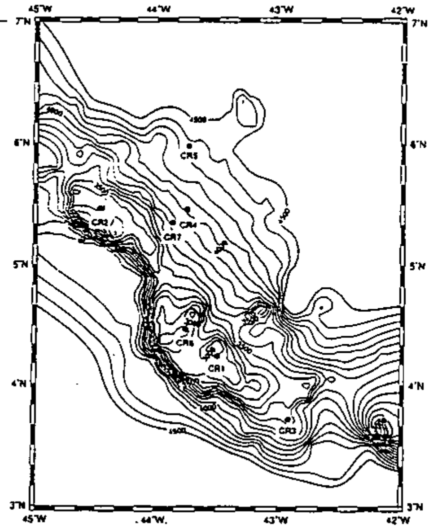


Figure 2. Location of seven coring and drilling targets for Ceara Rise. See Fig. 1 for general location. Bathymetry in meters based on site survey results (RV *Ewing* 9209 Hydrosweep center beam).

water masses vary in three dimensions, the bathymetric distribution of water mass properties contains fundamental information about the geometric relationships and mixing between water masses of different origin. Thus, from a single suite of cores located on the slopes of an aseismic rise, past changes in productivity, dissolution and mixing of deep water can be determined. To date, this bathymetric sampling strategy has been used with success on ODP Leg 108 (eastern equatorial Atlantic), Leg 113 (Maud Rise, subantarctic region), Leg 115 (Madingley Rise, equatorial Indian Ocean), Leg 117 (Owen Ridge, Arabian Sea), Leg 130 (Ontong Java Plateau, western equatorial Pacific), and Leg 145 (Detroit Seamount).

The purpose of Leg 154 is to sample an additional bathymetric transect in the western equatorial Atlantic at the Ceara Rise (Fig. 1) in order to fully evaluate the Cenozoic history of deep water circulation and chemistry. Deep water circulation in the Atlantic (and to a great extent in the world ocean) is controlled by the mixing between deep water masses in the western basins of the South Atlantic and southern ocean. The Atlantic contains the source regions for the two major water masses in the deep oceans today, and in the past this ocean probably contained the source area for at least one of the principal water masses. It is the mixing between water masses in the South Atlantic and southern ocean that produces the initial chemical and physical characteristics of the deep water that flows through the Indian Ocean and into the Pacific. Thus no reconstruction of Cenozoic deep water circulation and chemistry can be complete without a full understanding of the history of deep water circulation in the western Atlantic. On the basis of location, present oceanographic setting, and continuity of high sedimentation rates, the Ceara Rise probably provides the best target location for reconstructing this paleoceanographic history.

Proposed Sites

Because of the basic shape of Ceara Rise, the drilling sites are located on the NE flank of the northern half of Ceara Rise. It is in this region that the shallowest topography and gentlest slopes are encountered. In Fig. 2 the seven proposed drill sites are shown, five of which are high priority and form the Neogene depth transect, and three that form the Paleogene depth transect. The CCD is unusually deep at this location today, so it is necessary to have the transect span the entire depth range to 4373 m. The shallow depth sites will ensure that the sedimentary sections are mostly free of dissolution, while the deep sites will ensure that the full range of deep water chemical composition is sampled as well as provide a history of the highly variable depth of the CCD and lysocline.

In order to ensure that a complete, undissolved and undisturbed record of surface water conditions can be obtained, we anticipate coring several shallow sites. By combining the records from several sites, a complete record of surface conditions may be obtained, if hiatuses are of limited geographic or bathymetric extent. It will be necessary to offset APC cores vertically at each location to minimize sediment disturbance and loss between APC cores. At each of the sites, three holes will be cored in order to supply enough material for extensive biostratigraphic, sedimentologic, geochemical and paleomagnetic investigations.

Five mappable reflectors within the sediment column (Fig. 3) can be identified. Reflectors Blue and Purple divide the sediments into three acoustic units; Reflectors Red, Yellow and Orange subdivide each of these units, respectively. From top down the general features of these three units are: 1) seafloor to Blue is acoustically stratified, predominantly internally conformable; 2) Blue to Purple is pervasively hummocky without lateral continuity of reflectors; and 3) Purple to basement is stratified and onlapping.

Sedimentation rates exhibit large regional and glacial-

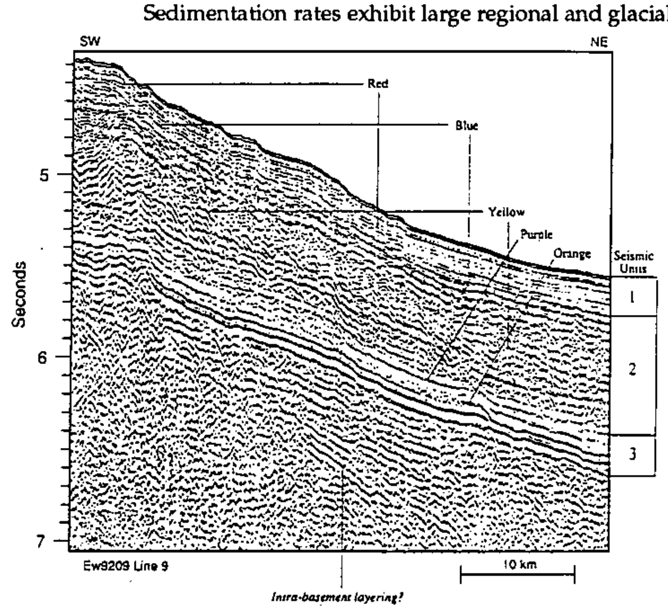


Figure 3. Typical seismic section for the NE slopes of Ceara Rise. The three mappable seismic units are found in varying thickness on the entire rise. In no location were erosional hiatuses observed that created windows to deeper drilling objectives.

interglacial changes that result from variations in the input of detrital components from the Amazon Cone. The large input of terrigenous material on the northern Ceara Rise increases sedimentation rates to about 5 cm/k.y. Toward the south, the proportion of Amazon Cone material decreases; here, sedimentation rates are usually between 3 and 4 cm/k.y. In addition, there is a strong glacial-interglacial signal in the sedimentation rates because of increased Amazon input during lowered sea level. On the basis of sedimentation rates it is likely that an excellent late Neogene depth transect can be obtained from the northeastern flank of Ceara Rise.

The seismic units are the same at each proposed site location, but vary in thickness (Fig. 4). The primary sites for the depth transect exhibit a systematic decrease in sediment thickness from about 1350 m at the shallow location (CR1) to about 950 m at the deepest site (CR5). This systematic decrease in sediment thickness is the expected result of calcium carbonate dissolution and also a sign that downslope reworking has not significantly altered the sediment deposition patterns in this region. Otherwise, increasing sediment thickness downslope would be expected, especially if turbidite deposition was a major redistribution process in this area.

Shipboard Science Strategy

The work aboard ODP Leg 138 showed that it is possible to plan drilling and shipboard work so as to be able to document truly complete recovery of the stratigraphic section at each site before proceeding to the next, at least for the part of the section that can be cored with the APC. With high-resolution downhole logs and continuous data on cores (magnetic susceptibility, GRAPE density, color) we expect on Leg 154 to extend this capability through the Paleogene. Since the sites to be cored on Leg 154 are all in a rather small geographical area, we expect also to be able to demonstrate high resolution correlations between the sites using magnetostratigraphy, and high resolution biostratigraphy as well as core and downhole log data. Thus we will generate high precision age-depth profiles for all the sites.

The objective of the shipboard science will be to complete this high resolution stratigraphy to enable shipboard scientists to develop a thoughtful sampling strategy for post cruise-research. Shore-based science will be planned largely to exploit the depth transect that we will recover. Most of the actual sampling for these studies will be carried out on shore soon after the completion of the leg.

Coring will be planned to ensure, inasmuch as possible, that the study will not be hampered by a shortage of material. Triple cores will be taken at most sites to ensure that high resolution sampling (e.g. U-channels) can be carried out on the last hole, but even so we expect to exceed normal sampling density in some intervals of the earlier holes to ensure that we have sampled the section completely at high resolution. Overlapping sections of several holes will be merged to produce a composite depth section that will be used to guide the high resolution sampling. It will be in these overlapping sections of the earlier (A and B) holes that we will likely exceed ODP sampling guidelines.

Drilling Strategy

Leg 154 will follow a drilling strategy that will result in a depth transect of APC, XCB and rotary cores for the sedimentary sequences deposited during the uppermost Cretaceous and Cenozoic sections of Ceara Rise. The present depths of our proposed drill sites range from 2901 to 4373 m. The sites are located at the most complete sections, with minimum distance separating the sites. They will be appropriate for several important limiting assumptions:

- that the input of carbonate is the same at each site, it originates in the photic zone of the upper ocean, and the principal method of delivery is from vertical settling processes;
- that loss of carbonate is only from dissolution; and
- that downslope reworking is minimized.

At least five drill sites are required to produce a depth transect that can reconstruct gradients in deep water properties in this region of the Atlantic Ocean. Because the mixing zone between water masses spans only several hundreds of meters, it is necessary to have a depth spacing in the transect on the order of every 300 m to capture past changes in deep water mass geometry. The principal sites (CR-1 through CR-5) are located at about 3037, 3317, 3602, 4018 and 4373 m. Drilling to basement (0.9 to 1.3 secs below seafloor) will be performed in only two of these sites.

Since it will not be clear how successful deep drilling will be on Ceara Rise until the rise is actually drilled, there will be some flexibility for at-sea decisions about coring operations. For instance, if core recovery is poor in the deep Paleogene sections high resolution depth transect comparisons cannot be accomplished. In this case wise use of the drilling time would be to sacrifice two of the deep drilling objectives and add the time to alternate sites CR6 and CR7. This would enhance the objectives of the Neogene portion of the study, but only after it is clear that poor recovery prohibits meeting the Paleogene objectives.

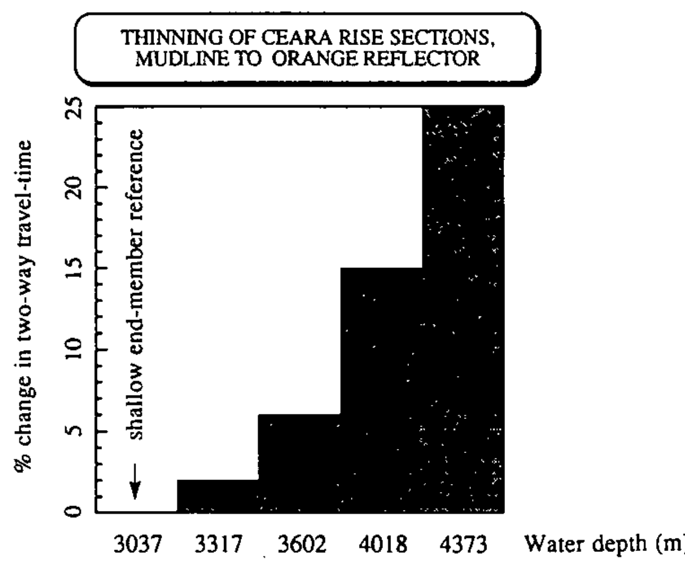


Figure 4. Thinning of sedimentary section with respect to the shallow coring location CR1. In the deepest location (CR5) more than 25% of the sediment appears to be missing, probably as a result of carbonate dissolution. This relationship suggests that downslope reworking has not been a major problem in the locations that were chosen for drilling.

Science Operator Prospectus Leg 155

Amazon Deep-Sea Fan

Dr. Roger D. Flood — Co-Chief Scientist
Dr. David J.W. Piper — Co-Chief Scientist
Dr. Adam Klaus — 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

Deep-sea fans represent an important part of the continental margin sedimentary record, and their deposits contain records of continental climate, ocean circulation, sea level and tectonic activity that can be interpreted in light of a detailed understanding of fan facies and growth pattern. The Amazon River and the Amazon Fan (the deep-water sediment deposit formed on the continental margin by the Amazon River since the mid Miocene) have played an important role in preserving these climate records especially during low sea-level stands when the Amazon River discharged its sediment load directly into the deep sea. ODP Leg 155 will sample the sediment facies of the Amazon Fan in order to study its sedimentary response to Pleistocene sea level variations, evolution of Equatorial South American climate, and changes in western Equatorial Atlantic Ocean circulation. The leg will also address general issues of the processes, character and architecture of turbidite deposition.

High-resolution seismic images of the Amazon Fan show that it has been built of a series of distinctive units that are typical of many mud-rich fans. These units include channel-levee systems of the upper and middle fan, reflective units of the lower fan, and large, transparent debris flows. These units stack and overlap to build the fan. Although the morphology of this and other muddy modern fans is often displayed on bathymetric and seismic profiles, the lithologies and ages of the sediments that make up these units, and the relationships between these units and sea-level change, are poorly defined. We will resolve these questions by sampling key acoustic units to determine their lithologies, facies and ages. Since fan sediments are river-derived, analysis of the sediments deposited in the channel levees (e.g., pollen, clay and sand mineralogy, bulk geochemistry, organic matter) should reveal a high-resolution record of equatorial land climate during several glacial-interglacial cycles. The integrated analysis of fan architecture and growth pattern, land climate as recorded in fan sediments, and paleocirculation patterns in the western Equatorial Atlantic will allow us to understand more fully the response of this important equatorial region to glacial-interglacial and other cycles.

Introduction

The Amazon Fan (Fig. 1) is one of the largest modern submarine fans (or, more generally, turbidite systems) and forms a significant portion of the continental margin off northeastern Brazil. The fan contains much of the material eroded from the continent within the Amazon drainage basin. Large mud-rich fans, such as the Amazon, Mississippi, Indus and Bengal fans, are formed by the long-term localized input of riverine sediments moderated by glacio-eustatic sea-level fluctuations, climate change, and tectonic activity. These large fans are also significant crustal loads and can create bulges at or near the coastline, which, in turn, affect sedimentation patterns. A knowledge of the morphology, structure, and sedimentation of large, muddy fans such as the Amazon Fan is important for understanding processes that control fan growth (including sea level), and also for revealing the record of climate change on land and ocean circulation. Because normal piston cores sample only the upper 10 m of these several- kilometer-thick deposits, an understanding of the sedimentary facies associated with the observed seismic and morphological units, and the age relationships of these units and the climatic record preserved in their sediments, remains poor. Deep, continuous sampling is required to make significant progress toward understanding fan growth and to obtain important and unique climatological records from fan sediments.

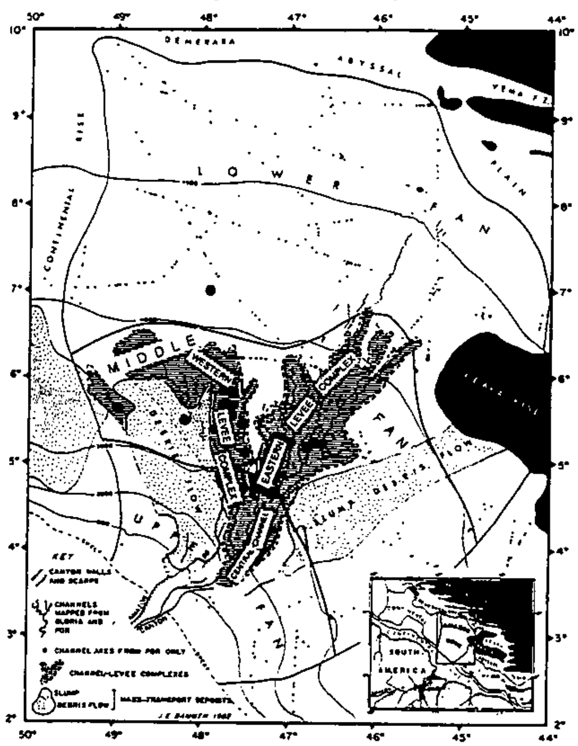


Figure 1. Morphological map of the Amazon Fan, showing locations of surficial channels, levees, canyons and debris flows. Solid black circles show approximate locations of holes AF-1 to AF-22 (see Fig. 2). Inset map shows location of Amazon Fan with respect to South America and the Amazon River. (Adapted from Damuth et al., 1983b.)

Scientific Objectives

1. Establishment of the relationship, if any, between the development of fan deposits, sea-level fluctuations, climatic change and uplift of the Andes.

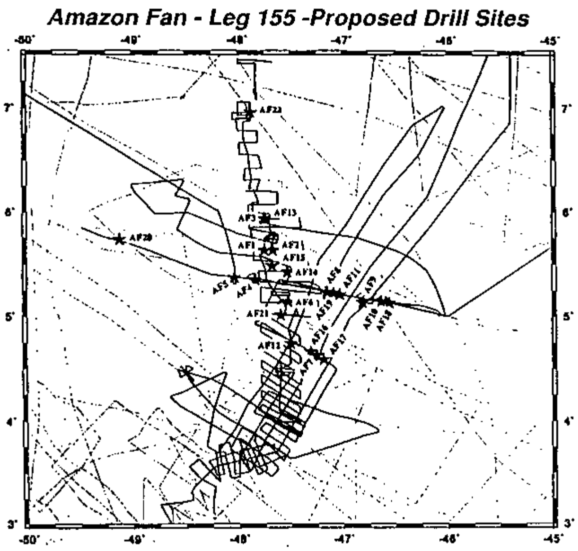


Figure 2. Locations of proposed Amazon Fan drill sites, digital seismic lines (bold lines), and analog seismic lines (dotted lines).

margin flexure) in the late Pleistocene and perhaps back into the mid-Pliocene.

2. Determination of the sediment lithologies characteristic of distinctive acoustic facies and an understanding of the evolution of turbidite facies in relation to fan morphology and flow processes.
3. Use of the stratigraphic record of the Amazon Fan to better understand climatic change within the Amazon drainage basin, the nature and timing of surface circulation patterns in the western Equatorial Atlantic, and Amazon Basin changes over glacial/interglacial cycles and integration of these into worldwide climatic signals.
4. Characterization and an understanding of the nature, origin and early diagenesis of organic carbon present in the different fan units.

Study Area

Analysis of high-resolution seismic reflection profiles (single- channel and 3.5-kHz); swath-mapping data (GLORIA sidescan sonar, SeaBeam bathymetry), and piston cores from the Amazon Fan have helped to reveal the structure of this complex sediment deposit, and have provided insights as to the kind of sampling strategies that are needed to understand continental margin sedimentation at lateral and temporal scales that are often difficult to approach. We propose to drill a series of generally shallow-penetration holes on the Amazon Fan (Fig. 2). These holes will provide critical information on sedimentary facies within different acoustic units, characterize temporal and spatial variations in the mineralogy, palynology and organic matter (and its early diagenesis), determine the ages and deposition rates of critical fan units, and reveal the evolution of fan architecture and its relationships to sea level, climatic, and tectonic events (Andean uplift as well as more localized margin flexure) in the late Pleistocene and perhaps back into the mid-Pliocene.

Fan Morphology and Growth Patterns

Detailed mapping of the fan from high-resolution seismic records, supplemented with swath-mapping data, has revealed a complex pattern of submarine channels and large debris flows. Channels are common from the base of the submarine canyon to about 4000 m water depth. These channels are remarkably sinuous, with length scales and sinuosities similar to those of terrestrial rivers, suggesting that the channels have been formed through a continuing interaction between turbidity current flow and sediment deposition. Although numerous channel segments are recognized on the fan, only one channel is now connected to the Amazon Submarine Canyon (termed Channel 1 or Amazon Channel); all other channels have been disconnected from their upstream source. Amazon Channel is the most recently active channel, and it has been studied in detail from the canyon to 4273 m water depth on the lower fan, where it is too small to be resolved on SeaBeam bathymetry (i.e., <200 m wide).

The sinuous fan channels, including Amazon Channel, are perched on top of lens-shaped, aggradational overbank deposits to form channel-levee systems in the

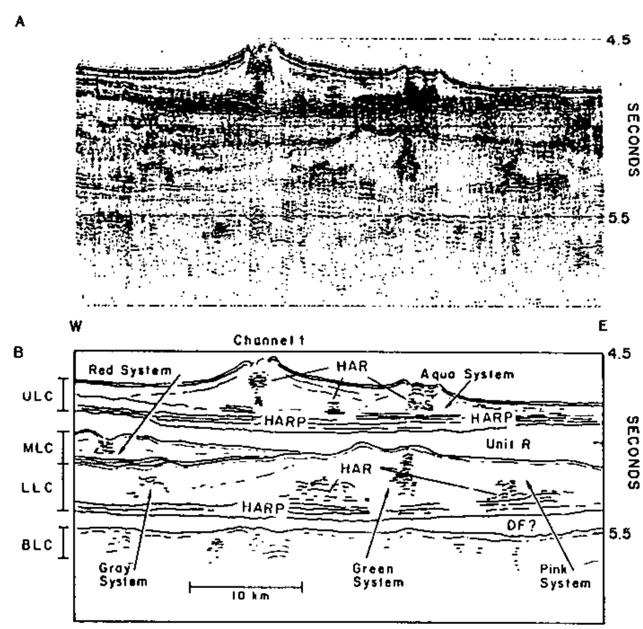


Figure 3. Original water gun seismic-reflection profile (A) and interpretation (B) from the middle fan at 3450 m, showing the relationship between the different seismic facies observed on the fan. Note the high-amplitude reflections (HAR) within the levee of Channel 1 (Amazon Channel) and the flatter lying high-amplitude reflection packets (HARP) that lie beneath the channel/levee system. Similar acoustic facies are also observed associated with other channel-levee systems (color names as given by Manley and Flood, 1988) both at the fan surface and at depth. Unit R, which separates the Upper Levee Complex (ULC) from the Middle and Lower Levee complexes (MLC and LLC), appears to be a debris- flow deposit. An inferred debris-flow deposit (marked DF?) separates the LLC from the more deeply buried Bottom Levee Complex (BLC). While surficial and buried channel-levee systems and other acoustic facies are well resolved, we do not have a very good understanding of the actual relationships between sedimentation pattern and sea level. (Adapted from Flood et al., 1991.)

upper and middle fan (Fig. 3). On both the upper and middle fan, channel axes are marked by zones of near-vertical, high-amplitude reflections (HAR). Drilling of the youngest channel floor on the Mississippi Fan has demonstrated that these high-amplitude reflections are associated with sands and gravels in the channel axis. The HAR pattern commonly appears to extend deep within the channel-levee system, and its presence and distribution within the levee have been used to map the evolution and meandering of the channel-levee system. As the lower fan is reached, levee deposits and debris flows pinch out to give rise to a sequence of highly reflective, nearly parallel horizons that extend at least to the lower fan. Channels on the lower fan are generally less than 20 m deep and have small, reflective levees. The abandoned channels that are followed on the fan surface and in subsurface have been assigned numbers (Damuth et al., 1983b) and color names (Manley and Flood, 1988).

Several approaches have been undertaken to estimate the age of distinctive seismic facies observed on the Amazon Fan to determine the possible relationships between fan activity and sea-level fluctuations. These estimates provide a wide range of possible ages, each having important implications for sea-level control on fan development. Only through deep sampling will we know the precise relationship between fan growth and sea level fluctuations.

Proposed Sites

A series of APC/XCB sites will penetrate a number of stacked middle- fan levee sequences, providing a complete stratigraphic sequence for the last major cycle of fan deposition which may span one or more glacial sea-level lowerings. These APC/XCB sites will be located on the levees of well-imaged channel-levee systems whose relative ages can be deduced from seismic profiles. The record will be considerably expanded (probably with a better pollen and mineralogy record) where the levees are near active channels, and somewhat compressed (probably with a better planktonic stratigraphy) where the thinner parts of active levees are sampled, especially on the tops of abandoned levees. To obtain a complete stratigraphy from both proximal and distal levee environments, sections from more than one channel-levee system will have to be combined. Sites will also be positioned along levee systems in order to determine variations in sedimentation and timing of deposition down-fan. Sampling sites will also include abandoned channel-floor deposits and the reflective, flat-lying HARP units that underlie channel-levee systems in order to characterize the turbidite facies and sequences within these units and their relationships with other acoustic units. Some holes will be deep enough to reach Unit R (the debris-flow deposit) that underlies the Upper Levee Complex and to reach channel-levee systems preserved in the buried Middle and Lower Levee complexes. These deeper holes are necessary to determine the upper age limit of these older levee complexes, to determine the sedimentological nature of the transparent and highly reflective acoustic zones between levee complexes, and to help understand longer-term fluctuations in fan growth that may be related to external influences such as Andean uplift.

Twenty-two sites (17 priority 1, 5 priority 2 and 3) have been identified on Amazon Fan. Several of the priority 1 holes have deeper extensions rated as priority 2. Seven holes will penetrate to depths of 100-179 mbsf, seven holes to 226-301 mbsf and three holes to 369 to 417 mbsf. The uppermost parts of many holes will be double APC-cored to ensure recovery of a complete section. While most of the holes will be in relatively fine-grained sediments, some holes will encounter unconsolidated sands. We anticipate logging all holes greater than about 250 m, although selected logs may be run in some shallower holes. We also plan to use the Pressure Core Sampler (PCS) in several holes where gassy (hydrated?) sediments are encountered. Time-to-depth conversions are based on velocities from sonobuoy measurements for the entire fan; there may be significant deviations from this profile, depending on the nature of the sediments at any site. Correlations between cored sections and the seismic profiles will need to be made rapidly to ensure that the target intervals on the seismic records are being sampled. Selected holes will be logged to improve correlation with seismic records and to better characterize the sediments.

Sites AF-1, AF-2, AF-3, and AF-14 are located on the middle fan and will sample the oldest fan sediments on the leg. All these holes will penetrate and sample the distinctive reflective layers that may be sheet sands associated with channel avulsion, to show us the character of the sediments that make up these layers and their likely depositional processes.

Site AF-6 is located on the levee of Amazon Channel near the location where the channel diverged from the path of the Aqua system. Sites AF-6, AF-12, and AF-15 are in areas of recent rapid deposition, and are aimed at studying early sediment and organic matter diagenesis.

Sites AF-7, AF-8, AF-9, AF-10, AF-11, AF-19, and AF-21 will sample proximal (upper middle fan) levee sediments (along with overlying hemipelagic sections) for the older channel-levee systems within the Upper Levee Complex.

Sites AF-2 through AF-12, AF-15 and AF-22 form an important suite of sites designed to recover proximal levee sediments from each of the channel-levee systems in the Upper Levee Complex.

Sites AF-13, AF-17, AF-18, and AF-20 are designed to sample the primarily pelagic material that is deposited on topographically isolated abandoned levees.

This material will contain a valuable record of river discharge and land climate moderated by the effects of sea level change. High sea level stands recovered at these sites should be clearly identified as pelagic sections that contain interglacial fauna, and thus would allow us to determine the sediments and fan units deposited during a glacial-interglacial cycle.

References

Damuth, J.E., Kowsmann, R.O., Flood, R.D., Belderson, R.H., and Gorini, M.A., 1983b. Age relationships of distributary channels on Amazon deep-sea fan: implications for fan growth pattern. *Geology*, 11:470-473.

Flood, R.D., Manley, P.L., Kowsmann, R.O., Appi, C.J., and Pirmez, C., 1991. Seismic facies and late Quaternary growth of Amazon submarine fan. *In* Weimer, P., and Link, M.H. (Eds.), *Seismic facies and sedimentary processes of modern and ancient submarine fans*. New York (Springer-Verlag), p. 415-433.

Manley, P.L., and Flood, R.D., 1988. Cyclic sediment deposition within the Amazon deep-sea fan. *Am. Assoc. Petrol. Geol. Bull.*, 72:912-925.

The South Atlantic: Present and Past Circulation

Liaison Group & Earth Science News

University of Bremen, Bremen, Germany, August 15 - 18, 1994

A symposium on *The South Atlantic: Present and Past Circulation* will take place at the University of Bremen. The aim is to assess the state of knowledge regarding the circulation of the South Atlantic Ocean, present and past. Of special interest are: (1) heat transport within the basin and exchange at its boundaries; (2) vertical mixing and upwelling zones of divergence and convergence; (3) evidence for and causes of variability at all time-scales. The symposium is sponsored by The Oceanography Society, The World Ocean Circulation Experiment (WOCE) and The Scientific Committee on Oceanic Research.

Interested colleagues should contact:

South Atlantic Symposium
Dr. Barbara Donner
Fachbereich Geowissenschaften
der Universität
Postfach 33 04 40
D-28334 Bremen

Sessions will involve the physical and chemical oceanographers within WOCE and other programs for the present circulation, the geological and geophysical communities for the circulation of the past, as revealed by the sediment record, and modelers studying both the present and the past.

Fifth International Conference on Paleoceanography

Halifax, Nova Scotia, Canada, 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
- Seafloor- Seawater Linkages (JGOFS and Flux Records)
- Ice Core Records
- Continent - Ocean Linkages
- Ocean - Atmosphere Linkages
- Physical Links Gateways and short-term tectonic events
- The Arctic - The missing link
- High Latitude - Low Latitude Linkage
- Tools and Proxies: Developments and Applications
- Modeling - The link between the past, present and future

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

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 <u>November 1994</u>

For information in the US on the atlas please contact:
JOI/USSAC,
Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., NW, Suite 800,
Washington, DC 20036-2102
Internet: joi@brook.edu

Requesters from countries other than the US should contact:

Ms. Annemor Brekke, Norsk Polarinstitutt
Middelthuns gate 29
Postboks 5072 Majorstua
N-0301 Oslo, Norway

ODP Site Summary Form6/93 Fill out one form for each proposed site and attach to proposal

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

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

	Sediments	Basement
Penetration:		
Lithology(ies):		

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

Downhole measurements:

*Systems currently under development

Target(s) :(see Appendix of Proposal Submission Guidelines6/93) A B C D E F G (check)ß

Site Survey Information (see Appendix of Proposal Submission Guidelines6/93 for details and requirements):

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

Weather, Ice, Surface Currents:

Seabed Hazards:

Territorial Jurisdiction:

Other Remarks:

	Name/Address	Phone/FAX/Email
Contact Proponent:		

Proposals Received at the JOIDES Office by January 1, 1994 for Review at the Spring 1994 Panel Meetings

ODP Proposal News

No.	Title	Author(s)
330-Add4	Refinement of sites for Eratosthenes Seamount Transect	A.H.F. Robertson
354-Rev2	Neogene History of the Benguela Current and Angola/Namibia Upwelling System	G. Wefer, W.H. Berger, U. Bleil, M. Breitzke, L. Diester-Haass, K. Gohl, W.W. Hay, P.A.Meyers, H. Oberhänsli, R. Schneider, V. Spieß and G. Uenzelmann-Neben
355-Rev3	Geophysical Estimates of Gas Hydrate Quantities: A Calibration Through ODP Drilling	R. von Huene, E. Suess, K.C. Emeis, K. Kvenvolden, T. Shipley and N. Kukowski
367-Rev	Great Australian Bight: Evolution of a Cenozoic Cool-water Carbonate Continental Margin	N.P. James and D.A. Feary
380-Rev4	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.P.E. Weaver, P.V.D. Bogaard, S. Cloetingh, R.E. Cranston, J.J. Dañobeitia, A. Freundt, H. Hirschleber, K. Hoernle, I. Jarvis, R.B. Kidd, R. Rihm, M. Schnaubelt, R.T.E. Schuttenhelm, K. Stattegger, H. Staudigel, J. Thompson, A.B. Watts, W. Weigel, G. Wissmann and R. Zahn
384-Rev3	The Connection Between the Pacific and Atlantic Oceans: the Venezuela Basin and Aruba Gap	A. Mauffret and S. Leroy
386-Add2	California Margin Drilling: Neogene Paleoceanography of the California Current, Coastal Upwelling, and Deformation of the Gorda Plate	M. Lyle, J. Barron, A.C. Mix and L. Stott
400-Add2	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
408-Add2	Neogene drilling transects in the Caribbean	A.W. Droxler, G.A. Haddad, R.T. Buffler, E. Rosencrantz, R.D. Norris, L.C. Peterson, A.C. Hine, P. Hallock and A. Mascle
415-Add2	Multi-objective ODP Drilling in the Caribbean Sea: Caribbean Ocean History, Ocean Plateau and the Cretaceous-Tertiary Boundary Impact Event	H. Sigurdsson, S. Carey, S. D'Hondt, A.W. Droxler, R.A. Duncan, C.W. Sinton, L. Abrams, T.W. Donnelly, L. Peterson, R.D. Norris, E. Rosencrantz, R.T. Buffler, A. Hine, P. Hallock and A. Mascle
421-Rev	Alkali-Acidic Rocks of the Volcano Trench	B.I. Vasiliev
431-Add	Western Pacific Seismic Network: Interaction of subducting plates and mantle	K. Suyehiro, T. Kanazawa, N. Hirata and Y. Fukao
435-Rev	Crustal Fluxes into the Mantle at Convergent Margins: A. The Nicaraguan Margin	T. Plank, M.J. Carr, E.A. Silver, J.B. Gill and J. Morris
435-Rev2	Crustal Fluxes into the Mantle at Convergent Margins: B. The Mariana-Izu Margins	T. Plank, J.B. Gill and R.L. Larson
NARM-Add3	Basement Sampling of the Ocean-Continent Transition West of Iberia: Sequel to Leg 149 studies of a non-volcanic rifted margin	T.J. Reston, MO Beslier, R. von Hüne, D. Sawyer and R. Whitmarsh
436----	Neogene Sequence Stratigraphy, Northern Campeche Bank	C.S. Fulthorpe, R.T. Buffler and M.B. Lagoe
437----	Lau-Havre-Taupo: Convergent margin spreading to rifting transect	L.M. Parson, J. Gamble, J. Hawkins, J. Pearce, U. von Stackleberg, M. Wiedicke, and I. Wright
438----	A drilling test of the origin of reflecting interfaces in oceanic crust	J.C. Mutter, J. Karson and C.Z. Mutter
439----	Mass Budget of Hot Spots: Deep Apron Drilling at the Marquesas	M.K. McNutt, J.H. Natland and C. Wolfe

440----	Investigating the Nature and Consequences of Hydrothermal Circulation in Oceanic Crust: Drilling on the Eastern Flank of the Juan de Fuca Ridge	E.E. Davis, M. Mottl, K. Rohr, K. Becker, D. Chapman, A. Fisher, G. Wheat and H. Villinger
441----	Southwest Pacific Gateway I & II: Palæoceanography, Climate & Sediment System dynamics of the Deep Pacific Source	R.M. Carter, L. Carter, K.B. Lewis, I.N. McCave, C.S. Nelson & P.P.E. Weaver
442----	The Magmatic and Tectonic Evolution of Rift Initiation in Back-Arc Basins: Drilling the northern Mariana Trough	R.J. Stern, T. Yamazaki, J.F. Allan, P. Fryer, F. Martinez, J. Hawkins and K. Marsaglia
443----	Oceanic Faults, Crustal Heterogeneity, and and Ridge Flank Hydrology and Alteration: Deepening of ODP Holes 504B and 896A	J.C. Alt and K. Becker
444----	History for Glacial-induced Sea-level fluctuations from siliclastic shelf and slope records of the Western Pacific, Joban Margin, off northeast Japan	W. Soh, F. Saito and Y. Yanagisawa
445----	Deformation and Fluid Flow Processes in the Nankai Trough Accretionary Prism	G.F. Moore, D.E. Karig, M. Kastner, T. Byrne and W. Brückmann
446----	Ocean Drilling in the Tonga forearc: A test of models for the origin of supra-subduction zone ophiolites, early arc volcanism, subduction initiation and subduction erosion/accretion	C.J. MacLeod and S.H. Bloomer
447----	Active Continental Extension in the Western Woodlark Basin	B. Taylor, J. Mutter, F. Martinez, R. Binns, H. Davies, G. Abers, S. Scott, M. Benes, C. Mutter, A. Goodliffe and R. Rogerson
448----	Assessing the origins, age and post-emplacement history of the Ontong Java Plateau through basement drilling	L.W. Kroenke, J.J. Mahoney and A.D. Saunders
449----	Drilling proposal for the Dronning Maud Land Margin (NE Weddell Sea): Evolution of the restricted Mesozoic Weddell Basin	S.W. Wise, S. O'Connell and W.V. Sliter
450----	Taiwan Arc-Continent Collision: Forearc Basin Closure and Orogenic History	N. Lundberg, D.L. Reed and T. Byrne
451----	The Tonga Ridge Longitudinal Island Arc Transect (Southwest Pacific Ocean)	D. Tappin, J. Hawkins, D. Scholl and B. Pelletier
452----	Antarctic Peninsula Pacific Margin: Antarctic Glacial History and Causes of Sea-Level Change	P.F. Barker, R.D. Larter, M. Rebesco, A. Camerlenghi and L. Gamboa
453----	Bransfield Strait, Antarctica: Marginal Basin Formation, Timing of Rift Volcanism, Mantle Geochemistry, and Antarctic Glaciation	M. Fisk, R. Keller, J. Anderson, L. Banfield, J.A. Austin, Jr., J. Bialas, R. Larter, A. Maldonado and L. Gamboâ

Letters of Intent Received for Review at the Spring 1994 Panel Meetings

No.	Title	Author(s)
15	Structure of the Paleozoic Basement Underneath the North-Central Adriatic Sea	U. Fracassi
16	Paleoceanographic Drilling South of Australia: Global Impact of a Mature Mid-Latitude Ocean	B. McGowran
17	Internal Anatomy of Two Hydrothermally-Active Volcanic Edifices in Back-Arc Settings	R.A. Binns & S.D. Scott
18	Southeast Pacific Paleoceanographic Depth Transects	Alan C. Mix
19	Hydrothermalism and Metallogenesis in the Red Sea	B. Sichler, M.F. Le Quentrec, A. Coutelle, Y. Fouquet and C. Ramboz
20	Proposal for an ODP Leg to Drill the Major Dilational Basins of the S.W. Pacific	A. Ewart & Others
21	Early Stages of Crustal Creation in the Western Pacific	R.J. Arculus
22	Laurentide Ice Sheet	Schafer, C.T.
23	Kerguelan Plateau and Broken Ridge: Timing of Emplacememt and Upper Crustal Stratigraphy of a Giant Igneous Province	M.F. Coffin
24	Cascadia Margin II: Nature and Effects of Fluids/Gas Migration and Explusion in an Active Accretionary Prism	Carson, R., Kulm, L., Moore, G., Moore, J.C., Suess, E.
25	Drilling Shatsky Rise: Testing the Plume-Head Hypothesis and its Implications	W.W. Sager, G.R. Brown, W.V. Sliter and R. Larson

26	Evolution of a Late Cretaceous-Cenozoic Seaway: Multiple ODP Drilling Objectives, Southeastern Gulf of Mexico/ Southern Straits of Florida	R.T. Buffler, W. Alvarez, J.A. Austin, W. Denny, A. Droxler, P. Mann and A. Hine
27	Integration of Slopes and Basins Gravity Sedimentation within the Sequence Stratigraphy Models Through Drillings in the Rhone and Var Turbiditic Systems, Western Mediterranean Sea	L. Droz
28	Japan Trench Downhole Observatory off Sanriku	T. Kanazawa, F. Hiromi, K. Suyehiro and A. Hasegawa
29	Evolution of the Hawaiian Hot Spot	K.J. Spencer and J.J. Mahoney
30	Erosion, Mass and Fluid Flux, and Terrigeneous Material Returned to the Mantle by Subduction	von Huene, R.
31	Investigation of a Lower-Plate Continental Margin, Great Australian Bight Region	H.M.J. Stagg and J.B. Willcox

Active Proposals in the ODP System

Proposals not updated since 1 January 1991 have become "inactive"

Proposal	Received	Brief Title	Contact Proponent
079-Rev2	06/28/93	Tethys and the birth of the Indian Ocean	Coffin, M.F.
086-Rev2	07/27/92	Drilling in the Red Sea	Bonatti, E.
253-Rev	06/19/91	Deposition of organic carbon-rich strata, ancestral Pacific	Sliter, W.V.
323-Rev3	07/01/93	Tectonic evolution of the Alboran Sea	Comas, M.C.
332-Rev3	02/04/92	Florida Escarpment drilling transect	Paull, C.K.
333-Rev2	07/01/93	Evolution of pull-apart basin, Cayman Trough	Mercier de Lépinay, B.
334-Rev3	06/30/93	Galicia margin S' reflector	Boillot, G.
337----	07/31/89	Tests of Exxon sea-level curve, New Zealand	Carter, R.M.
337-Add	12/21/92	Tests of Exxon sea-level curve, New Zealand	Carter, R.M.
338----	08/03/89	Sea-level fluct., Marion carbonate plateau, NE Australia	Pigram, C.J.
338-Add	07/13/92	Sea-level fluct., Marion carbonate plateau, NE Australia	Pigram, C.J.
340-Rev	12/31/92	Tectonic, climatic, oceano. change, N Australian margin	Symonds, P.
347-Rev	12/24/92	Late Cenozoic Paleoceanography, South-equatorial Atlantic	Wefer, G.
348-Add2	11/28/92	Uppper Paleogen to Neogene U.S. mid-Atlantic transect	Miller, K.G.
354-Rev2	12/30/93	Benguela Current and Angola/Namibia upwelling	Wefer, G.
355-Rev3	12/27/93	Formation of a gas hydrate	Von Huene, R.
356-Rev	05/01/91	Oceanogr./climatic changes, North Greenland Sea	Smolka, P.P.
363-Add	02/18/91	Paleoceanographic record at sites NR1, NR2, and NR3	Tucholke, B.E.
367-Rev	12/23/93	Great Australian Bight cool-water carbonates	James, N.P.
372----	02/26/90	Cenozoic circulation and chem. gradients, N Atlantic	Zahn, R.
372-Add2	07/01/93	Cenozoic circulation and chem. gradients, N Atlantic	Zahn, R.
376-Rev2	07/27/92	Vema F.Z.: Upper mantle, gabbro/dyke, limestone cap	Bonatti, E.
384-Rev3	01/01/94	Pacific-Atlantic connection, Venezuela basin, Aruba Gap	Mauffret, A.
386-Add2	12/30/93	California Margin(combination of 386-Rev2 and 422-Rev)	Lyle, M.
386-Rev2	02/10/92	California margin drilling	Lyle, M.
397----	02/20/91	Mantle plume and multiple rifting, North Atlantic	Gudlaugsson, S.T.
398----	02/22/91	Quat. paleoceanography, Grand Banks, Newfoundland	Piper, D.J.W.
400-Add2	12/30/93	Mass balance of Costa Rica accretionary wedge	Silver, E.A.
400-Rev	07/01/93	Mass balance of Costa Rica accretionary wedge	Silver, E.A.
401----	09/05/91	Evolution of a Jurassic Seaway, SE Gulf of Mexico	Buffler, R.T.
402----	09/09/91	Geochemical anomaly in MAR basalts between 12°-18°N	Sobolev, A.V.
403-Rev2	07/28/92	KT Boundary Drilling in the Gulf of Mexico	Alvarez, W.
404----	09/11/91	Neogene paleo. from W North Atlantic sediment drifts	Keigwin, L.D.
406----	09/16/91	North Atlantic climatic variability	Oppo, D.
406-Add	05/24/93	North Atlantic climatic variability	Oppo, D.
408-Add	07/01/93	Testing two new interpretations, N Nicaragua Rise	Droxler, A.W.
408-Add2	01/01/94	Caribbean Neogene Transects	Droxler, A.W.
408-Rev	12/28/92	Testing two new interpretations, N Nicaragua Rise	Droxler, A.W.
411----	12/09/91	The Caribbean Basalt Province - an oceanic basalt plateau	Donnelly, T.W.
412----	01/28/92	Bahamas transect: Neogene/Quat. sea level and fluid flow	Eberli, G.P.
412-Add	12/24/92	Bahamas transect: Neogene/Quat. sea level and fluid flow	Eberli, G.P.
412-Add2	07/01/93	Bahamas transect: Neogene/Quat. sea level and fluid flow	McNeill, D.F.
413----	02/03/92	Magmatic/tectonic evol. of oceanic crust: Reykjanes Ridge	Murton, B.J.

415-Add2	01/01/94	Caribbean Ocean History, Ocean Plateau, & K-T impact	Sigurdsson, H.
415-Rev	07/31/92	Caribbean ocean history and KT-boundary	Sigurdsson, H.
416----	03/11/92	Glacial history, Svalbard margin	Solheim, A.
417----	06/30/92	Gas hydrate in vicinity of gas plume, Okhotsk Sea	Soloviev, V.
418----	07/27/92	Miocene biomagnetostrat. reference section, Menorca Rise	Cita-Sironi, M.B.
419-Rev	12/31/92	Convergence at Azores-Gibraltar plate boundary	Zitellini, N.
420----	07/30/92	The evolution of oceanic crust	Purdy, G.M.
421-Rev	07/28/93	Alkali-acidic rocks of the Volcano Trench	Vasiliev, B.I.
422-Rev	12/31/92	Santa Monica Basin	Stott, L.D.
424-Rev	12/31/92	To "Cork" Hole 395A	Becker, K.
425-Rev	07/01/93	Mid-Antlantic Ridge Offset Drilling	Casey, J.F.
426----	08/20/92	Australia-Antarctic discordance	Christie, D.
427----	12/31/92	South Florida Margin SeaLevel	Hine, A.C.
427-Add	07/01/93	South Florida Margin SeaLevel	Locker, S.D.
428----	12/28/92	Tyrrhenian Seafloor and Hydrothermal Sulfide Deposits	Savelli, C.
429----	12/31/92	Atlantic-Mediterranean Gateway	Nelson, C.H.
430----	12/31/92	Subantarctic Southeast Atlantic Transect	Hodell, D.A.
431----	12/31/92	Western Pacific Seismic Network	Suyehiro, K.
431-Add	01/01/94	Western Pacific Seismic Network	Suyehiro, K.
432----	06/28/93	Galicia deep hole S-reflector	Reston, T.J.
433----	06/30/93	East Med. Orogeny	Hsü, K.J.
434----	07/01/93	Caribbean Quaternary climate	Peterson, L.C.
435-Rev	01/01/94	Crustal fluxes: Nicaragua Margin	Plank, T.
435-Rev2	01/01/94	Crustal fluxes: Mariana-Izu	Plank, T.
436----	12/20/93	Campeche Bank Stratigraphy	Fulthorpe, C.S.
437----	12/23/93	Lau-Havre-Taupo rift to drift	Parson, L.M.
438----	01/01/94	Test of reflecting interfaces in oceanic crust	Mutter, J.
439----	01/01/94	Marquesa Islands, mass budget of Hot Spots	McNutt, M.K.
440----	12/27/93	Hydrothermal Circulation at E. Juan de Fuca	Davis, E.E.
441----	12/27/93	Southwest Pacific Gateway I & II	Carter, R.M.
442----	12/27/93	Rift initiation in Back-arc Basins: N. Mariana	Stern, R.J.
443----	12/29/93	Faults, crustal heterogeneity & hydrology at 504B/896A	Alt, J.C.
444----	01/01/94	Joban margin sea level	Soh, W.
445----	01/01/94	Deformation & fluid flow in Nankai Trough	Moore, G.F.
446----	01/01/94	Ocean drilling in the Tonga forearc	Bloomer, S.H.
447----	01/01/94	Continental extension in W. Woodlark Basin	Taylor, B.
448----	01/01/94	History of the Ontong Java Plateau	Kroenke, L.W.
449----	01/01/94	Evolution of the Mesozoic Weddell Basin	Wise, S.W.
450----	01/01/94	Taiwan arc-continent collision	Lundberg, N.
451----	01/01/94	Tonga Ridge Island Arc Transect	Tappin, D.
452----	12/27/93	Antarctic glacial history & causes of sea level change	Barker, P.F.
453----	01/01/94	Bransfield Strait, Antarctica	Fisk, M.
NARM	09/10/91	North Atlantic Rifted Margins DPG Report	Larsen, H-C
NARM-Add	06/30/93	Newfoundland Basin	Austin, J.A., Jr.
NARM-Add2	07/01/93	Extension of E. Greenland Transect	Larsen, H-C
NARM-Add3	12/22/93	Basement sampling of OCT west of Iberia	Reston, T.J.
SR-Rev2	07/01/93	Sedimented Ridges II	Zierenberg, R.A.

Note:

In general, once proposals have been scheduled they become "inactive" for the purposes of panel ranking. In some cases proposals have remained active because all or significant portions of the proposals have not been scheduled or been scheduled and not drilled for reasons other than scientific priority, such as clearance or safety problems.

Proposal number refers to most recent update.

DEADLINES FOR PROPOSAL SUBMISSION

1 July 1994 for Fall 1994 review &
1 January 1995 for Spring 1995 review

10 copies of all new or revised Proposals, Addenda and Letters of Intent must be submitted to the JOIDES Office.
Proposals submitted directly to thematic panels are not reviewed.

ODP Science Operator

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

ODP Bibliography & Databases

Proceedings of the Ocean Drilling Program

Initial Reports & Scientific Results

	Init. Reports Vol.	Init. Reports Pub.	Sci. Results Vol.	Sci. Results Pub.
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	132/133	Nov 93
Leg 133	133	Sept 91	132/133	Nov 93
Leg 134	134	Mar 92		
Leg 135	135	May 92		
Leg 136	136/137	Jan 92	136	Dec 93
Leg 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	142/143	Apr 93		
Leg 143	142/143	Apr 93		
Leg 144	144	Aug 93		
Leg 145	145	Aug 93		
Leg 146				
Leg 147	147/148	Dec 93		
Leg 148	147/148	Dec 93		

Scientific Prospectuses and Preliminary Reports

	Prospectuses Vol.	Prospectuses Pub.	Prelimin. Rpts. Vol.	Prelimin. Rpts. Pub.
Leg 153	53	July 93	48	Apr 93
Leg 154	54	Sept 93	49	June 93
Leg 155	55	Dec 93	50	Sept 93
Leg 156	56	Jan 94	51	Oct 93
			52	Dec 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 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 Dist. 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 146 and 147 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 - 147. 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) 845-1303
Internet: chris@nelson.tamu.edu
The Assistant Curator takes an average of 1.8 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 101-146), and all DSDP and ODP core photographs. Descriptive data are available as paper or microfilm copies of original data sheets generated aboard JOIDES Resolution. Underway geophysical data are on 35 mm microfilm; all other data are on 16 mm microfilm.

All DSDP and most ODP data are contained in a computerized database. Data can be searched on most specified criteria. This data can be provided on Macintosh- or PC-formated disks, magnetic tape, hard-copy printouts, or through Internet file transfer.

Photos of ODP/DSDP cores and seismic lines can be obtained from the ODP Database office. Seismic line, whole core, and close-up photographs are available in black and white 8X10 prints. Whole core color 35 mm slides are also available.

Small requests are answered quickly, free of charge. If excessive materials are required, payment to cover these materials must be received prior to the beginning of request processing.

To submit a data request, contact the ODP Data Librarian.
Telephone: (409) 845-8495, Fax: (409) 845-4857, 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 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

The JOIDES/ODP Data Bank received the following data between Sept. 1, 1993 - Nov. 30, 1993.

- M. Comas (Insti. Andaluz de Geologia): Safety Package.
- R. Flood (SUNY, Stony Brook): Safety Package.
- TAMU: microfilms of seismic reflection, bathymetry and magnetics; tapes of underway geophysics and Informal Report from JOIDES Resolution cruises 143 and 144.
- D. McNeill and G. Eberli (RSMAS): navigation, reports (Straits of Florida) and MCS data.
- B. Curry (WHOI): safety package, seismic sect. EW9209.
- J. Mascle (Lab. Geodynamique Sous Marine) MCS, SCS, 3.5 kHz, bathymetry and navigation data.
- J. Mascle (Lab. Geodynamique Sous Marine) logs and locations of Kullenberg cores KS 11, 12, 14, 6, 7, 8 from *Equamarge* I and II cruises.
- C.K. Paull (Univ. North Carolina, Chapel Hill) 3.5 and piston core data, age table and seismic lines for Gas Hydrates sampling on Blake Ridge and Carolina Rise.
- B. Larsen (Geol. Surv. Denmark): navigation and copies of high resolution MCS data.
- J. Karson (Duke Univ.): 1985 Site Survey Report.
- W. Hieke (Geologisch-Paleontologisches Institut und Museum) copies of sidescan and 3.5 kHz (deep-towed SBP) records (sites MR-2 and MR-3).
- A. Camerlenghi (Osserv. Geofisico Sperimentale): parasound, hydrosweep bath. and nav. from *Meteor* 25-4 cruise MCS, SCS sidescan MAK and navigation from *Gelendzhik* 1993 cruise; navigation and 3.5 kHz for *Sonne* 30 cruise and heat flow report. CS profiles.
- B. Rinoldi (Univ. Studi di Milano): core desc., MT 7.
- G. de Lange (Inst. Earth Sciences Utrecht): nav., SCS profiles and 3.5 kHZ for sites 4A/4C, and 6A.
- M.B. Cita (Univ. Studi di Milano): core desc., core MT 7.
- P. Manley (Middlebury Coll.): MCS profiles from EW9302 cruise.
- D. Oppo: (WHOI): navigation, SCS and annotated percent carbonate records from EW9302 cruise and R/V Tydeman NA 87/4 cruise (Bjorn/Gardar Drift and Feni Drift areas).
- A. Solheim (Norwegian Polar Insti.): navigation, 3.5 kHz,SCS, MCS, magnetics, heat flow, SeaMARC II coverage, Seabeam, hydrosweep and Gloria coverage, report of Hakon Mosby/Mobile Search cruise (1987), gravity and core data.
- C. Marcussen (Geol. Surv. Greenland): navigation, bathymetry, sediment data and MCS profiles.
- T. Shipley (UT- Austin): Safety Package - Leg 156. Also, color figures, seafloor and basement structure map; décollement structure and ampl. map.
- H. Dick (WHOI): navigation for RC2709 site survey cruise,magnetic anomaly identifications and seabeam map for Atlantis II Fracture Zone, seabeam map and high resolution gridded magnetics for Site 735-B area.
- S. Humphris (WHOI): current meter data, summary diagrams and a summarry of the results from the TAG area for Leg 158 data package.
- K. Kastens (LDEO): Seafloor photo coverage from EW9305 cruise and hydrosweep bathymetry.
- R. Rihm (GEOMAR): navigation, parasound data, SCS and MCS profiles from Cruise Meteor 24/1.

For additional information on the ODP Data Bank, please contact Dan Quoidbach at Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, Internet: daniel@ldeo.columbia.edu.

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.

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

Locations of MRCs

Lamont-Doherty Geological Observatory
Palisades, NY 10964, Phone: (914) 735-4155

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

Texas A&M University, Dept. of Oceanography
College Station, TX 77843, Phone: (409) 845-8479

Scripps Inst. Oceanography
La Jolla, CA 92093, Phone: (619) 534-4386

DSIR Geology & Geophysics
PO Box 30 368, Lower Hutt, New Zealand, Phone: (04) 569-9059, Fax: (04) 569-5016

Institute of the Lithosphere, Staromonet 22, Moscow 109180, Russia, Phone: 231-48-36

National Science Museum, 3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo, 160, Japan, Phone: 03-364-2311

Natural History Museum, CH-4001 Basel, Switzerland, Phone: 061-29-55-64

E

ODP/JOIDES Alphabetical Directory

Committees

Executive Committee (EXCOM)

Member (Chair)	Alternate	Liaison to:
Beiersdorf, H.		
Briden, J.C.	Summerhayes, C.P.	
Duce, R.A.		
Eaton, G.P.	Kent, D. V.	
Frieman, E.A.	Altalo/Orcutt	
Gagosian, R.B.		
Hirano, T.	Taira, A.	
Lancelot, Y.		
Leinen, M.	Schilling, J.G.	
Malpas, J.	Falvey, D.A.	
Maxwell, A.E.	Davies, T.A.	
Nowell, A.	Heath, G.R.	
Raleigh, C.B.		
Rosendahl, B.R.	Harrison, C.G.A.	
Sartori, R.	Backman, J.	
Small, L.	Pisias, N.	

Planning Committee (PCOM)

Member (Chair)	Alternate	Liaison to:
Arculus, R.		SGPP
Becker, K.		DMP
Berger, W.H.	Kastner, M.	SGPP
Dick, H.J.B.	Curry, W.B.	SSP
Fox, P.J.	Larson, R.	SMP
Kidd, R.B.	Pearce, J. A.	SSP
Kudrass, H.	Beiersdorf, H	OHP
Larsen, H.C.	McKenzie, J.	TECP
Lewis, B.		EXCOM, PPSP
Mével, C.		LITHP
Mix, A.C.	Levi, S.	OHP
Mutter, J.	Langseth, M.	LITHP
Sager, W.W.		IHP
Shipley, T.H.		TEDCOM
Suyehiro, K.	Tamaki, K.	DMP
Taylor, B.	Moberly, R.	TECP

Technology & Engineering Development Committee (TEDCOM)

Member (Chair)	Alternate	Liaison to:
Beswick, J.	Pheasant, J.	
Luy, R.	Eickelberg, D.	
Marsh, G.L.		
Rischmüller, H.		
Schuh, F.J.		
Shanks, F.E.		
Shatto, H.L.		
Skinner, A.C.	Beswick, J.	
Sparks, C.		
Summerour, A.		
Svendsen, W.W.		
Takagawa, S.	Fujimoto, H.	
[illegible] S.		

Thematic Panels

Lithosphere Panel (LITHP)

Member (Chair)	Alternate	Liaison to:
Arai, S.		
Bloomer, S.H.		
Cannat, M.		TECP
Caress, D.		
Coffin, M.F.		
Fisher, A.T.		
Gillis, K.		
Herzig, P.M.	Rihm, R.	
Kempton, P.	Baker, P.E.	
Kristoffersen, Y.	Banda, E.	TEDCOM
Ludden, J.		
Sheehan, A.F.		
Tarduno, J.A.		OHP
Wilson, D.S.		
Zierenberg, R.A.		SGPP

Ocean History Panel (OHP)

Member (Chair)	Alternate	Liaison to:
Backman, J.	Weissert, H.	
Blake, G.H.		
Carter, R.M.	Pedersen, T.F.	
Clement, B.M.		
Delaney, M.L.		
Herbert, T.D.		
Hodell, D.A.		
Karpoff, A-M		
Leckie, R.M.		
Moore, T.C.		
Prell, W.L.		
Raymo, M.E.		
Takahashi, K.		
Weaver, P.P.E.	Kemp, A.E.S.	
Gersonde, R.		
Zachos, J.C.		SGPP

Sedimentary & Geochemical Processes Panel (SGPP)

Member (Chair)	Alternate	Liaison to:
Bahr, J.M.		DMP
Baker, P.A.		
Emeis, K.C.	Brumsack, H.J.	
Farrimond, P.	Parkes, R. J.	
France-Lanord, C.		
Garrison, R.		
Hiscott, R.N.	Chivas, A.	
Macko, S.A.		
McKenzie, J.A.		
Paull, C.K.		
Sarg, J.F.		
Shanks, W.C.		
Soh, W.	Yagishita, K.	TECP (for non-US)
Surlyk, F.		
Underwood, M.B.		TECP (for US)

Lir

M

[illegible]tonics Panel (TECP)

S[illegible]gar, S.M.		DMP
Ashi, J.		
Brown, K.M.		
Doglioni, C.	Skogseid, J.	
Hurst, S.D.		
Lagabrielle, Y.		
Lin, J.		
Moore, G.F.		TEDCOM
Robertson, A.H.F.	Parson, L.M.	SGPP
Steckler, M.		
Stock, J.M.		
Symonds, P.	Hall, J.	
Ten Brink, U.		
Von Huene, R.	Bleil, U.	
Yin, A.		

Service Panels

Member (Chair)	Alternate	Liaison to:

Downhole Measurements Panel (DMP)

Desbrandes, R.		
Draxler, J.K.	Wohlenberg, J.	
Dubuisson, G.		
Fryer, G.J.		
Green, A.S.P.	McCann, D.	
Hickman, S.H.		
Hutchinson, M.W.		
Jarrard, R.		
Lysne, P.		SMP
Nelson, P.H.		
Pedersen, L.B.	Woodside, J.	
Salisch, H.	Mwenifumbo, J.	
Von Damm, K.		
Williams, D.M.		
Yamano, M.	Kinoshita, H.	

Information Handling Panel (IHP)

Fryer, P.		
Gibson, I.L.	Jenkins, C.	
Huber, B.T.		OHP
Loughridge, M.S.		
Maudire, G.		
Richards, A.	Mikkelsen, N.	
Riedel, W.R.		
Saito, T.		
Spall, H.		
Brückmann, W.		
Wadge, G.	Kay, R.L.F.	
Watney, L.		
Wilkens, R.		

Shipboard Measurements Panel (SMP)

Brereton, N.R.	Chroston, N.	
Chaney, R.C.		
Gieskes, J.M.		
Nakashima, S.	Tada, R.	
Pariso, J.		
Rhodes, J.M.		
Thomas, E.		
[illegible]	Betzler, C.	

Site Survey Panel (SSP)

Camerlenghi, A.	Lykke-Andersen, H.	
Farre, J.A.		
Hinz, K.	Meyer, H.	
Kastens, K.A.		
Kuramoto, S.	Tokuyama, H.	
Mountain, G.		
Peterson, L.C.		
Scrutton, R	Skinner, A. C.	
Sibuet, J.C.		
Srivastava, S.P.	Johnson, D.	
Toomey, D.		
Tréhu, A.M.		

Pollution Prevention and Safety Panel (PPSP)

Ball, M.M.		SSP
Claypool, G.E.		
Delas, C.		
Fortier, M.	Powell, T.	
Garrison, L.		
Green, A.R.		
Haseldonckx, P.	Horn, D.	
Hovland, M.	Doyle, C.	
Katz, B.		
MacKenzie, D.B.		
Okuda, Y.		
Purdy, E.G.		

ODP Subcontractors

Member	Liaison to:

Science Operator

Allan, J.	SMP
Baldauf, J.	
Blum, P.	SSP
Clift, P.	TECP
Coyne, J.	IHP
Firth, J.	OHP
Francis, T.J.G.	PCOM, PPSP
Klaus, A.	DMP
Merrill, R.B.	IHP
Miller, D.J.	LITHP
Mills, B.	SMP
Rabinowitz, P.	EXCOM
Stokking, L.	SGPP
Storms, M.	TEDCOM

Wireline Logging Services

de Menocal, P. B.	OHP
Filice, F.	DMP
Goldberg, D.	LITHP, EXCOM, PCOM
Harvey, P.K.	SGPP
Pezard, P.	TECP
Rodway, K.L.	IHP
Sullivan, L.	BCOM

Site Survey Data Bank (SSDB)

Quoidbach, D.	SSP, PPSP

JOIDES Office

Clark, R.S.	
Collins, W.	SSP
Lewis, B.	PCOM Chair
Schmitt, K.	TECP

Other Representatives

Member (Chair) Liaison to:

Budget Committee (BCOM)

Kidd, R.B.
Lancelot, Y.
Lewis, B.
Maxwell, A.E.
Rosendahl, B.R.

ODP Council (ODPC)

Babcock, K.	Canada
Bjornsson, A.	Iceland
Brandt, B.	Sweden
Egelund, S.	Denmark
Ehlers, C.	Finland
Fratta, M.	ESF
Heinrichs, D.	US
Hertogen, J.	Belgium
Hirano, T.	Japan
Krebbs, J.	UK
Liberopoulos, P.	Greece
Madelain, F.	France
Maronde, D.	Germany
Pak, N.K.	Turkey
Pérez-Estaún, A.	Spain
Rutland, R.	Australia
Sartori, R.	Italy
Stel, J.H.	Netherlands
Weber, J.-B.	Switzerland
Westgaard, L	Norway

National Science Foundation (NSF)

Dauphin, J.P.	PCOM
Heinrichs, D.	EXCOM
Malfait, B.	EXCOM,PCOM
Shor, A.N.	SSP

Joint Oceanographic Institutions, Inc. (JOI)

Burns, A.	
Kappel, E.	
Pyle, T.	PCOM
Watkins, J. D.	EXCOM

Member Country Administrative Offices

ESF Consortium for Ocean Drilling (ECOD)

ESF Scientific Committee for ODP (ESCO) Secretariat

Dr. Hans-Christian Larsen, Chairman

ECOD is the acronym for the ESF Consortium for Ocean Drilling. It consists of twelve small European Countries (Belgium, Denmark, Finland, Greece, Holland, Iceland, Italy, Norway, Spain, Sweden, Switzerland, Turkey) and has been constituted under the umbrella of the European Science Foundation (ESF).

The Scientific Office of ECOD is called the ESCO Secretariat, ESCO is the acronym for the ECOD Scientific Committee for the ODP.

Address: Geological Survey of Denmark (DGU)
Thoravej 8
DK-2400 Copenhagen NV
Denmark

Telephone: 45-31-10 66 00
Fax: 45-31-19 68 68
Internet: BJ@dgu1.dgu.min.dk

Science Coordinator: Dr. Naja Mikkelsen
Administrative Officer: Ms. Birgit Jørgensen

ECOD Management Committee for the ODP (EMCO) Secretariat

Dr. Michele Fratta, EMCO Secretary

The ultimate decision-making body for matters of interest to the Consortium is EMCO, which reports to the appropriate ESF bodies.

Address: European Science Foundation
1 Quai Lezay-Marnesia
F-67080 Strasbourg Cedex

Telephone: 33 88 76 71 14
Fax: 33 88 37 05 32

Administrative Officer: Ms. M.-Aimée. Comte

Germany

German ODP Office

Dr. Helmut Beiersdorf, Director

Address: Bundesanstalt f. Geowiss. und Rohstoffe
Stilleweg 2, Postfach 510153
D-30631 Hannover
Germany

Telephone: 49 (511) 643-2795 or ext. 2413
Fax: 49 (511) 643-2304
Internet: beiersdorf@gate1.bgr.d400.de

Administrative Officer: Dr. Ursula Röhl
roehl@gate1.bgr.d400.de

Japan

ODP Japan Office

Dr. Tetsuya Hirano, Director

Address: Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo,164, Japan

Telephone: 81-3-5351-6437
Fax: 81-3-5351-6438
Internet ataira@aix3.ori.u-tokyo.ac.jp

Administrative Officer: Ms. Chizuru Kinoshita

The primary task of the ODP Japan Office is to distribute and handle information, to coordinate domestic ODP activities, to arrange traveling and to support public relations. The office publishes the *Japan ODP Newsletter* several times a year and hosts several workshops and symposiums a year.

France

Secrétariat ODP-France

Dr. Catherine Mével
Président du Comité Scientifique, ODP-France

Address: Secrétariat ODP-France
Université Pierre et Marie Curie
Case courrier 118
4 Place Jussieu
75252 Paris Cedex 05
France

Telephone: 33 (1) 44 27 51 55
Fax: 33 (1) 44 27 38 93
Internet: odpfr@ccr.jussieu.fr

Administrative Officer: Mme Martine Cheminée

Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER)

Dr. Pierre Papan
Président du Comité Directeur, ODP-France

Dr. Francois Madelain,
Directeur des Recherches Océaniques

Address: Technopolis 40
155 Rue Jean-Jacques Rousseau
92138 Issy-les-Moulineaux Cedix
France

Telephone: (1) 46 48 21 00
Telex: 631 912
Fax: (1) 46 48 22 24 (DRO)
Internet: bmetayer@paris.ifremer.fr

Administrative Officer: Mlle Bernadette Metayer

United Kingdom

UK ODP Office, Directorate Secretariat, Natural Environment Research Council

Dr. James Briden, Director
jbriden@mail.nsw.ac.uk

The UK ODP Office manages the national UK ODP Science Programme (ODPSP) and coordinates information exchange between the international elements of ODP (JOI, JOIDES) and the UK community.

Address: Polaris House
North Star Avenue
Swindon SN2 IEU
United Kingdom

Telephone 44 (0) 793 411573
Fax: 44 (0) 793 411584
Internet: R.Padgham@mail.nerc-swindon.ac.uk

Administrative Officer: Dr. R. C. Padgham

UK ODP Newsletter
Produced and distributed by Natural Environment Research Council. For copies, or to be placed on the distribution list contact:
Mr. P. Mason
Earth Sciences Directorate, NERC
Polaris House
North Star Avenue
Swindon SN2 1EU

Canada/Australia Consortium

Canadian ODP Secretariat

Dr. John Malpas, Director

Address: Memorial University
Centre for Earth Resources Research
St. John's , Newfoundland A1B 3X5
Canada

Telephone: 1 (709) 737-4708
Fax: 1 (709) 737-4702
Internet: ODP@kean.ucs.mun.ca

Administrative Officer: Mr. Jeff Saunders

Australian ODP Secretariat

Dr. Richard Arculus, Director
rarculus@basins.anu.edu.au

Address: Department of Geology and Geophysics
University of New England
Armidale, NSW 2351
Australia

Telephone: (67) 73 2860, international (61 67) 73 2860
Fax: (67) 71 2898, international (61 67) 71 2898
E-Mail: ODP@une.edu.au

Science Coordinator: Dr. Ian Metcalfe
imetcalf@metz.une.edu.au
Administrative Assistant: Ms. Raelene Moloney

ODP/JOIDES Alphabetical Directory

Country Codes used in this directory:

AUS	Australia
B	Belgium
CAN	Canada
CH	Switzerland
DK	Denmark
E	Spain
F	France
G	Germany
GR	Greece
I	Italy
IS	Iceland
J	Japan
N	Norway
NL	Netherlands
S	Sweden
SF	Finland
TR	Turkey
UK	United Kingdom
US	United States of America

Agar, Susan M.
Dept. of Geological Sciences
Northwestern University
Evanston, IL 60201 (US)
Tel: (708) 491-3238
Fax: (708) 491-8060
Internet: agar@earth.nwu.edu

Allan, Jamie
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-0506
Fax: (409) 845-0876
Internet: allan@nelson.tamu.edu

Altalo, Mary G.
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0212 (US)
Tel: (619) 534-2836
Fax: (619) 453-0167
Internet: maltalo@ucsd.edu

Arai, Shoji
Dept of Earth Sci, Faculty of Sciences
Kanazawa University
Kakuma-machi
Kanazawa 920-11 (J)
Tel: 81 (762) 64-5726
Fax: 81 (762) 64-5746

Arculus, Richard J.
Department of Geology
ANU
Canberra ACT 0200 (AUS)
Tel: 61 (6) 249 2056
Fax: 61 (6) 249 5544
Internet: rarculus@basins.anu.edu.au

Ashi, Juichiro
Geological Institute
University of Tokyo
7-3-1 Hongo, Bunkyo-ku
Tokyo 113 (J)
(3) 3812-2111, X4525

Babcock, Ken
Energy, Mines & Resources
Geological Survey of Canada
580 Booth Street, 20th Floor
Ottawa, Ontario K1A 0E4 (CAN)
Tel: (613) 992-5910
Fax: (613) 995-3082

Backman, Jan
Deep Sea Geology Division
Stockholm University
Kungstensgatan 45
S-10691 Stockholm
Tel: 46 (8) 164-720
Fax: 46 (8) 345-808
Internet: backman@geologi.su.se

Bahr, Jean M.
Department of Geology and Geophysics
University of Wisconsin-Madison
Weeks Hall, 1215 W Dayton St.
Madison, WI 53706 (US)
Tel: (608) 262-5513
Fax: (608) 262-0693
Internet: jmbahr@geology.wisc.edu

Baker, Paul A.
Department of Geology
Duke University
Durham, NC 27708 (US)
Tel: (919) 684-6450
Fax: (919) 684-5833
Internet: pbaker@rogue.geo.duke.edu

Baldauf, Jack
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-9297
Fax: (409) 845-0876
Internet: baldauf@nelson.tamu.edu

Ball, Mahlon M.
Petroleum Geology Branch
U.S. Geological Survey
Box 25046, MS-940, Denver Fedl. C.
Denver, CO 80225 (US)
Tel: (303) 236-5784
Fax: (303) 236-8822

Banda, Enrique
Consejo Superior de Invest. Cientificas
Instutut de Geologia-Jauma Almera
Marti i Franquez s/n
E-08028 Barcelona
Tel: 34 (3) 330-2716
Fax: 34 (3) 411-0012

Becker, Keir
Rosenstiel School of Marine & Atm. Sci.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149 (US)
Tel: (305) 361-4661
Fax: (305) 361-4632
Internet: KBecker@rsmas.miami.edu

Beiersdorf, Helmut
Bundesanstalt für Geowiss. u. Rohstoffe
Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-2413
Fax: 49 (511) 643-2304
Internet: beiersdorf@gate1.bgr.d400.de

Berger, Wolfgang H.
Scripps Institution of Oceanography
University of California, San Diego
3226 Ritter Hall
La Jolla, CA 92093-0215 (US)
Tel: (619) 534-2750
Fax: (619) 534-0784

Beswick, John
Kenting Drilling plc
Castle Donnington
Derby DE7 2NP (UK)
Tel: 44 (332) 850-060
Fax: 44 (332) 850-553

Betzler, Christian
Geologisch-Pälontologisches Institut
Senckenberganlage 32-34
D-60325 Frankfurt-am-Main (G)
Tel: 49 (69) 798 3107
Fax: 49 (69) 798 8383

Björnsson, Axel
Icelandic Council of Science
Barugötu 3
IS-Reykjavik
Tel: 354 1 10233
Fax: 354 1 21331

Blake, Gregg H.
Unocal
P.O. Box 4551
Houston, TX 77210-4551 (US)

Bleil, Ulrich
Fachbereich Geowissenschaften
Universität Bremen
Postfach 33 04 40
D-28334 Bremen (G)
Tel: 49 (421) 218 3366
Fax: 49 (421) 218 3116

Bloomer, Sherman H.
Department of Geology
Boston University
675 Commonwealth Avenue
Boston, Massachusetts 02215 (US)
Tel: (617) 353-2532
Fax: (617) 353-3290
Internet: bloomer@crsa.bu.edu

Blum, Peter
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-9299
Fax: (409) 845-0876
Internet: blum@nelson.tamu.edu

Brandt, Björn
Swedish Natural Science Res. Council
P.O. Box 6711
S-113 85 Stockholm
Tel: 46 (8) 610-0700
Fax: 46 (8) 610-0746
Internet: bjorn@nfr.se

Brereton, Robin
Regional Geophysics Group
British Geological Survey
Kingsley Dunham Centre, Keyworth
Nottingham NG12 5GG (UK)
Tel: 44 (602) 363-351
Fax: 44 (602) 363-145

Briden, James C.
Director, Earth Sciences
Natural Environment Research Council
Polaris House, North Star Ave.
Swindon SN2 1EU (UK)
Tel: 44 (793) 411-730
Fax: 44 (793) 411-584
Internet: jbriden@mail.nerc-swindon.ac.uk

Brown, Kevin M.
Geological Research Division
Scripps Institute of Oceanography
University of California, San Diego
La Jolla, CA 92093-0220 (US)
Tel: (619) 534-5368
Fax: (619) 534-0784
Internet: kmbrown@grdqmail.ucsd.edu

Brückmann, Warner
GEOMAR
Research Center for Marine Geoscience
Wischhofstrasse 1-3, Geb. 4
D-24148 Kiel (G)
Tel: 49 (431) 720-2148
Fax: 49 (431) 72-5391
Internet:
wbrueckmann@geomar.uni-kiel.d400.de

Brumsack, Hans J.
Institut für Chemie und Biologie
des Meeres
Postfach 2503
D-26015 Oldenburg (G)
Tel: 49 (441) 798 3584
Fax: 49 (441) 798 3384

Buchardt, Bjørn
Department of Geology
University of Copenhagen
Øster Voldgade 10
DK-1350 Copenhagen K
Tel: 45 (35) 322-626
Fax: 45 (35) 322-499

Burns, Allison
Joint Oceanographic Institutions Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102 (US)
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: aburns@brook.edu

Buttle, Eileen
Natural Environment Research Council
Polaris House, North Star Avenue
Swindon SN2 1EU (UK)
Tel: 44 (793) 411-653
Fax: 44 (793) 411-691
Internet: hqpo@mail.nsw.ac.uk

Camerlenghi, Angelo
Osservatorio Geofisico Sperimentale
P.O.Box 2011 (Opicina)
I-34016 Trieste
Tel: 39 (40) 214-0255
Fax: 39 (40) 327-307
Bitnet: acam@itsogs.bitnet

Cannat, Mathilde
Laboratoire de Petrologie
Université P. et M. Curie, URA 736
4 place Jussieu, tour 26, 3ème
F-75252 Paris cedex 05
Tel: 33 (1) 44-27-51-92
Fax: 33 (1) 44-27-39-11
Internet: MAC@ccr.jussieu.fr

Caress, Dave
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8501
Fax: (914) 365-3181
Internet: caress@ldeo.columbia.edu

Carter, Robert M.
Department of Geology
James Cook University
Townsville, QLD 4811 (AUS)
Tel: 61 (77) 814-536
Fax: 61 (77) 251-501
Internet: glrmc@marlin.jcu.edu.au

Chaney, Ronald C.
Dept. of Environmental Resources Eng.
Humboldt State University
Arcata, CA 95521 (US)
Tel: (707) 826-3619
Fax: (707) 826-3616

Cheminée, Martine
Secrétariat ODP-France
Université P. et M. Curie
4 place Jussieu, tour 26, Boîte 124
F-75252 Paris cedex 05
Tel: 33 (1) 4427 5155
Fax: 33 (1) 4427 3893
Internet: odpfr@ccr.jussieu.fr

Chroston, N.
School of Environmental Sciences
Univeristy of East Anglia
Norwich NR4 7TJ (UK)
Tel: 44 603 56161 ext. 3109
Fax: 44 603 507719

Chivas, Allan R.
Research School of Earth Sciences
The Australian National University
Canberra, ACT 0200 (AUS)
Tel: 61 (6) 249-3247
Fax: 61 (6) 249-0738
Internet: allan.chivas@anu.edu.au

Clark, R. Samuel
JOIDES Planning Office
University of Washington (HA-30)
3731 University Way N.E., Suite 104
Seattle, WA 98195 (US)
Tel: (206) 543-2203
Fax: (206) 685-7652
Internet: clark@ocean.washington.edu

Claypool, George E.
Mobil E&P Services Inc.
P.O. Box 650232
Dallas, TX 75265-0232 (US)
Tel: (214) 951-2837
Fax: (214) 951-2265

Clement, Bradford M.
Department of Geology
Florida International University
Miami, FL 33199 (US)
Tel: (305) 348-3085
Fax: (305) 348-3877
Internet: clementb@servax.fiu.edu

Clift, Peter
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-0879
Fax: (409) 845-0876
Internet: clift@nelson.tamu.edu

Coffin, Millard F.
Institute for Geophysics
University of Texas at Austin
8701 N Mopac Expressway
Austin, TX 78759-8397 (US)
Tel: (512) 471-0429
Fax: (512) 471-8844
Internet: mikec@coffin.ig.utexas.edu

Collins, William
JOIDES Planning Office
University of Washington (HA-30)
3731 University Way N.E.
Seattle, WA 98195 (US)
Tel: (206) 543-2203
Fax: (206) 685-7652
Internet: collins@ocean.washington.edu

Comte, Marie-Aimée
ESF Consortium for Ocean Drilling
European Science Foundation
1 quai Lezay-Marnésia
F-67080 Strasbourg Cedex
Tel: 33 (88) 76-71-14
Fax: 33 (88) 37-05-32

Coyne, John
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-1927
Fax: (409) 845-4857
Internet: coyne@nelson.tamu.edu

Curry, William B.
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000 x2591
Fax: (508) 457-2187
Internet: wcurry@whoi.edu

Dauphin, J. Paul
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230 (US)
Tel: (703) 306-1581
Internet: jdauphin@nsf.gov

Davies, Thomas A.
Institute for Geophysics
University of Texas
8701 N Mopac Expressway
Austin, TX 78759-8397 (US)
Tel: (512) 471-0409
Fax: (512) 471-8844
Internet: tomd@utig.ig.utexas.edu

de Menocal, Peter B.
Borehole Research Group
Lamont-Doherty Earth Observatory
Palisades, NY 10964 (US)
Tel: (914) 365-8483
Fax: (914) 365-2312
Internet: peter@ldeo.columbia.edu

Delaney, Margaret L.
Institute of Marine Sciences
University of California, Santa Cruz
Santa Cruz, CA 95064 (US)
Tel: (408) 459-4736
Fax: (408) 459-4882
Internet: delaney@cats.ucsc.edu

Delas, Claude
Total/CFP
Cedex 47
92069 Paris La Defense (F)
Tel: 33 (1) 4291-3704
Fax: 33 (1) 4135-4052

Desbrandes, Robert
Dept. of Petroleum Engineering
Louisiana State University
Baton Rouge, LA 70803-6417 (US)
Tel: (504) 388-5215
Fax: (504) 388-5990
Internet: rnd@r3.pete.lsu.edu

Dick, Henry J.B.
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000, X2095
Fax: (508) 457-2187
Internet: HDick@whoi.edu

Doglioni, Carlo
Dipartimento Geologia
Campus Universitario
V. Orabona, 4
I - 70125 Bari
Tel: 39 (80) 242-627
Fax: 39 (80) 242-625

Doyle, Claire
Maersk Olie og Gas A/S
Esplanaden 50
DK-1263 Copenhagen K
Tel: 45 (33) 11-46-76
Fax: 45 (33) 32-23-25

Draxler, Johann K.
Niedersächs. Landesamt f. Bodenforschung
Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-2673
Fax: 49 (511) 643-2304
Internet: draxler@gate1.bgr.d400.de

Dubuisson, Gilles
Département de Géologie
Ecole Normale Supérieure
24, rue Lhomond
F-75231 Paris Cedex 05
Tel: (33) 1 44 32 22 94
Fax: (33) 1 44 32 20 00

Duce, Robert A.
Coll. Geosciences & Maritime Studies
Texas A&M University
College Station, TX 77843 (US)
Tel: (409) 845-3651
Fax: (409) 845-0056
Internet: duce@triton.tamu.edu

Eaton, Gordon P.
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8348
Fax: (914) 359-2931
Internet: eaton@lamont.ldeo.columbia.edu

Egeberg, P.K.
Agder College
Tordenskioldsgate 65
N-4604 Kristiansand
Tel: 47 (42) 79557
Fax: 47 (42) 79501
Internet: perke@adh.no

Egelund, Susanne
Department of Research
Natural Science Research Council
H.C. Andersons Boulevard 40
DK-1553 Copenhagen V
Tel: 45 (33) 114-300
Fax: 45 (33) 323-501

Ehlers, Carl
Geologisk-Mineralogisk Inst.
Åbo Akademi
Domkyrkotorget 1
SF-20500 Åbo
Tel: 358 21 654 311
Fax: 358 21 654 818

Eickelberg, Dieter
Eichenstraße 10
D-48455 Bentheim (G)
Tel: 49 (5922) 5421

Emeis, Kay-Christian
Geologisch-Paläontologisches Institut
Universität Kiel
Olshausenstraße 40-60
D-24118 Kiel (G)
Tel: 49 (431) 880-2085
Fax: 49 (431) 880-4376
Internet: ngl20@rz.uni-kiel.d400.de
AFTER June 1, 1994
Institut fuer Ostseeforschung
Seestr. 15
P.O. Box 30 10 38
D-18111 Rostock
Internet: emeis@geo.io.warnemunde.d400.de

Falvey, David A.
Associate Director
Australian Geological Survey Organization
GPO Box 378
Canberra, ACT 2601 (AUS)
Tel: 61 (6) 249-9111
Fax: 61 (6) 257-4614

Farre, John A.
EXXON Production and Research
P.O. BOX 2189
Houston, TX 77252-2189 (US)
Tel: (713) 966-6149
Fax: (713) 966-7279

Farrimond, Paul
Fossil Fuels and Environmental Geochem.
Drummond Building
University of Newcastle upon Tyne
Newcastle upon Tyne NE1 7RU (UK)
Tel: 44 (91) 222 6000 (x6513)
Fax: 44 (91) 261 1182
Internet: paul.farrimond@newcastle.ac.uk

Filice, Frank
Borehole Research Group
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964
Tel: (914) 365-8336
Fax: (914) 365-3182
Internet: filice@ldeo.columbia.edu

Firth, John
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845 (US)
Tel: (409) 845-0507
Fax: (409) 845-0876
Internet: firth@nelson.tamu.edu

Fisher, Andrew T.
Dept of Geology/Indiana Geo Survey
Indiana University
611 North Walnut Grove
Bloomington, IN 47405 (US)
Tel: (812) 855-9992
Fax: (812) 855-2862
Internet: Fisher@gismo.geology.indiana.edu

Fortier, Mimi
Dept. of Indian and Northern Affairs
Northern Oil and Gas Directorate
10 Wellington Street, 6th Floor
Ottawa, Ontario K1A 0H4 (CAN)
Tel: (819) 953-8722
Fax: (819) 953-5828

Fox, P. Jeff
School of Oceanography
University of Rhode Island
Kingston, RI 02881 (US)
Tel: (401) 792-6229
Fax: (401) 792-6811
Internet: jfox@gsosun1.gso.uri.edu

France-Lanord, Christian
CRPG-CNRS
15, rue Notre Dame des Pauvres
B.P. 20
F-54501 Vandoeuvre-les-Nancy
Tel: (33) 83 51 22 13
Fax: (33) 83 51 17 98
Internet: cfl@crpg.cnrs-nancy.fr

Francis, Timothy J.G.
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-8480
Fax: (409) 845-1026
Internet: francis@nelson.tamu.edu

Fratta, Michele
European Science Foundation
1 Quai Lezay-Marnésia
F-67080 Strasbourg Cedex
Tel: 33 (88) 76-71-14
Fax: 33 (88) 37-05-32

Frieman, Edward A.
Scripps Institution of Oceanography
Univ. of California, San Diego
La Jolla, CA 92093-0210 (US)
Tel: (619) 534-2826
Fax: (619) 453-0167
Internet: efrieman@ucsd.edu

Fryer, Gerard J.
School of Ocean & Earth Sci. & Tech.
University of Hawaii
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-7875
Fax: (808) 956-2538
Internet: g.fryer@soest.hawaii.edu

Fryer, Patricia
Department of Geology and Geophysics
University of Hawaii at Manoa
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-3146
Fax: (808) 956-6322
Internet: patty@soest.hawaii.edu

Fujimoto, Hiromi
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (j)
Tel: 81 (3) 5351-6429
Fax: 81 (3) 5351-6429
Internet: fujimoto@aix3.ori-u-tokyo.ac.jp

Gagosian, Robert B.
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000
Fax: (508) 457-2190
Internet: rgagosian@whoi.edu

Garrison, Lou
8503 Amethyst Court
College Station, TX 77845 (US)
Tel: (409) 764-7473 or 845-485

Garrison, Robert
Earth Sciences Board
University of California at Santa Cruz
Santa Cruz, CA 95064 (US)
Tel: (408) 459-2114
Fax: (408) 459-3074
Internet: bobg@rupture.ucsc.edu

Gersonde, Rainer
Alfred-Wegener-Institut für
Polar- und Meeresforschung
Postfach 120161
D-27515 Bremerhaven (G)
Tel: 49 (471) 483-1203
Fax: 49 (471) 483 1149

Gibson, Ian L.
Department of Earth Sciences
University of Waterloo
Waterloo, Ontario N2L 3G1 (CAN)
Tel: (519) 885-1211 x2054
Fax: (519) 746-7484
Internet: igibson@sciborg.uwaterloo.ca

Gieskes, Joris M.
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0215 (US)
Tel: (619) 534-4257
Fax: (619) 534-2997
Internet: jgieskes@ucsd.edu

Gillis, Kathryn M.
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000 x2345
Fax: (508) 457-2183

Goldberg, David
Director of Operations, BRG
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8674
Fax: (914) 365-3182
Internet: goldberg@ldeo.columbia.edu

Green, Arthur R.
Exxon Exploration Company
P.O. Box 4788
Houston, TX 77210-4778 (US)
Tel: (713) 775-7529
Fax: (713) 775-7780

Green, Andrew S.P.
CSM Associates Ltd.
Rosemanowes, Herniss
Penryn
Cornwall TR10 9DU (UK)
Tel: 44 (0) 209 860 141
Fax: 44 (0) 209 861 013
Int: agreen@camborne-school-of-mines,ac.uk

Grout, Ron
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-2144
Fax: (409) 845-2308
Internet: grout@nelson.tamu.edu

Hall, Jeremy
Centre for Earth Resources Research
Memorial University of Newfoundland
St. John's, Newfoundland A1B 3X5 (Can)
Tel: (709) 737-4519
Fax: (709) 737-2589
Internet: jeremy@kean.ucs.mun.ca

Harrison, Christopher G.A.
Rosenstiel School of Marine & Atm. Sci.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149 (US)
Tel: (305) 361-4610
Fax: (305) 361-4711
Internet: CHarrison@rsmas.miami.edu

Harvey, Peter K.H.
Borehole Research
Department of Geology
University of Leicester
Leiscester, LE1 7RH (UK)
Tel: 44 533 523 796
Fax: 44 533 523 918
Internet: pkh@leicester.ac.uk

Haseldonckx, Paul
DEMINEX
Dorotheenstrasse 1
D-45130 Essen (G)
Tel: 49 (201) 726-3911

Heath, G. Ross
University of Washington, HN-15
583 Henderson Hall
Seattle, WA 98195 (US)
Tel: (206) 543-6605
Fax: (206) 543-6393
Internet: rheath@u.washington.edu

Heinrichs, Donald
National Science Foundation, OCE
4201 Wilson Boulevard
Arlington, VA 22230 (US)
Tel: (703) 306-1581
Fax: (202) 357-7621
Internet: dheinrichs@nsf.gov

Herbert, Timothy D.
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0215 (US)
Tel: (619) 534-4199
Fax: (619) 534-0784
Internet: tim@cyclone2.ucsd.edu

Hertogen, Jan
Fysico-Chemische Geologie
Universiteit Leuven
Celestijnenlaan 200 C
B-3001 Leuven
Tel: 32 (16) 20-10-15
Fax: 32 (16) 20-13-68
Internet: fgeeA03@cc1.kuleuven.ac.be

Herzig, Peter Michael
Institut für Mineralogie, Geochemie und
Lagerstaettenlehre
TU Bergakademie Freiberg
Brennhausgasse 14
D-09596 Freiberg
Tel: 49 (3731) 512662
Fax: 49 (3731) 513129
Internet:
herzig@mineral.geowiss.ba-freiberg.d400.de

Hickman, Stephen H.
Branch of Tectonophysics
U.S. Geological Survey
345 Middlefield Road, MS 977
Menlo Park, CA 94025 (US)
Tel: (415) 329-4807
Fax: (415) 329-5163
Internet: hickman@thedup.wr.usgs.gov

Hinz, Karl
Bundesanstalt für Geowiss. u. Rohstoffe
Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-3247
Fax: 49 (511) 643-2304
Internet: odp.ssp@gate1.bgr.d400.de

Hirano, Tetsuya
Director, Ocean Research Institute
University of Tokyo
1-15-1 Minimidai, Nakano-ku
Tokyo 164 (J)
Fax: 81 3 5351 6438
Internet: ataira@aix3.ori.u-tokyo.ac.jp

Hiscott, Richard N.
Department of Earth Sciences
Memorial University
St. John's, Newfoundland A1B 3X5 (CAN)
Tel: (709) 737-8394/4708
Fax: (709) 737-2589
Internet: rhiscott@kean.ucs.mun.ca

Hodell, David A.
Department of Geology
University of Florida
1112 Turlington Hall
Gainesville, FL 32611 (US)
Tel: (904) 392-6137
Fax: (904) 392-9294
Internet: hodell@nervm.nerdc.ufl.edu

Horn, Dietrich
DEMINEX
Dorotheenstrasse 1
D-45130 Essen (G)
Tel: 49 (201) 726-3905
Fax: 49 (201) 726 2942

Hovland, Martin
STATOIL
P.O. Box 300
N-4001 Stavanger
Tel: 47 (4) 807-130
Fax: 47 (51) 806-065

Huber, Brian T.
Department of Paleobiology, NHB 1121
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560 (US)
Tel: (202) 786-2658
Fax: (202) 786-2832
Internet: MNHpB007@sivm.si.edu

Hurst, Stephen D.
Geology Department
Duke University
Durham, NC 27708 (US)
Tel: (919) 681-8285

Hutchinson, Mark W.
Eastman Teleco
15355 Vantage Parkway West
Houston, TX 77032 (US)
Tel: (713) 985-3840
Fax: (713) 985-3842

Jarrard, Richard
Dept of Geology & Geophysics
University of Utah
717 Browning Bldg (603 WBB)
Salt Lake City, UT 84112 (US)
Tel: (801) 585-3964
Fax: (801) 581-7065
Internet: rich@westlog.utah.edu

Jenkins, Chris
Ocean Science Institute
University of Sydney
108 Darlington Road (H34)
Sydney, NSW 2006 (AUS)
Tel: 61 (2) 692-4068
Fax: 61 (2) 692-4202
Internet: chrisj@extro.ucc.su.oz.au

Johnson, David
Department of Geology
James Cook University, N. Queensland
Townsville, QLD 4811 (AUS)
Tel: 61 (77) 814-536
Fax: 61 (77) 251-501
Internet: glkgh@marlin.jcu.edu.au

Jørgensen, Birgit
Ministry of the Environment
Geological Survey of Denmark
Thoravej 8
DK-2400 Copenhagen NV
Tel: 45 (31) 106-600
Fax: 45 (31) 196-868
Internet: BJ@dgu1.dgu.min.dk

Kappel, Ellen
Joint Oceanographic Institutions Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102 (US)
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: ekappel@brook.edu

Karpoff, Anne-Marie
Centre de Géochimie de la Surface
Université Louis Pasteur
1, rue Blessig
F-67084 Strasbourg Cedex
Tel: (33) 88 35 85 65
Fax: (33) 88 36 72 35

Kasahara, Junzo
Earthquake Research Institute
University of Tokyo
1-1-1 Yayoi, Bunkyo-ku
Tokyo 113 (J)
Tel: 81 (3) 3812-2111 X5713
Fax: 81 (3) 3812-6979

Kastens, Kim A.
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8836
Fax: (914) 365-8156
Internet: kastens@lamont.ldeo.coumbia.edu

Kastner, Miriam
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0212 (US)
Tel: (619) 534-2065
Fax: (619) 534-0784
Internet: mkastner@ucsd.edu

Katz, Barry
TEXACO EPTD
P.O. Box 770070
Houston, TX 77215-0070 (US)
Tel: (713) 954-6093
Fax: (713) 954-6113

Kay, Lin
Earth Sciences Directorate
Natural Environment Res. Council
Polaris House, North Star Ave.
Swindon, SN2 1EU (UK)
Tel: 44 (793) 411-521
Fax: 44 (793) 411-584
Internet: R.Kay@mail.nerc-swindon.ac.uk

Kemp, Alan
Department of Oceanography
University of Southampton
Highfield
Southampton S09 5NH (UK)
Tel: 44 (703) 592-788
Fax: 44 (703) 593-059

Kempton, Pamela
Kingsley Dunham Centre
British Geological Survey
Keyworth
Nottingham NG12 5GG (UK)
Tel: 44 (602) 363-100
Fax: 44 (602) 363-200

Kent, Dennis V.
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8370 (or 8544)
Fax: (914) 365-2312
Internet: dvk@lamont.ldeo.columbia.edu

Kidd, Robert B.
Department of Geology
University of Wales, Cardiff
P.O. Box 914, Cathays Park
Cardiff CF1 3YE (UK)
Tel: 44 (222) 874-830
Fax: 44 (222) 874-326
Internet: sglrbk@CARDIFF.AC.UK

Kinoshita, Chizuru
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (J)
Tel: 81 (3) 5351-6435
Fax: 81 (3) 5351-6438
Internet: ataira@aix3.ori.u-tokyo.ac.jp

Kinoshita, Hajimu
Earthquake Research Institute
University of Tokyo
Bunkyo-ku
Tokyo 113 (J)
Tel: 81 (3) 3812-9417
Fax: 81 (3) 3816-1159

Klaus, Adam
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-3055
Fax: (409) 845-0876
Internet: klaus@nelson.tamu.edu

Krebbs, J.
Natural Environment Research Council
Polaris House
North Star Avenue
Swindon SN2 1EU (UK)
Tel: 44 793 411653
Fax: 44 793 411691
Internet: hqpo@mail.nsw.ac.uk

Kristoffersen, Yngve
Institute of Solid Earth Physics
University of Bergen
Allègaten 41
N-5014 Bergen
Tel: 47 (5) 213-420
Fax: 47 (5) 320-009

Kudrass, Hermann
Bundesanstalt für Geowiss. u. Rohstoffe
Postfach 51 01 53
D-30631 Hannover (G)
Tel: 49 (511) 643 2782
Fax: 49 (511) 643 2304
Internet: kudrass@gate1.bgr.d400.de

Kuramoto, Shin'ichi
Marine Geology Department
Geological Survey of Japan
1-1-3 Higashi, Tsukuba
Ibaraki, 305 (J)
Tel: 81-298-54-3768
Fax: 81-298-54-3589
Internet: kuramoto@gsjrstn.gsj.go.jp

Lagabrielle, Yves
UFR Sciences et Techniques
Université de Bretagne Occidentale
B.P. 452
F-29275 Brest Cedex
Tel: (33) 98 31 61 86
Fax: (33) 98 31 66 20

Lancelot, Yves
Laboratoire de Géologie du Quaternaire
CNRS-Luminy
Case 907
F-13288 Marseille Cedex 9
Tel: 33 91 269 650
Fax: 33 91 266 638
Internet: Y.Lancelot@omnet.nasa.gov

Langseth, Marcus
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8518
Fax: (914) 365-0718
Internet: langs@lamont.ldeo.columbia.edu

Larsen, Hans-Christian
Danish Lithosphere Centre &
Geological Survey of Greenland
Øster Voldgade 10
DK-1350 København K
Tel: 45 (33) 118-866
Fax: 45 (33) 935-352
Internet: larsenhc@ggu.min.dk

Larson, Roger L.
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882 (US)
Tel: (401) 792-6165
Fax: (401) 792-6160

Leckie, R. Mark
Dept. of Geology and Geography
University of Massachusetts
Amherst, MA 01003 (US)
Tel: (413) 545-1948
Fax: (413) 545-1200
Internet: leckie@ucsvax.ucs.umass.edu

Leinen, Margaret
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197 (US)
Tel: (401) 792-6222
Fax: (401) 792-6160
Internet: mleinen@gsosun1.gso.uri.edu

Levi, Shaul
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, OR 97331 (US)
Tel: (503) 737-2296
Fax: (503) 737-2400

Lewis, Brian T.R.
JOIDES Planning Office
University of Washington (HA-30)
3731 University Way N.E., #104
Seattle, WA 98195 (US)
Tel: (206) 543-2203
Fax: (206) 685-7652
Internet: blewis@ocean.washington.edu

Lin, Jian
Dept of Geology & Geophysics
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000, x2576
Fax: (508) 457-2187
Internet: jian@galileo.whoi.edu

Loughridge, Michael S.
Marine Geology and Geophysics Div.
Natl. Geophys. Data Center, E/GC3, NOAA
325 Broadway
Boulder, CO 80303 (US)
Tel: (303) 497-6487
Fax: (303) 497-6513
Internet: msl@mail.ngdc.noaa.gov

Lovell, Mike
Department of Geology
University of Leicester
Leicester (UK)
Tel: 44 (533) 522-522
Fax: 44 (533) 522-200

Ludden, John
Départment de Géologie
Université de Montreal
C.P. 6128, Succursale "A"
Montréal, Quebec (C)
Tel: (514) 343-7389
Fax: (514) 343-5782
Internet: luddenj@ere.umontreal.ca

Luy, Ralf
Inst für Tiefbohrkunde und Erdölgewinnung
Agricolastraße 10
D-38678 Clausthal-Zellerfeld (G)
Tel: 49 (5323) 722 450
Fax: 49 (5323) 723 146

Lykke-Andersen, Holger
Geophysical Institute
University of Aarhus
Finlandsgade 8
DK-8200 Aarhus
Tel: 45 (86) 16-16-66
Fax: 45 (86) 10-10-03

Lysne, Peter
Department 6111
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185 (US)
Tel: (505) 844-8885
Fax: (505) 844-3952
Internet: pclysne@sandia.gov

MacKenzie, David B.
1000 Ridge Road
Littleton, CO 80120 (US)
Tel: (303) 794-4750

Macko, Stephen A.
Department of Environmental Sciences
University of Virginia
Halsey Hall, Room 209
Charlottesville, VA 22903 (US)
Tel: (804) 924-2967 or 982-296
Fax: (804) 924-7761
Internet: sam8f@faraday.clas.virginia.edu

Madelain, François
IFREMER Technopolis 40
Direction des Recherches Océaniques
155, rue Jean-Jacques Rousseau
F-92138 Issy-les-Moulineaux Cedex
Tel: 33 (1) 46 48 22 17
Fax: 33 (1) 46 48 22 24

Malfait, Bruce
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230 (US)
Tel: (703) 306-1581
Fax: (703) 306-0390
Internet: bmalfait@nsf.gov

Malpas, John
Canadian ODP Secretariat
Memorial Univ., Earth Resources Res. Ctr.
Elizabeth Ave.
St. John's, Newfoundland A1B 3X5 (CAN)
Tel: (709) 737-4708
Fax: (709) 737-4702
Internet: odp@kean.ucs.mun.ca

Maronde, Dietrich
Deutsche Forschungsgemeinschaft
Kennedy-Allee 40
D-53175 Bonn (G)
Tel: 49 (228) 885-2328
Fax: 49 (228) 885-2221

Marsh, Gary L.
Shell Oil Company
One Shell Plaza, P.O. Box 2463
Houston, Texas 77252 (US)
Tel: (504) 588-6970
Fax: (504) 588-0213

Maudire, Gilbert
SISMER/IFREMER
Centre de Brest
B.P. 70
F-29280 Plouzané Cedex
Tel: (33) 98 22 42 16
Fax: (33) 98 22 46 44
Internet: gmaudire@ifremer.fr

Maxwell, Arthur E.
Institute for Geophysics
University of Texas at Austin
8701 N Mopac Expressway
Austin, TX 78759-8397 (US)
Tel: (512) 471-0411
Fax: (512) 471-8844
Internet: art@utig.ig.utexas.edu

McCann, Clive
PRIS
University of Reading
P.O. Box 227, Whiteknights
Reading RG6 2AH (UK)
Tel: 44 (734) 318-940
Fax: 44 (734) 310-279

McCann, D.
Regional Geophysics Group
British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham NG12 5GG (UK)
Tel: 44 602 363380
Fax: 44 602 363145

McKenzie, Judith A.
Geologisches Institut
ETH-Zentrum
Sonneggstrasse 5
CH-8092 Zürich (CH)
Tel: 41 (1) 632-3828
Fax: 41 (1) 252-0819
Bitnet: sediment@czheth5a.bitnet

Merrill, Russell B.
Manager, Science Services
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-2016
Fax: (409) 845-4857
Internet: merrill@nelson.tamu.edu

Métayer, Bernadette
IFREMER
Direction des Recherches Océaniques
155 rue Jean-Jacques Rousseau
F-92138 Issy-les-Moulineaux Cedex
Tel: 33 (1) 46 48 22 17
Fax: 33 (1) 46 48 22 24
Internet: bmetayer@paris.ifremer.fr

Metcalfe, Ian
Department of Geology and Geophysics
University of New England
Armidale, NSW 2351 (AUS)
Tel: 61 (67) 73-2860
Fax: 61 (67) 71-2898
Internet: imetcalfe@metz.une.edu.au

Mével, Catherine
Laboratoire de Pétrologie
Université Pierre et Marie Curie
4 Place Jussieu, Tour 26, 3me étage
F-75252 Paris Cedex 05
Tel: 33 (1) 44-27-51-93
Fax: 33 (1) 44-27-39-11
Internet: cam@ccr.jussieu.fr

Meyer, Heinrich
Bundesanstalt für Geowiss. u. Rohstoffe
Stilleweg 2, Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-3128
Fax: 49 (511) 643-2304
Internet: odp.ssp@gate1.bgr.d400.de

Mikkelsen, Naja
Geological Survey of Denmark
Thoravej 8
DK-2400 Copenhagen NV
Tel: 45 (31) 10-66-00
Fax: 45 (31) 19-68-68
Internet: nm@dgu1.dgu.min.dk

Miller, D. Jay
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-0876 (US)
Tel: (409) 845-2197
Fax: (409) 845-0876
Internet: jaymiller@nelson.tamu.edu

Mills, Bill
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-2478
Fax: (409) 845-2830
Internet: mills@nelson.tamu.edu

Mix, Alan C.
College of Oceanic & Atmospheric Sciences
Oregon State University
Oceanography Admin. Bldg. 104
Corvallis, OR 97331-5503 (US)
Tel: (503) 737-5212
Fax: (503) 737-2064
Internet: mix@oce.orst.edu

Moberly, Ralph
School of Ocean and Earth Sci. & Techn.
University of Hawaii at Manoa
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-8765
Fax: (808) 956-2538
Internet: rmoberly@soest.hawaii

Moore, Gregory F.
Department of Geology and Geophysics
University of Hawaii
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-6854
Fax: (808) 956-2538
Internet: moore@soest.hawaii.edu

Moore, Theodore C.
Cent. for Great Lakes & Aquatic Sci.
University of Michigan
2200 Bonisteel Blvd.
Ann Arbor, MI 48109-2099 (US)
Tel: (313) 747-2742
Fax: (313) 747-2748
Internet: ted.moore@um.cc.umich.edu

Moran, Kate
Atlantic Geoscience Centre
Bedford Institute of Oceanography
Box 1006
Dartmouth, NS B2Y 4A2 (CAN)
Tel: (902) 426-8159/5596
Fax: (902) 426-4104
Internet: kmoran@agcrr.bio.ns.ca

Mountain, Gregory
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8540
Fax: (914) 365-2312
Internet: mountain@ldeo.columbia.edu

Mutter, John
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8525
Fax: (914) 365-3181
Internet: jcm@lamont.ldeo.columbia.edu

Mwenifumbo, Jonathan
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8 (CAN)
Tel: (613) 992-6520
Fax: (613) 996-9295
Internet: jarako@gsc.emr.ca

Nakashima, Satoru
Geological Institute
University of Tokyo
7-3-1 Hongo, Bunkyo-ku
Tokyo 113 (J)
Tel: 81 (3) 3812-2111, X4515
Fax: 81 (3) 3815-9490
Internet: satoru@tsunami.geol.s.u-tokyo.

Natland, James H.
Rosenstiel School of Marine & Atm. Sci.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149 (US)
Tel: (305) 361-4658
Fax: (305) 361-4632
Internet: jnatland@umigw.miami.edu

Nelson, Philip H.
U.S.G.S.
Denver W Building 2, Room 110
P.O. Box 25046, MS 964
Lakewood, CO 80225 (US)
Tel: (303) 236-1322
Internet: pnelson@musette.cr.usgs.gov

Nowell, Arthur
University of Washington, WB-10
121 Ocean Teaching Building
Seattle, WA 98195 (US)
Tel: (206) 543-6487
Fax: (206) 543-6073
Internet: nowell@ocean.washington.edu

O'Reilly, Suzanne
Discipline of Physical Earth Science
Macquarie Universoty
North Ryde, NSW 2109 (AUS)
Tel: 61 (2) 805-8418
Fax: 61 (2) 805-8428

Okuda, Yoshihisa
Geological Survey of Japan
1-1-3, Higashi
Tsukuba
Ibaraki 305 (J)
Tel: 81 (298) 54-3594
Fax: 81 (298) 54-3589

Orcutt, John
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0225 (US)
Tel: (619) 534-2887
Fax: (619) 534-5332
Internet: john_orcutt@igppqm.ucsd.edu

Pak, Namil Kemal
TÜBITAK
Scientific and Technical Research Council
Ataturk Bulvari 221, Kavaklidere
TR-0611 Ankara
Tel: 90 (4) 427-74-83
Fax: 90 (4) 427-74-83

Pariso, Janet
School of Oceanography, WB-10
University of Washington
204 Marine Sciences Building
Seattle, WA 98195 (US)
Tel: (206) 543-8035
Fax: (206) 543-0275
Internet: pariso@ocean.washington.edu

Parkes, R. J.
Dept. Geology
University of Bristol
Wills Memorial Building
Queen's Rd
Bristol BS8 1RJ (UK)
Tel: 44 272 303030
Fax: 44 272 253385
Internet: j.parkes.@bristol.ac.uk

Parson, Lindsay M.
Institute of Oceanographic Scis.
Deacon Laboratory
Book Road, Wormley, Godalming
Surrey GU8 5UB (UK)
Tel: 44 (428) 684-141
Fax: 44 (428) 858-833
Internet: lmp@unixa.nerc-wormley.ac.uk

Paull, Charles K.
Department of Geology
University of North Carolina
213 Mitchell Hall
Chapel Hill, NC 27599-3315 (US)
Tel: (919) 966-4516
Fax: (919) 966-4519

Pearce, J. A.
Dept. Geology
University of Durham
South Rd
Durham DH1 3LE (UK)
Tel: 44 91 374 2528
Fax: 44 91 374 2528
Internet: j.a.pearce@durham.ac.uk

Pedersen, Laust B.
Department of Geophysics
Uppsala University
Box 556
S-751 22 Uppsala
Tel: 46 (18) 182-385
Fax: 46 (18) 501-110
Internet: ldp@geofys.uu.se

Pedersen, Thomas F.
Department of Oceanography
University of British Columbia
6270 University Boulevard
Vancouver, B.C. V6T 1Z4 (CAN)
Tel: (604) 822-5984
Fax: (604)822-6091
Internet: tfp@unixg.ubc.ca

Pérez-Estaún, Andrés
Departamento de Geologia
Universidad de Oviedo
Jesús Arias de Velasco s/n
E-33005 Oviedo
Tel: 34 (8) 510-3110
Fax: 34 (8) 523-3911
Internet: andres@asturias.ccu.uniovi.es

Peterson, Larry C.
Rosenstiel School of Marine & Atm. Sci.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098 (US)
Tel: (305) 361-4692
Fax: (305) 361-4632
Internet: PetersonL@rcf.rsmas.miami.edu

Pezard, Philippe
Institut Méditerranéen de Technologie
Technopôle de Château-Gombert
F-13451 Marseille Cedex 20
Tel: 33 91 05 44 44
Fax: 33 91 05 43 43
Internet: pezard@imtmer1.imt-mrs.fr

Pheasant, J.
Marine Geophys. & Offshore Survey Prog.
British Geologica Survey
Murchison House
West Mains Rd
Edinburgh EH9 3LA (UK)
Tel: 44 31 667 1000
Fax: 44 31 668 2683

Pisias, Nicklas G.
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, OR 97331 (US)
Tel: (503) 737-3504
Fax: (503) 737-2064
Internet: pisias@oce.orst.edu

Powell, Trevor
Division of Continental Geology
Bureau of Mineral Resources
GPO Box 378
Canberra, ACT 2601 (AUS)
Tel: 61 (6) 249-9111
Fax: 61 (6) 257-4614

Prell, Warren L.
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, OR 97331 (US)
Tel: (503) 737-3281
Fax: (503) 737-2064
Internet: wprell@oce.orst.edu

Purdy, Ed
PetroQuest International, Inc.
93/99 Upper Richmond Road
London SW15 2T9 (UK)
Tel: 44 (81) 780-1067
Fax: 44 (81) 788-1812

Pyle, Thomas
Joint Oceanographic Institutions Inc.
1755 Massachusetts Ave., NW, Suite 800
Washington, DC 20036-2102 (US)
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: tpyle@brook.edu

Quoidbach, Daniel
Manager, Site Survey Databank
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8542
Fax: (914) 365-2312
Internet: daniel@ldeo.columbia.edu

Rabinowitz, Philip
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-8480
Fax: (409) 845-1026
Internet: moy@nelson.tamu.edu

Raleigh, C. Barry
School of Oce. and Earth Sc. & Techn.
University of Hawaii at Manoa
1000 Pope Road
Honolulu, HI 96822 (US)
Tel: (808) 956-6182
Fax: (808) 956-9152
Internet: soest@soest.hawaii.edu

Raymo, Maureen E.
Dept of Earth Atmo & Planetary Science
M.I.T.
E34-254
Cambridge, MA 02139 (US)
Tel: (617) 253-0474
Fax: (617) 253-8630
Internet: raymo@mit.edu

Rhodes, J. Mike
Department of Geology and Geography
University of Massachusetts
Amherst, MA 01003 (US)
Tel: (413) 545-2841
Fax: (413) 545-1200

Richards, Adrian
Delft University of Technology
Uiterweg 309
NL-1431 AJ Aalsmeer
Tel: 31 2 977-40012
Fax: 31 2 977-40723

Riddihough, Robin
Energy, Mines and Resources
Geological Survey of Canada
601 Booth Street, Rm 240
Ottawa, Ontario K1A 0E8 (CAN)
Tel: (613) 995-4482
Fax: (613) 996-8059

Riedel, William R.
SIO Geological Research Division
University of California, San Diego
1140 Ritter Hall
La Jolla, CA 92093-0220 (US)
Tel: (619) 534-4386
Fax: (619) 534-0784
Internet: wriedel@ucsd.edu

Rihm, Roland
GEOMAR
Forschungszentrum für Marine Geowiss.
Wischhofstrasse 1-3
D-24148 Kiel (G)
Tel: 49 (431) 7202-197/156
Fax: 49 (431) 7202-217

Rischmüller, Heinrich
Niedersächs. Landesamt für Bodenforschung
Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-2669
Fax: 49 (511) 643-2686

Paertson, Alastair H. F.
Tfrant Institute of Geology
Fniversity of Edinburgh
IVest Mains Rd.
RÆdinburgh EH9 3JW (UK)
Tel: 44 (31) 667-1081 x3569
Fax: 44 (31) 668-3184
Internet: ahfr@srv0.glg.edinburgh.ac.uk

Rodway, Katherine L.
Borehole Research Group
Lamont-Doherty Earth Observatory
Palisades, NY 10964 (US)
Tel: (914) 365-8672
Fax: (914) 365-3182
Internet: rodway@ldeo.columbia.edu

Röhl, Ursula
Bundesanstalt f. Geowiss. und Rohstoffe
Postfach 510153
D-30631 Hannover (G)
Tel: 49 (511) 643-2795
Fax: 49 (511) 643-2304
Internet: roehl@gate1.bgr.d400.de

Rosendahl, Bruce R.
Rosenstiel School of Marine & Atm. Sci.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149 (US)
Tel: (305) 361-4000
Fax: (305) 361-4711
Internet: brosendahl@rsmas.miami.edu

Rowe, Gilbert T.
Department of Oceanography
Texas A&M University
College Station, TX 77843 (US)
Tel: (409) 845-7211
Fax: (409) 845-6331

Rutland, Roye
Australian Geological Survey Organisation
GPO Box 378
Canberra, ACT 2601 (AUS)
Tel: 61 (6) 249-9111
Fax: 61 (6) 257-4614

Sager, William W.
Department of Oceanography
Texas A&M University
College Station, TX 77843-3146 (US)
Tel: (409) 845-9828
Fax: (409) 845-6331
Internet: sager@triton.tamu.edu

Saito, Tsunemasa
Institute of Geology and Paleontology
Faculty of Science
Tohoku University
Sendai, 980 (J)
Tel: 81 (22) 222-1800 x3419
Fax: 81 (22) 262-6609

Salisch, Henry
Centre for Petroleum Engineering
University of New South Wales
P.O. Box 1
Kensington, NSW 2033 (AUS)
Tel: 61 (2) 697-5191
Fax: 61 (2) 662-6640

Sarg, J. Frederick
Mobil Exploration Technology
P.O. Box 650232
Dallas, TX 75265-0232 (US)
Tel: (214) 951-3060
Fax: (214) 637-2310

Sartori, Renzo
Dipartmento di Scienze Geologiche
Università di Bologna
via Zamboni 65
I-40127 Bologna
Tel: 39 (51) 354 551
Fax: 39 (51) 354 522

Sayles, Frederick L.
Department of Chemistry
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 (US)
Tel: (508) 457-2000 x2561
Fax: (508) 457-2193

Schilling, Jean-Guy
School of Oceanography
University of Rhode Island
Kingston, RI 02881 (US)
Tel: (401) 792-6222
Fax: (401) 792-6160

Schmitt, Karen R.
JOIDES Planning Office
University of Washington (HA-30)
3731 University Way N.E.
Seattle, WA 98195 (US)
Tel: (206) 543-2203
Fax: (206) 543-6073
Internet: schmitt@ocean.washington.edu

Schuh, Frank J.
Drilling Technology Inc.
5808 Wavertree, Suite 1000
Plano, TX 75075 (US)
Tel: (214) 380-0203
Fax: (214) 386-2103

Scrutton, Roger
Grant Institute of Geology
University of Edinburgh
West Mains Road
Edinburgh EH9 3JW (UK)
Tel: 44 (31) 667-1081
Fax: 44 (31) 668-3184
Internet: egeo22@castle.ed.ac.uk

Shanks, F. Earl
Drilling Technology
Mobil Exploration and Prod. Serv. Inc.
P.O. Box 650232
Dallas, TX 75265-0232 (US)
Tel: (214) 951-3271
Fax: (214) 951-2512

Shanks, III, Wayne C.
U.S. Geological Survey
973 Denver Federal Center
Denver, CO 80225 (US)
Tel: (303) 236-2497
Fax: (303) 236-3200
Internet: pshanks@helios.cr.usgs.gov

Shatto, Howard L.
444 Knipp Oaks 1
Houston, TX 77024-5055 (US)
Tel: (713) 467-8616
Fax: (713) 465-1716

CIRES, Camp
University of Colorado
Boulder, CO 80309-0216 (US)
Tel: (303) 492-1143
Fax: (303) 492-1149
Internet: afs@cires.colorado.edu

Shipley, Thomas H.
Institute for Geophysics
University of Texas at Austin
8701 N Mopac Expressway
Austin, TX 78759-8397 (US)
Tel: (512) 471-6156
Fax: (512) 471-8844
Internet: tom@utig.ig.utexas.edu

Shor, Alexander N.
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230 (US)
Tel: (703) 306-1581
Fax: (703) 306-0390
Internet: ashor@nsf.gov

Sibuet, Jean-Claude
IFREMER
Centre de Brest
B.P. 70
F-29280 Plouzané Cedex
Tel: (33) 98 22 42 33
Fax: (33) 98 22 45 49
Internet: jcsibuet@ifremer.fr

Sinha, Martin
Department of Earth Sciences
Cambridge University, Bullard Labs.
Madingley Road
Cambridge CB3 0EZ (UK)
Tel: 44 (223) 333-406
Fax: 44 (223) 333-450

Skinner, Alister C.
Marine Geophys. & Offshore Serv. Progr.
British Geological Survey
Murchison House, West Mains Road
Edinburgh EH9 3LA (UK)
Tel: 44 (31) 667-1000
Fax: 44 (31) 668-2683

Skogseid, Jakob
Department of Geology
University of Oslo
P.B. 1047, Blindern
N-0316 Oslo
Tel: 47 (22) 85 66 63
Fax: 47 (22) 85 42 15
Internet: jakob.skogseid@geology.uio.no

Small, Lawrence F.
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, OR 97331-5503 (US)
Tel: (503) 737-5195
Fax: (503) 737-2064
Internet: lsmall@oce.orst.edu

Soh, Wonn
Institute of Geosciences
Shizuoka University, Oya
Shizuoka, 422 (J)
Tel: 81 (54) 237-1111 ex.5818
Fax: 81 (54) 238-0491

ices

Spall, Henry
Office of Scientific Publications
U.S.G.S., National Center, MS-904
12201 Sunrise Valley Drive
Reston, VA 22092 (US)
Tel: (703) 648-6078
Fax: (703) 648-6138
Internet: hspall@usgs.gov

Sparks, Charles
Institut Français du Petrole
Direction: exploitation en mer
1 et 4, avenue de Bois-Préau, B.P. 311
F-92506 Rueil-Malmaison Cedex
Tel: 33 (1) 4752-6395
Fax: 33 (1) 4752-7002
Internet: sparks@c1.ifp.fr

Srivastava, Shiri
Atlantic Geoscience Centre
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, N.S. B2Y 4A2 (CAN)
Tel: (902) 426-3148
Fax: (902) 426-6152
Internet: srivasta@agcrr.bio.ns.ca

Stagg, Howard
Marine Geosc. & Petroleum Geology Program
Australian Geological Survey Organisation
GPO Box 378
Canberra, ACT 2601 (AUS)
Tel: 61 (6) 249-9111
Fax: 61 (6) 257-4614

Steckler, Michael
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964 (US)
Tel: (914) 365-8479
Fax: (914) 359-2931
Internet: steckler@lamont.ldeo.columbia.edu

Stel, Jan H.
Netherlands Marine Res. Foundation (SOZ)
Laan van Nieuw Oost Indie 131
NL-2593 BM The Hague
Tel: 31 (70) 344-0780
Fax: 31 (70) 383-2173
Omnet: SOZ.Office

Stock, Joann M.
Seismological Laboratory 252-21
California Institute of Technology
Pasadena, CA 91125 (US)
Tel: (818) 356-6938
Fax: (818) 564-0715
Internet: jstock@seismo.gps.caltech.edu

Stokking, Laura
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-5218
Fax: (409) 845-0876
Internet: stokking@nelson.tamu.edu

Storms, Michael
ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845-9547 (US)
Tel: (409) 845-2101
Fax: (409) 845-2308
Internet: storms@nelson.tamu.edu

Sullivan, Lawrence
Borehole Research Group
Lamont-Doherty Earth Observatory
Palisades, NY 10964 (US)
Tel: (914) 365-8805
Fax: (914) 365-3182
Internet: sullivan@lamont.ldeo.columbia.edu

Summerhayes, C.P.
Deacon Laboratory
Institute of Oceanographic Sciences
Brook Road, Wormley, Godalming
Surrey GU8 5UB (UK)
Tel: 44 (42) 879-4141
Fax: 44 (42) 879-3066

Summerour, A.
Drilling Technology Center
Chevron Services Co.
2202 Oil Contor Court, PO Box 4450
Houston, TX 77073 (US)
Tel: (713) 230-2793
Fax: (713) 230-2669

Surlyk, Finn
Department of Geology
University of Copenhagen
Øster Voldgade 10
DK-1350 Copenhagen K
Tel: 45 35 32 26 26
Fax: 45 35 32 24 99

Suyehiro, Kiyoshi
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (J)
Tel: 81 (3) 5351-6439
Fax: 81 (3) 5351-6438
Internet: suyehiro@aix3.ori.u-tokyo.ac.jp

Svendsen, Walter W.
1276 Highview Drive
New Brighton, MN 55112 (US)

Symonds, Phillip
Division of Marine Geoscience
Australian Geological Survey Organization
GPO Box 378
Canberra, ACT 2601 (AUS)
Tel: 61 (6) 249-9490
Fax: 61 (6) 257-6041
Internet: p_symonds@frend.bmr.gov.au

Tada, Ryuji
Geological Institute
University of Tokyo
7-3-1 Hongo, Bunkyo-ku
Tokyo 113 (J)
Tel: 81 (3) 3812-2111, X4523
Fax: 81 (3) 3815-9490
Internet: ryuji@tsunami.geol.s.u-tokyo.ac.jp

Taira, Asahiko
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (J)
Tel: 81 (3) 5351-6437
Fax: 81 (3) 5351-6438
Internet: ataira@aix3.ori.u-tokyo.ac.jp

Takagawa, Shinichi
Deep Sea Technology Department
Japan Marine Sci & Tech Center (JAMSTEC)
2-15 Natsushima-cho
Yokosuka 237 (J)
Tel: 81 (468) 66-3811 ext.262
Fax: 81 (468) 66-0970

Takahashi, Kozo
Dept of Marine Sci & Tech, Sch of Engineering
Hokkaido Tokai University
5-1-1-1, Minamisawa, Minami-ku
Sapporo 005 (J)
Tel: 81 (11) 571-5111, x615
Fax: 81 (11) 571-7879

Tamaki, Kensaku
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (J)
Tel: 81 (3) 5351-6443
Fax: 81 (3) 5351-6445

Tarduno, John A.
Department of Geological Sciences
Hutchison Hall
University of Rochester
Rochester, NY 14627 (US)
Tel: (716) 275-2410 or 8810
Fax: (716) 244-5689
Internet: john@skyline.geology.rochester.edu

Taylor, Brian
School of Ocean & Earth Sci. & Tech.
University of Hawaii
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-6649
Fax: (808) 956-2538
Internet: taylor@mano.soest.hawaii.edu

Ten Brink, Uri
Branch of Atlantic Marine Geology
U.S. Geological Survey
Quissett Campus
Woods Hole, MA 02543 (US)
Tel: (508) 548-2396
Fax: (508) 457-2310
Internet: tenbrink@nobska.er.usgs.gov

Thomas, Ellen
Department of Geology and Geophysics
Yale University
Whitney Avenue
New Haven, CT 06511 (US)
Tel: (203) 432-3169
Fax: (203) 342-3134

Thorhallsson, Sverrir
Orkustofnun
Grensásvegur 9
IS-103 Reykjavik
Tel: 354 (1) 813-600
Fax: 354 (1) 688-896

Thurow, Jürgen
Institut für Geologie
Ruhr-Universität
Postfach 102148
D-44721 Bochum (G)
Tel: 49 (234) 700-2307
Fax: 49 (234) 700-3200
Internet: ruba.rz.ruhr-uni-bochum.d400.de

Tokuyama, Hidekazu
Ocean Research Institute
University of Tokyo
1-15-1 Minamidai, Nakano-ku
Tokyo 164 (J)
Tel: 81 (3) 5351-6441
Fax: 81 (3) 5351-6438
Internet: tokuyama@aix3.ori.u-tokyo.ac.jp

Toomey, Douglas
Department of Geology
University of Oregon
Eugene, OR 97403 (US)
Tel: (503) 346-5576
Fax: (503) 346-4692
Internet: drt@mazama.uoregon.edu

Tréhu, Anne M.
College of Oceanic & Atmospheric Sciences
Oregon State University
Oceanography Admin. Bldg. 104
Corvallis, OR 97331-5503 (US)
Tel: (503) 737-3504
Fax: (503) 737-2064
Internet: trehu@oce.orst.edu

Underwood, Michael B.
Department of Geologic Sciences
University of Missouri
Columbia, MO 65211 (US)
Tel: (314) 882-4685
Fax: (314) 882-5458
Internet: geoscmbu@mizzou1.missouri.edu

Valet, Jean-Pierre
Inst. de Physique du Globe
Université Pierre et Marie Curie
4, Place Jussieu, Tour 24-25
F-75252 Paris Cedex 05
Tel: 33 (1) 4427-3566
Fax: 33 (1) 4427-3373
Internet: valet@ipgp.jussieu.fr

Von Damm, Karen L.
Department of Earth Sciences
University of New Hampshire
Durham, New Hampshire 03824-3589 (US)
Tel: (603) 862-0142
Fax: (603) 862-2649
Internet: K_Vondamm@unhh.unh.edu

von der Borch, Chris
School of Earth Sciences
Flinders University
Bedford Park
South Australia 5042 (AUS)
Tel: 61 (8) 275-2212
Fax: 61 (8) 275-2676
Internet: mgcvv@cc.flinders.edu.au

Von Huene, Roland
GEOMAR
Research Center for Marine Geoscience
Wischhofstrasse 1-3, Geb. 4
D-24148 Kiel (G)
Tel: 49 (431) 720-2272
Fax: 49 (431) 720-2293
Int: ngm12@geomar.uni-kiel.d400.de

Vrellis, Gregory
Drilling Department
Public Petroleum Co., (DEP-EKY-S.A)
199 Kiffissias Avenue
GR-15124 Maroussi, Athens
Tel: 30 (1) 806-9314

Wadge, Geoff
NUTIS
University of Reading
P.O. Box 227, Whiteknights
Reading RH6 2AH (UK)
Tel: 44 (734) 318-741
Fax: 44 (734) 755-865

Watkins, James D.
Joint Oceanographic Institutions, Inc.
1755 Massachusetts Ave., N.W., Suite 800
Washington, DC 20036-2102 (US)
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: jwatkins@brook.edu

Watney, Lynn
Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047 (US)
Tel: (913) 864-3965
Fax: (913) 864-5053
Internet: watney@kuhub.cc.ukans.edu

Weaver, Philip P.E.
Institute of Oceanographic Sciences
Deacon Laboratory
Brook Rd., Wormley, Godalming
Surrey GU8 5UB (UK)
Tel: 44 (428) 794-141
Fax: 44 (428) 793-066

Weber, Jean-Bernard
Swiss National Science Foundation
Postfach 2338
CH-3001 Bern
Tel: 41 (31) 301 30 09
Fax: 41 (31) 308 22 22

Weis, Dominique
Lab. Ass. Géol., Pétrol., Geochron.
Université Libre de Brusselles
Av. F.D. Roosevelt 50
B-1050 Brusselles
Tel: 32 (2) 650-3748
Fax: 32 (2) 650-2226

Weissert, Helmut
Geological Institute
ETH-Zentrum
Sonneggstrasse 5
CH-8092 Zurich
Tel: 41 (1) 256-3715
Fax: 41 (1) 252-0819

Westgaard, Leif
Head, International Department
The Research Council of Norway
P.O. Box 2700 St. Hanshaugen
N-0131 Oslo
Tel: 47 (22) 03-70-00 or 03-71
Fax: 47 (22) 03-70-01

Wilkens, Roy
Hawaii Institute of Geophysics
University of Hawaii at Manoa
2525 Correa Road
Honolulu, HI 96822 (US)
Tel: (808) 956-5228
Fax: (808) 956-5373
Internet: wilkens@mano.soest.hawaii.edu

Williams, Adrian
Division of Geomechanics
CSIRO
P.O. Box 54
Mount Waverley, VIC 3149 (AUS)
Tel: 61 (3) 881-1355
Fax: 61 (3) 803-2052

Williams, D. Michael
Research Dept., Dallas Research Lab
Mobil Research and Development Corp.
P.O. Box 819047
Dallas, TX 75381-9047 (US)
Tel: (214) 851-8589
Fax: (214) 851-8185
Internet: dmwillia@dal.mobil.com

Wilson, Douglas S.
Department of Geological Sciences
University of California, Santa Barbara
Santa Barbara, CA 93106-9630 (US)
Tel: (805) 893-8033
Fax: (805) 893-2314
Internet: wilson@sbugel.ucsb.edu

Winterhalter, Boris
Geological Survey of Finland (GTK)
Kivimiehentie 1
SF-02150 Espoo 15
Tel: 359 (0) 469-31

Wohlenberg, J.
Angewandte Geophysik
RW Technische Hochschule
Lochnerstraße 4-20
D-52064 Aachen (G)
Tel: 49 (241) 804 825

Woodside, John
Inst. voor Aardwetenschappen
Vrije Universiteit
De Boelelaan 1085
NL-1081 HV Amsterdam
Tel: 31 (20) 548-5587
Fax: 31 (20) 646-2457
Internet: wooj@geo.vu.nl

Yagishita, Koji
Department of Geology
Iwate University
3-18-33 Uyeda
Morioka, 020 (J)
Tel: 81 (196) 235-171 ex.2430
Fax: 81 (196) 544-214

Yamano, Makoto
Earthquake Research Institute
University of Tokyo
1-1-1 Yayoi, Bunkyo-ku
Tokyo 113 (J)
Tel: 81 (3) 3812-2111
Fax: 81 (3) 3812-6979

Yilmaz, Yücel
Istanbul Teknik Üniversitesi
Maden Fakültesi
Maslak
TR-80626 Istanbul
Tel: 90 (1) 276 6060

Yin, An
Department of Earth & Space Sciences
UCLA
Mail Code: 156704
Los Angeles, CA 90024-1564 (US)
Internet: yin%fault.span@sdsc.edu

Zachos, James C.
Earth and Marine Sciences
University of California, Santa Cruz
Santa Cruz, CA 95064 (US)
Tel: (408) 459-4644
Fax: (408) 459-3074
Internet: jzachos@rupture.ucsc.edu

Zierenberg, Robert A.
Branch of Western Mineral Resources
U.S. Geological Survey
345 Middlefield Road, MS-901
Menlo Park, CA 94025 (US)
Tel: (415) 329-5437
Fax: (415) 329-5490
Internet: robert@mojave.wr.usgs.gov

Zinkgraf, Duke
6675 West Loop South, Suite 745
Bellaire, TX 77401 (US)
Tel: (713) 665-1700
Fax: (713) 665-7862

Acronym Dictionary

APC .... Advanced Piston Corer
ASRC .... Advisory Structure Review Committee
ASTC.. Association of Science and Technology Centers
BGS .... British Geological Survey
BHA .... bottom-hole assembly
BHTV .... borehole televiewer
BSR .... bottom-simulating reflector
CGC .... Canadian Geoscience Council
CHT .... cross-hole tomography
CSDP .... Continental Scientific Drilling Program
DCB .... diamond core barrel
DCS .... diamond coring system
DFG .... Deutsche Forschungsgemeinschaft
DI-BHA .... Drill-in bottom-hole assembly
DP .... dynamic positioning
DPG .... Detailed Planning Group
DRB .... diamond coring system retractable bit system
ECB .... extended Core Barrel
ECOD .... ESF Consortium for Ocean Drilling
ECR .... East Coast Repository
EMCO .... ESF Management Committee for ODP
EPR .... East Pacific Rise
ESCO .... ESF Scientific Committee for ODP
ESF .... European Science Foundation
FDSN .... Federation of Digital Seismic Networks
FMS .... formation microscanner
FY .... fiscal year
GCR .... Gulf Coast Repository
GEOSECS .... Geochemical Ocean Sections Study
GLOBEC .... Global Ocean Ecosystem Dynamics
GOOS .... Global Ocean Observing System
GSGP .... Global Sedimentary Geology Program
HRB .... hard-rock guide base
HRO .... hard-rock orientation
IDAS .... isothermal decompression analysis system
IILP .... International Lithosphere Program
IMT .... Institut Méditerranéen de Technologie
INSU .... Institut de Sciences de l'Univers
InterRidge .... International Ridge Inter-Disciplinary Global Experiments
IPOD .... International Phase of Ocean Drilling
IPR .... intellectual property rights
JAMSTEC .... Japan Marine Science and Technology Center
JAPEX .... Japan Petroleum Exploration Company
LAST .... lateral stress tool
LDEO .... Lamont-Doherty Earth Observatory
LIPS .... large igneous provinces
LRP .... Long Range Plan
mbsf .... meters below seafloor
MCS .... multi-channel seismic
MDCB .... motor-driven core barrel
MOU .... memorandum of understanding
MOR .... mid-ocean ridge
MRC .... Micropaleontological Reference Center
MST .... multi-sensor track
NAD .... North Atlantic Deepwater
NADP .... Nansen Arctic Drilling Program
NERC .... Natural Environment Research Council
NGDC .... National Geophysical Data Center
NSF .... National Science Foundation
OBS .... ocean bottom seismometer
ODPC .... Ocean Drilling Program Council
ORI .... Ocean Research Institute of Univ. of Tokyo
OSN .... Ocean Seismic Network
PCS .... pressure core sampler
PDC .... poly-crystalline diamond compact (drilling bit)
RFP .... request for proposals
RFQ .... request for quotes
SCM .... sonic core monitor
SCS .... single-channel seismic
SES .... sidewall-entry sub
SOE .... Special Operating Expense
STA .... Science and Technology Agency (of Japan)
TAMU .... Texas A & M University
USSAC .... US Scientific Advisory Committee
USSSP .... US Science Support Program
VPC .... vibra-percussive corer
VSP .... vertical seismic profile
WCR .... West Coast Repository
WG .... Working Group
WOB .... weight on bit
WSTP .... water sampler, temperature, pressure (downhole tool)

JOIDES Committees and Panels:

BCOM .... Budget Committee
DMP .... Downhole Measurements Panel
EXCOM .... Executive Committee
IHP Information Handling Panel
LITHP .... Lithosphere Panel
OHP .... Ocean History Panel
PANCM .... Panel Chairs Meeting
PCOM .... Planning Committee
PPSP .... Pollution Prevention and Safety Panel
SGPP.... Sedimentary and Geochemical Processes Panel
SMP .... Shipboard Mearurements Panel
SSP .... Site Survey Panel
TECP .... Tectonics Panel
TEDCOM .... Technology and Engineering Development Committee

Detailed Planning Groups (DPG) and Working Groups (WG):

NAAG-DPG .... North Atlantic-Arctic Gateways DPG (disbanded)
NARM-DPG .... North Atlantic Rifted Margins DPG (disbanded)
SWD-WG .... Shallow Water Drilling Working Group

FY93 Programs:

NAAG-I .... North Atlantic Arctic Gateways, first leg (Leg 151)
NARM Non-Volcanic I .... North Atlantic Rifted Margins non-volcanic, first leg (Leg 149)
NJ/MAT .... New Jersey / Middle Atlantic Transect (Leg 150)

FY94 Programs:

NARM Volcanic-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
TAG .... Trans-Atlantic Geotraverse Hydrothermal Field (leg 158)

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.

Internet Directory

Help us build better lines of electronic communication, send your Internet address to the JOIDES Office (joides@ocean.washington.edu). We will update this general purpose directory as space allows and will also include non-panel/committee members (Note: the ODP Directory beginning on p. 46 has complete address information only for the panels/committees/ODP-TAMU/ODP-LDEO/ODPC/NSF/JOI/International offices) A copy of this Internet list can be obtained electronically from the new JOIDES Office FTP site on moby2.ocean.washington.edu or IP number (128.95.252.41)

Adams, Johanna	jadams@brook.edu
Agar, Susan M.	agar@earth.nwu.edu
Aitchison, Jonathan	jona@es.su.oz.au
Allan, Jamie	allan@nelson.tamu.edu
Alt, Jeff	Jeff.Alt@um.cc.umich.edu
Altalo, Mary	maltalo@ucsd.edu
Alvarez, Ana Maria	anamaria@lamont.ldeo.columbia.edu
Anderson, John	johna@geophysics.rice.edu
Arculus, Richard	rarculus@basins.anu.edu.au
Ashi, Juichiro	ashi@tsunami.geol.s.u-tokyo.ac.jp
Astiz, Luciana	luciana@geophys.washington.edu
Austin, Jamie	jamie@utig.ig.utexas.edu
Australia ODP Secretariat	odp@une.edu.au
Backman, Jan	Backman@geologi.su.se
Bahr, Jean M.	jmbahr@geology.wisc.edu
Baker, Paul	pbaker@rogue.geo.duke.edu
Baldauf, Jack	Baldauf@nelson.tamu.edu
Ball, Mahlon	clausen@bpgsvr.cr.usgs.gov
Balser, R.	rbalser@elm.circa.ufl.edu
Barker, Peter	U_PFB@VAXC.NERC-BAS.AC.UK
Barnes, Deborah	barnes@ldeo.columbia.edu
Barrett, Peter	Peter.Barrett@vuw.ac.nz
Barron, J.A.	jbarron@isdmnl.wr.usgs.gov
Beck, John	Beck@nelson.tamu.edu
Becker, Keir	kbecker@rsmas.miami.edu
Beggs, Mac	srlnjmb@lhn.gns.cri.nz
Behl, Rick	behl@magic.geol.ucsb.edu
Beiersdorf, Helmut	beiersdorf@gate1.bgr.D400.de
Bentley, C.R.	bentley@geology.wisc.edu
Bloomer, Sherman	bloomer@crsa.bu.edu
Blum, Peter	Blum@nelson.tamu.edu
Borehole Research Group, LDEO	borehole@ldeo.columbia.edu
Brandt, Bjorn	bjorn@nfr.se
Brass, Garrett	GBrass@rsmas.miami.edu
Briden, James	jbriden@mail.nerc-swindon.ac.uk
Bridger, Don	dbridger@u.washington.edu
Bristow, Jim	jfb@le.ac.uk
Brocher, T.	brocher@andreas.menlo.usgs.gov
Broermann, James	james@hwr.arizona.edu
Broglia, Cristina	chris@ldeo.columbia.edu
Brown, Kevin M.	kmbrown@grdqmail.ucsd.edu
Brückmann, Warner	wbrueckmann@geomar.uni-kiel.d4
Brunner, Charlotte A.	cbrunner@whale.st.usm.edu
Burke, Kevin	kburke@uh.edu
Burns, Allison	aburns@brook.edu
Byrne, Fabiola	fabiola@nelson.tamu.edu
Cambray, Herve	cambray@imtmer1.imt-mrs.fr
Camerlenghi, Angelo	acam@itsogs.bitnet
Canadian ODP Secretariat	odp@kean.ucs.mun.ca
Cande, Steve	cande@gauss.ucsd.edu
Cannat, Mathilde	mac@ccr.jussieu.fr
Caress, Dave	caress@ldeo.columbia.edu
Carter, R.M.	glkgh@marlin.jcu.edu.au
Channell, Jim	JETC@nervm.nerdc.ufl.edu
Charles, C.D.	ccharles@ucsd.edu
Chivas, Allan	allan.chivas@anu.edu.au
Christie, Dave	dchristie@oce.orst.edu
Christie-Blick, Nicholas	ncb@lamont.ldeo.columbia.edu
Clark, R. Samuel	clark@ocean.washington.edu
Clement, Bradford	clementb@servax.fiu.edu
Clift, Peter	clift@nelson.tamu.edu
Coffin, Mike	mikec@coffin.ig.utexas.edu
Collins, William	collins@ocean.washington.edu
Coyne, John	Coyne@nelson.tamu.edu
Crawford, Tony	Tony.Crawford@geol.utas.edu.au
Curry, William	wcurry@whoi.edu
Dauphin, J. Paul	jdauphin@nsf.gov
Davies, Tom	tomd@utig.ig.utexas.edu
Dawson, Alastair G.	gex014@cck.coventry.ac.uk
de Cossio, Guillermo Diaz	colofox@cicese.mx
de Menocal, Peter B.	peter@ldeo.columbia.edu
Delaney, John	jdelaney@u.washington.edu
Delaney, Margaret	delaney@cats.ucsc.edu
Desbrandes, Robert N.	rnd@r3.pete.lsu.edu
Detrick, Bob	bobd@copper.whoi.edu
Dick, Henry	hdick@whoi.edu
Divins, David L.	dld@Rimmer.ngdc.noaa.gov
DMP Discussion Group	dmp@sandia.gov
Dorman, LeRoy M.	dorman@mpl.ucsd.edu
Dowsett, Harry J.	harry@limulus.er.usgs.gov
Draxler, Johann	draxler@gate1.bgr.d400.de
Droz, Laurence	ldroz@ifremer.fr
Duce, Robert	duce@triton.tamu.edu
Duncan, Bob	rduncan@oce.orst.edu
Eaton, Gordon	eaton@lamont.ldeo.columbia.edu
Eberli, Gregor	eberli@RCF.rsmas.miami.edu
Egeberg, P.K.	perke@adh.no
Eldholm, Olav	olav.eldholm@geologi.uio.no
Emeis, Kay-Christian	ngl20@rz.uni-kiel.d400.de
Emerick, Tina	tina@ocean.washington.edu
ESCO Secretariat	bj@dgu1.dgu.min.dk
Farrimond, Paul	Paul.Farrimond@newcastle.ac.uk
Filice, Frank	filice@ldeo.columbia.edu
Firth, John	firth@nelson.tamu.edu
Fisher, Andy	Fisher@gismo.geology.indiana.edu
Fisk, Martin	mfisk@oce.orst.edu
Forster, Craig	gg-cbf@pines.utah.edu
Fox, Jeff	jfox@gsosun1.gso.uri.edu
France ODP Secretariat	odpfr@ccr.jussieu.fr
France-Lanord, Christian	cfl@crpg.cnrs-nancy.fr
Francis, Tim	francis@nelson.tamu.edu
Frieman, Edward A.	efrieman@ucsd.edu
Fryer, Gerard	g.fryer@soest.hawaii.edu
Fryer, Patricia	patty@loihi.soest.hawaii.edu
Fujimoto, Hiromi	fujimoto@aix3.ori.u-tokyo.ac.jp
Gagosian, Robert	rgagosian@whoi.edu
Garrison, Robert	bobg@rupture.ucsc.edu
Geli, L.	geli@ifremer.fr
GEOMAR Postmaster, W. Weinrebe	ngm12@geomar.uni-kiel.dbp.de
Gerland, Sebastian	sgerland@AWI-Bremerhaven.DE
Germany ODP Office	roehl@gate1.bgr.dbp.de
Giarratano, Milly	milly@ldeo.columbia.edu
Gibson, Ian	igibson@sciborg.uwaterloo.ca
Gieskes, Joris	jgieskes@ucsd.edu
Gill, Jim	jgill@rupture.ucsc.edu
Ginsburg, R. N.	ginsburg@RCF.rsmas.miami.edu
Goldberg, David	goldberg@ldeo.columbia.edu
Green, Andy	agreen@camborne-school-of-mines.ac.uk
Grevemeyer, Ingo	grevemeyer@dkrz.d400.de
Grout, Ron	grout@nelson.tamu.edu
Hacker, Bradley	hacker@pangea.stanford.edu
Hall, Jeremy	jeremy@kean.ucs.mun.ca
Harrison, Christopher	CHarrison@rsmas.miami.edu
Harvey, Peter	pkh@leicester.ac.uk
Heath, Ross	rheath@u.washington.edu
Heinrichs, Don	dheinrichs@nsf.gov
Helsley, Charles	chuck@soest.hawaii.edu
Herbert, Tim	tim@cyclone2.ucsd.edu
Hertogen, Jan	fgeeA03@cc1.kuleuven.ac.be
Herzig, Peter	herzig@mineral.geowiss.ba-freiberg.d400.de
Hickman, Steve	hickman@thepub.wr.usgs.gov
Hinz, Karl	odp.ssp@gate1.bgr.dbp.de
Hirano, Tetsuya	ataira@aix3.ori.u-tokyo.ac.jp
Hirata, Naoshi	hirata@eri.u-tokyo.ac.jp
Hiscott, Rick	rhiscott@kean.ucs.mun.ca
Hobart, Mike	mhobart@mines.utah.edu
Hodell, David A.	hodell@nervm.nerdc.ufl.edu
Holbrook, Steve	steveh@azure.whoi.edu
Hovan, Steve	hovan@geomag.gly.fsu.edu
Huber, Brian	MNHpB007@sivm.si.edu
Humphris, Susan	ridge@copper.whoi.edu
InterRidge	intridge@u.washington.edu
Introne, Douglas	Introne@maine.maine.edu
Jackson, Julie	lar@aip.org
Jacobson, Randy	randy@tomcat.onr.navy.mil
Jansen, Eystein	eystein.jansen@geol.uib.no
Japan ODP Office	ataira@aix3.ori.u-tokyo.ac.jp
Jarrard, Richard	rich@westlog.utah.edu
Jenkins, Chris	chrisj@extro.ucc.su.oz.au
Johnson, David	glkgh@marlin.jcu.edu.au
Johnson, Paul	paul@ocean.washington.edu
JOI Inc.	joi@brook.edu
Jorgensen, Birgit	BJ@dgu1.dgu.min.dk
Jukes, Dee	dju@mail.nerc-swindon.ac.uk
Kappel, Ellen	ekappel@brook.edu
Karson, Jeff	jkarson@rogue.geo.duke.edu
Kastens, Kim	kastens@lamont.ldgo.columbia.edu
Kastner, Miriam	mkastner@ucsd.edu
Kay, Lin	R.Kay@mail.nerc-swindon.ac.uk
Kazuo, Kobayashi	kobayashik@mstkid.jamstec.go.jp
Kent, Dennis	dvk@lamont.ldeo.columbia.edu
Kidd, Robert	sglrbk@cardiff.ac.uk
Kinoshita, Chizuru	ataira@aix3.ori.u-tokyo.ac.jp
Klaus, Adam	klaus@nelson.tamu.edu
Kudrass, Hermann	kudrass@gate1.bgr.d400.de
Kueppers, Andreas	kueppers@gfz-potsdam.de
Kuramoto, Shin'ichi	kuramoto@gsjrstn.gsj.go.jp
Lancelot, Yves	Y.Lancelot@omnet.nasa.gov
Langseth, Marcus	langs@lamont.ldeo.columbia.edu
Larsen, Hans Christian	larsenhc@ggu.min.dk
Lazarus, Dave	gonzo@erdw.ethz.ch
Leckie, Mark	Leckie@ucsvax.ucs.umass.edu
Leeman, Bill	leeman@geophysics.rice.edu
Leinen, Margaret	mleinen@gsosun1.gso.uri.edu
Lewis, Brian	blewis@ocean.washington.edu
Lin, Jian	jian@galileo.whoi.edu
Linzell, Robert S.	bob@sunisis.nrlssc.navy.mil
LISTSERVER	ODP-L@TAMVM1.bitnet
Locker, Stan	slocker@msl1.marine.usf.edu
Lofts, J.C.	lcj@leicester.ac.uk
Loughridge, Michael	msl@mail.ngdc.noaa.gov
Ludden, John	luddenj@ere.umontreal.ca
Lyle, Mitchell	mitch@rowena.idbsu.edu
Lysne, Peter	pclysne@sandia.gov
Macgregor, Ian	imacgreg@nsf.gov
Macko, Stephen A.	sam8f@faraday.clas.virginia.edu
Maillard, Catherine	catherine.maillard@ifremer.fr
Malfait, Bruce	bmalfait@nsf.gov
Malmgren, Bjorn	mgibm@marine-geology.gu.se
Malpas, John	ODP@kean.ucs.mun.ca
Mann, Paul	paulm@utig.ig.utexas.edu
Marlow, Mike	mikem@octopus.wr.usgs.gov
Mart, Yossi	euben@vmsa.technion.ac.il
Maudire, Gilbert	gmaudire@ifremer.fr
Maxwell, Art	art@utig.ig.utexas.edu
Mayer, Larry	larry@atlantic.cs.unb.ca
McArthur, Andrew	amcarthu@uvvm.uvic.ca
Mcclain, Jim	mcclain@geology.ucdavis.edu
McDuff, Russ	mcduff@ocean.washington.edu
McKenzie, Judy	sediment@czheth5a.bitnet

McNutt, Marcia .... marcia@pooh.whoi.edu
Mefferd, Matt .... Mefferd@nelson.tamu.edu
Mercier de Lepinay, B. .... Mercier@mimosa.unice.fr
Merrill, Russ .... Merrill@nelson.tamu.edu
Metayer, Bernadette .... bmetayer@paris.ifremer.fr
Metcalfe, Ian .... imetcalfe@metz.une.edu.au
Mevel, Catherine .... cam@ccr.jussieu.fr
Meyer, Heinrich .... odp.ssp@gate1.bgr.d400.de
Meyer, Robert .... meyer@ice.geology.wisc.edu
Mikkelsen, Naja .... nm@dgu1.dgu.min.dk
Miller, D Jay .... jaymiller@nelson.tamu.edu
Miller, Stephen .... miller@rapa.geol.ucsb.edu
Mills, Bill .... mills@nelson.tamu.edu
Mix, Alan .... mix@oce.orst.edu
Moberly, Ralph .... rmoberly@soest.hawaii.edu
Moore, Greg .... moore@soest.hawaii.edu
Moore, J. Casey .... casey@java.ucsc.edu
Moore, Ted .... Ted.Moore@um.cc.umich.edu
Moores, Eldridge .... moores@garnet.ucdavis.edu
Moos, Daniel .... moos@pangea.stanford.edu
Moran, Kate .... moran@agcrr.bio.ns.ca
Moser, Kathy .... kathy@utig.ig.utexas.edu
Mountain, Greg .... mountain@ldeo.columbia.edu
Moy, Agatha .... moy@nelson.tamu.edu
Murton, Bramley .... bjm@unixa.nerc-wormley.ac.uk
Mutter, John .... jcm@lamont.ldeo.columbia.edu
Mwenifumbo, Jonathan .... jarako@gsc.emr.ca
Myhre, Annik .... annik.myhre@geologi.uio.no
Nakajima, Satoru .... satoru@tsunami.geol.s.u-tokyo.
Natland, Jim .... JNatland@rsmas.miami.edu
Nelson, Philip H. .... pnelson@musette.cr.usgs.gov
Niu, Yaoling .... niu@earthsciences.uq.edu.au
Normark, William .... wnormark@usgs.gov
Nowell, Arthur .... nowell@ocean.washington.edu
Orcutt, John .... john_orcutt@igppqm.ucsd.edu
Pariso, Janet .... pariso@ocean.washington.edu
Parson, Lindsay .... lmp@unixa.nerc-wormley.ac.uk
Pedersen, Laust B. .... lbp@geofys.uu.se
Pedersen, Tom .... tfp@unixg.ubc.ca
Perez-Estaun, Andres .... andres@asturias.ccu.uniovi.es
Peterson, Larry C. ...... PetersonL@rcf.rsmas.miami.edu
Pezard, Philippe .... pezard@imtmer1.imt-mrs.fr
Pillsbury, Dale .... pillsbury@oce.orst.edu
Piper, Dave .... dzpiper@mojave.wr.usgs.gov
Pisias, Nick .... pisias@oce.orst.edu
Plank, Terry .... tplank@geology.tn.cornell.edu
Pratson, Elizabeth .... beth@ldeo.columbia.edu
Prell, Warren .... wprell@oce.orst.edu
Pyle, Tom .... tpyle@brook.edu
Quoidbach, Daniel .. daniel@lamont.ldeo.columbia.edu
Rabinowitz, Phil .... moy@nelson.tamu.edu
Rack, Frank .... rack@atlantic.cs.unb.ca
Raleigh, Barry .... soest@soest.hawaii.edu
Ramarui, Jenny .... jramarui@brook.edu
Raymo, Maureen .... raymo@mit.edu
Rea, David .... David_Rea@um.cc.umich.edu
Reagan, Mary .... mreagan@brook.edu
Reudelhuber, Dan .... reudelhuber@nelson.tamu.edu
RIDGE Office .... ridge@copper.whoi.edu
Riedel, William R. .... wriedel@sdsioa.ucsd.edu
Robertson, Alastair ... AHFR@srv0.glg.edinburgh.ac.uk
Rodway, Katherine .... rodway@ldeo.columbia.edu
Röhl, Ursula .... roehl@gate1.bgr.d400.de
Rosendahl, Bruce .... brosendahl@rsmas.miami.edu
Ruppel, Carolyn D. .... cdr@galileo.whoi.edu
Ryan, Bill .... billr@lamont.ldeo.columbia.edu
Sager, WIll .... sager@triton.tamu.edu
Sandwell, Dave .... sandwell@baltica.ucsd.edu
Sawyer, Dale .... dale@zephyr.rice.edu
Schaaf, Andre .... aschaaf@illite.u-strasbg.fr
Schlische, Roy .... schlisch@gandalf.rutgers.edu
Schmitt, Karen .... schmitt@ocean.washington.edu
Scrutton, Roger .... egeo22@castle.ed.ac.uk
Sempere, Jean-Christophe
.... sempere@ocean.washington.edu
Shackleton, N.J. .... NJS5@phoenix.cambridge.ac.uk
Shanks, Wayne .... pshanks@helios.cr.usgs.gov
Sharpton, Buck .... sharpton@lpi.jsc.nasa.gov
Sheehan, Anne F. .... afs@cires.colorado.edu
Sherin, Andy .... sherin@agcrr.bio.ns.ca
Shipley, Tom .... tom@utig.ig.utexas.edu
Shor, Sandy .... ashor@nsf.gov
Sibuet, Jean-Claude .... jcsibuet@ifremer.fr
Simoneit, Bernd .... bmcvicar@oce.orst.edu
Simpson, Mike .... mike@elepaio.soest.hawaii.edu
Site Survey Data Bank odp@lamont.ldeo.columbia.edu
Skinner, Alister .. E_ACS@vaxa.NERC-murchison.ac.uk
Skogseid, Jakob .... jakob.skogseid@geologi.uio.no
Small, Lawrence .... lsmall@oce.orst.edu
Smit, Jan .... smit@geo.vu.nl
Sondergeld, Carl H. .... csondergeld@amoco.com
Spall, Henry .... hspall@usgs.gov
Sparks, Charles .... sparks@cl.ifp.fr
Spencer, Khal .... khal@soest.hawaii.edu
Srivastava, Shiri .... srivasta@agcrr.bio.ns.ca
Steckler, Mike .... steckler@lamont.ldeo.columbia.edu
Stel, Jan .... SOZ.office@omnet.nasa.gov
Stock, Joann .... jstock@seismo.gps.caltech.edu
Stokking, Laura .... stokking@nelson.tamu.edu
Storms, Michael A. .... storms@nelson.tamu.edu
Stott, Lowell .... stott@gamera.usc.edu
Stroh, Trileigh .... intridge@u.washington.edu
Sullivan, Larry .... sullivan@ldeo.columbia
Suyehiro, Kiyoshi .... suyehiro@aix3.ori.u-tokyo.ac.jp
Swart, P.K. .... PSwart@rsmas.miami.edu
Symonds, Phil .... p_symonds@frend.bmr.gov.au
Tada, Ryuji .... ryuji@tsunami.geol.s.u-tokyo.ac.jp
Taira, Asahiko .... ataira@aix3.ori.u-tokyo.ac.jp
Talwani, Manik .... manik@gtri4.harc.edu
Tarduno, John .... john@skyline.geology.rochester.edu
Taylor, Brian .... taylor@mano.soest.hawaii.edu
Ten Brink, Uri .... tenbrink@nobska.er.usgs.gov
Thiede, Jorn .... JThiede@GEOMAR.uni-kiel.dbp.de
Thomas, E. .... ethomas@wesleyan.bitnet
Thurow, Jürgen ruba.rz.ruhr-uni-bochum.d400.de
Tokuyama, Hidekazu tokuyama@aix3.ori.u-tokyo.ac.jp
Toomey, Doug .... drt@mazama.uoregon.edu
Trehu, Anne .... trehu@oce.orst.edu
UK ODP Office .... r.kay@mail.nerc-swindon.ac.uk
Underwood, Michael
.... geoscmbu@mizzou1.missouri.edu
Uyeda, Seiya .... seiya.uyeda@tamu.edu
Valet, Jean-Pierre .... valet@ipgp.jussieu.fr
van der Pluijm, Ben A. ...... vdpluijm@um.cc.umich.edu
Vollbrecht, Ruediger .... rvollbr@gwdgv1.dnet.gwdg.de
Von Damm, Karen .... K_VonDamm@unhh.unh.edu
Von Herzen, Richard .... rvonh@red.whoi.edu
von der Borch, Chris .... mgcvv@cc.flinders.edu.au
von Huene, Roland
.... ngm12@geomar.uni-kiel.d400.de
von Rad, Ulrich .... vonrad@gate1.bgr.d400.de
Waasbergen, Robert Van .... robert@baltica.UCSD.EDU
Wallin, E. Timothy .... etw@nevada.edu
Watkins, James .... jwatkins@brook.edu
Watney, Lyn .... Watney@kuhub.cc.ukans.edu
Watts, Tony .... tony@earth-sciences.oxford.ac.uk
Weatherford, Linda ...... weatherford@nelson.tamu.edu
Webb, Shaune .... webb@nelson.tamu.edu
Weis, D. .... ulbg129@bbrnsf11.bitnet
Wessel, Paul .... gmt@soest.hawaii.edu
Whitmarsh, Robert ..... RBW@ibma.nerc-wormley.ac.uk
Wilcock, Will .... wilcock@ocean.washington.edu
Wilkens, Roy .... wilkens@mano.soest.hawaii.edu
Williams, D. Michael .... dmwillia@dal.mobil.com
Wilson, D.S. .... wilson@sbugel.ucsb.edu
Winterer, Jerry .... jwinterer@ucsd.edu
Wise, Sherwood .... wise@geomag.gly.fsu.edu
Woodside, John .... wooj@geo.vu.nl
Yasuda, Memorie .... myasuda@sdcc3.ucsd.edu
Yin, An .... yin%fault.span@Sdsc.Edu
Zachos, Jim .... jzachos@rupture.UCSC.EDU
Zierenberg, Bob .... robert@mojave.wr.usgs.gov
Zoback, Mark .... zoback@pangea.stanford.edu

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
Login: anonymous
Password: your userid

Subdirectory	Contents
/pub/JOIDES/Directory	*JOIDES Journal* Directory addresses
/pub/JOIDES/Meetings	JOIDES Meeting schedules
/pub/JOIDES/Minutes	JOIDES Panel minutes
/pub/JOIDES/Proposals	site summary forms and proposal submission guidelines
/pub/JOIDES/Reports	Reports from JOIDES committees and panels

See you again in October.....

The next issue (June 1994) of the JOIDES Journal will be a special issue. A new *Guide to the Ocean Drilling Program* will be produced and distributed in place of our regular June issue.

Publication Statement

The *JOIDES Journal* is edited at the JOIDES Office by Karen Schmitt; Bill Collins is the ODP International News, Liaison Group News and ODP Proposal News reporter, Sam Clark produces the ODP Directory. The JOIDES Office is located at the School of Oceanography, HA-30, University of Washington, Seattle, WA 98195
(Internet = joides@ocean.washington.edu)

The *JOIDES Journal* is printed and distributed by the Joint Oceanographic Institutions (JOI), Inc., Washington, D.C., for the Ocean Drilling Program (ODP) under the sponsorship of the National Science Foundation and participating countries. The material is based upon research supported by the National Science Foundation under Prime Contract OCE 83-17349.

The purpose of the *JOIDES Journal* is to serve as a means of communication among the JOIDES advisory structure, the National Science Foundation, the Ocean Drilling Program, JOI subcontractors thereunder, and interested earth scientists. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Publication History

The *JOIDES Journal* is published in yearly volumes which normally consist of three issues published in February (No. 1), June (No. 2), and October (No. 3). Publication commenced in 1975 with Volume I and has continued since then.

In addition, there are occasional special issues of the *JOIDES Journal* which are listed below:

Special Issue No. 1: Manual on Pollution Prevention and Safety, 1976 (Vol. II)
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)

JOIDES Office

Science Planning

School of Oceanography
Univ. of Washington, HA-30
Seattle, WA 98195 (US)
Tel: (206) 543-2203
Fax: (206) 685-7652
Internet:
joides@ocean.washington.edu

Proposal submissions—JOIDES Journal editor

JOI, Inc.

Prime Contractor

Joint Oceanographic Institutions Inc.
1755 Mass. Ave, NW Suite 800
Washington, DC 20036 (US)
Tel: (202) 232-3900
Fax: (202) 232-8203
Internet: joi@brook.edu

ODP publications—JOIDES Journal distribution

ODP/TAMU

Science Operations

ODP/Texas A&M University
1000 Discovery Drive
College Station, TX 77845 (US)
Tel: (409) 845-2673
Fax: (409) 845-4857
Internet:
moy@nelson.tamu.edu

ODP/DSDP sample requests — Leg staffing

ODP/LDEO

Wireline Logging Services

Borehole Research Group
Lamont-Doherty Earth Observatory
Palisades, NY 10964 (US)
Tel: (914) 365-8672
Fax: (914) 365-3182
Internet:
borehole@ldeo.columbia.edu

Logging information — Logging Schools

JOIDES Meeting Schedule

Date	Place	Panel
March 7 - 9, 1994	College Station, TX	TEDCOM
March 7 - 9, 1994	College Station, TX	SGPP
March 7 - 9, 1994	Washington, DC	BCOM
March 9 - 11, 1994	College Station, TX	IHP
March 10 - 11, 1994	College Station, TX	Com. RFP Eval.
March 10 - 12, 1994	Kona, HI	TECP
March 24 - 25, 1994	Bridgetown, Barbados	PPSP
March 28 - 30, 1994	College Station, TX	SMP
March 28 - 30, 1994	Bergen. Norway	LITHP
March 29 -31, 1994	Amherst, MA	OHP
April 13 - 15, 1994	Brest, France	SSP
April 18 - 21, 1994	Cardiff, Wales	PCOM
* May 17 - 19, 1994	Uppsala, Sweden	DMP
May 18 - 19, 1994	College Station, TX	Com. RFP Eval.
June 27 - 30, 1994	Washington, D.C.	EXCOM
* July 1994	Palisades, NY	SSP
August 8 - 12, 1994	Reykjavik	PCOM
* September 1994	Las Palmas, The Canaries	SMP
* Sept. 27- 29, 1994	Townsville, Australia	OHP
* October 1994	Fukuoka, Japan	SGPP
* November 1994	Palisades, NY	SSP

* Meeting not yet formally requested and approved

JOIDES Resolution Operations Schedule

Leg	Destination	Cruise Dates *	In Port †	Total days	Transit	On Site
154	Ceara Rise	Jan. 29 - Mar. 25, 1994	Barbados, Jan. 24 - 28, 1994	56	9	46
155	Amazon Fan	Mar. 29 - May 24, 1994	Barbados, Mar. 25 - 28, 1994	56	7	49
156	N. Barbados Ridge	May 29 - July 24, 1994	Barbados, May 24 - 28, 1994	56	1	55
157	VICAP/MAP	July 29- Sept. 23, 1994	Barbados, July 24 - 28, 1994	56	12	44
158	TAG	Sept. 28- Nov. 23, 1994	Las Palmas, Sept. 23-27, 1994	56		
	Transit and drydock					
159	Site 735	Jan. - Feb. 1995	Capetown	56	16	40
160	Eq. Atlantic Transform	March - April 1995	Capetown	56	15	41
161	Mediterranean I	May - June 1995	Dakar	56	18	38
162	Mediterranean II	July - August 1995	Napoli	56	11	45
163	Atl. Arctic Gate. II ø	Sept. - Oct. 1995	Aberdeen	56	15	41
164	Gas Hydrates	Nov. - Dec. 1995	Reykjavik	56	13	43
165	DCS Engineering	Jan. - Feb. 1996	Miami	56		

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

* The precise dates of Legs 159 - 165 cannot be determined until the drydock port has been fixed.

ø The Arctic Gateways leg may be inserted between the Mediterranean legs if that gives a better ice/weather window.