The Cretaceous/Tertiary contact, which appears in the photograph on the right, was located 106 cm down from the top of Section 3, Core 20 in Hole 524. The photograph on the left shows Core 20, Section 2, 83–117 cm, which contains some of the earliest Tertiary sediments. These early sediments appear 1 to 2 m above the Cretaceous/Tertiary contact and were deposited 30,000 to 50,000 yr. after the end of the Cretaceous, when the last Cretaceous forms became extinct. An iridium spike that may mark the instant of an extraterrestrial impact is present at the Cretaceous/Tertiary boundary (see the chapter on the terminal Cretaceous event by Hsü, this vol.). Environmental changes during the earliest Tertiary have also been revealed by stable-isotope analyses. The only visible lithologic change across the boundary is, however, the absence of bioturbation in the earliest Tertiary sediments, as shown by the photographs signifying perhaps the near absence of benthic organisms at this site after the terminal Cretaceous mass mortality. Bioturbation is very common in all Cretaceous and all other Paleogene sediments cored at this site. A boundary clay almost devoid of calcium carbonate is present in Core 20, Section 3, 104–106 cm, representing the time when the production of oceanic planktons was minimal.
This material is based upon research supported by the National Science Foundation under Contract No. C-482.

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.

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 DSDP Initial Reports

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.

Mailing dates of the more recent Initial Reports of the Deep Sea Drilling Project are as follows:

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Volume 66—March, 1982
Volume 67—November, 1982
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Volume 69—May, 1983
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The world's first major oceanographic expedition took place between 1872 and 1876. This four year expedition, aboard the H.M.S. Challenger covering nearly 70,000 nautical miles and gathering oceanographic data from 362 stations, expanded our basic knowledge of the world's oceans and provided a solid foundation for future studies in marine geology. A century later, another vessel also named Challenger has continued to expand our knowledge of the world's ocean and has helped revolutionize our concepts of how the seafloor and the continents form and change. The Drilling Vessel Glomar Challenger is plying the same waters as its historic counterpart, seeking answers to new questions concerning the history of our planet and the life it supports. The continued advancement of knowledge about the fundamental processes and dynamics of the earth will lead to a greater understanding of our planet and more intelligent use of its resources.

Since 1968, the Deep Sea Drilling Project has been supported by the National Science Foundation, primarily through a contract with the University of California which, in turn, subcontracts to Global Marine Incorporated for the services of the D/V Glomar Challenger. Scripps Institution of Oceanography is responsible for management of the University contract.

Through contracts with Joint Oceanographic Institutions, Inc. (JOI, Inc.), the National Science Foundation supports the scientific advisory structure for the project and funds pre-drilling geophysical site surveys. Scientific planning is conducted under the auspices of the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES). The JOIDES advisory group consists of over 250 members who make up 24 committees, panels and working groups. The members are distinguished scientists from academic institutions, government agencies and private industry from all over the world.

In 1975, the International Phase of Ocean Drilling (IPOD) began. Present IPOD member nations, Federal Republic of Germany, Japan, United Kingdom and France, provide partial support of the project. Each member nation takes an active role in the scientific planning of
the project through membership in JOIDES. Scientists from these countries also participate in the field work aboard the D/V Glomar Challenger and post-cruise scientific studies.

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, Mediterranean Sea, and Antarctic waters, the scientific objectives that had been proposed were successfully accomplished. Primarily, the age of the ocean basins and their processes of development were determined. The validity of the hypothesis of sea floor spreading was firmly demonstrated and its dynamics studied. Emphasis was placed on broad reconnaissance and testing the involvement of mid-oceanic ridge systems in the development of the ocean basin. Later legs of the Challenger's voyages concentrated on the nature of the oceanic crust, the sedimentary history of the passive ocean margins, sediment dynamics along active ocean margins and other areas of interest. The accumulated results of this project have led to major new interpretations of the pattern of sedimentation and the physical and chemical characteristics of the ancient oceans.

Technological advances have provided new tools which in turn have opened new dimensions of scientific discovery. Since the introduction of the Hydraulic Piston Corer in 1979 virtually undisturbed cores of soft sediment layers can now be obtained. This technological advance has greatly enhanced the ability of scientists to study ancient ocean environments, as recorded by sediment characteristics and flora and fauna preserved in these sedimentary layers.

A second major advance is the use of the hole after it is drilled. The project continually logs holes and performs geophysical and geochemical studies before, during and after drilling. Long term downhole geophysical seismic monitoring devices have been implanted successfully in DSDP holes. These new listening devices and geophysical studies have provided valuable information as to the origin and nature of the dynamic processes involved with plate tectonics.

These reports contain the results of the initial studies of the recovered core material and the associated geophysical information. All people benefit either directly or indirectly from this fundamental research. Knowledge about past and present conditions and processes are the foundations for future predictions and developments. Both short and long term benefits are obtained by advances in drilling technology and instrumentation. Information is being obtained about the origin and geographic distribution of natural resources. Just as the H.M.S. Challenger had a profound impact on scientific thought for over a century, this second Challenger expedition has given and will continue to give a greater understanding of the oceans and the processes that form and shape the earth.

Edward A. Knapp,
Director
Washington, D.C.
July 1983
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; Rosenstiel 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 Natural Environment 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, who 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 investigating 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 onshore, is published after the completion of each cruise. These reports are a cooperative effort of shipboard and shore-based scientists 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. xix) approved by the National Science Foundation.

The advent of Glomar Challenger, with its deep-water drilling capability, 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 have 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. This 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, are eloquent testimony to 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 to all humanity for many years to come.
Deep Sea Drilling Project

MEMBER ORGANIZATIONS OF THE JOINT OCEANOGRAPHIC INSTITUTIONS FOR DEEP EARTH SAMPLING (JOIDES):¹

Bundesanstalt für Geowissenschaften und Rohstoffe, Federal Republic of Germany
University of California at San Diego, Scripps Institution of Oceanography
Centre National pour l'Exploitation des Océans, Paris
Columbia University, Lamont-Doherty Geological Observatory
University of Hawaii, Hawaii Institute of Geophysics
University of Miami, Rosenstiel School of Marine and Atmospheric Science
Natural Environment Research Council, London
Oregon State University, School of Oceanography
University of Rhode Island, Graduate School of Oceanography
Texas A&M University, Department of Oceanography
University of Tokyo, Ocean Research Institute
University of Washington, Department of Oceanography
U.S.S.R. Academy of Sciences²
Woods Hole Oceanographic Institution

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

DEEP SEA DRILLING PROJECT
Dr. M. N. A. Peterson
Principal Investigator
Project Manager
Mr. Robert S. Bower
Assistant Project Manager for Administration and Contracts Officer
Dr. Yves Lancelot
Chief Scientist
Dr. Matthew H. Salisbury
Associate Chief Scientist for Science Operations
Dr. Russell B. Merrill
Associate Chief Scientist for Science Services
Dr. William R. Riedel
Curator
Mr. Stanley T. Serocki
Project Development Engineer
Mr. Paul Porter
Operations Manager
Mr. William T. Soderstrom
Finance Administrator
Mr. Robert Olivas
Logistics Officer
Ms. Sue Strain
Personnel Officer

¹ Includes member organizations during time of cruise.
² This institution and its committees and panel members are noncontributing members to JOIDES.
Participants aboard
GLOMAR CHALLENGER for Leg Seventy-three

Dr. Kenneth J. Hsü
Co-Chief Scientist
Geologisches Institut
Eidgenössische Technische Hochschule Zürich
Sonneggstrasse 5
CH-8006 Zürich
Switzerland

Dr. John L. LaBrecque
Co-Chief Scientist
Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964

Dr. Max F. Carman, Jr.
Igneous Petrologist
Department of Geophysics
University of Houston
Houston, Texas 77004

Dr. Andrew M. Gombos, Jr.
Paleontologist (diatoms)
Exxon Production Research Company
P.O. Box 2189
Houston, Texas 77001

Dr. Anne-Marie Karpoff
Sedimentologist
Institut de Géologie
1, Rue Blessig
67084 Strasbourg Cedex
France

Dr. Judith A. McKenzie
Sedimentologist
Eidgenössische Technische Hochschule Zürich
Sonneggstrasse 5
CH-8006 Zürich
Switzerland

Mr. Stephen F. Percival, Jr.
Paleontologist (nannofossils)
Stratigraphic Laboratory
Exploration Services Center
Mobil Oil Corporation
P.O. Box 900
Dallas, Texas 75221

Dr. Nikolai P. Petersen
Paleomagnetist
Institut für Geophysik
University of Munich
Theresienstr. 41
D-8000 Munich
Federal Republic of Germany

Dr. Kenneth A. Pisciotto
Sedimentologist
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92037

Dr. Richard Z. Poore
Paleontologist (foraminifers)
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

Dr. Edward Schreiber
Physical Properties Specialist
Department of Earth & Environmental Sciences
Queens College (CUNY)
Flushing, New York 11367

Dr. Lisa Tauxe
Paleomagnetist
Department of Geological Sciences
Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964

Dr. Peter Tucker
Paleomagnetist
Department of Geophysics
University of Edinburgh
Edinburgh
United Kingdom

Dr. Helmut J. Weissert
Sedimentologist
Department of Geological Sciences
University of Southern California
Los Angeles, California 90007
Captain Sidney Shuman
Master of the Drilling Vessel
Global Marine Inc.
8369 Vickers Street
San Diego, California 92111

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

Mr. Robert Connolly
Weatherman
Deep Sea Drilling Project, A-031
Scripps Institution of Oceanography
La Jolla, California 92093

Mr. James P. Guess
Drilling Superintendent
Global Marine, Inc.
8369 Vickers Street
San Diego, California 92111

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

Ms. Amy Altman
Curatorial Representative
Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964

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

Deep Sea Drilling Project Publications Staff

Principal Editor
Jan H. Blakeslee

Editors
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Universität Hamburg
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 to 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 JOIDES 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. A paper too late for inclusion in the Initial Reports for a specific cruise may not be published elsewhere until publication of that Initial Reports for which it was intended. Notice of submission to other journals and a copy of the article should be sent to the DSDP Staff Science Representative for that leg.

*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, and 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 50 ml 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 samples 10 ml or smaller. 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 Curator 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; 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 remainder 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.

3. 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.

Data Distribution Policy

Data gathered on board D/V Glomar Challenger and in DSDP shore laboratories are available to all researchers 12 months after the completion of each cruise. The files are part of a coordinated computer database, fully searchable and coordinated to other files. Data sets representing a variety of geologic environments can be arranged for researchers who may wish to manipulate the database directly.

Most data requests are filled free of charge, except if they are unusually large or complex and direct costs exceed $50.

When data are used for publication, the National Science Foundation must be acknowledged and DSDP provided with five reprints for inclusion in the DSDP index of publications and investigations. Requests for data should be submitted to:

Data Manager, Deep Sea Drilling Project
Scripps Institution of Oceanography (A-031)
University of California, San Diego
La Jolla, California 92093
Telephone: (714) 452-3526
Cable Address: SIOCEAN

I. The database includes files generally available both in digital form on magnetic tape and as microfilm copies of the original observation forms.

A. Geophysical data include underway bathymetry, magnetics, and sub-bottom profiles; bathymetry data exist both as 12-kHz and 3.5-kHz records. Underway data are processed by DSDP and the Geological Data Center at Scripps Institution of Oceanography (SIO). Seismic records are available in microfilm and photographic prints.

B. Physical property data obtained on board Glomar Challenger include:
- Analytical water content, porosity, and density
- Density and porosity by Gamma Ray Attenuation Porosity Evaluator (GRAPE)
- Acoustic velocity by Hamilton Frame Method
- Thermal conductivity
- Heat flow (in situ)
- Natural gamma radiation (discontinued after Leg 19)
- Well logs

C. Sediment data obtained on board ship and from core samples in DSDP shore laboratories include:
- Core photographs
- Visual core descriptions
- Smear slide descriptions
- X-ray diffraction
- X-ray fluorescence
- Total carbon, organic carbon, and carbonate determinations
- Grain-size determinations (sand, silt, clay)
- Interstitial water chemistry
- Gas chromatography

D. Igneous rock data include:
- Core photographs
- Visual core descriptions
- Rock chemistry
- Paleomagnetics
- Thin-section descriptions

E. Paleontologic data include fossil names, abundance, preservation, and age of sample and are available, for selected sites, for Tertiary and Mesozoic taxa. Range charts can be generated from the database, using the line printer. A glossary of fossil names is available on microfiche or magnetic tape.

F. Ancillary files include:
- Site positions
- Sub-bottom depths of cores
- Master Guide File (a searchable core data summary file)

II. Additional publications, aids to research, are periodically updated and distributed to libraries. Single copies, at no charge, are distributed on microfiche at 48X magnification, except for the Data Datas (C, below), which are at 24X. They include:

A. Guides to DSDP Core Materials, a series of printed summaries containing maxima, minima, and typical values for selected observations. Guides are available for each of the
major ocean basins and for Phases I, II, and III of the drilling program. The source data summary file is also available.

B. Index to *Initial Reports and Subsequent Publications and Investigations* is a comprehensive key word index to chapters of the *Initial Reports* and to papers and investigations in progress which cite DSDP samples or data. The Index and its annotated bibliography serve to inform researchers of other investigators working on similar projects. Each paper is assigned key words for field of study, material, geographic area, and geologic age. A complete citation, including the assigned key words, is printed in the bibliography. Key words are permuted to form a comprehensive cross-index to the author reference list.

C. Data Data, a series of informal memoranda providing a quick reference to accessible data, is available on microfiche. Also available is a site position map to assist researchers in large-area studies. (Site positions are plotted on a bathymetry map compiled by the SIO Geologic Data Center.)

D. Data Retrieval and Application Computer Programs to perform data management and retrieval functions and a set of programs designed to provide special graphic displays of data are available; they may be of limited use because of differences in computer hardware. All current programs are written in ALGOL for a Burroughs 7800 computer system. Software inquiries may be addressed to the Data Manager.
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The precruise site surveys were carried out by the University of Texas Institute of Marine Sciences at Galveston, Texas. A survey of the Cape Basin by a French-German expedition on the R/V Jean Charcot provided additional information that was critical to our selection of Site 524. We would like to express our appreciation for the help of both groups.

The captain and the crew of the D/V Glomar Challenger maintained their high standard of performance. Glen Foss of DSDP was a friendly operations manager. We are, however, grateful most of all to the engineers at DSDP who designed and manufactured the hydraulic piston corer. It was the hydraulic piston corer that made possible the distinct achievements of precision stratigraphy.