PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

VOLUME 143
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NORTHWEST PACIFIC ATOLLS AND GUYOTS

Covering Leg 143 of the cruises of the Drilling Vessel *JOIDES Resolution*, Honolulu, Hawaii, to Majuro, Republic of Marshall Islands, Sites 865–870, 18 March–19 May 1992

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Foreword

By the National Science Foundation

The Ocean Drilling Program (ODP) is a major component of the National Science Foundation's continuing commitment to the study of the geologic processes that have shaped our planet and modified its environment. The scientific problems being addressed range from the geologic history and structure of continental margins to the processes responsible for the formation and alteration of the ocean's crust. In a time of enhanced public and scientific interest in problems of global change, ODP provides critical data on changes in ocean circulation, chemistry, and biologic productivity and their relation to changes in atmospheric circulation and glacial conditions. The Ocean Drilling Program has a unique role in addressing these problems, since it is the only facility for continuously sampling the geologic record of the ocean basins, which cover 70% of our planet.

The ODP is the successor to the Deep Sea Drilling Project (DSDP), which was a global reconnaissance of the ocean basins. DSDP began operations in 1968 at Scripps Institution of Oceanography, using a 400-foot drillship, the *Glomar Challenger*. DSDP was supported initially by only the National Science Foundation, with extensive involvement of international scientists who were invited to participate on drilling cruises. As this international interest continued to grow in the early 1970's, formal participation in the project was offered to the international geoscience community. In 1975, five nations (France, the Federal Republic of Germany, Japan, the United Kingdom, and the Soviet Union) accepted this commitment to joint planning and conduct of the project, as well as to financial support for operations. This International Phase of Ocean Drilling (IPOD) continued to 1983. Although the *Challenger* had reached the limits of her capabilities, the remarkable scientific success of the DSDP and the new questions it had generated demanded a continuing capability for drilling in the oceans.

The Ocean Drilling Program was organized, international participation was coordinated, a new drillship (the *JOIDES Resolution*) was contracted and outfitted, and her first cruise sailed in early 1985, within 18 months of the retirement of the *Challenger*. This is a remarkable accomplishment that reflects the efforts and excellence of the Joint Oceanographic Institutions, Inc. (prime contractor for ODP), Texas A&M University (science and ship operator), Lamont-Doherty Geological Observatory (logging operator), and the international science community in organizing and planning the new program. It was argued in planning for the ODP that a larger drillship was required to provide space for the increasing U.S. and international demand for shipboard participation, improved and expanded laboratory capabilities, and improvements in coring and logging systems. A larger and better equipped vessel would also provide better stability and working conditions in high-latitude regions of the oceans. The success of the *JOIDES Resolution* has proven the wisdom of these early arguments.

ODP now has operated in all oceans except the ice-covered Arctic. We have drilled above the Arctic circle and within sight of the Antarctic continent. Over 1000 scientists from 25 nations have participated in the initial ODP cruises. The larger scientific parties have allowed an increased emphasis on student participation and training aboard ship. The state-of-the-art laboratories support rapid and complete initial analyses of samples that provide both scientific results and guide subsequent shore-based studies. Nearly 1000 additional scientists have used these data and requested samples from the program's core and data archives for continuing study. The geochemical and geophysical logging capability is unsurpassed in either academia or industry and has provided remarkable new data with which to study the Earth. New experiments to measure and monitor geologic processes have been deployed in ODP boreholes.

The international commitment to ocean drilling has increased in the ODP. In addition to our five partners in IPOD—France, the Federal Republic of Germany, Japan, the Soviet Union, and the United Kingdom—two consortia have joined ODP: Canada-Australia and the European Science Foundation (representing Belgium, Denmark, Finland, Greece, Iceland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey). The 20 countries of the ODP represent the community of nations that have a global interest in the geosciences and oceanography. This global scientific participation has assured the program's scientific

excellence by focusing and integrating the combined scientific knowledge and capabilities of the program's 20 nations. It has allowed problems of a global nature to be addressed by providing databases and background studies which are openly shared for planning and interpreting drilling results. It has eased problems of access to territorial waters, allowing comparative studies to be done among oceans. Finally, the international sharing of program costs has allowed this important and large program to proceed without detrimental impact to the research budgets of any one nation.

The Ocean Drilling Program, like its predecessor, DSDP, serves as a model for planning, conducting, and financing research to address problems of global importance. The National Science Foundation is proud to have a leading role in this unique international program, and we look forward to its continuing success.

Walter E. Massey
Director
National Science Foundation

Washington, D.C.

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 permitting 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 Geological 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 Geological Observatory (LDGO) 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 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 TAMU, ODP and DSDP Atlantic and Antarctic cores at LDGO, and DSDP Pacific and Indian Ocean cores at the Scripps Institution of Oceanography.

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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Joint Oceanographic Institutions, Inc.

Washington, D.C.

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CD-ROM
(in back pocket)

Structure:

The CD-ROM in the back of this volume is a "data-only" CD-ROM, containing about 500 megabytes of depth-shifted and processed logging data collected during Leg 143. Both processing and CD-ROM production were carried out by the Borehole Research Group at Lamont-Doherty Earth Observatory (formerly Lamont-Doherty Geological Observatory), Wireline Logging Operator for ODP.

The CD-ROM is structured as follows:

INDEX
README
DATA

- GENERAL INFORMATION
  - Format documentation
  - README
  - Software documentation
- HOLE NUMBER
  - Conventional logs
    - General information
      - Acronyms and units
      - Processing history of log data
    - Log data
      - Individual tool data files
  - FMS (formation microscanner) and dipmeter data
    - Dipmeter in ASCII format
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    - FMS raster files in PBM (portable bit map—8 bit binary) format
      - 1:1 ratio image raster files (every 10 m)
      - 1:10 ratio image raster files (every 100 m)

The INDEX file contains a summary of all the files loaded on the CD-ROM.

The software documentation file in the GENERAL INFORMATION subdirectory contains information on which software packages work best to import PBM raster files. It also includes network sources for the graphics software and data-compression information.

The ASCII files are TAB delimited for compatibility with most spreadsheet and database programs. Holes that have more than one logging pass with the same tools are labeled "Pass 1," "Pass 2," etc. Holes that have long logging runs are commonly divided into TOP, MIDDLE, and BOTTOM sections.

Leg 143 Log Data:

Hole 865A:
- Conventional logs
- FMS data
- Dipmeter data

Hole 866A:
- Conventional logs
- FMS data
- Dipmeter data

Hole 867B:
- Conventional logs
- FMS data
- Dipmeter data

Hole 869B:
- Conventional logs
- Geochemical logs (element and oxide weight %)
- FMS data
- Dipmeter data

Dedication

We dedicate this volume to the memory of our late colleague Seymour O. ("Sy") Schlanger, in recognition of the key role he played for nearly 40 years in the advancement of knowledge about the Western Pacific, and especially about the seamounts and coral reefs that abound in this region. His early studies of the petrology and stratigraphy of drill cores from the carbonate platform of Anewetak Atoll established an enduring model for later workers, and he was among the first to appreciate the volume and importance of mid-Cretaceous midplate volcanism in the Western Pacific. He pursued his researches on flood basalts, oceanic plateaus, seamounts, and guyots on many expeditions to the Marshall and Line Islands seamount chains, and he was a participating or chief scientist on DSDP Legs 17, 33, 61, and 89. He was a principal proponent of the proposal for ODP drilling in the Marshall Islands region, and was a close collaborator on the proposal to drill guyots elsewhere in the Western Pacific. Sy died tragically a short time before the JOIDES Planning Committee approved the two Western Pacific guyot-drilling proposals which were combined to become ODP Legs 143 and 144. This volume is in many ways part of the legacy that Sy left to his profession.

Acknowledgments

This volume is the culmination of years of work by hundreds of people. We are indebted to our co-investigators on the site survey cruises and co-proponents of the drilling proposals, Marcia McNutt, James Natland, Sy Schlanger, and Fred Duennebier. We thank also those members of the panels, particularly the Planning Committee and Ocean History Panel, who recognized the merit of Leg 143 and pushed to make it a reality. Likewise, we acknowledge with gratitude the members of the Atolls and Guyots Detailed Planning Group, chaired by David Rea, for helping to turn our drilling fantasies into a solid and workable schedule.

Leg 143 depended on the efforts of many people for whom ocean research and drilling is all in a day's work. Without their professionalism, its outcome would have been much less fruitful. Indeed, Hole 866A, the record-setting, deepest single-leg-penetration hole is a testament of their efforts. Geophysical data collected by the scientists and crews of the *Kana Keoki, Moana Wave,* and *Thomas Washington* played an important role in bringing the scientific problems to maturity and allowing drill sites to be chosen. Aboard the *JOIDES Resolution,* our successes were the result of team efforts by all departments. In particular, we thank Captain Ed Oonk, his officers, and crew; the SEDCO personnel and Drilling Superintendant Ken Hatfield, the ODP technicians and Laboratory Officer Brad Julson, as well as Operations Superintendant Gene Pollard.

We are also indebted to those people at ODP who work behind the scenes to keep the drill ship afloat, staffed, and pointed in the right direction, as well as those who toil to put our results and ideas into print. We thank Phil Rabinowitz, Tim Francis, Audrey Meyer, Jack Baldauf, and Russ Merrill for keeping the show running, Jack Foster for managing the computer system, and Bill Rose for getting the words out. Fabiola Byrne and Laura Young coordinated the compilation of site chapters during the post-cruise meeting. The text was finalized with the editorial assistance of Sondra Stewart, and the illustrations were prepared for production under the direction of Debbie Partain.