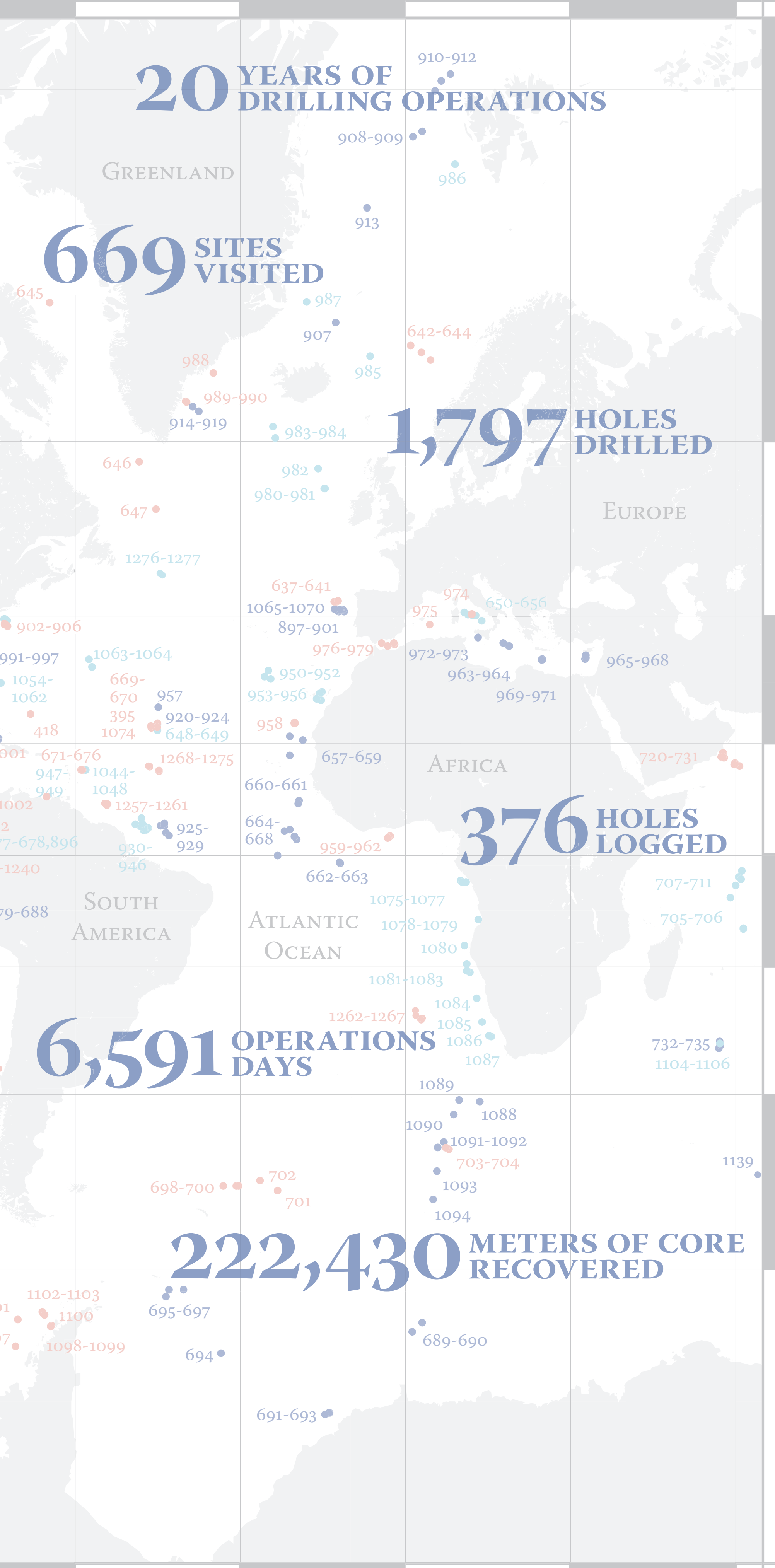


Ocean Drilling Program

Final Technical Report

1983 – 2007

Ocean Drilling Program

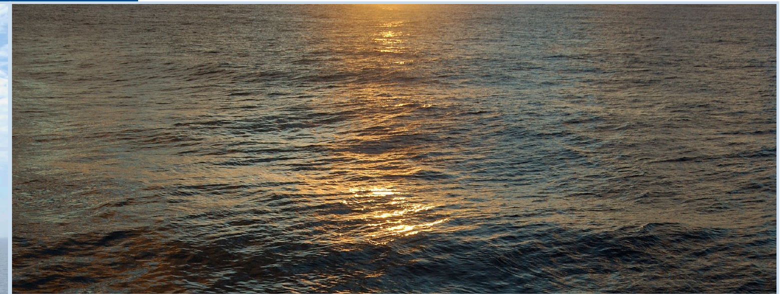
Final Technical Report
1983 – 2007

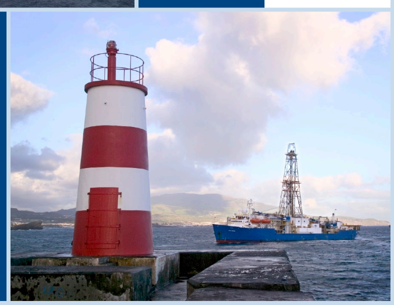
Consortium for Ocean Leadership, Inc.

Lamont-Doherty Earth Observatory
of Columbia University

Texas A&M University

National Science Foundation
Contracts ODP83-17349 and OCE93-08410


JOIDES Resolution

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OCEAN
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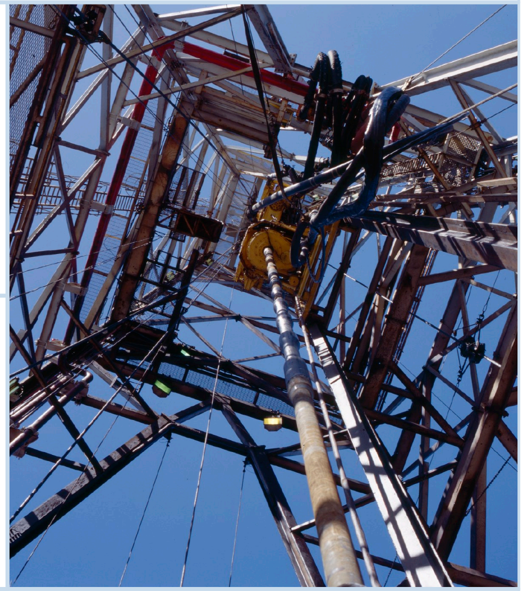
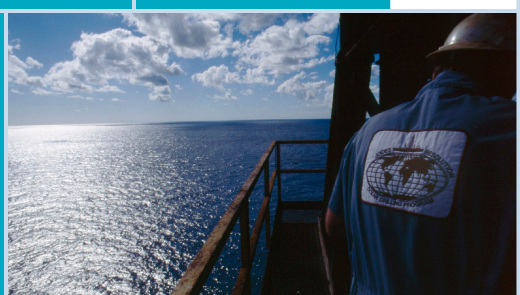
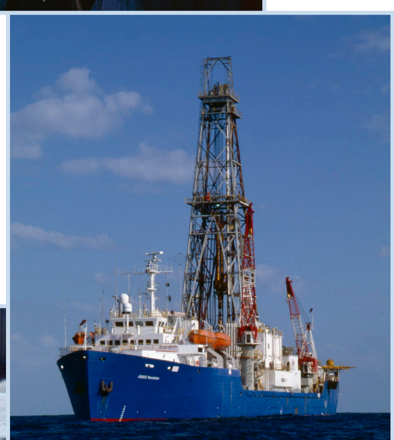
PROGRAM

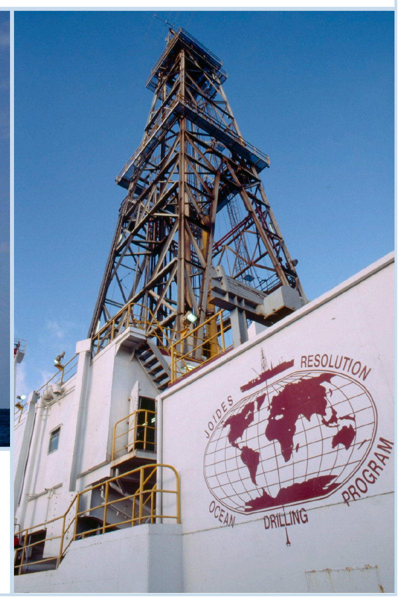




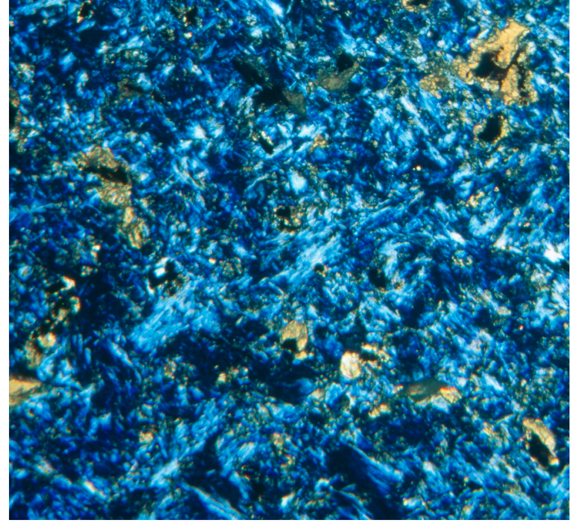
OCEAN DRILLING PROGRAM
JOIDES RESOLUTION

OCEAN DRILLING PROGRAM
1985





Executive Summary



The Ocean Drilling Program (ODP) operated successfully under National Science Foundation (NSF) Contracts ODP83-17349 (1 October 1983–30 September 1993) and OCE93-08410 (1 October 1993–30 September 2007). The ODP Final Technical Report provides an overview of the management and organization of ODP and highlights 20 years of technical and scientific accomplishments.

Ocean Drilling Program Administration

ODP was the direct successor of the Deep Sea Drilling Project (DSDP), which began in 1968. DSDP sampled the global seafloor by deep ocean coring and downhole logging, and its accomplishments were striking. Research based on the samples strongly supported the hypotheses of seafloor spreading—the relationship of crustal age to the record of Earth's magnetic reversals—and plate tectonics.

ODP was an international partnership of scientists and research institutions organized to explore Earth's history and structure as recorded in the ocean basins. ODP provided sediment and rock samples (cores), downhole geophysical and geochemical measurements (logging), opportunities for special experiments to determine in situ conditions beneath the seafloor, and shipboard and shore-based facilities for the study of samples. ODP studies led to a better understanding of plate tectonic processes, Earth's crustal structure and composition, environmental conditions in ancient oceans, and climate change.

ODP was funded by NSF and by international partners, which during the course of the Program included the Australia/Canada/Chinese Taipei/Korea Consortium for Ocean Drilling, the European Science Foundation Consortium for Ocean Drilling (representing Belgium, Denmark, Finland, Greece, Iceland, Ireland, Italy, Norway, Portugal, Spain, Sweden, Switzerland, The Netherlands, and Turkey), France, Germany, Japan, the United Kingdom, Russia, and the People's Republic of China. The ODP Council, representing all of the partners, provided a forum for exchange of views among member nations and reviewed financial,

A Sampling of Historic Events during the Ocean Drilling Program

1984

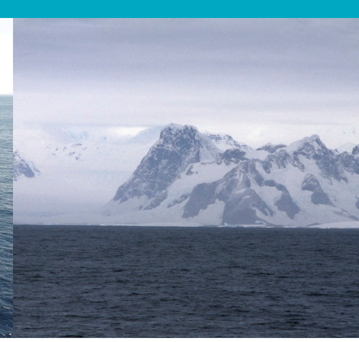
Converted the oil exploration drilling vessel SEDCO/BP 471 for scientific ocean drilling.

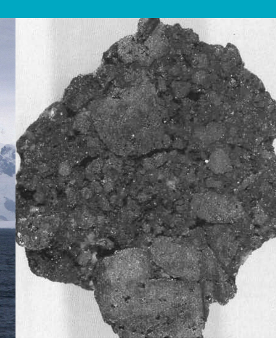
1985

Leg 100, Gulf of Mexico: Initiated scientific drilling operations and sailed the drillship on its first scientific expedition.

Leg 105, Baffin Bay and Labrador Sea: Collected almost 1 mile of sediment and rock cores from as deep as 1,147 meters beneath the seafloor at the highest latitude and in the deepest water ever drilled that far north by a scientific vessel.

Leg 106, Mid-Atlantic Ridge: Collected first samples ever taken adjacent to Atlantic Ocean "black smokers."





managerial, and other matters regarding the overall support of ODP.

Joint Oceanographic Institutions, Inc. (JOI), now known as the Consortium for Ocean Leadership, Inc., provided central management and, through subcontractors, the full array of services at sea and on land for ODP. Texas A&M University (TAMU) served as Science Operator, and the Borehole Research Group (BRG) at Lamont-Doherty Earth Observatory (LDEO) of Columbia University provided logging and other wireline services. LDEO also provided Site Survey Data Bank services. JOI's responsibilities as Program Manager also included management or support of a number of Program-related activities, including the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) Science Advisory Structure (SAS) for ODP through the JOIDES office. Additionally, under a separate contract, JOI managed the U.S. Science Support Program (USSSP), which supported U.S. scientists' participation in ODP and carried out much of the Program's educational outreach efforts (e.g., Distinguished Lecture Series, Schlanger Fellowships, etc.).

Scientific direction for ODP was provided by JOIDES, an international organization of advisory committees and panels that provided planning and program advice regarding science goals and objectives, facilities, scientific personnel, and operating procedures. Long-range planning for the Program was conducted utilizing reports generated from the 1981 and 1987 Conferences on Scientific Ocean Drilling (COSOD) and 1993 U.S. Committee on Post-1998 Ocean Drilling (COMPOST) meeting, 1990 and 1996 ODP Long Range Plans, 65 Predrilling Workshops held between 1985 and 2003, and recommendations that were provided every 3–5 years by a panel of experts called the Performance Evaluation Committee (PEC).

"ODP was an international partnership... organized to explore Earth's history and structure as recorded in the ocean basins."

Scientists representing the ODP partners reviewed drilling proposals and participated in each ODP research cruise. This unique format brought together researchers from universities, industry, and government laboratories in the member nations to work in a state-of-the-art shipboard laboratory on focused scientific

1986

Leg 108, Eastern Tropical Atlantic: Documented a shift to drier climate in Central East Africa thought to have been the impetus for human migration from Africa starting 2 million years ago.

1987

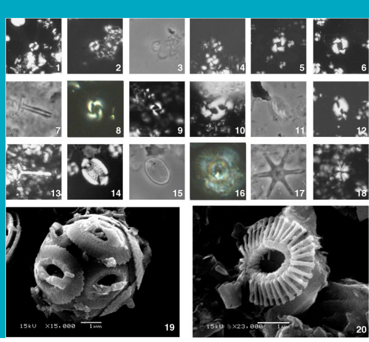
Leg 113, Weddell Sea: Cored southernmost site at 70.8°S and documented the establishment of a permanent West Antarctic ice sheet at ~5 Ma.

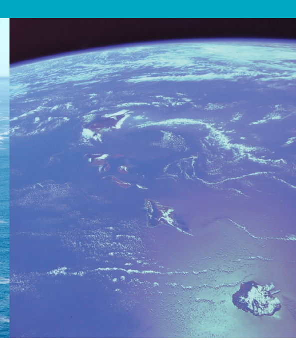
Leg 115, Mascarene Plateau: Recovered first evidence of long-lived hotspot tracks.

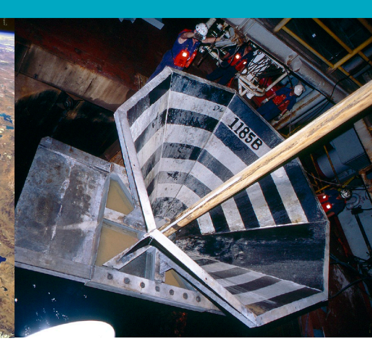
Leg 116, Distal Bengal Fan: Established the hypothesis that uplift of the Himalayas enhanced global cooling.

1989

Leg 128, Japan Sea: Installed the first long-term ocean-bottom seismometer in one of the world's most active earthquake zones, off western Japan.







goals. Students also participated in drilling cruises, working with some of the world's leading scientists and becoming part of the intellectual fabric essential for future advances in the earth sciences.

Scientific Results

Scientific ocean drilling has made fundamental contributions to our understanding of the Earth. For instance, we now know that the paradigm of plate tectonics offers tremendous new insights into the way Earth works, including a better understanding of natural hazards such as earthquakes and volcanoes. Studies of marine sediments have resulted in a much better understanding of natural climatic variability, and we are beginning to learn how to factor global change into planning for the future. Evidence was found during scientific ocean drilling cruises for present-day formation of huge ore-grade deposits of iron, copper, and zinc precipitated out of hydrothermal fluids heated to more than 300°C and rising as hot springs from the center of spreading ridges as well as evidence for large amounts of less-heated water percolating through the ridge flanks, which has implications for the recycling of ocean water through the crust. Earth was even more thermally active during the Cretaceous, when enormous plumes of mantle rock rose beneath the lithosphere and triggered the formation of individual volcanoes and volcanic plateaus at rates unknown in today's world. We have confirmed that large volumes of natural gas (methane) are frozen within deep-sea marine sediments as gas hydrates, and we have produced quantitative measurements of the amount of inert gas hydrate and gas offshore South Carolina. From our results, it also appears that the oceanic crust is home to an unforeseen microbial community called the deep biosphere, whose concentration is small but, because oceanic crust is the most abundant rock sequence on Earth, may contain a significant fraction of Earth's biomass.

Engineering and Science Operations

With the combination of a unique research vessel, dedicated staff at ODP-supported institutions, and scientific participants worldwide,

1989

Leg 129, Mariana Basin: Drilled in deepest water depth (5,980 meters) and recovered the oldest remaining remnants of the Pacific Ocean's original seafloor—175-million-year-old fragments of sediments and ocean crust from the Jurassic period (~170 Ma).

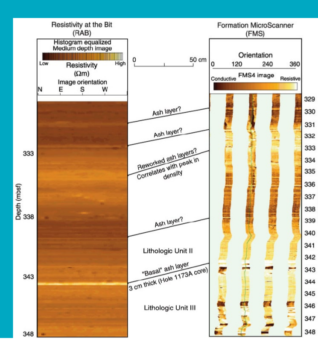
1991

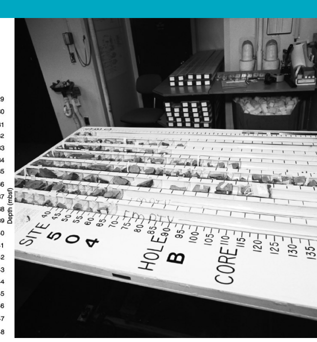
Leg 139, Middle Valley and Juan de Fuca Ridge: Recovered hydrothermal metal deposits and installed the first of many long-term geochemical observatories using an instrumented borehole seal called the circulation obviation retrofit kit (CORK).

Leg 140, Costa Rica Rift: Penetrated into pillow lavas and sheeted dikes, and documented that the Layer 2C/Layer 3 boundary (which is seismic in character) could be caused by a velocity gradient and not a lithologic boundary.

1993

Leg 148, Costa Rica Rift: Drilled deepest hole (2,111 meters) in the ocean's crust.





ODP conducted cutting-edge exploration from January 1985 through September 2003. During this time, more than 2,600 international scientists sailed on more than 110 cruises on board the *JOIDES Resolution,* a 469-foot-long and 68.9-foot-wide research vessel named after James Cook's flagship of two centuries ago, the HMS *Resolution.*

ODP often drilled into environments of enormous pressure, elevated temperatures, and chemical toxicity. Scientific advancements in these environments were made possible by breakthroughs in ODP technology, including the development of many drilling tools and techniques, as ODP was the first organization to drill into such deepwater and hostile environments. Additionally, developments in sediment analysis, analytical instruments, age models, seafloor observatories, and measurement of in situ conditions along with software development and joint ventures entered into by ODP in conjunction with industrial partners helped advance our understanding of Earth's structure and evolution.

Samples, Data, and Publications

Each recovered core provides unique and valuable information regarding Earth's history and processes. Samples of subseafloor sediments and rocks collected during ODP are indispensable to scientists expanding mankind's knowledge of environmental change, earthquake genesis, volcanic processes, evolution of life, and other scientific questions.

Cores collected during the Program were stored at shore-based core repositories in the United States (Texas A&M University, Scripps Institution of Oceanography, and Lamont-Doherty Earth Observatory of Columbia University) and Germany (University of Bremen), providing the international scientific community with access to the core collection as well as sediment and rock samples for further research. Additionally, micropaleontological reference centers established on four continents and hosted by more than a dozen major institutions around the

1994

Leg 156, Barbados Accretionary Prism: First successful penetration of the décollement fault and first use of logging-while-drilling (LWD) tools.

1995

Leg 164, Blake Ridge: Sailed inaugural gas hydrate expedition in the Atlantic Ocean and confirmed that significant amount of gas deposits are contained in ocean sediments.

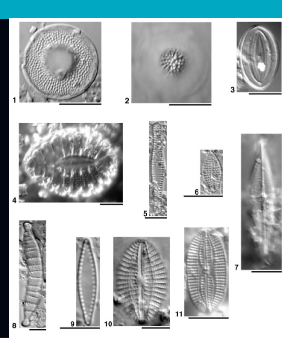
1997

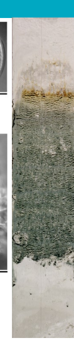
Leg 171B, Blake Nose Paleoceanographic Transect: Confirmed the catastrophic impact of a meteorite with Earth 65 million years ago that led to the extinction of dinosaurs and other plants and animals at the end of the Cretaceous period.

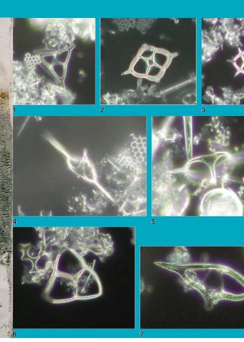
Leg 175, Benguela Current: Recovered the most core (8,003 meters) collected during a single expedition.

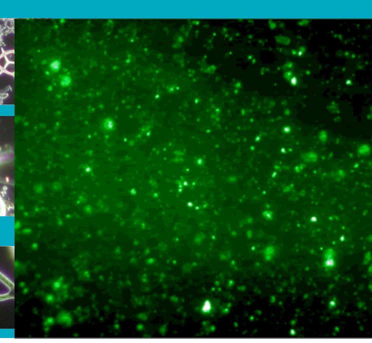
1998

Leg 180, Woodlark Basin: Discovered microbes living in sediments 800 meters beneath the seafloor.









world provided scientists the opportunity to examine, describe, and photograph microfossils of various geological ages and provenance (iodp.tamu.edu/curation/mrc/institutions.html).

The *Initial Reports* and *Scientific Results* volumes of the *Proceedings of the Ocean Drilling Program* were published to summarize the scientific and/or technical accomplishments of each cruise. This publication series includes predrilling geological and geophysical site surveys, leg objectives, planning documentation, core records, physical and geochemical measurements, logging data, core photographs, paleontology and petrological reports, scientific research results, and syntheses. Near the conclusion of the Program, all ODP printed publications were digitized and made available online (www.odplegacy.org/samples_data/publications.html).

The results of research based on ODP data have been published openly in leading scientific journals as well as in the *Proceedings of the Ocean Drilling Program.* The Ocean Drilling Citation Database (iodp.tamu.edu/publications/citations/database.html) serves as a comprehensive reference to all scientific drilling publications. Covering research spanning from 1969 to the present, it contains more than 22,500 citations related to the Ocean Drilling Program and its related programs DSDP and the Integrated Ocean Drilling Program (IODP). Two volumes of abstract collections, *ODP's Greatest Hits,* published in November 1997, and *ODP Highlights,* published in December 2004, illustrate the rich diversity of the international scientific community's accomplishments through ODP (www.odplegacy.org/science_results/highlights.html).

ODP scientific data are housed in databases that are accessible online, allowing easy retrieval for users worldwide. The core data, which are housed in a relational database called Janus, are available at iodp.tamu.edu/database/index.html and are also archived by the National Geophysical Data Center in Boulder, Colorado. Janus contains 450 tables of ODP's marine geoscience data that were collected on board the drillship *JOIDES Resolution,* including paleontological, lithostrati-

1999

Completed major modifications to the ship's capabilities during dry dock, including upgrades of the science infrastructure and installation of a permanent microbiology laboratory.

Leg 186, Western Pacific: Using the longest casing string yet suspended from a deep-sea drillship, installed long-term ocean-bottom seismometers and strain meters in two holes off Japan.

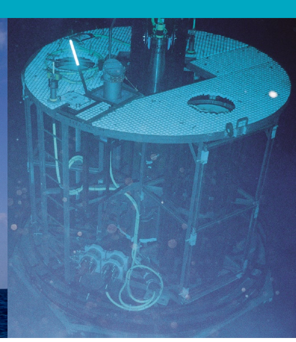
2000

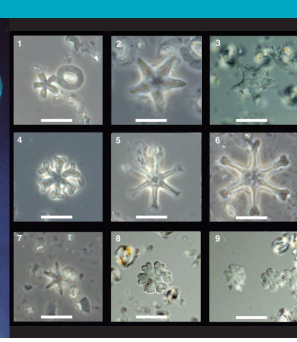
Leg 189, Tasmanian Gateway: Confirmed the formation of the Antarctic Circumpolar Current 33 million years ago and subsequent climatic cooling that ended the "hothouse" era.

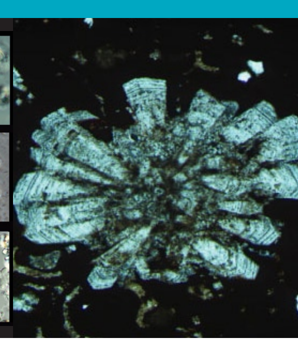
Leg 193, Manus Basin: Obtained results from a potential deep-sea mine for metallic resources that led to the development of new guidelines for future land-based mineral exploration.

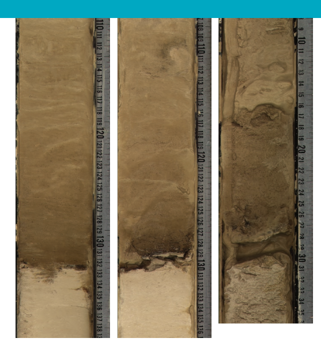
2001

Legs 198 and 199, central Pacific Ocean: Documented abrupt climate change during the Paleocene/Eocene Thermal Maximum (PETM).







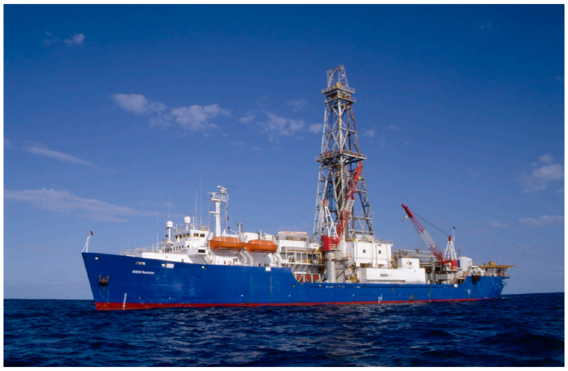


graphic, chemical, physical, sedimentological, and geophysical data for ocean sediments and hard rocks. Logging data are available at iodp.ldeo.columbia.edu/DATA. The log database contains standard downhole logs (e.g., geophysical data and resistivity images), logs from specialty tools (e.g., borehole televiewer, geochemical, multichannel sonic, logging-while-drilling [LWD], and temperature tools), and processed and original wireline and LWD data for DSDP and ODP.

Outreach

Working within a limited budget, Program staff raised ODP visibility and informed the scientific community and general public of important discoveries that heightened understanding of Earth's history and scientific ocean drilling. This was accomplished through a variety of creative outreach activities and products, including documentaries, newspaper and magazine articles, press releases, exhibit booths at science conferences, and port call events. Public relations and outreach products and activities for ODP are documented on the ODP Legacy Web site (www.odplegacy.org/outreach).

The ODP Legacy Web site (www.odplegacy.org) was launched in September 2006 in recognition of the importance of preserving and



compiling the scientific, technological, and experiential legacy of ODP. This Web site was developed to encourage interest, awareness, and understanding of ODP as a program; preserve the data, documents, and publications produced during the Program; and highlight the scientific and technical accomplishments of the Program. Users can access scientific data generated during operations on board the *JOIDES Resolution* and later shore-based activities via various links to on the Web site. Although the site is not intended as a comprehensive historical archive, it contains downloadable documents that cover a wide spectrum of Program information, from laboratory and instrument manuals to all of the Program's scientific publications, journals, and educational materials. The ODP Legacy Web site also includes some data and publications related to DSDP, the ground-breaking precursor to ODP.

2002

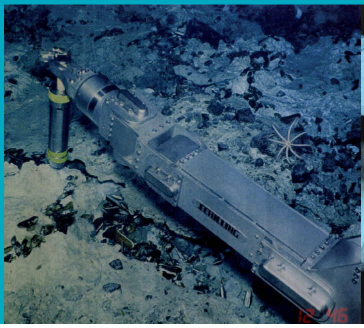
Leg 201, Eastern Equatorial Pacific and Peru Margin: Discovered evidence of vast, active deep biosphere in ocean sediments and crust.

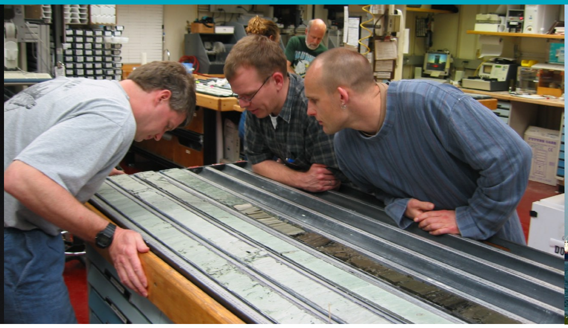
Leg 204, Hydrate Ridge: Multiple gas hydrate cores recovered under in situ pressure, first use of LWD tools for gas hydrate studies.

2003

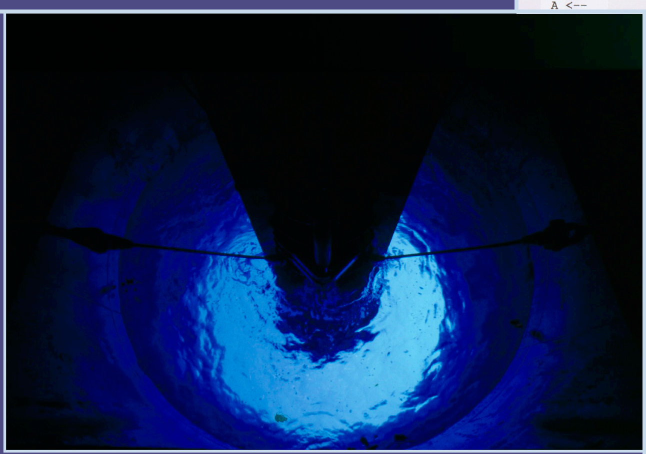
Legs 207 and 208, Demerara Rise and Walvis Ridge: Recovered samples from the Cretaceous/Paleogene (K/P) boundary and the PETM that provided evidence of rapid global climate and ocean circulation changes that led to periods of plant and animal mass extinctions.

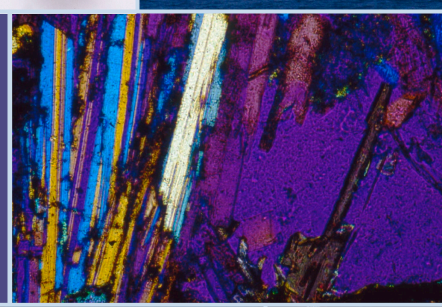
Leg 210, Newfoundland Margin: Concluded ODP operations and began demobilization of the *JOIDES Resolution* in Galveston, Texas.

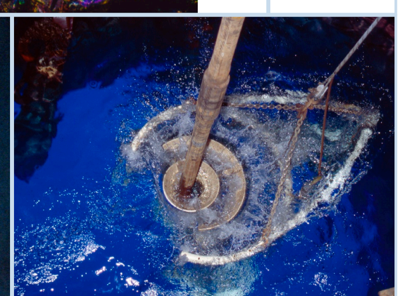




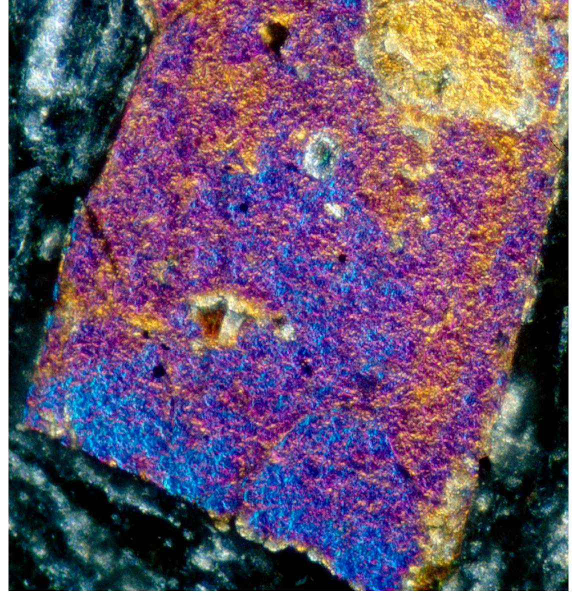
ODP Final Technical Report







Program Administration



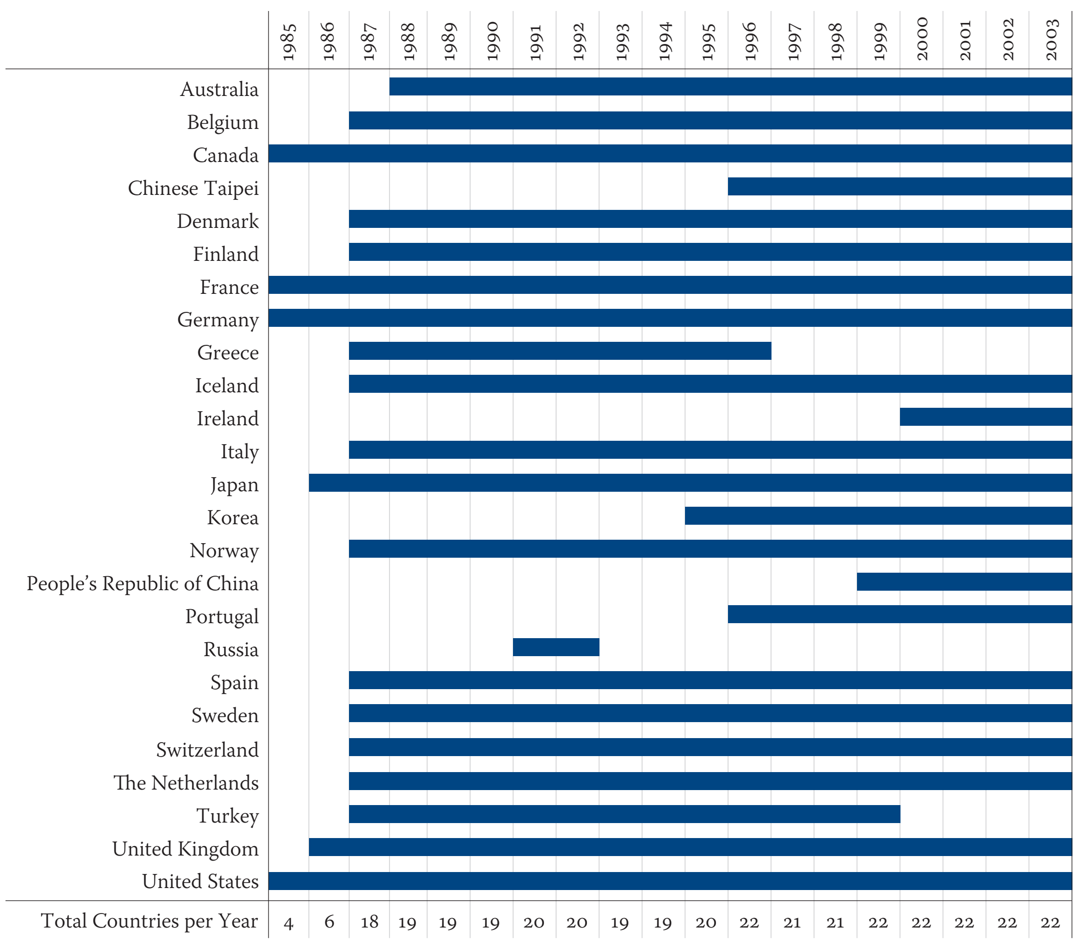
Administrative Structure

The Ocean Drilling Program (ODP) was funded by the U.S. National Science Foundation (NSF) and 22 international partners (as of 2003) and was directed by Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), an international community of scientists from ODP's member countries who served on advisory committees and panels to provide planning and program advice regarding science goals and objectives, facilities, scientific personnel, and operating procedures.

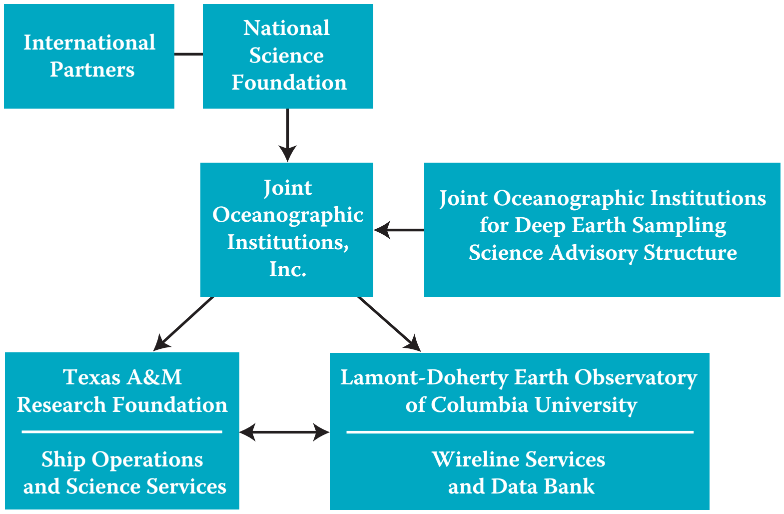
The ODP office at NSF was responsible for overseeing the Program and administering commingled funds from the international partners. The ODP Council, representing all of the partners, provided a forum for exchange of views among member nations and reviewed financial, managerial, and other matters regarding the overall support of ODP.

Joint Oceanographic Institutions, Inc. (JOI), served as the Program Manager, providing central management and, through subcontractors, the full array of services at sea and on land for ODP.

ODP Member Countries



Ocean Drilling Program Organizational Structure



Contract and Subcontract Structure and Roles

Prime Contractor (Program Manager)

JOI, a nonprofit (501[c]3) oceanographic organization, was formed in 1976 by the U.S. member institutions of JOIDES to facilitate scientific ocean drilling and advance oceanographic research in general and to provide overall management as the prime contractor to NSF. JOI was the prime contractor for ODP from its inception in 1983. JOI's responsibilities as Program Manager also included management or support of a number of Program-related activities, including the JOIDES Science Advisory Structure (SAS) for ODP through the JOIDES office.

Additionally, under a separate contract, JOI managed the U.S. Science Support Program (USSSP), which supported United States scientists' participation in ODP and carried out much of the Program's education/outreach work, such as the Distinguished Lecture Series and the Schlanger Fellowships.

Subcontractors

JOI established subcontracts with Texas A&M University (TAMU) through the Texas A&M Research Foundation (TAMRF) to serve as Science Operator and with the Borehole Research Group (BRG) at Lamont-Doherty Earth Observatory (LDEO) of Columbia University to serve as Wireline Services Operator and provide logging and other wireline services. LDEO also provided Site Survey Data Bank (SSDB) services. Through a subcontract to the JOIDES office, JOI provided support for JOIDES activities.

"The Ocean Drilling Program was funded by the U.S. National Science Foundation and 22 international partners…."

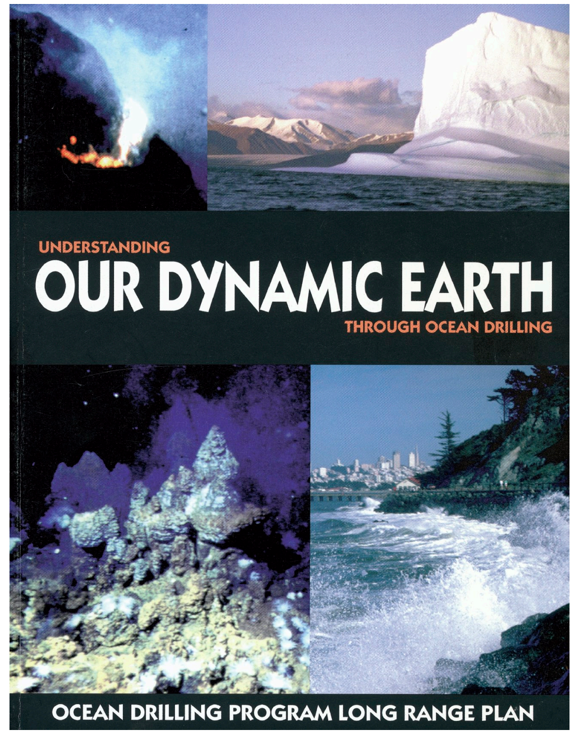
ODP-TAMU and ODP-LDEO provided scientific and operational technical, engineering, and logging support and innovation involving close collaboration and subcontracts with industry (e.g., active heave compensation, rig instrumentation system [RIS]), successfully managing a variety of long- and short-term subcontracts, including Overseas Drilling Limited (ODL) for the lease of the *JOIDES Resolution* and Schlumberger for logging services. In addition, ODP engaged in two-way collaborative relationships with offshore oil and gas industrial and service groups supporting scientific drilling research and development contracts in support of science drilling (e.g., hammer drill-in casing) and technology transfer from scientific drilling to the industrial sector (e.g., Fugro hydraulic piston corer).

Science Operator

The Science Operator, ODP-TAMU, was responsible for operation of the *JOIDES Resolution* and associated activities of cruise staffing; logistics; engineering development; operations; shipboard laboratories; acquisition, curation, and distribution of core samples and data; publication of scientific results; and assistance with ODP public relations. On board the ship, ODP-TAMU maintained the laboratories and provided technical and logistical support for shipboard scientific teams. On shore, ODP-TAMU managed scientific and drilling activities before and after each cruise, curated the cores, distributed samples, edited and published scientific results, archived core data, provided data distribution services, and provided administrative and logistical support for all these activities. ODP-TAMU also performed core data verification and processed requests from the scientific community for core data and photos.

Wireline Services Operator

As Wireline Services Operator, ODP-LDEO provided state-of-the-art downhole logging capabilities customized to scientists' needs. This involved acquiring, processing, and presenting in situ logging measurements in usable scientific form; shipboard supervision of Schlumberger logging activities; and management of shipboard and shore-based log interpretation centers. ODP-LDEO provided data analysis and distribution services to assist scientists using these logs to solve particular scientific problems. ODP-LDEO also provided technical and logistical support for provision of third-party wireline logging tools, development of log interpretation software, and engineering developments for new downhole measurements.



Site Survey Data Bank

The ODP SSDB was located at LDEO, where it housed regional geophysical and site survey data submitted in support of proposed drilling programs. The SSDB assisted in the planning and development of ODP programs by compiling packages of available data for each ODP proposal for review by various JOIDES advisory panels, supplying each shipboard scientific party with the geophysical data necessary for proper conduct of scheduled drilling cruises, and assisting drilling proponents in the development of data packages and site surveys in support of their proposals.

Throughout ODP, the SSDB compiled an extensive collection of geophysical data for use in support of scientific ocean drilling. The

SSDB also developed visualization tools to assist in management and review of data during the transition from paper submissions to electronic data submissions. The data archive and management tools were transferred to the IODP SSDB.

JOIDES Office

The JOIDES office, under the direction of the Chair of the JOIDES Scientific Committee (SCICOM), was responsible for coordinating all the advisory committees and panels within the JOIDES SAS. This office also integrated advice from the panel substructure in a manner suitable for policy decisions by the JOIDES Executive Committee (EXCOM). The JOIDES Office also produced the *JOIDES Journal* (www.odplegacy.org/program_admin/joides_journal.html) to keep the scientific community informed of planning for the drilling program and to summarize Program activities.

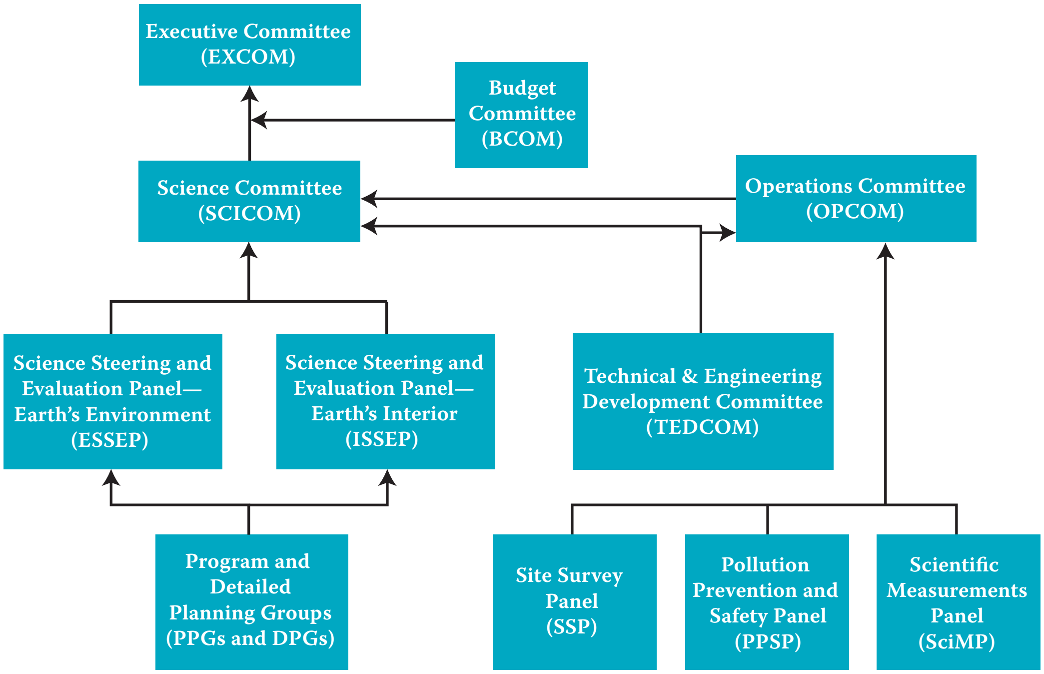
Scientific Direction

JOIDES Science Advisory Structure

The JOIDES SAS was restructured in 1996 to better undertake the initiatives and objectives contained in the 1996 long-range plan, *"Understanding our Dynamic Earth through Ocean Drilling"* (www.odplegacy.org/PDF/Admin/Long_Range/ODP_LRP_1996.pdf). The SAS structure as of 2003, at the end of ODP operations, is discussed below.

JOIDES was responsible for establishing scientific objectives for ODP legs through the SAS that involved more than 100 scientists and engineers on standing committees and panels and almost 100 in the shorter-lived planning groups. Each committee, panel, planning group, and working group operated under a mandate and with guidelines on membership and frequency of meetings. In addition to SCICOM and EXCOM, the JOIDES SAS consisted of the following groups:

JOIDES Science Advisory Structure (as of 2003)



- The Budget Committee (BCOM), a subcommittee of EXCOM, which was responsible for overseeing and reviewing ODP Program Plans and budgets.

- The Operations Committee (OPCOM), created as a subcommittee of SCICOM, which dealt with operational issues, such as ship scheduling, technological development, and scientific measurements.

- Two Science Steering and Evaluation Panels (SSEPs)—the Dynamics of Earth's Environment SSEP and the Dynamics of Earth's Interior SSEP—which provided SCICOM with evaluations of high-priority drilling proposals and advice on longer-term thematic development.

- The Site Survey Panel (SSP), which assessed the adequacy of survey data for proposed drilling targets and assisted in the international coordination and implementation of additional site surveys.

- The Pollution Prevention and Safety Panel (PPSP), which gave independent advice to OPCOM and to ODP on potential safety and pollution hazards that might exist because of general and specific geologic circumstances of proposed drill sites and advised proponents and Co-Chief Scientists on safe site selection.

- The Scientific Measurements Panel (SciMP), which contributed information and advice on handling of ODP samples and data and on methods and techniques used for all shipboard and downhole measurements and experiments.

- The Technology and Engineering Development Committee (TEDCOM), which provided long-term technological advice to SCICOM and OPCOM on drilling tools and techniques required to meet the objectives of planned drill holes, provided a forum for the exchange of ideas and information between ODP and the commercial drilling industry, and also identified and monitored the development of drilling tools and techniques needed to meet the objectives of the long-range plan.

- Ad hoc Detailed Planning Groups (DPGs), which were short-lived groups formed by SCICOM that met only once or twice for more intensive study of certain aspects of planning.

- Program Planning Groups (PPGs), which developed plans to address new ODP initiatives or to define new technological strategies and played a vital role in promoting high-priority scientific objectives in areas where proposals were lacking and in fostering communication and collaboration between ODP and other international geoscience programs.

- Working Groups, which were short-lived groups formed by SCICOM with the purpose of taking ideas originating from workshops or topics discussed at SAS panel meetings and developing possible models/strategies and recommendations for the assigned topic.

Mandates for these groups and minutes for meetings of many of these groups are available on the ODP Legacy Web site (www.odplegacy.org/program_admin/sas.html).

JOIDES Journal

Throughout ODP, the *JOIDES Journal* served as a means of communication among the JOIDES committees and advisory panels, NSF and non-U.S. participating organizations, JOI and its subcontractors, and interested earth scientists. The *JOIDES Journal* provided information on JOIDES committees and panels, cruise schedules, science summaries, and meeting schedules. The ODP Legacy Web site includes links to *JOIDES Journal* issues 1 through 30 (1975–2004) (www.odplegacy.org/program_admin/joides_journal.html).

Long-Range Planning

The report from the first Conference on Scientific Ocean Drilling (COSOD), held in November 1981, documented the scientific basis and justification for ODP. This report identified 12 major scientific themes for which JOIDES developed specific drilling plans. The report of the second COSOD meeting, held in July 1987, provided the framework for scientific ocean drilling through the 1990s.

The ODP Long Range Plan (published in 1990) distilled the COSOD themes, JOIDES panel white papers, and other scientific and technical advice into a scientific and engineering strategy from 1990 through 2002. A report from the October 1993 U.S. Committee on Post-1998 Ocean Drilling (COMPOST) meeting identified the needs of the U.S. scientific community for ocean drilling in the post-1998 time frame and related facility requirements. This report resulted in a second ODP Long Range Plan, published in 1996, that updated and extended the 1990 Long Range Plan (www.odplegacy.org/program_admin/long_range.html).

Predrilling Workshops

Predrilling Workshops provided opportunities for members of the scientific community to evaluate the current state of knowledge concerning a particular topic, or field of research, and discuss ways in which scientific ocean drilling could advance knowledge in that area. Workshop topics were selected on the basis of unsolicited proposals submitted by individuals willing to undertake the task of locating a suitable venue and organizing the proposed workshop. Participation was open to any interested member of the scientific community. A limited number of essential participants at each workshop received travel funds to support their participation. Financial support for the workshops was provided by USSSP, often in collaboration with other national or international funding agencies.

Following each workshop, the organizers were required to prepare a written report of the proceedings and recommendations of the workshop and were encouraged to publish a brief summary of their report for wider circulation. Workshop reports often formed the basis for specific drilling proposals subsequently submitted for consideration by the SAS. The ODP Legacy Web site includes a listing of all Predrilling Workshops held between June 1985 and July 2003 and links to reports from most of these workshops (www.odplegacy.org/program_admin/workshops.html).

Program Evaluation

Beginning in 1985, ODP was evaluated every 3–5 years by a panel of experts, the Performance Evaluation Committee (PEC), and recommendations were disseminated in their reports (www.odplegacy.org/program_admin/evaluation.html). Committee members were appointed by JOI on the advice of JOIDES, NSF, and other experts in geology, geophysics, ocean drilling, and logging technology.

PEC evaluations provided valuable feedback regarding the effectiveness of JOI program management and the performance of ODP-TAMU and ODP-LDEO and indicated whether the program was meeting its scientific goals. The evaluations also produced data or verified results that could be used for public relations and ODP promotion in the community. Recommendations and information obtained from PEC evaluations were not only used to improve ODP during the life of the Program but also served to determine what lessons were learned and what modifications (e.g., legacy preservation, overarching education and outreach plans, etc.) should be addressed for IODP, the successor program to ODP.

Program Management

ODP Policy Manual

ODP was managed and operated under policies and guidelines outlined in the ODP Policy Manual. The last revision of the manual (2003) is available on the ODP Legacy Web site (www.odplegacy.org/program_admin/policies.html).

Program Plans

ODP work was carried out in accordance with annual and multiyear Program Plans developed by JOI, ODP-TAMU, and ODP-LDEO in consultation with the NSF Program Officer and approved in writing by the NSF Contracting Officer. Program Plans addressed programmatic goals; scheduled activities; scheduled ship operations, staffing, and organizational plans; budgets; scientific objectives defined by JOIDES; and major planning and

review activities. Preparations for each annual Program Plan started a year in advance; the program plan was submitted to NSF a few months before the start of the fiscal year.

Leg Planning

After the SAS accepted a scientific ocean drilling proposal for incorporation into the drilling schedule, substantial preparations were required to ensure successful execution of the proposed program (www.odplegacy.org/program_admin/leg_planning.html). Some programs required multiple cruises for completion of the scientific objectives. Each individual cruise was referred to as a "leg" and had its own technical crew and shipboard scientific party. Leg planning was a collaborative effort involving the Science Operator, Wireline Services Operator, Co-Chief Scientists, and Drilling Contractor. The major tasks that had to be accomplished before the *JOIDES Resolution* sailed and the time frame during which these tasks had to be accomplished are described below. The detail, complexity, and level of effort required to plan a leg varied significantly depending on the location and the scientific and operational complexity of the proposed program.

12–18 Months Precruise

With input from the Science and Wireline Services Operators, OPCOM developed the ship schedule at least a year in advance. The schedule was constructed from the list of proposals approved for future ocean drilling, taking into account any priorities established by JOIDES. The Science Operator provided OPCOM with estimates of the ship time required for each proposal and identified operational issues (both engineering and weather) and possible port calls. The ship schedule was then constructed to maximize on-site time and minimize travel time between sites or to and from port. Proposals that did not require a full 2-month ODP leg were combined to maximize efficient use of ship time and to allow the Drilling Contractor to maintain a regular crew rotation.

9–12 Months Precruise

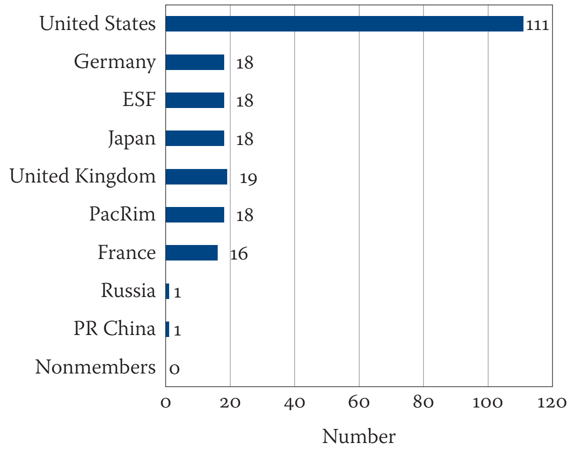
Special engineering/equipment needs and clearance requirements for operations in national waters of non-U.S. coastal states were identified. A detailed operations schedule was prepared, refining the preliminary time and material estimates in accordance with more specific plans for the leg.

Co-Chief Scientists were selected by the Science Operator from a list of individuals nominated by ODP member countries. The Co-Chief Scientist Agreement outlined their responsibilities and represented a contract between the Co-Chief Scientist and ODP (see "Appendix Q" of the ODP Policy Manual [www.odplegacy.org/program_admin/policies.html]). By accepting an invitation, Co-Chief Scientists acknowledged their responsibilities and obligations to the Program.

The following key operator personnel were also designated:

- The Leg Project Manager/Staff Scientist, a scientist on the staff of the Science Operator, was responsible for overseeing and coordinating all precruise preparations. This included coordinating drilling, logging, and science plans with the Co-Chief Scientists and other Science and Wireline Operator staff and maintaining regular communication with the members of the shipboard scientific party to keep them apprised of progress and remind them of preparations for which they were responsible (e.g., submitting sample requests, making travel arrangements, etc.) The Leg Project Manager then sailed on the leg as Staff Scientist, coordinating the efforts

ODP Co-Chief Scientists from Member Countries or Consortia



of the shipboard scientific party to ensure that the proposed shipboard work was accomplished in a timely manner, scientific objectives were met, and cruise results were documented in the appropriate reports and publications postcruise.

- The Operations Manager, an engineer on the staff of the Science Operator, was responsible for planning and overseeing all operational aspects of the leg. At sea, the Operations Manager oversaw the work of the Drilling Contractor and served as liaison between the Co-Chief Scientists and the drilling crew. The Operations Manager served as the Science Operator's representative on board the ship for

contractual matters relating to the Drilling Contractor's services.

- The Logging Staff Scientist, a member of the Wireline Services Operator staff, was responsible for planning the wireline and logging-while-drilling program for the leg. At sea, the Logging Staff Scientist was responsible for the execution of the logging program, including preliminary processing of logging results and production of logging-related reports in a timely manner and for contributing as a member of the shipboard scientific party.

- The Laboratory Officer, a member of the Science Operator staff, led the shipboard technical support staff and was responsible for all aspects of shipboard laboratory operations, including safety.

Co-Chief Scientists worked with the SSDB to develop a safety report for proposed drill sites. These reports were presented with supporting geophysical data to the PPSP at biannual meetings. Sites posing no hazard were approved for drilling. For sites posing potential hazards, the PPSP worked with the Co-Chief Scientists to find acceptable alternate sites that still met the leg's scientific objectives.

6–9 Months Precruise

A Precruise Meeting, led by the Leg Project Manager, was held for Co-Chief Scientists and key personnel. The objectives of the meeting included the following:

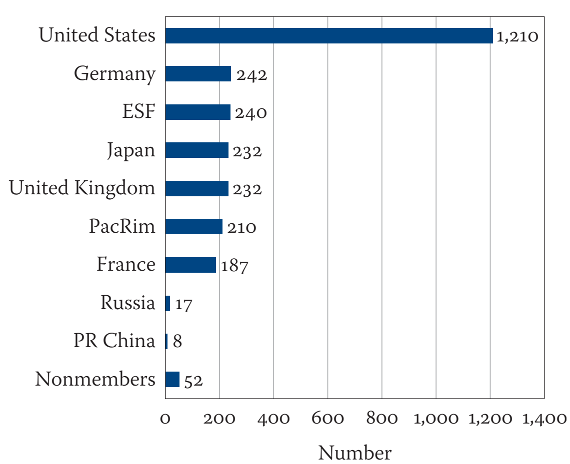
- Acquaint Co-Chief Scientists with key ODP staff involved in cruise planning and execution.

- Finalize operational plan and requirements.

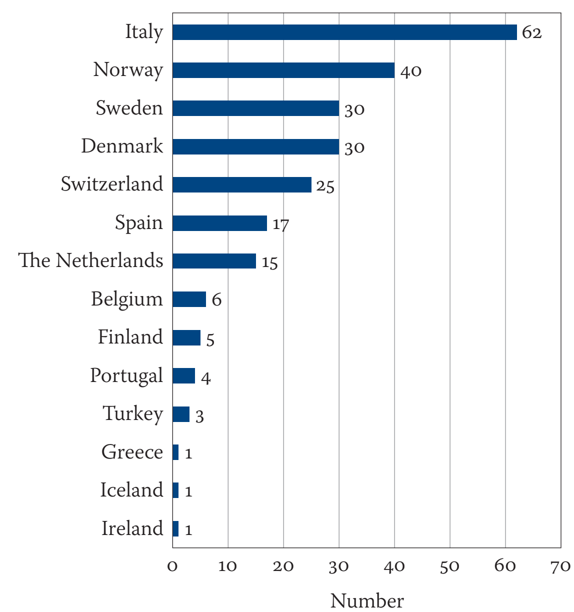
- Familiarize Co-Chief Scientists with ODP policies and procedures.

- Select shipboard scientific party members. Each ODP leg had a shipboard scientific party of approximately 24 scientists, in addition to the Co-Chief Scientists, Staff Scientist, and Logging Staff Scientist. Shipboard scientific party members were selected by the Science Operator, in consultation with the Co-Chief Scientists, from lists of individuals nominated by ODP

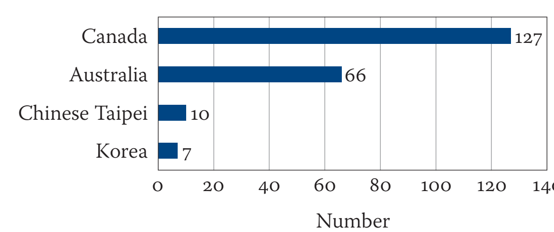
ODP Scientists from Member Countries or Consortia



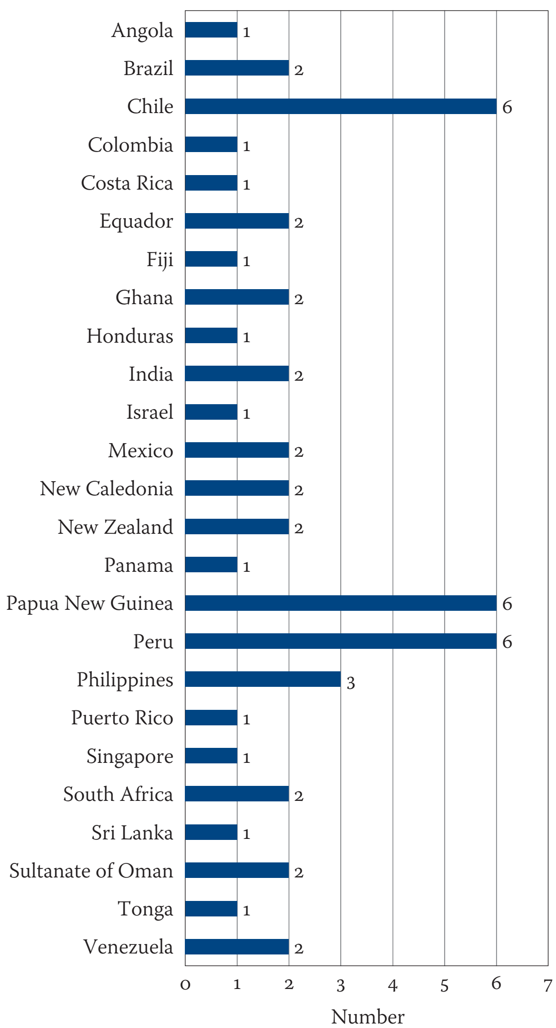
ODP Scientists from European Science Foundation Consortium



ODP Scientists from Pacific Rim Consortium



ODP Scientists from Nonmember Countries



member countries. The selection process took into account the expertise required to conduct the scientific program of the leg and the requirement to maintain a balance of representation from the different ODP members.

- Complete the *Scientific Prospectus,* which laid out the scientific and operational plan for the leg (www.odplegacy.org/samples_data/publications.html). In addition to providing information for prospective leg participants and others involved in ODP, the *Scientific Prospectus* formed the basis for the leg operational plan and future associated leg-related decisions and provided essential information for any necessary foreign clearance requests. Any departure from the plans set forth in the *Scientific Prospectus* required approval from the Science Operator and JOIDES. Changes to logging plans required approval from the Wireline Services Operator.

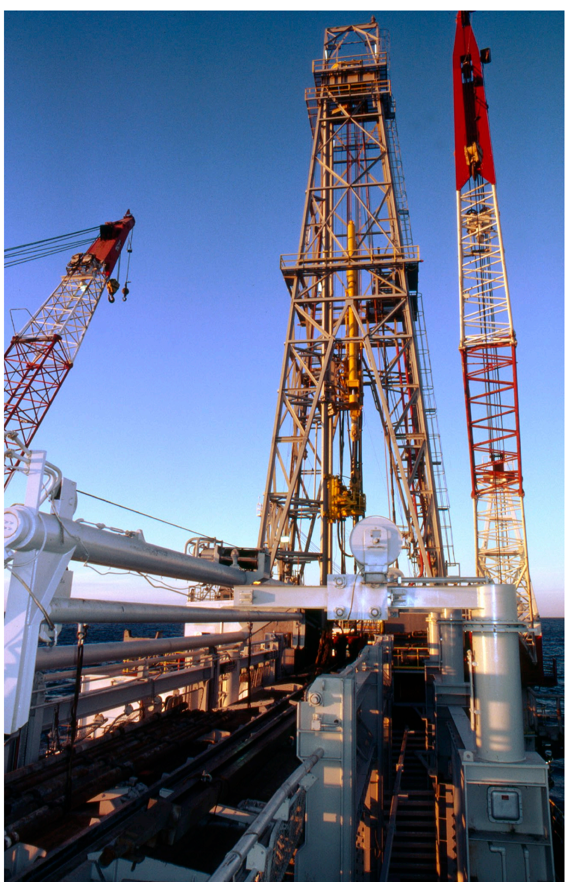
After the Precruise Meeting, applications were made, via the U.S. Department of State, for foreign clearances (if needed), and invitations were issued to prospective shipboard scientific party members that outlined the shipboard and postcruise tasks to be performed (see "Appendix R" of the ODP Policy Manual

[www.odplegacy.org/program_admin/policies.html]). In accepting an invitation, scientists acknowledged their responsibilities and obligations to the Program.

3–6 Months Precruise

Members of the shipboard scientific party submitted requests for samples necessary for them to carry out their work for the leg, and the sample requests were collated by the ODP Curator into an initial sampling plan. Conflicts resulting from duplication of requests or requests for excessive numbers of samples were resolved prior to the leg by the Sample Allocation Committee (SAC), which consisted of the Leg Project Manager, Co-Chief Scientists, and ODP Curator (see "Appendix D" of the ODP Policy Manual [www.odplegacy.org/program_admin/policies.html]). At sea, the Shipboard Curator replaced the Curator as a member of the SAC. With SAC approval, the sampling plan was often modified while the ship was at sea in response to the amount and type of core material recovered.

Also during this time frame, special laboratory requirements were identified, technical support staffing was completed, and shipping deadlines and procedures were established for materials going to the ship.



1–3 Months Precruise

Materials and supplies were gathered in one location to be packed for shipping and then shipped to the port of departure. Travel arrangements were verified for all leg participants and staff attending port call, and public relations and outreach activities associated with the leg were initiated. The SSDB compiled site survey data for scheduled sites and produced three data packages for delivery to the Co-Chief Scientists and the Science Operator.

2 Weeks Precruise

A Port Call Meeting was held between the Science Operator and Drilling Contractor personnel to coordinate upcoming port call activities.

1–0 Weeks Precruise

Port call logistics personnel coordinated the arrival of shipments, dock logistics, and other activities. Local port call activities were conducted, including public relations and media events (e.g., news conferences, receptions, tours of the ship, etc.), and the leg began.

Modifications to Operational Plan

It is important to note that, although the operational plan was defined at the Precruise Meeting, it was continuously refined as the scientific goals and objectives became more clearly defined, and the plan details were often modified after the ship sailed as a result of conditions encountered during drilling.

Postcruise Documentation

Within 2 months of the end of each leg, a *Preliminary Report* documenting preliminary scientific and operational results from the leg was published (www.odplegacy.org/samples_data/publications.html). In addition, the shipboard scientific party received a paper copy of the initial draft of the *Proceedings of the Ocean Drilling Program, Initial Reports* volume that contained scientific and engineering results from the ODP leg. This content was then edited and formatted by the ODP Publication Services staff in preparation for a meeting that was held 3–5 months postcruise at ODP-TAMU. During this weeklong meeting, the Co-Chief Scientists, Staff Scientists, and members of the shipboard scientific party finalized the content of the *Initial Reports* volume. The volume was published 1 year postcruise (www.odplegacy.org/samples_data/publications.html).

"…ODP managed to continuously and consistently serve the needs of individual scientists and the scientific objectives of ODP cruises…."

Scientists were required to conduct personal postcruise research after the end of each leg. A second Postcruise Meeting was held 12–24 months after the leg to provide an opportunity for the entire shipboard scientific party to share the results of their work. Also during the meeting, a list of all leg-related publications was generated. The Co-Chief Scientists and Staff Scientist were responsible for staying abreast of the work carried out postcruise and for carrying out Editorial Review Board duties. This included working with ODP Publication Services staff members who coordinated peer review of contributions to the *Scientific Results* volume and monitored manuscript submissions to other journals. The *Scientific Results* volume was initially published 3 years postcruise (Legs 101–163) and subsequently published 4 years postcruise (www.odplegacy.org/samples_data/publications.html).

In addition to the *Proceedings* series, postcruise documentation included detailed laboratory and tool manuals, technical reports, and other legacy documents that were produced during the life span of the Program.

Contractual and Financial Accountability

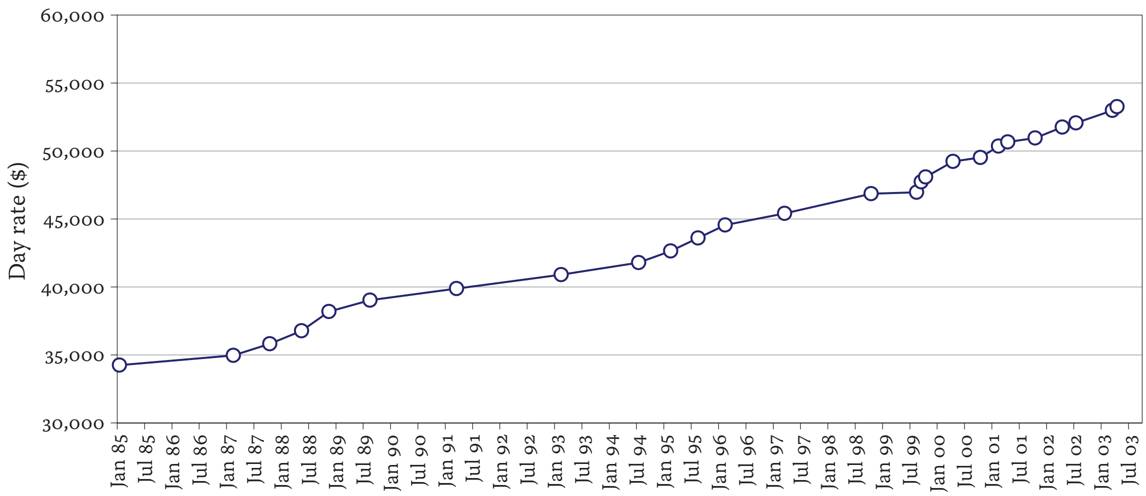
JOI consistently received top marks from NSF in annual performance evaluations for delivery

of the full range of ODP services. Annual and triannual audits of JOI's financial records for compliance with U.S. Office of Management and Budget (OMB) Circular 133 identified only 0.0003% in disallowed costs over the past 5 years. Audits of ODP-LDEO identified no disallowed costs since 1989, and audits of ODP-TAMU disallowed only 0.0008% of expenditures to date.

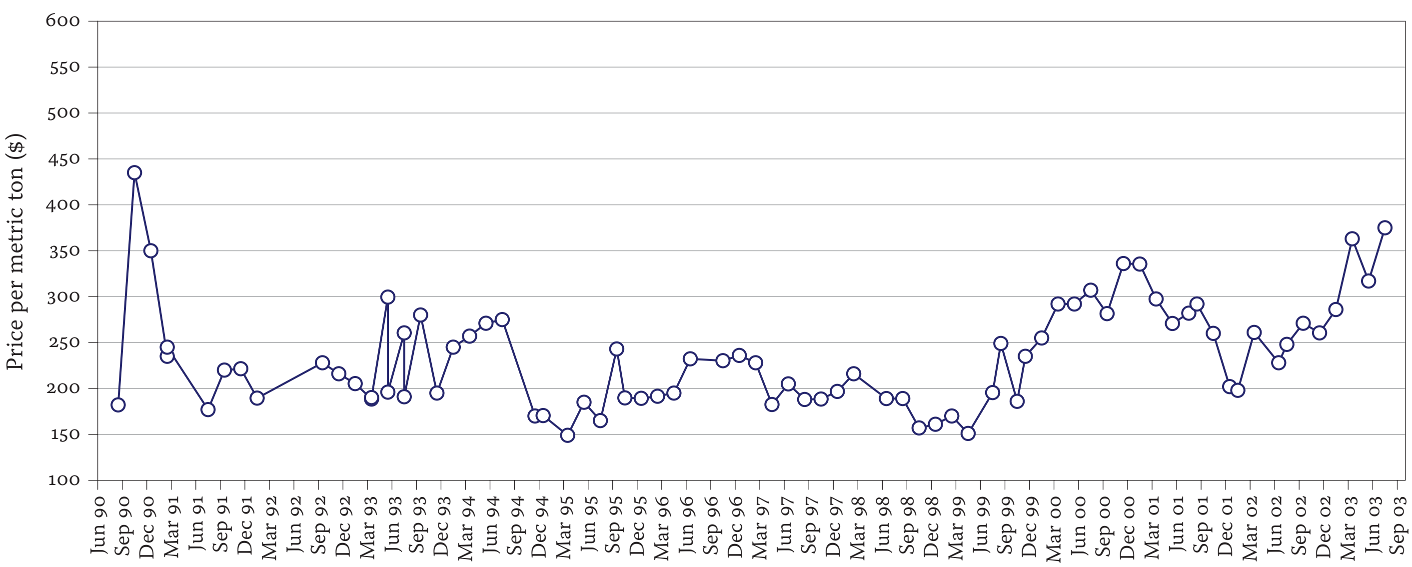
Economic Context

During the last 10 operating years of ODP, operating day rate costs increased 30% and the average price of fuel per metric ton increased more than 50%; however, during the last 8

***JOIDES Resolution* Operating Day Rate**
January 1985 to October 2003



ODP Fuel Prices, 1990–2003



years of operations, awarded funds increased only 3%. Despite this disparity, ODP-TAMU and ODP-LDEO managed to continuously and consistently serve the needs of individual scientists and the scientific objectives of ODP cruises, follow the advice and recommendations of international technical and scientific advisory panels, acknowledge the mandates of the international advisory and governance structure of ODP, and meet contractual terms set by NSF and the ODP Council.

The success of the Program was due, in part, to a variety of cost-control measures initiated by ODP-TAMU and ODP-LDEO. For example, in 1994 and 1998, ODP-TAMU, through TAMRF, renegotiated a subcontract with ODL for the *JOIDES Resolution* that resulted in rates 50% lower than commercial rates. ODP-TAMU negotiated a 47% reduction in insurance costs and ODP-LDEO negotiated a low average insurance rate of 13% of the equipment value over the past 12 years. In addition, LDEO's Schlumberger subcontract for logging services supported cooperative cost control, resulting in rates 30%–40% lower than industry rates. Such reductions were possible because of the excellent operations record of ODP.

ODP Funding Summary

Fiscal Year	Program Plan	Annual Expenditures
1994	$ 45,088,726	$ 39,362,762
1995	44,000,000	43,165,773
1996	44,400,000	46,299,977
1997	45,236,525	44,208,451
1998	49,138,998	45,270,433
1999	48,532,000	48,186,549
2000	46,626,060	49,790,792
2001	46,536,058	46,294,636
2002	47,985,258	47,078,006
2003	46,582,529	46,192,619
2004	12,927,935	9,393,019
2005	3,203,032	2,924,313
2006	3,934,893	2,068,974
2007*	1,999,621	2,057,697
Total	$ 486,191,635	$ 472,294,001

Note: * as of August 2007.

Cruise Evaluation Quotes

"It is an amazing experience to be able to walk on to a ship and carry out a scientific program that is technically very complex…. The overall reliability of the operation (on the rig floor and in the labs) is something that ODP can be proud of."

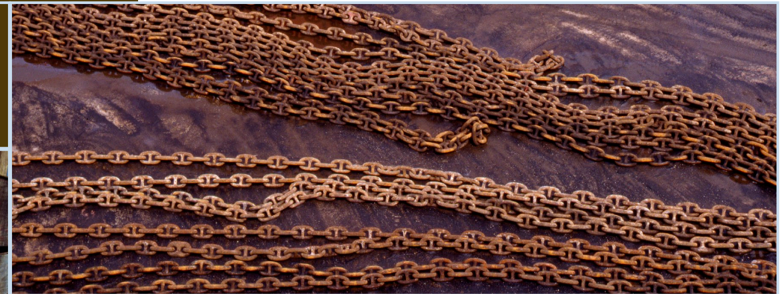
"I am very impressed with the management of technology on board from the active heave compensator (extraordinary piece of technology) to the laboratories."

"I am impressed with the improvements to the ship and her capabilities since the last time I sailed. When last I sailed, the idea of a Janus database was just a gleam in the eye! After my 5th leg, I am still in awe of the sheer professionalism of the whole undertaking. Given the technical challenges that were met on this leg, I have to say that the ship and crew did an excellent job making sure that we achieved as much as possible."

"Shore-based friendships and collaborations have definitely stemmed from this cruise and will certainly last a lifetime. A week's worth of work is accomplished in one 24-hour period, so it is absolutely necessary to be out here with as many resources as possible. I think ODP has accomplished that…."

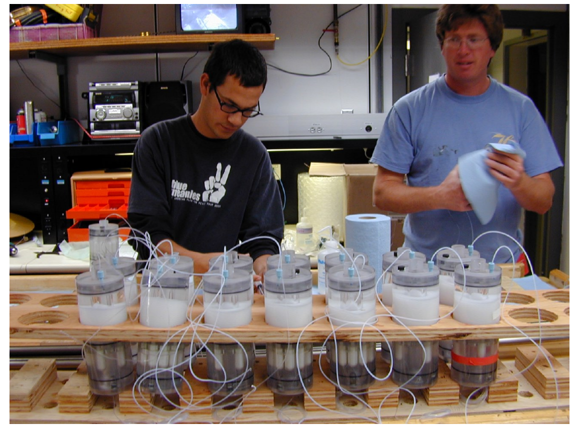
"I found the general organization on board particularly impressive—it is practically perfect."

"The techs are a really knowledgeable group of people without whom the quality of science on this ship would certainly deteriorate."



Scientific Results

The Ocean Drilling Program (ODP) ranks as one of the most significant international scientific endeavors ever, rivaling the international collaborations among physicists in the early 20th century. ODP traversed the world's oceans from the Arctic Ocean to the Weddell Sea, collecting sediment and rock samples, recording downhole geophysical and geochemical information, and establishing long-term borehole observatories. More than 2,500 scientists representing more than 220 institutions sailed on ODP legs (see "Leg Planning" in the "Program Administration" chapter). These legs retrieved 36,365 cores—nearly 223 kilometers of sediment and rock—leading to more than 7,200 peer-reviewed scientific publications. The "Scientific Themes/Objectives" figure below illustrates the number of legs devoted to each of the scientific themes that were drawn from the 1989–2002 ODP Long Range Plan and pursued during the Program.

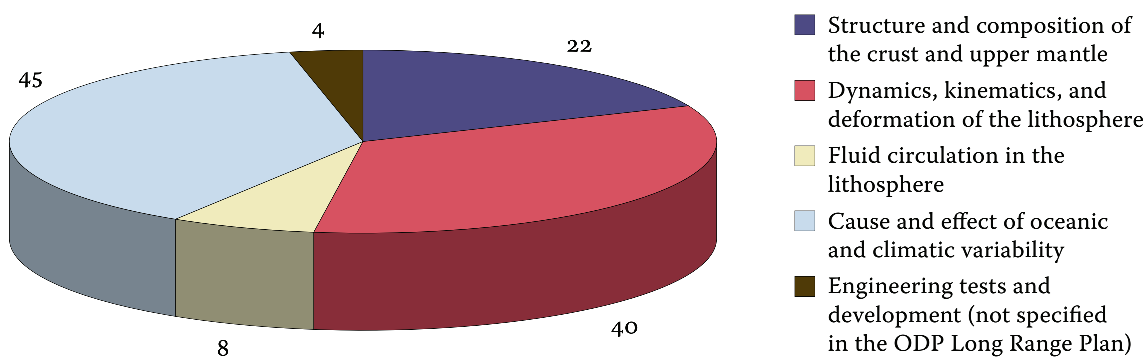


"ODP ranks as one of the most significant international scientific endeavors ever..."

Scientific ocean drilling has made fundamental contributions to our understanding of the Earth. For instance, we now know that the paradigm of plate tectonics offers tremendous new insights into the way Earth works, including a better understanding of natural hazards such as earthquakes and volcanoes. ODP scientific research has deepened our understanding of the mechanics of plate tectonics and continental drift by elucidating various plate motions and evolution of continental drift over the past 100 to 120 million years, demonstrating that hotspots—once thought to be stationary—can slowly migrate, confirming that the oldest ocean crust is younger than Jurassic in age, and quantifying the amount of ocean sediment recycled into Earth's mantle at subduction zones.

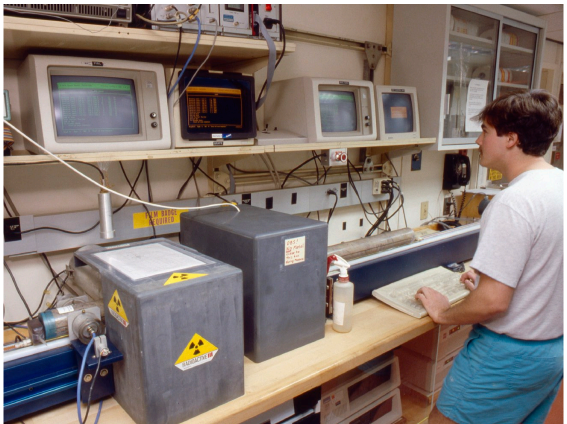
Studies of marine sediments have resulted in a much better understanding of natural climatic variability, and we are beginning to learn how to factor global change into planning for the future. We have established and quantified

ODP Legs Grouped by Scientific Themes/Objectives from the 1989–2002 Long Range Plan



global environmental changes over the past 100 to 120 million years by discovering rapid (decadal) climate change as a global phenomenon, documenting and quantifying climate extremes (including ocean anoxic events) over the last 120 million years, and confirming details of the "hothouse" world 55 million years ago when tropical climates prevailed at the polar regions. ODP scientists proposed the hypothesis that rapid (decadal) climate change was initiated by global decomposition of methane hydrates in ocean sediments and confirmed the timing of the gateway opening between Australia and Antarctica, which was critical to the establishment of the Antarctic Circumpolar Current that ended the "hothouse" era and began a 40-million-year cooling of the Earth. ODP scientists established the hypothesis that uplift of the Himalayas enhanced global cooling, determined the history of sea level rise and fall over the past 60 million years, and discovered global environmental impacts caused by the extrusion of large volumes of igneous rocks known as "large igneous provinces." Research results also documented extreme drought in Central East Africa, thought to have been the impetus for human migration from Africa 1–2 million years ago.

During scientific ocean drilling cruises, evidence was found for present-day formation of huge ore-grade deposits of iron, copper, and zinc precipitated out of hydrothermal fluids heated to more than 300°C and rising as hot springs from the center of spreading ridges.



Evidence was also found for large amounts of less-heated water percolating through the ridge flanks, which has implications for the recycling of ocean water through the crust. Thus, the understanding of the formation of submarine copper and zinc mineral resources was revolutionized, leading international resource companies to revise their exploration strategies (annual impact of roughly $500 million).

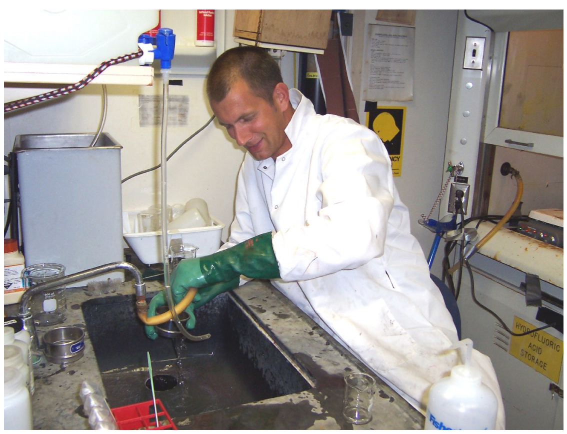
We know that Earth was even more thermally active during the Cretaceous, when enormous plumes of mantle rock rose beneath the lithosphere and triggered the formation of individual volcanoes and volcanic plateaus at rates unknown in today's world. Scientific ocean drilling has changed the understanding of the nature and genesis of geologic hazards by evaluating fluid flow in the accretionary

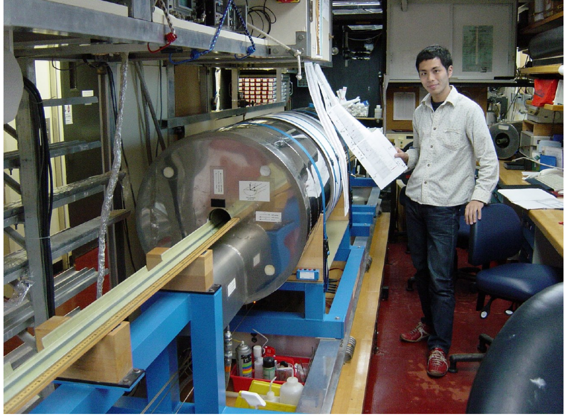
"Scientific ocean drilling has made fundamental contributions to our understanding of the Earth."

sediments in subduction zones and elucidating the role of water in subduction zone earthquakes, determining the significance of mud volcanoes in subduction zone dehydration and the connection of dehydration to earthquakes and explosive volcanoes, and discovering the existence and cause of major undersea landslides of sufficient size to generate large tsunamis. With an eye toward the future, ODP established seafloor observatories to monitor earthquakes, tsunamis, and fluid flow in ocean sediments and crust.

Results from scientific ocean drilling research have confirmed that large volumes of natural gas (methane) are frozen within deep-sea marine sediments as gas hydrates and have produced quantitative measurements of the amount of inert gas hydrate and gas offshore South Carolina. ODP has determined the nature of chemosynthetic communities associated with methane hydrates in ocean sediments, documented the vertical and horizontal distribution of methane hydrates in ocean sediments, and acquired the necessary core and downhole data at key sites to quantify the volume of gas (and carbon) and infer the size of the global methane hydrate reservoir in ocean sediments.

Scientific ocean drilling research confirmed the catastrophic impact of a meteorite with Earth 65 million years ago that led to the extinction of dinosaurs and other plants and animals at the end of the Cretaceous Period. Drilling research also determined that the oceanic crust is home to an unforeseen microbial community called the deep biosphere, whose





"ODP experience has shown that future studies will bring more startling and unexpected discoveries than we could ever have expected."

concentration is small but, because oceanic crust is the most abundant rock sequence on Earth, may contain a significant fraction of Earth's biomass.

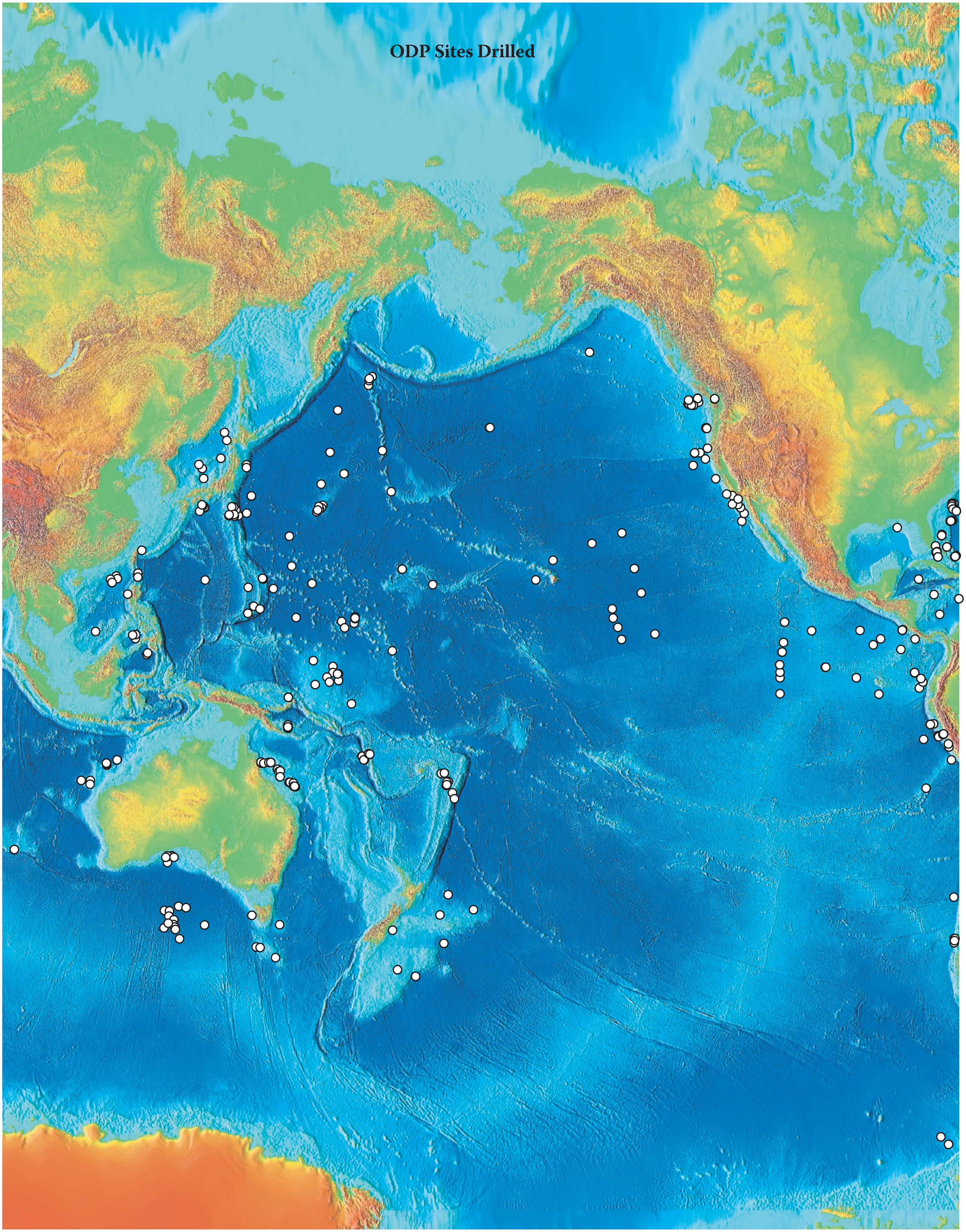
These fundamental contributions to our understanding of the Earth have simultaneously shown how little we know of the sediment and rock under the oceans. The following map of ODP drilled sites reveals how much of the ocean floor remains to be explored—how much more there is to discover. For the past 30 years, scientific ocean drilling has been the inward-looking "telescope" for the integrated study of how Earth works as a dynamic planet. ODP experience has shown that future studies will bring more startling and unexpected discoveries than we could ever have expected.

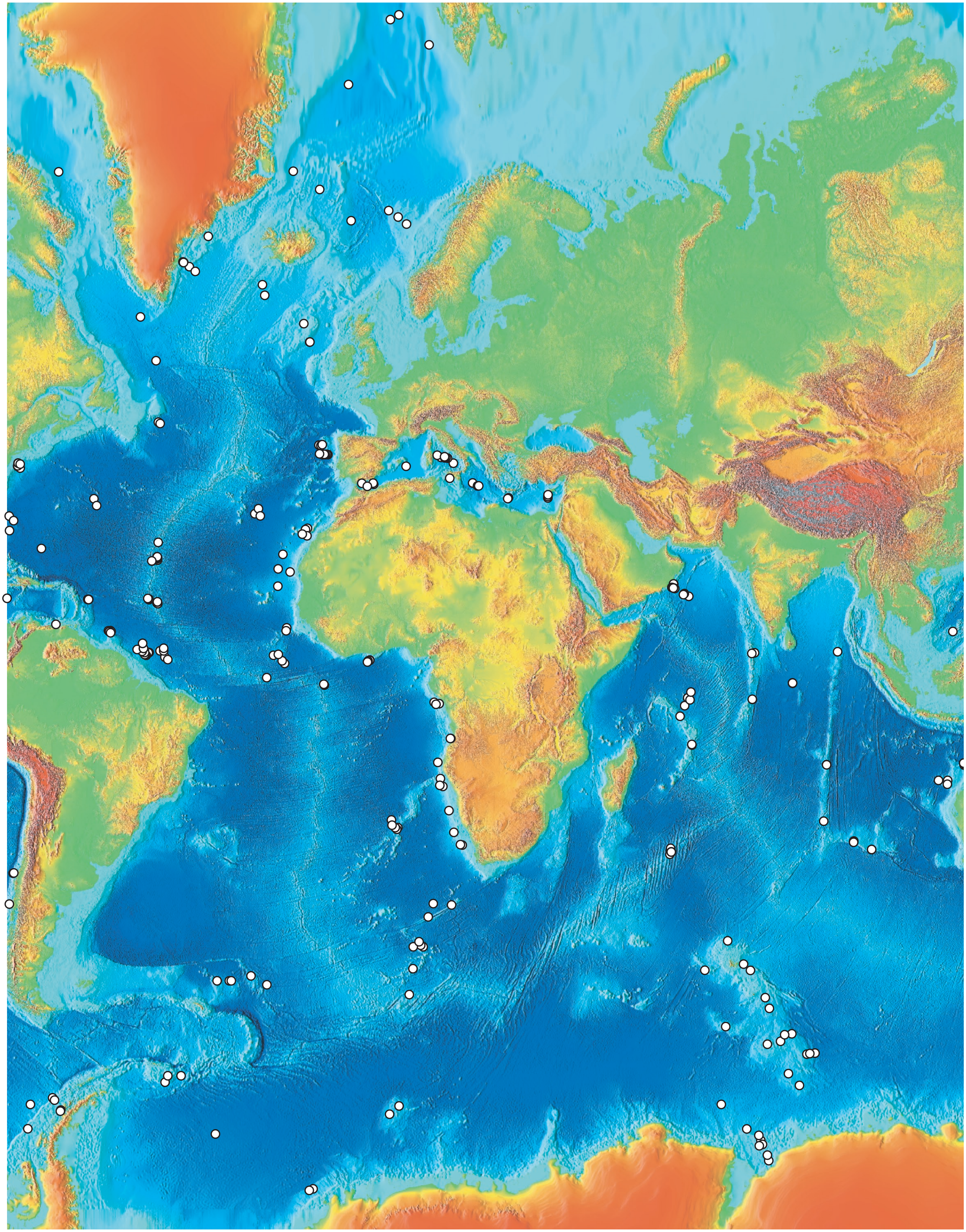
ODP Leg Summary

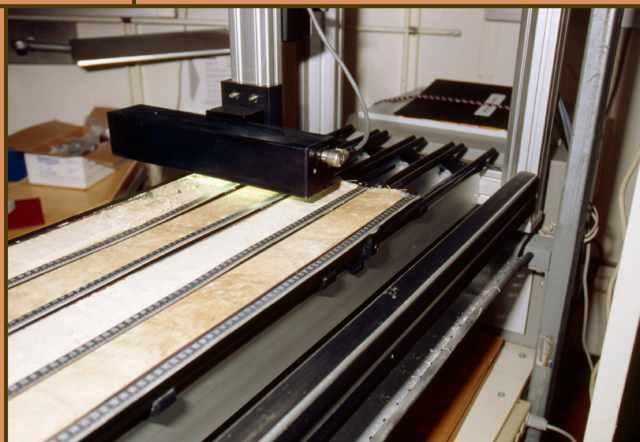
Leg	Start date	End date	Port	Sites	Region	Staff Scientists (TAMU, LDEO)	Co-Chief Scientists
100	1/11/85	1/29/85	Pascagoula, Mississippi	625	Northeastern Gulf of Mexico	Kidd	Rabinowitz, Garrison
101	1/29/85	3/14/85	Miami, Florida	626–636	Bahamas	Palmer	Austin, Schlager
102	3/14/85	4/25/85	Miami, Florida	418	Bermuda Rise	Auroux, Moos	Salisbury, Scott
103	4/25/85	6/19/85	Ponta Delgada, Azores Islands	637–641	Galicia Margin	Meyer, Goldberg	Boillot, Winterer
104	6/19/85	8/23/85	Bremerhaven, Germany	642–644	Norwegian Sea	Taylor, Barton	Eldholm, Thiede
105	8/23/85	10/27/85	St. John's, Newfoundland	645–647	Baffin Bay and Labrador Sea	Clement, Jarrard	Arthur, Srivastava
106	10/27/85	12/26/85	St. John's, Newfoundland	648–649	Mid-Atlantic Ridge	Adamson	Detrick, Honnorez
107	12/26/85	2/18/86	Malaga, Spain	650–656	Tyrrhenian Sea	Auroux, Broglia	Kastens, Mascle
108	2/18/86	4/17/86	Marseille, France	657–668	Eastern Tropical Atlantic	Baldauf	Ruddiman, Sarnthein
109	4/17/86	6/19/86	Dakar, Senegal	395, 648, 669–670	Mid-Atlantic Ridge	Adamson, Moos	Bryan, Juteau
110	6/19/86	8/16/86	Bridgetown, Barbados	671–676	Barbados Ridge	Taylor, Williams	Moore, Mascle
111	8/16/86	10/20/86	Bridgetown, Barbados	504, 677–678	Costa Rica Rift	Merrill, Lovell	Becker, Sakai
112	10/20/86	12/25/86	Callao, Peru	679–688	Peru Continental Margin	Emeis, Greenberg	Von Huene, Suess
113	12/25/86	3/11/87	Valparaíso, Chile	689–697	Weddell Sea and Antarctica	O'Connell, Golovchenko	Kennett, Barker
114	3/11/87	5/13/87	East Cove, Falkland Islands	698–704	Subantarctic South Atlantic	Clement, Mwenifumbo	Ciesielski, Kristoffersen
115	5/13/87	7/2/87	Port Louis, Mauritius	705–716	Mascarene Plateau	McDonald, Hobart	Backman, Duncan
116	7/2/87	8/19/87	Colombo, Sri Lanka	717–719	Distal Bengal Fan	Auroux, Williams	Cochran, Stow
117	8/19/87	10/18/87	Colombo, Sri Lanka	720–731	Oman Margin	Emeis, Jarrard	Prell, Niitsuma
118	10/18/87	12/14/87	Port Louis, Mauritius	732–735	Southwest Indian Ridge	Adamson, Goldberg	Robinson, Von Herzen
119	12/14/87	2/21/88	Port Louis, Mauritius	736–746	Kerguelen Plateau and Prydz Bay	Baldauf, Ollier	Barron, Larsen
120	2/21/88	4/30/88	Fremantle, Australia	747–751	Central Kerguelen Plateau	Palmer, Pratson	Schlich, Wise
121	4/30/88	6/28/88	Fremantle, Australia	752–758	Broken Ridge and Ninetyeast Ridge	Taylor, Wilkinson	Weissel, Peirce
122	6/28/88	8/28/88	Singapore, Singapore	759–764	Exmouth Plateau	O'Connell, Golovchenko	Von Rad, Haq
123	8/28/88	11/1/88	Singapore, Singapore	765–766	Argo Abyssal Plain and Exmouth Plateau	Adamson, Castillo	Gradstein, Ludden
124	11/1/88	1/4/89	Singapore, Singapore	767–771	Celebes and Sulu Seas	Von Breymann, Jarrard	Silver, Rangin
124E	1/4/89	2/16/89	Apra Harbor, Guam	772–777	Philippine Sea	Rose	None
125	2/16/89	4/18/89	Apra Harbor, Guam	778–786	Bonin/Mariana Region	Stokking, Hobart	Fryer, Pearce
126	4/18/89	6/19/89	Tokyo, Japan	787–793	Bonin Arc-Trench System	Janecek, Pezard	Fujioka, Taylor
127	6/19/89	8/21/89	Tokyo, Japan	794–797	Japan Sea	Allan, Schaar	Pisciotto, Tamaki
128	8/21/89	11/20/89	Pusan, South Korea	794, 798–799	Japan Sea	Von Breymann, Bristow	Suyehiro, Ingle
129	11/20/89	1/19/90	Apra Harbor, Guam	800–802	Pigafetta and Mariana Basins	Fisher, Molinie	Larson, Lancelot
130	1/19/90	3/27/90	Apra Harbor, Guam	803–807	Ontong Java Plateau	Janecek, Lyle	Berger, Kroenke
131	3/27/90	6/1/90	Apra Harbor, Guam	808	Nankai Trough	Firth, Chabernaud	Taira
132	6/1/90	8/4/90	Pusan, South Korea	809–810	Western and Central Pacific	Rack	Natland
133	8/4/90	10/11/90	Apra Harbor, Guam	811–826	Northeast Australian Margin	Julson, Jarrard	Davies, McKenzie
134	10/11/90	12/17/90	Townsville, Australia	827–833	Vanuatu (New Hebrides)	Stokking, Hobart	Collot, Greene
135	12/17/90	2/28/91	Suva, Fiji	834–841	Lau Basin	Allan, Reynolds	Hawkins, Parson
136	2/28/91	3/20/91	Honolulu, Hawaii	842–843	Hawaiian Arch	Firth, Goldberg	Dziewonski, Wilkens
137	3/20/91	5/1/91	Honolulu, Hawaii	504	Costa Rica Rift	Graham, Kramer	Becker, Foss
138	5/1/91	7/4/91	Balboa, Panama	844–854	Eastern Equatorial Pacific	Janecek, Lyle	Pisias, Mayer
139	7/4/91	9/11/91	San Diego, California	855–858	Middle Valley and Juan de Fuca Ridge	Fisher, Langseth	Davis, Mottl
140	9/11/91	11/12/91	Victoria, British Columbia	504	Costa Rica Rift	Stokking, Pezard	Dick, Erzinger
141	11/12/91	1/12/92	Balboa, Panama	859–863	Chile Triple Junction	Musgrave, Golovchenko	Behrmann, Lewis
142	1/12/92	3/18/92	Valparaíso, Chile	864	East Pacific Rise	Allan	Batiza
143	3/18/92	5/20/92	Honolulu, Hawaii	865–870	Northwest Pacific Atolls and Guyots	Firth, Golovchenko	Winterer, Sager
144	5/20/92	7/20/92	Majuro, Marshall Islands	801, 871–880	Northwest Pacific Atolls and Guyots	Rack, Ladd	Haggerty, Premoli-Silva
145	7/20/92	9/20/92	Yokohama, Japan	881–887	North Pacific Transect	Janecek, deMenocal	Rea, Basov
146	9/20/92	11/22/92	Victoria, British Columbia	888–893	Cascadia Margin	Musgrave, Jarrard	Carson, Westbrook
147	11/22/92	1/21/93	San Diego, California	894–895	Hess Deep Rift Valley	Allan, Célérier	Gillis, Mével
148	1/21/93	3/10/93	Balboa, Panama	504, 896	Costa Rica Rift	Stokking, Pezard	Alt, Kinoshita
149	3/10/93	5/25/93	Balboa, Panama	897–901	Iberia Abyssal Plain	Klaus, Hobart	Sawyer, Whitmarsh
150	5/25/93	7/25/93	Lisbon, Portugal	902–906	New Jersey Continental Slope and Rise	Blum, Guerin	Mountain, Miller
151	7/25/93	9/24/93	St. John's, Newfoundland	907–913	North Atlantic-Arctic Gateway	Firth, Bristow	Myhre, Thiede
152	9/24/93	11/22/93	Reykjavík, Iceland	914–919	East Greenland Margin	Clift, Cambray	Larsen, Saunders
153	11/22/93	1/24/94	St. John's, Newfoundland	920–924	Mid-Atlantic Ridge	Miller, Rodway	Karson, Cannat
154	1/24/94	3/25/94	Bridgetown, Barbados	925–929	Ceara Rise	Richter, deMenocal	Curry, Shackleton
155	3/25/94	5/25/94	Bridgetown, Barbados	930–946	Amazon Fan	Klaus, Thibal	Flood, Piper
156	5/24/94	7/24/94	Bridgetown, Barbados	947–949	Northern Barbados Ridge	Blum, Goldberg	Shipley, Ogawa

ODP Leg Summary (continued)

Leg	Start date	End date	Port	Sites	Region	Staff Scientists (TAMU, LDEO)	Co-Chief Scientists
157	7/24/94	9/23/94	Bridgetown, Barbados	950–956	Gran Canaria and Madeira Abyssal Plain	Firth, Bristow	Schmincke, Weaver
158	9/23/94	11/22/94	Las Palmas de Gran Canaria	957	Trans-Atlantic Geotraverse	Miller, Guerin	Humphris, Herzig
159T	12/23/94	1/3/95	Las Palmas de Gran Canaria	958	Eastern Canary Basin	Firth	None
159	1/3/95	3/2/95	Dakar, Senegal	959–962	Eastern Equatorial Atlantic	Clift, Ewert	Mascle, Lohmann
160	3/2/95	5/2/95	Marseille, France	963–973	Mediterranean Sea I	Richter, Major	Emeis, Robertson
161	5/2/95	7/2/95	Napoli, Italy	974–979	Mediterranean Sea II	Klaus, de Larouziere	Comas, Zahn
162	7/2/95	9/3/95	Leith, Scotland	907, 980–987	North Atlantic-Arctic Gateways II	Blum, Higgins	Jansen, Raymo
163	9/3/95	10/7/95	Reykjavík, Iceland	988–990	Southeast Greenland Margin	Allan, Cambray	Larsen, Duncan
164	10/7/95	12/19/95	Halifax, Nova Scotia	991–997	Blake Ridge and Carolina Rise	Wallace, Ladd	Matsumoto, Paull
165	12/19/95	2/18/96	Miami, Florida	998–1002	Carribean Sea	Acton, Louvel	Leckie, Sigurdsson
166	2/17/96	4/10/96	San Juan, Puerto Rico	1003–1009	Bahamas Transect	Malone, Pirmez	Eberli, Swart
167	4/20/96	6/16/96	Acapulco, Mexico	1010–1022	California Margin	Richter, deMenocal	Koizumi, Lyle
168	6/16/96	8/15/96	San Francisco, California	1023–1032	Juan de Fuca Ridge	Firth, Sun	Davis, Fisher
169S	8/15/96	8/21/96	Victoria, British Columbia	1033–1034	Saanich Inlet	Firth	Bornhold
169	8/21/96	10/16/96	Victoria, British Columbia	856–858, 1035–1038	Northeast Pacific Ocean	Miller, Guerin	Fouquet, Zierenberg
170	10/16/96	12/17/96	San Diego, California	1039–1043	Costa Rica Accretionary Wedge	Blum, Myers	Kimura, Silver
171A	12/17/96	1/8/97	Balboa, Panama	1044–1048	Northern Barbados Ridge	Klaus, Saito	Moore
171B	1/8/97	2/14/97	Bridgetown, Barbados	1049–1053	Blake Nose Paleoceanographic Transect	Klaus, Alexander	Kroon, Norris
172	2/14/97	4/15/97	Charleston, South Carolina	1054–1064	Northwest Atlantic	Acton, Williams	Keigwin, Rio
173	4/15/97	6/15/97	Lisbon, Portugal	1065–1070	Iberia	Wallace, Louvel	Whitmarsh, Beslier
174A	6/15/97	7/19/97	Halifax, Nova Scotia	1071–1073	New Jersey Mid-Atlantic Transect	Malone, Pirmez	Austin, Christie-Blick
174B	7/19/97	8/9/97	New York, New York	395, 1074	North Atlantic Ocean	Malone, Goldberg	Becker
175	8/9/97	10/8/97	Las Palmas de Gran Canaria	1075–1087	Benguela Current	Richter, Cambray	Berger, Wefer
176	10/8/97	12/9/97	Cape Town, South Africa	735	Indian Ocean	Miller, Iturrino	Dick, Natland
177	12/9/97	2/5/98	Cape Town, South Africa	1088–1094	Southern Ocean	Blum, Ninnemann	Gersonde, Hodell
178	2/5/98	4/9/98	Punta Arenas, Chile	1095–1103	Antarctic Peninsula	Acton, Williams	Barker, Camerlenghi
179	4/9/98	6/7/98	Cape Town, South Africa	1104–1107	Indian Ocean	Miller, Myers	Pettigrew, Casey
180	6/7/98	8/11/98	Darwin, Australia	1108–1118	Woodlark Basin and Papua New Guinea	Klaus, Célérier	Taylor, Huchon
181	8/11/98	10/8/98	Sydney, Australia	1119–1125	Southwest Pacific Gateways	Richter, Handwerger	Carter, McCave
182	10/8/98	12/7/98	Wellington, New Zealand	1126–1134	Great Australian Bight	Malone, Spence	Feary, Hine
183	12/7/98	2/11/99	Fremantle, Australia	1135–1142	Kerguelen Plateau-Broken Ridge	Wallace, Delius	Coffin, Frey
184	2/11/99	4/12/99	Fremantle, Australia	1143–1148	South China Sea	Blum, Lauer-Leredde	Wang, Prell
185	4/12/99	6/14/99	Hong Kong	801, 1149	Izu-Mariana Margin	Escutia, Guerin	Plank, Ludden
186	6/14/99	8/14/99	Yokohama, Japan	1150–1151	Western Pacific	Acton, Sun	Sacks, Suyehiro
187	11/16/99	1/10/00	Fremantle, Australia	1152–1164	Australian-Antarctic Discordance	Miller, Einaudi	Christie, Pedersen
188	1/10/00	3/11/00	Fremantle, Australia	1165–1167	Prydz Bay-Cooperation Sea and Antarctica	Richter, Williams	Cooper, O'Brien
189	3/11/00	5/6/00	Hobart, Tasmania	1168–1172	Tasmanian Gateway	Malone, Ninnemann	Exon, Kennett
190	5/6/00	7/16/00	Sydney, Australia	1173–1178	Nankai II	Klaus, Tobin	Moore, Taira
191	7/16/00	9/8/00	Yokohama, Japan	1179–1182	Northwest Pacific	Escutia, Einaudi	Kanazawa, Sager
192	9/8/00	11/7/00	Apra Harbor, Guam	1183–1187	Ontong Java Plateau	Wallace, Cairns	Mahoney, Fitton
193	11/7/00	1/3/01	Apra Harbor, Guam	1188–1191	Manus Basin	Miller, Iturrino	Binns, Barriga
194	1/3/01	3/2/01	Townsville, Australia	1192–1199	Marion Plateau and Northeast Australia	Blum, Delius	Isern, Anselmetti
195	3/2/01	5/2/01	Apra Harbor, Guam	1200–1202	Mariana/West Pacific	Richter, Barr	Salisbury, Shinohara
196	5/2/01	7/1/01	Keelung, Taiwan	808, 1173	Nankai II	Klaus, Saito	Mikada, Becker, Moore
197	7/1/01	8/27/01	Yokohama, Japan	1203–1206	North Pacific Basin	Scholl, Einaudi	Duncan, Tarduno
198	8/27/01	10/23/01	Yokohama, Japan	1207–1214	Shatsky Rise	Malone, Williams	Bralower, Premoli-Silva
199	10/23/01	12/16/01	Honolulu, Hawaii	1215–1222	Paleogene Equatorial Transect (Pacific Ocean)	Janecek, Gaillot	Lyle, Wilson
200	12/16/01	1/27/02	Honolulu, Hawaii	1223–1224	Central Pacific	Acton, Sun	Kasahara, Stephen
201	1/27/02	3/29/02	San Diego, California	1225–1231	Eastern Equatorial Pacific and Peru Margin	Miller, Guerin	D'Hondt, Jørgensen
202	3/29/02	5/30/02	Valparaíso, Chile	1232–1242	Southeast Pacific	Blum, Ninnemann	Mix, Tiedemann
203	5/30/02	7/7/02	Balboa, Panama	1243	Equatorial Pacific	Davies, Buysch	Orcutt, Schultz
204	7/7/02	9/2/02	Victoria, British Columbia	1244–1252	Cascadia Margin	Rack, Guerin	Bohrmann, Tréhu
205	9/2/02	11/6/02	Victoria, British Columbia	1253–1255	Costa Rica Continental Margin	Klaus, Moe	Morris, Villinger
206	11/6/02	1/4/03	Balboa, Panama	1256	Guatemala Basin	Acton, Einaudi	Teagle, Wilson
207	1/4/03	3/6/03	Bridgetown, Barbados	1257–1261	Demerara Rise	Malone, Rea	Erbacher, Mosher
208	3/6/03	5/6/03	Rio de Janeiro, Brazil	1262–1267	Walvis Ridge	Blum, Gaillot	Kroon, Zachos
209	5/6/03	7/6/03	Rio de Janeiro, Brazil	1268–1275	Mid-Atlantic Ridge	Miller, Iturrino	Kelemen, Kikawa
210	7/6/03	9/6/03	St. George, Bermuda	1276–1277	Newfoundland Margin	Klaus, Delius	Sibuet, Tucholke


ODP Sites Drilled



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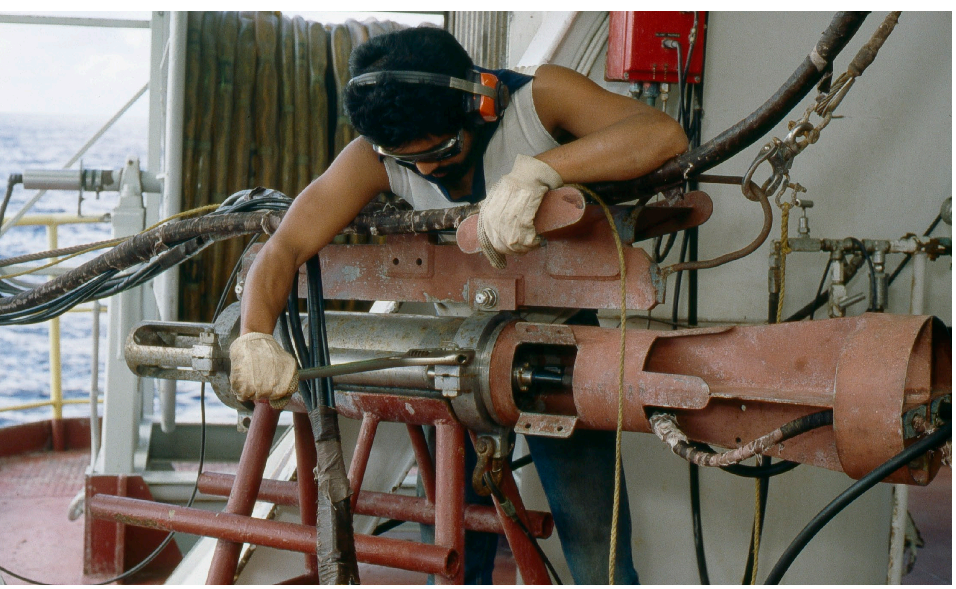
Engineering and Science Operations

General Information

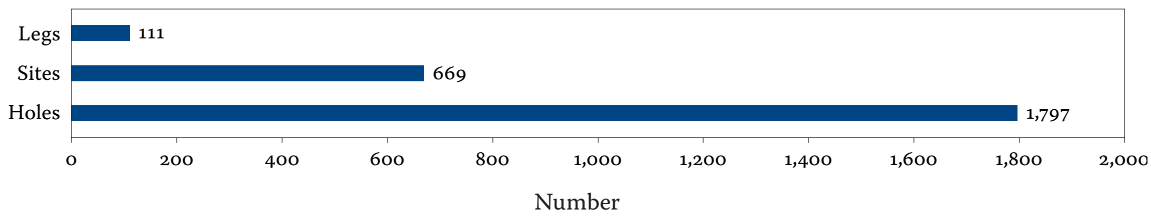
The ship used for Ocean Drilling Program (ODP) operations was built in Canada in 1978 and operated as the oil exploration drilling vessel SEDCO/BP 471. In 1984, the ship was converted for scientific ocean drilling. The dynamically positioned drillship was 143 meters (469 feet) long and 21 meters (68.9 feet) wide with a derrick 61.5 meters (202 feet) high that was capable of suspending as much as 9,150 meters (30,020 feet) of drill pipe. The principal changes to the ship necessary to meet the needs of scientific ocean drilling were addition of laboratories for the analysis of cores, core samples, and downhole measurements (logs) and installation of additional berths to accommodate the shipboard scientific party.

Cores of crustal rocks and sediments from the seafloor were collected by wireline coring using conventional rotary drilling and coring techniques. Hydraulic piston coring (APC) was used to collect superior quality cores of soft sediment, and an extended core barrel (XCB) was used with the rotary bit to improve core recovery in semilithified sediments composed of alternating hard and soft layers (see ODP *Technical Note* 31, "Overview of Ocean Drilling Program Engineering Tools and Hardware" [www.odplegacy.org./samples_data/publications.html]). Once on board the ship, the cores were subjected to a standard series of continuous measurements of characteristics such as bulk density, seismic velocity, natural gamma radiation, color reflectance, and magnetic properties, before being photographed, described, and sampled for further detailed study. Downhole measurements of physical and chemical formation properties were accomplished using standard wireline logging tools and/or measurement-while-drilling (MWD) tools. In addition to adapting standard tools to meet ODP's unique requirements, ODP engineers developed special tools and techniques for permanent emplacement of downhole instrument packages (seismometers, borehole observatories) and specific downhole measurement devices (high-temperature logging and coring tools, logging-while-coring [LWC] tools) at selected sites.

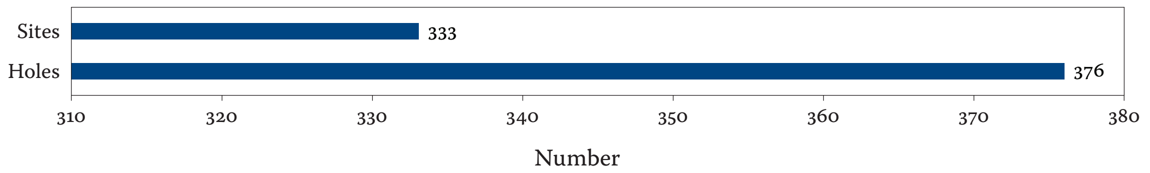


One of the outstanding legacies of scientific ocean drilling has been the development of special drilling and coring tools and technologies that enable researchers to recover better-quality core under a wide range of environmental conditions. The engineers of ODP and the predecessor program, the Deep Sea Drilling Project (DSDP), were extremely successful in developing new tools to meet unique scientific ocean drilling requirements (e.g.,

ODP Legs, Sites, and Holes



ODP Sites and Holes Logged



the APC) and adapting established oil and mining industry technologies to the operational demands of the global ocean. A detailed description of the *JOIDES Resolution,* the tools used for coring and acquisition of downhole data, and the shipboard laboratories as configured in the later stages of ODP are included on the ODP Legacy Web site (www.odplegacy.org/operations).

Drilling. Coring, and Logging Statistics

During almost 20 years of ODP operations, the *JOIDES Resolution* traveled 355,781 miles and occupied 669 sites, covering all the oceans of the world. The most northerly site (Site 911) was located at 80.5°N, 8.2°E in the Arctic Ocean, and the most southerly (Site 693) at 70.8°S, 14.6°W, was in the Weddell Sea near Antarctica. Coring operations were successfully conducted in water depths ranging from 37.5 meters (123 feet) to 5,980 meters (19,620 feet). The deepest hole drilled extended 2,111 meters (6,936 feet) below the seafloor. A total of 36,365 cores were collected, yielding 222,430 meters (729,757 feet) of core material for study. Details of the operational data for each leg of ODP (Legs 100–210) are available from the ODP Legacy Web site (www.odplegacy.org/operations/overview.html).

Of the sites drilled by ODP, 55 were designated "legacy sites," with downhole instruments emplaced to make long-term measurements of the subseafloor environment and/or reentry cones installed to allow future use of the existing holes.

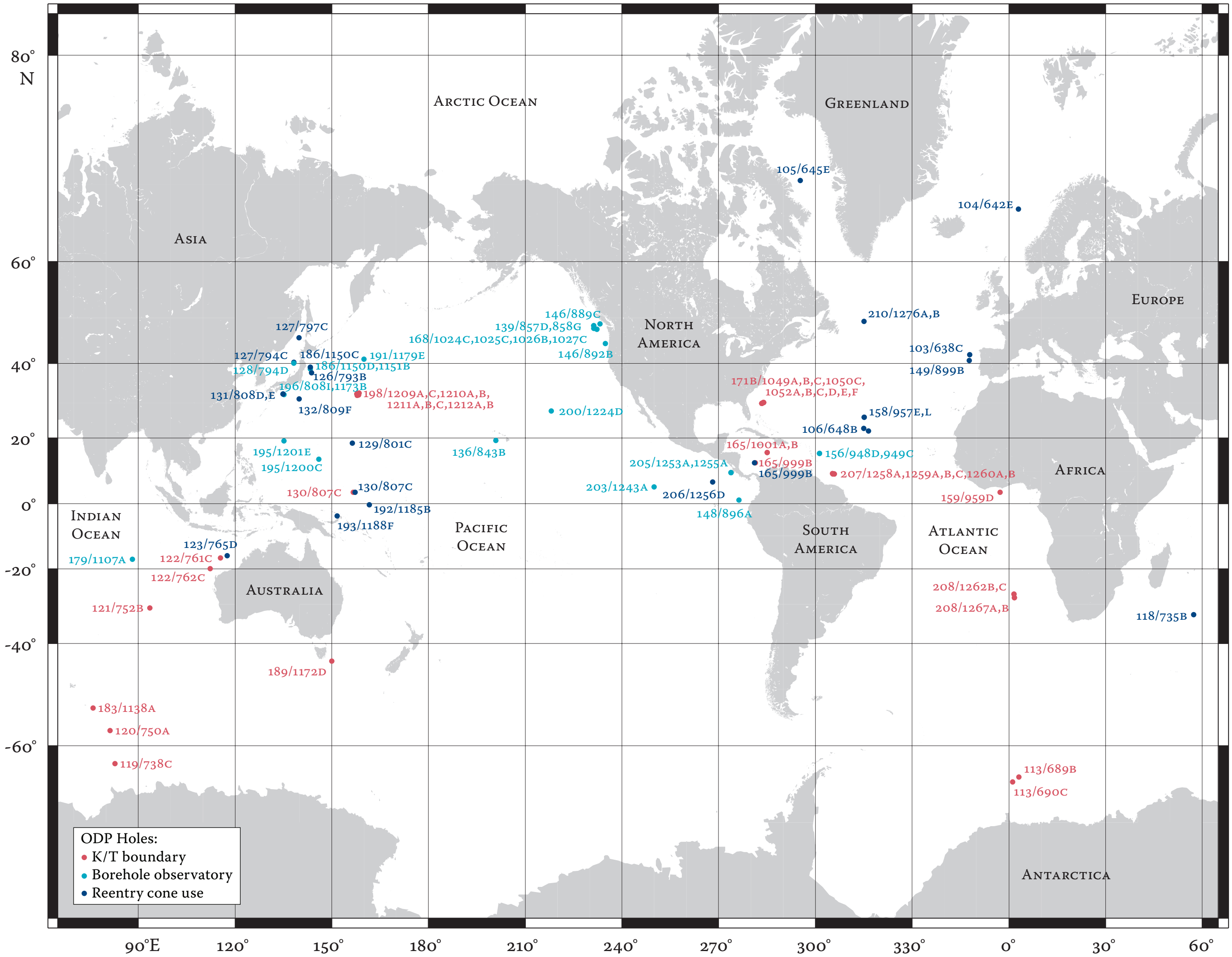
> *"One of the outstanding legacies of scientific ocean drilling has been the development of special drilling and coring tools and technologies…."*

The ODP Legacy Web site (www.odplegacy.org/science_results/leg_summaries.html) contains a summary of the ports of call, start and end dates, site numbers, ocean region, Staff Scientists, Co-Chief Scientists, and links to related information (Leg Summary, participants list, photographs, and leg logo) for each leg sailed by ODP (see the "ODP Leg Summary" table for an excerpt of this information).

Operational and Laboratory Advancements

The capabilities of the *JOIDES Resolution* and the tools and techniques used to address the objectives of ODP were continually improved during the life span of the Program. Dry dock and refitting periods in 1989, 1994, and 1999

ODP Legacy Sites



provided opportunities to implement major upgrades, but improvements and enhancements were made continually whenever it was possible to do so without serious negative impacts on the ongoing scientific mission. Some of the major advances occurring during dry dock, refitting, and the subsequent 5-year intervals follow.

1984–1989

The newly converted drillship offered ample laboratory space and basic drilling and coring capability but clearly presented opportunities for improvement and enhancement. Major developments occurred quickly during the first 5 years of ODP operations. Engineering enhancements included upgrading the APC and XCB to enhance core quality and recovery and developing a free-fall funnel that provided the capability for reentry into sediment boreholes for bit changes and logging runs, allowing recovery of cores from deeper geological formations. A wireline heave compensator was designed to reduce the effect of ship heave on downhole logging measurements.

To facilitate core description, a prototype multisensor track (MST) system for continuous measurement of magnetic susceptibility, gamma ray attenuation porosity, and natural gamma radiation on whole-core sections was installed, along with a prototype three-axis pass-through cryogenic magnetometer for acquisition of magnetic properties data using either a split-core section scan or discrete samples. X-ray fluorescence capability was added to the suite of instruments available for core description and analysis.

To support science operations, a VAX minicomputer with multiple user terminals provided data acquisition, processing, and storage capabilities. Relational database technology was introduced to facilitate data storage and access. Because many academic geologists were unfamiliar with wireline logging technology and its application to geologic problems, the Wireline Services Operator published a Logging Manual (www.odplegacy.org/operations/downhole.html) and held the first 10 (of 16) logging schools in the United States, Japan, France, Canada, and Germany (see "Documentation and Training").

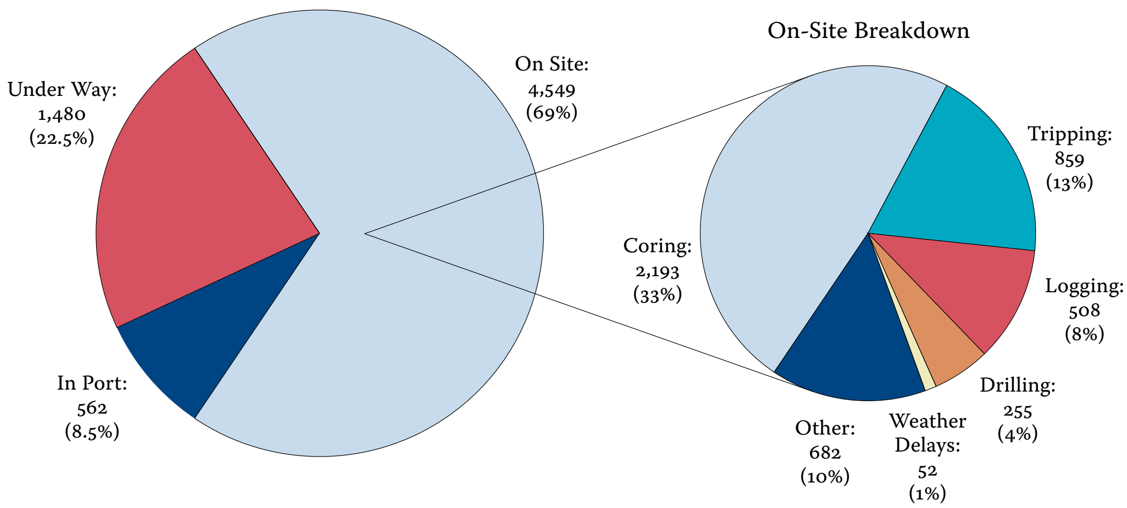
Inmarsat A, a mobile satellite service using analog techniques, was available from the beginning of the Program but was limited in technical abilities—users could make phone calls and transfer data with a modem (9600 bits/s [bps]). Initially, the service was typically used only for telex and facsimile traffic. ODP began transferring official traffic to and from shore twice daily.

1990–1994

Drilling and logging technology enhancements during this period facilitated the establishment of hard rock holes, improved hard rock core recovery and rate of penetration, and enhanced logging data acquisition capabilities. An update of the drill-in casing system enabled drilling-in a short casing string simultaneously with the bit to penetrate through an unstable sediment zone and enable continued coring. The first triple casing string (multiple nested casing sizes) was deployed. Through use of the conical side-entry sub, logging tools were inserted into the drill pipe and carried to the bottom of the hole with circulation. This was particularly useful when attempting to log swelling or bridging formations where circulation had to be maintained to keep the hole open. ODP's first use of logging-while-drilling (LWD) tools enabled the acquisition of logging data in unstable accretionary prism environ-

> *"During almost 20 years of ODP operations, the* JOIDES Resolution *traveled 335,781 miles and occupied 669 sites...."*

ODP Ship Operations (days)



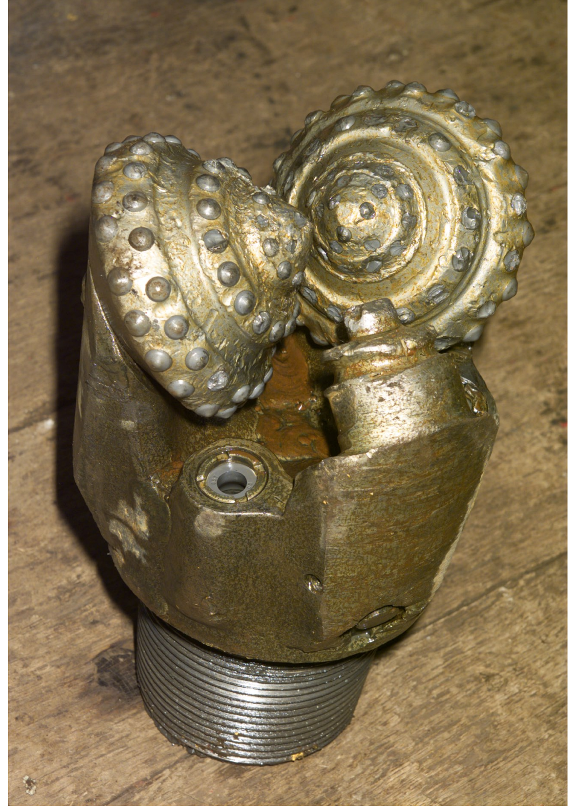
ments. The first in situ borehole laboratories (circulation obviation retrofit kits [CORKs]) were developed. The prototype CORK provided a top seal on the casing with fluid sampler valves and data ports for downhole instrumentation. Construction of the subsea shop on the drillship provided air-conditioned work and storage space for servicing subsea electronics and instrumentation. The international logging consortium was established to provide log analysis centers and staff in the United Kingdom, France, and the United States, with later additions in Germany and Japan.

In the laboratories, a split-core color scanner was installed to acquire quantitative sediment color data. The natural gamma radiation detection instrumentation was upgraded to scan cores for natural radioactive elements and offered the potential for spectral analysis. A monitoring system and operating procedures were put in place for working in hydrogen sulfide–rich environments.

Ship-to-shore data transfers were accomplished at a higher rate of 28,800 bps via analog modem.

1995–1999

An active heave compensator, the largest of its kind, reduced absolute drill string motion, which reduced weight-on-bit and torque variation and improved drilling and coring penetration rates and bit life. A rig instrumentation system (RIS) provided real-time acquisition and storage of drilling parameters for optimization and analysis of drilling operations. The hammer drill system, which used a fluid-driven hammer to advance the bit, was developed and deployed for drilling holes or installing drill-in casing in hard rock. The wireline heave compensator was improved to enable responsive tuning of the system during logging operations. Existing logging systems were refurbished and the log acquisition system was replaced with the newer Schlumberger Minimum Configuration Maxis (MCM) system. The first deployment of the Inmarsat B system on the drilling platform enabled rapid transmissions of logging data from ship to shore and provided shipboard Internet access. The implementation of the Inmarsat B system successfully proved the concept of using satellite transmission to provide processed logging data during a cruise. Labview software improved the acquisition of MST, gas chromatograph, carbonate coulometry, moisture and density, and alkalinity data. The growing interest in subseafloor microbiology also led to development and installation of a perfluorocarbon (PFC) tracer system, with PFC injection at the mud pump, to permit evaluation of the degree of contamination of cores during the coring process.



A temporary laboratory addition enabled real-time shipboard microbiological analytical capabilities. A permanent additional level was subsequently added to the shipboard laboratories to provide expanded space for downhole tools, microbiology laboratories, and conference facilities. Installation of an inductively coupled plasma–atomic emission spectrometer (ICP-AES), funded by the U.S. Department of Energy, increased the efficiency and spectrum of elemental analysis possible on shipboard core samples.

The shipboard computer system was upgraded and Novell servers were installed to expand shipboard networking, transmission, and data storage. The first groupware system (cc:Mail) was introduced and e-mail was transferred between ship and shore twice daily. The introduction of broadband satellite transmission for near-real-time log processing allowed transmission of raw and processed log data between ship and shore. Mail was transferred more often (4–6 times daily) because of increased traffic, and it was more practical to send larger files (5–10 MB). The cost of transfer decreased so much that it was cheaper to send logging files to shore for postprocessing than to sail personnel to process the files aboard the ship.

"The capabilities of the JOIDES Resolution*… to address the objectives of ODP were continually improved during the life span of the program."*

Core Log Integration Platform (CLIP) software provided the ODP community with a set of graphic, interactive data analysis products for depth-merging and integrating core and downhole log data. On cruises where it was important to recover complete "spliced" sediment sections, a Stratigraphic Correlator was staffed to provide real-time feedback on the completeness of the recovered sediment record to help determine operational and drilling plans.

The RIS was installed. This system was critical for sending real-time vessel and drilling mechanics data directly to the LWD acquisition system. The data were used to optimize drilling parameters in order to ensure high-quality downhole data. Vessel accelerometer data were also captured by the RIS and used in conjunction with downhole acceleration and bottom-hole assembly (BHA) dynamics data to evaluate various heave compensation systems.

ODP installed and tested two data talkers and, for the first time, routed standard transmission control protocol/Internet protocol (TCP/IP) traffic between ship and shore. This enabled

ODP to conduct a distance education pilot program with the ability to reach multiple classrooms on shore with a broadcast from the ship.

2000–2003

Growing interest in methane gas hydrates led to improvements in the pressure core sampler and testing of gas hydrate autoclave coring equipment. An infrared scanning camera was used to locate gas hydrates in uncut whole cores. A drill string acceleration tool, deployable with any ODP core barrel, facilitated evaluation of the effectiveness of the drill string heave compensator. A number of new logging tools were deployed, including the MWD pulser tool, which enabled real-time transmission of LWD data, and the resistivity-at-the-bit tool, which enabled measurement of total gamma counts and 360° electrical resistivity images from seafloor to total depth. LWC methodology, developed jointly by the Wireline Services Operator, Schlumberger, and the Science Operator, resulted in the first ever successful LWC operations.

The microbiology laboratory facilities were enhanced with additional permanent equipment and a separate van for sampling and adding radioactive markers to biological samples. A digital imaging system was installed in the core laboratory to provide high-resolution images of cores for later quantitative analysis.

ODP installed a Very Small Aperture Terminal (VSAT) system and began testing its viability as a permanent service on the ship. The initial test showed immediate and permanent improvements on ship and shore operations and enabled completion of a proof of concept and successful design. The most obvious benefits of the VSAT service included:

- Real-time communications on par with what users were accustomed to while on shore.
- Standard TCP/IP traffic routing in a constant manner, instead of on demand, allowing the use of standard local area network/wide area network (LAN/WAN) software, equipment, and utilities to control movement of data between ship and shore without custom programming.
- Enhanced telephone service with multiple phone lines that terminated in a College Station, Texas, local access and transport area, allowing personnel to pay only standard long distance charges outside of the 979 area code.
- Video conferencing as a viable form of communication.
- Enhanced e-mail service, with e-mail transferred every half hour using file transfer protocol (ftp), leading to discussions of reconfiguring the mail system

to use standard protocols to send and receive mail continuously.

- Enhanced file transfer ability, with transfers of 600 MB successfully tested.

- Full-time Internet access.

These advances in communications not only increased ship-to-shore communication but also vessel safety.

Safety and Environment

Drilling operations on the *JOIDES Resolution* followed offshore industry best practices, as reflected in the drilling subcontractor's company policies and procedures. Although operations routinely pushed drilling technology to the limit, an extremely low equipment failure rate was achieved. Between 1998 and 2001, only 54 hours of operational time were lost because of failure of the ship or drilling equipment. Rig time lost because of equipment failure during logging operations (averaging 2.6 hours per leg) was well below industry rates because of a rigorous maintenance and equipment upgrade program.

Adherence to safe operating practices and employee safety was a priority for both the Science Operator and the drilling subcontractor. As a result, the Program maintained an accident rate only a fraction of the average rate found in commercial industries. In the last decade of ODP, only three injuries associated with ODP drilling operations prevented immediate return to work and none involved

permanent disability. Specific policies and procedures relating to handling hazardous cores containing hydrogen sulfide or gas hydrate were developed and implemented when operations took the ship into regions where the risk of encountering these materials increased. ODP policies regarding safety in general and laboratory safety in particular can be accessed on the ODP Legacy Web site (www.odplegacy.org/operations/safety.html).

> *"Although operations routinely pushed drilling technology to the limit, an extremely low equipment failure rate was achieved."*

Because ODP operations involved riserless drilling with no blowout prevention equipment, environmental safety and pollution prevention were always a concern. These issues were addressed in a comprehensive environmental impact statement prepared at the beginning of the operational phase of the Program (see "Appendix J" of the ODP Policy Manual [www.odplegacy.org/program_admin/policies.html]).

The first line of defense for operational safety was the careful evaluation of proposed drill sites by the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) Site Survey Panel and Pollution Prevention and Safety

Panel. These panels established policies and procedures for site selection (see "Appendix I" of the ODP Policy Manual [www.odplegacy.org/program_admin/policies.html]). In addition, the Science Operator established a separate Safety Panel to provide an independent assessment of risks associated with proposed sites. The goal was to ensure that the ship did not drill in locations posing a significant risk of encountering hydrocarbons. It is a testimony to the effectiveness of these review procedures that no uncontrolled release of hydrocarbons into the marine environment occurred as a result of ODP operations during the entire 20-year operational phase of the Program.

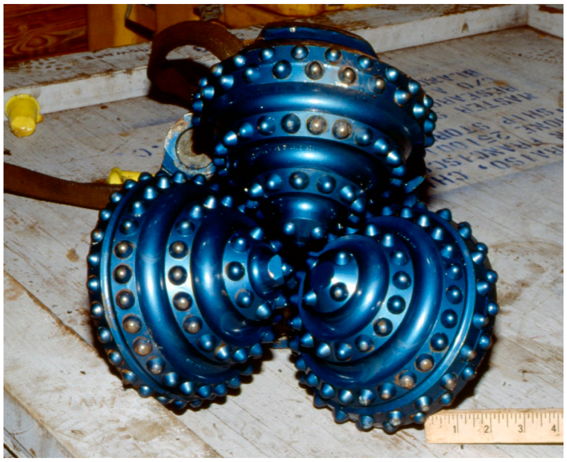
Another environmental concern was the direct risk to marine life from ODP operations, particularly when operations were planned in sensitive areas such as the Great Barrier Reef. In such cases, the Science Operator worked with the appropriate authorities to develop specific operating guidelines acceptable to all parties involved. In later years, concern developed over the risk to marine mammals from seismic (air gun) operations from the drillship. This led to the development of a rigorous marine mammal policy designed to minimize the impact of ODP operations (see "Appendix Y" of the ODP Policy Manual [www.odplegacy.org/program_admin/policies.html]).

Documentation and Training

ODP procedures were extensively documented to help standardize shipboard operations, train new staff, and facilitate later interpretation of the scientific results of ODP. A series of "tool sheets" provided an overview of the engineering tools and hardware used in ODP and their operation (www.odplegacy.org/operations/coring.html). A similar set of tool sheets summarized the logging tools (www.odplegacy.org/operations/labs/downhole/tools.html). More detailed tool manuals provided shipboard scientists and technicians with step-by-step instructions for use of tools and hardware.

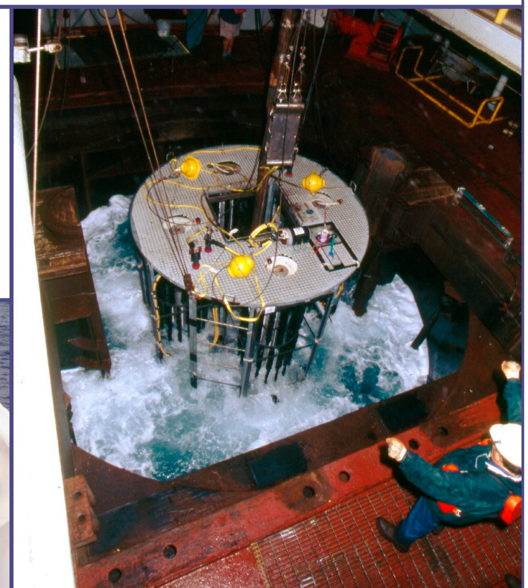
ODP-TAMU laboratory procedures were described in a series of "cookbooks" and standard operating procedures (SOPs) (www.odplegacy.org/operations/labs.html). The laboratory cookbooks were simplified manuals that provided background information regarding specific measurements or groups of related measurements and information regarding laboratory procedures and limitations for each type of measurement, whereas the SOPs consisted of lists of specific tasks associated with each measurement or laboratory and the order in which they had to be completed.

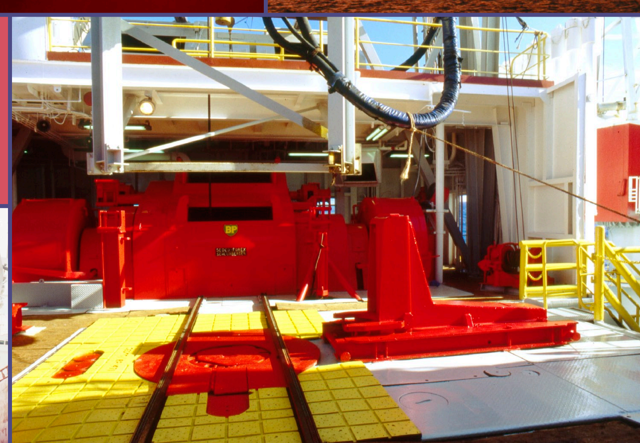
ODP-LDEO developed a Logging Manual and a series of cookbooks giving specific instructions for procedures associated with each downhole measurement (www.odplegacy.org/operations/downhole.html). Because downhole logging was unfamiliar to many academic geologists, the Wireline Services Operator also organized a series of 16 logging schools, which were held at venues around the world and provided logging training for scientists sailing as JOIDES loggers or who were interested in in-depth analysis of logs.



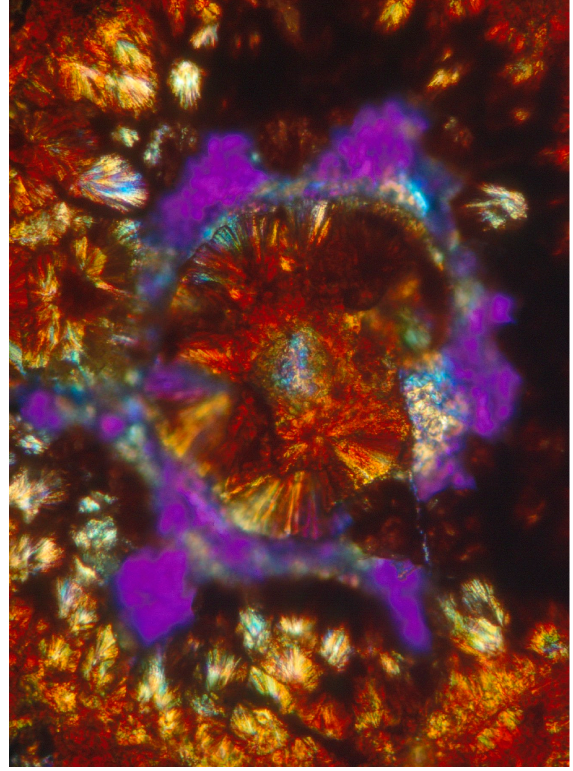
Logging School Schedule

Fiscal Year	City	Country
1986	La Jolla, California	United States
1987	Palisades, New York	United States
1987	Tokyo	Japan
1987	Cambridge	United Kingdom
1987	Paris	France
1987	Montreal	Canada
1987	Hanover	Germany
1987	Hanover (2nd event in FY87)	Germany
1989	Denver, Colorado	United States
1989	San Francisco, California	United States
1989	Washington, D.C.	United States
1990	College Station, Texas	United States
1990	Houston, Texas	United States
1991	Townsville	Australia
1992	Tokyo	Japan
1994	San Francisco, California	United States





Samples, Data, and Publications



The Ocean Drilling Program (ODP) curated more than 130 miles (222,430 meters) of core recovered during 20 years of operations. Ongoing scientific study of these cores provides an enormous wealth of information to researchers around the world that is invaluable to developing a better understanding of Earth's history. Scientists were able to access core material through one of four ODP core repositories, where the collected cores were sampled and preserved. Scientific data generated from the cores was made publicly available through the ODP Janus database and various scholarly publications produced by ODP.

The Samples, Data, and Publications section of the ODP Legacy Web site (www.odplegacy.org/samples_data/) provides information on collection, curation, and preservation of cores and samples; data sets, databases, and data documentation; and publications and resources.

Core Curation and Repository Management

The primary source of data archived by ODP was shipboard analyses of cores and core samples collected during each cruise. Data were also archived from postcruise analysis, for which careful preservation of cores and core material was critical. Procedures developed early in the Program for shipboard and shore-based handling and curation of core material have been continually improved over the years in order to best preserve these priceless materials.

Early on, ODP refrigerated cores to retard desiccation, mold growth, and chemical changes. More recently, additional antidesiccation methods were implemented at the repositories to better preserve cores. Situation-specific improvements were also made; for example, recovery of significant amounts of sulfide mineral cores in the 1990s necessitated development of special nitrogen-filled impermeable core storage bags.

Additional materials curated and preserved at the core repositories include permanent archive halves, processed sample residues, thin sections, smear slides, evaporite cores, frozen whole rounds, frozen whole-round gas hydrate samples, and pressurized gas hydrate samples.

Sample collection procedures, repository information, and instructions for requesting samples are available from the ODP Legacy Web site (www.odplegacy.org/samples_data/samples.html).

Scientific Databases

Core Database

Prime scientific data collected during ODP cruises were assembled and archived from

Number of ODP Samples Processed

	FY85–FY99	FY00	FY01	FY02	FY03	FY04	Total
Shipboard Samples	735,885	65,150	47,156	133,256	45,946	3,738	1,031,131
Repository Samples	742,451	62,053	75,483	90,867	159,217	72,560	1,202,631
Total ODP Samples	1,478,336	127,203	122,639	224,123	205,163	76,298	2,233,762
Scientists who Received Samples	10,346	563	631	704	664	469	13,377

Volume of ODP Core Data Collected

Data Type	Size (GB)
ODP data in Janus database online	15.53
ODP data outside Janus—stored online	24.60
ODP low-resolution image data—stored online	81.90
Core-table photos	13.47
Section images	27.85
Scanned paper prime data (VCDs, log sheets, etc.)	10.84
Close-up photos	10.83
Miscellaneous images	18.91
ODP data in logging database online	81.00
ODP high-resolution image data—stored offline	3,173.00
Core-table photos	1,400.00
Section images	1,100.00
Scanned paper prime data (VCDs, log sheets, etc.)	70.50
Close-up photos	602.50
Total ODP data stored online	203.03
Total ODP data stored offline	3,173.00
Total	3,376.03

ODP Core Data Details

Images Archived on Server(s)	Size (GB)
Core-table photos (PDF)	13.47
Core-section images (JPG)	27.85
Close-up photos (JPG*)	7.11
Microphotos (TIF)	0.26
DITIMAGE (SID)	18.43
Additional (TIF)	0.22
Scanned paper prime data images (PDF)	10.83
Total archived on server/Janus	78.18

*closeup estimate after completion = 10.83 GB

Images Archived on Disc/Photo/Paper	Size (GB)
Estimated amount from media	
Scanned core-table photos (TIF)	1,400.00
Section images (Legs 198–210) (TIF)	1,100.00
Scanned close-up photos (Legs 134–210) (TIF)	602.50
Stored offline on hard drive	
Scanned paper prime data (TIF)	70.50
Total	3,173.00

the beginning of the Program. Data were initially collected digitally in a relational data management system known as S1032, and core descriptions and some other prime data were recorded on paper. Original raw files were archived for any future data verification purpose.

Janus, an Oracle-based relational database with a Web interface, was developed between 1994 and 1997. This database provided an integrated view of the core sections, samples, and science data collected in all laboratories on board the ship. Janus was first utilized during Leg 171.

"The Ocean Drilling Program curated more than 130 miles of core recovered during 20 years of operations."

The Janus Web interface was created to provide standard data queries for the public and scientists to view and download data from the ODP database. The Janus database was continually improved from 1997 through the end of ODP operations in 2003. Some enhancements included modifications in calibration procedures, addition of new data types, and improvements to overall database performance. A significant addition to Janus was access to digital images of cores, core sections, and scans of prime paper data (e.g., hand-drawn visual core description notes).

During the final decade of the Program, data from Legs 101–170 were migrated into Janus. The Janus database currently contains paleontological, lithostratigraphic, chemical, physical, sedimentological, and geophysical data from more than 2 million ODP core samples (www.odplegacy.org/samples_data/data.html). At the end of the Program, all legacy data (Legs 100–210) were transmitted to the National

Geophysical Data Center in Boulder, Colorado, where they are also archived.

Log Database

Throughout the Program, downhole logging data were obtained through wireline logs and later also by logging while drilling (LWD). These data were collected digitally and processed using the GeoFrame software from Schlumberger. Data were initially returned to shore by tape at the end of each cruise. With the advent of the VSAT Internet connection, files were transferred to shore for processing and archiving and then processed data were returned to the ship for use by the scientific party.

Logging data are archived at ODP-LDEO in a Web-searchable database that contains downloadable original and processed files. This database, which has been available online since 1996, contains data from DSDP, ODP, and IODP and will continue to grow as new data are collected by IODP (www.odplegacy.org/samples_data/data.html).

Reports and Publications

Publications produced by ODP are the primary source of analytical results and scientific interpretation of the extensive data collected both on the ship and later on shore by individual scientists. Program publications included pre- and postcruise leg-related reports, technical notes, and the *Proceedings of the Ocean Drilling Program,* a two-part monograph series containing detailed cruise site reports, data reports, and peer-reviewed scholarly research for each leg (www.odplegacy.org/samples_data/publications.html).

Leg-related Reports

The *Scientific Prospectus* for each cruise, a detailed precruise plan, was published several months before each cruise. This report outlined and described the scientific objectives and operational strategies established for the leg and provided a valuable resource for scientists to plan their cruise participation, research goals, and sample requests.

The *Preliminary Report* from each leg was published online within 2 months of completion of the cruise. This report summarized the preliminary scientific and operational results of the cruise and evaluated fulfillment of the original scientific objectives.

Proceedings of the Ocean Drilling Program

At the conclusion of each leg, scientific data and results from the leg were compiled and published in the *Proceedings of the Ocean Drilling Program,* a two-volume set consisting of an *Initial Reports* volume and a *Scientific Results* volume.

The *Initial Reports* volume contained scientific and engineering results prepared during the cruise by the Shipboard Scientific Party by the conclusion of each leg. This volume was published at the end of the sample and data moratorium period, approximately 1 year after completion of the leg.

The *Scientific Results* volume contained data reports, peer-reviewed scientific manuscripts, and disciplinary syntheses prepared by scientific party members. Volumes also contained a synthesis of the science data and results generated through analysis of leg materials. This volume was distributed approximately 4 years after completion of the leg. Originally, all postcruise research results were documented in this volume; however, beginning with Leg 160, publication of postcruise results was allowed in peer-reviewed journals and books that published in English.

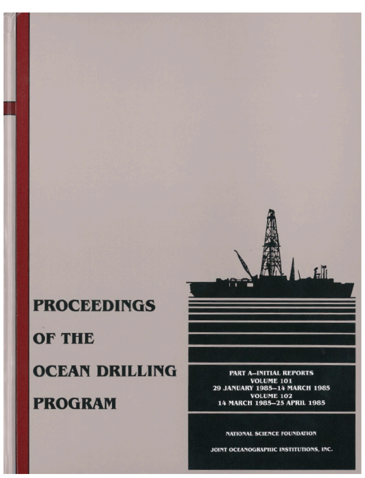
The *Initial Reports* volumes for Legs 100–175 and the *Scientific Results* volumes for Legs 100–169S were printed and distributed as archive-quality, printed books. Beginning in 1997, the books were accompanied by a CD-ROM that contained the entire volume in digital format along with electronic data sets. In 1999, the Program converted the *Proceedings* format to printed hard-cover booklets containing a summary chapter, table of contents, and index (*Scientific Results* only) distributed with a CD-ROM that contained the entire volume in digital format along with electronic data sets.

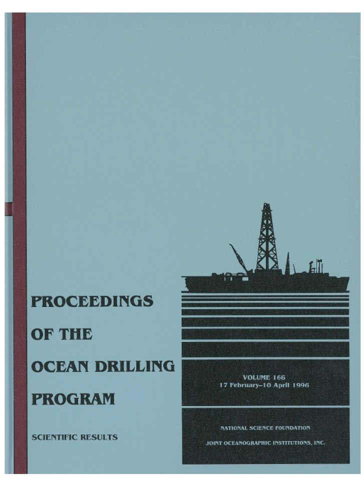
The *Proceedings* volumes were also published with open access on the Web. Between 2003 and 2007, the printed *Proceedings* volumes from the first half of the Program were digitized in a collaborative project with Texas A&M University, and now the ODP *Proceedings* volumes for Legs 100–210 are available online (www.odplegacy.org/samples_data/publications.html).

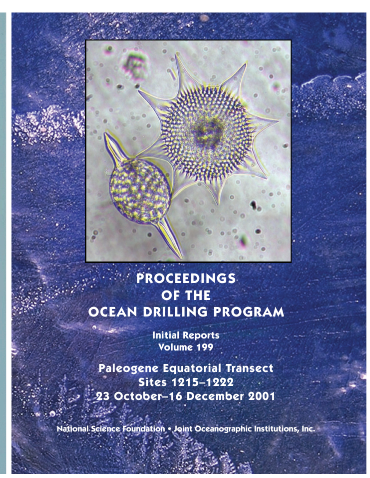
A cumulative index covering the entire *Proceedings of the Ocean Drilling Program* will be completed under the NSF System Integration Contract in FY08 after the final *Scientific Results* volume is published.

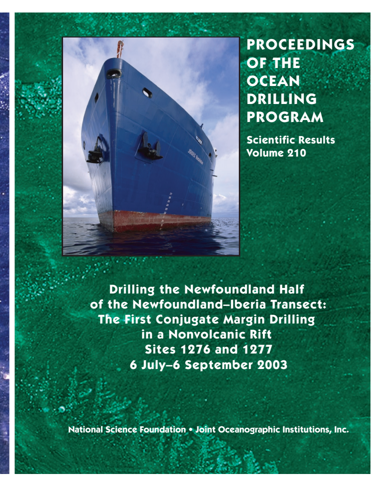
Technical Notes

ODP published 37 *Technical Notes,* a series of laboratory, engineering, and drilling reports and manuals. These reports were used primarily by ODP shipboard scientific party members and staff.









Operations Manuals

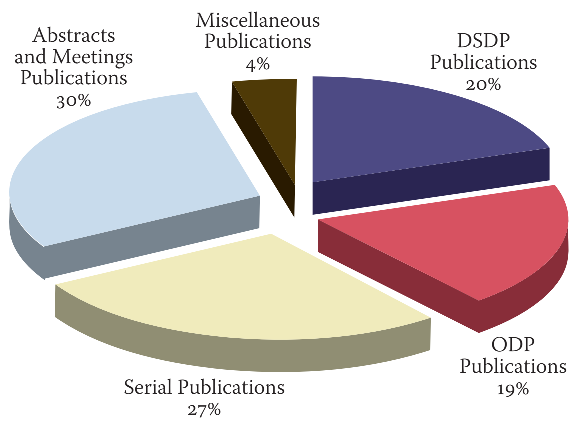
ODP produced 16 Operations Manuals, which describe the components, assembly, deployment, and development of coring and downhole measurement tools utilized by ODP Drilling Services (www.odplegacy.org/operations). These manuals were primarily designed to be used by ODP engineers and Ocean Drilling Limited (ODL) drilling staff during cruise operations. The final document, which covers borehole installations including circulation obviation retrofit kits (CORKs), will be completed under the NSF System Integration Contract in FY08.

Bibliographic Databases

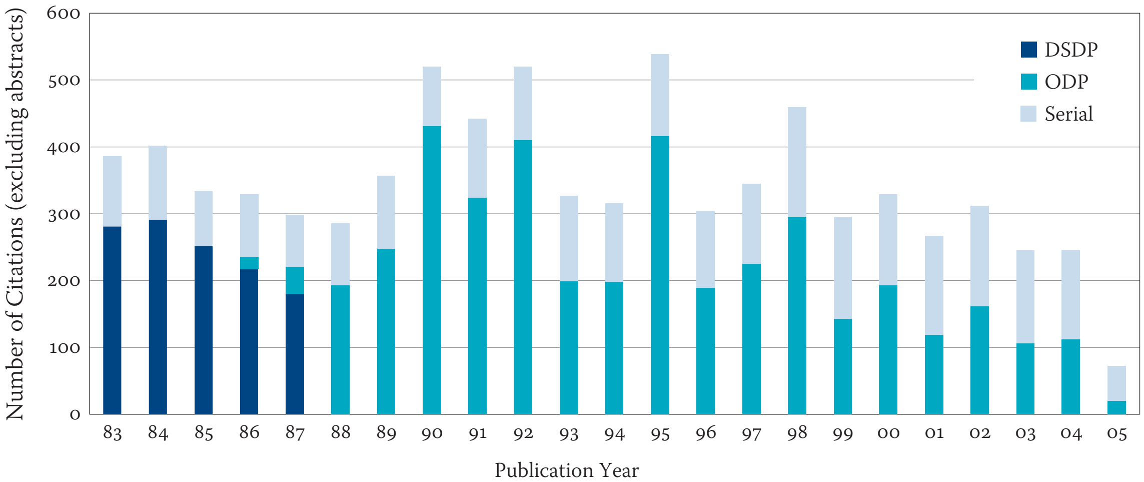
In 1998, the Joint Oceanographic Institutions, Inc. and ODP-TAMU collaborated with the American Geological Institute (AGI) to compile a collection of DSDP- and ODP-related citations called the Ocean Drilling Citation Database. AGI provided a subset of the AGI GeoRef database to ODP on a CD-ROM, and ODP solicited the ocean drilling community for additional DSDP- and ODP-related citations for inclusion in GeoRef and the Ocean Drilling Citation Database. The database became available to the scientific community online through AGI in 2002. As of 2007, the database contained over 22,500 citations related to DSDP, ODP, and IODP research.

Beginning in 1999, ODP-TAMU used the Ocean Drilling Citation Database to produce annual studies that documented the number and venue of publications generated from each leg. These data were also used to compile the number of publications authored by scientists from various member countries and other information valuable to ODP members. Annual statistical studies were generated in 1999, 2000, and 2002–2007. The most recent study is available on the Web (iodp.tamu.edu/publications/citations/AGI_study.pdf).

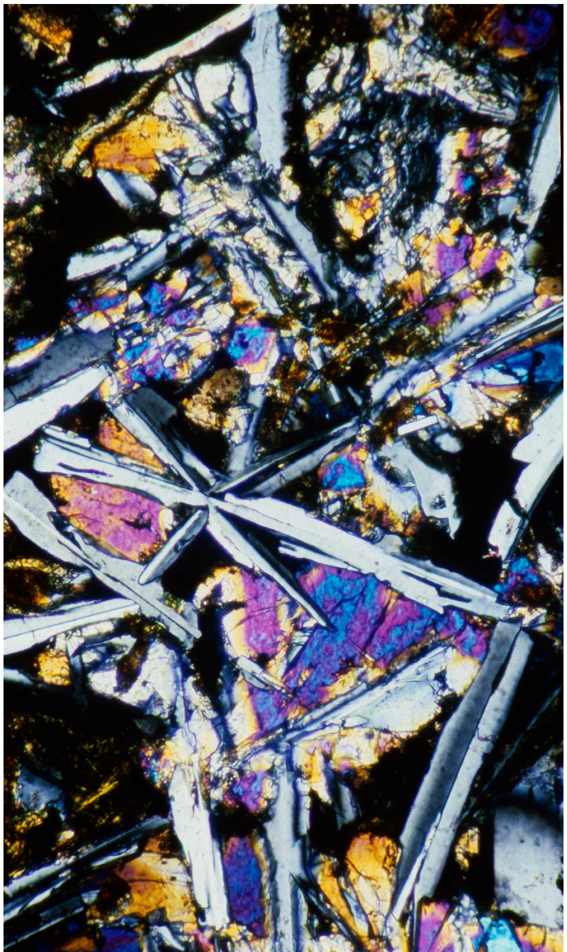
Sources of Citations in Ocean Drilling Citation Database



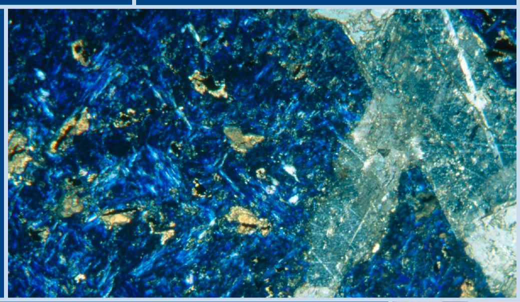
Program versus Serial Publications

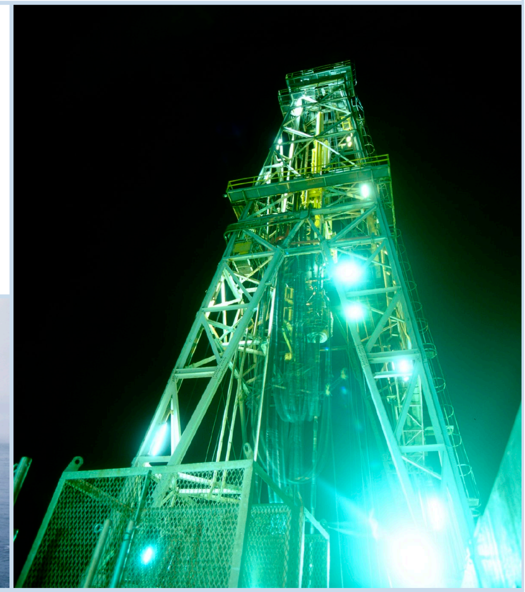


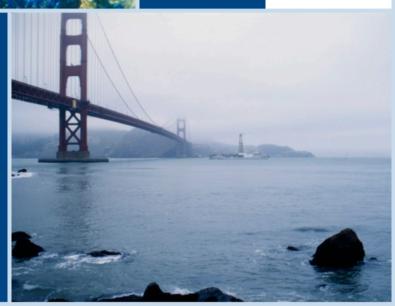
"Ongoing scientific study of these cores provides an enormous wealth of information to researchers around the world that is invaluable to developing a better understanding of Earth's history."

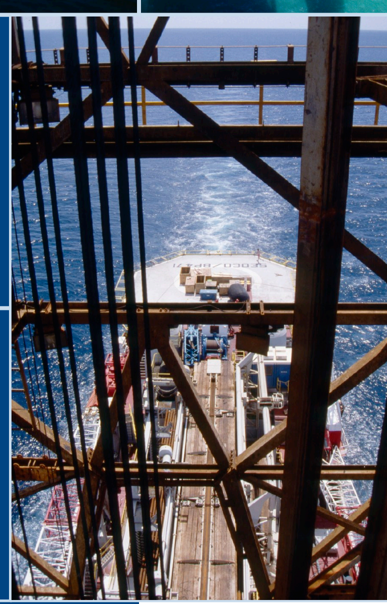


ODP Final Technical Report







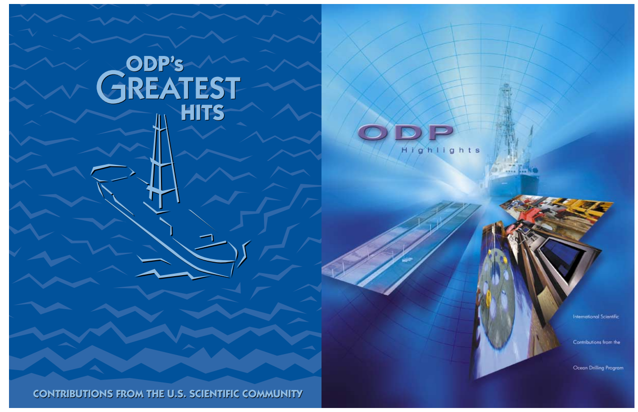


Outreach

The primary goal of outreach activities conducted during the Ocean Drilling Program (ODP) was to disseminate ODP scientific results to the geoscience community. Outreach activities increased the general public's awareness of ODP and maintained support and enthusiasm for scientific ocean drilling while explaining its value in terms of Earth processes and its relevance to society. This was accomplished through a variety of exciting activities and products that ranged from media events, exhibit booths at science conferences, and port call activities to pre- and postcruise press releases, brochures, and videos. Other public affairs/outreach activities included providing information to journalists and authors, conducting presentations, and working with television production companies to improve public understanding of ODP.

"Outreach activities increased the general public's awareness of ODP and maintained support and enthusiasm for scientific ocean drilling."

The U.S. Science Support Program (USSSP), funded under a separate contract, produced valuable supplemental ODP outreach and education products such as *ODP's Greatest Hits, ODP Highlights,* and the interactive CD-ROMs titled *From Gateways to Glaciation* and *From Mountains to Monsoons,* which were widely

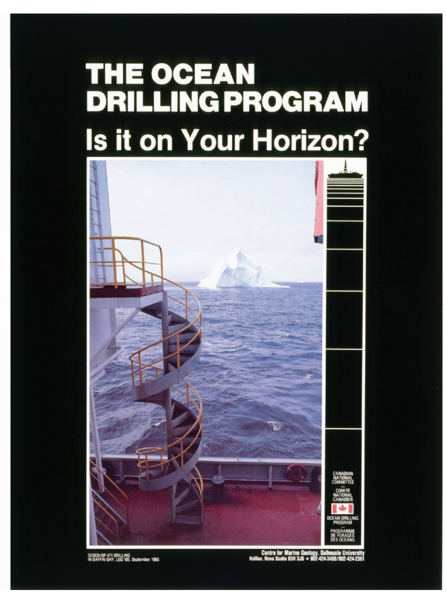


used to communicate the value and excitement of scientific ocean drilling to the public. The USSSP also carried out much of the Program's educational outreach efforts.

Descriptions of outreach activities conducted for ODP and outreach products developed during the life of the Program are listed below.

Outreach Activities

- **Port Call Activities**—These activities consisted of dockside tours of the *JOIDES Resolution,* press conferences, and public affair events such as receptions and public lectures. Tours of the *JOIDES Resolution* were organized by the Public Affairs office prior to a port call and conducted by ODP personnel for organized groups, journalists, congressional representatives, local government officials, and faculty and students from local universities. These tours were a very effective outreach and public affair activity conducted at the end and/or beginning of a cruise to acquaint members



of the community with research done on the ship.

- **Congressional Visits**—These annual events brought scientists, engineers, researchers, educators, and technology executives to Washington, D.C., to raise visibility and support for ODP.

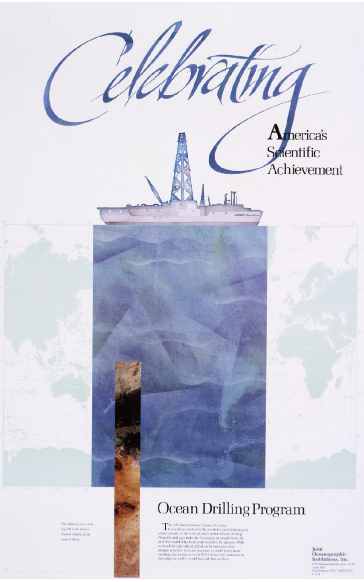
- **Media Relations Efforts**—ODP outreach personnel created media lists and developed relationships with national and foreign correspondents/science journalists.

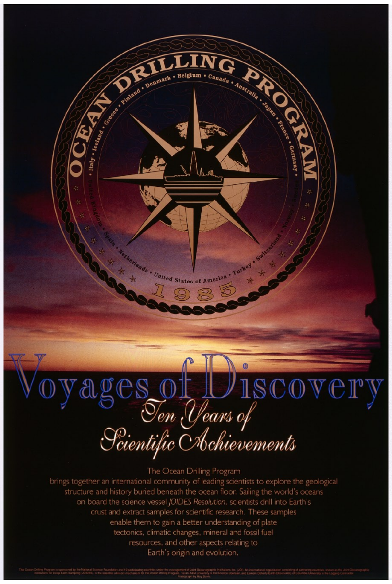
- **Science and Industry Conferences**—ODP outreach activities at national and international science and industry conferences included exhibit booths, media events, public meetings, posters, individual seminars, and special symposia. Annual exhibit venues included conferences organized by the American Geophysical Union (AGU) and the Geological Society of America (GSA), among others.

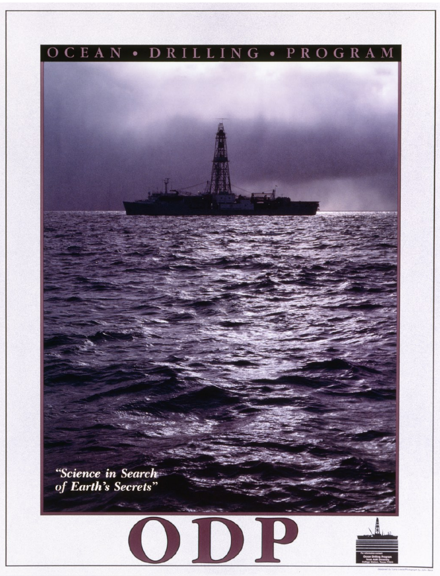
  Scientific community leaders provided brief updates regarding ODP at public "town hall" meetings held at various science conferences such as the AGU Fall Meeting and the GSA Annual Meeting. This venue gave members of the community the opportunity to ask questions and comment on ODP.

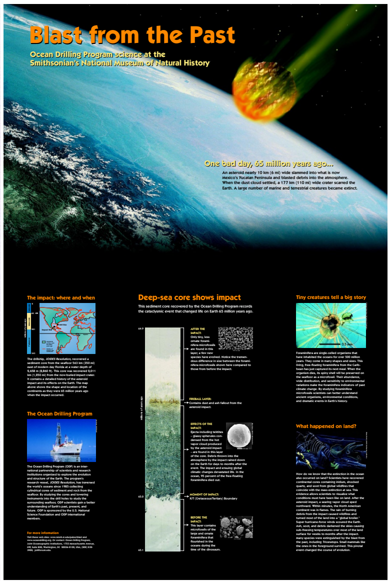
- **Laboratory and Core Storage Facility Tours**—ODP-TAMU Staff Scientists, the ODP Curator, and the curatorial staff at each repository conducted guided tours of the laboratory and repository facilities to promote public interest in ODP.

- **Educational Outreach**—ODP staff and Program participants gave presentations in classrooms and set up exhibits for "Science Days" at museums and schools throughout the United States. Lamont-Doherty Earth Observatory (LDEO) of Columbia University also highlighted ODP at their annual fall Open House. Presentations and exhibits included general information about ODP as well as specific leg results and accomplishments. ODP cosponsored a program called "Ocean Drilling Distance Learning Program," in which a teacher sailed on ODP Leg 194 and recorded lectures that were broadcast to shore and disseminated to schools engaged in the distance learning program (oceandrilling.coe.tamu.edu). Other educational outreach initiatives included partnering with the









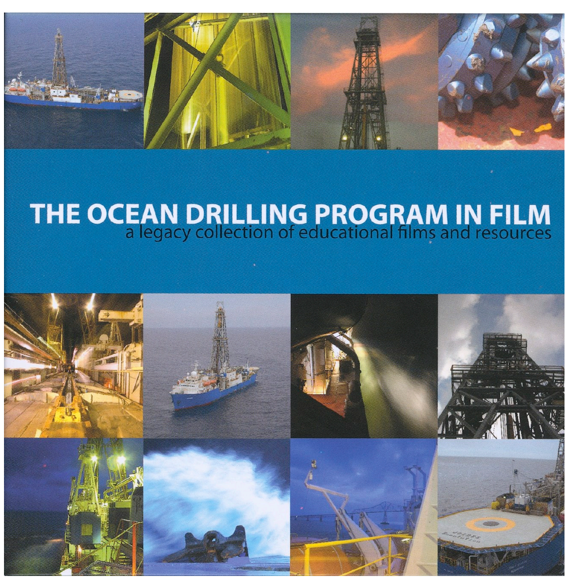
Smithsonian Institution to design and print a poster highlighting results of Leg 171B in the "Blast from the Past" exhibit, currently on display at the National Museum of Natural History.

Outreach Products

- **Press Releases**—Press releases were issued at the conclusion of each cruise to announce results of the leg and discoveries of special interest. Press releases were also issued to announce special events, such as a country becoming a member of ODP (www.odplegacy.org/outreach/press.html).

- **Domestic and International Articles**—ODP staff and scientists prepared articles to promote and inform the community of ODP accomplishments and recent events. These articles were published in prestigious and renowned journals such as *Science; Scientific American; National Geographic; Nature; Eos, Transactions of the American Geophysical Union,* and *New Scientist.*

- **Videos**—Documentary films of varying lengths were produced to promote an understanding of ODP and to provide information on special aspects or achievements of ODP. Videos were designed for different audiences and were updated as major discoveries in the Program occurred. While originally created as separate products, these valuable pieces are now available on a single DVD compilation titled "The Ocean Drilling Program in Film: A legacy collection of educational films and resources."



- *Windows to the Past: Discovering Earth's Future* introduces members of the community to ODP. This video, which aired on the Arts and Entertainment Network on 24 July 1991, was first produced as an hour-long broadcast on ODP drilling in Baffin Bay, Canada. The existing video is a shorter version produced in 1993 for showing at exhibit booths and in classrooms.

- *A Planet in Motion* was created in 1996. This video shows, among other things, aerial footage of the *JOIDES Resolution,* rig floor activity, core-sample preparation, scientists working in the ship's twelve laboratories, animations of the drilling process, and seafloor tectonics. It also includes a demonstration of the ship's dynamic positioning system.

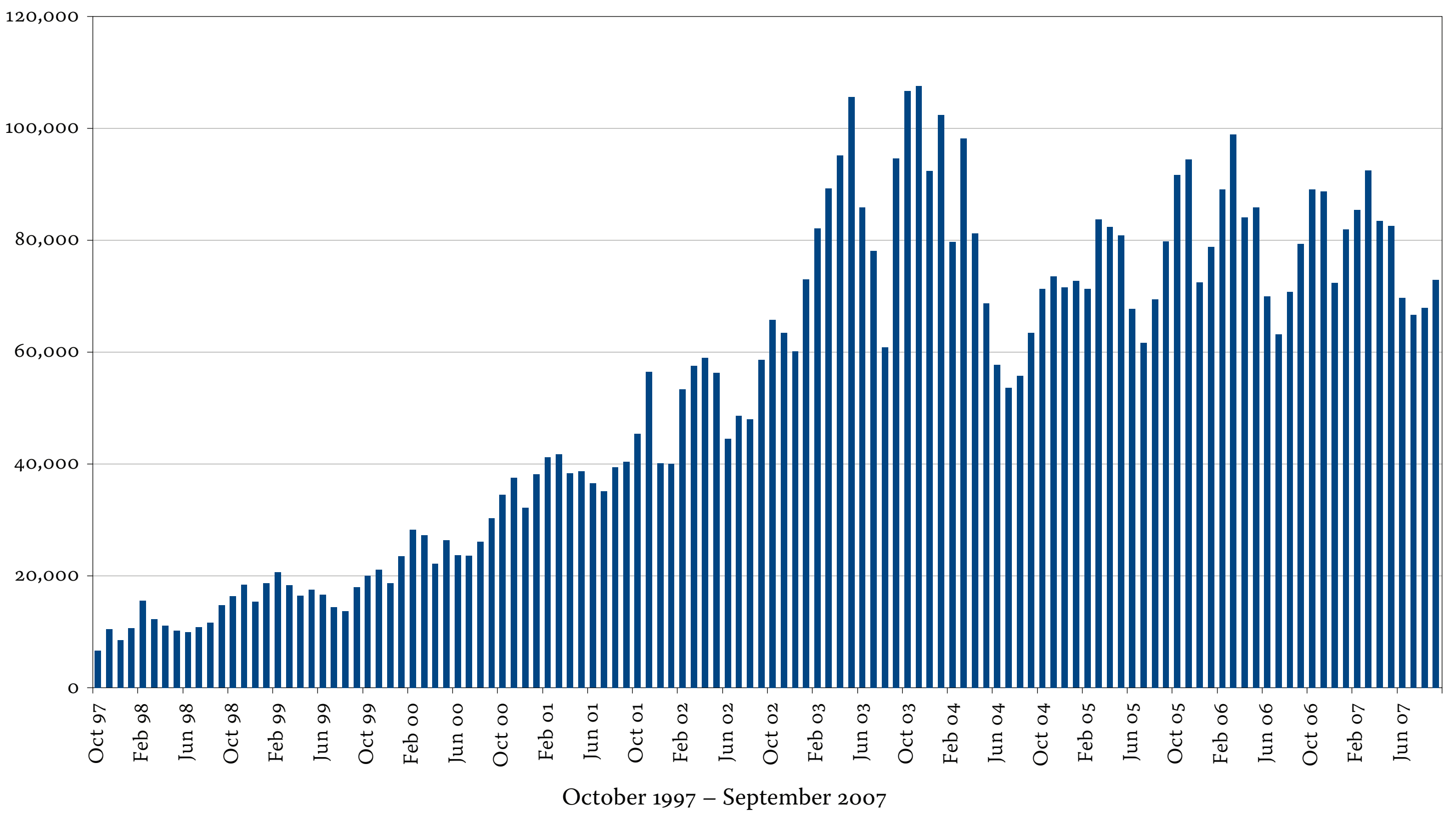
- *Out to Sea: Life as a Crew Member Aboard a Geologic Research Ship* was produced in 2003 in partnership with New Mexico middle school teacher, K. Tauxe, a former marine technician who had worked aboard the *JOIDES Resolution* in the early years of ODP. The video, developed to engage the interest of middle-school students, uses the *JOIDES Resolution* as the centerpiece of a presentation focused on the lives of people who work aboard the ship, and conveys the excitement of science communicated through an active shipboard experience.

- **ODP Traveling Exhibit**—Created at the beginning of the Program, this portable display was used for many years at events ranging from port calls and individual ODP country member society meetings (both academic and industry related) to museums and ODP international meetings. The traveling exhibit effectively brought ODP to large groups of people who might not otherwise have had the opportunity to visit the ship or attend a conference. By 1993, the exhibit was redesigned to include a model of the *JOIDES Resolution* reentering a drillhole, a rotating core bit, and a "super core" representing several layers of sediment and rock. Because this version was so successful, replicas were created and sent for use by several museums throughout the United States and overseas (e.g., Pier Museum in St. Petersburg, Florida; the New England Science Museum in Worcester, Massachusetts; the Colburn Gem and Mineral museum in Ashville, North Carolina; and the Museum of Wales, in the United Kingdom).

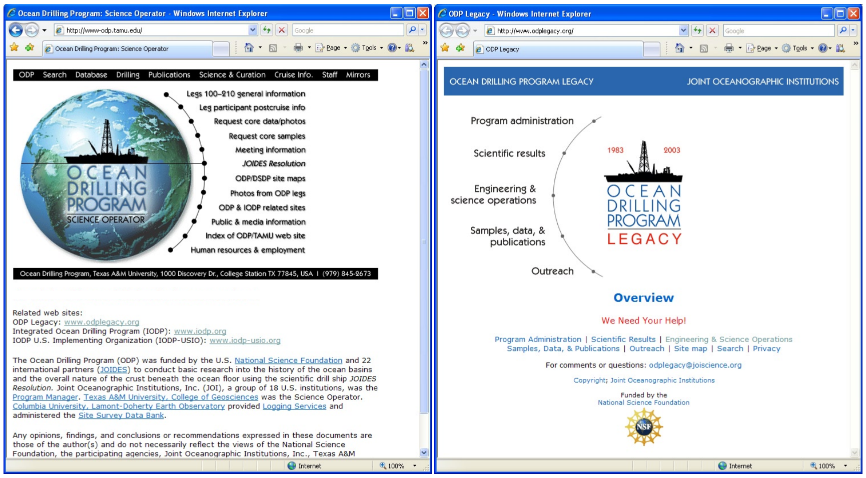
The most popular ODP-related exhibit was created in 1997 and remains on display at the Smithsonian Institution's National Museum of Natural History. It includes a section of deep-sea core recovered during Leg 171B and a video that highlights the *JOIDES Resolution* and how core is recovered. The Cretaceous/Tertiary (K/T) boundary core is the centerpiece of a multimedia exhibit, "Blast from the Past," which presents the hypothesis that an asteroid collision devastated terrestrial and marine environments worldwide 65 million years ago.

- **ODP Web site**—Web site content for ODP began to appear in the mid-1990s,

Number of ODP-TAMU Web Site Visits: FY98–FY07



Note: Statistics only cover ODP-TAMU Web site; no statistics were collected for the Joint Oceanographic Institutions, Inc., Web site and statistics were not available for the ODP-LDEO Web site at time of report publication.

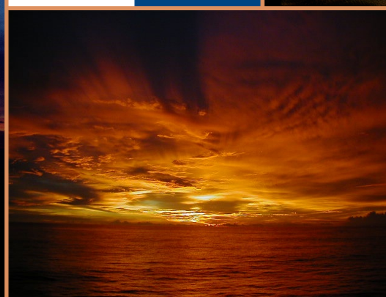


and by 1996, the ODP Web site (previously oceandrilling.org) was formally established. A main Web page provided a uniform entry point for accessing information on the Program, and Joint Oceanographic Institutions, Inc. (JOI), ODP-LDEO, and ODP-TAMU each maintained a separate site that contained information about the areas of the Program for which they were responsible. Content included staff directories, cruise information, online data and data request forms, photographs (general ODP and leg group photos), and ODP publications such as the *Proceedings of the Ocean Drilling Program, Preliminary Report, Scientific Prospectus,* and *Technical Notes.* Logging data was available online in early 1996. The ODP relational database, Janus, was made available on the ODP Web site in early 1998, allowing users to search and download ODP leg data via easy-to-use and predefined data requests or queries. In 2003, as part of the legacy documentation process, the Program initiated plans to create an ODP Legacy Web site and acquired the domain www.odplegacy.org. Population of the site began in 2003 and continued through 2007. A Web site was also established for Deep Sea Drilling Project (DSDP) publications (deepseadrilling.org) as a legacy project during ODP.

- ***JOIDES Journal***—This biannual publication prepared by the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) Office served as a means of communication among the JOIDES committees and advisory panels, National Science Foundation (NSF) and international participating organizations, JOI and its subcontractors, and interested earth scientists from 1975 to 2004. For more information regarding this product, see "Scientific Direction" in the "Program Administration" chapter.

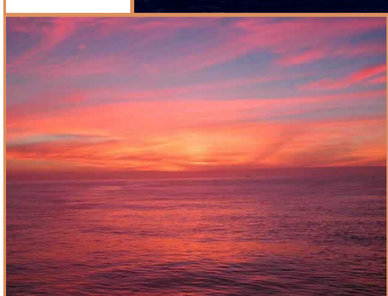
- **Ocean Drilling Citation Database**—JOI and ODP-TAMU collaborated with the American Geological Institute (AGI) to develop a database of ODP-related citations. This subset of the AGI GeoRef database was created to serve as a source of ODP information to be used for a variety of purposes, serving as a resource for scientific researchers and media relations professionals; a tool for use in the assessment of ODP against its Long Range Plan; and a source of data on the value of the scientific accomplishments of the Program that supported the value of continuing the Program with the successor to ODP, the Integrated Ocean Drilling Program (IODP). For more information, see "Bibliographic Databases" in the "Samples, Databases, and Publications" chapter.

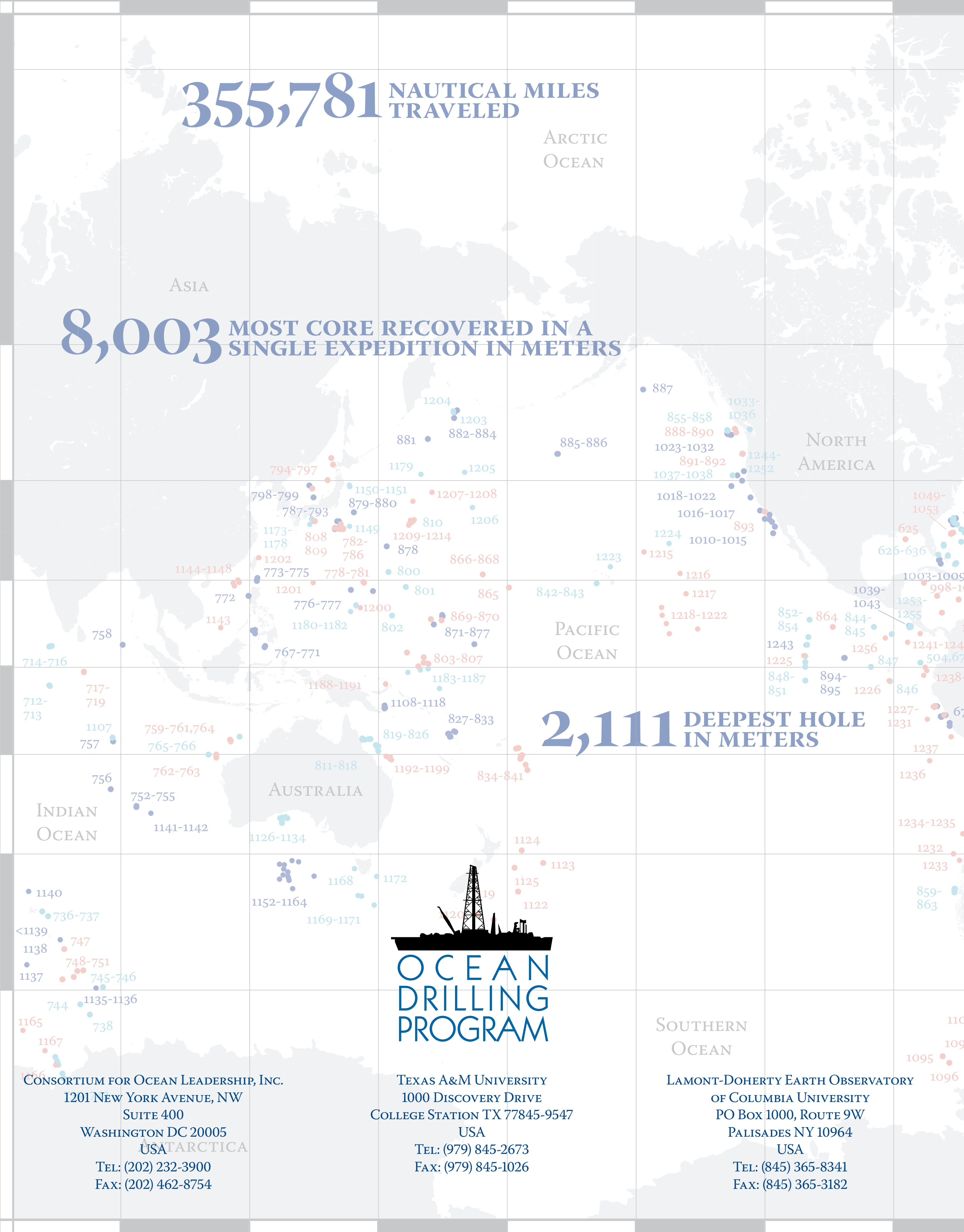
Most of the outreach activities and products described above are available on the ODP Legacy Web site (www.odplegacy.org/outreach), which was launched in September 2006 to encourage interest, awareness, and understanding of ODP as a program; preserve the data, documents, and publications produced during the Program; and highlight the scientific and technical accomplishments of 20 years of scientific ocean drilling. Users can access scientific data generated during operations on board the *JOIDES Resolution* and later shore-based activities via links to various databases. Although the site is not intended as a comprehensive historical archive, it contains downloadable documents that cover a wide spectrum of Program information, from laboratory and instrument manuals to all of the Program's scientific publications, journals, and educational materials. The ODP Legacy Web site also includes some data and publications related to DSDP, the ground-breaking precursor to ODP.



Eternal sunrise,
eternal dawn and gloaming,
on sea and continents and islands,
each in its turn,
as the round earth rolls.

—John Muir





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