Interval 120-747A-19X-2, 109-130 cm: lower Eocene to Danian hardground with large filled burrows, cracks, pyrite, and coated grains.

Section 120-747C-4R-CC: Maestrichtian to Danian polygenic breccia with smectite clay matrix and chert, limestone, soft clay pellets, and diverse volcanic rocks, including weathered scoria, fresh basalt with filled vesicles, hard phenocryst basalt, and an inoceramid fragment.

Interval 120-747A-21X-4, 104-122 cm: Maestrichtian nannofossil ooze with laminated phosphatic hardground.

Section 120-747C-16R-3, Piece 5: aphyric, red, weathered basalt with irregular stretched vesicles filled with zeolites, clay, and minor calcite.

Interval 120-748C-45R-CC: glauconitic bioclastic rudstone with bryozoan, inoceramid, red algal, benthic foraminifer, and sponge debris.

Section 120-748C-73R-6, 118-131 cm: glauconitic sand with altered volcanic grains and serpulid and molluscan fossils.

Interval 120-748C-32R-1, 32-38 cm: thin section in cross nicols of a large, obliquely cut bryozoan fragment, about 1.4 mm long, with well-preserved zooecia and zones of partial silicification.

Interval 120-748C-79R-4, 113-114 cm: thin section under cross nicols across a mollusc fragment from matrix of basaltic cobbles showing thick shell and excellent preservation of laminations.

Section 120-748C-79R-7 at 40 cm: thin section from alkali basalt with analcime alteration (gray), red hematite weathering, and blue-green celadonite vein and vesicle fillings.

Interval 120-750B-9W-1, 134-148 cm: Upper Cretaceous, pale grayish green chalk and silicification front with darker silicified limestone below.

Section 120-751A-6H-1: diverse irregular, Pliocene, lepisphere porcellanite cavities from a bed at about 20 mbsf, which was fragmented into disturbed diatom nannofossil ooze.

Interval 120-750B-11W-1, 75-87 cm: greenish gray, Cenomanian, burrowed nannofossil chalk with black marly interbeds.

Interval 120-750B-13W-1, 55-70 cm: mud pebble conglomerate with kaolinite clays, multicolored ferruginous volcanioclastic components, siderite, and black coaly fragments.

Section 120-750A-15R-3, 78-94 cm: Cretaceous/Tertiary boundary sequence, with slight disturbance at boundary. Danian greenish gray nannofossil chalk vs. white Maestrichtian foraminifer-nannofossil chalk with scattered dark chert bits.

Interval 120-750B-14R-1, Piece 3: grayish green, fine-grained plagioclase phric basalt with irregular vesicles filled with light green clays and veins with calcite.
This publication was prepared by the Ocean Drilling Program, Texas A&M University, as an account of work performed under the international Ocean Drilling Program, which is managed by Joint Oceanographic Institutions, Inc., under contract with the National Science Foundation. Funding for the program was provided by the following agencies at the time of this cruise:

Department of Energy, Mines and Resources (Canada)
Deutsche Forschungsgemeinschaft (Federal Republic of Germany)
European Science Foundation Consortium for Ocean Drilling (Belgium, Denmark, Finland, Iceland, Italy, Greece, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey)
Institut Français de Recherche pour l'Exploitation de la Mer (France)
National Science Foundation (United States)
Natural Environment Research Council (United Kingdom)
University of Tokyo, Ocean Research Institute (Japan)

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

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


Effective Publication Dates of ODP Proceedings

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

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

Volume 133 (Initial Reports): September 1991
Volume 134 (Initial Reports): March 1992
Volumes 136/137 (Initial Reports): January 1992
Volume 121 (Scientific Results): November 1991
Volume 122 (Scientific Results): February 1992
Volume 124 (Scientific Results): September 1991

Distribution

Copies of this publication may be obtained from Publications Distribution Center, Ocean Drilling Program, 1000 Discovery Drive, College Station, Texas 77845-9547. Orders for copies will require advance payment. See current ODP publication list for price and availability of this publication.

Printed April 1992

ISSN 0884-5891
Library of Congress 87-642-462

Foreword
By the National Science Foundation

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

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

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

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

The international commitment to ocean drilling has increased in the ODP. In addition to our five partners in IPOD—France, the Federal Republic of Germany, Japan, the Soviet Union, and the United Kingdom—two consortia have joined ODP: Canada-Australia and the European Science Foundation (representing Belgium, Denmark, Finland, Greece, Iceland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey). The 20 countries of the ODP represent the community of nations that have a global interest in the geosciences and oceanography. This global scientific participation has assured the program's scientific
excellence by focusing and integrating the combined scientific knowledge and capabilities of the program's 20 nations. It has allowed problems of a global nature to be addressed by providing databases and background studies which are openly shared for planning and interpreting drilling results. It has eased problems of access to territorial waters, allowing comparative studies to be done among oceans. Finally, the international sharing of program costs has allowed this important and large program to proceed without detrimental impact to the research budgets of any one nation.

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

Walter E. Massey
Director
National Science Foundation

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

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

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

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

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

The ship, registered as SEDCO/BP 471 after her owners and her length in feet (144 meters), is 70 feet (21 meters) wide, and has a displacement of 16,595 long tons. Her derrick towers 200 feet (61 meters) above the waterline, and a computer-controlled dynamic-positioning system stabilizes the ship over a specific location while drilling in water depths up to 27,000 feet (8230 meters). The drilling system collects cores from beneath the seafloor with a derrick and drawworks that can handle 30,000 feet (9144 meters) of drill pipe. More than 12,000 square feet (1115 square meters) of space distributed throughout the ship is devoted to scientific laboratories and equipment. The ship sails with a scientific and technical crew of 50 and a ship's crew of 65.

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

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

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

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

D. James Baker
President
Joint Oceanographic Institutions, Inc.

Washington, D.C.
Preface

The Scientific Results volumes of the Proceedings of the Ocean Drilling Program contain specialty papers presenting the results of up to one and one-half years of research in various aspects of scientific ocean drilling. I acknowledge with thanks the authors of the papers published in this volume, who thereby have enabled future investigators to gain ready access to the results of their research.

Each of the papers submitted to a Scientific Results volume undergoes rigorous peer review by at least two specialists in the author’s research field. A paper typically goes through one or more revision cycles before being accepted for publication. Our goal is to maintain a peer-review system comparable to those of the most highly regarded journals in the geological sciences.

The Editorial Review Board for a Scientific Results volume is responsible for obtaining peer reviews of papers submitted to the volume. This board usually is made up of the two co-chief scientists for the cruise, the ODP staff scientist for the cruise, and one external specialist who is familiar with the geology of the area investigated. In addition, the ODP staff editor assigned to the volume helps with any manuscripts that require special attention, such as those by authors who need assistance with English expression.

Scientific Results volumes may also contain short reports consisting of good data that are not ready for final interpretation. Papers in this category are segregated in a section in the back of the volume called Data Reports. Although no interpretation is permitted, these papers ordinarily contain a section on methodology or procedures. Data Report papers are read carefully by at least one specialist to make sure they are well organized, comprehensive, and discuss the techniques thoroughly.

In acknowledgment of the contributions made by this volume’s Editorial Review Board, names of the individual Board members are listed on the title page. Reviewers of manuscripts for this volume, whose efforts are so essential to the success of the publication, are listed in the front portion of the book, without attribution to a particular manuscript.

On behalf of the Ocean Drilling Program, I extend sincere appreciation to members of the Editorial Review Boards and to the reviewers for giving so generously of their time and efforts in ensuring that only papers of high scientific quality are published in the Proceedings.

Philip D. Rabinowitz
Director
Ocean Drilling Program
Texas A&M University
College Station, Texas
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Program, Department of Energy, Mines and Resources
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PRIME CONTRACTOR
Joint Oceanographic Institutions, Inc.
Washington, D.C.
Thomas E. Pyle
Director, Ocean Drilling Programs

OPERATING INSTITUTION
College of Geosciences and Maritime Studies
Texas A&M University
College Station, Texas
Robert A. Duce
Dean

OCEAN DRILLING PROGRAM
Philip D. Rabinowitz
Director
Timothy J.G. Francis
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Administrator
Jack G. Baldauf, Acting Manager
Science Operations
Barry W. Harding, Manager
Engineering and Drilling Operations
Russell B. Merrill, Curator and Manager
Science Services
Robert E. Olivas, Manager
Technical and Logistics Support

LOGGING OPERATOR
Borehole Research Group
Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York
Roger N. Anderson, Head
PARTICIPANTS ABOARD JOIDES RESOLUTION FOR LEG 120*

Sherwood W. Wise, Jr.
Co-Chief Scientist
Department of Geology
Florida State University
Tallahassee, Florida 32306

Roland Schlich
Co-Chief Scientist
Institut de Physique du Globe
Université Louis Pasteur
5, Rue René Descartes
67084 Strasbourg Cedex
France

Amanda A. Palmer Julson
ODP Staff Scientist/Sedimentologist
Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station, Texas 77845-9547

Marie-Pierre Aubry
Paleontologist (nannofossils)
Département des Sciences de la Terre
Université Claude Bernard
15-43 Bd. du 11 Novembre
69622 Villeurbanne
France
(current address:
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Quissett Campus
Woods Hole, Massachusetts 02543)

William A. Berggren
Paleontologist (foraminifers)
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Quissett Campus
Woods Hole, Massachusetts 02543

Peter R. Bitschene
Inorganic Geochemist
Institut für Mineralogie
Ruhr-Universität Bochum
Postfach 102148
D-4630 Bochum
Federal Republic of Germany

Neal A. Blackburn
Logging Scientist
Britoil plc.
301 St. Vincent Street
Glasgow G25 DD
United Kingdom

James Breza
Sedimentologist
Department of Geology
Florida State University
Tallahassee, Florida 32306

Millard F. Coffin
Physical Properties Specialist
Division of Marine Geosciences
Bureau of Mineral Resources, Geology and Geophysics
P.O. Box 378
Canberra City, A.C.T. 2601
Australia

David M. Harwood
Paleontologist (diatoms)
Byrd Polar Research Center
Ohio State University
125 South Oval Mall
Columbus, Ohio 43210

Franz Heider
Paleomagnetist
Geophysics Laboratory
University of Toronto
Toronto, Ontario M5S 1A7
Canada
(current address:
Institut für Allgemeine und Angewandte Geophysik
Ludwig-Maximilians-Universität
Theresienstrasse 41
D-8000 München 2
Federal Republic of Germany)

Mary Anne Holmes
Sedimentologist
Department of Geology
University of Nebraska
Lincoln, Nebraska 68588-0340

William R. Howard
Sedimentologist
Department of Geological Sciences
Brown University
Providence, Rhode Island 02912-1846

Hiroo Inouzuki
Paleomagnetist
Faculty of Science
Department of Earth Sciences
Kobe University
Nada, Kobe 657
Japan
(current address:
Marine Biological Station
Faculty of Science
Kobe University
Iwaya, Awaji, Tsuchi
Awaji Island, Hyogo 656-24
Japan)

*Address at time of cruise.
Kerry Kelts  
Sedimentologist  
Geology Section  
EAWAG/ETH  
CH-8600 Dübendorf  
Switzerland

David B. Lazarus  
Paleontologist (radiolarians)  
Department of Geology and Geophysics  
Woods Hole Oceanographic Institution  
Quissett Campus  
Woods Hole, Massachusetts 02543  
(current address:  
Geologisches Institut  
Eidgenössische Technische Hochschule  
Sonnteggstrasse 5  
CH-8092 Zurich  
Switzerland)

Andreas Mackensen  
Paleontologist (foraminifers)  
Alfred Wegener Institute for Polar and Marine Research  
Columbusstrasse  
D-2850 Bremerhaven  
Federal Republic of Germany

Toshiaki Maruyama  
Paleontologist (diatoms)  
Department of Earth Science  
College of General Education  
Tohoku University  
Kawauchi, Sendai 980  
Japan

Marc Munschy  
Geophysicist/Logging Scientist  
Institut de Physique du Globe  
Université Louis Pasteur  
5, Rue René Descartes  
67084 Strasbourg Cedex  
France

Elizabeth Pratson  
LDGO Logging Scientist  
LDGO-Borehole Research Group  
Columbia University  
Palisades, New York 10964

Patrick G. Quilty  
Paleontologist (foraminifers)  
Antarctic Division  
Channel Highway  
Kingston 7030  
Tasmania  
Australia

Frank Rack  
Physical Properties Specialist  
Ocean Drilling Program  
Texas A&M University  
1000 Discovery Drive  
College Station, Texas 77845-9547

Vincent J.M. Salters  
Igneous Petrologist  
Department of Earth, Atmospheric and Planetary Sciences  
54-1116, M.I.T.  
Cambridge, Massachusetts 02139

James H. Sevigny  
Igneous Petrologist  
Department of Geology and Geophysics  
The University of Calgary  
Calgary, Alberta T2N 1N4  
Canada

Michael Storey  
Igneous Petrologist  
Department of Geology  
University of Leicester  
University Road  
Leicester LE1 7RH  
United Kingdom

Atsushi Takemura  
Paleontologist (radiolarians)  
Faculty of Science  
Department of Geology and Mineralogy  
Kyoto University  
Kyoto 606  
Japan  
(current address:  
Geoscience Institute  
Hyogo University of Teacher Education  
Yashiro-cho, Kato-gun  
Hyogo, 673-14  
Japan)

David K. Watkins  
Paleontologist (nannofossils)  
Department of Geology  
University of Nebraska  
Lincoln, Nebraska 68588-0340

Hubert Whitechurch  
Igneous Petrologist  
Institut de Géologie  
Université Louis Pasteur  
1 rue Blessig  
67084 Strasbourg Cedex  
France  
(current address:  
Institut de Physique du Globe  
Université Louis Pasteur  
5, rue René Descartes  
67084 Paris Cedex  
France)

James Zachos  
Sedimentologist/Organic Geochemist  
Graduate School of Oceanography  
University of Rhode Island  
Narragansett Bay Campus  
Narragansett, Rhode Island 02882-1197  
(current address:  
Department of Geological Sciences  
University of Michigan  
1006 C. C. Little Building  
Ann Arbor, Michigan 48109-1063)
Ocean Drilling Program Publications Staff

Publications Supervisor
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ACKNOWLEDGMENTS

In this volume we present the results of many months of dedicated scientific research from laboratories around the globe. The challenges and difficulties during drilling on the remote Kerguelen Plateau have culminated in this compilation of our shore-based research. Along with our satisfaction over the success of the Kerguelen operations, we wish to express our appreciation for the efforts of the many people who contributed to the Leg 120 drilling program. First and foremost, we wish to express our deep regard and affection for our late Operations Superintendent, Mr. Lamar Hayes. As noted earlier (Proceedings of the Ocean Drilling Program, Initial Reports, Vol. 120), we have dedicated our cruise volumes to his memory.

We again pass on our gratitude to the drillship’s captain and crew, the drilling staff, and the ODP technical support group. We also acknowledge the efforts of the French and Australian site survey teams, and the governments of France and Australia for permission to drill on Kerguelen.

We also thank the members of the JOIDES advisory panels for their advice in planning the leg, and all the ODP shore-based staff who contributed to its success. We also appreciate the funding support of the various member nations for enabling us to conduct our shore-based research. U.S. workers, in particular, acknowledge grant assistance from JOI-USSAC in supporting the investigations reported in this volume.

Each of the scientific contributions presented in this volume was subjected to at least two external peer reviews, and we are grateful for the diligent efforts of these reviewers. A list of the reviewers for this volume appears on a separate page.

Finally, the Leg 120 scientific party also wishes to acknowledge the ODP Publications staff, especially Janalisa Soltis, Jill Mutschler-Fontenot, Gigi Delgado, Eva Barbu, Janna Abel, Jaime Gracia, and Jill Butler for their hard work in preparing this volume for publication. Our manuscript coordinators, Janalisa Soltis, Jill Mutschler-Fontenot, and Gigi Delgado, volunteered much additional time to help us contact our referees. Eva Barbu, our volume editor, devoted many nights and weekends to ensure the best possible editorial product. Janna Abel, Jaime Gracia, and Jill Butler kept the volume flowing despite its enormous size. To all Publications staff members, we express our sincere appreciation for helping us bring this project to completion.