31 March 1995

The Ocean Drilling Program is exploring new territory with this volume. You will find an electronic version of the Leg 151 *Initial Reports* volume on the CD-ROM in the back of the book. Please note that a few figures are not included because we could not get them into electronic form; however, the electronic book duplicates most of the printed version.

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The CD-ROM also includes ASCII files of data which could not be printed in Volume 151, and other data files from Volume 153.

The Table of Contents printed in the book includes information about the directory structure of the CD-ROM. Please see the README files on the CD for additional information.

PLEASE NOTE: If you received a copy of Volume 152 *Initial Reports*, please check to see if you have the correct CD-ROM in the volume. If you do not, contact the Chief Production Editor at the above address.

PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

VOLUME 153

INITIAL REPORTS

MID-ATLANTIC RIDGE

Covering Leg 153 of the cruises of the Drilling Vessel *JOIDES Resolution*,
St. John's Harbor, Newfoundland, to Bridgetown, Barbados, Sites 920–924,
22 November 1993–20 January 1994

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in cooperation with the
NATIONAL SCIENCE FOUNDATION
and
JOINT OCEANOGRAPHIC INSTITUTIONS, INC.

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Foreword

By the National Science Foundation

The National Science Foundation is proud to play a leading role in partnership with the U.S. oceanographic community in the operation and management of the Ocean Drilling Program (ODP). We are equally proud of the cooperation and commitment of our international partners, who contribute both financial and intellectual resources required to maintain the high quality of this unique program. The Ocean Drilling Program, like its predecessor, the Deep Sea Drilling Project (DSDP), is a model for the organization and planning of research to address global scientific problems that are of high priority internationally and of long-term interest to the scientific community and general public.

Major scientific themes guiding the development of specific drilling cruises range from determining the causes and effects of oceanic and climatic variability to understanding the circulation of fluids in the ocean crust and the resultant formation of mineral deposits. Although such studies are at the forefront of basic scientific inquiry into the processes that control and modify the global environment, they are equally important in providing the background for assessing man's impact on the global environment or for projecting resource availability for future generations.

The transition from the DSDP to the ODP was marked by a number of changes. The 471-foot *JOIDES Resolution,* which replaced the *Glomar Challenger,* has allowed larger scientific parties and the participation of more graduate students, a larger laboratory and technical capability, and operations in more hostile ocean regions. The *JOIDES Resolution* has drilled in all of the world's oceans, from the marginal ice regions of the Arctic to within sight of the Antarctic continent. Over 1,200 scientists and students from 26 nations have participated on project cruises. Cores recovered from the cruises and stored in ODP repositories in the United States and Europe have provided samples to an additional 1,000 scientists for longer term post-cruise research investigations. The downhole geochemical and geophysical logging program, unsurpassed in either academia or industry, is providing remarkable new data with which to study the Earth.

In 1994, NSF and our international partners renewed our commitment to the program for its final phase. Of the 20 countries that supported ODP initially, only one, Russia, has been unable to continue for financial reasons. As the reputation and scientific impact of the program continue to grow internationally, we hope to add additional members and new scientific constituencies. This global scientific participation continues to assure the program's scientific excellence by focusing and integrating the combined scientific knowledge and capabilities of its member nations.

We wish the program smooth sailing and good drilling!

Neal Lane
Director
National Science Foundation

Arlington, Virginia

Foreword

By Joint Oceanographic Institutions, Inc.

This volume presents scientific and engineering results from the Ocean Drilling Program (ODP). The papers presented here address the scientific and technical goals of the program, which include providing a global description of geological and geophysical structures including passive and active margins and sediment history, and studying in detail areas of major geophysical activity such as mid-ocean ridges and the associated hydrothermal circulations.

The Ocean Drilling Program, an international activity, operates a specially equipped deep-sea drilling ship, the *JOIDES Resolution* (Sedco/BP 471), which contains state-of-the-art laboratories, equipment, and computers. The ship is 471 feet (144 meters) long, is 70 feet (21 meters) wide, and has a displacement of 18,600 short tons. Her derrick towers 211 feet (64 meters) above the waterline, and a computer-controlled dynamic-positioning system stabilizes the ship over a specific location while drilling in water depths up to 27,000 feet (8230 meters). The drilling system collects cores from beneath the seafloor with a derrick and drawworks that can handle 30,000 feet (9144 meters) of drill pipe. More than 12,000 square feet (1115 square meters) of space distributed throughout the ship is devoted to scientific laboratories and equipment. The ship sails with a scientific and technical crew of 51 and a ship's crew (including the drill crew) of 62. The size and ice-strengthening of the ship allow drilling in high seas and ice-infested areas as well as permit a large group of multidisciplinary scientists to interact as part of the scientific party.

Logging, or measurements in the drilled holes, is an important part of the program. ODP provides a full suite of geochemical and geophysical measurements for every hole deeper than 1300 feet (400 meters). For each such hole, there are lowerings of basic oil-industry tools: nuclear, sonic, and electrical. In addition, a borehole televiewer is available for imaging the wall of the hole, a 12-channel logging tool provides accurate velocity and elastic property measurements as well as sonic waveforms for spectral analysis of energy propagation near the wall of the hole, and a vertical seismic profiler can record reflectors from below the total depth of the hole.

The management of the Ocean Drilling Program involves a partnership of scientists and governments. International oversight and coordination are provided by the ODP Council, a governmental consultative body of the partner countries, which is chaired by a representative from the United States National Science Foundation. The ODP Council periodically reviews the general progress of the program and discusses financial plans and other management issues. Overall scientific and management guidance is provided to the operators of the program by representatives from the group of institutions involved in the program, called the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES).

The Executive Committee (EXCOM), made up of the administrative heads of the JOIDES institutions, provides general oversight for ODP. The Planning Committee (PCOM), with its advisory structure, is made up of working scientists and provides scientific advice and detailed planning. PCOM has a network of panels and working groups that screen drilling proposals, evaluate instrumentation and measurement techniques, and assess geophysical-survey data and other safety and siting information. PCOM uses the recommendations of the panels and committees to select drilling targets, to specify the location and major scientific objectives of each two-month drilling segment or leg, and to provide the science operator with nominations for co-chief scientists.

Joint Oceanographic Institutions, Inc. (JOI), a nonprofit consortium of U.S. oceanographic institutions, serves as the National Science Foundation's prime contractor for ODP. JOI is responsible for seeing that the scientific objectives, plans, and recommendations of the JOIDES committees are translated into scientific operations consistent with scientific advice and budgetary constraints. JOI subcontracts the operations of the program to two universities: Texas A&M University and Lamont-Doherty Earth Observatory of Columbia University. JOI is also responsible for managing the U.S. contribution to ODP.

Texas A&M University (TAMU) serves as science operator for ODP. In this capacity, TAMU is responsible for planning the specific ship operations, actual drilling schedules, and final scientific rosters, which are developed in close cooperation with PCOM and the relevant panels. The science operator also ensures that adequate scientific analyses are performed on the cores by maintaining the shipboard scientific laboratories and computers and by providing logistical and technical support for shipboard scientific teams. Onshore, TAMU manages scientific activities after each leg, is curator for the cores, distributes samples, and coordinates the editing and publication of scientific results.

Lamont-Doherty Earth Observatory (LDEO) of Columbia University is responsible for the program's logging operation, including processing the data and providing assistance to scientists for data analysis. The ODP Data Bank, a repository for geophysical data, is also managed by LDEO.

Core samples from ODP and the previous Deep Sea Drilling Project are stored for future investigation at four sites: ODP Pacific and Indian Ocean cores at TAMU, DSDP Pacific and Indian Ocean cores at the Scripps Institution of Oceanography, ODP and DSDP Atlantic and Antarctic cores through Leg 150 at LDEO, and ODP Atlantic and Antarctic cores since Leg 151 at the University of Bremen, Federal Republic of Germany.

Scientific achievements of ODP include new information on early seafloor spreading and how continents separate and the margins evolve. The oldest Pacific crust has been drilled and sampled. We have new insights into glacial cycles and the fluctuations of ocean currents throughout geological time. Many of the scientific goals can be met only with new technology; thus the program has focused on engineering as well as science. To date, ODP engineers have demonstrated the capability to drill on bare rock at mid-ocean-ridge sites and have developed techniques for drilling in high-temperature and corrosive regions typical of hydrothermal vent areas. A new diamond coring system promises better core recovery in difficult areas.

In addition, ODP is cooperating closely with other geological and geophysical programs; for example, in 1991 the first hole was drilled by ODP for emplacement of a seismometer near Hawaii for the Ocean Seismic Network. JOI is pleased to have been able to play a facilitating role in the Ocean Drilling Program and its cooperative activities, and we are looking forward to many new results to come.

D. James Baker
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VOLUME 153—INITIAL REPORTS

Back Pocket
Leg 153 Mid-Atlantic Ridge CD-ROM

The accompanying CD-ROM for this volume (back pocket) contains the following directories: SPREADS, TEXTSUM, STRUCTURE, STRCDRAW, DEPTH, PMAGDATA, and MISC153. GRAPE, magnetic susceptibility, and index properties data supplied from the ODP Database Group are also reported on the CD-ROM; configuration of these data appears in the latter part of this list.

Files on this CD-ROM are generally text files readable by word processors and spreadsheets. Refer to the README file on the CD-ROM for access documentation.

SPREADS includes text versions of the linked spreadsheets (also called VCDs) described in the "Linked Spreadsheets and Database" section of the "Explanatory Notes" chapter of the Leg 153 *Initial Reports* volume. Those that are saved as text files having all links between the spreadsheets have been lost. The data should be complete because each was updated at the end of the cruise.

TEXTSUM contains the text of all section summaries for each hole generated immediately after core descriptions. It contains subdirectories for each site.

STRUCTURE contains subdirectories 92x_LOGS, REPT92x, THINSECT, KEYS, STR_DIP, and EXPLNOTE. 92x_LOGS (one for each site, Sites 920–924) contain the final versions of the detailed structural spreadsheets with the data for each feature noted in the core. In many cases a sorted spreadsheet is also included. REPT92x includes compressed archives of the figures for the *Initial Reports* and shipboard core descriptions. The files were compressed with the Stuffit 1.5.1 utility for the Macintosh. EXPLNOTE includes the equivalent archive for the "Explanatory Notes." THINSECT contains spreadsheets and text summaries of the structural notes for the thin sections made aboard the *JOIDES Resolution*. KEYS includes spreadsheets and text describing the codes and identifiers used on the detailed spreadsheets. STR_DIP contains the original apparent dip data from the detailed structure spreadsheets, the true strike and dip as calculated from the data, and the program used to convert the data. The converted true strike and dip data are saved in spreadsheet form and in a form formatted for easy input into the shareware Allmindinger Stereonet program for the Macintosh. LinesToPlane, a utility program to convert two apparent dips as recorded on the spreadsheets into a true strike and dip, is archived in Stuffit 1.5.1 format. Documentation and test data are included with the program.

STRCDRAW contains scanned images (in TIFF format) of the drawings made by the structural geologists of each section of recovered core. The drawings are significantly more detailed than the barrel sheets published in the *Initial Reports* volume and contain the location of each feature measured on the structure spreadsheets noted above and in the "Explanatory Notes" of this volume.

DEPTH includes the template, macro, corelog database, and spreadsheets used for calculating depths on a piece by piece basis for each hole. These spreadsheets were used by the structural geologists on board to add depth data to the detailed structure spreadsheets.

PMAGDATA contains all paleomagnetic data recorded on board, including raw AMS data, half core NRM and susceptibility, discrete sample demagnetization measurements, summary tables, and archived figures from summary reports.

MISC153 contains subdirectories GENFINAL, SITESURV, 153_COR, and SPLLISTS.

GENFINAL includes XRF and XRD data for all samples measured, a list of color photographs taken for all cores, and a summary sample list for all shipboard samples.

ODP Leg 153 Data (from ODP Database Group)

README document

SITE # subdirectory

HOLE # subdirectory

GRAPE data file

INDEX data file

MAGSUS data file

GRAPE documentation file

Index properties documentation file

Magnetic susceptibility documentation file

All ASCII data files are TAB delimited for compatibility with most spreadsheet and database programs. All ASCII documentation files should be compatible with any word processing program.

Summary of ODP Core Data

- Site 920
  - Hole 920B
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 920D
    - Grape.dat
    - Index.dat
    - Magsus.dat
- Site 921
  - Hole 921A
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 921B
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 921C
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 921D
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 921E
    - Grape.dat
    - Index.dat
    - Magsus.dat
- Site 922
  - Hole 922A
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 922B
    - Grape.dat
    - Index.dat
    - Magsus.dat
- Site 923
  - Hole 923A
    - Grape.dat
    - Index.dat
    - Magsus.dat
- Site 924
  - Hole 924B
    - Grape.dat
    - Index.dat
    - Magsus.dat
  - Hole 924C
    - Grape.dat
    - Index.dat
    - Magsus.dat

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The Leg 153 Shipboard Scientific Party thanks Captain Tom Ribbens and the officers and crew of the *JOIDES Resolution (SEDCO/BP 471)* and the Ocean Drilling Program (ODP) staff for helping make our drilling in the slow-spreading crust of the Mid-Atlantic Ridge a success. We thank Operations Superintendent Tom Pettigrew, Special Engineer Leon Holloway, Drilling Superintendent Bob Caldow, and the rig floor crew for their efforts in probing the plutonic foundation of the oceanic crust.

We also thank the marine technical staff who made it possible for the Shipboard Scientific Party to describe, analyze, and sample the 260 m of hard-rock core recovered. These rocks promise to shed new light on the processes by which mantle melting and crustal accretion produce new oceanic lithosphere at the Mid-Atlantic Ridge.

We gratefully acknowledge the contributions of Dr. J.-M. Auzende and Dr. C. Mével who served as chief scientists on recent *Nautile* submersible studies of the area. Dr. Mével was also a proponent on the ODP proposal that made this drilling leg possible.

Finally, we wish to thank the ODP editorial staff who put this volume together.