

Initial Reports of the Deep Sea Drilling Project

A Project Planned by and Carried Out With the Advice of the
JOINT OCEANOGRAPHIC INSTITUTIONS FOR DEEP EARTH SAMPLING (JOIDES)

Volume XLIX

covering Leg 49 of the cruises of the Drilling Vessel *Glomar Challenger*
Aberdeen, Scotland to Funchal, Madeira
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PARTICIPATING SCIENTISTS

Bruce P. Luyendyk, Joe R. Cann,
Wendell A. Duffield, Angela M. Faller, Kazuo Kobayashi, Richard Z. Poore,
William P. Roberts, George Sharman, Alexander N. Shor, Maureen Steiner,
John C. Steinmetz, Jacques Varet, Walter Vennum,
David A. Wood, and Boris P. Zolotarev

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George Sharman

POST-CRUISE SCIENCE REPRESENTATIVE

Stan M. White

SCIENCE EDITOR

James D. Shambach

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UNIVERSITY OF CALIFORNIA
Scripps Institution of Oceanography
Prime Contractor for the Project

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Foreword

For the three and one-half years between 1872 and 1876, the H.M.S. CHALLENGER—after which D/V GLOMAR CHALLENGER is named—undertook the world's first major oceanographic expedition. It is fitting that our century should have its counterpart to that famous ship a century ago whose voyages helped established oceanography as a science. It is equally fitting that GLOMAR CHALLENGER should be plying the same waters one century later seeking answers to new questions concerning the history of our planet and the life it supports. The fundamental advancement of our knowledge of the earth will lead to enhanced capabilities to understand its processes and to use its natural resources intelligently.

The Deep Sea Drilling Project is being undertaken within the context of the National Science Foundation's Ocean Sediment Coring Program. The Foundation is funding the project by means of a contract with the University of California, and the Scripps Institution of Oceanography is responsible for its management. The University has, in turn, subcontracted with Global Marine Incorporated for the services of the drilling ship, GLOMAR CHALLENGER.

Scientific planning is conducted under the auspices of the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES). The JOIDES consortium has convened advisory panels for that purpose, consisting of a large number of distinguished scientists from the academic institutions, Government agencies, and private industry of many countries. Altogether, the project has involved the active interest and participation of many of the world's best scientists and technologists.

The first ocean coring operations for the Deep Sea Drilling Project began on August 11, 1968. During the ensuing years of drilling operations in the Atlantic, Pacific, and Indian Oceans, the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea, and Antarctic waters, the scientific objectives that had been set forth were successfully accomplished. Primarily, the age of the ocean basins and their processes of development were determined. Emphasis was placed on broad reconnaissance and on testing the involvement of the mid-oceanic rise systems in the development of the ocean basins.

From these concepts come major interpretations of the results of the drilling as they bear on patterns of sedimentation and physical and chemical characteristics of the ancient oceans.

As a result of the success of the Deep Sea Drilling Project, the National Science Foundation extended its contract with the University of California to encompass an additional 36 months of drilling, allowing GLOMAR CHALLENGER to continue operations throughout the oceans of the world in exploring the deep ocean floors for a period presently extending one full decade. Scientific interest will involve major effort in drilling deeply into the oceanic crustal igneous rocks to study the processes and mechanisms leading to the formation of the oceanic crust.

These reports contain the results of initial studies of the recovered core material and the associated geophysical information. The contribution to knowledge has been exceedingly large and future studies of the core material over many years will contribute much more.

The importance of the work of the Deep Sea Drilling Project and D/V GLOMAR CHALLENGER is internationally recognized. In response to this recognition, a number of nations are providing partial support. Effective January 1974, the USSR and the Federal Republic of Germany entered into agreements with the United States for participation and support. Similar arrangements were agreed to by Japan in July 1975, the United Kingdom in September 1975, and France in January 1976.

All people, in their lives, activities, and industry, should benefit greatly from the project—from the technological advances that are being made and through the information being obtained on natural resources.



Richard C. Atkinson
Director

Washington, D. C.
October 1976

Preface

Recognizing the need in the oceanographic community for scientific planning of a program to obtain deep sedimentary cores from the ocean bottoms, four of the major oceanographic institutions that had strong interests and programs in the fields of marine geology and geophysics, formed in May 1964, the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES). This group, Lamont-Doherty Geological Observatory; Rosentiel School of Marine and Atmospheric Science, University of Miami; the Scripps Institution of Oceanography, University of California at San Diego; and the Woods Hole Oceanographic Institution, expressed an interest in undertaking scientific planning and guidance of the sedimentary drilling program. It was the purpose of this group to foster programs to investigate the sediments and rocks beneath the deep oceans by drilling and coring. The membership of this original group was later enlarged in 1968 when the University of Washington became a member, and again in 1975 when University of Hawaii Institute of Geophysics, the Oregon State University School of Oceanography, the University of Rhode Island Graduate School of Oceanography, and Texas A&M University Department of Oceanography became members. In accordance with international agreements, institutions of participating nations became members of JOIDES. Thus, during 1974 to 1976, the Bundesanstalt für Geowissenschaften und Rohstoffe of the Federal Republic of Germany, the Centre National pour l'Exploitation des Océans of France, the National Environmental Research Council of the United Kingdom, the University of Tokyo of Japan, and Academy of Sciences of the USSR became JOIDES members.

Through discussions sponsored by the JOIDES organization, with support from the National Science Foundation, Columbia University's Lamont-Doherty Geological Observatory operated a drilling program in the summer of 1965, on the Blake Plateau region off Jacksonville, Florida.

With this success in hand, planning began for a more extensive deep sea effort. This resulted in the award of a contract by the National Science Foundation to the Scripps Institution of Oceanography, University of California at San Diego for an eighteen-month drilling program in the Atlantic and Pacific Oceans, termed the Deep Sea Drilling Project (DSDP). Operations at sea began in August 1968, using the now-famous drilling vessel, the *Glomar Challenger*.

The goal of the Deep Sea Drilling Project is to gather scientific information that will help determine the age and processes of development of the ocean basins. The primary strategy is to drill deep holes into the ocean floor, relying largely on technology developed by the petroleum industry.

Through the efforts of the principal organizations and of the panel members which were drawn from a large cross section of leading earth scientists and associates, a scientific program was developed.

Cores recovered from deep beneath the ocean floor provide reference material for a multitude of studies in fields such as biostratigraphy, physical stratigraphy, and paleomagnetism, that afford a new scope for studies of the physical and chemical aspects of sediment provenance, transportation, deposition, and diagenesis. In-hole measurements, as feasible, provide petrophysical data to permit inference of lithology of intervals from which no cores were recovered.

A report, describing the core materials and information obtained both at sea and in laboratories on shore, is published after the completion of each cruise. These reports are a cooperative effort of the scientists participating in the cruise and are intended primarily to be a compilation of results which, it is hoped, will be the starting point for many future new and exciting research programs. Preliminary interpretations of the data and observations taken at sea, are also included.

Core materials and data collected on each cruise will be made available to qualified scientists through the Curator of the Deep Sea

Drilling Project, following a Sample Distribution Policy (p. xvii) approved by the National Science Foundation.

The advent of *Glomar Challenger*, with its deep-water drilling ability, is exceedingly timely. It has come when geophysical investigation of the oceans has matured through 20 to 30 years of vigorous growth to the point where we have some knowledge about much of the formerly unknown oceanic areas of our planet. About one million miles of traverses had been made which tell us much about the global pattern of gravity, magnetic and thermal anomalies, and about the composition, thickness, and stratigraphy of the sedimentary cover of the deep-sea and continental margin. The coverage with such data has enabled the site selection panels to pick choice locations for drilling. The knowledge gained from each hole can be extended into the surrounding area. Detailed geophysical surveys were made for most of the selected locations prior to drilling.

The earth sciences have recently matured from an empirical status to one in which substantial theories and hypotheses about major tectonic processes are flourishing. Theories about the origin of magnetic fields and magnetic reversals, about ocean floor spreading and continental drift, and about the thermal history of our planet, have led to specific predictions that could be tested best by an enlightened program of sampling of deep-sea and continental margin sediments and underlying rocks.

In October 1975, the International Phase of Ocean Drilling (IPOD) began. This international interest, and the true participation of both the scientists and governments of a number of nations, is elegant testimony of the importance of the work being done by the Deep Sea Drilling Project.

The members of JOIDES and DSDP and the scientists from all interested organizations and nations who have served on the various advisory panels are proud to have been of service and believe that the information and core materials that have been obtained will be of value to students of earth sciences and all humanity for many years to come.

Deep Sea Drilling Project

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

Bundesanstalt für Geowissenschaften und Rohstoffe,
Federal Republic of Germany

Lamont-Doherty Geological Observatory, Columbia
University

Rosenstiel School of Marine and Atmospheric
Science, University of Miami

Scripps Institution of Oceanography, University of
California

USSR Academy of Sciences

University of Washington

Woods Hole Oceanographic Institution

OPERATING INSTITUTION:

W. A. Nierenberg, Director
Scripps Institution of Oceanography
University of California at San Diego
La Jolla, California

DEEP SEA DRILLING PROJECT

David G. Moore
Project Chief Scientist

M. N. A. Peterson
Principal Investigator and Project Manager

* Includes member organizations during time of the
cruise.

SENIOR PROJECT PERSONNEL

Mr. Frank C. MacTernan
Principal Engineer and
Deputy Project Manager

Dr. Stan M. White
Associate Chief Scientist for
Science Operations

Dr. John L. Usher
Associate Chief Scientist for
Science Services

Mr. William R. Riedel
Curator

Mr. Stanley T. Serocki
Project Development Engineer

Mr. Valdemar Larson
Operations Manager

Mr. William T. Soderstrom
Finance Administrator

Mr. Robert Olivas
Logistics Officer

Mr. Robert S. Bower
Contracts Officer

Ms. Sue Strain
Personnel Officer

Participants Aboard

GLOMAR CHALLENGER for Leg Forty Nine:

Dr. Bruce P. Luyendyk
Co-Chief Scientist
*Department of Earth Sciences
University of California, Santa Barbara
Santa Barbara, California 93106*

Dr. Joe R. Cann
Co-Chief Scientist
*School of Environmental Sciences
University of East Anglia
Norwich NR4 7TJ
England*

Dr. Wendell A. Duffield
Igneous Petrologist
*U.S. Geological Survey
Branch of Field Geochemistry and Petrology
345 Middlefield Road
Menlo Park, California 94025*

Dr. Angela M. Faller
Paleomagnetist
*Department of Earth Sciences
Leeds University
Leeds LS2 9JT
England*

Dr. Kazuo Kobayashi
Paleomagnetist
*Ocean Research Institute
University of Tokyo
Nakano, Tokyo 164
Japan*

Dr. Richard Z. Poore
Paleontologist (Foraminifers)
*U.S. Geological Survey
Branch of Paleontology and Stratigraphy
345 Middlefield Road
Menlo Park, California 94025*

Dr. William P. Roberts
Sedimentologist
*Department of Geology
Madison College
Harrisonburg, Virginia 22801*

Dr. George Sharman
Sedimentologist & Science Representative
*Scripps Institution of Oceanography
La Jolla, California 92093*

Dr. Alexander N. Shor
Sedimentologist
*Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543*

Dr. Maureen Steiner
Paleomagnetist (Sediments)
*University of Wyoming
Department of Geology
Laramie, Wyoming 82071*

Mr. John C. Steinmetz
Paleontologist (Nannofossils)
*University of Miami
Rosenstiel School of Marine and Atmospheric
Science
4600 Rickenbacker Causeway
Miami, Florida 33149*

Dr. Jacques Varet
Igneous Petrologist
*Dt. Sciences de la Terre
Université de Paris Sud
91405 Orsay
France*

Dr. Walter Vennum
Igneous Petrologist
*Division of Natural Sciences
California State College, Sonoma
Rohnert Park, California 94928*

Dr. David Wood
*University of Birmingham
Dept. of Geological Science
P.O. Box 363
Birmingham B15 2TT, U.K.*

Dr. Boris P. Zolotarev
Igneous Petrologist
*Geological Institute of the USSR
Academy of Sciences of the USSR
Pyzhevskiy per 7
Moscow
USSR*

Mr. Donald N. Collins
Cruise Operations Manager
*Husky Oil Company
6000 South Cherry Street
Denver, Colorado 80222*

Mr. Melvin Fields
Weatherman
*NOAA—National Weather Service
439 West York Street
Norfolk, Virginia 23510*

Captain Joseph A. Clarke
Captain of the Drilling Vessel
*Global Marine, Inc.
Los Angeles, California*

Mr. James Ruddell
Drilling Superintendent
Global Marine, Inc.
Los Angeles, California

Mr. Ted Gustafson
Laboratory Officer
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Richard Myers
Chemist
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Ms. Barbara Long
Curatorial Representative
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Paul Laughlin
Electronics Technician
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Bernie Laughlin
Marine Technician
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Frederick Van Woy
Marine Technician
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. John Rutherford
Marine Technician
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Kevin Reid
Marine Technician
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Larry Lauve
Photographer
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Ms. Lou Henry
Yeoperson
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Deep Sea Drilling Project Publications Staff

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Dr. W. Riedel
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Dr. H. Schrader
Geol. Inst. der Universität Kiel

Dr. N. Shackleton
University of Cambridge

Dr. Y. Takayanagi
Geological & Paleontological Inst.

Dr. H. Thierstein
Scripps Institution of Oceanography

Dr. Tj H. van Andel
Oregon State University

Dr. Edward L. Winterer (Ex-officio)
Scripps Institution of Oceanography

Dr. T. Worsley
University of Washington

Advisory Panel on Site Surveying

Dr. Brian T. R. Lewis, Chairman
University of Washington

Dr. Elizabeth T. Bunce
Woods Hole Oceanographic Institution

Dr. LeRoy M. Dorman
Scripps Institution of Oceanography

Dr. Edgar S. Driver
Gulf Global Exploration Company

Dr. Davis A. Fahlquist
Texas A&M University

Dr. Dennis Hayes
Lamont-Doherty Geological Observatory

Dr. Karl Hinz
*Bundesanstalt für Geowissenschaften
und Rohstoffe, Abt. Geophysik*

Dr. Donald M. Hussong
Hawaii Institute of Geophysics

Dr. L. Kogan
Southern Branch of the Institute of Oceanology

Dr. I. P. Kosminskaya
Academy of Sciences of the USSR

Dr. Marcus G. Langseth (Ex-officio)
Lamont-Doherty Geological Observatory

Dr. Shozaburo Nagumo
The University of Tokyo

Dr. Vince Renard
Centre Océanologique de Bretagne

Dr. Roland Schlich
*Institut de Physique du Globe
Observatoire Géophysique du Parc*

Dr. G. Stober
*Deutsche Erdölversorgungsgesellschaft
m.b.H. Deminex*

Dr. Roland Von Huene
U.S. Geological Survey

Dr. Joel Watkins
University of Texas

Advisory Panel on Stratigraphic Correlations

Dr. R. H. Benson
Smithsonian Institution

Professor Dr. H. M. Bolli
*Eidg. Technische Hochschule Zurich
Geologisches Institut*

Dr. D. Bukry
U.S. Geological Survey

Dr. P. Cepek
*Bundesanstalt für Geowissenschaften
und Rohstoffe*

Dr. R. G. Douglas
University of Southern California

Dr. S. R. Hammond
Hawaii Institute of Geophysics

Dr. N. Hughes
Department of Geology, Sedgwick Museum

Dr. M. Petrushevskaya
USSR Academy of Sciences

Dr. W. R. Riedel
Scripps Institution of Oceanography

Dr. T. Saito
Lamont-Doherty Geological Observatory

Dr. J. B. Saunders
Naturhistorisches Museum Basel

Dr. N. F. Sohl
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Deep Sea Drilling Project SAMPLE DISTRIBUTION POLICY*

Distribution of Deep Sea Drilling samples for investigation will be undertaken in order to (1) provide supplementary data to support GLOMAR CHALLENGER scientists in achieving the scientific objectives of their particular cruise, and in addition to serve as a mechanism for contributions to the *Initial Reports*; (2) provide individual investigators with materials that are stored with samples for reference and comparison purposes.

The National Science Foundation has established a Sample Distribution Panel to advise on the distribution of core materials. This panel is chosen in accordance with usual Foundation practices, in a manner that will assure advice in the various disciplines leading to a complete and adequate study of the cores and their contents. Funding for the proposed research must be secured separately by the investigator. It cannot be provided through the Deep Sea Drilling Project.

The Deep Sea Drilling Project's Curator is responsible for distributing the samples and controlling their quality, as well as preserving and conserving core material. He also is responsible for maintaining a record of all samples that have been distributed, shipboard and subsequent, indicating the recipient, and the nature of the proposed investigation. This information is made available to all investigators of DSDP materials as well as other interested researchers on request.

The distribution of samples is made directly from one of the two existing repositories, Lamont-Doherty Geological Observatory and Scripps Institution of Oceanography, by the Curator or his designated representative.

1. *Distribution of Samples for Research Leading to Contributions to Initial Reports*

Any investigator who wishes to contribute a paper to a given volume of the *Initial Reports* may write to the Chief Scientist, Deep Sea Drilling Project (A-031) Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California 92093, U.S.A., requesting samples from a forthcoming cruise. Requests for a specific cruise should be received by the Chief Scientist two months in advance of the departure of the cruise in order to allow time for the review and consideration of all requests and to establish a suitable shipboard sampling program. The request should include a statement of the nature

of the study proposed, size and approximate number of samples required to complete the study, and any particular sampling technique or equipment that might be required. The requests will be reviewed by the Chief Scientist of the Project and the cruise co-chief scientists; approval will be given in accordance with the scientific requirements of the cruise as determined by the appropriate JODIES Advisory Panel(s). If approved, the requested samples will be taken, either by the shipboard party if the workload permits, or by the curatorial staff shortly following the return of the cores to the repository. Proposals must be of a scope to ensure that samples can be processed and a contribution completed in time for publication in the *Initial Reports*. Except for rare, specific instances involving ephemeral properties, sampling will not exceed one-quarter of the volume of core recovered, with no interval being depleted and one-half of all core being retained as an archive. Shipboard sampling shall not exceed approximately 100 igneous samples per investigator; in all cases co-chief scientists are requested to keep sampling to a minimum.

The co-chief scientists may elect to have special studies of selected core samples made by other investigators. In this event the names of these investigators and complete listings of all materials loaned or distributed must be forwarded, if possible, prior to the cruise or, as soon as possible following the cruise, to the Chief Scientist through the DSDP Staff Science Representative for that particular cruise. In such cases, all requirements of the Sample Distribution Policy shall also apply.

If a dispute arises or if a decision cannot be reached in the manner prescribed, the NSF Sample Distribution Panel will conduct the final arbitration.

Any publication of results other than in the *Initial Reports* within twelve (12) months of the completion of the cruise must be approved and authored by the whole shipboard party and, where appropriate, shore-based investigators. After twelve months, individual investigators may submit related papers for open publication provided they have submitted their contributions to the *Initial Reports*. Investigations not completed in time for inclusion in the *Initial Reports* for a specific cruise may not be published in other journals until final publication of that *Initial Report* for which it was intended. Notice of submission to other journals and a copy of the article should be sent to the DSDP Chief Science Editor.

* Revised October 1976

2. *Distribution of Samples for Research leading to Publication other than in Initial Reports*

- A. Researchers intending to request samples for studies beyond the scope of the *Initial Reports* should first obtain sample request forms from the Curator, Deep Sea Drilling Project (A-031), Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California 92093, U.S.A. On the forms the researcher is requested to specify the quantities and intervals of the core required, make a clear statement of the proposed research, state time required to complete and submit results for publication, specify the status of funding and the availability of equipment and space foreseen for the research.

In order to ensure that all requests for highly desirable but limited samples can be considered, approval of requests and distribution of samples will not be made prior to 2 months after publication of the Initial Core Descriptions (I.C.D.). ICD's are required to be published within 10 months following each cruise. The only exceptions to this policy will be for specific instances involving ephemeral properties. Requests for samples can be based on the Initial Core Descriptions, copies of which are on file at various institutions throughout the world. Copies of original core logs and data are kept on open file at DSDP and at the Repository at Lamont-Doherty Geological Observatory, Palisades, New York. Requests for samples from researchers in industrial laboratories will be handled in the same manner as those from academic organizations, with the same obligation to publish results promptly.

- B. (1) The DSDP Curator is authorized to distribute samples to 50ml per meter of core. Requests for volumes of material in excess of this amount will be referred to the NSF Sample Distribution Panel for review and approval. Experience has shown that most investigations can be accomplished with 10ml sized samples or less. All investigators are encouraged to be as judicious as possible with regard to sample size and, especially, frequency within any given core interval. The Curator will not automatically distribute any parts of the cores which appear to be in particularly high demand; requests for such parts will be referred to the Sample Distribution Panel for review. Requests for samples from

thin layers or important stratigraphic boundaries will also require Panel review.

(2) If investigators wish to study certain properties which may deteriorate prior to the normal availability of the samples, they may request that the normal waiting period not apply. All such requests must be reviewed by the curators and approved by the NSF Sample Distribution Panel.

- C. Samples will not be provided prior to assurance that funding for sample studies either exists or is not needed. However, neither formal approval of sample requests nor distribution of samples will be made until the appropriate time (Item A). If a sample request is dependent, either wholly or in part, on proposed funding, the Curator is prepared to provide to the organization to whom the funding proposal has been submitted any information on the availability (or potential availability) of samples that it may request.

- D. Investigators receiving samples are responsible for:

(1) publishing significant results; however contributions shall not be submitted for publication prior to 12 months following the termination of the appropriate leg;

(2) acknowledging, in publications, that samples were supplied through the assistance of the U.S. National Science Foundation and others as appropriate;

(3) submitting five (5) copies (for distribution to the Curator's file, the DSDP Repositories, the GLOMAR CHALLENGER's Library, and the National Science Foundation) of all reprints of published results to the Curator, Deep Sea Drilling Project (A-031), Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California 92093, U.S.A.;

(4) returning, in good condition, the remainders of samples after termination of research, if requested by the Curator.

- E. Cores are made available at repositories for investigators to examine and to specify exact samples in such instances as may be necessary for the scientific purposes of the sampling, subject to the limitations of B (1 and 2) and D, above, with specific permission of the Curator or his delegate.

F. Shipboard-produced smear slides of sediments and thin sections of indurated sediments, igneous and metamorphic rocks, will be returned to the appropriate repository at the end of each cruise or at the publication of the *Initial Reports* for that cruise. These smear slides and thin sections will form a reference collection of the cores stored at each repository and may be viewed at the respective repositories as an aid in the selection of core samples.

G. The Deep Sea Drilling Project routinely processes by computer most of the quantitative data presented in the *Initial Reports*. Space limitations in the *initial Reports* preclude the detailed presentation of all such data. However, copies of the computer readout are available for those who wish the data for further analysis or as an aid on selecting samples. A charge will be made to recover expenses in excess of \$50.00 incurred in filling requests.

3. *Other Records*

Magnetics, seismic reflection, downhole logging, and bathymetric data collected by the GLOMAR CHALLENGER will also be available for distribution at the same time samples become available.

Requests for data may be made to:

Associate Chief Scientist, Science Services
Deep Sea Drilling Project (A-031)
Scripps Institution of Oceanography
University of California at San Diego
La Jolla, California 92093

A charge will be made to recover the expenses in excess of \$50.00 in filling individual requests. If required, estimated charges can be furnished before the request is processed.

4. *Reference Centers*

As a separate and special category, samples will be distributed for the purpose of establishing up to five reference centers where paleontologic materials will be available for reference and comparison purposes. The first of these reference centers has been approved at Basel, Switzerland.

CONTENTS

Chapter	Page	Chapter	Page
DEDICATION	1	13. ASH LAYERS INTERLAYERED WITH THE SEDIMENTS OF HOLES 407 AND 408, IPOD LEG 49	437
PART I. INTRODUCTION AND SITE REPORTS	3	Jacques Varet and Nicole Metrich	
1. INTRODUCTION: BACKGROUND AND EXPLANATORY NOTES	5	14. CLAY MINERALS OF SEDIMENTS FROM DSDP LEG 49	443
Bruce P. Luyendyk, J. R. Cann, and George S. Sharman		P. P. Timofeev, N. V. Rengarten, M. A. Rataev, and V. V. Eremeev	
2. SITE 407	21	15. OLIGOCENE THROUGH QUATERNARY PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY OF THE NORTH ATLANTIC: DSDP LEG 49	447
Shipboard Scientific Party		R. Z. Poore	
3. SITE 408	101	16. CALCAREOUS NANNOFOSSILS FROM THE NORTH ATLANTIC OCEAN, LEG 49, DEEP SEA DRILLING PROJECT....	519
Shipboard Scientific Party		John C. Steinmetz	
4. SITE 409	161	17. CALCAREOUS NANNOPLANKTON AND SILICOFLLAGELLATE BIOSTRATIGRAPHY AT REYKJANES RIDGE, NORTH-EASTERN NORTH ATLANTIC (DSDP LEG 49, SITES 407 AND 409).....	533
Shipboard Scientific Party		Erlend Martini	
5. SITE 410	227	18. COCCOLITH AND SILICOFLLAGELLATE STRATIGRAPHY, NORTHERN MID-ATLANTIC RIDGE AND REYKJANES RIDGE, DEEP SEA DRILLING PROJECT LEG 49	551
Shipboard Scientific Party		David Bukry	
6. SITE 411	315	19. RADIOLARIANS FROM THE WEST FLANK OF REYKJANES RIDGE, LEG 49 OF THE DEEP SEA DRILLING PROJECT	583
Shipboard Scientific Party		Hsin Yi Ling	
7. SITE 412	339	20. OPAL PHYTOPLANKTON IN DSDP LEG 49 SAMPLES	589
Shipboard Scientific Party		Hans-Joachim Schrader	
8. SITE 413	391	PART II: STUDIES AT SHORE LABORATORIES: SECTION B. THE BASEMENT ROCKS: PETROLOGY, GEOCHEMISTRY, AND PHYSICAL PROPERTIES	595
Shipboard Scientific Party		21. THE PETROLOGY, GEOCHEMISTRY, AND MINERALOGY OF NORTH ATLANTIC BASALTS: A DISCUSSION BASED ON IPOD LEG 49	597
9. SITE 414	407	D. A. Wood, J. Varet, H. Bougault, O. Corre, J. L. Joron, M. Treuil, H. Bizouard, M. J. Norry, C. J. Hawkesworth, and J. C. Roddick	
Shipboard Scientific Party			
10. SITE SURVEY FOR SITE 410, AN EXAMPLE OF THE USE OF LONG-RANGE SIDE-SCAN SONAR (GLORIA)..	413		
R. C. Searle, A. S. Laughton, and B. D. Loncarevic			
PART II. STUDIES AT SHORE LABORATORIES: SECTION A. SEDIMENTOLOGY, STRATIGRAPHY, AND BIOSTRATIGRAPHY	419		
11. ORIGIN OF BASALTIC GRAVELLY SANDS, HOLES 410, 410A, 412A, AND 413	421		
William P. Roberts			
12. STUDY OF TECTONIC DEFORMATION IN SEDIMENTS INTERLAYERED WITH THE BASALTS FROM HOLE 412A, IPOD LEG 49	427		
J. Varet and P. Choukroune			

Chapter	Page	Chapter	Page
22. MINOR-ELEMENT GEOCHEMISTRY OF BASALTS FROM LEG 49, NORTH ATLANTIC OCEAN	657	32. PALEOMAGNETISM OF BASALTS AND INTERLAYERED SEDIMENTS DRILLED DURING DSDP LEG 49 (N-S TRANSECT OF THE NORTHERN MID-ATLANTIC RIDGE)	769
John Tarney, Andrew D. Saunders, Stephen D. Weaver, Nigel C. B. Donnellan, and Graham L. Hendry		A. M. Faller, M. Steiner, and K. Kobayashi	
23. FIRST-ORDER ALTERATION CHEMISTRY OF LEG 49 BASEMENT ROCKS	693	33. MAGNETIC PROPERTIES OF BASALTS FROM DSDP LEG 49	781
P. A. Floyd and J. Tarney		R. Day, S. Halgedahl, M. Steiner, K. Kobayashi, T. Furuta, T. Ishii, and A. Faller	
24. LOW-TEMPERATURE ALTERATION OF OCEANIC BASALTS, DSDP LEG 49.....	709	34. MAGNETIC MINERALOGY OF BASALTS FROM LEG 49	793
Richard G. Pritchard, Johnson R. Cann, and David A. Wood		K. Kobayashi, M. Steiner, A. Faller, T. Furuta, T. Ishii, P. Shive, and R. Day	
25. SIGNIFICANCE OF CONTRASTING VESICULARITY IN BASALT FROM DSDP SITES 407, 408, AND 409 ON THE WEST FLANK OF THE REYKJANES RIDGE...	715	35. SUMMARY OF MAGNETIC OBSERVATIONS, LEG 49	807
Wendell A. Duffield		M. Steiner, R. Day, K. Kobayashi, and A. Faller	
26. LEAD ISOTOPE STUDIES OF BASALTS FROM IPOD LEG 49.....	721	36. PALEOCOLATITUDES FROM MAGNETIC INCLINATION DETERMINED AT LEG 49 DSDP DRILL SITES.....	813
James M. Mattinson		Bruce P. Luyendyk	
27. PETROCHEMISTRY OF BASALTS AND DISTRIBUTION OF ORGANIC GASES: HOLES 407, 408, 409, 410, 410A, 411, 412, AND 413, DSDP LEG 49	727	PART III: SYNTHESSES OF LEG 49	823
B. P. Zolotarev, D. Ya. Choporov, and G. I. Voitov		37. GENERAL IMPLICATIONS OF THE LEG 49 DRILLING PROGRAM FOR NORTH ATLANTIC OCEAN GEOLOGY	825
28. CHROMIAN SPINELS IN LEG 49 BASALTS: A PRELIMINARY CHEMICAL STUDY	745	Bruce P. Luyendyk, Alexander Shor, and J. R. Cann	
J. A. Templeman		38. MANTLE HETEROGENEITY IN THE NORTH ATLANTIC: EVIDENCE FROM LEG 49 GEOCHEMISTRY	841
29. AUTOCLASTIC SUBMARINE BRECCIAS IN HOLE 410, LEG 49, AND OTHER DSDP SITES	749	J. R. Cann, J. Tarney, J. Varet, and D. A. Wood	
Jacques Varet and Jacques Demange		39. BIOSTRATIGRAPHIC SUMMARY OF DSDP LEG 49	851
30. LABORATORY MEASUREMENTS OF COMPRESSIONAL WAVE VELOCITIES AND ELECTRICAL RESISTIVITY OF BASALTS FROM DSDP LEG 49.....	761	R. Z. Poore, J. C. Steinmetz, and Hans-Joachim Schrader	
P. N. Chroston, C. J. Evans, and C. Lee		40. BOTTOM CURRENTS AND ICE RAFTING IN THE NORTH ATLANTIC: INTERPRETATION OF NEOGENE DEPOSITIONAL ENVIRONMENTS OF LEG 49 CORES....	859
31. MEASUREMENTS OF THERMAL CONDUCTIVITY	765	Alexander N. Shor and Richard Z. Poore	
E. R. Oxburgh and D. Griffiths		41. GRAIN-SIZE AND CARBON/CARBONATE ANALYSES, LEG 49.....	873
PART II: STUDIES AT SHORE LABORATORIES: SECTION C. PALEOMAGNETISM AND ROCK MAGNETISM	767	Stan M. White and Gerald W. Bode	

Chapter	Page	Chapter	Page
PART IV: APPENDICES	883	IV. TRANSITIONAL-METAL AND TRACE-ELEMENT ANALYSES OF LEG 49 SAMPLES	897
I. LEG 49 SAMPLES FOR GEOCHEMICAL ANALYSIS	885	D. A. Wood, J. Varet, H. Bougault, O. Corre, J. L. Joron, M. Treuil, H. Bizouard, M. J. Norry, C. J. Hawkesworth, and J. C. Roddick	
II. MAJOR-ELEMENT CHEMICAL ANALYSES	889	V. THIN-SECTION DESCRIPTIONS	903
D. A. Wood, J. Varet, H. Bougault, O. Corre, J. L. Joron, M. Treuil, H. Bizouard, M. J. Norry, C. J. Hawkesworth, and J. C. Roddick		VI. COMMENTS ON OPAL PHYTOLITHS AND STRATIGRAPHY OF NEOGENE SILICOFLAGELLATES AND COCCOLITHS AT DEEP SEA DRILLING PROJECT SITE 397 OFF NORTHWEST AFRICA	977
III. NORMS (CIPW WITH IRVINE AND BARRAGER [1971] CORRECTIONS)	893	David Bukry	
D. A. Wood, J. Varet, H. Bougault, O. Corre, J. L. Joron, M. Treuil, H. Bizouard, M. J. Norry, C. J. Hawkesworth, and J. C. Roddick		INDEX	1011

LEG 49 — DEDICATION TO RICHARD KEITH MEADOWS

The night of 4 August 1976 was cold, drizzly, and windy. The *Challenger* was drilling on Site 409 just south of Iceland. We were down over 200 meters into basement and were just breaking open a core on the rig floor. At about 4:30 AM, rotary helper Richard Meadows was struck suddenly by a falling piece of rig machinery and killed. This tragedy affected us all, each of us in different ways, and we feel that dedicating this volume to Richard is one way of showing how we appreciate the kind of men who do this hard and dangerous work.

Richard was born 17 March 1942 in Lone Pine, California. Up to the time of his death he resided in Lore City, Ohio, and was married to Virginia Meadows. He is survived by his wife, his infant daughter Jennifer, his mother Irma Owens, and his stepfather and stepbrother, David and Stephen Owens. After being honorably discharged from the U.S. Navy in 1959, Richard worked as a driller's helper on the North Slope. He joined Global Marine in 1973 and worked aboard the *Glomar Explorer* as a crane operator, rig mechanic, and pipe handler; he transferred to the *Glomar Challenger* in November 1975 as a rotary helper (roughneck).

My own recollections of Richard are from sharing the midnight-to-noon shift aboard the *Challenger*. From a distance his good-natured manner was apparent. Those nights in the North Atlantic were particularly unpleasant, and I can remember huddling in the driller's shack with Richard and the rest of the drilling crew to avoid the wind and rain. Even then he seemed to be enjoying himself.

Richard was a very special kind of man — as are the others who do this type of job. The labor is exhausting, lasting twelve hours per shift in all varieties of weather. There is also the loneliness of separation from family and friends for six months of the year and the boredom that can only be experienced at sea. The dangers on the rigs are present and unpredictable, and injuries are not uncommon. Men do this kind of work because they know they are different. The rest of us should from time to time remind ourselves of these facts and of our debt to those who are willing to give so much.

I myself am not experienced in dealing with sudden death. When I think of this tragedy I find myself trying to understand it; but that is not possible.

Bruce P. Luyendyk
Co-Chief Scientist
Leg 49
Deep Sea Drilling Project