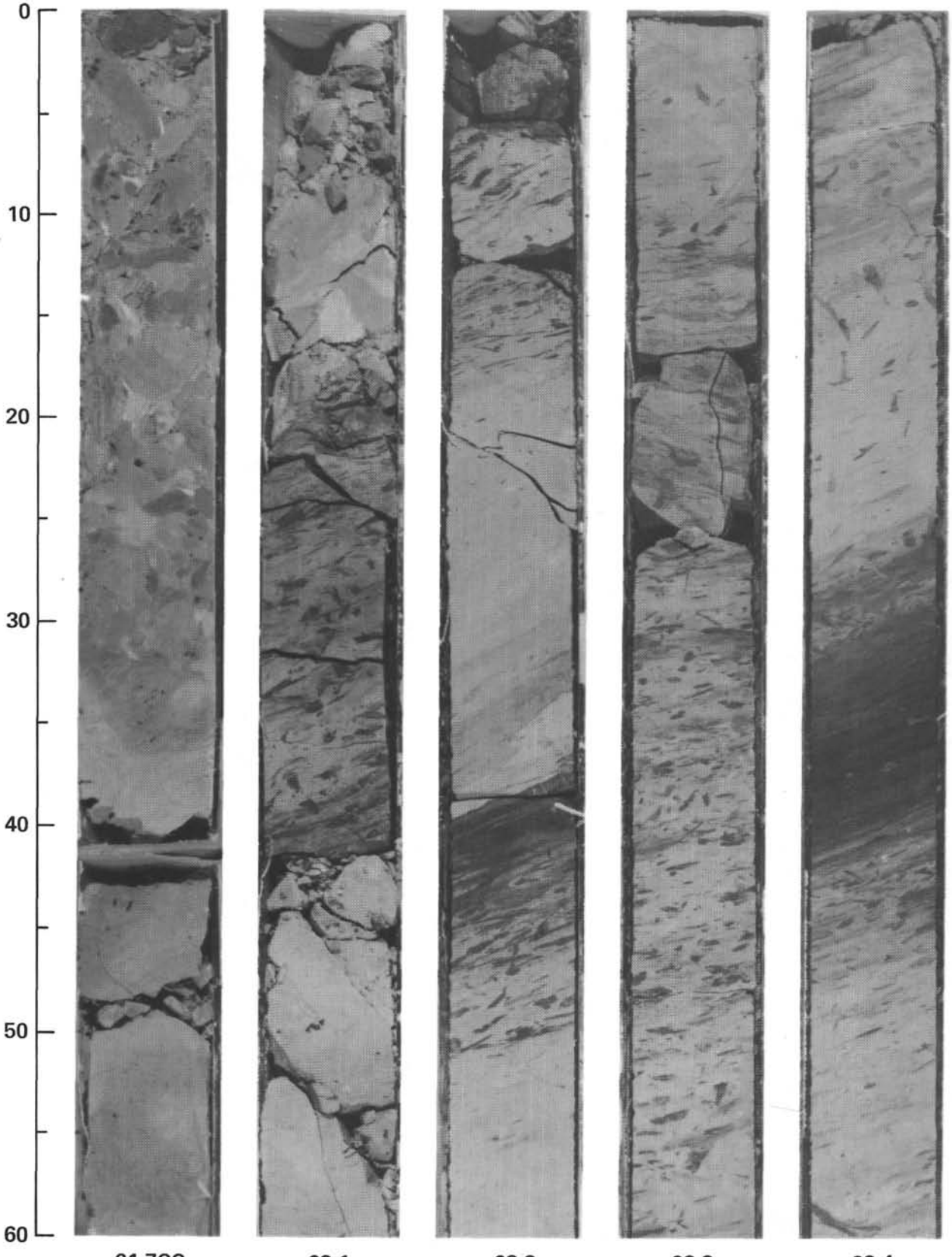
Core 61 from Hole A at Site 400 contains the unconformable contact between the upper Campanian and the upper Albian. The former, a reddish yellow marly nannofossil chalk with brown streaks of organic matter, is preserved in Core 61 as cavings along with light brown to greenish gray marly chalk fragments in a grayish orange pink matrix. At the unconformity the upper Albian nannofossil chalk is reddish brown but, in the underlying Core 62 it is mainly light to medium bluish gray, is bioturbated and mottled medium dark gray, and contains grayish black carbonaceous layers characterized by very fine laminations. The latter are referred to in this volume as the Albian black shales.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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 XLVIII

covering Leg 48 of the cruises of the Drilling Vessel *Glomar Challenger*
Brest, France to Aberdeen, Scotland
May-July 1976

PARTICIPATING SCIENTISTS

Lucien Montadert, David G. Roberts,
Gerard A. Auffret, Wayne D. Bock, Pierre A. Dupeuble,
Ernest A. Hailwood, William E. Harrison, Hideo Kagami, David N. Lumsden,
Carla M. Muller, Detmar Schnitker, Robert W. Thompson,
Thomas L. Thompson, and Peter P. Timofeev

Shipboard Science Representative
Robert W. Thompson

Science Editor

John L. Usher

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Scripps Institution of Oceanography
Prime Contractor for the Project

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Schnitker, D., 1979. Cenozoic deep water benthic foraminifers, Bay of Biscay, *In* Montadert, L., Roberts, D. G., et al., *Initial Reports of the Deep Sea Drilling Project,* v. 48: Washington (U.S. Government Printing Office), p. 377-414.

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Associate Chief Scientist
Science Services
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

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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 and 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 Eight:

Dr. Lucien Montadert
Co-Chief Scientist
Institut Français du Pétrole
BP 18
92502 Rueil-Malmaison
France

Dr. David G. Roberts
Co-Chief Scientist
Institute of Oceanographic Sciences
Wormley, Godalming GU8 5UB
Surrey
England

Dr. Gerard A. Auffret
Sedimentologist
Centre Océanologique de Bretagne
BP 337
29273 Brest Cedex
France

Dr. Wayne D. Bock
Paleontologist (Foraminifers)
Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Causeway
Miami, Florida 33149

Dr. Pierre A. Dupeuble
Paleontologist (Foraminifers)
Université de Rouen
76130 Mont-Saint-Aignan
France

Dr. Ernest A. Hailwood
Paleomagnetist
Department of Oceanography
University of Southampton
Southampton SO9 5NH
England

Dr. William E. Harrison
Organic Geochemist
Oklahoma Geological Survey
University of Oklahoma
830 van Fleet Oval
Norman, Oklahoma 73069

Dr. Hideo Kagami
Sedimentologist
Ocean Research Institute
University of Tokyo
Tokyo
Japan

Dr. David N. Lumsden
Sedimentologist
Department of Geology
Memphis State University
Memphis, Tennessee 38152

Dr. Carla M. Müller
Paleontologist (Nannofossils)
Geologisch-Palaontologisches Institut
Johann-Wolfgang-Goethe Universität
Frankfurt
Federal Republic of Germany

Dr. Detmar Schnitker
Paleontologist (Foraminifers)
Department of Oceanography
University of Maine
Walpole, Maine 04573

Dr. Robert W. Thompson
Sedimentologist/Shipboard Science Representative
Humboldt State University
School of Natural Resources-Oceanography
Arcata, California 95521

Dr. Thomas L. Thompson
Petroleum Geologist
University of Oklahoma
Department of Geology and Geophysics
Norman, Oklahoma 73069

Dr. Peter P. Timofeev
Sedimentologist
Geological Institute
USSR Academy of Sciences
Pyzhevskiy per 7
Moscow ZH 17
USSR

Mr. Robert Knapp
Cruise Operations Manager
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Robert J. Connolly
Weatherman
NOAA-National Weather Service
439 West York Street
Norfolk, Virginia 23510

Captain Loyd Dill
Captain of the Drilling Vessel
Global Marine, Inc.
Los Angeles, California 90017

Mr. Cotten Guess
Drilling Superintendent
Global Marine, Inc.
Los Angeles, California 90017

Mr. G. Lamb
Schlumberger Inland Service, Inc.
Albany House
London SW1 9EA

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

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

Mr. Steve Richards
Curatorial Representative
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. Jean-Loup Laporte
XRF Technician
Institut Français du Pétrole
BP 18
92502 Rueil-Malmaison
France

Mr. Robert Byrne
Downhole Instrument Specialist
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

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

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

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

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

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

Ms. Gayle Burns
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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Eichhaldestrasse 79/3
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Dr. A. Lisitzin
Academy of Sciences of the USSR

Dr. T. C. Moore
Graduate School of Oceanography

* Alternate

Dr. Premoli-Silva
Instituto di Paleontologie

Dr. W. Riedel
Scripps Institution of Oceanography

Dr. Michael Sarnthein
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Dr. H. Schrader
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Geological & Paleontological Inst.

Dr. H. Thierstein
Scripps Institution of Oceanography

Dr. Tj H. van Andel
Oregon State University

Dr. T. Worsley
University of Washington

Advisory Panel on Site Surveying

Dr. Brian T. R. Lewis
University of Washington

Dr. Mahlon Ball
Rosenstiel School of Marine and Atmospheric Science

Dr. Elizabeth T. Bunce
Woods Hole Oceanographic Institution

Dr. Edgar S. Driver
Gulf Global Exploration Company

Mr. John I. Ewing
Lamont-Doherty Geological Observatory

Dr. Davis A. Fahlquist
Texas A&M University

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Bundesanstalt für Geowissenschaften und Rohstoffe

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Hawaii Institute of Geophysics

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Southern Branch of the Institute of Oceanology, USSR

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Academy of Sciences of the USSR

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Lamont-Doherty Geological Observatory

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University of Tokyo

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Centre Océanologique de Bretagne

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Observatoire Géophysique du Parc St.-Maur

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und Rohstoffe

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USSR Academy of Sciences

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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.

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Lithologic Core Descriptions, Sites 399 through 406, on microfiche cards.

"The present is the key to not much more than the Pleistocene and Pliocene." Anonymous Sedimentologist

ACKNOWLEDGMENTS

Leg 48 of the Deep Sea Drilling Project was the second leg of the International Phase of Ocean Drilling to be dedicated to drilling passive ocean margins in the northeast Atlantic. Its success was due to the hard work of many persons before, during, and after the leg.

Formulation of the objectives of passive margin drilling both in general and in the northeast Atlantic owes much to the critical reviews and stimulating contributions made by the JOIDES Ocean Margin Passive Panel under the able guidance of Joe Curray (Chairman). We wish to thank John Ewing, Bert Bally, Karl Hinz, Danny Bernoulli, John Hunt, Hideo Kagami, Eugen Seibold, Dave Moore, Jorn Thiede, Peter Vail, Bill Bryant, Helmut Beirsdorf, Robert Sheridan, and John Grow for their guidance and comments both before and after the leg.

The success of Leg 48 in large part was due to the thorough multichannel surveys made before and after the cruise in both the Biscay and Rockall areas. These surveys enabled definition of scientific objectives, assigning priority to problems, and application of the drilling results to the margin as a whole. We wish to thank the Department of Energy (UK) and IFP-CNEXO-CEPM for their financial support of pre- and post-cruise surveys and for their agreement to reproduce the seismic profiles in this *Initial Report*.

At sea, Captain L. Dill and his crew responded splendidly to operational difficulties. We would particularly like to thank the drilling crew for their superior effort in replacing the lost drill string whilst at sea; especial thanks go to Bob Knapp, Operations Manager, for his unstinting help in these difficult circumstances in reformulating the drilling program and, indeed, throughout the leg. Our marine technicians, under the able guidance of Mike Lehmann, did a fine job. Gayle Burns, our yeoman, coped with massive amounts of Franglais, American English, and English English with aplomb that added greatly to the efficiency and success of the cruise.

During Leg 48, logging of passive margin sites was carried out at sea for the first time. The logging program was generously provided through the Natural Environment Research Council by the Department of Energy (UK) whom we wish to thank. David Mann of the Department of Energy and Schlumberger Ltd. (UK) helped formulate the logging suite and also contributed to the analysis of the logs; Geoff Lamb of Schlumberger Ltd. (UK) carried out the logging on board with great efficiency. The success of the logging program in single-bit holes owes all to the ingenious bit release mechanism developed by V. F. "Swede" Larson of DSDP Operations. During the leg, complete monitoring of hydrocarbons and source-rock potential was made possible by the generous loan of the IFP Pyrolysis Analyzer from the Institut Français du Pétrole and by the hard work of Jean Laporte. A complete paleomagnetics program was made possible by the provision of a magnetometer by the Natural Environment Research Council (UK). By no means least, we would like to thank Dave Moore for his help throughout the planning and execution of the leg, and especially for allowing us (when called at 0300 California time) to be flexible in choosing new sites after the loss of the drill string.

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