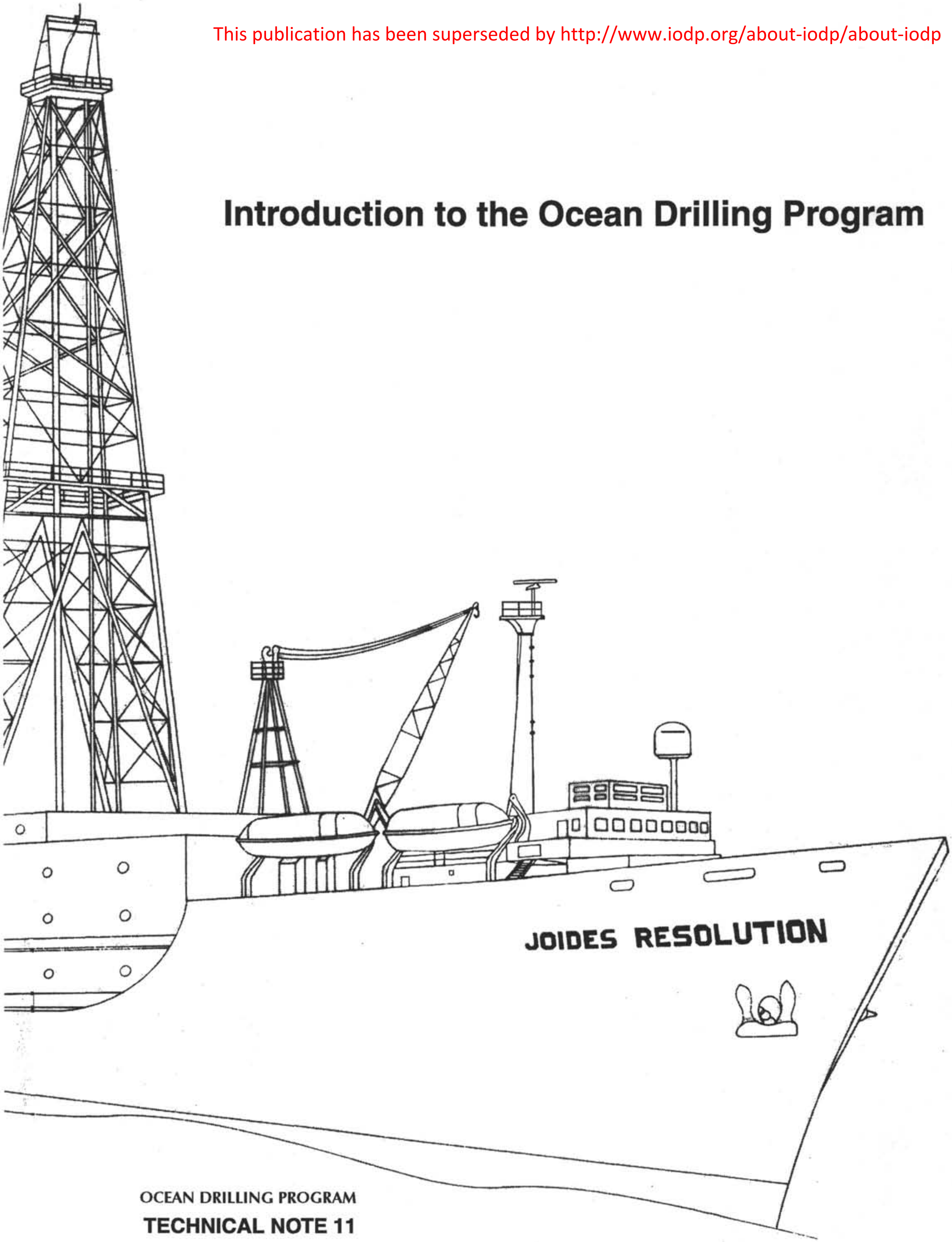
Introduction to the Ocean Drilling Program



OCEAN DRILLING PROGRAM

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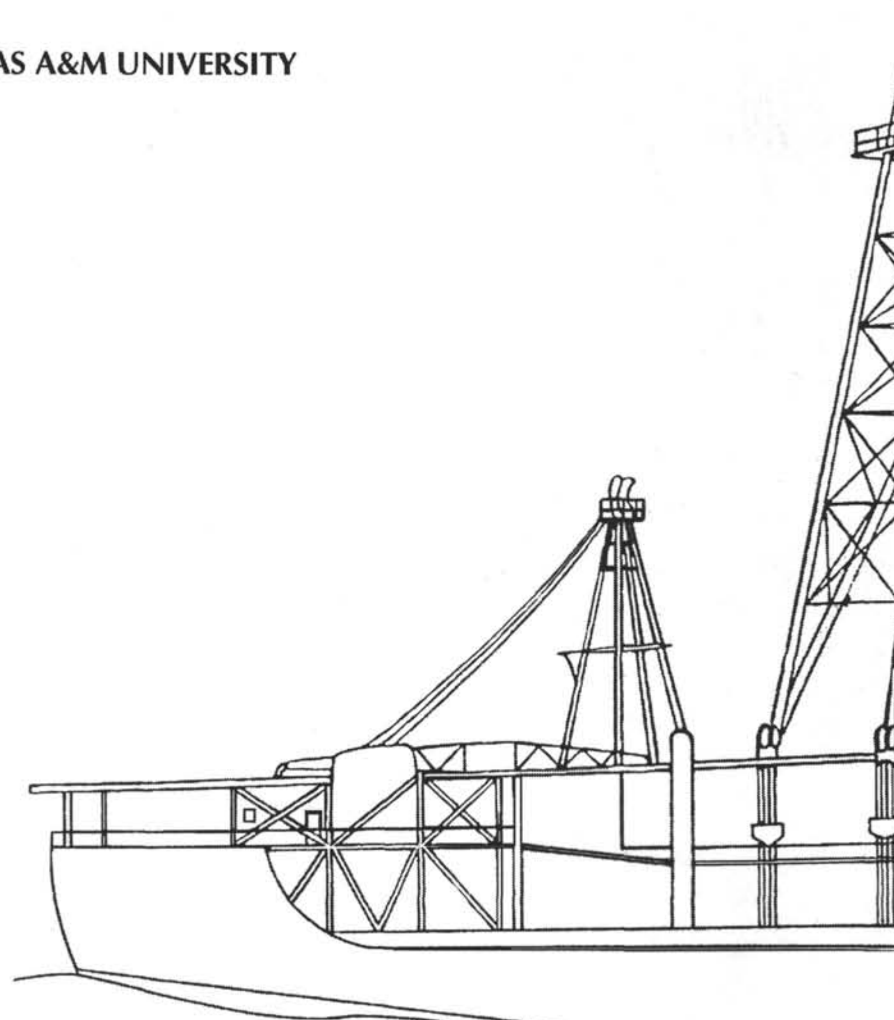

ODP 1989

INTRODUCTION TO THE OCEAN DRILLING PROGRAM

Ocean Drilling Program

Texas A&M University

Technical Note No. 11

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I. INTRODUCTION

A. Purpose of This Handbook

The Ocean Drilling Program (ODP) has much to offer the scientific community, including samples, data, and opportunities to plan and participate on drilling legs. In order to make these resources more readily available, we have assembled this informational guide to the Ocean Drilling Program.

In the following sections we summarize information about the organizational structure of ODP, its general functions, and the various ways in which interested scientists may participate. Included here is information about submitting proposals for deep-ocean drilling using JOIDES Resolution, joining the shipboard party on a cruise or becoming a shore-based contributor, developing research programs within and beyond the ship's laboratory capabilities, and obtaining samples, data, and publications from ODP. Also in these pages is a list of contact personnel, their specialized areas of expertise, and how they can assist the scientific community. Finally, the shipboard laboratory facilities are detailed. Cruise Participant Application, Sample Request, and Site Proposal Summary forms are appended.

The Ocean Drilling Program coordinates international cooperation in seeking to understand what lies beneath the ocean's deepest floors, and so must address the needs of all interested scientists with respect to what scientific returns can and should be expected from the Program. While there are constraints on time, money, and operational technology, ODP endeavors to provide state-of-the-art facilities in order to help realize scientists' goals in as many fields of research as possible. In exchange, ODP requires the attention of the scientific community through drilling proposals, suggestions for equipment and experiments, and, most especially, shipboard participation.

B. The Ocean Drilling Program in Brief

ODP is an international partnership of scientists and governments which have joined together to explore the structure and history of the earth beneath the ocean basins. The central purpose of ODP is to provide core samples and downhole measurements from beneath the oceans' floors and the facilities to study those samples. The United States, the Federal Republic of Germany, France, the Canada/Australia Consortium for the Ocean Drilling Program, Japan, the United Kingdom, and the European Science Foundation Consortium for the Ocean Drilling Program (including Belgium, Denmark, Finland, Iceland, Italy, Greece, the Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey) are working together to organize the scientific study of the sediments and rocks that fill and underlie the ocean basins. The data generated will lead to a better understanding of the processes of plate tectonics, of the earth's crustal structure and composition, of conditions in ancient oceans, and of changes in climate through time, and in turn to a fuller comprehension of the evolution of our planet.

A predecessor to ODP, the Deep Sea Drilling Project (DSDP), was established in 1966 at Scripps Institution of Oceanography to acquire deep sea cores on a routine basis for scientific study. Utilizing the drilling vessel Glomar Challenger between 1968 and 1983, scientists were able to obtain more than 60 miles of core from over 1000 holes at 624 sites around the world. During this remarkably successful expedition, techniques were developed for computer-controlled dynamic positioning, which stabilizes the ship over a borehole in mid-ocean; for most of the specialized coring technology that today allows continuous core recovery from boreholes situated in deep water; and for reentry systems that allow drill bits to be changed and then reinserted into the drill hole.

As Science Operator for the Ocean Drilling Program, Texas A&M University leased in 1985 the drilling vessel SEDCO/BP 471, also known as JOIDES Resolution (Fig. 1; see also Section IV, "Ship Description and Statistics"), to conduct the present phase of ocean exploration. JOIDES Resolution offers such capabilities as (1) a 30,000-ft (9150-m) drill string, (2) a stable drilling platform, (3) large, enclosed storage areas for drill pipe and casing, (4) a draw works with 31,000 ft (9450 m) of wireline, (5) berths for 51 scientific and technical personnel, (6) 12,000 sq ft (1080 sq m) of lab and office space, and (7) a strengthened hull for drilling in high-latitude waters. Based on input from advisory panels and other members of the scientific community, JOIDES Resolution shipboard laboratories have been equipped with state-of-the-art scientific equipment.

In addition to operating and staffing the drilling ship, the Science Operator also maintains the shipboard scientific labs (see Section V, "Scientific Laboratory and Data-Collection Facilities"), provides logistical and technical support for each cruise, curates the cores and distributes samples (see Section II.D.4, "Shore-based Investigators"), and edits and publishes the scientific results (see Section VI.C, "Bibliography of the Ocean Drilling Program").

During each cruise, specific scientific objectives are pursued by the personnel on board. The complement of approximately 25 scientists works on routine core studies in addition to performing special sampling and analytical projects within their own fields (see Section II.D.2, "Selection Process for Shipboard Scientists on ODP Cruises"). About 25 mostly ODP personnel provide technical support for shipboard data collection and operational procedures, and assist in upgrading and maintaining the shipboard labs and scientific equipment (see Section III.B, "ODP/TAMU Shipboard Personnel"). The ship's crew of 65 consists of those engaged in the drilling operations and those who run and service the ship.

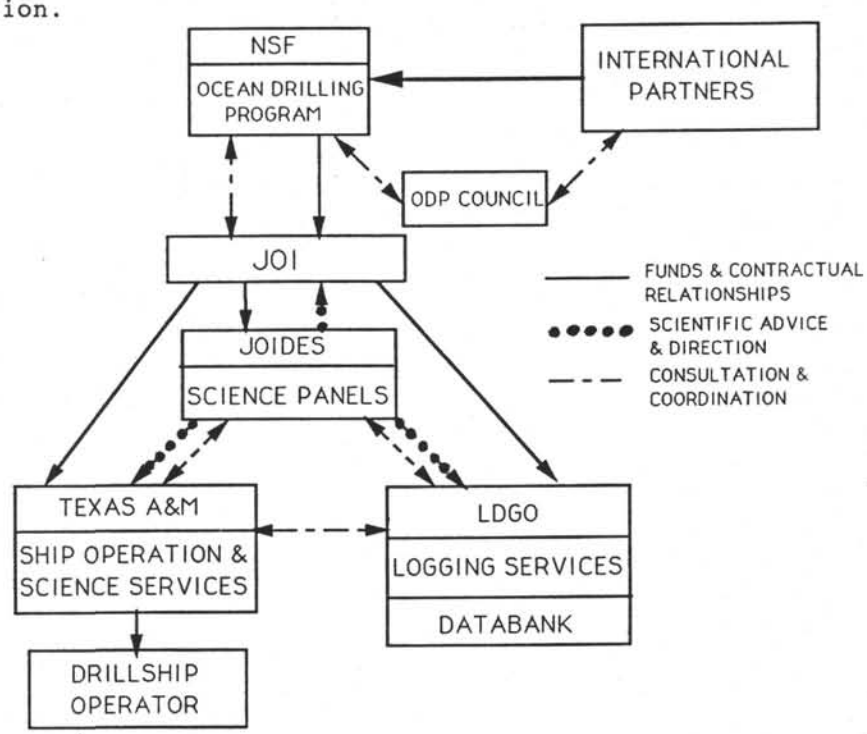
The Borehole Research Group at Lamont-Doherty Geological Observatory (LDGO) of Columbia University operates the shipboard logging program. LDGO contracts with Schlumberger Offshore Services for commercial logging services. The ODP Site-Survey Databank is also located at LDGO. (See Section III.C, "Key ODP/LDGO Personnel").

The Science Operator at Texas A&M University curates all DSDP and ODP cores. Cores retrieved by JOIDES Resolution are stored at three sites: the East Coast Repository (at LDGO) houses DSDP and ODP cores from the Atlantic and Southern oceans; the Gulf Coast Repository (at Texas A&M University) receives ODP cores from the Pacific and Indian oceans and all special collections; the West Coast Repository (at Scripps Institution of Oceanography) contains DSDP cores from the Pacific and Indian oceans.

Results of each cruise are published in two hard-bound volumes of the Proceedings of the Ocean Drilling Program: the "Initial Reports," which is published about 14 months post-cruise, and the "Scientific Results," which is published about 3 years post-cruise. Geotimes and Nature "News and Views" articles are usually published shortly after the cruise is completed.

C. JOI and JOIDES

The National Science Foundation (NSF), an independent U.S. government agency, has chosen the Joint Oceanographic Institutions, Inc. (JOI) to act as a manager of ODP. JOI is a consortium of 10 major U.S. oceanographic institutions and provides management support to scientific research programs. The 10 institutions involved are the University of California at San Diego, Columbia University, University of Hawaii, University of Miami, Oregon State University, University of Rhode Island, Texas A&M University (TAMU), University of Texas at Austin, University of Washington, and Woods Hole Oceanographic Institution.



OCEAN DRILLING PROGRAM MANAGEMENT STRUCTURE

JOI receives guidance regarding science goals and objectives, facilities, scientific personnel, and operating procedures from the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), an international group of scientists.

The JOIDES office provides support for the science advisory structure. This office rotates among the U.S. member institutions on a two-year basis and will be located at the University of Hawaii's Hawaii Institute of Geophysics during 1988-1990. One of the activities of this office is publication of the JOIDES Journal, which serves as a means of communication among the JOIDES Committees and Advisory Panels, the National Science Foundation, JOI and its subcontractors thereunder, and the international science community at large. Updates on ODP cruise schedules and prospectuses, preliminary leg results, and data availability all appear in this publication. Copies of the current issues and available back issues may be requested from: Joint Oceanographic Institutions, Inc., Suite 800, 1755 Massachusetts Avenue NW, Washington, DC 20036. Also available at no charge from JOI at the above address is the JOI/USSAC Newsletter. The Newsletter contains information on workshops, fellowships, site survey augmentation, and information on upcoming events concerning the U.S. ocean drilling scientific community.

JOIDES consists of an Executive Committee (EXCOM) together with a science advisory structure headed by the Planning Committee (PCOM). EXCOM formulates scientific and policy recommendations with respect to ODP. It conducts ODP planning, as well as evaluation and assessment of the Program by comparing its accomplishments to established goals and objectives. Members of EXCOM include representatives of the six non-U.S. member countries or consortia, and representatives from each of the ten JOI U.S. institutions.

The Science Advisory Structure of JOIDES consists of the Planning Committee, Technology and Engineering Development Committee, four thematic panels, five service panels, and a varying number of ad hoc "Detailed Planning Groups." Drilling proposals submitted by members of the scientific community (see Sections II.A and II.B) are reviewed by the thematic panels, whose recommendations are used by the JOIDES Planning Committee to determine JOIDES Resolution's cruise schedule. A complete membership listing of all JOIDES advisory groups appears annually in JOIDES Journal.

D. National ODP Structures

The ODP office in NSF oversees the Program and administers commingled funds from the NSF and non-U.S. partner nations. The office is also responsible for support of U.S. science drilling-related activities. The NSF convenes an annual meeting of the international ODP Council and acts as permanent chairman of the consultative body. The Council itself is made up of a representative from each partner country, and provides a means of communication between NSF and the other international funding agencies.

The Federal Republic of Germany signed a Memorandum of Understanding with NSF for participation in ODP in March 1984. The Bundesanstalt für Geowissenschaften und Rohstoffe coordinates German activities within ODP. Dr. Hans J. Duerbaum, Dr. Helmut Beiersdorf, and Dr. Ulrich von Rad are key contacts (all at BGR, D-3000 Hannover 51, Postfach 510153, Federal Republic of Germany).

France has also been a member since 1984. The Institut Français de Recherche pour l'Exploitation de la Mer coordinates French participation in ODP. Dr. Bernard Biju-Duval (IFREMER, 66 Avenue d'Iena, Paris 75116 France) and Dr. Yves Lancelot (Univ. Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris Cedex 05 France) are key contacts.

Japan became a full member of ODP in 1985. The Ocean Research Institute of the University of Tokyo is responsible for the scientific operation of the program. Dr. Takahisa Nemoto, Dr. Kazuo Kobayashi, and Dr. Asahiko Taira are key contacts (all at ORI, Univ. of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164 Japan).

The United Kingdom joined ODP in 1986. The Natural Environment Research Council houses the British ODP office. Dr. James C. Briden (NERC, Polaris House, North Star Avenue, Swindon SN2 1EU United Kingdom), Dr. A. S. Laughton (Institute of Oceanographic Sciences, Brook Road, Wormley, Godalming, Surrey GU8 5UB) and Dr. Hugh C. Jenkyns (Department of Earth Sciences, University of Oxford, Parks Road, Oxford OX1 3PR) are key contacts.

The European Science Foundation Consortium for the Ocean Drilling Program joined ODP in 1986. Key contacts are Dr. Jan Stel (KNAW/Netherlands Council for Oceanic Research, P.O. Box 19121, NL-1000 GC, Amsterdam, the Netherlands), Dr. Olav Eldholm (Institute for Geology, University of Oslo, Postboks 1047, Blindern N-0316, Oslo 3 Norway), and Dr. Michele Fratta (European Science Foundation, 1 Quai Lezay-Marnesia, F-6700 Strasbourg, France). In addition, individual scientists in each ESF partner country provide liaison with their country's scientific community.

Canada joined as a full member of ODP in 1985; Australia joined with Canada in November 1988 to form the Canada/Australia Consortium for the Ocean Drilling Program. Key contacts are Dr. Christopher R. Barnes (Geological Survey of Canada, 580 Booth St., Ottawa, Ontario K1A 0E4 Canada), Dr. John Malpas (Memorial University, Elizabeth Avenue, St. John's, Newfoundland A1B 3X5 Canada), and Dr. David Falvey (Division of Marine Geosciences, Bureau of Mineral Resources, GPO Box 378, Canberra, ACT 2601 Australia).

E. Further Information on the Ocean Drilling Program

Further information of the Ocean Drilling Program may be obtained from the Coordinator of Public Information (see Section III.A.1), including the following publications:

- Ocean Drilling Program (in English, French, Spanish, Japanese, or German)
- Onboard JOIDES Resolution
- ODP Engineering and Drilling Operations
- Multilingual brochure with a synopsis of ODP in English, German, French, Japanese, and Spanish
- ODP Poster

Promotional materials, including brochures and a portable ODP display are also available from JOI (1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036).

II. PRE-CRUISE ACTIVITIES

A. From Proposal to Drilling Leg

Each Ocean Drilling Program cruise has its origins in a drilling proposal submitted to the JOIDES Office. Through proposals, individual scientists and groups have the opportunity to respond to the major thematic priorities for ODP (as developed by the JOIDES panels and published in the JOIDES Journal) and to contribute their expertise. The COSOD (Conference on Scientific Ocean Drilling) report from the meeting held in 1981 at Austin, TX, and the report from COSOD II held in 1987 at Strasbourg, France, are important bases for defining the goals of ODP science. Copies of these reports are available from JOI.

After proposals are submitted to the JOIDES Office, they are forwarded to the thematic advisory panels for review. The reviewing panels prioritize the proposals and advise the Planning Committee of their recommendations. The panels may request additional information from the proponents and may suggest that the proposal be modified to enhance its scientific merit. Some proposals of limited scope may be incorporated by the advisory panels into a proposal of broader scope.

Thematic panels are primarily concerned with the process aspects of the science, developing scientific drilling objectives established by COSOD-type conferences and helping to define the long-term scientific goals of ocean drilling. Detailed Planning Groups are short-lived planning groups organized to conduct more intensive study of certain aspects of planning in order to recommend integrated drilling programs for their assigned topics and/or regions of interest. As the proposal proceeds through the advisory system, service panels may offer advice or recommendations regarding technical aspects of proposed drilling (e.g., site survey review, safety recommendations, or downhole measurements review), but service panels are not directly involved with selection of drilling targets or definition of cruise objectives.

The Planning Committee monitors and directs the proposal review process, reviews the recommendations of the advisory panels, decides the fate of proposals, and ultimately integrates the approved proposals into a detailed drilling plan and ship's track.

B. Guidelines for Submission of Drilling Proposals

JOIDES accepts input by individuals or groups into the Ocean Drilling Program in the form of preliminary or mature proposals for drilling programs. The JOIDES Office is always available to advise proponents of proposal requirements. The current address (1988-1990) for the JOIDES Office is:

Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, HI 96822

In each JOIDES Journal, all proposals that were received during the past year are classified on a regional basis and listed with information on the availability of site survey data and reference to panels/working groups. Proposal lists are updated in succeeding issues of the JOIDES Journal. Deadlines for submitting proposals are also printed in the Journal. When received, proposals are classified as one of the following:

1. Preliminary Proposals

These are ideas and suggestions for scientific ocean drilling--for example, objectives (a specific geologic process), drilling targets, or downhole experiments may be submitted at any time to the JOIDES Office. Such input generally lacks either geographic specificity, site survey data, or both. Preliminary proposals should be sent in triplicate to the JOIDES Office.

2. Mature Drilling Proposals

Ideas that become part of the drilling program do so either by evolving into a mature proposal or by incorporation into an existing proposal with multiple objectives. Proposals are considered mature when accompanied by a specific set of minimum data (listed below) provided by the proponents or JOIDES (certain technical data may not be readily available to proponents). It follows that the time required for an idea or proposal to be processed by the JOIDES science advisory structure and become part of the drilling plan will depend on the completeness of the required data at the time of submission. Proponents are urged to submit as complete a package as possible. In general, a minimum of at least 36 months lead time is required from of proposal submission to actual drilling. Exceptionally, a shorter lead time may be acceptable in those cases where extensive site surveys are not required. Six copies of mature proposals should be submitted to the JOIDES Office. [Note: if foldouts can be reduced to standard-size pages, it greatly expedites distribution of a proposal to panels.]

C. Minimum Requirements for Mature Proposal Submission

The following items should be discussed in a mature proposal: (1) specific scientific objectives with priorities; (2) proposed site locations and alternative sites [proponents are also required to submit a Site Proposal Summary Form (see Appendix) for each proposed drilling site]; (3) background information, including regional and local geologic setting and identification of existing geophysical/geological data base; (4) drilling requirements for each objective (e.g., steaming time, estimated drilling time, water depth, penetration depths, reentry) [information on estimated drilling times may be found in Preliminary Time Estimates for Coring Operations (ODP Technical Note No. 1). Proponents are advised to contact Drilling Operations at ODP/TAMU (see Section III.A.5) for advice in preparing time estimates]; (5) logging, downhole experiments, and other supplementary programs (estimated time, specialized tools and requirements, etc.); (6) known deficiencies in data required for (i) location of drill sites (site surveys), (ii) interpretation and extrapolation of drilling results (regional geophysics) [ODP has established standards for site survey data, which are available from the JOIDES Office, outlining the techniques to be used in the various environments that may be encountered]; (7) statement of potential safety and pollution problems in implementing proposed drilling; (8) other potential problems (weather window, territorial jurisdiction, etc.); (9) the name and address of an individual assigned as a proponent for each site who will serve as a contact for JOIDES when additional information is required.

Proponents of mature proposals are also asked to identify pertinent available data in three categories: (1) the primary data necessary and sufficient to support the scientific proposal; the ODP Databank is authorized to duplicate and distribute these data as needed for ODP evaluation and planning procedure; (2) other data relevant to the proposal which may be obtained from publicly accessible databases in the U.S. and elsewhere; and (3) data which will eventually be available for public access but have release clauses imposed by the data holder (proponent); these data are not normally considered as part of the evaluation of the scientific merit of the related proposal.

It is emphasized that supporting data for a proposal in the above categories must be deposited with the ODP Databank (see Section III.C.2) to ensure that a proposal is considered mature.

D. Scientific Participation in the Ocean Drilling Program

1. Selection Process for Co-Chief Scientists on ODP Cruises

Co-Chief Scientists are selected by ODP/TAMU from a list of names forwarded by the JOIDES Planning Committee (PCOM). This list comes from names suggested by advisory panels, by non-U.S. science advisory committees, and names suggested by PCOM. The list may also include people who have expressed an interest in participating as a Co-Chief on a particular leg. In providing advice to ODP, PCOM identifies names of original proponents, those who carried out pre-drilling site surveys, those with major interest in the region to be drilled, and those with expertise in the problems being addressed by the particular leg. Also, PCOM may identify names of those who have been Co-Chiefs previously in order to bring attention to new people on the list who have not had the opportunity to participate in the program as a Co-Chief Scientist.

The Co-Chief selection process is intended to identify those who have the experience, maturity, and scientific expertise to coordinate and conduct the scientific program assigned to each leg. Because many legs are developed from combinations of proposals and different data sources, and because of the obligations stated in the Memorandum of Understanding (MOU) signed by the ODP member countries, it is not possible to guarantee that all proponents will be selected to serve as Co-Chief Scientists.

The responsibilities of Co-Chief Scientists begin some time (usually 10-12 months) prior to the cruise, when they are appointed by ODP/TAMU. From their appointment onward they aid ODP staff in refining the scientific objectives of the cruise, taking account of operational constraints. The Co-Chiefs work with ODP/TAMU to prepare a scientific cruise prospectus that is distributed to participants and the JOIDES community about 3 months pre-cruise. They also make preparations for JOIDES Safety Panel review of the proposed drill sites.

The Co-Chief Scientists review all applications for cruise participation and make recommendations for the shipboard party to the ODP Manager of Science Operations. They also review requests for samples from the cruise and work with ODP/TAMU to prepare a cruise sampling plan. They are charged with implementing at sea the recommendations of the JOIDES Planning Committee for drilling, coring, and logging, after the recommendations have been reviewed operationally and approved by ODP/TAMU management. At sea, they ensure optimum use of the vessel's time, coordinate scientists' responsibilities during the cruise, organize scientific meetings aboard ship, and oversee the scientific reports generated during the cruise.

After the cruise ends, the Co-Chief Scientists are charged with ensuring that the results of the cruise are reported promptly to the scientific community. They coordinate the post-cruise efforts of shipboard and shore-based researchers so that their results are reported in a timely fashion for the <u>Proceedings of the Ocean Drilling Program</u>. The Co-Chief Scientists attend post-cruise meetings at ODP Headquarters to prepare the "Initial Reports" volume for publication, serve on the Editorial Review Board for their "Scientific Results" volume, and review each manuscript for both volumes.

2. Selection Process for Shipboard Scientists on ODP Cruises

ODP/TAMU has responsibility for selecting all scientific staff who will participate on a specific leg. All non-U.S. partners will have, on average, two shipboard scientists on each ODP cruise. The remainder usually, but not always, comes from the U.S. scientific community.

Scientists interested in participating on an ODP cruise must complete a "Cruise Participation Application" (see Appendix). U.S.

scientists and scientists from non-member countries should submit this form to the Manager of Science Operations at ODP/TAMU; scientists from non-U.S. member countries should submit the form to ODP/TAMU and give a copy of the application to the ODP office in their country. Though applications are accepted until the specific cruise leaves port, ideally they should be submitted by about 12 months prior to the cruise to make sure they receive complete consideration.

ODP/TAMU works closely with the designated Co-Chief Scientists in staffing each cruise. Therefore, the staffing procedure does not begin until the Co-Chief Scientists have been identified, usually by one year prior to the start of the cruise. After the Co-Chief Scientists are invited, the ODP Manager of Science Operations discusses shipboard scientific staffing needs with them and solicits nominations for scientists from the non-U.S. member countries. This process takes several months. Invitations are mailed to most of the prospective shipboard scientists by about 8 months prior to the cruise. Because inevitably a number of invitees cannot participate and must be replaced by other applicants, staffing is usually not completed until about 4 months prior to the cruise. Even then, last-minute changes in shipboard scientists' plans sometimes mean that other applicants may be invited to participate on a cruise on much shorter notice.

The shipboard staffing timetable outlined above is an ideal schedule, allowing most scientists adequate time to arrange to be absent from their offices for the duration of the cruise. However, this timetable cannot be maintained when cruise objectives and/or Co-Chief Scientist selections are not identified by 1 year prior to sailing. In such situations, staffing proceeds in an identical manner, but on an accelerated timetable so as to give shipboard scientific invitees as much time as possible before the cruise.

3. Brief Job Descriptions of Shipboard Scientists

a. General Responsibilities

Shipboard scientists collect, analyze, and compile data in accordance with ODP standards and format. They assist the Co-Chief Scientists in producing shipboard scientific reports by recording data on standard ODP forms or data bases and writing a description of their disciplines' results for each site chapter of the "Initial Reports" volume of the <u>Proceedings of the Ocean Drilling Program</u>.

Scientists aid the ODP/TAMU Curatorial Representative by taking samples for themselves and others for later shore-based study. A team of highly trained marine technicians, some specializing in particular equipment areas, is on hand to assist the shipboard scientists in maintaining the flow of core samples through the laboratories and to help with analyses.

Shipboard scientists are primarily on board to pursue their own scientific interests. After the cruise, they are responsible for analyzing their samples/data and reporting the results which are included in the ODP data base and published in the cruise "Scientific Results" volumes. Following is a brief description of the shipboard responsibilities of the scientific staff.

b. **Sedimentologists** provide accurate visual and written descriptions of the cored sediments and interpretations of depositional and diagenetic history or other related sedimentological processes. They work as a team, designating a lead sedimentologist for each site and exchanging specific responsibilities from site to site. Sedimentologists' responsibilities include (1) written and graphic core descriptions on ODP data forms, including the sedimentologic portion of core description forms ("barrel sheets"); (2) smear-slide preparation and petrographic analysis of smear slides and thin sections; and (3) selection of samples for shipboard analyses of X-ray diffraction (XRD), X-ray fluorescence (XRF), carbonate percentage, and thin sections.

c. **Paleontologists'** chief responsibility is to obtain dates from core-catcher samples immediately after the cores are recovered. They may need to examine additional samples to provide as complete a biostratigraphic characterization of the cored section as possible within the time available, including recognition of boundaries and hiatuses. Within time constraints, paleontologists may also make paleoenvironmental interpretations for each site.

d. **Petrologists** classify thin sections and hand specimens, and provide the written and graphic descriptions of all igneous and metamorphic rocks recovered on the cruise. Petrologists should be experienced in one or more of all the following aspects of the petrology of oceanic rocks: chemical petrology, lithology and volcanology, or mineralogy and petrography.

e. **Paleomagnetists** conduct or supervise all paleomagnetic measurements including the reduction of paleomagnetic data to intensities and direction of magnetization. Paleomagnetists work with other shipboard scientists and the drilling crew to ensure that core material is not magnetically damaged by heating or exposure to strong magnetic fields and that core sections are not inverted.

f. **Physical properties specialists** select cores to determine velocities, shear strength, thermal conductivity, and index properties (water content, porosity, and bulk density). They also ensure that data are collected in a manner consistent with ODP format. The physical properties specialists and the sedimentologists select samples for carbonate analysis.

g. **Organic geochemists** monitor cores for gas and oil (hydrocarbon accumulations) and organic compounds. They advise when hydrocarbons in cores may constitute a safety or pollution hazard.

h. **Inorganic geochemists** are primarily responsible for conducting interstitial water, XRD, and XRF analyses. They are assisted by ODP Chemists and Marine Technicians.

i. **Logging scientists** advise the Co-Chief Scientists on the cruise logging program. They work closely with the Schlumberger field engineer and the LDGO Borehole Research Group logging scientist in designing, implementing, and interpreting the program.

4. Shore-based Investigators

Becoming a shore-based investigator involves receiving samples or data collected during a cruise or cruises (with Co-Chief approval if within one year of the end of the cruise), and returning published results to ODP within an agreed-upon time frame. An investigator who requests samples or data prior to or within one year after a cruise must accept the requirement that scientific results be published first in the "Scientific Results" volume of the Proceedings of the Ocean Drilling Program for that cruise.

The two ways in which scientists not participating on a given cruise can become shore-based contributors to the "Scientific Results" volume differ more in timing than in procedure. These two ways are as "Shipboard/Shore-based Requests" and as "Post-Cruise Requests."

a. Shipboard/Shore-based Requests

Scientists who are aware of the location and objectives of a particular cruise of interest may complete a Shipboard/Shore-based Sample Request and submit it to the ODP Curator (see Section III.A.6) at least two months prior to the beginning of the cruise. This request is an outline of the planned study and should usually take a "pilot study" approach to sampling, since shipboard sampling is necessarily limited; requests for additional samples can be filled by the repositories soon after the cores arrive.

Requests received two months before the cruise begins are grouped with requests made by members of the shipboard party, and are reviewed by the Curator, the Co-Chief Scientists, and the shipboard party as a whole. If a shore-based contributor's request is considered beneficial to the overall objectives of the cruise, and if it does not conflict or overlap with requests made by shipboard participants, it may be approved. Sampling for shore-based contributors may be done aboard ship as the cores are received, or it may be deferred until after the cores arrive at the repository. Samples taken aboard ship are sent immediately to the requestor; the length of time before samples are sent after deferred sampling depends primarily upon how soon after the end of the cruise the cores are received at the repository.

The advantage of this early approach to requesting samples is that the requests are treated, along with those of the shipboard party, as part of the basic cooperative studies for the cruise, and are considered to be integral parts of the anticipated scientific results.

It is important to submit unrelated requests on separate sample request forms; each request must be judged on its own merit.

b. Post-Cruise Sample Requests

After a cruise is over, preliminary results are disseminated as quickly as possible in Nature and Geotimes articles and other publications. Scientists who wish to request samples based on this preliminary information must submit a request to the Curator stating the general terms of the study. This request is reviewed by the Co-Chief Scientists and the Curator, and if it is approved, the requesting scientist is sent a copy of the cruise Hole Summaries. The scientist then prepares a specific request that contains an itemized list of exact sample locations.

Sample requests accepted within one year post-cruise must yield information that is publishable in the "Scientific Results" volume of the Proceedings of the Ocean Drilling Program.

c. Requests Made After One Year Post-Cruise

There is a one-year moratorium on sampling for investigators other than shipboard or shore-based contributors to the Proceedings volume. After the one-year moratorium has passed for a particular cruise, the post-cruise sample request procedure is followed, with the exception that agreement to publish in the Proceedings volume is not a prerequisite for request approval, nor is Co-Chief review of the request required. The same one-year moratorium applies to all data collected on cruises.

d. Educational Samples

Two levels of sample requests can be made for purposes other than research programs yielding publishable results. One level of request is for research-quality materials from particular intervals or of specific composition--for example, for a reference collection. All pertinent sample information is sent with such samples. Second, scientists, educators, or other interested investigators may request samples to be used, for example, for teaching purposes. These sample requests usually can be filled from core material that is deemed to be non-critical (e.g., residues from other sampling programs or intervals disturbed by drilling), but that is suitable for the purposes of the request. No scientific information is provided with these samples. All such sample requests are reviewed by the ODP/TAMU Curator.

e. Shipboard and Shore-based Sampling Procedures

Usually, shipboard sampling takes place about 4-6 hours after each core arrives on deck. Each approximately 9.5-m core is cut into 1.5-m sections, and the sections split lengthwise. One half (the "archive" half) is described by shipboard sedimentologists while the other half (the "working" half) is sampled. The Curatorial Representative is assisted by all shipboard scientists in taking samples for the shipboard and shore-based programs that make up the Cruise Sample Plan. Sample size for sediments is normally 2-10 cm^3 samples are taken by pressing a small plastic tube into the sediment, removing the tube and sediment plug, and sealing the sample in a clear plastic bag labeled with the sample's identifier (leg-site-hole-core-section-interval, plus the investigator's three-letter code). Hard-rock samples are cut on a rock saw into quarter-rounds or slabs, or may be cut using a drill press and special "mini-corer" diamond bit. Hard-rock samples are also bagged, sealed, and labeled.

By special prior request, sediment samples taken from the working halves of core sections may be frozen--for example, for organic-geochemical analyses. Routinely, 25-cm pieces of sediment core are taken at specified intervals and frozen whole, before the cores are split and described. Frozen samples and the 25-cm whole-rounds are kept frozen during the cruise, during shipment, and after they arrive at the repository. The frozen whole-rounds thus provide the opportunity to request frozen samples after the cruise has ended.

Shore-based sampling follows similar procedures to those detailed above. All samples are sent to the investigator with an inventory list.

5. Special Experiments

Written proposals for special shipboard experiments must be made as early as possible in the planning stages for a particular cruise. Proposals for large-scale experiments that may extend through more than one cruise; involve coordinated activities with other ships, countries, or institutions; or clearly require a major commitment from all ODP departments are addressed to the ODP Deputy Director (see Section III.A.1), who will direct the proposal to the JOIDES Planning Committee (and/or other JOIDES panels) if warranted. Most requests will involve smaller-scale, leg-specific shipboard scientific experiments and are referred to the ODP Manager of Science Operations (see Section III.A.3). It is recommended that proposals for special experiments be brought to the attention of the Manager of Science Operations when the cruise Participation Application is submitted. Inquiries before that time are welcomed.

E. Arrangements for Sending Equipment to the Ship

For those scientists who are sending equipment to the ship for special experiments approved prior to the cruise, arrangements can be made to ship these items to the port call along with the regular ODP freight. Information on the equipment must be provided to the ODP Technical and Logistics Support office (see Section III.A.4) by or before 4-6 months pre-cruise and should include a description of the equipment, value(s), serial number(s), owner(s), place(s) of manufacture, and dimension(s)/weight(s). Normally, all such equipment is sent via ocean freight, which requires several weeks, and often months, of transit time to the port. Therefore, it is imperative that the equipment arrive at ODP/TAMU in ample time to be assured delivery. The Logistics office will supply cut-off dates upon request as to when equipment must be available at ODP/TAMU.

Alternatively, the Logistics office will supply the correct address and labeling requirements so that scientists can send their equipment prepaid directly to the port. In such a case, the sender must inform the Logistics office of the Air Way Bill Number (or Bill of Lading), routing, number of pieces, estimated time of arrival, and whether any special handling is required for the equipment. After use aboard the vessel, equipment can be returned via the next scheduled ODP ocean freight shipment to ODP/TAMU and then sent on to the recipient, or sent via collect air freight directly to the recipient. Boxes, crates, and other containers should be saved for shipping home, because such materials are in limited supply on board.

III. ODP KEY PERSONNEL

A. Key Shore-based ODP/TAMU Personnel

This list provides contact information for key ODP/TAMU personnel, as well as a brief guide to the services and resources that may be obtained from them. All are located at the following address:

Ocean Drilling Program
1000 Discovery Drive
Texas A&M University Research Park
College Station, TX 77840

Note: Anyone at ODP/TAMU may be reached by telephone through the Receptionist, (409) 845-2673.

FAX: 409-845-4857
Telex Number: 792779 ODP TAMU
Easylink Number: 62760290
BITNET: username@TAMODP (usernames are listed with each individual's BITNET address below)

1. Headquarters

a. Director
Dr. Philip Rabinowitz
409-845-8480
BITNET "PHIL@TAMODP"
The Director is responsible for all ODP/TAMU operations.

b. Deputy Director
Dr. Louis Garrison
409-845-8480
BITNET "GARRISON@TAMODP"
The Deputy Director assists the Director with ODP/TAMU operations.

c. Coordinator of Public Information
Ms. Karen Riedel
409-845-9322
BITNET "KARENR@TAMODP"
The Coordinator of Public Information is responsible for the coordination and dissemination of general information about ODP, including tours, press releases, brochures, and audiovisual materials.

2. Administration

a. Administrator
Ms. Sylvia DeVoge
409-846-3068
BITNET "DEVOGE@TAMODP"
Contact the Administrator for information regarding financial services, contracts (compliance, negotiations, subcontracts), and general administrative services (purchasing, insurance, personnel, and travel).

b. Travel Supervisor
Ms. June Anderson
409-845-0924
BITNET "ANDERSON@TAMODP"
Contact the Travel Supervisor with questions regarding arrangements for ODP conferences and meetings, and USSAC-sponsored travel.

3. Science Operations

a. Manager of Science Operations
Dr. Audrey Meyer
409-845-7209
BITNET "AUDREYM@TAMODP"
b. Assistant Manager of Science Operations
Dr. Jack Baldauf
409-845-7209
BITNET "BALDAUF@TAMODP"
Contact the Science Operations office for information about pre-cruise planning and staffing, and with any questions of a scientific nature regarding ODP cruises, shipboard facilities, etc. Science Operations oversees the development, maintenance, and dissemination of all numerical data associated with cores and underway geophysical data collected on board ship. Applications for cruise participation are handled through this office.

c. Supervisor of Databases
Ms. Patricia Brown
409-845-1927
BITNET "BROWN@TAMODP"
The Supervisor of Databases is responsible for creating and curating electronic and paper databases which document and make available results of cruises and subsequent work on samples. Contact the Supervisor for information regarding the ODP database.

d. Data Librarian
Ms. Kathe Lighty
409-845-8495
BITNET "DATABASE@TAMODP"
Contact the Data Librarian for assistance with data requests and database searches.

4. Technical and Logistics Support

a. Manager of Technical and Logistics Support
Mr. Robert Olivas
409-845-2363
BITNET "OLIVAS@TAMODP"

b. Assistant Manager of Technical and Logistics Support
Mr. Joseph Peloso
409-845-2367
BITNET "PELOSO@TAMODP"

Contact the office of Technical and Logistics Support regarding matters related to the purchase, furnishing, shipping, and maintenance of shipboard facilities and equipment. Technical and Logistics Office representatives work closely with the ship's agent for each port call. This office also handles the staffing of marine technicians for ODP cruises.

c. Supervisor of Technical Support
Mr. Dennis Graham
409-845-2445
BITNET "GRAHAM@TAMODP"

The Supervisor of Technical Support is responsible for hiring, training, and scheduling Marine Technicians, for coordinating shipboard and shore-based technical activities, and for maintenance of shipboard and shore-based laboratories.

5. Engineering and Drilling Operations

a. Manager of Engineering and Drilling Operations
Mr. Barry Harding
409-845-2024
BITNET "HARDING@TAMODP"

Engineering and Drilling Operations is the primary interface with the drillship subcontractor (Underseas Drilling, Inc.) for operational matters; it is responsible for long- and short-range planning and execution of drilling and coring operations; it develops new technology to meet scientific and operational needs, and improves reliability and performance of existing systems. Contact this office with questions regarding the operational aspects of the Ocean Drilling Program.

b. Supervisor of Drilling Operations
Mr. Ron Grout
409-845-2042
BITNET "GROUT@TAMODP"

The Supervisor of Drilling Operations is responsible for the shipboard drilling and coring program, on-site decision making, and for scientific, subcontract, technical and logging personnel at sea. Contact the Supervisor with questions regarding drilling operations: drilling time estimates, drilling equipment specifications, coring procedures, etc.

c. Supervisor of Engineering Development

Mr. Michael Storms
409-845-2101
BITNET "STORMS@TAMODP"

The Supervisor of Engineering Development coordinates and supervises improvements to existing drilling and downhole technologies, and oversees new technology development to achieve scientific objectives. Contact the Supervisor with questions regarding drilling equipment and/or procedures under development.

6. Science Services

a. Curator and Manager of Science Services

Dr. Russell Merrill
409-845-9324
BITNET "MERRILL@TAMODP"

Science Services is responsible for the distribution, record-keeping, and inventory for samples; coordination and production of ODP publications; supervision of the cartographic unit, photographic lab, and computer services; and supervision and coordination of repositories. Contact the Science Services office for general information on these services, or contact the individuals listed below with more specific questions and/or requests.

b. Supervisor of Curation and Repositories

Ms. Christine Mato
409-845-4819
BITNET "CHRIS@TAMODP"

The Supervisor of Curation and Repositories directly supervises the three ODP Repositories (East, West and Gulf coasts), and processes sample requests under the general direction and supervision of the Curator. Contact this office to obtain sample request forms, sample policy booklets, or with questions regarding sample requests.

c. Supervisor of Publications

Mr. William Rose
409-845-1191
BITNET "ROSE@TAMODP"

The Supervisor of Publications oversees the editing and production of the Proceedings of the Ocean Drilling Program and other major ODP publications. Contact this office regarding matters related to the production of ODP Publications.

d. Publications Distribution Specialist

Ms. Fabiola Byrne
409-845-2016
BITNET "FABIOLA@TAMODP"

Contact the Publications Distribution Specialist for information regarding the availability of ODP publications, including Scientific Prospectuses, Preliminary Reports, Technical Notes, and Proceedings of the Ocean Drilling Program.

e. Supervisor of Computer Services

Mr. Jack Foster
409-845-9323
BITNET "FOSTER@TAMODP"

The Supervisor of Computer Services directs the activities of the computer services group, and oversees the shipboard and shore-based computer systems. Contact this office for more information on these systems or with specific questions regarding ODP computer facilities and/or capabilities.

B. ODP/TAMU Shipboard Personnel

1. Engineering and Drilling Operations

a. ODP/TAMU Operations Superintendent

The Operations Superintendent is the senior ODP representative aboard ship, and is responsible for the execution of the recommendations and procedures made by the Safety and Pollution Prevention Panel of JOIDES and approved by the Ocean Drilling Program. He is responsible for all matters affecting the technical and operational success of the entire expedition; he plans, directs, and supervises the activities of Underseas Drilling, Inc. (UDI/SEDCO)--i.e., ship contractor personnel--through their designated supervisor and is charged with the responsibility of ensuring that the best possible techniques, equipment, and work efforts are being utilized to maximize scientific results with minimum risk of loss of equipment or personal safety.

b. Special Tools Engineer

On some cruises a Special Tools Engineer is aboard to supervise the maintenance and deployment of special coring tools (i.e., downhole tools under development), to train rig crews in the routine use of new tools, and to assist in the deployment of rarely operated equipment.

2. ODP/TAMU Technical and Logistics Support

a. Laboratory Officer

While at sea, the Laboratory Officer is responsible to the Co-Chief Scientists for the direct supervision, performance, and safety of the ODP/TAMU technical staff (Marine Technicians, Computer System Manager, Curatorial Representative, and Electronics Technicians) in the collection of core material and recording of data; and for the proper, efficient, and safe operation and maintenance of the ship's laboratories and related equipment. In normal practice he directs these activities in a way consistent with the guidelines and overall priorities, policies, and assignments made by ODP.

b. Marine Technicians

Under the supervision of the Laboratory Officer, the ODP/TAMU Marine Technicians are responsible for the collection, recording, and preservation of core material and scientific data and for the proper operation and maintenance of the ship's laboratories and related equipment. The marine technical staff on board JOIDES Resolution generally consists of a Laboratory Officer, 8 Marine Technicians, 1 Photographer, 1 Yeoperson, 2 Chemists, 2 Electronics Technicians, 1 Computer System Manager, and 1 Curatorial Representative.

3. ODP/TAMU Science Operations: Staff Scientists

In addition to being a member of the shipboard scientific party in his or her field of scientific expertise, while aboard ship the Staff Scientist acquaints scientists with the shipboard facilities and informs the scientific party of the procedures and policies of ODP regarding format and content of data forms and published materials. While on shore, the Staff Scientist serves as the scientific focal point at ODP for all post-cruise activities, organizes a post-cruise meeting of the shipboard scientists to finalize the "Initial Reports" volume of the ODP Proceedings, and serves as a member of the editorial board for review and revision of manuscripts submitted for the "Scientific Results" volume of the Proceedings.

C. Key ODP/LDGO Personnel

1. LDGO Borehole Research Group

Dr. Roger N. Anderson, Director of Operations
914-359-2900 extension 335
Dr. Rich Jarrard, Chief Scientist
914-359-2900 extension 343
Borehole Research Group (BRG)
Lamont-Doherty Geological Observatory
Palisades, NY 10964

LDGO, as the prime logging contractor for ODP, supplies a full suite of geophysical and geochemical services which involve the acquisition, processing, and presentation in usable scientific form of in situ logging measurements to JOIDES scientists. On each cruise a LDGO logging staff scientist sails to assist the Co-Chief Scientists and logging scientist(s) in the design, implementation, and subsequent interpretation of the logging program. Contact BRG for information on shipboard logging and the log analysis center at LDGO.

2. ODP Site Survey Databank

Mr. Carl Brenner
914-359-2900 extension 542
ODP Databank
Lamont-Doherty Geological Observatory
Palisades, NY 10964

The Databank catalogs site-survey and other geophysical data received from site proponents and other donors, and distributes it to JOIDES panels and individuals associated with academic ocean drilling. Individuals seeking information and/or data in support of a drilling proposal (or for post-drilling studies) are encouraged to request data from the ODP Databank.

IV. SHIP DESCRIPTION AND STATISTICS

A. Description of JOIDES Resolution (SEDCO/BP 471)

The vessel used in the Ocean Drilling Program, known as JOIDES Resolution, is a dynamically positioned drilling ship with a length of 470 ft (143 m), beam of 70 ft (21 m), and draft of 27.6 ft (8.4 m). The displacement of the ship is 16,596 long tons. She is a completely self-sustained unit carrying sufficient fuel, water, and stores to enable her to remain working at sea for 70 days without replenishing. Emergency reserves for an additional 35 days are carried on board. On site, she can suspend as much as 30,000 ft (9150 m) of drill pipe and maintain her position in up to 27,000 ft (8200 m) of water. The vessel is capable of operating in air temperatures of -18°C to 43°C and sea temperatures of -2°C to 27°C. Her hull is ice strengthened for navigation in medium ice conditions.

The vessel is of the flush deck type with a forecastle (fo'c'sle) and poop deck (Fig. 2). Forward of the 202-ft (62-m) derrick is a seven-story module (the "lab stack") containing scientific work areas. A 22-ft (7-m) diameter well, the moonpool, is located on centerline amidships under the derrick to provide an area for running drilling equipment to the seabed. Thruster wells are located on centerline forward, on the forward port side, and on the aft starboard side of the vessel, as well as in the ship's skeg. The drilling and thruster wells are free-flooding. Crew accommodations and navigation facilities are located forward; electrical generation, propulsion machinery, and a heliport are located aft. Drilling equipment, machinery, tools, and supplies are located amidships. Subdivision of the hull is provided by nine major transverse bulkheads, two longitudinal wing bulkheads, and an inner bottom.

The drilling, propulsion, and positioning equipment is diesel-electric powered, and twin propellers give her an average cruising speed between sites of 11 kt. Special features of her design particularly valuable for deep-sea drilling include dynamic positioning with a computerized control system and satellite navigation equipment.

B. Dynamic Positioning

JOIDES Resolution's dynamic positioning system employs an acoustic referencing device to maintain the ship over a specific location while drilling in water depths of up to 27,000 ft (8200 m). The positioning system uses 10 retractable thrusters occupying forward, port, and starboard wells and 2 fixed thrusters in the skeg, each capable of producing 22,600 lb (100,525 newtons) of thrust. When operating in conjunction with the main screws of the ship, the thrusters enable her to move in any direction. Four hydrophones are mounted within the hull and continually receive signals transmitted from a sonar beacon on the ocean floor. The signals are fed into a computer that calculates the position of the ship relative to the beacon as based on the delay times of the arriving signals. The computer automatically controls the thrusters and main propulsion unit to maintain the ship's heading and location over the hole. The dynamic positioning system has both computerized and manual controls. Under normal operating conditions, the system can safely maintain the ship at a desired surface location within 2% of water depth.

V. SCIENTIFIC LABORATORY AND DATA-COLLECTION FACILITIES

This section includes brief descriptions of the scientific systems and equipment presently aboard JOIDES Resolution. The labs are set up for continuing routine studies, and some of the equipment is also adaptable to more detailed programs by individual scientists. Questions concerning the availability of specific scientific systems can be addressed to the Supervisor of Technical Support (see Section III.A.4.b). Procurement of items of considerable expense or in limited demand, other than those normally aboard ship, is the responsibility of those wanting to use them.

All proposals for special shipboard experiments must be formulated in writing and are then delegated to the appropriate personnel at ODP. Large-scale experiments that may pervade more than one cruise; involve coordinated activities with other ships, countries, or institutions; or clearly require a major commitment of all ODP departments should be referred to the ODP Deputy Director. Most requests will involve smaller scale, leg-specific shipboard scientific experiments and should be referred to the ODP Manager of Science Operations.

Locations of the laboratories discussed below are shown in Figure 2.

A. Core Laboratory

The core lab is divided into the core entry lab, core splitting room, sampling area, description area, and photo table (sedimentology lab) (Fig. 3). The core splitting room is isolated from the rest of the laboratory. After whole-round core measurements are made, the cores are cut longitudinally into work and archive halves, and core description and sampling are begun.

The sedimentology lab contains separate description and photography tables, as well as bench space and microscope stations. Smear slides are prepared using Isotemp ovens and hot plates under benchtop fume adsorbers. Diverse mounting media are available: Hyrax, Piccolite, Permount, Gum tragacanth, clove oil, a German synthetic Canada Balsam (Eukitt), and Norland Optical Adhesive (U/V light set-up available). Most standard chemicals and lab equipment are available, as well as the following stains and dyes: Methylene blue, Malachite green, Rose bengal, Alizarin Red "S," and Safranin "O."

Standard testing sieves in a variety of mesh sizes and a Labtec laser particle-size analyzer (PSA) are available for grain-size studies. The PSA provides rapid percentage measurements of silt- and clay-sized particles using a focused laser diode light source (0.8 x 2.0 microns) to measure the sizes of individual particles in solution. The PSA can be operated in either of two size ranges: 250-<4 microns and 125-<2 microns, respectively, with eight size intervals measured for each range.

The optical equipment in the sedimentology lab is similar to that available in the microscope lab (see Section V.F.1), and includes two Zeiss standard WL microscopes and two Zeiss SR stereomicroscopes. Oculars, objectives, micrometers, filters, and camera attachments for these microscopes are interchangeable among all the Zeiss microscopes on board. Each microscope is supported by a vibration isolation system.

Core sampling equipment includes stainless steel sampling tools, Felker radial arm saw, drill press with diamond minicorer, heat guns, and heat sealers. Computer terminals are used for direct input of sampling and smear slide data and for printing sample labels.

B. Paleomagnetics Laboratory

1. Introduction

The shipboard paleomagnetics lab is located at the aft end of the core lab on the lab structure's bridge deck (Fig. 3). The paleomagnetics lab is equipped for measurement of magnetic remanence (using the spinner and cryogenic magnetometers) and volume magnetic susceptibility of split (or whole) cores of sediment and discrete samples of sediment and rock. Discrete samples may be demagnetized with alternating magnetic field or thermal demagnetizers. Split archive halves may be AF-demagnetized (using in-line demagnetization coils built into the cryogenic magnetometer) to an intensity limit of 25 mT. Cores may be geographically oriented as they are taken, using the Multishot core orientation tool (see Sections V.B.4 and V.O.2.a). The results of these analyses are thus available for immediate integration with other shipboard data. Shipboard measurements help to reduce the effects on data of alterations such as oxidation, mechanical disturbances, and exposure to high magnetic fields that occur between coring and shore-based sampling.

2. Paleomagnetics Sampling

Hard rock samples are taken with either the minicoring drill presses, producing a cylinder of 2.54 cm (1 in.) diameter, or with the rock saws (including a double-bladed saw), to convenient dimensions. The cylinders may be cut to variable length. Shipboard supplies for sediment sampling are limited to clear plastic cubes with an interior volume of 7 cm^3. Various devices are available for assisting in sampling with these cubes. Other sampling containers (such as U-channels or cubes of a different size) must be provided by the scientist who wishes to use them. All sampling schemes must be cleared with the ODP Curator prior to the cruise.

3. Paleomagnetics Equipment

The Molspin Minispin spinner magnetometer is a basic field unit interfaced with an IBM PCXT-compatible microcomputer for control and data acquisition. The BASIC program for the Minispin executes spin sequences and from the data from each spin calculates declination, inclination, and intensity in mA/m corrected for the volume of the sample. A series of measurements is made on each sample as it is run through a demagnetization sequence. The Minispin can measure both rock and sediment samples up to 2.54 cm (1 in.) cubed in size, with intensities ranging from 0.05 to 105 mA/m. Ordinarily, six separate spin orientations are required to produce an accurate measurement. In general, the processing rate will vary with the NRM intensity and response to demagnetization of the samples from a particular lithologic unit.

The Schonstedt Alternating Field Demagnetizer is used for demagnetization of discrete samples of rock or sediment. The user can select a range of peak fields from 0 to 100 mT.

The Schonstedt Thermal Demagnetizer is used for thermal demagnetization of dry rock samples with a temperature range of 0-800°C.

An Applied Physics Systems Model 520 Portable Triaxial Fluxgate Magnetometer is available to measure ambient fields, with a range of 1 Oe to 10^{-6} Oe. The sensor is small enough to fit into small spaces such as the sample access tube of the cryogenic magnetometer.

The Bartington Magnetic Susceptibility Meter has two sensors: one for discrete samples and a loop for whole core pass-through measurements. The meter has two measurement modes for different sensitivities. An accuracy of 1.0×10^{-6} cgs can be obtained with a 1-s measurement cycle and one of 0.1×10^{-6} cgs with the 10-s cycle using either sensor. This instrument is now part of the Multi-Sensor Track system (see Section V.C.4). This system uses a new 80-mm dual frequency loop (0.47 and 4.70 kHz.)

The 2G 760-R Superconducting (Cryogenic) Magnetometer is used primarily for continuous NRM measurements on archive halves of cores, though these cores may be uniformly demagnetized inside the mu-metal shielding of the cryogenic magnetometer and subsequently measured by the magnetometer. It is calibrated in units of magnetic flux, phi0, and measures in units of mA/m. The cryogenic magnetometer may also be used to measure and demagnetize discrete samples; a control program facilitates these measurements.

The best-shielded instrument is the cryogenic magnetometer, which resides inside three concentric mu-metal cylinders. Its AF coil assembly is also contained within these shields. A superconducting lead shield surrounds the sensing region and maintains an absolutely stable field within. The two Schonstedt demagnetizers and the fluxgate unit in the Minispin are each housed in three nested cylinders. The sample storage cans are cylinders 12 in. in diameter and 24 in. in length.

4. Core Orientation

Using the Eastman-Whipstock Multishot orientation tool (see Section V.O.2), cores may be oriented in situ with respect to the downhole ambient field. This tool requires a special nonmagnetic drill collar as part of the bottom hole assembly, as well as a variety of expendable items to be stocked (film, batteries, etc.) and additional setup time on the part of the technicians. Thus, it is imperative to develop a coring plan that can be discussed at the Co-Chief Scientists' pre-cruise meeting (usually held about 4-6 months pre-cruise), and to decide well in advance of the cruise whether or not to orient cores from a given site. It is also important to provide the technical/ logistics staff with an estimate of the number of cores to be oriented.

5. Data Processing

Initial data acquisition is done by various computers and data are stored temporarily on diskettes. These diskettes are uploaded to the central VAX computer where further processing can take place. Some processing routines have been developed to concatenate files into convenient units and to assign a preliminary sub-bottom depth value to each data point. The VAX is well suited to data manipulation, and plots can be generated easily.

C. Physical Properties Laboratory

1. Introduction

The physical properties lab is located near the core entry doors of the core lab (Fig. 3). The shipboard physical properties program is aimed at monitoring variations and values of physical and mechanical properties of recovered lithologies. Since the properties of sediments and rock change with time after they are recovered, a complete shipboard physical properties program represents the best opportunity to obtain reliable physical properties data from the cores. In addition to providing results for specific physical properties studies, results from this lab are valuable for correlating drilled sequences to seismic reflection and refraction profiles and downhole logging results, and for defining the nature of lithologies derived from distinct geologic settings.

2. Whole Core Section Analyses

A number of physical properties tests require full-round lengths of core sections and therefore must be performed prior to having the core sections split. These tests include whole-section logging for density, porosity, and velocity, thermal conductivity, and vane shear measurements made perpendicular to bedding. Density, porosity, velocity, and magnetic susceptibility of a core section are measured on the Multi-Sensor Track (MST) system. A computer-controlled stepping motor drives a fiberglass core boat through the sensing devices. Bulk density and porosity are determined by measuring the attenuation of a gamma beam through the sample. Compressional-wave (P-wave) velocity is measured while the core section passes between two 500-kHz transducers. Magnetic susceptibility is measured as the core stops in a sensing loop (see Section V.B.3).

The MST was designed to accommodate up to eight sensors, each controlled by its own microcomputer. A master microcomputer controls track movement and coordinates data acquisition of the individual sensor computers and data transferal to the main shipboard VAX computer complex.

3. Whole Round Samples for Consolidation/Triaxial Testing

The GDS Consolidation Testing System measures dynamic properties such as compressibility of nonlithified, undisturbed sediment samples. The system also measures permeability to yield information regarding pore pressure conditions, state of consolidation, and hydrothermal flow rates. These tests are performed on an 8-10-cm sample cut from a whole round core section. The GDS system resides at the ODP shore-based facilities at Texas A&M University, available to visiting scientists. With early notification, the system can be made available for shipboard work at the request of the scientist.

Present JOIDES guidelines approve one 8-10-cm sample per major lithologic unit for consolidation testing. Additional samples may be requested by investigators for consolidation and/or shore-based triaxial testing, but requests must be made well in advance of the cruise. One constant rate of strain consolidation test can be performed in a 24-hour period, so several tests can be completed during a cruise.

4. Split Core Sample Analyses

The physical properties specialists are the first to work with the split core because core desiccation begins immediately after splitting. This procedure applies to both hard rock and sediment cores; samples for routine analyses should be taken immediately after splitting to minimize water loss.

a. Compressional Wave Velocity

The shipboard laboratory is equipped with a Hamilton frame velocimeter to measure velocities parallel and perpendicular to bedding. Velocities of very soft sediments, in high-quality APC cores, can be obtained from continuous P-wave scans. If the sediment is firm enough to trim, sample chunks are measured in the compressional-wave frame. The trimmed faces of the sediment/rock chunk must be flat and parallel, or the measured velocities are too low. A dual-blade trim saw is used for cutting parallel faces of firm to hard rocks.

"Biscuits" of hard sediment are probably representative of the sediment in situ and are easy to sample, but they must be carefully examined and trimmed before measurements are made.

b. Index Properties

The index properties that are determinable with shipboard equipment include bulk density, water content, grain density, porosity, and void ratio. All measurements are made by noting gravimetric-volumetric relationships on wet and dry samples using a programmed, dual-pan Scientech system (weight), an automatic Quantachrome Pentapycnometer (volume), and a freeze-drier. Wet samples are weighed and measured for volume as quickly as possible to prevent desiccation. Then the samples are freeze-dried for approximately 24 hours, re-weighed, and the volume determined. All index properties are calculated from these raw data. The dried material is then used for carbonate analysis and for XRD analysis if requested. Bulk density and porosity of porous, hard lithologies can also be obtained from relationships of sample weights in air and submerged, using an Ohaus triple-beam balance. In basalts, this latter method has yielded better results for the wet-stage volumetric measurement relative to the pycnometer.

Another measure of bulk density and porosity can be made utilizing special 2-min GRAPE counts. Though the GRAPE does not give a direct measurement of density, it has the significant advantage of being insensitive to ship motion. For this analysis, samples initially used for velocity analyses are plastic-wrapped to prevent moisture loss and placed in the scanning GRAPE. Measurements are made parallel and perpendicular to bedding.

c. Vane Shear Strength

Shear strength measurements are made both parallel and perpendicular to bedding. Measurements perpendicular to bedding require inserting the blade into a full-round sample. Measurements parallel to bedding are performed on the split working half on unlithified sediments in areas of minimum disturbance. A Wykeham-Farrance spring-type device and a torque transducer/X-Y plotter system are the two motorized vane-shear strength apparatuses available on board. Generally, once a sediment becomes "biscuited" the vane tests are not meaningful.

Hand-held torvanes are also available for vane shear strength determinations. Adapter heads are used with the torvanes to obtain a wider range of sensitivity.

d. Thermal Conductivity

Thermal conductivity measurements are made using a Thermcon-87 electronics unit box equipped with five sensors. These measurements require temperature drift rates $<0.4°C/min$; thus, most cores need about 2-4 hours to reach laboratory temperature equilibrium.

This measurement is generally performed in whole-round sections using a needle probe in soft lithologies. A half-space needle probe and water bath are used in hard lithologies. Since good contact between the sample and half-space probe is necessary for valid thermal conductivity measurements, it is recommended the sample face be polished prior to testing.

e. Resistivity

Sediment and pore fluid resistivity measurements are attainable for unconsolidated materials. A four-electrode probe inserted into split cores is used to obtain resistivity using a Wayne-Kerr Precision Component Analyzer (Model 6425). Normal operating conditions are 0.5 Vac at 1 kHz. Pore fluid resistivities are measured using another resistivity unit in conjunction with a 0.5 mL teflon cell.

f. Other Measurements

The Physical Properties Specialist is encouraged to expand upon the conventional tests listed above. A liquid limit device and a plate for plastic limits are available for determining Atterberg limits. Hand penetrometers are available for another measure of strength.

D. Chemistry Laboratory

1. Introduction

The chemistry lab is located on the lab structure's fo'c'sle deck (Fig. 4). On most ODP cruises two Chemistry Technicians provide full-time coverage in the chemistry lab and assist shipboard geochemists.

The ODP Chemists' first responsibility is hydrocarbon monitoring. Routinely, a 7-10-cm^3 sediment head-space sample is taken in the section adjacent to the IW sample. This sample is heated to 70°C for 20-30 min and analyzed on the natural gas analyzer (NGA). When gas pockets are detected in the core liner, a vacutainer-type gas sample is taken and analyzed immediately. If no gas is suspected and no gas pockets are identified through the core liner, the only routine sample taken is the headspace sample.

Occasionally coring will continue only after gas analysis results come back from the chemistry lab. If the levels are critical, this information goes directly to the Operations Superintendent so that he, in consultation with the Co-Chief Scientists and Organic Geochemist, may make the final decision on whether to continue drilling.

The Chemists' second area of responsibility is maintenance of the chemistry lab and equipment and collection of routine chemistry data. Scientists may bring along their own equipment and/or analytical programs to be run in conjunction with the ongoing shipboard analyses, but 2-3 months lead time is essential to guarantee the availability of necessary space and supplies. The shipboard scientists may request assistance from the Chemists with these special programs, but this takes second priority to the collection of routine chemistry data.

Some analyses use microcomputers to set parameters and collect data so that transfer to the shipboard computer system is simplified. Other analyses require that the generated data be entered manually into the shipboard computer system for data archiving and formatted plots. Graphics programs are available for sample data reduction and plotting.

2. Gas Monitoring Equipment

Gas monitoring equipment in the chemistry lab includes two Hewlett Packard 5890 Gas Chromatographs and a Carle model 101 GC. The Carle is used for the rapid analysis (less than 5 min) of methane/ethane ratios. One of the 5890s is configured as a natural gas analyzer (NGA) with three chromographic columns which enable hydrocarbon separations as well as stationary gas separations. These gases include oxygen, nitrogen, carbon dioxide, hydrogen sulfide, and hydrocarbons through C_{14}. The second 5890 is a dedicated research GC, unless it is necessary for gas analysis owing to the failure of both the NGA and the Carle. The research GC is fitted with a split/splitless 50-m fused quartz small-bore column. This gas chromatograph is used primarily for hydrocarbon analysis of liquid extracts. If necessary, this GC can be fitted with a single Poropak column for separation of light hydrocarbons. Both 5890s are equipped with a thermal conductivity detector (TCD) and a flame ionization detector (FID) in series, and the Carle GC only operates with an FID.

The GCs are connected to the Lab Automation System (LAS) via an HPIB loop which stores, converts, and integrates data output, and generates a customized report for each analysis. Three HP3393 Integrators are also used to calculate results of each analysis. The LAS is an HP1000 minicomputer and consists of a 600+ CPU and a 28-megabyte Winchester disk. The HP1000 is available for programming using the RTE-A operating system.

3. Carbon Analyzers

The Delsi Nermag Rock-Eval II Plus TOC is a microprocessor-based instrument for whole-rock pyrolysis, used to evaluate type and maturity of organic carbon, calculate petroleum potential, and detect oil shows. It has a printing recorder and an automatic sampler for 24 samples.

Two Coulometrics analyzers are available which produce accurate colorimetric measurements of total and carbonate carbon in sediments. The inorganic coulometer uses hydrochloric acid to convert carbonate to carbon dioxide, which is then back-titrated to a colorimetric endpoint. In the total carbon analysis, the sample is heated to about 1000°C and the resulting CO_2 is back-titrated to a colorimetric endpoint.

A Carlo Erba Elemental Analyzer for carbon, nitrogen, and sulfur complements the elemental and molecular analyses performed aboard ship.

A Halliburton ultraviolet ray box in the core lab produces qualitative analyses of hydrocarbon shows.

4. Interstitial Water Program

Interstitial water core samples are scraped of contamination and placed in a Manheim squeezer apparatus. The squeezer is then placed in one of three Carver hydraulic presses that are capable of 25 tons constant pressure, and squeezed until a sufficient quantity of water is extracted, usually 30 mL from a 500-cm^3 sample. The resultant pore water is filtered into a syringe and prepared for analysis.

First, the water is titrated for a pH/alkalinity determination. This analysis is automated by interfacing a Metrohm 655 Dosimat autotitrator, a Metrohm 605 pH meter, and an HP86B microprocessor.

Titrations of calcium, magnesium, and chlorinity are performed using a Metrohm 655 Dosimat, which is capable of dispensing titrant in microliter amounts.

Colorimetric measurements of ionic concentrations in pore-water samples are conducted on the Bausch & Lomb Model 1001 Spectrophotometer. In a wavelength range of 190-950 nm, analyses can be made of concentrations of nitrate, silica, ammonia, nitrite, phosphate, bromide, and other common pore-water constituents. The spectrophotometer can accommodate a variety of cell types and sizes, facilitating the precise analysis of small (microliter) sample volumes.

A Varian Atomic Absorption Spectrometer (AA) has recently been added to the chemistry lab. The AA is supplied with lamps for analysis of calcium, iron, potassium, magnesium, strontium, sodium, manganese, and lithium.

A Dionex Ion Chromatograph produces sulfate and potassium data with the possibility of automated calcium and magnesium data in the future. The IC uses the patented Dionex system of two-column chemical suppression. It is microprocessor-controlled and attached to the LAS. Its autosampler can hold 56 samples.

5. Associated Lab Instruments

Two balance systems are available in the chemistry lab. A Cahn 29 balance mounted on a gimbaled table is used to measure small sample sizes (from micrograms to 1250 mg). Twin Scientech balances are available for measuring larger size samples (1 mg to 40 g). By employing a method of differential counterbalancing with computer averaging, these balance systems compensate for all but the roughest sea state.

A Labconco 39-port freeze drier is used to remove water from sediment samples. It can hold 39 individual samples of up to 15 cm^3 each, one at each port, or larger sample(s) in the central manifold.

The ship's potable water is further purified by passing through a Barnstead ultra-pure water purifier, to produce both lab and reagent

(>18 ohm/cm) grade waters by osmotic pressure, which is stored in a 100-L reservoir.

Electric agate mortar/grinders and hardened steel ball Spex mill grinders for homogenizing dried sediment samples and a shatterbox for pulverizing basalt or hard-rock samples are all available. Various drying and ashing ovens are available, as are refrigerators and freezers. There are three fume hoods: one is for solvents, the other two are for chemical reactions.

6. Chemicals and Gases

Two hydrogen generators in the chemistry lab supply the GC FIDs. Bottled helium (GC carrier gas) and oxygen are kept aboard the ship. The ship's pressurized air system is available throughout the lab structure and is appropriately filtered.

The chemistry lab contains a complete set of standard lab chemicals: acids, bases, solvents, etc. Since the ODP Technical and Logistics Support Office maintains an up-to-date inventory and can supply additional information about the availability of specific chemicals and supplies, it is suggested that scientists contact this office if any question arises about any procedure or supply. Even though a complete set of standard lab chemicals and supplies is kept aboard ship, it is advisable to check well in advance of a cruise to assure that specific requirements can be met.

E. Paleontology Preparation Laboratory

The paleontology preparation laboratory is located on the fo'c'sle deck (Fig. 4). The paleo prep lab contains equipment and supplies needed to process micropaleontological samples and make slides. Required items not appearing on the list below should be brought to the attention of the ODP Technical and Logistics Support Office well in advance of the cruise departure date. A reasonable effort will be made to obtain such materials, or paleontologists may be advised to bring the items to the ship themselves, provided no item will constitute a hazard in the shipboard environment.

1. Lab Equipment

- 2 ovens
- 3 infrared lamps
- 3 hotplates
- 2 U/V light set-ups
- 2 sonic baths
- 1 sonic probe
- 2 slide warmers
- 2 benchtop fume adsorbers
- 3 filtration systems
- 1 lab glassware washer
- 1 sample splitter

- 1 microsplitter
- 1 centrifuge
- assortment of U.S. standard testing sieves (44-1000 microns)
- sieve cleaning brushes
- beakers, funnels, filters, evaporating dishes, etc.
- glass microslides and coverslips, cardboard micropaleo slides and metal slide holders, slide storage boxes
- slide labels, sample vials, sieve cleaning brushes, stage and eyepiece micrometers, drawing tubes for microscopes
- sable hair brushes, picking trays, England Finder slides, photo supplies, and manual point counters are available from the Lab Officer

c. Chemicals, Mounting Media, Stains and Dyes
- acetic acid, acetone, bromoform, Calgon, formaldehyde, glycerin, hydrochloric acid, hydrogen peroxide, Quaternary "O," sodium hydroxide, sodium pyro-phosphate, toluene, xylene, numerous other types
- Hyrax, Piccolite, Permount, clove oil, gum tragacanth, Eukitt (a German synthetic Canada Balsam), Norland Optical Adhesive
- Methylene Blue, Malachite Green, Rose Bengal, Alizarin Red "S," Safranin "O"

F. Microscope Laboratory

The microscope laboratory (Fig. 4) is for the use of both paleontologists and petrologists. It is equipped with vibration-isolated Zeiss stereo and binocular microscopes and accessories (see below for details). At the start of each cruise, the microscopes are set up with color-coded parts that can be interchanged with other microscopes if necessary; the technician responsible for microscopes will modify the set-ups as requested. Below is a list of additional equipment: specific objectives, oculars, etc.

There are one Zeiss Photomicroscope III, two Zeiss Standard WL microscopes, and three Zeiss stereomicroscopes intended for use by shipboard paleontologists. Also in the microscope lab are one Zeiss Photomicroscope (type III POL) and two standard Zeiss WL petrographic microscopes, with polarizing lenses and accessories for reflected light and optical figure analysis, intended for use by petrologists. All of these microscopes also have interchangeable accessories that are compatible with other Zeiss models, and accept still photographic and video camera attachments.

Two video screen printers are available in the microscope lab: a black-and-white Mitsubishi printer and a color Hitachi printer. These instruments are intended to provide "photodocumentation" of specimens more rapidly and inexpensively than possible with regular photographic techniques. Although the resulting images are not of publication quality, they are valuable for study and interpretation. The Marine Technicians can assist in setting these up on microscopes with the video camera attachments and demonstrating their correct usage.

A shipboard paleontology library is kept in the microscope lab. This collection of texts, journals, and reprints is cataloged in a separate paleontology library catalog and cross-indexed in the main shipboard science library catalog. Although considerable effort has gone into assembling as complete a set of references as possible for biostratigraphic age determination, some important references may still be missing. In particular, paleontologists are advised to bring along their own copies of reprints that are critical to their shipboard work. Efforts to expand the paleontology library holdings are ongoing, and the assistance of shipboard paleontologists in suggesting or contributing additional reference materials greatly benefits future shipboard parties. The Yeoperson can catalog, bind, and add donated materials directly to the shipboard library.

Also available is the computer program Checklist II for IBM PC (paleontology data analysis and graphics).

1. List of Shipboard Optical Equipment

a. Optical Equipment for Paleontology

<u>Zeiss Standard WL microscope</u>

Set up for standard, phase contrast or Nomarski differential interference contrast microscopy with the following objectives (all with DIC adapter ring): PH2 25X Neofluar, PH3 63X Neofluar, PH3 63X Planapo, 63X Planapo, 100X Planapo.

<u>Zeiss Standard WL microscope</u>

Set up for standard, phase contrast or Nomarski differential interference contrast microscopy with the following objectives (all with DIC adapter ring): 10X Neofluar, PH2 16X Plan, 25X Plan, PH2 40X Neofluar, PH3 63X Neofluar.

<u>Photomicroscope III</u>

Set up for standard, phase contrast or Nomarski differential interference contrast microscopy with the following objectives (all with DIC adapter ring): 40X Planapo objective, PH2 40X Neofluar, PH3 63X Neofluar, 63X Planapo, 100X Planapo.

<u>Zeiss SR Stereomicroscopes</u>

Set up for reflected light microscopy with the following features: 10X wide oculars, standard and F=50 objectives, black and white stage, glass stage, fiber light illuminator.

b. Optical Equipment for Petrography

<u>Zeiss Photomicroscope III</u>

<u>Zeiss Standard WL Microscope</u>

Set up for transmitted or reflected light microscopy with: rotary polarizer and rotary analyzer; 2.5 Plan, 10X Pol, 25X Neofluar, 40X Pol, and 63X Neofluar objectives; epi-condenser (incident light attachment); 4X Epiplan, 8X Epiplan, 16X Epiplan, and 40X Epiplan objectives.

Zeiss Standard WL Microscope

Set up for transmitted light microscopy with: rotary polarizer and rotary analyzer; 2.5 Plan, 10X Pol, 25X Neofluar, 40X Pol, and 63X Neofluar objectives.

c. Additional Equipment

- oculars: S-KPL 10X/20, KPL 10X wide, and KPL 16X/12.
- eyepieces: KPL 16X and KPL 25X focusing stereo eyepieces.
- objectives: 3.2X Plan (Pol), 10X Pol (Achromat), 16X Epiplan (dry), 16X Neofluar, 25X Neofluar (Pol;dry), PH2 25X Neofluar, 40X Pol (Achromat), 63X Achromat (Pol;dry), and 100X Pol.

G. Thin Section Laboratory

The thin section laboratory (Fig. 4) has been outfitted to make thin sections by traditional methods as well as to provide quantity output. When only one or two thin sections are required, they are made "by hand" using a Buehler Petro-Thin thin-sectioning system and thin-section grinder. When large batches of thin sections are requested, the Logitech LP-30 lapping machine can be used to produce approximately 200 high-quality thin sections in a 40-hour week, in batches of 40 at a time. The sections are polished on a Logitech WG-2 polishing system. Special support equipment in the thin section lab includes a Logitech CS-10 thin section cut-off saw and IU-20 impregnation unit used to impregnate porous or friable specimens with synthetic resins. Delicate or critical samples are cut on a Leco VC-50 Vari-speed diamond saw. A Zeiss standard WL binocular microscope is available in this lab for monitoring slide preparation.

H. XRF and XRD Laboratory

1. Introduction

The X-ray laboratory, on the lab stack's fo'c'sle deck (Fig. 4), contains state-of-the-art equipment chosen for its stability in a shipboard environment. Use of the lab is planned at the Co-Chief Scientists' pre-cruise meeting; the Lab Officer, with guidance from the Co-Chief Scientists, assigns technical support to this lab as required to meet the scientific goals of the cruise.

2. X-ray Fluorescence

An Applied Research Laboratory 8400 hybrid spectrometer is used for X-ray fluorescence analysis. This instrument is fully microprocessor-controlled with auto-sample loading. It has an end-window Rhodium X-ray tube, a 60 kV generator, and two independent goniometers with scintillation, flow proportional (P-10), and sealed Kr detectors. The following analytical crystals are available: LiF 200, LiF 220, LiF 420, PET, TLAP, and GE. A DEC Micro-11 computer with a 28-megabyte Winchester disk drive supports the ARL-8400. Software includes quantitative, qualitative, statistical analysis, and fundamental parameters (XRF-11) programs.

3. X-ray Diffraction

A Philips ADP 3520 is used for X-ray diffraction analysis. It is fully microprocessor-controlled with auto sample loading, and is configured with a Cu X-ray tube and monochromator. A second DEC Micro-11 computer with 28-megabyte Winchester disk drive supports this system. Software support includes quantitative, qualitative, search-match of JCPDS and user data bases, line profile analysis, and statistical analysis programs.

4. Sample Preparation Equipment and Supplies

a. Grinders
- shatter box (tungsten-carbide)
- auto-mortar and pestle (agate)
- mixer-mill (steel)

b. Fusion Devices
- Claisse fluxer-bis (Au-Pt crucibles)
- programmable ashing furnace

c. Chemicals
- flux: 80% lithium tetraborate, 20% lanthanum oxide
- boric acid (powder)
- $NaNO_3$ (powder)
- NaI
- organic liquid binder

I. Shipboard Computer System

1. Introduction

JOIDES Resolution is equipped with a research-oriented computer system designed to perform routine clerical and arithmetical tasks in order to free scientists and technicians for more creative research activities. The super-mini VAX and peripheral equipment, the Computer System Manager's office, and a computer users' area with computer terminals, study carrels, and work tables are all housed on the lab structure's new main deck (Fig. 5).

The central computer system assists in performing such diverse functions as core-log entry, core sampling, data analysis, drill string engineering, presentation graphics, chemistry, inventory control, office automation, and manuscript preparation. This is accomplished through conveniently located microcomputer workstations arranged in a distributed processing architecture. A central theme in the design of the shipboard system was the offloading of common tasks onto the workstations for more efficient use of the central system. This type of computer system architecture minimizes the possibility that shipboard operations would ever be delayed by a central system failure. All major system components are backed up with redundant twins or a complete complement of spare parts. The result of this approach is a system which fails gently, with a gradual degradation of performance when individual components fail, in contrast to a system where the demise of any one piece of equipment creates a catastrophic failure.

The central VAX system is configured as a combination of four computers, two VAX 11/750s, and two VAX 3500s, to meet the changing requirements of each cruise. These systems are connected in a clustered environment allowing them to share data and peripheral devices. The 11/750s serve as disk and print servers, offloading these time-consuming tasks from the 3500s. The VAX 3500s provide high-speed computational power and serve shipboard users directly.

The system offers archival storage of shipboard data on 3.5 gigabytes (almost 1 million typed pages) of rapid access mass storage. Among the disk drives providing this storage are both fixed and removable magnetic disks as well as high-density optical disks. In addition, magnetic tape drives are available which are capable of reading and writing 1600-bpi 9-track tapes.

Most of the daily workload is handled on microcomputer workstations. Several workstation configurations are available including IBM-PC-compatible, Apple Macintosh and DEC PRO 350. Each of the workstations is configured for a specific set of tasks. Word-processing stations, for example, are connected to a local dot matrix printer and have word-processing software installed on the system hard disk. Other specialized workstation component lists are included in the Shipboard System Description below. All workstations are connected to the central VAX system for easy transfer of documents and data files.

A networked satellite communications capability allows the shipboard host computer system to access a similar VAX system at ODP headquarters in College Station, Texas. This communications link operates at 2400 bits per second through the Marisat satellite communications system. Capabilities of the system include access to scientific data from past cruises, shipboard inventory control, and electronic mail.

2. Shipboard System Description

a. Host system
- VAX 3500 CPU with 16 meg RAM
- VAX 11/750 CPU with 14 meg RAM memory
- 3.5 gigabyte mass storage (1 million typed pages)
- Magnetic tape drives (1600 bpi)
- 48 port asynchronous communications capability
- 2400 baud asynchronous satellite communications link
- Redundancy in all major system components
- 48 line terminal server (ethernet)
- Local area VAXcluster environment

b. Workstations
- Word-processing stations

- IBM-PCXT compatibles (23)
- Dot matrix printer
- Core sampling stations (2)
  - PRO 350 microcomputer (hard disk)
  - Dot matrix printer
  - Sample bag printer
  - Sampling station interface
- Data acquisition stations (5)
  - PRO 350 microcomputer (hard disk)
  - Real time interface
- Graphics CRT (10)
- Macintosh Plus
  - external floppy (400K)
  - internal floppy (400K)
  - Imagewriter printer
- Macintosh SE (2)
  - one internal floppy (800K)
  - one internal hard disk (20 meg)
- Macintosh II (2)
  - two internal floppy (800K)
  - one internal hard disk (40 meg)

c. System peripherals
- Laser printers (2)
- High-speed printer/plotter (2)
- 36-in. drum plotter (1)
- Letter-quality printers (2)
- Apple Laserwriter IINT

d. Software
- VAX VMS operating system
- P/OS operating system (PRO 350)
- BASIC
- COBOL
- FORTRAN
- PASCAL
- DATATRIEVE (relational database)
- System 1032 (relational database)
- WordPerfect (word processing)
- MS DOS 3.2
- Checklist II (paleontology data analysis and graphics)
- RS/1 (data analysis and graphics)
- IMSL (statistics)
- Minitab (statistics)
- 20/20 (spreadsheet)
- BLAST (communications)
- SMOOTH (navigation plotting)
- SAS (statistics)
- DI-3000 (graphics)
- Picsure (presentation graphics)
- CORELOG (coring inventory)
- SAM (core sampling)

- SLIDES (smear slide description)
- CHEMDB (chemistry database)
- PHYSPROPS (physical properties database)
- MATMAN (inventory control)
- Data Acquisition (GRAPE, etc.)
- Cruise Logistics
- Macintosh OS V5.0 (list of additional software for Macintosh is available from System Manager)

e. Computer subsystems
- Underway Seismic
  - Masscomp UNIX system
  - Underway interface
- Gas Chromatography
  - HP Lab Automation System
  - A/D interfaces
- X-ray Lab
  - XRF Micro-11 system
  - XRD Micro-11 system

f. Functions to be assisted or performed
- Navigation
- Coring records
- Core sampling
- Underway geophysics
- Geochemistry
- Archival data storage
- Drill string engineering
- Data acquisition (physical properties, paleomagnetics, smear slides)
- Presentation graphics
- Inventory control
- Data analysis
- Office automation
- Manuscript preparation and tracking

g. DSDP data available on *JOIDES Resolution*

All computerized data generated from Legs 1 through 96 of the Deep Sea Drilling Project (DSDP) are available for use on *JOIDES Resolution*. The DSDP data are stored in System 1032 (S1032), which is a database management system used by ODP.

J. Science Offices

Ample work space for scientists is provided on *JOIDES Resolution*. Each lab contains desks and tables for use when working directly with core material and analytical equipment. In addition, the science library on the ship's main deck, and the computer users' area and science lounge on the lab structure's new main deck, contain tables, easy chairs, computer terminals, and carrels for data compilation, writing, study, and reading (Figs. 5, 6). A portable light table is set up in the science library. Basic drafting supplies are stocked aboard ship; scientists must provide their own specalized drafting equipment.

The Yeoperson's and Curatorial Representative's offices are located in the lab stack on the new main deck. Prime data files are kept in these offices. On the ship's bridge deck are the Co-Chief Scientists', Staff Scientist's, Laboratory Officer's, and Operations Superintendent's offices.

K. Science Library

The shipboard library is located on the fo'c'sle deck in the forward part of the ship (Fig. 6). This collection of more than five hundred volumes contains basic reference works, ODP Proceedings volumes, a set of DSDP Initial Reports, Hole Summaries from recent legs, geologic and bathymetric maps, and selected monographs covering various aspects of geology and oceanography. In addition, at the beginning of each cruise, collected reprints relating to the cruise objectives are added to the library. These materials are intended to provide the necessary resources for shipboard analysis of drilling results.

All scientific library materials are cataloged and shelved according to U.S. Library of Congress call numbers. Scientific books and other research items are primarily for use in the library. A simple checkout system is provided for materials that must be removed to other parts of the ship. Used materials returned to the library are reshelved by the Yeoperson.

A separate paleontology library housed in the microscope lab is cross-indexed in the main shipboard science library card catalog.

Other library facilities include 10 study carrels, a large map/chart table, microfiche and microfilm readers, a computer terminal, a copying machine, and a portable light table.

L. Photographic Laboratory

1. Introduction

The primary function of the shipboard photographic lab is to document the cores while they are fresh. In addition, the Photographic Technician is responsible for core closeups meant for publication and hole summaries, seismic profile copywork, documentation of shipboard equipment and procedures, and public relations photography. The processing of photomicrographs, X-radiographs, and cruise-related personal copywork is accomplished on a time-available basis.

2. Labs and Equipment

A comprehensively equipped photographic lab is on the upper 'tween deck (Fig. 7). The Photographic Technician is in sole charge of this lab, and no other personnel are allowed to use its equipment. The darkroom has facilities for black-and-white developing and printing (both manually and with the Kreonite Print Processor) and for E-6

Ektachrome color film developing using a Wing-Lynch Film Processor. There is an MP4 copystand for seismic profile and document copying. Public relations photographs and other special photographic projects are performed with still camera systems and a video camera.

In the core lab, an area is set up for core photography of the archive halves of each core. This table is equipped with a 4- x 5-in. overhead-mounted view camera for black-and-white and color sheet film. There is also an MP4 copystand with 4- x 5-in. and 35-mm cameras for core closeups.

The binocular microscopes available in the core lab and the microscope labs have Polaroid and 35-mm camera attachments. Black-and-white film is supplied by the Photographic Technician and 35-mm film development is done on a time-available basis. Finally, scientists making X-radiographs of core sections have these developed in the darkroom.

M. Electronics Shop

The Electronics Shop, located on the upper 'tween deck (Fig. 7), is operated by ODP Electronics Technicians (ETs), who are responsible for maintaining and repairing all shipboard ODP electrical equipment.

N. Second-Look Laboratory

The second—look lab is located on the lower 'tween deck outside the core locker (Fig. 8); scientists can use this lab to carry out further descriptive work after cores have been removed from the core lab and stored in the refrigerated locker. The lab is equipped with a table for core description, a binocular microscope, a hotplate for smear slides, basic supplies, and a computer terminal for data entry and comparison purposes.

O. Downhole-Measurements Laboratory

The downhole-measurements lab is located atop the laboratory structure (Fig. 2). It contains the LDGO-operated logging control room and lab, and space for the ODP downhole instrumentation (Fig. 9).

1. LDGO Wireline Logging Program

According to JOIDES policy, all holes deeper than 400 m sub-bottom penetration and all holes that penetrate into basement rocks are logged with a standard suite of wireline logs. Logging facilities aboard JOIDES Resolution are provided by the Borehole Research Group at Lamont-Doherty Geological Observatory, with a prime subcontract to Schlumberger. Geophysical log data are recorded using probes that are lowered on the end of a wireline through the drill pipe and into the previously drilled borehole. The depth at which the measurements are made is determined primarily by measuring the length of cable run into the hole. The Schlumberger logging tools can be stacked in certain combinations so that several types of measurement can be made on each lowering. Because much of the analysis of wireline logs depends on the ability to compare at each depth the results from different lowerings of the various tool combinations, each combination includes some form of gamma-ray detector; in general, different logging runs can be depth-shifted using this common measurement. Each specialty log is recorded during a separate lowering. Log data are usually recorded whenever the logging sonde is moving in the open hole, both descending and ascending. Data are usually recorded at half-foot (0.15-m) intervals in the borehole.

The Schlumberger logging tools, run in the ODP boreholes by a Schlumberger engineer, are combined into multiple-tool strings for efficient operations. At present, three standard tool combinations are in operation: the seismic stratigraphic, the litho-porosity, and the geochemical combinations. Some of the more sophisticated post-processing and analysis cannot be accomplished without data from all three lowerings.

Following are descriptions of the most commonly run logging tools and tool combinations:

a. Seismic Stratigraphic Combination

Includes the digital sonic (SDT), phasor induction (DITE), natural gamma spectrometry (NGT), and caliper (MCD) tools. Its value to seismic stratigraphy is that it directly measures compressional-wave sound velocity and indirectly measures the two variables that most often affect velocity: porosity and clay mineral percentage.

b. Litho-porosity Combination

Includes natural gamma spectrometry (NGT), lithodensity (LDT), and compensated neutron (CNT-G) tools. This combination provides measurements of formation porosity and density as well as an estimate of the proportions of the primary radioactive elements (U, K, and Th).

c. Geochemical Combination

Includes natural gamma spectrometry (NGT), induced gamma ray spectrometry (GST), and the aluminum clay tool (ACT: a second NGT paired with a Californium-source CNT-G neutron tool). Its value to geochemistry comes from its ability to measure relative concentrations of 11 elements: silicon, calcium, iron, sulfur, aluminum, manganese, hydrogen, chlorine, potassium, thorium, and uranium.

d. Dual Laterolog

Induction logging probes do not produce reliable results in highly resistive formations such as oceanic basalts. The Schlumberger Dual Laterolog (DLL) provides the deeper measurement of resistivity into the rock with high precision at high resistivities. This tool is also used for determination of the relative abundance of horizontal and vertical fractures.

e. Magnetometer/Hole Orientation

An additional measurement cartridge (the GPIT) can be included in the string of the litho-porosity or geochemical combinations to determine hole azimuth and deviation and the vector components of the magnetic field. Although this device is not oriented gyroscopically, magnetic field inclination can be measured accurately. The device also monitors vertical and horizontal accelerations applied to the logging probe and thus can be used to determine the effects of ship heave on the logging run.

f. Well Seismic Tool (WST)

This is a well-bore clamped single-component geophone used to record vertical seismic profiles in a borehole. It provides a measure of formation velocity at seismic frequencies by measuring the traveltime between a surface seismic shot and the well-bore geophone, useful in depth correlating reflectors on nearby seismic lines. The WST is not used routinely aboard ship.

The LDGO Borehole Research Group owns two types of logging tools that are run by the LDGO Logging Scientist:

g. Borehole Acoustic Televiewer

An acoustic beam scans horizontally around the circumference of the borehole wall as the tool is moved vertically. Televiewers are very sensitive and can outline quite small features such as fractures, vugs, or other large-size porosity and bedding planes. They are used to detect and evaluate fractures and bedding intersecting the borehole wall.

h. Multichannel Sonic Log

The complete waveform of the acoustic or sonic signal is recorded by the MCS log at each of 12 receivers spaced 15 cm apart. Subsequent waveform analysis allows determination of the velocities of shear waves, compressional waves, and Stoneley wave modes, as well as their energy and frequency content. Thus, various elastic properties of the formation can be estimated.

Many other measurements that have been made in boreholes on land have been obtained in ODP boreholes for use by members of the scientific party of various legs. These include long-spaced resistivity, precision temperature, magnetic susceptibility, and gyroscopically oriented vector magnetic field.

Shipboard scientists sometimes bring specialty logging equipment on board to run experiments at particular sites. Software is available to permit data acquisition on the LDGO logging computer. Several restrictions should be noted by prospective logging investigators. These include the TAMU weight restriction (minimum weight of 100 lb floating for uncentralized tools and 200 lb floating for tools with centralizers), the limitations in cable speed (100 m/hr lower limit), the specifications of the cable (7 conductors, 170-ohm line resistance, Gearhart-Owens cablehead or a compatible pigtail), the determination of depth (500 ppf quadrature signal), and a limited amount of space available for staging the log and recording data.

Planning for specialty logging by individual shipboard scientists must begin as early as possible, but not later than the Co-Chief Scientists' pre-cruise meeting, held at ODP about 4-6 months before the cruise departure date. Both the ODP Engineering and Drilling Operations Department and the LDGO Borehole Research Group must be notified of the particulars of such planning during or prior to the pre-cruise meeting.

LDGO has established two logging interpretation centers to collect and analyze ODP well-log data, one on the ship and one at LDGO. The shipboard logging facility is a rapid analysis combination of uphole recording, playback, and cross-correlation software designed for real-time assistance in geological interpretation while still on the drill site. The logging facility at LDGO is a more elaborate facility where interested scientists can work on seismic spectra, chemical alteration, lithologic variation, fracture distribution, porosity changes, etc.: in sum, an entire array of scientific cross-correlation software designed to return maximum scientific results from the ODP logging program.

2. ODP Downhole Tools

While LDGO manages and supervises routine downhole instruments using the logging wireline that is connected to either the Schlumberger computer or the LDGO computer, ODP is in charge of other downhole instrumentation--that is, equipment on the sand line, core lines, hydraulic piston core, etc. The downhole tools that ODP/TAMU provides are described in detail in ODP Technical Note 10 (A Guide to ODP Tools for Downhole Measurements, by Keir Becker).

a. Magnetic Azimuth Core Orientation System Using the Advanced Hydraulic Piston Corer (APC)

The magnetic orientation system used with the APC hydraulic piston corer was developed to take advantage of the nonrotary nature of piston coring in soft sediments. The core orientation system provides a magnetic reference azimuth for each core as well as a measurement of deviation from vertical and the azimuth direction of the nonverticality--that is, the angle of the hole at the specific location of the core in question and which way it is pointing.

The decision to obtain oriented piston cores from a given site should be made at the pre-cruise Co-Chiefs' meeting, and in any case must be made before the bottom hole assembly (BHA) is made up and the pipe run in the hole at the site. The 30-ft nonmagnetic drill collar must be included in the BHA just above the bottommost drill collar (also known as the outer core barrel). Planning for oriented piston coring must also take into account the fact that Multishot handling and delay time add 5-10 min per core to normal operating time while piston coring.

b. Formation Packers

The TAM drill-string straddle packer is operated by ODP and is generally available for use in reentry holes that penetrate stable formations. It is designed to be a weight-bearing part of the drill string, and has two hydraulic seals with which the zone between or below the seals can be tested. The original TAM straddle design was modified in consultation with ODP engineers to allow maximum flexibility for ODP use. By assembling it in the drill string with or without certain parts, it can be used in four possible modes, all of which are resettable: (1) as a single-element packer, (2) as a double-element double-strength single packer, (3) as a straddle packer, and (4) as a straddle packer with the option to separately test the straddled interval or the interval below the lower element (to total depth).

The TAM rotatable packer is a single-element drill-string packer with rotational capability, which means that it can be included as part of a rotating, coring BHA. It differs from the straddle packer in that the rotatable packer has a much stronger, thicker walled internal mandrel to withstand both the torque and compressive loads of drilling, a plumbing system that will permit cuttings to be circulated away without inadvertently inflating the packer element, and a more complicated go-devil and control sub. Both packers are compatible with the same set of downhole pressure recorders, and both are fully compatible with logging.

The ODP packers are not kept aboard ship. Planning for their use must be developed early in the formation process of cruise objectives. More detailed information about packers can be found in an appendix to the LDGO Borehole Research Group's Wireline Logging Manual, entitled "Drillstring Packers in the Ocean Drilling Program," by Keir Becker (also printed in shorter form in JOIDES Journal, 12(2): 51-57, 1986).

c. In Situ Pore Water Sampler and Temperature/Pressure Measurement Instrument (WSTP)

A completely new version of the "Barnes" in situ pore water sampler has been developed and will soon be in use. The prototype of the original sampler was first used on DSDP Leg 47B and was carried over for use on early ODP legs. The new instrument integrates water sampling plus temperature and pressure measurements and could accommodate additional measurement functions in the future. It has been adapted for open-hole fluid sampling as well as in situ filtration from sediments at the bottom of the hole. The tool is lowered down the drill pipe on the sand line, and the filter probe extends more than 1 m beyond the end of the drill bit.

d. Probeless Pore Water Sampler

The Probeless Pore Water Sampler (PWS) comprises a WSTP tool modified to be used in conjunction with the inflated ODP rotatable drill-string packer. Development of this mode of sampling has been suspended until the rotatable packer is proven, but it may also be feasible with the reliable drill-string straddle packer.

e. Kuster Sampler

The Kuster Sampler consists of a bottle with an inlet valve, two nonreturn valves, a locking device, and a mechanical clock. In operation, the clock is wound and the tool is lowered into the open hole on the coring line. When the clock reaches the programmed sampling time, it releases the locking mechanism, thereby allowing the inlet valve to open and the sample chamber to fill. When the tool is retrieved, the pressurized sample must be released using a special extractor body. There is no standard valve/hose system, and a custom system may need to be constructed for each leg, depending on factors such as anticipated sample pressures, requirements to preserve dissolved gases, etc. It is the responsibility of the Co-Chief Scientists, in consultation with participating fluid chemists, to specify any special requirements for such a sample extraction system at the pre-cruise meeting.

f. Kuster Pressure Gauge

Downhole pressures can be measured using several kinds of recorders. At present, ODP maintains three self-contained mechanical model K-3 recorders made by Kuster Co., calibrated for three different pressure ranges (0-9950, 0-11,900, and 0-15,275 psi), and which can be set to record for 3, 6, or 12 hours. The resulting charts must be read using a calipered, microscopic chart reader, one of which is kept at the University of Miami.

g. Temperature Measurement Tool (APC Heat Flow Shoe)

A self-contained temperature recording device is under development for use with the hydraulic piston corer. The standard single cutter shoe/core catcher is replaced on data runs by a special two-piece assembly. Pressure-tight pockets in the wall of the shoe contain a small thermistor/electronics package and a battery. Temperature data are recorded (at pre-set time intervals) throughout the core run. About 5 min of penetration is required for partial equilibration after actuation of the corer and before retrieval commences. On recovery, data may be read directly, plotted by computer, and extrapolated to estimate in situ temperature accurately.

h. Other Engineering Tools

A series of tools is used by the ODP Engineering and Drilling Operations Department to monitor and improve drilling capabilities on the ship. These tools are deployed when they can be fit into normal operations in order to increase the quantity and quality of baseline data. These data provide information on actual accelerations at the bit during coring or other selected operations, and drill-pipe stresses including binding, tension, and torque. The shipboard-mounted Ship Motion Data System, a vertically stabilized gyro sensor package, gives continuous data on roll, pitch, and heave of the ship, and this information correlates with the downhole tools' data. Dedicated shipboard programs using these tools can impact scientific time allotments, but information gained is used to verify analytical computer model predictions of fatigue and stress and provides ODP with guidelines on safe drill-string operating limits.

P. Underway Geophysics Laboratory (Fig. 10)

1. Navigation Data Recording

A Magnavox 1107-GPS combination Transit and Global Positioning Satellite Navigator, equipped with a rubidium frequency standard, allows navigation during selected time intervals using only two GPS satellites. A Magnavox MX 4400 GPS receiver is on the ship's bridge. Other navigational equipment on the bridge includes a Magnavox MX702A Transit Receiver, and Decca and Loran C positioning systems. An additional survey-quality Loran C unit is in the underway lab.

Complete GPS and Transit position and status data are stored on a disk file at an operator-selected interval, independent of the shot interval. The operator can switch to a new file at any time, allowing the old file to be archived on floppy disk or tape, or to be sent to the main computer (VAX) where it is stored and later sent to a pen plotter to generate navigation plots.

A "SMOOTH" program was developed by the ODP Computer Group to plot the navigation on board. SMOOTH accepts GPS, Transit Satellite, course, and speed changes and produces a sorted file of updated fixes. These fixes are plotted with respect to time; the operator can delete bad fixes from the file or manually input fixes obtained from any other positioning system. Fixes collected while on site are averaged and a single point is plotted for the site. The edited file then passes through a smoothing fit algorithm that produces coordinates for drawing a ship's track. Finally the "smooth" track is plotted in a device-independent format. The user can choose the scale of the plotting and a wide variety of projection systems.

Navigation plots are produced after each transit and each site survey by the Marine Technician in charge of the underway geophysics lab, if so directed by the Laboratory Officer and Co-Chief Scientists.

2. Bathymetric Data Recording

For collecting bathymetric data, both 3.5-kHz and 12-kHz Precision Depth Recorder (PDR) systems are available aboard ship. A Raytheon PTR105B transceiver and 12 Raytheon transducers are used to gather 3.5-kHz data; another PTR105B transceiver and an EDO 323B transducer are used to gather 12-kHz data. Two Raytheon LSR1807M recorders are used for display. The 3.5-kHz and 12-kHz systems normally operate with CESP-III Correlators that give approximately a 20-dB signal-to-noise improvement over the standard system.

Owing to previous difficulties in obtaining a good bathymetric signal at speeds greater than 8 kt, a sonar dome was attached to the ship's hull. The sonar dome contains 2 12-kHz transducers and an array of 12 3.5-kHz transducer bottles. The sonar dome is designed to extend far enough below the ship's hull to escape the noise created by air bubbles along the hull/seawater interface.

3. Magnetic Data Recording

Magnetic data at a density of one reading per seismic shot are recorded in the header of seismic tapes. These data are collected using a Geometrics 801 proton precession magnetometer and displayed on a strip chart recorder.

4. Single-Channel Seismic System

a. Sources

The standard seismic sources used aboard JOIDES Resolution are two 80-in.^{2} Seismic Systems, Inc. water guns. One 400-in.^{2} SSI water gun is also available. The following air guns are available on board: one Bolt 1500-C with chambers of 120 or 300 in.^{2} and three Bolt 600-A with firing chambers that can be varied from 5 to 80 in.^{2}.

b. Streamer-hydrophones

Two Teledyne streamers are mounted on winches on the fantail. They each contain sixty hydrophones, are 100 m long, and can be towed up to 500 m behind the ship; the towing depth can be maintained by external depth depressors (birds). Streamer output is transformer coupled to the ship via the tow cable. The hydrophone elements are combined to produce a single signal. A 10-Hz low cut filter is inserted between the streamer and the rest of the electronics to reduce high-amplitude low-frequency noise which might overload the amplifier.

c. Data Recording

The seismic system operates independently from the main computer system (VAX), using a Masscomp 561 super-microcomputer as the central unit to record, process, and display the data. Data are processed and displayed in real time on a 15-in.-wide Printronix high-resolution graphic printer (160 dots/in.). The raw data are recorded on tape; processed data can also be displayed on a 22-in.-wide Versatec plotter that gives a higher resolution display (200 dots/in.).

Raw seismic data are also displayed in real time in analog format on two Raytheon LSR1807M recorders, using only a streamer, Ithaco amplifier, and Khron-Hite filter. This analog mode would be the primary recording mode should irreparable equipment failure preclude digitizing.

The software and interfaces of the various components of the ODP shipboard seismic system were developed at the University of Texas at Austin in close cooperation with ODP staff. The software package includes the following processing/reprocessing modules: Input Data (Trace Edit), Output Data (disk file, or SEG-Y format tape), Display (Printronix or Versatec), Band-pass Filter, Automatic Gain Control (AGC), Trace Autocorrelation, Mutes (seafloor), T-Gain, Trace Equalization, and Time Window. The seismic system was designed to allow for other scientific experiments such as vertical and oblique seismic profiling.

VI. ADDITIONAL ODP RESOURCES

A. ODP and DSDP Databases

The ODP databases currently available include all DSDP computerized data files and core photos (Legs 1 through 96), and geological/ geophysical data and core photos collected by ODP from Legs 101-124 (check with the ODP Data Librarian for updates; see Section III.A.3.d).

Most data collected by ODP are available as paper and microfilm copies of the original paper forms collected aboard JOIDES Resolution. Underway geophysical data are on 35-mm continuous-roll microfilm. All other data are on 16-mm microfilm.

All DSDP data and most of the ODP data are contained in a computerized database; details can be obtained from the ODP Data Librarian. Computerized data are currently available on hard-copy printouts, on magnetic tape, or through the BITNET network. These data can be searched on almost any specified criteria related to the database. All data files can be cross-referenced so that a data request can include information from more than one file. For example, a customized search could be done to locate all samples (from DSDP and ODP legs) taken in the Indian Ocean with $CaCO_3$ content greater than 55% and a quartz component greater than 10%.

Photos of the cores and seismic lines collected by ODP and DSDP are also available. Seismic-line, whole-core, and closeup photos are available in black and white 8- x 10-in. prints. Whole-core 35-mm slides are also available.

The following can also be requested: (1) ODP Data Announcements, which contain information about the ODP database; (2) Data File Documents, which contain information about specific ODP data files; (3) ODP Technical Note 9, Deep Sea Drilling Project Data File Documents, which includes all the DSDP data-file documents. To obtain data or additional information, please contact the ODP Data Librarian (see Section III.A.3.d). Small requests can be answered quickly and free of charge. If a charge must be made to recover expenses, an invoice will be sent and must be paid before the request is processed.

B. Data Available from the National Geophysical Data Center (NGDC)

DSDP data files can be provided by NGDC in their entirety on magnetic tape according to user specifications. NGDC is also able to provide researchers with a full range of correlative marine geological and geophysical data from other sources. NGDC will provide a complimentary inventory of all data available on request. Inventory searches are custom tailored to each user's needs (i.e., geographic area, parameter measured, etc.).

Information from the DSDP Site Summary file is fully searchable and distributable in PC-compatible form on floppy diskette, as well as in the form of computer listings and graphics, and magnetic tape. NGDC is working on making all of the DSDP data files fully searchable and available in PC-compatible form. Digital DSDP geophysical data are fully searchable and available on magnetic tape.

In addition to the DSDP data files, NGDC can also provide analog geological and geophysical information from DSDP on microfilm. Two summary publications are available: (1) "Sedimentology, Physical Properties, and Geochemistry in the Initial Reports of the Deep Sea Drilling Project volumes 1-44: An Overview," Report MGG-1; (2) "Lithologic Data from Pacific Ocean Deep Sea Drilling Project Cores," Report MGG-4.

Data Announcements describing each DSDP data set in detail are available on request at no charge. For additional information on data availability, costs, ordering, etc., please contact:

Marine Geology & Geophysics Division
National Geophysical Data Center
NOAA E/GC 3 Dept 334
325 Broadway
Boulder, CO 80303
(303) 497-6338 (or FTS 320-6338)

C. Bibliography of the Ocean Drilling Program

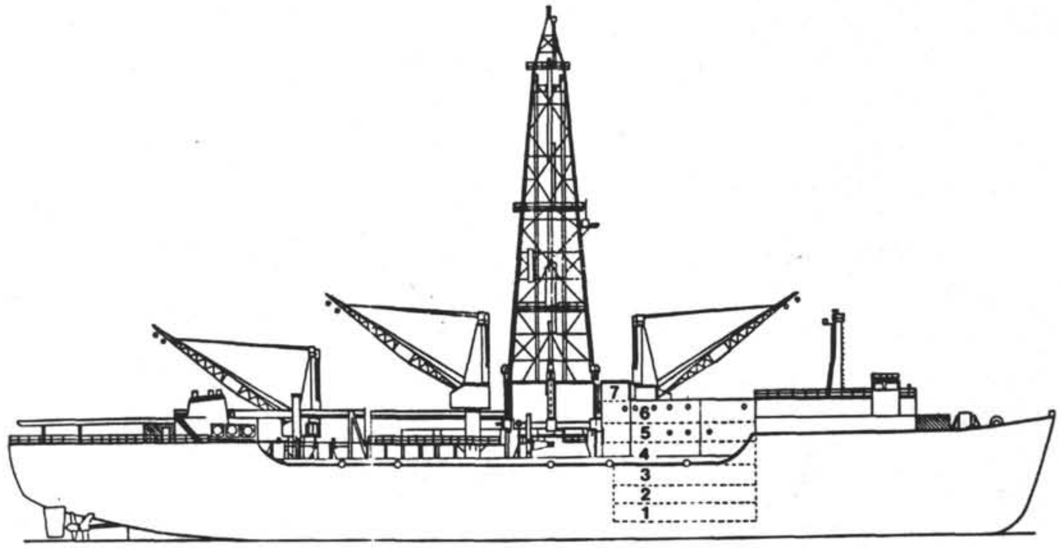
The following publications are available from the Ocean Drilling Program (contact the Publications Distribution Specialist; see Section III.A.6.d):

<u>Proceedings of the Ocean Drilling Program, Initial Reports</u> (for each leg)
<u>Proceedings of the Ocean Drilling Program, Scientific Results</u> (for each leg)
Scientific Prospectuses (for each leg until the "Initial Reports" volume is published)
Preliminary Reports (for each leg until the "Initial Reports" volume is published)
ODP Technical Notes (listed below)
ODP Sample Distribution Policy
Instructions for Contributors to the <u>Proceedings of the Ocean Drilling Program</u>
A User's Guide to the <u>JOIDES Resolution</u> Computer System

Available from the ODP Coordinator of Public Information (see Section III.A.1.c) are a number of informational brochures as well as reprints of leg-specific articles from <u>Nature</u> and <u>Geotimes</u>, and an ODP poster showing the drilling vessel <u>JOIDES Resolution.</u>

Available from the Borehole Research Group, Lamont-Doherty Geological Observatory, Palisades, NY 10964, is their "Wireline Logging Manual."

Figure 1.



Deck 6 : Bridge Deck
- Core Entry Lab
- Physical Properties Lab
- Paleomagnetics Lab
- Core Splitting
- Core Description and Sampling
- Photo Station

Deck 5 : Fo'c'sle Deck
- Microscope Lab
- Paleo Prep Lab
- Chemistry Lab
- Thin Section Lab
- X-Ray Lab

Deck 4 : Main Deck
- Computers
- Computer User Room
- Science Lounge
- Yeoperson's Office
- Curator's Office

Deck 3 : Upper 'Tween Deck
- Electronics Shop
- Photo Darkroom
- Photo Finish Room

Deck 2 : Lower 'Tween Deck
- Refrigerated Core Storage
- Cold Storage
- Second-Look Lab

Deck 1 : Hold Deck
- Refrigerated Core Storage
- Freezer

Deck 7 : Lab House Top
- Downhole Measurements

Poop Deck
- Underway Geophysics Lab

Fo'c'sle Deck (Forward)
- Library

Figure 2: JOIDES RESOLUTION – Ship Schematic

1. SAFETY SHOWER & EYE BATH
2. ELECTRONICS RACK
3. FAXITRON (X-RAY)
4. COMPUTER TERMINAL
5. THERMAL CONDUCTIVITY
6. MST
7. THEMAL DEMAGNETIZER
8. MINI-SPIN MAGNETOMETER
9. A/C DEMAGNETIZER
10. PENTA-PYCNOMETER
11. THERMAL DEMAGNETIZER
12. BALANCE
13. CRYOGENIC MAGNETOMETER
14. TRIM SAW
15. VANE SHEAR
16. VELOCIMETERS
17. OVEN
18. HEAT SEALER
19. CAPSTAN MOTOR & CORE SPLITTER
20. TOOL BOX
21. MINI-CORERS
22. FELKER SAW
23. MICROSCOPE STATION
24. CLOSE-UP PHOTO TABLE
25. DATA BOARD
26. RIG FLOOR MONITORS

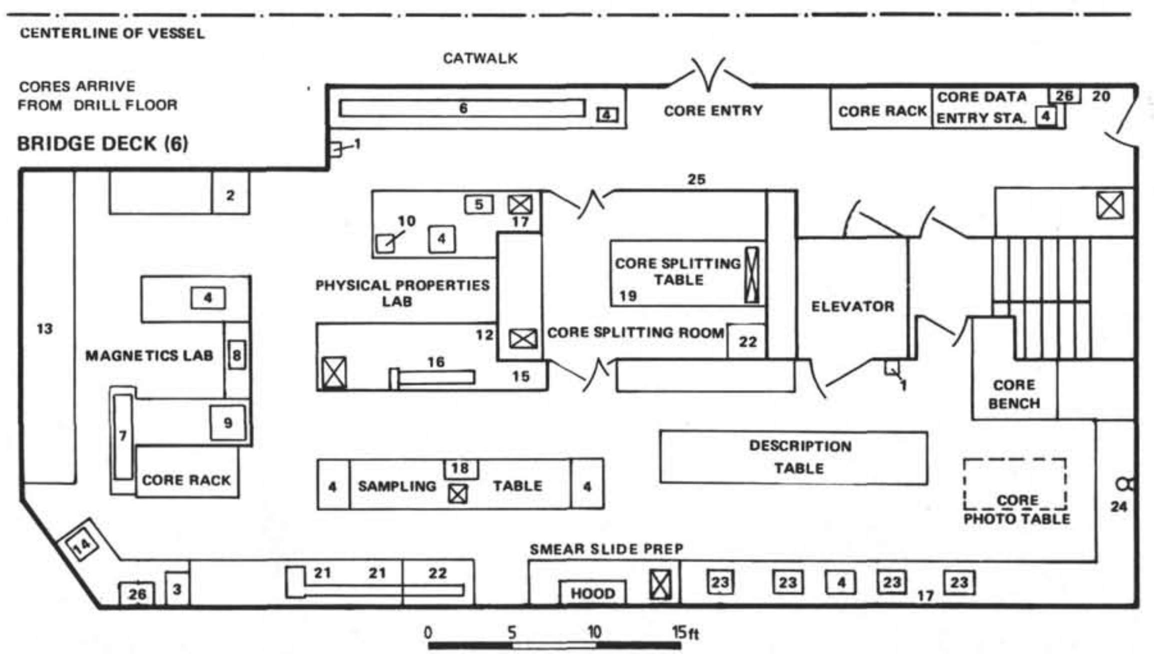


Figure 3.

1. BALANCE
2. AUTOMATED C-H-N-S ANALYSER
3. ROCK EVALUATION SYSTEM
4. CANOPY HOOD
5. FUME HOOD
6. PRESSES
7. ION CHROMATOGRAPH
8. AUTOMATIC TITRATION
9. FREEZE DRYER
10. FREEZER BELOW
11. WATER PURIFICATION SYSTEM
12. GRINDERS
13. ATOMIC ABSORPTION
14. STORAGE CABINET
15. GAS STORAGE & CENTRAL REGULATOR
16. SAFETY SHOWER & EYE BATH
17. HP 1000 COMPUTER FOR CHEMISTRY LAB
18. GAS CHROMATOGRAPH
19. SPECTRO PHOTOMETER
20. ELECTRONICS/COMPUTER CABINET
21. XRF MONITOR
22. PW/1730 X-RAY GENERATOR
23. GAS BOTTLE STORAGE
24. DEC. MINICOMPUTER AND XRD CONTROLLER
25. HEAT EXCHANGER
26. X-RAY SPECTROMETER
27. XRD PW 1720 GENERATOR
28. COLOR PLOTTER
29. COLOR TERMINAL
30. OVENS
31. COMPUTER TERMINAL
32. SAW GS-10
33. PETRO-THIN GRINDER
34. LOGITECH LP .30 GRINDER POLISHER
35. BUEHLER LAP WHEEL
36. W-20 VAC IMPREGNATOR
37. FINE POLISHER
38. SLIDE PREP
39. MICROSCOPE
40. FURNACE
41. STEAM WASHER BELOW
42. $CACO_3$ COULOMETER
43. TOC COULOMETER

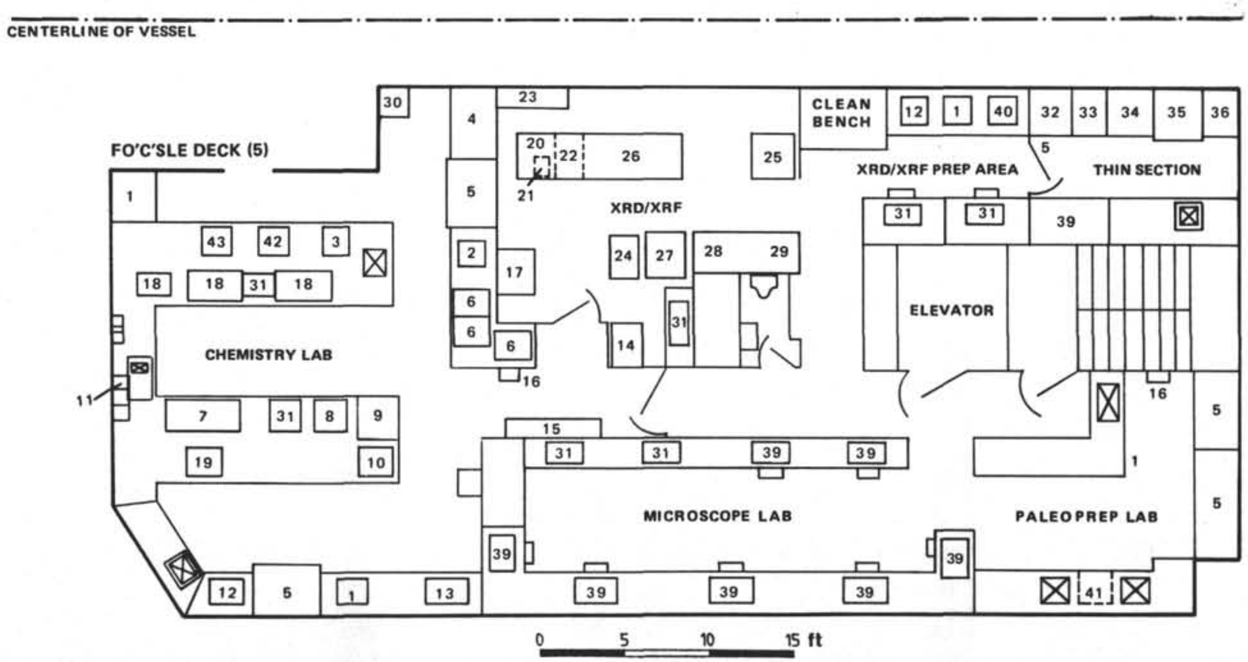


Figure 4.

COMPUTER

1. POWER CONDITIONER
2. VIDEO SYSTEMS CONTROL
3. TAPE STORAGE
4. DISC DRIVES
5. STORAGE CABINET
6. VAX-CPU

COMPUTER OFFICE

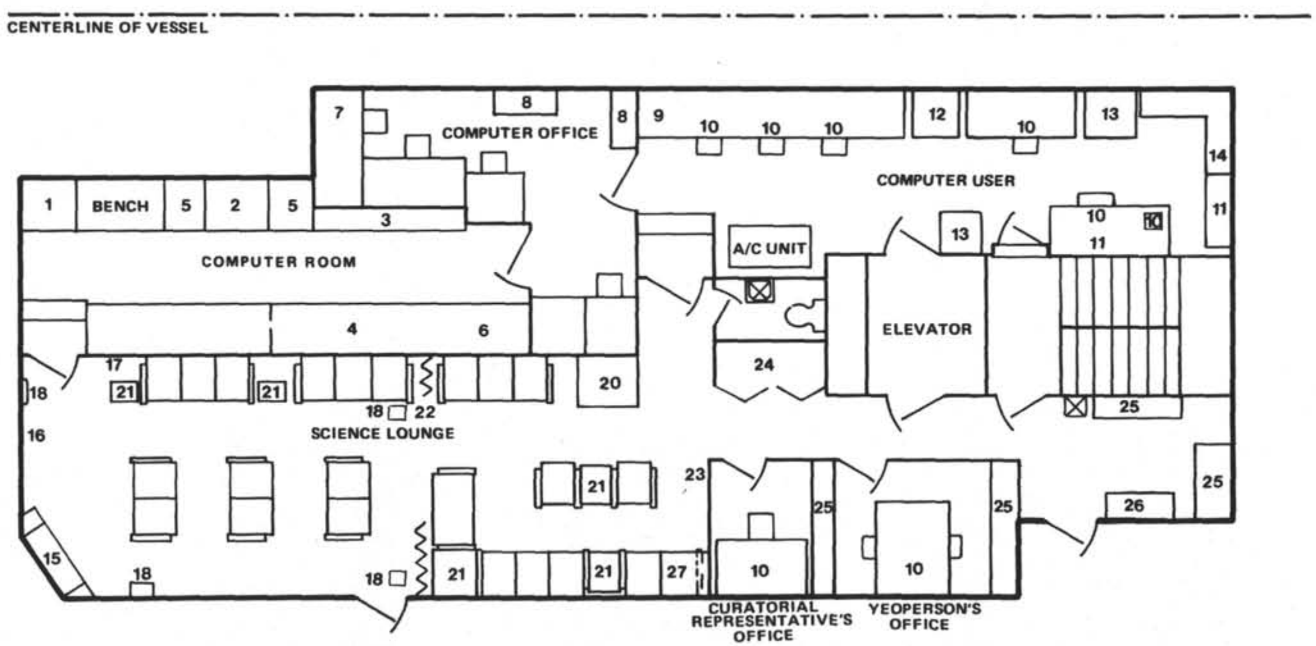
7. VAX SYSTEM CONSOL
8. TAPES & STORAGE

COMPUTER USER

9. DAISY PRINTER
10. TERMINALS
11. PLOTTER
12. LASER PRINTER
13. LINE PRINTER
14. TAPE STORAGE RACKS

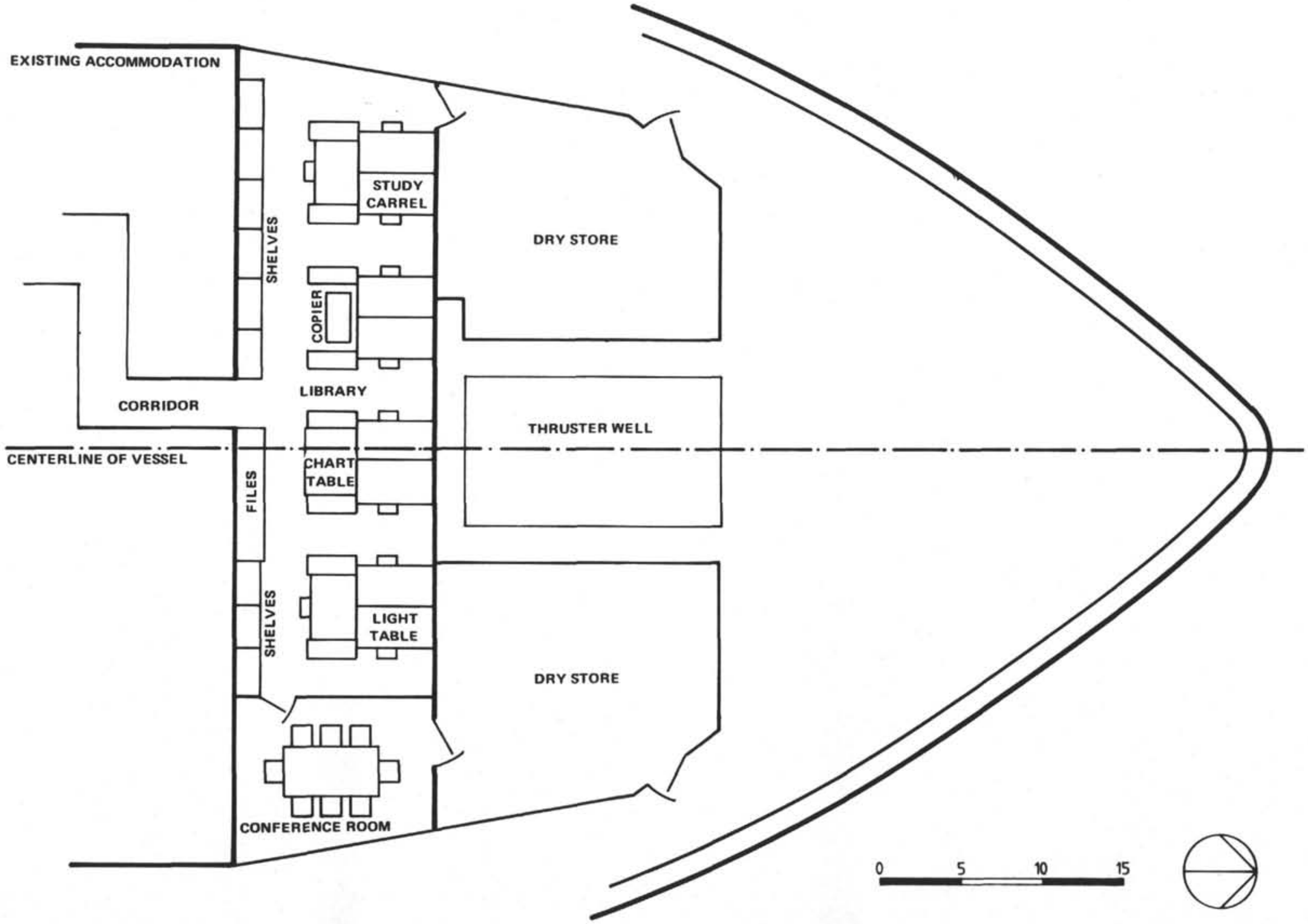
SCIENCE LOUNGE

15. VIDEO RECEIVER/AMP STEREO,
    VCR-STEREOS, BETA/ VHS,
    LASER DISC PLAYER
    TAPE & VIDEO DISC LIBRARY
    STEREO SPEAKERS
16. LARGE SCREEN COLOR T.V.
17. WALL OF REMOVABLE ACCESS PANELS
18. SMALL WALL-MOUNT SPEAKERS
19. RIG VIDEO MONITOR, CEILING MOUNTED
20. STEREO CASSETTE PLAYER,
    MOVIE PROJECTOR,
    SLIDE PROJECTOR
    OVERHEAD PROJECTOR
    GAMES & PUZZLES
    HEADPHONES
    MAGAZINES
    VIDEO GAMES
21. COFFEE TABLE
22. FOLDING CURTAIN
23. SCREEN & DEMO BOARD
24. MOVIE PROJECTOR
    SLIDE PROJECTOR
    OVERHEAD PROJECTOR
25. SHELVES
26. COPY MACHINE
27. FILE CABINET



NEW MAIN DECK (4)

Figure 5.



Fo'c'sle Deck (Forward)

Figure 6.

PHOTO DARKROOM

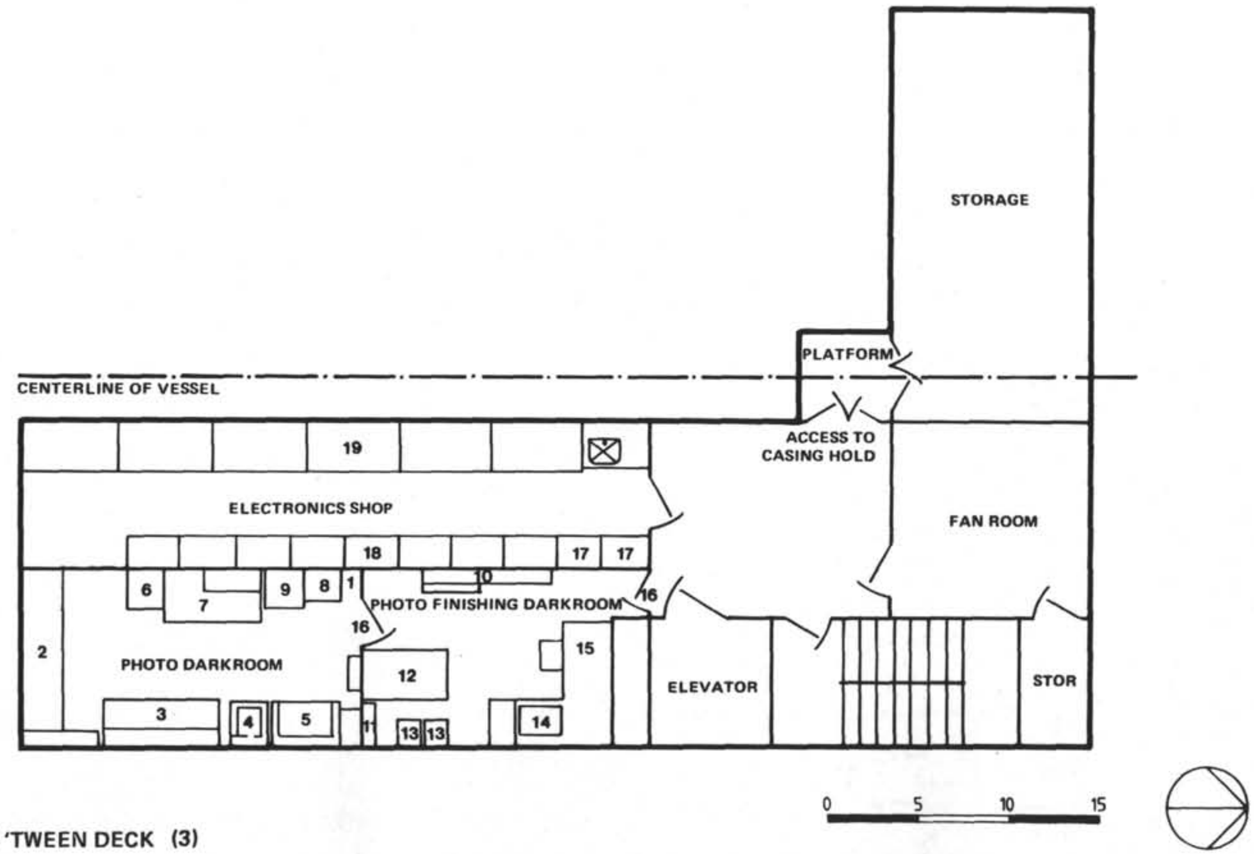
1. NITROGEN BOTTLES & REGULATORS
2. FINISHING AREA
3. TRAY PROCESSING SINK
4. LIGHT TIGHT DRAWERS & VIEW LIGHT
5. ENLARGING STATION
6. FILM PROCESSOR
7. AIR TEMPERED FILM PROCESSOR
8. FILM DRYING CABINET
9. FILM REFRIGERATOR

PHOTO FINISHING DARKROOM

10. WASH UP SINK
11. THERMOSTATIC WATER MIXING
12. AUTOMATIC PRINT PROCESSOR
13. PORTABLE CHEMICAL MIXERS
14. COPY STUDIO
15. FINISHING DESK
16. LIGHT TIGHT DOORS

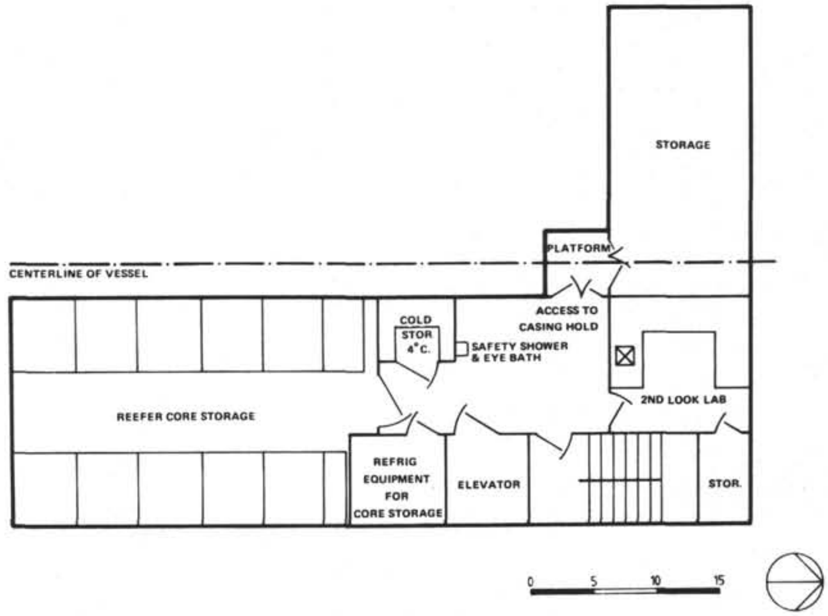
ELECTRONICS SHOP

17. FILE CABINETS
18. STORAGE CABINETS
19. WORK BENCHES

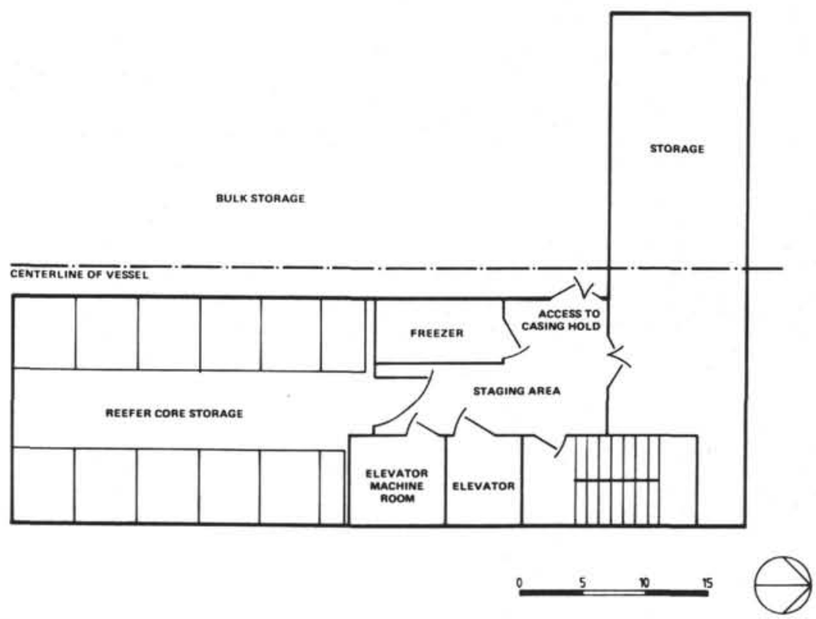


UPPER 'TWEEN DECK (3)

Figure 7.



LOWER 'TWEEN DECK (2)



HOLD DECK (1)

Figure 8.

CONTROL ROOM

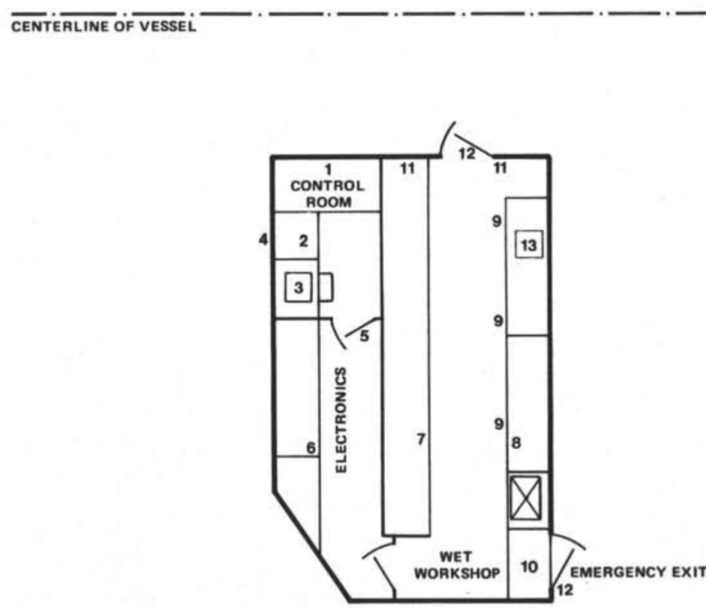
1. ELECTRONICS RACK
2. FOLD DOWN COUNTER
3. CONTROL DESK WITH COMPUTER & INTERCOM TO LOGGING WINCH OPERATION
4. OPERATION VIEWING PORT HOLE
5. AIRTIGHT DOOR

ELECTRONICS

6. WORKBENCH

WET WORKSHOP

7. HEAVY DUTY WOOD WORK BENCH DOWNHOLE TOOL RACKS BELOW
8. HEAVY DUTY WOOD WORKBENCH RE-ENTRY TOOL RACKS BELOW
9. HOOK-ON WORKBENCH EXTENSIONS
10. FOLD DOWN TABLE
11. MONORAIL ABOVE
12. WATERTIGHT DOOR
13. COMPUTER TERMINAL



BRIDGE ROOF DOWNHOLE LOGGING (7)

Figure 9.

UNDERWAY GEOPHYSICS LAB

1. SUPPLY FAN
2. PRO-350 & MASSCOMP COMPUTERS
3. SEISMIC EQUIPMENT RACKS
4. SONOBUOY & MAGNETOMETER EQUIPMENT RACKS
5. VERSATEC PLOTTER
6. WORK TABLE WATCH STANDER'S
7. WORK BENCH
8. 3.5 KHZ P.D.R.
9. 12.0 KHZ P.D.R.
10. FLATBED RECORDER

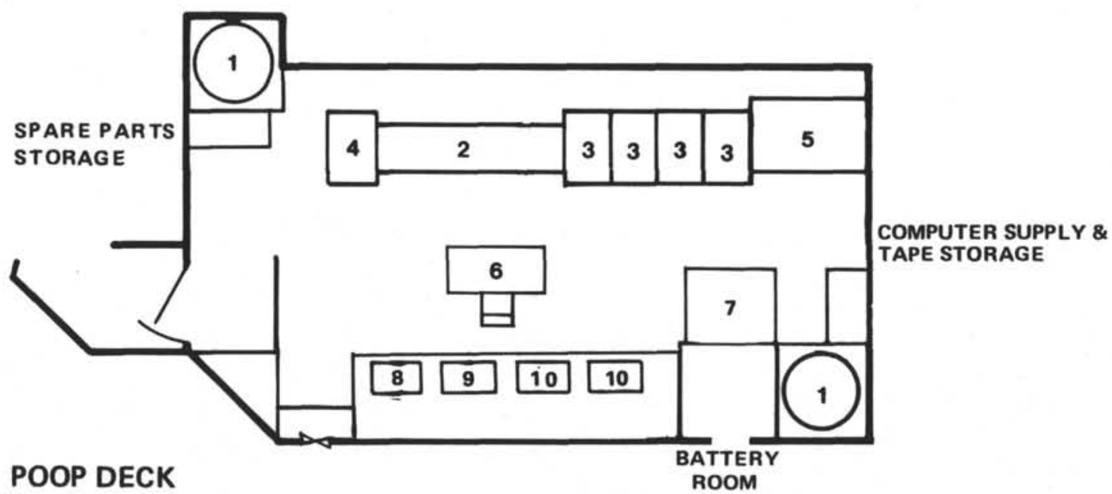


Figure 10.

APPENDIX 1.

ODP SITE PROPOSAL SUMMARY FORM

Proposed site:	General Objective:
General Area:	
Position:	Thematic Panel interest:
Alternate Site	Regional Panel interest:

Specific Objectives:

Background Information:
  Regional Data:
    Seismic profiles:

  Other Data:

Operational Considerations:

Water Depth: (m)   Sed. Thickness: (m)   Total penetration: (m)

HPC____   Double HPC____   Rotary Drill____   Single Bit____   Reentry____

Nature of sediments/rock anticipated:

Weather conditions/window:

Territorial jurisdiction:

Other:

Special requirements (Staffing, instrumentation, etc.)

Proponent: Date submitted to JOIDES Office:

APPENDIX 2.

Ocean Drilling Program
Cruise Participant Application Form

Name (first, middle, last): ______________________________

Institution (including address): ____________________ **Telephone** (work): ____________________

______________________________ (home): ____________________

______________________________ **Telex/Cable:** ____________________

Permanent Institution Address (if different from above): __________ **Bitnet Address:** ____________________

____

Present Position: ____________________ **Country of Citizenship:** ____________________

Place of Birth: ____________________ **Date of Birth:** __________ **Sex:** ______

Passport No.: __________ **Place Issued:** __________ **Date Issued:** __________ **Exp. Date:** __________

Geographic Region(s), Scientific Problem(s) of Interest (Leg number(s) if known): ____________________

____

____

Date(s) Available: ______________________________

Reason(s) for Interest (if necessary, expand in letter): ____________________

____

____

Expertise (petrologist, sedimentologist, etc.): ____________________

Education (highest degree and date): ____________________

Experience (attach curriculum vitae): ____________________

____

____

____

____

Selected Publications You Have Authored Relevant to Requested Cruise: ____________________

____

____

____

____

Personal and/or Scientific References (name and address): ____________________

____

____

Previous DSDP/ODP Involvement and Nature of Involvement: (i.e. cruise participant, shore-based participant, contributor, reviewer, etc.): ____________________

____

____

Staffing decisions are made in consultation with the co-chief scientists and take into account nominations from partner countries; final responsibility for staffing rests with ODP at TAMU.

Please return this form to:

Manager of Science Operations
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840-3469

Applicants from JOIDES partner countries should ensure that they send a **copy** of their applications to their respective national ODP offices.

Responsibilities of Shipboard Scientists

Shipboard scientists collect, analyze and compile data conforming to ODP standards and format. They assist the co-chief scientists in producing shipboard scientific reports by recording data on standard ODP forms and writing a description of their disciplines' results for each site chapter of Part A of the Proceedings of the Ocean Drilling Program.

Scientists aid the curatorial technician by taking samples for themselves and others for later shorebased study. A team of highly trained marine technicians, some specializing in particular equipment areas, is on hand to assist the shipboard scientists maintain the flow of core samples through the laboratories and to help with analyses.

At the end of the cruise the shipboard paleomagnetist, physical properties specialist, geochemist and logging scientist write informal reports about the status of their laboratory equipment and procedural modifications in their laboratory areas.

Shipboard scientists are primarily on board to pursue their own scientific interests. After the cruise, they are responsible for analyzing their samples and reporting the results which are included in the ODP data base and published in the cruise volumes. Following is a brief description of the shipboard responsibilities of the scientific staff.

Sedimentologists provide accurate visual and written descriptions of the cored sediments and interpretations of depositional and diagenetic history or other related sedimentological processes. They work as a team, designating a lead sedimentologist for each site and exchanging specific responsibilities from site to site. Sedimentologists' responsibilities include:

1. written and graphic core descriptions on ODP data forms, including the sedimentologic portion of core description sheets (barrel sheets),
2. smear-slide preparation and petrographic analysis of smear slides and thin sections, and
3. selection of samples for shipboard analyses of XRD, XRF, SEM, carbonate percentage and thin sections.

The **paleontologists'** chief responsibility is to obtain dates from core-catcher samples as soon as possible after cores are recovered. They may need to examine additional samples to provide as complete a biostratigraphic characterization of the cored section as possible within the time available, including recognition of boundaries and hiatuses.

A reference library with texts, journals and reprints is available to help shipboard paleontologists identify fossil groups that do not fall within their areas of expertise.

Petrologists classify thin sections and hand specimens, and provide the written and graphic descriptions of all igneous and metamorphic rocks recovered on the cruise. Petrologists should be experienced in one or more of the following aspects of the petrology of oceanic rocks: chemical petrology, lithology and volcanology or mineralogy and petrography.

Paleomagnetists conduct or supervise all paleomagnetic measurements including the reduction of paleomagnetic data to intensities and direction of magnetization.

Paleomagnetists work with other shipboard scientists and the drilling crew to ensure that core material is not magnetically damaged by heating or exposure to strong magnetic fields and that core sections are not inverted.

Physical properties specialists select cores to determine velocities, shear strength, thermal conductivity and index properties (water content, porosity and bulk density). They also ensure that data are collected in a manner consistent with ODP format. The physical properties specialists and the sedimentologists select samples for carbonate analysis.

Organic geochemists monitor cores for gas and oil (hydrocarbon accumulations) and organic compounds. They advise when hydrocarbons in cores may constitute a safety or pollution hazard.

Inorganic geochemists are primarily responsible for conducting interstitial water, X-ray diffraction (XRD), and X-ray fluorescence (XRF) analyses. They are assisted by ODP chemists and marine technicians.

Logging scientists advise the co-chief scientists on the logging program for the cruise. They work closely with the Schlumberger field engineer and the Lamont-Doherty Geological Observatory logging scientist in designing, implementing and interpreting the program.

OCEAN DRILLING PROGRAM SAMPLE REQUEST FOR SHIPBOARD AND SHOREBASED CRUISE PARTICIPANTS

(submit to Curator *at least* TWO MONTHS before cruise departs)

Please be aware of the current sample distribution policy which is published in recent issues of *Initial Reports of the Deep Sea Drilling Project* and in reports of the Ocean Drilling Program.

1. Proposed leg name (include number if known):

2. Name(s), office address, telephone number, and telex number of investigator(s):

3. Purpose(s) of request. Please summarize the nature of the proposed research concisely in 5-7 lines below. [This summary will be included in various official reports]. Also, provide a detailed description of the proposed research, including techniques of sample preparation and analysis, roles of individual investigators, etc., on an attached sheet. This detailed description of the project will be employed in reviewing the sample request.

4. Please describe the proposed core sampling program in detail sufficient so that those who must carry it out onboard ship will understand your needs. Specify the size of samples (cubic centimeters); the number of samples to be taken from each section, core and/or hole; particular stratigraphic or lithologic units to be sampled; special sampling techniques, equipment (for example, specialized tools which you are providing), storage or shipping requirements; or any other information that will be helpful in conducting your sampling program. Be aware that, if the number of samples which you are requesting is large, the taking of your samples is likely to be delayed until the cores reach the repository (4 to 6 months following the cruise), so it is to your advantage to keep the total number of samples small.

5. Are sufficient funds, space and facilities now available to support the proposed research?
   Source of funds:

   NSF:__________ Other (identify agency):______________________

   Space:______________________ Facilities:______________________

   If funds, space or facilities now available are inadequate, how do you anticipate remedying the situation? If a sample request is dependent, wholly or partially, upon proposed funding from the National Science Foundation, the sample request and funding proposal must be considered together; therefore, it is important that the funding proposal be submitted at the same time as this request.

   If NSF funding is to employed in the proposed research, please enter the relevant NSF grant no. ________ or NSF proposal no. ______, and percent of funding in that grant which would be devoted to research on these samples: _______%.

6. Please estimate the time it will require for you to obtain publishable results:

7. In what condition will the samples be once your research is complete? Will they be useful to others? If so, for what kinds of research?

8. If you have ever before received samples from DSDP or from ODP, please attach a comprehensive list of the publications which resulted from each sample request. If you reference publications which have not yet been forwarded to the curator, please enclose six (6) reprints of each. If work is still in progress, please attach a brief (2–3 page) progress report. If the work has ended, please return the residues.

9. Please summarize any other information which you feel would be useful in reviewing you request on an attached sheet.

10. Would you prefer that we:
    a) ship your samples to you,
    b) give them to you at the end of the cruise so that you can put them in your suitcase, or
    c) pack them in a box and give them to you at the end of the cruise?

Acceptance of samples implies willingness and responsibility on the part of the investigator(s) to fulfill certain obligations:

(a) To publish significant results promptly; however, no contribution may be submitted for publication prior to twelve (12) months following the termination of the relevant leg unless it is approved and authored by the entire shipboard party.

(b) To acknowledge in all publications that the samples were supplied through the assistance of the international Ocean Drilling Program and others as appropriate.

(c) To submit six (6) copies of reprints of all published works to the Curator, Ocean Drilling Program, Texas A&M University, College Station, Texas 77843-3469, U.S.A. These reprints will be distributed to the repositories, to the ship, to the National Science Foundation, and to the Curator's reprint file. All papers received will be logged in a searchable bibliographic data base.

(d) To submit all final analytical data obtained from the samples to Data Base Manager, Ocean Drilling Program, Texas A&M University, College Station, Texas 77843-3469, U.S.A. Please consult recent issues of the JOIDES Journal or call 409-845-2673 for information on acceptable data formats. Investigators should be aware that they may have other data obligations under NSF's Ocean Science Data Policy or under relevant policies of other funding agencies which require submission of data to national data centers.

(e) To return all unused or residual samples, in good condition and with a detailed explanation of any processing they may have experienced, upon termination of the proposed research. In particular, all thin sections and smear slides manufactured onboard the vessel or in the repositories are to be returned to the Curator. Paleontological materials may be returned either to the Curator at ODP or to one of the designated paleontological reference centers.

It is understood that failure to honor these obligations will prejudice future applications for samples.

All requests will be reviewed by the curatorial representative, by the ODP staff science representative, and by the Co-chief Scientists for the cruise, who will prepare a science study plan which will be submitted to the Curator for approval.

Approval/disapproval will be based upon the scientific requirements of the cruise as determined by the appropriate JOIDES advisory panel(s). In the case of duplicate proposals, shipboard scientists will have priority over shorebased scientists. Requests for samples for post-cruise studies will be handled separately.

Completion of this form in no way implies acceptance of your proposed investigation.

____

____

____

Signature of
Investigators

****

Send this completed form to the Curator *at least* TWO MONTHS in advance of the cruise departure date. The Curator's address:

Curator, Ocean Drilling Program
Texas A&M University
College Station, Texas 77843-3469
U.S.A.

****

ACTION TAKEN: Approved Conditionally Approved Denied

Comments:

Date:________________ Sig:____________________________________

BIBLIOGRAPHY OF THE OCEAN DRILLING PROGRAM

The following technical notes are available from the Manager of Science Operations, Ocean Drilling Program, 1000 Discovery Drive, College Station, Texas 77845-9547 USA.

Technical Note 1:	Preliminary Time Estimates for Coring Operations (revised edition, December 1986)
Technical Note 3:	Shipboard Scientists' Handbook (revised edition, March 1990)
Technical Note 5:	Water Chemistry Procedures aboard JOIDES Resolution (September 1986)
Technical Note 6:	Organic Geochemistry aboard JOIDES Resolution - An Assay (September 1986)
Technical Note 7:	Shipboard Organic Geochemistry on JOIDES Resolution (September 1986)
Technical Note 8:	Shipboard Sedimentologists' Handbook (January 1988)
Technical Note 9:	Deep Sea Drilling Project Data File Documents (January 1988)
Technical Note 10:	A Guide to ODP Tools for Downhole Measurements (June 1988)
Technical Note 11:	Introduction to the Ocean Drilling Program (February 1989)
Technical Note 12:	Handbook for Shipboard Paleontologists (March 1989)
Technical Note 13:	Your Stay Aboard *JOIDES Resolution* (draft version, 1990)
Technical Note 14:	A Guide to Formation Testing Using ODP Drill-String Packers (November 1990)

Also available from ODP Science Operations are the following pamphlets:

A User's Guide to the *JOIDES Resolution* Computer System (December 1988)
Instructions for Contributors to the *Proceedings of the Ocean Drilling Program*
Ocean Drilling Program Sample Distribution Policy
Ocean Drilling Program Guidelines for Pollution Prevention and Safety (JOIDES Journal Volume XII, Special Issue No. 5, March 1986)
Depth Control, Weight Indications, and Logging Cable Adaption for Third Party Tools aboard *JOIDES Resolution* (June 1986)