



# **VOLUME 191 INITIAL REPORTS**

## **NORTHWEST PACIFIC SEISMIC OBSERVATORY AND HAMMER DRILL TESTS SITES 1179-1182**

### **PROCEEDINGS OF THE OCEAN DRILLING PROGRAM**

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

# PROCEEDINGS OF THE OCEAN DRILLING PROGRAM

Volume 191

Initial Reports

Northwest Pacific Seismic Observatory and Hammer Drill Tests

Covering Leg 191 of the cruises of the Drilling Vessel *JOIDES Resolution*

Yokohama, Japan, to Apra Harbor, Guam

Sites 1179–1182

16 July–18 September 2000

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Reference to the whole or to part of this volume should be made as follows:

**Print citation for Chapter 1:**

Shipboard Scientific Party, 2001. Leg 191 summary. *In* Kanazawa, T., Sager, W.W., Escutia, C., et al., *Proc. ODP, Init. Repts.*, 191: College Station TX (Ocean Drilling Program), 1–49.

**CD-ROM volume citation:**

Kanazawa, T., Sager, W.W., Escutia, C., et al., 2001. *Proc. ODP, Init. Repts.*, 191 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

**CD-ROM chapter citation:**

Shipboard Scientific Party, 2001. Site 1179. *In* Kanazawa, T., Sager, W.W., Escutia, C., et al., *Proc. ODP, Init. Repts.*, 191, 1–159 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

This volume also appears on the World Wide Web. See [www-odp.tamu.edu/publications](http://www-odp.tamu.edu/publications) for Web citation formats.

### Effective publication dates of ODP *Proceedings*

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

The printing date of this volume: September 2001

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

Volume 187 (*Initial Reports*): January 2001

Volume 188 (*Initial Reports*): March 2001

Volume 189 (*Initial Reports*): May 2001

Volume 170 (*Scientific Results*): February 2001

Volume 171A (*Scientific Results*): December 2000

Volume 171B (*Scientific Results*): April 2001

Copies of this publication may be obtained from Publications Distribution Center, Ocean Drilling Program, Texas A&M University, 1000 Discovery Drive, College Station TX 77845-9547, USA. See the ODP publication list at [www-odp.tamu.edu/publications](http://www-odp.tamu.edu/publications) or contact ODP for prices and ordering information. Orders for copies require advance payment.

### ISSN

Printed booklet: 0884-5883; CD-ROM volume: 1096-2522; World Wide Web volume: 1096-2158  
Library of Congress 87-642-462

## PUBLISHER'S NOTES

This volume also appears on the World Wide Web. Any corrections, revisions, or additions will be noted in the chapter (see "Chapter Notes") at [www-odp.tamu.edu/publications](http://www-odp.tamu.edu/publications).

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

Australia/Canada/Chinese Taipei/Korea Consortium for Ocean Drilling: Department of Primary Industries and Energy (Australia), Natural Resources Canada, National Taiwan University in Taipei, and Korean Institute for Geology, Mining and Minerals

Deutsche Forschungsgemeinschaft (Federal Republic of Germany)

European Science Foundation Consortium for Ocean Drilling (Belgium, Denmark, Finland, Iceland, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland)

Institut National des Sciences de l'Univers–Centre National de la Recherche Scientifique (INSU-CNRS) (France)

Marine High-Technology Bureau of the State Science and Technology Commission of the People's Republic of China

National Science Foundation (United States)

Natural Environment Research Council (United Kingdom)

University of Tokyo, Ocean Research Institute (Japan)

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, the participating agencies, Joint Oceanographic Institutions, Inc., Texas A&M University, or Texas A&M Research Foundation.

Abbreviations for names of organizations and publications in ODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

The bulk of the shipboard-collected data from this leg is available on the World Wide Web and is accessible at [www-odp.tamu.edu/database](http://www-odp.tamu.edu/database). If you cannot access this site or need additional data, please contact the ODP Data Librarian, Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. E-mail: [database@odpemail.tamu.edu](mailto:database@odpemail.tamu.edu).

The map at the front of this volume was produced using Generic Mapping Tools (GMT) of Paul Wessel and Walter H.F. Smith ([gmt.soest.hawaii.edu](http://gmt.soest.hawaii.edu)). A site map showing the drilling locations for this leg and maps showing the drilling locations of all Ocean Drilling Program (ODP) and Deep Sea Drilling Project (DSDP) drilling sites are available on the volume CD-ROM in PDF format.

Cover photograph, by ODP Photographer L. Shannon Center, is of the drill rig in action at night. Except for transit time, the rig runs around the clock.

# FOREWORD

## BY JOINT OCEANOGRAPHIC INSTITUTIONS, INC.

This volume presents scientific and engineering results from the Ocean Drilling Program (ODP). These results address the scientific and technical goals of the program, which are focused on the study of the dynamics of Earth's interior and environment, the evolution of oceanic crust, and the fluctuations of climate. In addition, study of the Earth's deep biosphere is an emergent research objective.

ODP, an international partnership of scientists and research institutions from 22 countries, operates the drillship *JOIDES Resolution*. This state-of-the-art research vessel contains eight levels of laboratories and other scientific facilities required for carrying out the program's objectives.

The management of ODP involves a partnership of scientists and governments. International oversight and coordination are provided by the ODP Council, which is made up of representatives from the member countries. Overall scientific and management guidance is provided by representatives from the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES).

Joint Oceanographic Institutions, Inc. (JOI), a nonprofit consortium of 14 U.S. oceanographic institutions, serves as the National Science Foundation's prime contractor for ODP. JOI implements scientific objectives, plans, and recommendations of the JOIDES committees through major subcontracts to Texas A&M University (TAMU) for science operations and to Lamont-Doherty Earth Observatory (LDEO) of Columbia University for geochemical and geophysical well-logging services.

JOI, TAMU, and LDEO have worked together successfully for many years to manage the Ocean Drilling Program. We look forward to many exciting discoveries and continued international collaboration as we further our scientific mission, especially the planning for the future of ocean drilling beyond 2003.

Steven R. Bohlen

President of the Joint Oceanographic Institutions and Executive Director of the Ocean Drilling Programs  
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\*At time of publication. See [Publisher's Notes](#), p. 5, for list of funding agencies at time of cruise. For an up-to-date list of current member organizations and office contact information, see the ODP Web site: [www.oceandrilling.org](http://www.oceandrilling.org).



Australia/Canada/Chinese Taipei/Korea Consortium for Ocean Drilling: Department of Primary Industries and Energy (Australia), Natural Resources Canada, National Taiwan University in Taipei, and Korean Institute for Geology, Mining and Minerals

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## ACKNOWLEDGMENTS

Despite setbacks from typhoons, medical emergencies, and broken equipment, ODP Leg 191 was successful owing to the tireless efforts of all on board the *JOIDES Resolution*—as well as support from “the beach.” Finding the rig inoperable after an emotionally draining couple of days spent effecting a medical evacuation, it would have been easy to quit and head for port a few days early. But that was an option no one wanted. Instead, the order had to come from headquarters to quit and go to Guam. To many on board the *Resolution*, it may be “just a job,” but we could not have asked for greater skill and professionalism.

In particular, we thank Captain Tom Hardy and his officers for running a “tight ship,” making it possible to have a home and laboratory on the high seas, and for keeping their sense of humor while keeping the *Resolution* and its inhabitants out of harm’s way. Dodging typhoons pits the captain and officers against both the scientists, who would continue to work until too late, and the merciless elements, which would claim *Resolution* if given the chance. Captain Hardy and his men played this balancing act with skill. Thanks also go to ODP Operations Manager Mike Storms, Transocean Sedco Forex Operations Superintendent Wayne Malone, and Rig Superintendent Jose “Pepe” Estevez, who never questioned “Plan B,” or even “Plan C,” but made sure the work was done. Certainly, we cannot forget the roughnecks, roustabouts, and other members of the crew who make possible our scientific explorations. Nor can we ignore the contributions of the marine technical staff, ably led by Laboratory Officer Bill Mills. Without our trusty techs at our sides, much of the science would not get done (or entered into the Janus database).

Rick Goebel and Taras Olijnyk, SDS Digger Tools engineers, deserve mention. Despite a barrage of setbacks that appeared certain to render their two months at sea a waste, these two kept a “stiff upper lip” and cheerful disposition. And when the time came for them to go into action, they were ready and more than willing.

A special thanks also go to the people back at ODP headquarters for their support. Sure, we love to complain about “the beach” forgetting about us on weekends, but when it came time to call at 3 a.m. to request help, Jack Baldauf or Tom Davies were always there (and reasonably cheerful given the hour). The people back at ODP somehow managed to get us the spare parts we needed and get them halfway around the world in time that we could continue with our work.

## DEDICATION



We, the scientists of Leg 191, wish to express our appreciation to our good friend and colleague, Ralph Moberly, for his contributions to our cruise and his long dedication to ocean drilling and marine geology of the Pacific. Ralph is not retiring just yet, but he has admitted it will not be far in the future, and Leg 191 may or may not be his last cruise (sometimes he says it will be, but we hope not). Nevertheless, we take this opportunity to recognize the accomplishments of a fine scientist and true gentleman. When you work with him for months at sea, the things you notice about Ralph are his extensive knowledge of geology and sedimentology (and many other things, for that matter), his keen eye for detail, his understated wit, and his self-effacing manner. As a scientist on our team, we could ask for none better; as a human being, we could ask for none more genuine.

Ralph Moberly was a key player in the Deep Sea Drilling Program (DSDP) sampling of the western Pacific Ocean. He sailed as a scientist on Legs 7, 17, and 61 and as co-chief scientist on Legs 32 and 89,

investigating the distribution of sediments and Cretaceous volcanics in the western Pacific. From 1988 to 1990, he was chairman of the JOIDES Planning Committee and head of the JOIDES office during its stay at the University of Hawaii. In the past two decades, Ralph has spent his time serving in a number of administrative roles and as chair, as well as guiding the University of Hawaii Geology and Geophysics Department from 1990 to 1993 and the Ocean Engineering Department from 1995 to 1998. Previously, he served as chair of the Geology and Geophysics Department from 1964 to 1965 and 1975 to 1980 and was associate director of the Hawaii Institute of Geophysics from 1983 to 1990.

Ralph's love affair with the sea began with the U.S. Navy in 1950. As a lieutenant junior grade, he worked in oceanographic surveying until 1953. After obtaining his Ph.D. at Princeton in 1956, where he worked with Harry Hess, Ralph did a brief stint with Standard Oil in California before being hired as the third faculty member in the University of Hawaii's Geology Department in 1959. During the 1960s, he completed a pioneering study of Hawaiian shorelines and sand reservoirs as well as studies of basalt weathering products and their conversion into marine muds. His first DSDP cruise, Leg 7, set sail a few months before the end of that decade. During the 1970s, Ralph was one of the first to apply the concepts of the then-new global tectonics theory to the western Pacific in an article titled "Origin of lithosphere behind island arcs, with reference to the western Pacific." His interest in active margin tectonics continued with his participation in the IDOE Nazca project in the early 1970s. Through the decade, he participated in DSDP Legs 17, 32, and 61. Active margins kept Ralph's interest through the 1980s, during which he published studies on forearc basins in Peru, Ecuador, and Chile and the structure and tectonics of the continental margin of Peru. During 1982, he was co-chief scientist on DSDP Leg 89. Since then, his work on Pacific geology has continued as his engagement in administrative endeavors have increased.

As he nears the close of a noteworthy career, we wish to recognize Ralph for his unselfish service to the ocean drilling community, marine geology, his university, and his students. He is one of those unsung heroes who made a difference but did not seek the spotlight. He is also a friend for whom we will always harbor fond memories.

## DEDICATION



On the morning of 25 August 2000, everyone on board the *JOIDES Resolution* was jolted by the news that Ross Diaz, one of the Filipino roustabouts, was seriously ill, having suffered a stroke. It was a time for all on board the *Resolution* to realize how similar we all are, adrift together, vulnerable to a turn of bad fortune, and yet how far apart. Well known and respected among the crew, few scientists could claim to know Ross. Now many of us wish we did, for Ross was a dedicated worker, husband, and father. We therefore dedicate this volume to Ross Diaz and the other unsung heroes like him who make it possible for the Ocean Drilling Program to operate at the frontier of science in far-flung locations on the high seas.

Friends and co-workers speak highly of Ross. They note his experience, leadership, loyalty, patience, and hard work. Ross began his career working on the *Glomar III* in 1973. Since 1987, he has worked on the *JOIDES Resolution*. Along the way, he trained many of the men who work the drill rig floor and earned the nickname “The Godfather” for looking after his charges.

Ross was born on 9 December 1945 and grew up in the Philippines. He was one of eight children. He married

Nanie and they have three children and two grandchildren. People who know him say that Ross likes the simple pleasures: entertaining friends, playing his guitar, drinking wine with buddies, and spending time with his family.

To Ross we say “thanks” for all the hard work over the many years and for loyalty to Sedco, co-workers, and friends. We also say “farewell and Godspeed” and add a wish for a speedy recovery.

# CD-ROM CONTENTS: CHAPTERS

- 1. Leg 191 Summary**  
Shipboard Scientific Party
- 2. Explanatory Notes**  
Shipboard Scientific Party
- 3. Borehole Seismological Observatory**  
Shipboard Scientific Party
- 4. Site 1179**  
Shipboard Scientific Party
- 5. Hammer-Drill Sites (1180–1182)**  
G. Leon Holloway and Shipboard Scientific Party

## CD-ROM CONTENTS: CORE DESCRIPTIONS

Visual core descriptions (VCDs), smear-slide and thin-section data tables, and digital micrograph and core images are included in this section. VCDs and smear-slide and thin-section data tables are combined into one PDF file. ASCII versions of the smear-slide data tables are also available (see "[ASCII Tables](#)").

### Site 1179

[Visual Core Descriptions](#) · [Smear Slides](#) · [Thin Sections](#)



## CD-ROM CONTENTS: ASCII TABLES

This CD-ROM contains ASCII versions of selected coring summary, biostratigraphy, inorganic geochemistry, paleomagnetism, structural geology, physical properties, and borehole instrument deployment **data tables** presented in Chapter 4 and **smear-slide data tables** presented under “Core Descriptions.” A complete listing of the ASCII data tables can be found on the next two pages.

You can access these data directly from the PDF files. Depending on your computer platform, the following information applies.

### PC COMPUTERS

By default, clicking on a filename with a .TXT extension will launch the Notepad application. You can configure your computer’s operating system so that files on this CD with .TXT extensions automatically open in other software, such as Microsoft Excel. Follow these steps from the pull-down menu: Windows 95 and NT operating systems: View > Options > File Types; and Windows 98 systems: View > Folder Options > File Types.

### MAC COMPUTERS

All table files with .TXT extensions will automatically open into Excel. If you do not have Excel installed on your computer, you may view these files through other spreadsheet or text-editor programs. Open the application of your choice, select File > Open, and open the ASCII file.

### UNIX COMPUTERS

You can open files with .TXT extensions in any text editor or spreadsheet program, but not directly from PDF files.

## Chapter 4, Site 1179

**Table T1.** Coring summary, Site 1179.

**Table T2.** Carbon and elemental analyses of Site 1179 sediments.

**Table T3.** Distribution and relative abundance of radiolarians, Site 1179.

**Table T4.** Core samples collected for microbiological experiments and results of chemical analyses.

**Table T5.** Magnetic susceptibility tie point depths correlating cores from Holes 1179A, 1179B, and 1179C.

**Table T7.** Subdivision of the basalt pile, Hole 1179D.

**Table T8.** Phenocryst distribution in basalts, Hole 1179D.

**Table T9.** Glass/palagonite contents of basalts, Hole 1179D.

**Table T10.** Chemical analyses of basalts, Hole 1179D.

**Table T11.** CIPW norm composition of basalts, Hole 1179D.

**Table T12.** PWS3 split-core *P*-wave velocities.

**Table T13.** Index properties of discrete samples, Holes 1179A, 1179B, and 1179C.

**Table T14.** Thermal conductivity values, Holes 1179A, 1179B, and 1179C.

**Table T15.** *P*-wave velocities and densities in basalts.

**Table T16.** Average physical properties by lithostratigraphic unit.

**Table T17.** Vane shear data, Holes 1179A, 1179B, and 1179C.

**Table T18.** Correlation of reflection traveltime with the lithostratigraphic column using measured *P*-wave velocities, Site 1179.

**Table T19.** Correlations of reflection traveltime with the lithostratigraphic column, Site 1179.

**Table T20.** Instrument package deployment, Site 1179.

## Smear-Slide Data Tables

Smear-slide table, **Holes 1179A and 1179B.**

Smear-slide table, **Holes 1179C and 1179D.**

## CD-ROM CONTENTS: SUPPLEMENTARY MATERIALS

This CD-ROM contains supplementary materials consisting of JPG and HTML photographs that present a pictorial record of the preparation and installation of the borehole seismometer instruments. For a thumbnail view of the photographs and links to the captions, see [SUPP\\_MAT/BOREHOLE/INDEX.HTM](#). If this link does not open INDEX.HTM, users may open the file directly in a Web browser.

## CD-ROM CONTENTS: DRILLING LOCATIONS MAPS

A site map showing the drilling locations for this leg and maps showing the drilling locations of all Ocean Drilling Program (ODP) and Deep Sea Drilling Project (DSDP) drilling sites are available in PDF format.

**ODP Leg 191 Site Map**

**ODP Map** (Legs 100–191)

**DSDP Map** (Legs 1–96)

## RELATED LEG DATA

### DOWNHOLE LOGGING AND CORE DATA

A second CD-ROM is included with this volume. The “Log and Core Data” CD contains Leg 191 depth-shifted and processed downhole logging data and shipboard core logging data (gamma-ray attenuation bulk density, natural gamma radiation, magnetic susceptibility, *P*-wave velocity, and moisture and density). The downhole logging data are provided by the Borehole Research Group at the Lamont-Doherty Earth Observatory, Wireline Logging Operator for ODP.

The majority of the logging data included on the CD are available on the World Wide Web at [www.ideo.columbia.edu/BRG/ODP](http://www.ideo.columbia.edu/BRG/ODP). If you cannot access this site or want to order the CD, please contact: ODP Logging Services Operator, Lamont-Doherty Earth Observatory, Route 9W, Palisades NY 10964, USA; Tel: (845) 365-8341; Fax: (845) 365-3182; E-mail: [borehole@ideo.columbia.edu](mailto:borehole@ideo.columbia.edu).

The majority of the core data on the CD are available on the Web at [www-odp.tamu.edu/database](http://www-odp.tamu.edu/database). If you cannot access the ODP database or need additional data, please contact: ODP Data Librarian, Ocean Drilling Program, Texas A&M University, 1000 Discovery Drive, College Station TX 77845-9547, USA; Tel: (979) 845-8495; Fax: (979) 458-1617; E-mail: [database@odpemail.tamu.edu](mailto:database@odpemail.tamu.edu).

## COMPILED ELECTRONIC INDEX

The Compiled Electronic Index of the *Proceedings of the Ocean Drilling Program* included on the *Initial Reports* CD-ROM contains individual indexes of Volumes 101–171B, 173, and 174B. The indexes are contained in the directory titled ODPINDEX and are named ###NDX.PDF (### = the leg number). These indexes can be searched individually or collectively.

# CD-ROM DIRECTORY STRUCTURE

<b>191IR.PDF</b> (Preliminary pages and table of contents)		
<b>README.PDF</b> (Information about the volume CD-ROM)		
<b>README.TXT</b> (Information about the volume CD-ROM in ASCII format)		
<b>ACROREAD</b> (Acrobat Reader 4.0.5 installation software and instructions for different platforms)	<b>MAC</b>	
	<b>UNIX</b>	
	<b>WINDOWS</b>	
	<b>README.TXT</b>	
<b>MAPS</b> (Drilling locations maps)	<b>191_MAP.PDF</b> (Leg 191 site map)	
	<b>ODPMAP.PDF</b> (ODP map, Legs 100 through 191)	
	<b>DSDPMAP.PDF</b> (DSDP map, Legs 1 through 96)	
<b>VOLUME</b> (Leg 191 <i>Initial Results</i> volume)	<b>CHAPTERS</b> (Volume chapters)	<b>IR191_01.PDF</b> (Leg 191 Summary)
		<b>IR191_02.PDF</b> (Explanatory Notes)
		<b>IR191_03.PDF</b> (Borehole Seismological Observatory)
		<b>IR191_04.PDF</b> (Site 1179)
		<b>IR191_05.PDF</b> (Hammer-Drill Sites [1180–1182])
	<b>CORES</b> (Visual core descriptions, smear-slide and thin-section data tables, and digital photomicrograph and core images)	<b>COR_1179.PDF</b> (Site 1179)
		<b>IMAGES</b> (PDF files of core images)
		<b>PHOTOMIC</b> (PDF files of photomicrographs)
	<b>TABLES</b> (ASCII-format tables of selected coring summary, biostratigraphy, inorganic geochemistry, paleomagnetism, structural geology, physical properties, borehole instrument deployment, and smear-slide data)	<b>IR191_04</b> (Site 1179 files)
		<b>S_SLIDES</b> (Smear slides from Site 1179)
<b>README.TXT</b>		
<b>SUPP_MAT</b> (Supplementary Material)	<b>BOREHOLE</b> (Digital photographs of preparation and installation of the borehole instrument assembly)	<b>INDEX.HTM</b> (Main page)
		<b>PHOTO001.HTM through PHOTO128.HTM</b> (Photo pages)
		<b>INDEX001.JPG through INDEX128.JPG</b> (Photo thumbnails)
		<b>PHOTO001.JPG through PHOTO128.JPG</b> (Full-sized photos)
		<b>CAPTIONS.HTM</b> (Explanations of photos)
		<b>README.TXT</b>
<b>ODPINDEX</b> (Compiled Electronic Index of the <i>Proceedings of the Ocean Drilling Program</i> )	<b>101NDX.PDF through 171BNDX.PDF, 173NDX.PDF, and 174BNDX.PDF</b> (Index files)	
	<b>NDX.PDX</b> (Acrobat file used to enable Acrobat Search of the Compiled Electronic Index)	