

PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

VOLUME 114
INITIAL REPORTS

SUBANTARCTIC SOUTH ATLANTIC

Covering Leg 114 of the cruises of the Drilling Vessel *JOIDES Resolution*,
East Cove, Falkland Islands, to Port Louis, Mauritius, Sites 698-704,
11 March 1987-13 May 1987

Paul F. Ciesielski, Yngve Kristoffersen, Bradford Clement,
Jean-Pierre Blangy, Robert Bourrouilh, Jason A. Crux, Juliane M. Fenner,
Philip N. Froelich, Ernest Hailwood, David Hodell, Miriam E. Katz,
Hsin Yi Ling, Jürgen Mienert, Daniel Müller, C. Jonathan Mwenifumbo,
David C. Nobes, Marisa Nocchi, Detlef A. Warnke, and Frances Westall
Participating Scientists

Bradford Clement
Shipboard Staff Scientist

Elsa Kapitan Mazzullo
Editor

Prepared by the
OCEAN DRILLING PROGRAM
Texas A&M University
in cooperation with the
NATIONAL SCIENCE FOUNDATION
and
JOINT OCEANOGRAPHIC INSTITUTIONS, INC.

This publication was prepared by the Ocean Drilling Program, Texas A&M University, as an account of work performed under the international Ocean Drilling Program, which is managed by Joint Oceanographic Institutions, Inc., under contract with the National Science Foundation. Funding for the program was provided by the following agencies at the time of this cruise:

Department of Energy, Mines and Resources (Canada)

Deutsche Forschungsgemeinschaft (Federal Republic of Germany)

Institut Français de Recherche pour l'Exploitation de la Mer (France)

National Science Foundation (United States)

Natural Environment Research Council (United Kingdom)

University of Tokyo, Ocean Research Institute (Japan)

Any opinions, findings, and 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, the participating agencies, Joint Oceanographic Institutions, Inc., Texas A&M University, or Texas A&M Research Foundation.

It is recommended that reference to the whole or to part of this volume be made in one of the following forms, as appropriate:

Ciesielski, P. F., Kristoffersen, Y., et al., 1988. *Proc. ODP, Init. Repts.*, 114: College Station, TX (Ocean Drilling Program).

Brenner, C., and LaBrecque, J., 1988. Bathymetry of the Georgia basin and environs. *In* Ciesielski, P. F., Kristoffersen, Y., et al., *Proc. ODP, Init. Repts.*, 114: College Station, TX (Ocean Drilling Program), - .

Shipboard Scientific Party, 1988. Site 699. *In* Ciesielski, P. F., Kristoffersen, Y., et al., 1988. *Proc. ODP, Init. Repts.*, 114: College Station, TX (Ocean Drilling Program), - .

Effective Publication Dates of ODP *Proceedings*

According to the International Code of Zoological Nomenclature, the date of publication of a work and of a contained name or statement affecting nomenclature is the date on which the publication was mailed to subscribers, placed on sale, or when the whole edition is distributed free of charge, mailed to institutions and individuals to whom free copies are distributed. The mailing date, *not the printed date*, is the correct one.

The mailing dates of recent *Proceedings of the Ocean Drilling Program* are as follows:

Volume 107 (*Initial Reports*): October 1987

Volume 108 (*Initial Reports*): March 1988

Volumes 106/109/111 (*Initial Reports*): March 1988

Volume 110 (*Initial Reports*): April 1988

Volume 112 (*Initial Reports*): August 1988

Volume 113 (*Initial Reports*): September 1988

Distribution

Copies of this publication may be obtained from Publications Distribution Center, Ocean Drilling Program, 1000 Discovery Drive, College Station, Texas 77840. Orders for copies will require advance payment. See current ODP publication list for price and availability of this publication.

Printed November 1988

ISSN 0884-5883

Foreword

By the National Science Foundation

The scientists of the Ocean Drilling Program (ODP) have embarked on what could prove to be one of the most important earth science initiatives of the decade—an initiative rivaling in scope and impact the exploration of the frontiers of outer space. The program explores our planet's last frontier—the Earth's structure and history as it is revealed beneath the oceans. The scope of the program's scientific goals excites the imagination, challenges the intellect, and enhances the spirit of cooperation among peoples in countries around the world.

Between 1872 and 1876, HMS *Challenger* undertook the world's first major oceanographic expedition. That expedition greatly expanded man's knowledge of the world's oceans and revolutionized our ideas about planet Earth. From 1968 to 1983, another ship named *Challenger* logged more than 375,000 miles on 96 voyages across every ocean for the Deep Sea Drilling Project (DSDP), operated by Scripps Institution of Oceanography. Among the project's many remarkable discoveries were the confirmation of seafloor spreading and the establishment of the relative youth of the seafloor, thus verifying the dynamic and changing nature of the Earth's crust.

Today, the Ocean Drilling Program, which began in 1983, brings new resources to bear on scientific ocean drilling. A new drillship is in operation—the *JOIDES Resolution*—one of the world's most modern and best equipped drillships with enhanced capability for drilling and coring in polar areas and rough weather, expanded laboratory space, facilities for more scientists, and a major drill-hole logging program. The name of the ship was derived from the international scientific partnership that directs the program—the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES)—and from the flagship of Captain Cook's second voyage to the Pacific Ocean in the late 18th century. Texas A&M University is responsible for science operations in the program, and Lamont-Doherty Geological Observatory is responsible for the logging program.

The Ocean Drilling Program truly has international participation. In 1975, the International Phase of Ocean Drilling began with member nations—the U.S.A., U.S.S.R., the Federal Republic of Germany, Japan, the United Kingdom, and France—all providing funds and scientific guidance for the project. Today, ODP partners include the U.S.A., Canada, France, the Federal Republic of Germany, Japan, the United Kingdom, and the European Science Foundation, which represents Sweden, Finland, Norway, Iceland, Denmark, Belgium, the Netherlands, Spain, Switzerland, Italy, Greece, and Turkey.

The National Science Foundation, with funds contributed by the United States and international partners, supports the scientific operations and planning for the ODP through a contract with Joint Oceanographic Institutions, Inc. (JOI).

The information gained by the program leads to a better understanding of the Earth and its dynamic processes. Drilled sediment cores and logs reveal clues to past climatic history and tie into parallel studies of paleoclimates from glacial ice cores drilled on the continents. Understanding these sediment cores will enable scientists to complete the map of major geologically active regions of the Earth, and to identify processes that lead to dynamic change such as earthquakes, volcanic eruptions, and mountain and continental growth. We are far from being able to predict such changes accurately now; but with the new tools and understanding, the accuracy of such predictions can be improved. This better understanding of the Earth's system(s) will allow us to identify regions of potential mineral and energy resource development, an issue of worldwide human interest. The Ocean Drilling Program is not in itself aimed at finding resources, but the knowledge of the Earth's processes that is gained through such a basic research program will inevitably provide pieces of information required for such resource discovery and exploitation.

The program is fully under way in its aim to further the understanding of the Earth's dynamic systems. People of our planet will benefit directly and indirectly from this research in both their daily living and work activities. This multinational endeavor will perhaps foster other cooperative efforts in science or among societies. The Ocean Drilling Program has distinguished ancestors in the original *Resolution* and *Challenger* expeditions and the Deep Sea Drilling Project. The National Science Foundation is proud to be playing a leading role in this program, and we are looking forward to significant and innovative science for many years to come.



Erich Bloch
Director
National Science Foundation

Washington, D.C.

Foreword

By Joint Oceanographic Institutions, Inc.

This volume presents results from the Ocean Drilling Program (ODP), where scientists use a specially equipped ocean drilling ship to sample and measure the properties of the submerged part of the Earth's crust. These data are then synthesized with other information to yield new insights into earth processes.

These results address the scientific goals of the program, which include providing a global description of geological and geophysical structures and materials, studying in detail areas of major geophysical activity such as mid-ocean ridges and the associated hydrothermal circulations, and studying passive and active continental margins. In addition, the ODP data support the study of sea-level and ocean-circulation changes, the effects of the Earth's orbital variations on climate, and the study of processes and mechanisms of evolution from the biological records in the cores which are recovered from drilling.

The Ocean Drilling Program is a partnership of scientists and governments. Overall scientific policy and management guidance is provided by Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), which consists of committees and panels made up of representatives of the participating institutions and other scientific and engineering experts. The JOIDES Executive Committee (EXCOM) provides general oversight; the JOIDES Planning Committee (PCOM) is the focal point for all scientific planning for the ODP and is key to the scientific success of the program.

The PCOM has a network of panels and working groups which screen drilling proposals, evaluate instrumentation and measurement techniques, and assess geophysical survey data and other safety and siting information. PCOM uses the recommendations of these panels and committees to select drilling targets, to specify the major scientific objectives of each two-month drilling segment or leg, and to provide the science operator with nominations for co-chief scientists. The science operator, Texas A&M University, in turn is responsible for planning the detailed ship's operations, actual drilling schedules, and final scientific rosters, which are developed in close cooperation with PCOM and the cognizant panels.

Many of the scientific goals can be met only with new technology. Thus the program has identified engineering goals, which include the ability to start a hole and to core on bare rock at mid-ocean ridge sites, to drill in high-temperature and corrosive regions typical of hydrothermal areas, and to core in high latitudes with minimum interference from high seas and sea ice. To meet these needs, the program operates a specially equipped drillship, the *JOIDES Resolution*, which contains laboratories and equipment that are state-of-the-art, and carries a major new logging program.

The ship, registered as SEDCO/BP 471 after her owners and her length in feet (144 meters), is 70 feet (21 meters) wide, and has a displacement of 16,595 long tons. Her derrick towers 200 feet (61 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 50 and a ship's crew of 65.

Logging is a major part of the overall operation. The program 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 televiwer is available for imaging the well-bore wall, 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 well bore, and a vertical seismic profiler records reflectors from below the total depth of the hole.

Texas A&M University serves as science operator for the Ocean Drilling Program. In this capacity, they operate and staff the drillship to collect cores from JOIDES-designated sites from around the world. The science operator also ensures that adequate scientific analyses are performed on the cores by maintaining the shipboard scientific laboratories and by providing logistical and technical support for shipboard scientific teams. Onshore, Texas A&M manages scientific activities after each leg, is curator for the cores, distributes samples, and coordinates the editing and publication of the scientific results. Lamont-Doherty Geological Observatory (LDGO) of Columbia University manages the program's logging operations, which include processing the data and provision of assistance to scientists in data analysis. The ODP Data Bank, a repository for geophysical data, is also managed by LDGO. Core samples from ODP and the previous Deep Sea Drilling Project are stored for future investigation at three sites: ODP Pacific and Indian Ocean cores at Texas A&M University, ODP and DSDP Atlantic and Antarctic cores at Lamont-Doherty Geological Observatory, and DSDP Pacific and Indian Ocean cores at Scripps Institution of Oceanography.

International oversight and coordination are provided by the ODP Council, a governmental consultative body of partner country representatives, chaired by the United States, which periodically reviews the general progress of the program and discusses financial plans and other management issues. Joint Oceanographic Institutions, Inc., a nonprofit consortium of U.S. oceanographic institutions, serves as the National Science Foundation's prime contractor and manages the ODP. JOI is responsible for seeing that the scientific objectives and plans are translated into scientific operations consistent with JOIDES recommendations and budgetary constraints.

Scientific achievements of the ODP already include new data on early seafloor spreading and how continents separate and their margins evolve. We have new insight into glacial cycles and the fluctuations of currents throughout geological time. Technical achievements include the first bare-rock coring, and logging data more accurate and complete than ever before. JOI is pleased to have played a facilitating role in the Ocean Drilling Program.



D. James Baker
President
Joint Oceanographic Institutions, Inc.

Washington, D.C.

OCEAN DRILLING PROGRAM

MEMBER ORGANIZATIONS OF THE JOINT OCEANOGRAPHIC INSTITUTIONS FOR DEEP EARTH SAMPLING (JOIDES):

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University of Rhode Island, Graduate School of Oceanography

Texas A&M University, Department of Oceanography

University of Texas at Austin, Institute for Geophysics

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European Science Foundation Consortium for Ocean Drilling (ECOD), Belgium, Denmark, Finland, Iceland, Italy, Greece, the Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey

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France, Institut Français de Recherche pour l'Exploitation de la Mer

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United Kingdom, Natural Environment Research Council

PRIME CONTRACTOR

Joint Oceanographic Institutions, Inc.
Washington, D.C.

Thomas E. Pyle
Director, Ocean Drilling Programs

OPERATING INSTITUTION

College of Geosciences
Texas A&M University
College Station, Texas

Melvin Friedman, Principal Investigator

OCEAN DRILLING PROGRAM

Philip D. Rabinowitz
Director

Louis E. Garrison
Deputy Director

Sylvia Cecile DeVoge
Administrator

Audrey W. Meyer, Manager
Science Operations

Barry Harding, Manager
Engineering and Drilling Operations

Russell B. Merrill, Curator and Manager
Science Services

Robert E. Olivas, Manager
Technical and Logistics Support

LOGGING OPERATOR

Borehole Research Group
Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York

Roger N. Anderson, Head

PARTICIPANTS ABOARD JOIDES RESOLUTION FOR LEG 114

Paul F. Ciesielski
Co-Chief Scientist

*Department of Geology
University of Florida
Gainesville, Florida 32611*

Yngve Kristoffersen
Co-Chief Scientist

*Seismological Observatory
University of Bergen
Allegaten 41
N-5014 Bergen
Norway*

Bradford Clement
ODP Staff Scientist/Paleomagnetist

*Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station, Texas 77840*

Jean-Pierre Blangy
Logging Scientist

*Department of Geophysics
Stanford University
Stanford, California 94305
Present address:
UNOCAL Geophysics
Box 76
376 South Valencia Avenue
Brea, California 92621*

Robert Bourrouilh
Sedimentologist

*Faculté des Sciences
Université de Pau
Avenue de l'Université
64000 Pau
France*

Jason A. Crux

Paleontologist (nannofossils)
*British Petroleum Company, Ltd.
B.P. Research Centre
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 7LN
United Kingdom*

Juliane M. Fenner

Paleontologist (diatoms)
*Geologisches-Paläontologisches Institut und Museum
Christian-Albrechts Universität Kiel
Olshausenstrasse 40
D-2300 Kiel
Federal Republic of Germany*

Philip N. Froelich

Sedimentologist/Inorganic Geochemist
*Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964*

Ernest A. Hailwood

Paleomagnetist
*Department of Oceanography
The University
Southampton SO9 5NH
United Kingdom*

David A. Hodell

Sedimentologist
*Department of Geology
University of Florida
Gainesville, Florida 32611*

Miriam E. Katz

Paleontologist (benthic foraminifers)
*Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964*

Hsin Yi Ling

Paleontologist (radiolarians and ebridians)
*Department of Geology
Northern Illinois University
DeKalb, Illinois 60115*

Jürgen Mienert

Physical Properties Specialist
*Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543
Present address
GEOMAR Marine Res. Inst.
Univ. Kiel
Wischhofstrasse 1-3, GEB 4
D-2300 Kiel 14
F.R.G.*

Daniel W. Müller

Sedimentologist
*Geologisches Institut
ETH—Zentrum
Sonneggstrasse 5
CH-8092 Zürich
Switzerland
Present address
Department of Geology
University of Florida
Gainesville, Florida 32611*

C. Jonathan Mwenifumbo

Logging Scientist
*Geological Survey of Canada
Department of Energy, Mines and Resources
601 Booth Street
Ottawa, Ontario K1A 0E4
Canada*

David C. Nobes

Physical Properties Specialist
*Department of Earth Sciences and
Department of Physics
University of Waterloo
Waterloo, Ontario N2L 3G1
Canada*

Marisa Nocchi
Paleontologist (benthic foraminifers)
Dipartimento di Scienze della Terra
Università di Perugia
Piazza della Università
06100 Perugia
Italy

Detlef A. Warnke
Sedimentologist
Department of Geological Sciences
California State University, Hayward
Hayward, California 94542

Frances Westall
Sedimentologist
Alfred Wegener Institut für Polar und Meeresforschung
Postfach 120161
D-2850 Bremerhaven
Federal Republic of Germany

SEDCO OFFICIALS

Captain Edwin G. Oonk
Master of the Drilling Vessel
Underseas Drilling, Inc.
707 Texas Avenue South
Suite 103D
College Station, Texas 77840-1917

Kenneth D. Horn
Drilling Superintendent
Underseas Drilling, Inc.
707 Texas Avenue South
Suite 103D
College Station, Texas 77840-1917

ODP TECHNICAL AND LOGISTICS PERSONNEL

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