The Non-Riser Drilling Vessel for the *Integrated Ocean Drilling Program*: A Report from the *Conceptual Design Committee**

Performance Specifications, On Board Scientific Measurement Capabilities, and Survey of Drilling Vessels

March 2000

*An Activity of the United States Science Advisory Committee (USSAC)

A Report to the U.S. National Science Foundation

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Executive Summary

Compelling scientific objectives require ocean drilling as a means of acquiring samples, measuring properties in situ, and conducting experiments to address questions of fundamental significance in the earth and ocean sciences. The scientific community has consistently emphasized that riser (well-control) vessel, non-riser vessel, and mission-specific drilling capabilities will be required in a new international scientific ocean drilling program. The U.S. National Science Foundation (NSF) has indicated that it would seek the necessary resources to bring a non-riser vessel of the *JOIDES Resolution* class but with significantly enhanced capabilities to a future program. In response to a charge from NSF, the United States Science Advisory Committee (USSAC) formed the Conceptual Design Committee (CDC) to formulate the conceptual design characteristics of a single, non-riser drilling vessel, optimally configured, to address the widest possible range of non-riser scientific drilling objectives. We report here on our definition of the performance specifications for the non-riser vessel and on the results of a survey of existing and planned vessels relative to these performance specifications.

We synthesized high priority drilling targets into nine *target sections*, emphasizing technical aspects relevant to the design of a drilling vessel capable of recovering these sections. The target sections have the following scientific themes: observatory, rifting processes, convergent margin, large igneous province, oceanic crust, hydrothermal system and massive sulfide deposit, deep ocean sediment, passive margin stratigraphy, and carbonate reef, atoll, or bank. We defined drilling platform characteristics for the purposes of the ship survey. These characteristics include: riserless drilling; continuous sampling; space for mud and casing storage; water depths as shallow as possible and as deep as 7000 m; drilling depths as deep as possible beyond 2 km; combined drill string length of ~11,000 m; dynamic positioning; endurance of up to 8 weeks without resupply or port call; global operation; sufficient laboratory space, including 1800 m^2 interior heated/air conditioned laboratory space, deck space for special-purpose lab modules, deck space for refrigerated containers for core storage, and geophysics lab space.

We carried out a survey of drilling vessels, with the goal of gathering information about present and planned international capabilities. We started by identifying 41 existing and announced new-build drilling platforms in the international market using information available in the public domain. We sent a three-part survey to the vessel managers, with an introductory letter introducing the Integrated Ocean Drilling Program (IODP), CDC, and the purpose of the survey; a questionnaire requesting specific technical information and specifications for the platforms, and a questionnaire soliciting additional information and subjective responses in the event that the platform met certain minimum criteria. We received responses from 12 of the 19 vessel manager companies, with responses providing information on 31 of the 41 vessels identified. We applied an initial screening for two most basic criteria: dynamic positioning and the capacity to drill to 9000 m or deeper. Nineteen vessels met these two criteria. We discuss possible evaluation approaches, as further screening would depend on the physical and operational characteristics to be most heavily weighted. We discuss issues around well control and blow-out prevention and about hole diameter. We briefly discuss other platform types, as no single non-riser vessel will necessarily and economically meet the full range of needs captured in the target sections. We discuss drilling and sampling systems, and we emphasize their importance in the ultimate selection of a non-riser vessel.

Scientific Ocean Drilling in the Twenty-First Century

Compelling scientific objectives require ocean drilling as a means of acquiring samples, measuring properties in situ, and conducting experiments to address questions of fundamental significance in the earth and ocean sciences. The needs for scientific ocean drilling and for a multi-platform approach within an international framework have been recognized explicitly in a number of U.S. and international vision and planning documents[1] over the past decade.

For example, documents focused on ocean drilling from the U.S. and international perspective define the multi-platform strategy as a key component of scientific success. The COMPOST Report (*COMPOST: Committee on Post-1998 Drilling, Report to the U.S. Science Advisory Committee*; based on a meeting in October 1993, Seattle, Washington) includes the following conclusions:

> Drilling is an essential tool of the marine Earth science community in the U.S. and should continue beyond 2003.
> The U.S. community requires a drilling program that is global in scope and is internationally organized and funded.
> Scientific programs in the U.S. will in the future require access to two different types of drilling platforms: 1) a modified *JOIDES Resolution*-class vessel, and 2) a platform capable of deep (> 2 km) drilling.

This report emphasized the need for significantly enhanced capabilities beyond the *JOIDES Resolution* for drilling beyond 2003. The 1996 JOIDES Long Range Plan (LRP) for the Ocean Drilling Program (ODP) (*Understanding Our Dynamic Earth through Ocean Drilling*, *Ocean Drilling Long Range Plan into the 21st Century*, March 1996) defined "Phase IV" of ocean drilling beyond 2003 with a two drill-ship strategy, one riserless vessel and one riser vessel. The U.S. interests in a new, international multi-platform scientific ocean drilling program were reaffirmed in *A New Vision for Scientific Ocean Drilling*, *A Report from COMPOST-II: The U.S. Committee for Post-2003 Scientific Ocean Drilling* (March 1998). This report, endorsing the Long Range Plan multi-platform approach to the accomplishment of U.S. scientific objectives, states that accomplishing these objectives requires the capability to drill and sample in water depths from the beach to the abyss, including:

> complete recovery of continuous, undisturbed, high-sedimentation-rate sections across a diverse suite of geologic environments and ages;
> improved recovery and penetration of difficult-to-sample lithologies (e.g., young, fractured basalts) and geologic environments (e.g., overpressured sections); and
> new capability to reach subseafloor depths in excess of 2 km.

[1] Of the documents mentioned in this section, the following are available by request to joi@brook.edu and by following the "Publications" link at http://www.joi-odp.org/ web site: (1) *COMPOST: Committee on Post-1998 Drilling, Report to the U.S. Science Advisory Committee*; (2) *Understanding Our Dynamic Earth through Ocean Drilling*, *Ocean Drilling Long Range Plan into the 21st Century*; (3) *A New Vision for Scientific Ocean Drilling*, *A Report from COMPOST-II: The U.S. Committee for Post-2003 Scientific Ocean Drilling*; and (4) *The Future of Marine Geology and Geophysics: Report of a Workshop*. The other three documents are currently in draft form, and their final versions are expected to receive wide distribution.

The significance of scientific ocean drilling as a fundamental tool for U.S. scientists is affirmed in "vision" documents focused on the future of the ocean sciences in the U.S. National Science Foundation (NSF) funded community. The Marine Geology and Geophysics community's vision is presented in the FUMAGES Report (*The Future of Marine Geology and Geophysics: Report of a Workshop*, December 1996, Ashland Hills, Oregon), with discussion summarized in four thematic areas within marine geology and geophysics: solid Earth, paleoceanography, sediments, and fluids. Several overarching new directions were identified:

> The societal imperative of making rapid progress in scientific understanding of complicated, nonlinear systems.
> The central role of focused fluids in producing volcanic, tectonic, and thermal modification of the planet.
> The recognition that present-day conditions may not be representative of the whole of geologic history.
> The importance of explicit incorporation of effects of and on the marine biosphere into marine geology and geophysics.
> The appreciation that we must move beyond steady-state models to study geologic events as they happen.
> The limitations of present funding structures and technology for problems that span the shoreline.

Along with these new directions, common themes in infrastructure were identified, including the clear statement that "all thematic groups identified some form of ocean drilling (Ocean Drilling Program-like) capability as a long-term requirement of their sampling and sometimes their monitoring strategies."

The FUMAGES Report, along with vision documents in the other disciplinary areas of NSF Ocean Sciences, are being used to help frame a synthesis document, the *NSF Decadal Report for Oceanography*. This report will highlight seven areas of possible rapid advance and cross-cutting science in the ocean sciences, four of which have the need for scientific ocean drilling to achieve aspects of their objectives:

> climate and carbon cycle,
> fluids in the crust and sediments,
> coastal dynamics, and
> the subduction factory.

A May 1999 conference *COMPLEX: Conference on Multiple Platform Exploration of the Ocean* (Vancouver, British Columbia) focused on non-riser drilling in the context of planning for a new international program. The meeting report is organized around new foci for scientific ocean drilling and integrated strategies to address fundamental questions:

New Foci for Scientific Ocean Drilling
- The deep biosphere
- Gas hydrates
- *Mare Incognitum*—The Arctic Ocean

New Integrated Strategies to Address Fundamental Earth System Questions
    Global change processes and climate
    Solid Earth cycle
    Seismogenic zone
    Core and mantle dynamics
    Large igneous provinces
    Marine biosphere
    Catastrophic events

Finally, the Integrated Ocean Drilling Program (IODP) Planning Sub-Committee (IPSC) is crafting *Earth, Oceans, and Life: Scientific Opportunities to Study the Planet Earth System using New Drilling Technologies and Multiple Platforms*, the Initial Science Plan, 2003-2013, for IODP. The prime thematic areas and subthemes are:

The Deep Biosphere and the Sub-Seafloor Ocean
    The sub-seafloor ocean in different geological settings
    The deep biosphere
    Gas hydrates
Environmental Change and its Impact on Life
    Internal forcing of environmental change
    External forcing of environmental change
    Environmental change induced by multiple internal and external processes
Solid Earth Cycles and Geodynamics
    Formation of passive continental margins and LIPs
    Evolution of oceanic lithosphere
    Recycling of oceanic lithosphere into the mantle and the formation of arcs

A Non-Riser Vessel for a Multi-Platform Program

Numerous planning documents prepared by the international scientific ocean drilling community, including the documents summarized above, have identified a wide range of important scientific objectives for the follow-on program (post-September 2003) that will succeed the present Ocean Drilling Program (ODP). To meet all of these objectives, the scientific community has consistently emphasized that riser (well-control) vessel, non-riser vessel, and mission-specific drilling capabilities will be required. Japan's Science and Technology Agency (STA) is building a large (ca. 210 m, 50,000 ton) riser/well-control vessel meant to address some of these future requirements. The scientific drilling community has repeatedly argued that any future program would also require a non-riser vessel of the *JOIDES Resolution* class but with significantly enhanced capabilities. The U.S. NSF has indicated that it would seek the necessary resources to bring such a vessel to a future program. This vessel would constitute a major capital asset of the future IODP. To accomplish this, the operational and scientific capabilities of this drilling vessel, as well as its possible limitations and the resulting need for additional platforms, must be carefully identified.

The *Conceptual Design Committee*: Creation, Charge, and Membership

In May 1999, NSF requested the U.S. Science Advisory Committee (USSAC) to the U.S. Science Support Program (USSSP) to assist with this effort. In response to this request, USSAC, under its then-chair Professor Michael Arthur (The Pennsylvania State University), formed the *Conceptual Design Committee* (CDC; Table 1).

The charge to the CDC was as follows:

> Formulate the conceptual design characteristics of a single, non-riser drilling vessel, optimally configured, to address the widest possible range of non-riser scientific drilling objectives identified by the JOIDES LRP, the COMPLEX report, and other U.S. planning documents. This vessel should be capable of operating globally, to the extent possible in a maximum range of water depths (shallow to deep), and have endurance characteristics similar to the present *JOIDES Resolution*. The drilling limitations relative to defined scientific objectives for such a single vessel should be addressed and alternative drilling capabilities identified.
>
> Identify the optimal configuration of on-board scientific measurement capabilities, i.e., geophysical, geotechnical, and scientific laboratory facilities required to achieve the scientific objectives of the program.
>
> Provide a feasibility survey of existing and planned drilling vessels having the potential for conversion or modification to meet these operational and scientific requirements.
>
> Prepare a detailed report which specifies the operational and scientific characteristics of this non-riser drilling vessel and the science objectives that it will be expected to address.

Overview of the Workings of the CDC

The CDC held two meetings, one in June 1999 and one in September 1999, as well as conducted much business by e-mail. Our strategy was to identify high priority drilling targets, as indicated in a variety of U.S. and international science planning documents, and to synthesize them into *type sections* or *target sections*, which emphasize technical aspects relevant to the design of a drilling vessel capable of recovering these sections. We defined the on board scientific measurement capabilities required with input from the JOIDES Scientific Measurements Panel (SCIMP), including reviewing their advice on the existing laboratory facilities and equipment on the *JOIDES Resolution* and on the plans for the riser vessel, and from IPSC consultations with the community about desired shipboard capabilities. We used the target sections and the laboratory needs to define the performance specifications of the new vessel. We canvassed international ship owners for information on existing and planned vessels capable of meeting the specified requirements. In the sections of this report providing information about each of these aspects, we describe in greater detail how we proceeded and the substantive specifications and information that resulted.

Table 1. Membership of the Conceptual Design Committee (CDC)

Peggy Delaney, Chair
Professor and Chair, Ocean Sciences
University of California, Santa Cruz
Areas of expertise: Paleoceanography, marine geochemistry
Scientific ocean drilling activities:
- USSAC member, 1996-1999; Chair, 1999-
- Ocean History Panel, member 1989-1991; Chair 1992-1994
- Inorganic geochemist, ODP legs 130 and 167

Timothy Byrne
Associate Professor and Chair, Department of Geology and Geophysics
University of Connecticut
Areas of expertise: Structural geology, including tectonics, sediment deformation, fault zone development, and regional-scale geophysics
Scientific ocean drilling activities:
- Structural geologist, ODP leg 131
- Tectonics Panel Member, 1995-96 (Tectonics Panel Liaison to SGPP, 1995-96)
- Riser Technology Conference Participant, Yokohama, Japan, 1996
- CONCORD Steering Committee member, 1997
- USSAC, 1999-

Steven C. Clemens
Senior Research Associate, Geological Sciences
Brown University
Areas of expertise: Paleoceanography, paleoclimate
Scientific ocean drilling activities:
- Environmental Science Steering and Evaluation Panel (ESSEP) Member, 1999-
- Sedimentologist, ODP Leg 117
- Stratigraphic correlator, ODP Leg 184
- Member, Scientific Committee on Ocean Research (SCOR) Asian Monsoon Working Group

Susan E. Humphris
Senior Scientist, Geology and Geophysics Dept.
Woods Hole Oceanographic Institution
Areas of expertise: Geology and geochemistry of hydrothermal systems
Scientific ocean drilling activities:
- JOIDES Science Committee, chair 1996-1998; member 1998-1999
- JOIDES Lithosphere Panel, member 1988-1990; chair 1990-1993
- Shipboard scientist, DSDP leg 54, ODP leg 106
- Co-chief scientist, ODP leg 158

Roger Ingersoll (member through 12/99)
Geotechnical Engineer
Mobil
Areas of expertise: Geotechnical sampling

Thomas Janecek
Curator, Antarctic Research Facility
Florida State University
Areas of expertise: Paleoceanography, sedimentology
Scientific ocean drilling activities:
- SCIMP member 1997-1998; Chair 1998-
- Staff Scientist, ODP legs 126, 130, 138, 145
- Sedimentologist, DSDP leg 86, ODP legs 108, 121, 136
- Stratigraphic correlator, ODP legs 160, 167, 177, 189

Consultant to the committee
Brian B. Taylor, Ph.D., P.Eng.
Senior Geotechnical Engineer
Jacques, Whitford and Associates, Ltd.
Areas of expertise: Marine geotechnical engineering

IPSC Liaison to CDC
James A. Austin
Senior Research Scientist
University of Texas, Austin

We presented progress reports on this work at the August 1999 JOIDES Science Committee (SCICOM) meeting (Santa Cruz, California); at the October 1999 Industry/Academia Workshop (Houston, Texas); to members of the COMPLEX Steering Committee at their working meeting held at the Monterey Bay Aquarium Research Institute (Monterey, California) in October 1999; to the Joint Oceanographic Institutions, Inc. (JOI) Board of Governors in December 1999 (San Francisco, California); to an AGU Town Hall Meeting on Scientific Ocean Drilling in December 1999 (San Francisco, California); to IPSC at their December 1999 meeting (San Francisco, California); to the January 2000 USSAC meeting (New Orleans); to the joint JOIDES Executive Committee (EXCOM)/SCICOM meeting in February 2000 (Washington, D.C.); and to the International Working Group (IWG) Meeting in February 2000 (Washington, D.C.). Our work culminated in this report and its delivery to NSF in March 2000.

Target Sections

Approach: Community Survey

Defining the operational, technical, and scientific capabilities required of a single non-riser drilling to meet the needs of the future IODP required a census of the broad geographic and lithologic array of future drilling targets. To accomplish this, we solicited input, using a cover letter (Appendix 1) and a target section template, from several sources: Co-Chairs of the fourteen COMPLEX working sessions, Chairs of eight planning groups (Program Planning Groups [PPG] and Detailed Planning Groups [DPG]) then in the JOIDES Advisory Structure (Appendix 2). These individuals, in their capacity as chairs of these working sessions and of groups charged with developing drilling approaches to scientific issues of high priority, represented hundreds of members of the U.S. and international scientific communities involved in scientific ocean drilling. These individuals were charged with developing target drill sites that cover the broadest array of drilling and sampling capabilities required to meet the scientific objectives as defined by the members of their sessions and planning groups. Using the template we had designed to collect target section information, we asked for information about the following characteristics of each proposed target section:

- Model site location and description
- Scientific objective
- Water depth range (minimum and maximum depths)
- Maximum penetration below the seafloor
- Lithology and thermal gradient expected
- Conditions (degree of fractures, porosity, pore pressure, presence of volatiles)
- Recovery required; maximum core disturbance tolerated
- Sampling needs (core sampling, number of holes, desired core diameter, in situ sampling and testing needs)
- Down-hole logging needs
- Endurance capabilities required (days at sea without resupply)
- Environmental conditions (wind, sea state, temperature, ice cover conditions)
- Other program requirements

Submitted Target Sections

The response to our requests was excellent, and we received a total of 30 target sections (Table 2). The individuals we contacted used the broad input given to them as chairs of the various sessions and planning groups, as well as frequently consulting broadly in the construction of the target sections submitted. In a few instances, where a target section was not received for a particular scientific objective that had consistently been identified as high priority, a CDC member prepared a target section. In our solicitation, we had encouraged a focus on the scientific goals without regard to the current limitations of the existing non-riser platform, the *JOIDES Resolution*. As described in the following section, this free rein is clearly reflected in the wide geographic extent and the tremendous water depth and depth of penetration ranges of the identified targets, all of which represent high-priority scientific goals consistent with the COMPLEX report, the JOIDES Long Range Plan, and other U.S. and international planning documents.

Synthesis Target Sections

The goal for our use of the target sections was to efficiently describe the performance specifications for the non-riser vessel, and especially to identify those characteristics that might be used to differentiate among possible platforms. To accomplish this, we grouped the submitted target sections into nine "synthesis" target sections (Table 2). The synthesis target sections were grouped and defined largely on the basis of the range of environments to be drilled and the technology required to achieve the scientific goals. In this transformation from science-based to technology-based target sections, we have necessarily abbreviated the "Scientific Objectives" section for the nine synthesis target sections; detailed discussion of the scientific justification for drilling these wide-ranging targets can be found in the various scientific planning documents. The synthesized sections were returned to the original contributors for review to ensure that their needs and goals had been appropriately represented, and the synthesis target sections were then further revised as needed. We also solicited expert input on the down-hole logging needs for all nine synthesis sections, and all nine target sections were provided to USSAC in February 2000 for additional review.

The synthesis target sections (Target Sections 1-9)[2] represent the following scientific themes:

Observatory
Rifting Processes
Convergent Margin
Large Igneous Province
Oceanic Crust
Hydrothermal System and Massive Sulfide Deposit
Deep Ocean Sediment
Passive Margin Stratigraphy
Carbonate Reef, Atoll, or Bank

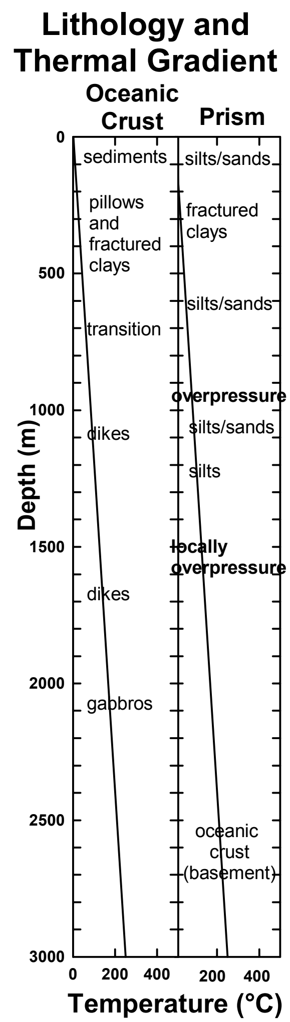
[2] See Appendix 3 for definition of acronyms used in down-hole logging part of the target sections.

Table 2. Target Sections Submitted

Submitted Target Section	Submitted By	Incorporated into Synthesis Target Section
Oceanic crustal section	Keir Becker	Observatory
Oceanic Seismic Network sites	John Orcutt	
Seismogenic zone	Keir Becker	
Active rifting	Gary Karner	Rifting Processes
Accretionary prism 1	J. Casey Moore	Convergent Margin
Accretionary prism 2	Miriam Kastner	
Collisions–Taiwan	Neil Lundberg	
Costa Rica	Roland von Huene	
Generic mass balance	Julie Morris	
Seismogenic zone	Kevin Brown	
LIP oceanic crustal plateau	Millard Coffin	Large Igneous Province
LIP volcanic margin	Millard Coffin	
Crustal windows	Rodey Batiza	Oceanic Crust
Intact section: Older crust	Rodey Batiza	
Mid-ocean ridge crest	Rodey Batiza	
Ridge flank: Hydrogeology	Andrew Fisher	
Massive sulfide deposit	Andrew Fisher	Hydrothermal System and Massive Sulfide Deposit
Sedimented ridge crest	Andrew Fisher	
Catastrophic events: Yucatan to Campeche Escarpment transect	Timothy Bralower	Deep Ocean Sediment
Earth's biosphere	Richard Murray and Steven D'Hondt	
Extreme climates	Richard Kroon	
Pacific Paleogene	James Zachos	
Gas hydrates	Gerald Dickens	
High latitude (Arctic)	Steven Clemens/CDC	
Intermediate water depths—Santa Barbara Basin type	Rob Dunbar	
Nearshore stratigraphic drilling	Kenneth Miller	Passive Margin Stratigraphy
Climate and tectonic PPG	Greg Mountain	
Modern lagoon, reef, and fore-reef	Greg Mountain	Carbonate Reef, Atoll, or Bank
Coral reefs	Steven Clemens/CDC	
Coral drilling—shallow water	Robert Dunbar	

Target Section 1
Observatory

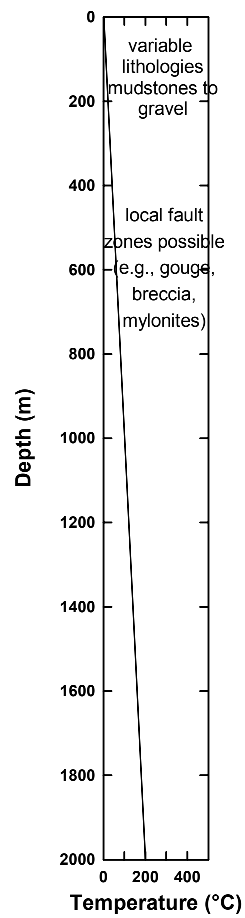
Model Site Description	Global
Scientific Objectives	Emplace seismographs, CORKS, A-CORKS, and strain gauges To study Earth's structure, hydrology, and deformation
Water Depth Range (m)	2000–6500
Maximum penetration (m below sea floor)	100 for seismographs 2000–4000 for others
Possible Conditions	
Degree of fractures	Common
Porosity	Variable: high in crust and fault zones; low elsewhere
Pore pressure	Up to lithostatic in fault zones
Existence of volatiles	Probably not
Percent Recovery Required	Low recovery acceptable for seismograph observatories High recovery necessary for fluid and strain observatories
Maximum Core Disturbance Tolerated	Some disturbance acceptable for seismograph observatories Minimum disturbance required for fluid and strain observatories
Sampling, Testing, and Logging Needs	
Core sampling	Some coring necessary for seismograph observatories Continuous coring desired for fluid and strain observatories
Core sample diameter	–
In situ sampling and testing	– (for seismograph observatories) Geothermal tools, pore pressure, pore waters Long-term straddle packer, pump tests
Down-hole logging	*Essential logs:* natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, BHTV, resistivity (DLL), check shots (WST) *Useful logs:* LWD, resistivity images (ARI), geochemical (GLT), fluid sampling/pump tests/pore pressure (MDT), permeability (MDT and NMR), VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	14 (for seismograph observatories) Up to 60 for other observatories
Environmental Conditions	
Wind	Highly variable for seismograph observatories Moderate for fluid and strain observatories
Sea state	Highly variable for seismograph observatories Moderate for fluid and strain observatories
Temperature	Highly variable for seismograph observatories Moderate for fluid and strain observatories
Ice conditions	Not likely
Other Program Requirements	Proper casing Reentry cone Multi-level A-CORK



Target Section 2
Rifting Processes

Model Site Description	Areas of continental extension (e.g., Gulf of Aden, Woodlark Basin)
Scientific Objective	Determine fabric and deformation history, including the role of low-angle normal faults
Water Depth Range (m)	200–2000
Maximum penetration (m below sea floor)	2000
Possible Conditions	
Degree of fractures	Generally minor, can be high
Porosity	Generally high (70–80%), can be low (5%)
Pore pressure	Generally minor, can be high
Existence of volatiles	Possible hydrocarbons
Percent Recovery Required	As high as possible (typically 70–80% for sediments; 50–60% for igneous rocks)
Maximum Core Disturbance Tolerated	Minimum disturbance required
Sampling, Testing, and Logging Needs	
Core sampling	XCB and RCB for sediments; RCB for igneous rocks
Core sample diameter	Standard ODP
In-situ sampling and testing	Geothermal gradient; in-situ pore water sampling; pore pressure
Down-hole logging	*Essential logs:* natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, BHTV, resistivity (DLL), check shots (WST), fluid sampling (MDT), LWD (resistivity images and density/porosity) *Useful logs:* resistivity images (ARI), geochemical (GLT), VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	Up to 60
Environmental Conditions	
Wind	Gentle to moderate for wind, sea state, and temperature; requires picking the right season
Sea state	
Temperature	
Ice-conditions	–
Other Program Requirements	CORKS, A-CORKS, packer experiments

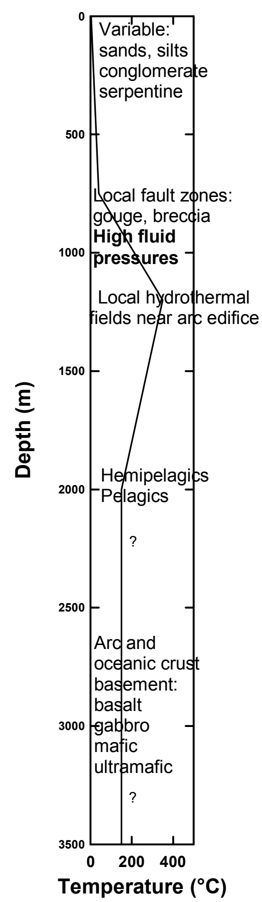
Lithology and Thermal Gradient



Target Section 3
Convergent Margin

Model Site Description	Convergent margins (e.g., Nankai, Central America, Izu Bonin-Mariana, Aleutians, Scotia, Taiwan)
Scientific Objectives	Determine relationship between physical and chemical properties of rocks in zones of active seismicity Quantify kinematics and document role of normal faulting in exhumation Quantify/monitor fluxes of sediment, fluids, and basalt Determine early arc history and investigate hydrothermal and ore-forming processes
Water Depth Range (m)	500–7000
Maximum penetration (m below sea floor)	2000–4500
Possible Conditions	
Degree of fractures	High probability of fractures, possibly complicated by swelling clays
Porosity	Variable: moderate (10–20%) to high (60–70%)
Pore pressure	Variable: hydrostatic to lithostatic
Existence of volatiles	Gas hydrates, biogenic and thermogenic methane, and heavier hydrocarbons
Percent Recovery Required	As high as possible; if low, then stable holes with logs required
Maximum Core Disturbance Tolerated	Minimal to preserve structural fabrics and to minimize contaminating core interiors
Sampling, Testing, and Logging Needs	
Core sampling	APC, XCB, and RCB with large sample volumes for physical properties and geochemical and structural studies; possible interbeds of mud and thick unconsolidated sands requiring use of short stroke (~2 m) APC and/or vibracore techniques; directional drilling desirable; oriented cores necessary for structural studies; coring system effective to maintain in-situ P, T
Core sample diameter	ODP core diameter acceptable; larger diameter better to allow running some downhole logging tools
In situ sampling and testing	Temperature, pore pressure, gas and fluid compositions, permeability, microbial Sample coils recoverable from outside seal
Down-hole logging	*Essential logs*: natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, resistivity (DLL), check shots (WST), fluid sampling (MDT), LWD (resistivity images and density/porosity), geochemical (GLT) *Useful logs:* resistivity images (ARI), BHTV, magnetic susceptibility/reversals (GHMT), VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	Fit-to-mission
Environmental Conditions	
Wind	Variable; up to typhoon
Sea state	Flat to large swells; currents to 2-3 knots in some areas
Temperature	Variable
Ice conditions	–
Other Program Requirements	CORKS, A-CORKS (multi-packers), strain, Packer experiments Casing program as needed Shipboard laboratory facilities for handling microbial and chemical samples at in-situ P,T; improved shipboard chemistry analyses (e.g., ICP-OES)

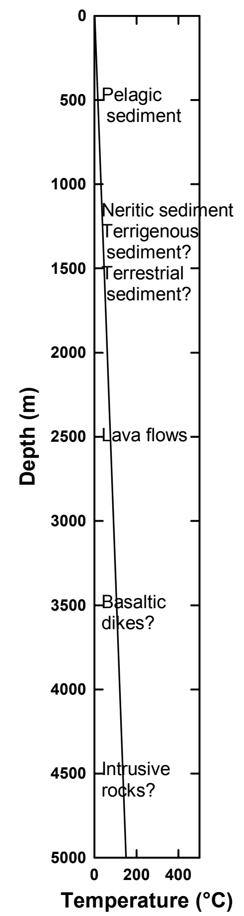
Lithology and Thermal Gradient



Target Section 4
Large Igneous Province

Model Site Description	Oceanic plateaus and volcanic margins with pelagic, neritic, terrigenous, and terrestrial sediment overlying igneous basement
Scientific Objectives	Investigate magmatic and tectonic development of oceanic plateaus and volcanic passive margins
Water Depth Range (m)	50–6000
Maximum penetration (m below sea floor)	5000
Possible Conditions	
Degree of fractures	Low to high
Porosity	Low to high
Pore pressure	Unknown
Existence of volatiles	Possible in sediments
Percent Recovery Required	100% for temporal and geochemical development of volcanics, dikes, and plutonics 100% of sediment section
Maximum Core Disturbance Tolerated	Minor stretching/squeezing in sediment cores; no biscuiting Minimal induced fracturing of rocks
Sampling, Testing, and Logging Needs	
Core sampling	Triple offset APC, XCB in soft semi-consolidated sediments; RCB in lithified material and igneous rock; complete recovery of soft sediment intercalated with lavas
Core sample diameter	>60 mm ODP standard APC; >60 mm ODP standard XCB
In situ sampling and testing	Geothermal gradient
Down-hole logging	*Essential logs:* Natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, BHTV, resistivity (DLL), check shots (WST) *Useful logs:* LWD (resistivity images and density/porosity), resistivity images (ARI), geochemical (GLT), magnetic susceptibility, VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	60
Environmental Conditions	
Wind	Moderate
Sea state	Maximum ~5 m swell (15–20 m for polar LIPs)
Temperature	~30°C (below freezing for polar LIPs)
Ice-conditions	Not for most sites (10/10 ice cover for polar LIPs)
Other Program Requirements	–

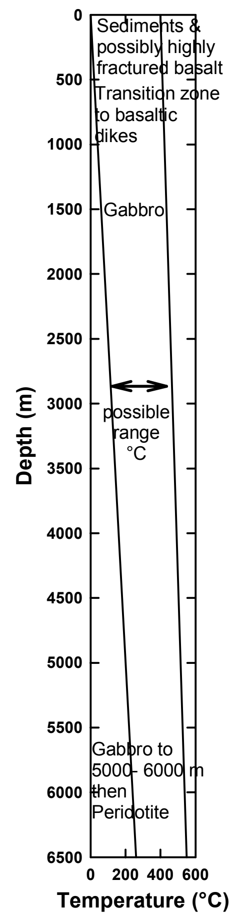
Lithology and Thermal Gradient



Target Section 5
Oceanic Crust

Model Site Description	Sections within oceanic crust that might include: bare-rock drilling; drilling through sediment into older crust; drilling in tectonic windows
Scientific Objectives	Delineate crustal architecture Define seismic boundaries and faults Mode of formation and alteration Examine hydrologic properties, fluid and rock chemistry Evaluate subsurface biosphere
Water Depth Range (m)	500–6500
Maximum penetration (m below sea floor)	7000
Possible Conditions	
Degree of fractures	Extreme in upper 100–300 m volcanics; lower with depth except in short intervals at fault zones where extreme
Porosity	30–80% in sediments; 1–40% in basalts; decreasing with depth
Pore pressure	Up to 1–2 MPa over or under hydrostatic at ridges; lower off-axis
Existence of volatiles	Possible at ridges; unlikely off-axis
Percent Recovery Required	70–90%
Maximum Core Disturbance Tolerated	Minimal disturbance to sediments (if present); minimal induced fracturing preferred
Sampling, Testing, and Logging Needs	
Core sampling	APC, XCB, and RCB, or other to make hole and collect core Diamond drilling with narrow kerf for high recovery of fractured and brecciated material Core orientation Horizontal (directional) drilling could provide huge benefits
Core sample diameter	2–3" or greater
In situ sampling and testing	Formation hydrologic properties; fluid and biological sampling; borehole stress; long-term observatories
Down-hole logging	*Essential logs:* natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, BHTV, resistivity (DLL), VSP (3-comp./offset), fluid sampling and permeability (MDT and NMR), geochemical (GLT) *Useful logs:* LWD (resistivity images and density/porosity), resistivity images (ARI), magnetic susceptibility
Endurance	
Maximum days at sea without resupply	Up to 60
Environmental Conditions	No unusual conditions expected:
Wind	Up to Force 8, but most likely moderate
Sea state	Moderate
Temperature	Moderate
Ice-conditions	Only for Arctic drilling (lower priority); mostly latitudes <40°
Other Program Requirements	–

Lithology and Thermal Gradient

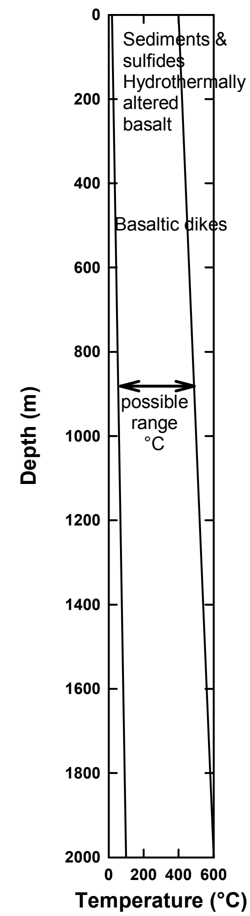


Target Section 6

Hydrothermal System and Massive Sulfide Deposit

Model Site Description	Sulfide deposits and hydrothermal upflow zones at bare-rock and sedimented ridges, in back arcs and in fracture zones
Scientific Objectives	Delineate sulfide and stockwork architecture down to reaction zone Investigate fluid and rock chemistry, hydrogeologic properties, significance of subsurface biosphere Examine faults
Water Depth Range (m)	500–4000
Maximum penetration (m below sea floor)	2000
Possible Conditions	
Degree of fractures	Moderate to extreme
Porosity	30–80% in sediments; 10–40% in sulfides; 1–40% in basalts
Pore pressure	Up to 1–2 MPa over or under hydrostatic pressure possible
Existence of volatiles	Likely, particularly hydrogen sulfide
Percent Recovery Required	70–90%
Maximum Core Disturbance Tolerated	Minimal disturbance to sediments (if present) and sulfides; minimal induced fracturing of consolidated sulfides and basalts
Sampling, Testing, and Logging Needs	
Core sampling	APC, XCB, RCB, or other to make hole and collect core Diamond drilling with narrow kerf for high recovery of fractured and brecciated material Core orientation Horizontal (directional) drilling could provide huge benefits
Core sample diameter	2–3" or more
In situ sampling and testing	Formation hydrologic properties; fluid and biological sampling; borehole stress; long-term observatories
Down-hole logging	*Essential logs:* natural gamma, density, sonic (V_p and V_s), caliper, porosity, temperature, FMS/FMI, BHTV, resistivity (DLL), check shots (WST), fluid sampling and permeability (MDT and NMR), geochemical (GLT), LWD (resistivity images and density/porosity), magnetic susceptibility *Useful logs:* resistivity images (ARI), VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	60
Environmental Conditions	No unusual conditions expected:
Wind	Up to Force 8, but most likely moderate
Sea state	Moderate
Temperature	Moderate
Ice-conditions	–
Other Program Requirements	–

Lithology and Thermal Gradient

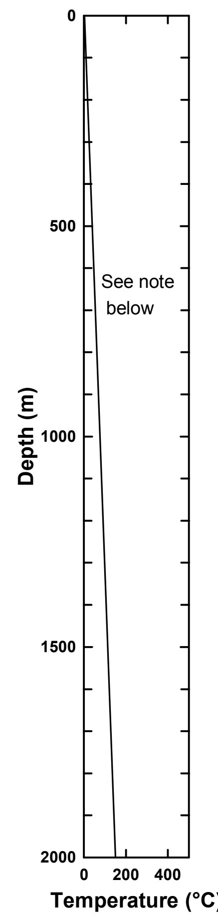


Target Section 7

Deep Ocean Sediment

Model Site Description	Low to high latitude sedimentary sections
Scientific Objectives	Understand mechanisms of climate variability through analysis of oceanic sediment sections with temporal resolutions ranging from seasonal to tectonic Document depth, geographic extent, trophic strategies, and ecological structure of the recently discovered 'Deep Bacterial Biosphere' and understand its distribution relative to temperature, pH, pressure, redox potential, host lithological substrate, and aqueous media Examine fundamental processes associated with formation, stability, and dissociation of gas hydrates and potential impact of rapid hydrate dissociation on global carbon cycle Document and understand effects of impact events on global climate and mass extinctions
Water Depth Range (m)	200–6000
Maximum penetration (m below sea floor)	2000 (to 150°C isotherm for deep biosphere work)
Possible Conditions	
Degree of fractures	Minor in most sections; extreme in meteor impact sites
Porosity	Highly variable according to lithology
Pore pressure	Hydrostatic; overpressure possible in organic rich sequences
Existence of volatiles	Variable according to location; definitely for gas hydrates
Percent Recovery Required	Generally as high as possible (90–100%) As low as 20% per lithology for impact deposit sites
Maximum Core Disturbance Tolerated	Minor vertical stretching/squeezing generally acceptable (but undesirable) in soft sediments; extensive biscuiting/fracturing not acceptable; microbiological/ chemical contamination not acceptable in core interiors
Sampling, Testing, and Logging Needs	
Core sampling	Continuous, multiple offset coring in all cases: APC, XCB, RCB for typical pelagic sections depending on induration; vibra or hammer coring for sandy intervals Diamond coring or other for alternating hard/soft sections PCS for recovery of sediments containing volatiles *Desirable:* minimize magnetic overprint due to drilling/coring; APC/XCB to RCB coring without tripping drill string
Core sample diameter	Many requests for larger than current ODP APC/XCB standard for sample volume/availability and minimal contamination of core interior
In situ sampling and testing	Pore waters, microbiology, geothermal gradient, volatiles and hydrates
Down-hole logging	*Essential logs:* magnetic susceptibility/ reversals (GHMT), natural gamma, sonic (V_p and V_s), density, caliper, resistivity, porosity, FMS/FMI, VSP (3-comp./offset), fluid sampling and permeability (MDT and NMR) *Useful logs:* geochemical (GLT), LWD (resistivity images and density/porosity)
Endurance	
Maximum days at sea without resupply	60
Environmental Conditions	
Wind	To 70 knots
Sea state	To Beaufort 8
Temperature	Below freezing to 30°C
Ice-conditions	Up to 8/10 to 10/10 ice cover, 2.5 m thick, drifting at 0.1 to 0.5 knots
Other Program Requirements	Icebreaker support as needed, CORKS, VSP's, 3-D seismic surveys

Lithology and Thermal Gradient



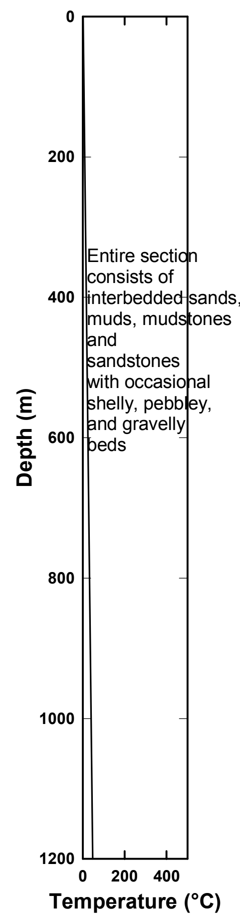
No single lithologic section covers range of expected lithologies. Possible lithologies include:

- Biogenic soft lithologies (siliceous and calcareous oozes)
- Biogenic firm and hard lithologies (chalks, cherts, limestones)
- Interbedded soft and hard lithology possible
- Clastic lithologies (clays/claystones, muds/mudstones, silt/siltstones, with varying sand contents, sandstones, and shales
- Impact breccia
- Volcanogenic sediments
- Turbidites

Target Section 8
Passive Margin Stratigraphy

Model Site Description	Low to mid-latitude siliciclastic nearshore and passive margin sediments–stratigraphic drilling
Scientific Objectives	Understand controls on geometry and composition of shallow water stratigraphic record in relation to changes in sea level, climate, and tectonics Evaluate amplitude and mechanisms of global and regional sea level change Understand impact of fluid flow on geochemical and isotopic composition of the global ocean
Water Depth Range (m)	1–1000
Maximum penetration (m below sea floor)	1200
Possible Conditions	
Degree of fractures	Minimal
Porosity	60–75% in shallower parts of section, less at depth
Pore pressure	Hydrostatic to pressures requiring BOP
Existence of volatiles	Yes
Percent Recovery Required	80–100%
Maximum Core Disturbance Tolerated	Vertical stretching/squeezing acceptable in soft sediments; extensive biscuiting/fracturing not acceptable
Sampling, Testing, and Logging Needs	
Core sampling	Slim-line might enhance core recovery, but would limit range of logging tools available as well as sample volume Continuous, multiple-hole sites required using short stroke (~2 m) APC and RCB techniques to recover inter-bedded soft mud and unconsolidated sand lithologies
Core sample diameter	2–3" or more
In-situ sampling and testing	Fluid and biological sampling
Down-hole logging	*Essential logs:* natural gamma, density, caliper, sonic (V_p and V_s), resistivity, porosity, FMS/FMI, magnetic susceptibility/reversals (GHMT), check shots (WST), fluid sampling and permeability (MDT and NMR) *Useful logs:* geochemical (GLT), LWD, VSP (3-comp./offset)
Endurance	
Maximum days at sea without resupply	14–60
Environmental Conditions	
Wind	To 40 knots
Sea state	To Beaufort 5
Temperature	0 to 30°C
Ice-conditions	–
Other Program Requirements	Casing Anchored platform, jackup rig, or semi-submersible

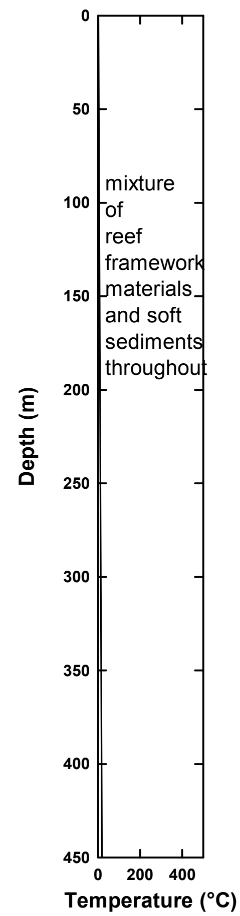
Lithology and Thermal Gradient



Target Section 9
Carbonate Reef, Atoll, or Bank

Model Site Description	Barrier reefs, atolls, carbonate banks and platforms
Scientific Objectives	Determine rates, amplitudes and mechanisms of global sea level change Document inter-annual and seasonal variability of sea surface temperature Understand impact of fluid flow on geochemical and isotopic composition of the global ocean Evaluate reef carbonate production and its impact on global carbon budget.
Water Depth Range (m)	5–1000
Maximum penetration (m below sea floor)	450
Possible Conditions	
Degree of fractures	Low to high
Porosity	Variable: 10–90%
Pore pressure	Near hydrostatic pressure
Existence of volatiles	–
Percent Recovery Required	75–100%
Maximum Core Disturbance Tolerated	Vertical stretching/squeezing acceptable in soft sediments; extensive biscuiting/fracturing not acceptable
Sampling, Testing, and Logging Needs	
Core sampling	High recovery RCB cores required to recover intact pieces of reef framework sufficiently large for fine-scale timeseries sampling
Core sample diameter	Slim-line might enhance core recovery, but would limit range of logging tools available as well as sample volume
In situ sampling and testing	Fluid and biological sampling
Down-hole logging	*Essential logs:* sonic (V_p and V_s), GHMT, natural gamma, density, caliper, resistivity, porosity, FMS/FMI, check shots (WST) *Useful logs:* geochemical (GLT), fluid sampling (MDT), temperature
Endurance	
Maximum days at sea without resupply	20–60
Environmental Conditions	
Wind	Generally up to 30 m s^{-1}; seasonal cyclone potential
Sea state	Beaufort 0 to 5 except seasonal cyclone activity
Temperature	15–30°C
Ice-conditions	–
Other Program Requirements	Anchored or jack-up barge, seabed drilling platform

Lithology and Thermal Gradient



Deep biosphere issues are of broad significance to future scientific ocean drilling. Although these are given as an explicit objective in the *Deep Ocean Sediment* section (Target Section 7), we note here that microbial studies could be highlighted as an objective for each of the target sections. Since our goal is to use these target sections to define ship capabilities, not a prioritized science plan, we have not explicitly added the deep biosphere objectives to each target section. In addition, the recognition of the importance of the deep biosphere and the outstanding questions yet to be resolved around this issue highlight the increasing integration of pore water geochemical studies and microbial studies in all scientific ocean drilling.

Moving from Target Sections to Defining Platform Capabilities

From the perspective of defining the operational and scientific characteristics of the non-riser platform, the performance specifications required to meet all high priority scientific objectives summarized in the nine summary target sections are relatively extreme. In a substantial number of cases, they are well beyond the capabilities of the *JOIDES Resolution* as currently configured and operated and beyond those of any other single vessel of its class as well. This clearly emphasizes the need for a widely versatile non-riser platform as well as mission-specific platforms in the IODP. The range of capabilities defined by the target sections are summarized in Table 3.

Table 3. Summary of Platform Capabilities Defined by Target Sections

Water Depth Range (m)	1–7000
Maximum penetration below sea floor	from 100 m to as deep as possible below 2 km
Total drillstring length (m)	~11,000
Lithology	Full range: biogenic and lithogenic sediments, continental and oceanic crust
Possible Conditions	
Degree of fractures	Negligible to extreme
Porosity	1–90%
Pore pressure	Large range, up to pressures requiring well control
Existence of volatiles	None to hydrates, hydrocarbons, hydrogen sulfide
Sampling and Logging Needs	
Core sampling	Continuous coring/sampling with high recovery in all lithologies; Advanced Piston Corer cores should be oriented
Core sample diameter	See discussion below
Down-hole logging	Maximum penetrations desired (from >2 km and up to 7 km; Target Sections 1-7) are likely to require high temperature down-hole capability; this may limit logging tools available New, higher resolution logging tools are desirable (Target Sections 7-9) Remotely operated drilling devices will require new adaptations of logging tools and technologies to slim, shallow-penetrating core barrels
Endurance and Capacity	Global operations; up to 60 days without resupply; scientific party of sufficient size to address measurements related to safety, real-time drilling decisions, and ephemeral properties at a minimum
Environmental Conditions	Equatorial to 10/10 drifting ice cover; wide range of wind and sea state conditions
Other Program Requirements	Casing program (1500 m), mud storage

The ranges in Table 3 represent the extremes; it is important to note that the bulk of targeted drilling is well within the technological capabilities of a single non-riser vessel. In an integrated, multi-platform program, careful consideration of assigning the most appropriate and effective platform to address given scientific objectives will be needed. However, given the mandate to design a vessel capable of addressing the widest possible range of high-priority targets, we note the following factors which approach or exceed the capabilities of the *JOIDES Resolution* as currently configured and operated.

Shallow Water Drilling (as shallow as ≤10 m)

The need for drilling in shallow to very shallow waters stems from a variety of high priority targets, including investigations of volcanic margins (Target Section 4), passive margins (Target Section 8), and very shallow carbonate systems (Target Section 9). These targets sometimes require drilling in waters as shallow as a few meters to tens of meters deep.

Deep Water Drilling (>6000 m)

The need for drilling in deep water involves scientific objectives for the investigation of oceanic crust and of convergent margin settings, as well as for emplacement of down-hole observatories (Target Sections 1, 3, and 5). For these target sections, water depths up to 6 to 7 km have been targeted, in addition to more moderate depths.

Deep Penetration (>2000 m below sea floor)

Deep penetration below the seafloor is indicated for drilling sites in convergent margins, in large igneous provinces, and in the oceanic crust, as well as for emplacement of down-hole observatories (Target Sections 1, 3, 4, and 5). The challenges of well control and high temperatures in such deep penetrations pose additional problems, and deep penetrations may require use of the riser vessel for hole stability.

High Latitude Operations

Meeting aspects of the scientific objectives encompassed in the large igneous province, oceanic crust, and deep ocean sediment target sections (Target Sections 4, 5, and 7) requires drilling in high latitudes, including ice covered regions.

Well Control and Blow-Out Prevention

Although the bulk of the drilling targeted does not require blow-out prevention, a number of target sections indicate the possible to definite presence of hydrocarbons and other volatiles (Target Sections 2, 3, 4, 5, 6, 7, and 8). Targets with need for well control and blow-out prevention may require the use of the riser vessel, but concerns arise because of the water depths limitations of that vessel (no shallower than 500 m; initial maximum depth of 2500 m) relative to the water depth requirements of the target sections. We assume that sedimentary targets requiring well control (blow-out prevention) in water depths >500 m must be addressed by the riser platform, while those in water depths <500 m will require mission-specific platforms. We discuss these issues relative to their impact on non-riser vessel evaluation later in the report.

Sampling, Testing, and Logging Needs

Sampling, testing, and logging needs are considered in this report because they influence large scale design characteristics of the non-riser vessel, and they highlight the importance of advances in coring, sampling, and in situ testing and logging required to meet scientific objectives expressed in the target sections. These considerations are held in common across nearly all target sections and thus we do not make explicit reference to individual sections in the following discussion.

A wide variety of coring tools are called for in addition to the ODP standard Advanced Piston Corer (APC), Extended Core Barrel (XCB), and Rotary Core Barrel (RCB) tools. Additional tools include vibra or hammer coring to better recover unlithified coarse materials, diamond coring to better recover alternating hard/soft lithologies and fractured or brecciated material, and a pressure coring system to better recover sediments containing volatiles at in situ conditions. The ability to change from APC/XCB to RCB without a string trip is also desirable as a means of efficiency, enhanced flexibility, and enhanced recovery. Finally, oriented cores are required for paleomagnetic studies, and directional drilling is needed in order to better characterize structure and to better sample horizontally varying lithologies.

Many of the submitted target sections and, as a consequence, several of the synthesis target sections called for core sample diameter greater than the current ODP standard, and certainly no less than the current standard. This desire for larger core diameter is reflected in the COMPLEX Report as well. Requests for larger core diameters often result from the desire for larger volume samples, reflecting the increasing number of different types of analyses done on each sample, especially those with paleoceanographic and paleoclimatic objectives, but including a wide array of objectives (e.g., ocean crustal drilling). The call for larger volume cores in the case of deep biosphere work, and work on fluid chemistry as well, reflects the desire for decreased within-core contamination. At the same time, there is an equally strong call for decreased core disturbance in terms of squeezing, stretching, and biscuiting of APC and XCB material and fracturing of lithified XCB and RCB material. Note that these objectives (larger core diameter and reduced core disturbance) may be in conflict for rotary coring processes as larger core diameter (and kerf width) is generally associated with increased core disturbance (as discussed in the *Report of the International Workshop on Riser Technology*, 1996, pp. 220-221). In addition, issues of core diameter and thus pipe diameter can not be separated in discussion from those related to down-hole logging.

Down-hole logging will continue to be an integral part of drilling operations in many environments. Tool development is in a continual state of flux, and we recognize that there is really no single “industry standard” in terms of tool size. The target sections capture the need for a wide range of logging tools in accomplishing the scientific objectives. Finally, there is a need for a wider selection of high temperature logging and sampling tools for those sites where penetration of several km will be required.

How Big a Hole? Issues Around Core Diameter

We do not reach a final recommendation on the issue of hole diameter in terms of specifying the size. Issues of size, strength, and weight of the drill string need careful consideration and engineering study beyond the scope of this work. Instead, we describe the guiding principles we think should be used in designing this aspect of the non-riser vessel for IODP:

(1) Sample volume is important in achieving many scientific objectives encompassed in the target sections.
(2) Sample quality (i.e., minimal disturbance, minimal contamination of the interior) is important in addressing many scientific objectives, especially those relying on studies involving structural fabrics, magnetic signatures, microbiology, and pore water geochemistry.
(3) Hole stability is important in achieving desired depths of penetration, and hole diameter plays a key role in hole stability.
(4) The widest availability of appropriate down-hole logging tools is important to achieving the scientific objectives encompassed in the target sections.
(5) Compatibility with the riser vessel is desirable for drilling, sampling, and down-hole tools in an integrated, multi-platform program.

On Board Scientific Measurement Capabilities

One of the most important things we have learned from the present and past international drilling programs concerning the conduct of science and the achievement of scientific goals is that a substantial shipboard team of scientists who work together to achieve these goals is a critical and indispensable element of a scientific drilling program and should be preserved. The synergistic and educational benefits of such teams, combined with their unparalleled degree of productivity, should not be lost in the new program. An additional dimension of the “floating international university” model we value is that scientific enthusiasm is infectious and good for the operation of the whole ship, not just the science party. A well-equipped laboratory environment aboard the non-riser drill ship, with additional space, capabilities, and flexibility relative to that aboard the *JOIDES Resolution*, is required to achieve the scientific goals of IODP.

Overview of Laboratory Configuration Needs

In order to accomplish the objectives outlined in the target sections, the laboratory configuration should consist of a mixture of flexible interior space and outside containerized space. The interior of the laboratory space should contain areas for (1) core processing (e.g., core handling, cutting, splitting), (2) initial core characterization (e.g., multi-sensor tracks [MSTs], core description area, core sampling areas, geochemical analyses, and stratigraphic analyses), and (3) other miscellaneous functions including (but not limited to) office space, computer-user rooms, meeting areas, data-processing/integration areas, and science supply storage. Additional interior laboratory space for geophysical data collection is required at the stern of the ship. Exterior laboratory requirements include space on top of (or in close proximity to) the main laboratory space for standard 20 ft containers for “as needed” scientific lab modules and for core storage.

(1) Interior Laboratory Space

Core Processing Laboratories

The core processing area is best located near the drill floor, forward of the derrick. The main interior core processing area should be designed to easily move 1.5 m long sections of core through the lab and thus, every effort should be made to minimize the number of different levels (decks) within the laboratory space.

Flexibility in use and configuration of the laboratory stack is paramount. Exterior access to the core processing and analytical areas should be available at each level, with exterior crane access to facilitate the movement of equipment in and out of the laboratory space. Interior wall design should be as flexible as possible so laboratory space can be reconfigured to fit the demands of a particular leg or set of legs. Interior space within the main core processing levels must be designed so that standard whole-core/split core logging equipment (e.g., physical property MSTs, image capture tracks, and paleomagnetic tracks) can be moved about without major redesign or modifications that require extended port calls. All laboratory levels require freight elevator access. Other interior laboratory space such as offices, computer areas, meeting rooms, supply storage should be located within or in very close proximity to the core processing area.

We estimated the space needed for these functions based on knowledge of the existing *JOIDES Resolution* laboratories and their shortcomings, on SCIMP review of the existing laboratory facilities and the required space for measurements related to safety decisions, real time drilling decisions, and ephemeral properties. In summary, approximately 1800 m^2 of interior laboratory space, a 50% increase over the current space on the *JOIDES Resolution*, is needed to house the core processing and sample processing areas, office space, and other needs within the main laboratory areas.

Geophysical Laboratory

A geophysical data collection laboratory should be located near the stern of the ship, as close to the waterline as possible, for the deployment, servicing, and storage of geophysical survey equipment. Approximately 50 m^2 of space should be dedicated to the geophysical data collection laboratory. Additional geophysical processing equipment need not be located in this geophysical data collection laboratory and is more appropriately located in the data integration areas in the main laboratory stack.

(2) Containerized Space

"As Needed" Container Space

A key aspect of any post 2003 riserless ship is the need for short-term use (e.g., 1-2 legs) of "mission-specific" or "as needed" portable containers. Full-service pads for five standard 20' containers should be located near the lab stack. One additional full-service pad should be located well away from other laboratory space in order to conduct tracer studies and at the same time prevent contamination of other core material and laboratory spaces. All pads should be fully compatible with containers used on Japan's riser vessel. The deck space must be adequate for the containers to be individually accessible, placed in a single layer (no stacking), located near the main laboratory space, fully serviced (electricity, compressed air, potable water, and waste-water drains), and convenient for loading and off-loading of the containers while in port.

Core Storage

Refrigerated containerized core storage units capable of holding 8000 m of core should be located on a single (top-most) deck near the laboratory stack, with accessibility to the core processing area via freight elevators. The refrigerated containers should be fully compatible with core storage containers on Japan's riser vessel. The deck space must be adequate for the containers to be individually accessible, placed in a single layer (no stacking), located near the main laboratory space, serviced with electricity, and convenient for loading and off-loading of the containers while in port.

Required Drilling Platform Characteristics

Based on the scientific objectives encapsulated in the target sections and the on-board scientific measurement capabilities required, a number of drilling platform characteristics were defined for the purposes of the ship survey. These characteristics are summarized below[3].

1. Riserless drilling: The single most distinguishing characteristic of the vessel is that it will drill without a riser. This is the mode that the *JOIDES Resolution* presently operates in. Those objectives that can only be met by a platform with riser capabilities will be pursued by Japan's contribution to IODP.

2. Continuous sampling: The scientific objectives dictate that continuous or near-continuous high-quality samples will be required from the seafloor to the target depths. This is in stark contrast to typical exploration/production drilling, where the primary objective is to "make hole," especially in the upper portions of the section. High quality sampling may require improved heave compensation, drill string stabilization, or a new combined compensation and stabilization system.

3. Mud and casing storage: Because of the riserless operation of the vessel and hence no mud returns, the capacity for bulk mud storage will be important. Sufficient storage and handling facilities for 1500 m of casing will also be required.

4. Water depths: The scientific community has identified drilling targets in very shallow water (<20 m) and in water as deep as 7000 m.

5. Drilling depths: Drilling depths as deep as possible beyond 2000 m below seafloor will be required.

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[3] Note that the depths given in items 4-6 differ from those in drilling platform survey (Appendix 4), with the drilling platform survey giving deeper water depths (as deep as 10,000 m), deeper drilling depths (as deep as 7,500 m below seafloor), and longer combined drill strength length (in excess of 11,000 m). The list in the survey letter was designed to elicit information on the capabilities of the existing fleet relative to the scientific needs.

6. Combined drill string length: The maximum combined drill string length (water depth plus drilling depth) that has been identified is approximately 11,000 m.

7. Drill string: The drill string should be composed of industry-standard drill pipe, and should have a minimum ID of 4.125 inches (105 mm) in order to pass sampling, coring, and wireline logging tools.

8. Station keeping: The vessel must be dynamically positioned. For work in shallow water, an anchoring system would be advantageous. The vessel should be able to continue dynamic positioning (DP) operations in Beaufort 8 conditions or worse.

9. Endurance: The vessel must be able to remain on location for periods up to 8 weeks without resupply or port call.

10. Laboratory and sample storage: Four elements of laboratory and sample storage space have been identified:

    a. 1,800 m^2 of interior heated/air conditioned lab space.

    b. Deck space for no. 10 20-foot refrigerated containers for the storage of samples.

    c. Deck space for no. 5 20-foot containers for special-purpose labs.

    d. Geophysics doghouse, 50 m^2, located on the stern.

11. Accommodations: There should be accommodations and services for 60 scientific staff (over and above marine, drilling, and catering crew), in 2-person cabins, with no more than 4 persons per head/shower. Suitable recreational facilities would also be needed.

12. Safety, Lifesaving, and Communications: The vessel should be equipped with safety, lifesaving, and communications equipment to allow it to operate in any jurisdiction in the world.

Ship Survey Methodology and Data Sources

The goal of the ship survey was to gather information about present and planned international capabilities. The execution of the work can be described as having taken place in four phases, as described below.

Phase 1: Platform and Owner Identification

In order to identify the existing and announced new-build drilling platforms in the international market, a data gathering exercise was undertaken, primarily making use of information available in the public domain. The primary thrust of this first phase was to identify individual platforms by name, the owner/manager companies, and the individual(s) within those companies to whom specific inquiries should be addressed.

The sources of data consulted in order to obtain initial information included a keyword search on the Internet, periodicals such as *Oil and Gas Journal* or *Offshore* (PennWell Publishing Company), contacts within the industry, and Oceandril Data Services, Inc. When an owner/manager company was identified, they were contacted by facsimile, e-mail, or both, introducing CDC and requesting the point of contact within the company to whom further inquiries should be addressed.

Phase 2: Identification of Scientific Drilling Objectives and Platform Characteristics

Phase 2 was carried out in parallel with Phase 1. We used the synthesis target sections and the defined on board scientific measurement capabilities to describe drilling platform requirements, summarized in the preceding section.

Phase 3: Drilling Platform Survey

Phase 3 consisted of the design of a survey of drilling platforms, and sending the survey to each of the platform owner/manager companies for completion. The survey (Appendix 4) consisted of three parts: an introductory letter introducing IODP, CDC, and the purpose of the survey; a questionnaire requesting specific technical information and specifications for the platforms, and a questionnaire soliciting additional information and subjective responses in the event that the platform met certain minimum criteria. Surveys were sent directly to the individuals identified in each owner/manager company, if possible first by facsimile, and followed by a copy by mail.

Phase 4: Platform Evaluation

Using the information available for each platform (or in some instances, class of platform), the platform specifications were weighed against the list of desirable platform characteristics identified by CDC. We present an initial evaluation process on the most basic of the key criteria, as one of elimination; those vessels not meeting certain key criteria were eliminated. Further screening would depend on the physical and operational characteristics to be most heavily weighted.

Vessel Survey and Response

The drilling platforms identified on the international market, together with the owner/manager company, are presented in Table 4. Only drillships are identified in the list; for reasons explained more fully in a later section, some classes of platform were eliminated prior to the survey questionnaires being sent out.

The survey questionnaire (Appendix 4) was sent to the contact for each vessel manager. Of the 19 manager companies identified in the previous phase of the work, responses were received from 12. Those responses provided information on 31 of the 41 vessels identified (Table 5). Of those companies that responded, most replied to Part A, the questionnaire requesting specific technical information and specifications for the platforms. Fewer responded to Part B, the part soliciting additional information and subjective responses. The complete responses received from each respondent were provided to CDC for reference. Table 6 presents a summary of the response information for the vessels, with data based wherever possible on information provided in the returned surveys. Where survey data are incomplete, the table shows data from other sources.

Table 4. Drilling Vessels Identified on the International Market

Vessel Manager	Owner	Vessel Name
Diamond Offshore	Diamond Offshore	Ocean Clipper
Foramer	Foramer	Deep Sea Worker
Gazflot Ltd.	Gazflot Ltd.	Gazprom I
Global Marine Drilling Company	Global Marine	Glomar CR Luigs
	Global Marine	Glomar Explorer
	Global Marine	Glomar Jack Ryan
	Global Marine	Robert F Bauer
GNPC	GNPC	Discoverer 511
IPC (Lundin S.A.)	Prosafe ASA	Discover 1
JSL Drilling	JSL Drilling	Energy Searcher
Navis ASA	Navis ASA	Navis Explorer 1
Noble Drilling	Noble Drilling	Leo Segerius
	Noble Drilling	Noble Muravlenko
	Noble Drilling	Roger Eason
Northern Offshore	Northern Offshore	Northern Explorer II
	Northern Offshore	Northern Explorer III
ONGC	ONGC	Sagar Bhushan
Petrolia Drilling	Petrolia Drilling	Valentin Shasin
Pride Offshore	Pride International	Pride Africa
	Pride International	Pride Angola
R&B Falcon	R&B Falcon	Deepwater Discovery
	Deepwater Drilling	Deepwater Frontier
	Deepwater Drilling	Deepwater Millennium
	Deepwater Drilling	Deepwater Pathfinder
	R&B Falcon	Falcon Duchess
	R&B Falcon	Falcon Ice
	R&B Falcon	Peregrine I
	R&B Falcon	Peregrine II
	R&B Falcon	Peregrine III
	R&B Falcon	Peregrine IV
	R&B Falcon	Peregrine VII
Saipem	Saipem	Saipem 10000
Schahin Cury	Schahin Cury	SC Lancer
Sedco Forex	Sedco	JOIDES Resolution
	Sedco	Sagar Vijay
Smedvig Offshore A/S	Navis AS	West Navion
Transocean Offshore Deepwater Drilling Inc.	Transocean	Discover 534
	Transocean	Discover 7 Seas
	Transocean	Discover Deep Seas
	Transocean	Discover Enterprise
	Transocean	Discover Spirit

Table 5. Summary of Response Information from Vessel Managers

Vessel Manager	**Vessel Name**	Response?	Comment
Diamond Offshore	Ocean Clipper	Y	
Foramer	Deep Sea Worker	–	No response
Gazflot Ltd.	Gazprom I	–	Response for vessel from Petrolia
Global Marine Drilling Company	Glomar CR Luigs	Y	
	Glomar Explorer	Y	
	Glomar Jack Ryan	Y	
	Robert F Bauer	Y	
GNPC	Discover 511	Y	
IPC (Lundin S.A.)	Discover 1	–	No response
JSL Drilling	Energy Searcher	–	No response
Navis ASA	Navis Explorer 1	Y	
Noble Drilling	Leo Segerius	–	No response
	Noble Muravlenko	–	
	Roger Eason	–	
Northern Offshore	Northern Explorer II	–	No response
	Northern Explorer III	Y	
ONGC	Sagar Bhushan	–	No response
Petrolia Drilling	Valentin Shasin	Y	
Pride Offshore	Pride Africa	Y	
	Pride Angola	Y	
R&B Falcon	Deepwater Discovery	Y	
	Deepwater Frontier	Y	
	Deepwater Millennium	Y	
	Deepwater Pathfinder	Y	
	Falcon Duchess	–	Judged not suitable by owner
	Falcon Ice	–	Judged not suitable by owner
	Peregrine I	Y	
	Peregrine II	–	Cold stacked
	Peregrine III	Y	
	Peregrine IV	–	Information not available
	Peregrine VII	Y	
Saipem	Saipem 10000	Y	
Schahin Cury	SC Lancer	–	No response
Sedco Forex	JOIDES Resolution	Y	
	Sagar Vijay	–	No response
Smedvig Offshore A/S	West Navion	Y	
Transocean Offshore Deepwater Drilling Inc.	Discoverer 534	Y	
	Discoverer 7 Seas	Y	
	Discoverer Deep Seas	Y	
	Discoverer Enterprise	Y	
	Discoverer Spirit	Y	

Table 6. Summary of Vessel Information

VESSEL NAME	Year Constructed	Quarters Capacity (persons)	Length (m) (Panamax = 289.56 m)	Width (m) (Panamax = 32.31 m)	Transit Draft (m) (Panamax = 12.04 m)	Max height at transit draft (m) (Panamax = 62.48 m)	Moonpool Dimensions (m)	Total Vessel H.P.	D.P. Rating, manufacturer	Top drive load rating (tonnes)	Drilling wave/wind (m/kt)	Maximum Water Depth Non-riser (m)	Minimum Water Depth Non-riser (m)	Maximum Drilling Depth (m)	Derrick Rating (static) (tonnes)	Derrick Height (m)	Drawworks hook load (tonnes)	Compensator type	Compensator lift capacity (active/locked) (tonnes)	Total Stroke (m)	Mud Pit Active Volume (m^3)	Bulk Storage Capacity (m^3)	Sack storage (sacks)
Ocean Clipper	1977	116	161	34.0	7.3		6.1x7.3	25,000	Class 2/Nautonix 4003	650	9.1/68	2,286		9,906	635	55	650	Shaffer 18/600	272/680	5.5	142	483	1,500
Deep Sea Worker	1999											3,048											
Gazprom I	1996	109	159	25.3	7.6			18,000	Dual redundant Selvinit 280	none	7/45	300			400	45			200/400	5.5	240	756	510 m^3
Glomar CR Luigs	2000	150	231.34	36.0	9.5	89.92	12.8x12.8 / 5x6	46,300	DPS3/Nautronix	750	5.8/41	3,658	31	10,668	1,000	55	1,000	active	500/1,000	20	477	779	10,000
Glomar Explorer	1972	140	188.6	35.3	10.7	87.2	12.7x22.6	35,200	DPS-1/Nautronix ASK 4003	680.4	8.8/35	3,048	30	9,144	907	52	907	active and passive	--/454	8	239	3,058	7,000
Glomar Jack Ryan	2000	150	231.34	36.0	9.5	89.92	12.8x12.8 / 5x6	46,300	DPS3/Nautronix	750	5.8/41	3,658	31	10,668	1000	55	1,000	active	500/1,000	20	477	779	10,000
Robert F Bauer	1983	99	135.5	23.1	7.9	77.7	7.9x7.9	9,600	none	750	6.1/40	838	36.5	7,620	590	58	567	passive	227/454	5.49	94	478	3,000
Discoverer 511	1965	122	156.7	21.6	8.2	71	6.7	7,200	none	500	6.7/--	610	38	6,096	450	51		Houston Drilling Systems	180/540	6.1	190	385	120 m^3
Discoverer 1	1977	108	115.8	21.3								457		6,096	603	52							
Energy Searcher	1982	95	185.9	24.4								457		7,620	510	49							
Navis Explorer 1	2000	130	201.1	40.0	8.0	112 +/-	12.5x24 + 2@10x20	26,820	DP Class 3 / Konsberg	750	7/55	3,000		11,278	907		907	active	--/907	Note 1	470	1,300	
Leo Segerius	1981	100	149.4	26.8	7.3		8.23x7.01	19,000	11-Ceg 903			1,494		7,620	603	49			--/272		433	517	
Noble Muravlenko	1982	95	149.4	24.1	7.3		7.92x7.01	19,400	11-Ceg 903			1,219		7,620	454	49			--/272		191	547	
Roger Eason	1977	105	164.9	24.4	9.1		6.86x7.92	32,000	11-Ceg 903			1,981		7,620	454	49			--/272		199	708	
Northern Explorer II	1976	106	114.9	30.5								183		7,620	603	49							
Northern Explorer III	1973	103	149.3	23.8	7.5	72	6.8x7.9	6,000	--	500	4.6 / 60	300	40	6,100	590	49	500	IHC crown compensator	200/456	4.6	210	544	8,960
Sagar Bhushan	1987	108	146.0	24.7								305		6,096	635	49							
Valentin Shasin	1981	116	149.4	28.8	7.3	86	5.0x6.5	18,000	Class 3 AUTR / Konsberg-Simrad	650	5/70	no limit	35	6,500	454	49	650	Hydralift	252/680	7.5	282	212	2,000
Pride Africa	1999	130	207	30.0	10.0		11x12	28,845	3,000 M / CEGELEC	585	6/46	3,048	100	12,000	725	55		active	453/725	8	134	564	410 m^3
Pride Angola	1999	130	207	30.0	10.0		11x12	28,845	3,000 M / CEGELEC	585	6/46	3,048	100	12,000	725	55		active	453/725	8	134	564	410 m^3
Deepwater Discovery	2000	140	227.6	42.0	14.3	123.75	12.48x16.08	57,530	DPS-3, Simrad	680.72	7.9/55	3,048		11,195	998	64	907	active	453/907	7.62	954	1,190	10,000
Deepwater Frontier	1999	130	221.5	42.0	13.9	88.2	12.48x12.08	46,797	DPS-3, Simrad	682	5.79/50.5	3,048		11,652	907	52	680	active	435/na	Note 1	215	963	10,000
Deepwater Millennium	1999	130	221.5	42.0	13.9	88.2	12.48x12.08	46,797	DPS-3, Simrad	682	5.79/50.5	3,048		11,652	907	52	680	active	435/na	Note 1	215	963	10,000
Deepwater Pathfinder	1998	130	221.5	42.0	13.9	88.2	12.48x12.08	46,797	DPS-3, Simrad	682	5.79/50.5	3,048		11,652	907	52	680	active	435/na	Note 1	215	963	10,000
Falcon Duchess	1975	115	147.2	25.3								305		7,620	605	49							
Falcon Ice	1975	100	169.5	21.6								305		6,096	454	49							
Peregrine I	1982	116	149.9	24.0	8.3	73.6	7.16x5.28	17,186	NMD Class 2	650	5/66	1,900	46	7,619	544	53	650	passive	272/544	7.61	197	552	365 tonnes
Peregrine II	1979	99	149.4	23.5					yes			1,006		6,096	603	49							
Peregrine III	1976	124	148.7	23.5	7.5	73.6	7.2x8.25	15,600	DYNPOS AUTR / Nautronix 4003	650	5 / 45	1,800	10	5,188	604	53	545	active	272 / 545	7.5 effective	227	664	140 pallets
Peregrine IV	1995	128	171.9	28.3	7.9		7.92x8.53	22,500	Autr Dynpos			3,048		9,144	907				--/385		636	354	
Peregrine VII	1971	123	167.7	26.3	7.6	82.16	8.8x8.95	24,560	NMD DP Class II	750	3/45	2,286	152	9,144	681	66	623	active	363/737	7.62	460	535	3,000
Saipem 10000	2000	160	227.6	42.0	8.5		38.4x12.48	70,500	DPS-3 / Konsberg	680	5.8 / 50	1,829		13,000	907	61	907	active	450 / 907	7.62	2,000	1,120	14,000
SC Lancer	1977	99	137.2	23.5			7.32x8.23	17,000	DP			1,219		6,096	454	49					386		
JOIDES Resolution	1978	114	143.2	21.3	5.5	61.5	6.7x6.7	19,450	dual redundant / Nautronix		4.6 / 45	8,230	50	9,144	536	45		active	357/536	6	340	377	161 m^2
Sagar Vijay	1985	108	136.9	24.4								305		6,096	635	49							
West Navion	1998	117	253	42.0	13.2	84	19.2x12.5	16,315	DP3, DYNPOS AUTRO / Simrad	650	6.5/40	4,300	350	10,000	750	43	750	active	750	36	422	840	185 pallets
Discoverer 534	1975	128	163	27.0	5.1		7.6 dia.	16,000	Simrad ADP 703 MK1	650	7.6/50	2,134	244	7,620	590	52		active	--/600	6	215	340	204.4 m^2
Discoverer 7 Seas	1976	140	163	24.0	5.1		7.3 dia.	16,000	Simrad ADP 703 MK1	650	7.6/50	1,981	244	7,620	590	52		active	--/650	6	241	340	710 m^3
Discoverer Deep Seas	1999	200	255	38.0	11.9		9.1x24.4	42,000	DP3, Konsberg-Simrad	750	12/80	3,048		10,668	2000	69		active	500/1,000	7.6	2,448	456	16,000
Discoverer Enterprise	1999	200	255	38.0	11.9		9.1x24.4	42,000	DP3, Konsberg-Simrad	750	12/80	3,048		10,668	2000	69		active	500/1,000	7.6	2,448	456	16,000
Discoverer Spirit	1999	200	255	38.0	11.9		9.1x24.4	42,000	DP3, Konsberg-Simrad	750	12/80	3,048		10,668	2000	69		active	500/1,000	7.6	2,448	456	16,000

Note 1: n/a - heave compensated drawworks

Data not provided directly by vessel owner /manager

Other Types of Drilling Platforms

Early in the evaluation process, entire classes of platform were eliminated as unfeasible or not suitable as the major non-riser vessel in IODP to meet the broadest range of scientific objectives described in the synthesis target sections. This elimination occurred prior to the Phase 3 work, such that surveys were not sent for these potential platforms, such as submersibles, semi-submersibles, jack-up rigs, etc. The classes of platform that were eliminated, together with the reasons for elimination, are given in Table 7.

Table 7. Other Platform Types Not Surveyed

Class	Disadvantages
Geotechnical drillship	Limited drilling depth Limited accommodations
Submersible	Limited water depth
Semisubmersible	Port options limited Slow in transit May require dedicated support vessel Limited deck/variable load High day rate
Jack-up	Limited water depth Slow in transit May require dedicated support vessel

Limitations of the Non-Riser Vessel: Need for "Mission-Specific" Platforms

We emphasize here a main part of our charge: "to formulate the conceptual design characteristics of a single, non-riser drilling vessel…to address the widest possible range of non-riser scientific drilling objectives…The drilling limitations relative to defined scientific objectives for such a single vessel should be addressed and alternative drilling capabilities identified." While we anticipate that the majority of the drilling, sampling, testing, and logging needs expressed in the target sections should be met with the non-riser vessel, the wide variety of high-priority targets in very shallow water and in high latitude with substantial ice cover indicate the need for mission-specific platforms in IODP. Sites in <500 m water depth with need for well control will also require a mission-specific platform, while deeper sites with such needs must be addressed by the riser vessel. Arctic drilling will require platforms suitable for work in ice covered regions, and we did not assess this class of platforms. The platform types we did not survey may prove suitable in IODP for mission-specific uses, as no single non-riser vessel will necessarily and economically meet the full range of needs captured in the target sections.

Evaluation Process: Non-Riser Drilling Vessels

Initial Screening: Dynamic Positioning and Drilling Depth

The elimination of the above four classes of platform leaves the drillship as the remaining class that could be considered. Furthermore, existing hulls without drilling capability were not considered as part of the evaluation, in that such choices can be taken as being clearly more costly to convert to scientific drilling than an existing drillship.

From the vessel characteristics outlined above, identified by the CDC, some key criteria were derived against which the vessels within the existing fleet were measured. The two most important criteria were:

(a) The vessel must have dynamic positioning (DP).
(b) The vessel must have the capacity to drill to 9000 m or deeper, combined water plus hole depth. This depth was selected as being that which satisfies the majority of the scientific needs.

Eliminating those vessels not meeting the above criteria left the vessels shown in Table 8. It is noted that in meeting these two criteria, all vessels with quarters capacity less than the *JOIDES Resolution* were also eliminated, without having used that as a screening criteria.

Blow-Out Prevention

Some of the target sections identify the possible presence of hydrocarbons and other volatiles (gas hydrates, hydrogen sulfide), and drilling these can require the use of a blow-out preventer (BOP). In terms of performance specifications for the non-riser vessel, this was not included as a screening criteria for several reasons. All of the ships surveyed have this capability as they are presently configured (the *JOIDES Resolution* would need to have this capability re-established). However, BOP power and control are usually via the riser, and if the riser is eliminated then an alternative method of BOP power and control would have to be engineered. This would be true for all of the surveyed vessels. In addition, having the capability to deploy BOP equipment would come with the trade-off of the substantial space requirements for such capability. In addition, installation of the BOP requires penetrations of the shallowest parts of the seabed in depths where volatiles may occur. Industry tolerates a different set of protocols and potential risks of hydrocarbon release than has been the case in scientific ocean drilling. On balance, we recommend that sites requiring BOP equipment in water depths >500 m for IODP must be addressed by the riser vessel. Sites in shallower water depths will require mission-specific platforms or will require a tolerance of penetrating the seafloor where there is the possibility of hydrocarbons or gassy sediments.

Table 8. Vessels Meeting DP and Drilling Depth Criteria

VESSEL NAME	Quarters Capacity (persons)	D.P. Rating/Manufacturer	Maximum Drilling Depth (m)
Ocean Clipper	116	Class 2 / Nautronix 4003	9,906
Glomar CR Luigs	150	DPS3/Nautronix	10,668
Glomar Explorer	140	DPS-1/Nautronix ASK 4003	9,144
Glomar Jack Ryan	150	DPS3/Nautronix	10,668
Navis Explorer 1	130	DP Class 3 / Konsberg	11,278†
Pride Africa	130	3,000 M / CEGELEC	12,000
Pride Angola	130	3,000 M / CEGELEC	12,000
Deepwater Discovery	140	DPS-3, Simrad	11,195
Deepwater Frontier	130	DPS-3, Simrad	11,652
Deepwater Millennium	130	DPS-3, Simrad	11,652
Deepwater Pathfinder	130	DPS-3, Simrad	11,652
Peregrine IV	128†	Autr Dynpos†	9,144†
Peregrine VII	123	NMD DP Class II	9,144
Saipem 10000	160	DPS-3 / Konsberg	13,000
JOIDES Resolution	114	dual redundant / Nautronix	9,144
West Navion	117	DP3, DYNPOS AUTRO / Simrad	10,000
Discoverer Deep Seas	200	DP3, Konsberg-Simrad	10,668†
Discoverer Enterprise	200	DP3, Konsberg-Simrad	10,668†
Discoverer Spirit	200	DP3, Konsberg-Simrad	10,668†

† Data not provided directly by vessel owner/manufacturer.

Further Screening: Possible Approaches

Further refinement of the choice of vessel from the list of nineteen given in Table 8 would require defining the most appropriate criteria for screening. Some of these criteria could be quite straightforward, and they should be defined by the scientific needs to be addressed with this platform and within the context of the multi-platform structure of IODP. We give some examples of these issues here. The total range in quoted maximum speed is not large (10-14 kts), and speeds in actual operation may differ even less. All of the vessels listed in Table 8 have top drive systems for rotating the drill string, and most have (or are in the process of installing) an active heave compensation system. Many of the vessels listed in Table 8 have one or more dimensions that restrict them from being able to transit the Panama Canal. More sophisticated criteria could also be developed, for example, one weighing the maximum wave height during which drilling could be operated against other parameters.

Our survey also asked vessel managers about issues such as approximate charter rates, expectations of when the vessel would be available for lease, and estimates of how long conversion to meet the specified needs would take. We do not focus on these responses in any detail in this report for several reasons. Only some of the respondents provided information in response to these questions. Quite obviously, few vessel managers were willing to provide charter rate information for competitive reasons. We expect issues about availability and cost to be accurately assessed only in response to a competitive bidding process. All but one of the vessels listed in Table 8 would require conversion to operation in riserless mode and conversion of space (generally riser storage space) to laboratory space to meet the defined needs; the *JOIDES Resolution* operates in riserless mode, and has existing laboratory space, although less than defined here.

Drilling and Sampling Systems

Drilling Systems

Marine drilling systems, including that employed on the *JOIDES Resolution*, have certain elements in common. A drilling system has a method of rotating the drill string, either with a rotary table/kelly drive or with a top drive rotary. Although the vessels surveyed have rotary tables, their use in practice is limited. A top drive system is greatly preferred, because it allows additional joints of drill pipe to be made up onto the top of the drill string without raising the bit any appreciable distance off the bottom of the hole. All of the vessels in Table 8 use a top drive system.

In any floating drilling operation, the rig must compensate for heave on the drill string, otherwise the bit will bounce on the bottom of the hole making drilling virtually impossible. Heave pulls weight off the bit as the floating rig rides to the crest of a wave and places weight back on the bit as the rig rests in the trough. Thus, drillships must compensate for vertical drill string movements induced by a heaving vessel. Heave compensators consist either of a piston-and-cylinder assembly that is crown mounted at the top of the derrick or mounted directly under the traveling block, or of a motion compensated drawworks. Both types of motion-compensation systems work to maintain relative position between the top drive and the bottom of the well.

Most of the drillships in the international fleet use an active compensator. An active compensator reacts differently than a passive drive in that the system attempts to anticipate up-and-down movements instead of reacting passively. The system measures real-time rig displacement by integrating signals derived from an accelerometer and inclinometers. From this continuous calculation, the system adds or subtracts the residual motion imparted to the drill string by raising or lowering the drill string relative to the vessel. The work done by the system removes up to 95% of the unwanted excitation imparted to the drill string by the passive compensation system. In other words, an active system greatly reduces the magnitude of the variation in drill bit weight on the bottom of the borehole, which for a passive system can amount to as much as 20% of the weight of the drill string. Active heave compensation is an important criteria in selection of the new non-riser vessel.

Some of the new-generation drillships in the international fleet are designed for dual-activity. Dual-activity capability is intended to reduce well construction time by enabling operations to be conducted simultaneously in parallel, rather than sequentially in series as is traditionally required due to equipment limitations. By-products of the dual-activity concept include an increase in well construction quality, reduction of nonproductive time due to advanced inspection and pre-testing capabilities, flexibility to perform a wide range of subsea jobs, and redundancy of technically advanced high-capacity drilling equipment. Simultaneous operations necessitate a high level of job-specific planning to ensure the maximum reduction in critical path time is achieved. The scheduling of equipment and personnel coupled with real-time management of dual-activity operations is essential to success. Dual-activity capability is provided by a forward work area and an aft work area, each centered around a rotary table. The rotary tables are spaced 40 ft apart above an 80-ft by 30-ft moonpool and are serviced by independent drilling equipment packages. Upon arrival on location, the aft work area is utilized to jet structural pipe in, drill conductor hole, and run and cement conductor casing and the wellhead while running the BOP stack in the forward work area. However, since the IODP vessel is intended to operate in riserless mode, dual-activity capability provides little or no advantage.

Sampling Systems

Sampling systems in use around the world in association with marine drilling may be divided into two broad areas: those employed by the oil and gas industry, and those employed by the marine geotechnical community. Because of their specialization, the sampling tools developed for scientific purposes, that is, by and for the Deep Sea Drilling Project and the ODP, can be taken as a third category.

The suite of tools presently used by ODP for sampling include the Advanced Piston Corer (APC) for soft ooze and sediments; the Rotary Core Barrel (RCB) for medium to hard crystalline sediments; the Extended Core Barrel (XCB) for firm sediments; the Diamond Core Barrel (DCB) for hard formations; the Motor Driven Core Barrel (MDCB) for interbedded materials and hard fractured rock; the Pressure Core Sampler (PCS) for in situ pressure sediments; and the Tricone Retractable Bit (TRB). Some of these tools incorporate technologies also used by the oil and gas industry, but others are unique to ODP and the scientific community.

The sampling tools used by the oil and gas industry are in general designed to obtain samples of sedimentary rock, those being the formations within which hydrocarbon deposits are found. Hence, oil and gas industry sampling devices are in the main devoted to rotary coring and sidewall sampling in competent formations. As such, they are not directly suitable for some of the wide range of conditions that are of interest to ODP and IODP. As is evident from the nature of the tools used by ODP, these conditions vary from very soft near surface unconsolidated sediments, to very hard crystalline igneous and metamorphic bedrock. Nonetheless, ODP (and IODP engineers) should continue to adapt technologies developed by the oil and gas industry for their specialized purposes.

One of the common expressed requirements for scientific advances captured in the target sections, as well as in the needs of current ODP operations, has been for increased sample quality and recovery. In that respect, there is probably some benefit to be gained from adapting some of the techniques used by the marine geotechnical community.

There are a limited number of marine geotechnical contractors around the world, and their drilling and sampling systems tend to be similar. The market is dominated by the Dutch firm Fugro, but UK- and Switzerland-based SAGE also has capability. They rely on top drive rotary drill rigs and heave compensators adapted from the oil and gas industry. The compensation systems are frequently active, using the relative motion between the vessel and a seafloor reaction mass to activate the motion of the compensator. The sampling systems consist of short (1 m±) tubes that are pushed into unconsolidated sediments. The motive force is supplied by a hydraulic piston powered by an hydraulic umbilical from the surface through the drill string, or by mud pressure through the drill string similar to the APC. They also use in situ testing tools, in which power and data collection are via umbilical from the surface, or power is supplied by a battery pack, and control and data logging functions are supplied by an on-board computer. The most common in situ testing tools are the cone penetrometer and the in situ vane, both of which are used in unconsolidated sediments. The capability for coring rock is somewhat limited. Oil field bits and core barrels are used. Less commonly, a separate diamond coring system, designed for land-based minerals exploration, is deployed through the standard drill string to obtain a small diameter but high quality rock core. This is sometimes called a piggyback system.

The technique used by marine geotechnical contractors that differs most significantly from both the oil and gas industry and ODP is the use of the seafloor reaction mass. Prior to commencing drilling, the reaction mass is lowered to the seafloor. The drill string passes through the center of the reaction mass. When a sample is to be taken or a test is to be conducted, a clamp in the reaction mass is activated from the surface to grip the drill string. This eliminates any residual motion of the bit imparted by the compensation system, and allows high quality sampling and testing. As the seafloor reaction mass system is presently implemented, it cannot be engaged while coring, in that it does not permit rotation or advancement of the drill string when the drill string is clamped. This does not apply to the piggyback coring system, however, which is deployed through the stabilized drill string. Seafloor reaction mass systems have only been developed for water depths less than those of the full range of interest to ODP and IODP.

Importance of Drilling and Sampling Systems in Evaluation of Non-Riser Vessel

Envisioning the future of scientific ocean drilling, as we asked the community members to do in providing target sections, often required that the vision transcend the limitations of the non-riser vessel best known to the community, the *JOIDES Resolution*, and, particularly, the limitations of the existing drilling and sampling systems. Advances in the scientific questions of fundamental importance in earth and ocean sciences that need ocean drilling require not simply a "bigger, better vessel," but absolutely require improved drilling and sampling systems regardless of the choice of platform. The systems in current use are the <u>minimum</u> required for a new integrated program, and that program cannot succeed without significant advances in these areas. For example, the shortcomings of our current drilling and sampling systems in a significant number of areas are well-known; these include fractured rocks, alternating hard and soft lithologies (e.g., alternating cherts and chalks, interbedded sediments and basalts), sands and semi- and unconsolidated coarse grain sediments, and laminated, gassy sediments. In addition, the ability to construct truly continuous sedimentary sections via multiple and overlapping holes with high recovery has led to significant scientific successes in paleoceanography and paleoclimatology. Many areas of investigation would benefit significantly from improved core recovery and improved continuity of final sections, and this was a clear need identified in the submitted target sections. Although drilling and coring systems were not an explicit focus of this committee, these are of the utmost importance to the success of the non-riser vessel in meeting the scientific objectives. Attention to this matter in selecting a potential vendor and a non-riser vessel is emphatically emphasized here.

Summary

An integrated, multi-platform strategy has been identified consistently in vision and planning documents as a key element of the design of a future scientific ocean drilling program, critical to successful progress on fundamental scientific questions in the earth and ocean sciences. The contribution of a riser vessel by Japan's STA addresses one component, and the U.S. NSF has indicated the intention to bring a non-riser vessel to the program. The purpose of this report is to specify the performance specifications for this platform in a form that can be used to solicit international comment and criticism in the context of planning for IODP. To achieve the definition of the performance specifications, we constructed nine synthesis *target sections*, encapsulating the scientific objectives of various planning documents in a description of the locations to be drilled and their characteristics. We provided recommendations on the types and amount of on board scientific measurement capabilities. We conducted a survey of drilling vessels suitable for modification and conversion. We defined basic screening criteria for narrowing the list of potential platforms, and we provided initial guidance on how screening criteria might be applied in selecting a non-riser platform. We discussed briefly other types of platforms, and we provided an overview of drilling and sampling systems. We found the enthusiastic responses from the scientific community to our requests for target sections and the enthusiastic responses of vessel owners and managers to our letter soliciting information about drilling platforms positive and encouraging for the prospects for the future program.

Appendix 1. Target Section Request Letter

This letter was sent requesting target sections, accompanied by a template to be completed describing the target section fully. We also provided an example completed template as reference.

Dear Colleague:

In preparation for ocean drilling post-2003, NSF requested that the U.S. Science Advisory Committee (USSAC) define the operational and scientific capabilities required of a single non-riser drilling vessel to meet the needs of the future Integrated Ocean Drilling Program (IODP). In response, USSAC formed the Conceptual Design Committee (CDC) for non-riser drilling. We are charged with formulating the optimal design characteristics of a non-riser drilling vessel capable of addressing the widest possible range of objectives identified in the JOIDES Long Range Plan (LRP), the COMPLEX report, and other U.S. planning documents. These design characteristics will be considered by NSF in formulating an RFP (Request for Proposals) regarding the non-riser vessel.

We recognize that in many geologic environments there will be overlaps between the potential capabilities of a non-riser vessel, the OD21 riser vessel, and 'fit-to-mission' platforms. We most want to hear about high-priority scientific needs. This will help CDC and ultimately IPSC, with whom we have active communication, to identify the potential overlaps between different platforms. Scientific planning (and fitting to technology) can then be more smoothly integrated into the multi-platform environment envisioned by IPSC.

In consultation with geotechnical engineers, the CDC identified a number of key parameters for which information is required over the broadest geographic and lithologic array of IODP drilling targets. As chair of the [COMPLEX session or JOIDES PPG on *topic*], we request that you fill out the attached Excel matrix and lithological section such that it encompasses the broadest array of drilling and sampling capabilities required to meet the scientific objectives defined in your session. The matrix is designed to meet the needs of both hard- and soft-rock sections so certain parameters may be more or less applicable to your model site. If more than one model site is necessary feel free to create another. Please pay special attention to the section on sampling, in-situ testing, and logging needs. Holes are easy to make; to improve scientific return we need better recovery of undisturbed material and in-situ borehole information. Above all, BE BOLD. Do not feel constrained by the current limitations of the *JOIDES Resolution*.

We are on a relatively tight schedule. Please return these forms as soon as possible by e-mail attachment or by fax if it is more convenient for you to print it out and fill it in by hand. Please feel free to contact me or other CDC members with any questions or comments you may have. Thanks much for your input during this critical time.

Sincerely,
[Signature of committee member]

Appendix 2. Target Section Solicitations

We solicited target sections from the following individuals. Although we have named the affiliation under which we contacted them, we note that these individuals frequently play many roles in the planning and vision structure for scientific ocean drilling (e.g., a co-chair of a COMPLEX session may also be a member of a JOIDES planning group or of some other relevant group). We did not receive responses from every individual contacted, and at times, the resulting target section was submitted by a different individual (see list in Table 2, main text). We reviewed the target sections submitted to ensure that all relevant themes in our solicitation were indeed covered.

Individual	Session, PPG, or Disciplinary Area
COMPLEX Session Co-Chair (U.S.)	***COMPLEX Working Session Title (number)***
James Zachos	Extreme climates (#1)
Bill Curry	Climate variability (#2) - deep sea
Robert Dunbar	Climate variability (#2) - shallower water
Millard Coffin	Constructing oceanic lithosphere (#3)
Don Forsyth	Constructing oceanic lithosphere (#3)
Neil Lundberg	Subduction factory and convergent margin processes (#4)
Julie Morris	Subduction factory and convergent margin processes (#4)
John Mutter	Geologic processes related to rifting (#5)
Maureen Raymo	Climate forcing on long timescales—tectonics and climate (#6)
Alan Mix	Climate forcing on short timescales—external and internal mechanisms (#7)
Andrew Fisher	Evolution of the crust and lithosphere (#8)
Michael Mottl	Evolution of the crust and lithosphere (#8)
Kevin Brown	Seismogenic zone (#9)
Richard Walcott	Seismogenic zone (#9)
Ken Miller	Basin and passive margin evolution (#10)
John Orcutt	Dynamics of the Earth's interior (#11)
Timothy Bralower	Catastrophic events (#12)
John Hayes	Understanding the Earth's biosphere (#13)
Gerald Dickens	Gas Hydrates (#14)
Nick Pisias	COMPLEX Co-Chair (as information item)
Chair or Co-Chair (U.S. or as noted)	***JOIDES Planning Group[4]***
Rodey Batiza	The Architecture of the Oceanic Lithosphere PPG
Tom Crowley	Climate-Tectonics Links PPG
John Parkes (U.K.)	Deep Biosphere PPG
Richard Kroon (U.K.)	Extreme Climates and Environments of the Paleogene and Cretaceous PPG
Charlie Paull	Gas Hydrates PPG
Keir Becker	Long-term Observatories PPG
Terry Quinn	Scientific Drilling of Shallow Water Systems PPG
Greg Mountain	Scientific Drilling of Shallow Water Systems PPG (emphasis on down-hole tools)
Miriam Kastner (member)	Seismogenic Zone DPG
Casey Moore (member)	Seismogenic Zone DPG
Roland von Huene	Seismogenic Zone DPG
Other individuals contacted	***Affiliation***
Sherman Bloomer	Member, COMPLEX session: Subduction factory and convergent margin processes (#4)
Gary Karner	Member, COMPLEX session: Geologic processes related to rifting (#5)
Tom Shipley	Member, COMPLEX session: Constructing oceanic lithosphere (#3)

[4] PPG stands for Program Planning Group; DPG stands for Detailed Planning Group. The Arctic's Role in Global Change PPG and the Hydrogeology PPG were not staffed at the time we solicited target sections.

Appendix 3. Acronyms Used for Down-hole Logging Tools in Target Sections

ARI	Azimuthal Resistivity Imager
BHTV	Borehole Televiewer
DLL	Dual Laterolog
FMS/FMI	Formation MicroScanner/Formation Micro Imager
GHMT	Geologic High Resolution Magnetic Tool
GLT	Geochemical Logging Tool
LWD	Logging While Drilling
MFT	Modular Formation Dynamics Tester
NMR	Nuclear Magnetic Resonance Tool
VSP	Vertical Seismic Profiling Tool (3-comp. geophone)
WST	Well Seismic Tool

Appendix 4. Drilling Platform Survey

September 22, 1999

[company name]
[company address]

Dear [Vessel Owner/Manager]:

1.0 INTRODUCTION

The purpose of this letter is to solicit information regarding drillships owned/operated by [company name]. It is not a Request for Proposal nor a Request for Quotation. The reasons that we are asking for information at this time are outlined below.

The Ocean Drilling Program (ODP) is an internationally-funded program for the scientific drilling and sampling of the seafloor around the world. The overall objectives of the program fall into two major themes: dynamics of Earth's environment, and dynamics of Earth's interior. The vessel used for this work is the drillship *JOIDES Resolution* (Sedco/BP 471).

The Ocean Drilling Program is due to wind down in the year 2003. It will be replaced by the Integrated Ocean Drilling Program (IODP) which, unlike ODP, will utilize more than one research drilling platform. As part of IODP, the United States of America plans to operate a drillship intended to fulfill many of the objectives presently pursued by the *JOIDES Resolution*.

2.0 THE CONCEPTUAL DESIGN COMMITTEE

The Conceptual Design Committee, a subcommittee of the United States Science Advisory Committee of ODP, has been charged by the National Science Foundation with the responsibility of determining the characteristics of the US-operated drillship that will meet the anticipated scientific objectives, within the overall framework of IODP. These design characteristics will be considered by the National Science Foundation in formulating a Request for Proposal regarding the vessel. The characteristics are summarized below.

- <u>Riserless drilling</u>: The single most distinguishing characteristic of the vessel is that it will drill without a riser. This is the mode that the *JOIDES Resolution* presently operates in. (Those objectives that can only be met by a vessel with riser capabilities will be pursued by Japan's contribution to IODP.)

- Continuous sampling: The scientific objectives dictate that continuous or near-continuous high-quality samples will be required from the seafloor to the target depths. This is in stark contrast to typical exploration/production drilling, where the primary objective is to "make hole", especially in the upper portions of the section. High quality sampling may require improved heave compensation, drillstring stabilization or a new combined compensation and stabilization system.

- Mud and casing storage: Because of the riserless operation of the vessel and hence no mud returns, the capacity for bulk mud storage will be important. Sufficient storage and handling facilities for 1500 m of casing will also be required.

- Water depths: The scientific community has identified drilling targets in very shallow water (<20 m) and in water as deep as 10,000 m.

- Drilling depths: Drilling depths as deep as 7,500 m below seafloor may be required.

- Combined drill string length: The maximum combined drill string length (water depth plus drilling depth) that has been identified is in excess of 11,000 m.

- Drill string: The drill string should be composed of industry-standard drill pipe, and should have a minimum ID of 4.125 inches (105 mm) in order to pass sampling, coring, and wireline logging tools.

- Subsea BOP: The vessel should be able to deploy a subsea BOP.

- Station keeping: The vessel must be dynamically positioned. For work in shallow water, an anchoring system would be advantageous. The vessel should be able to continue DP operations in Beaufort 8 conditions or worse.

- Endurance: The vessel must be able to remain on location for periods up to 8 weeks without resupply or port call.

- Laboratory and sample storage: Four elements of laboratory and sample storage space have been identified:

  - 1,800 m^2 of interior heated/air conditioned lab space. This interior volume should be contiguous, and arranged on as few decks as possible, e.g., on 3-4 decks. There should be a minimum number of or no interior bulkheads to allow flexibility of lab arrangement. The volume should be forward of the derrick. There should be exterior crane access to all decks (with the possible exception of one) to facilitate the movement of equipment in and out of the labs.

  - Deck space for no. 10 20-foot refrigerated containers for the storage of samples. The deck space must be adequate for the containers to be individually accessible, placed in a single layer (no stacking), located near the main laboratory space, serviced with electricity, and convenient for loading and off-loading of the containers while in port.

– Deck space for no. 5 20-foot containers for special-purpose labs. The deck space must be adequate for the containers to be individually accessible, placed in a single layer (no stacking), located near the main laboratory space, fully serviced (electricity, compressed air, potable water, and waste-water drains), and convenient for loading and off-loading of the containers while in port.

– Geophysics doghouse, 50 m^2, located on the stern, as close to the waterline as is practicable, for the deployment, servicing, and storage of geophysical survey equipment.

- Accommodations: There must be accommodations and services for 60 scientific staff (over and above marine, drilling, and catering crew), in 2-person cabins, with no more than 4 persons per head/shower. Suitable recreational facilities would also be needed.

- Safety, Lifesaving, and Communications: The vessel should be equipped with safety, lifesaving, and communications equipment to allow it to operate in any jurisdiction in the world.

3.0 OUR REQUEST TO [NAME OF COMPANY]

As part of their effort, the Conceptual Design Committee is performing a survey of existing and announced new-build drillships. One purpose of this exercise is to inform the Committee, and hence the United States Science Advisory Committee, of present international capabilities relative to the scientific objectives. The information will also relate, in an initial broad sense, to the budget allocations that will have to be made in future years to support the Integrated Ocean Drilling Program.

We have attached a questionnaire that we ask that you complete for each of the drillships that you have. Note that at present the Conceptual Design Committee is only considering drillships; semisubmersibles are being considered for use within IODP as well, but probably only on a case-by-case basis. In contrast, the dynamically-positioned drillship is likely to be continuously leased by the National Science Foundation for a period of 5 or perhaps even 10 years. According to information available to us, the drillships owned/operated by [company name] are:
[list vessels for company]

Please complete the questionnaire for each of the drillships and return by October 13, 1999 to:

Brian B. Taylor, Ph.D., P.Eng.
Conceptual Design Committee
c/o Jacques, Whitford and Associates Ltd.
3 Spectacle Lake Drive
Dartmouth, Nova Scotia
CANADA B3B 1W8

If you wish, returns may be made via fax, attention Brian Taylor, at +1 902 468 9009. Any questions may be directed to Dr. Taylor via fax or via e-mail at btaylor@jacqueswhitford.com.

4.0 CLOSING

As mentioned in the opening of this letter, this is not a Request for Proposal (RFP). It is anticipated that a RFP will be issued in the 4th quarter of 2001 or the 1st quarter of 2002. It is also anticipated that a long-term lease period of 5 to 10 years will be considered in the RFP. By asking for a long-term lease, it is hoped that there will be sufficient incentive to encourage modification, conversions, or even new-builds to meet the needs presented by the scientific objectives.

On behalf of the Conceptual Design Committee, I would like to thank you in advance for the time, effort and cooperation that you put into responding to our questionnaire. We will be certain to include [company name]'s name in our report together with your response to the questionnaire.

Yours sincerely,

Brian B. Taylor, Ph.D., P.Eng.
on behalf of the Conceptual Design Committee

PART A: VESSEL PARTICULARS

Please complete this part for each drillship in your fleet. If you have additional information that distinguishes the vessel, please attach.

1	**Ship Information**				
	Vessel Name				
	Port of Registry				
	Year built				
	Year last upgraded				
	Classification Society				
	Classification(s)				
	Ice Class				
2	**Size**				
	Overall length (m)				
	Breadth (moulded) (m)				
	Draft, operating (m)				
	Draft, transit (m)				
	Max. height of vessel at transit draft (m)				
	Max. variable load (tonnes)				
	Moonpool dimensions (m)				
3	**Design operating conditions**				
	Drilling (wave, wind) (m, knots)				
	Survival (wave, wind) (m, knots)				
	Max. water depth (non-riser mode) (m)				
	Limiting factor on max. water depth				
	Min. water depth, drilling (m)				
	Limiting factor on Min. water depth				
	Max. drilling depth (m, combined water depth plus penetration)				
4	**Propulsion**				
	Total vessel power (HP)				
	No. main screws				
	Ship's maximum speed (knots)				
5	**Maneuvering Equipment**				
	No. Thrusters				
	Type				
	HP each thruster				

6	**Dynamic positioning system**				
	DP rating				
	Manufacturer				
7	**Mooring system**				
	Mooring winches (no.)				
	Mooring wire/chain (m length each winch)				
	Anchors (tonnes)				
8	**Cranes**				
	Boom length (m)				
	Whipline capacity (tonnes)				
	Lift at max extension (specify angle)				
9	**Quarters capacity**				
	Total personnel capacity (persons)				
	Capacity for supernumaries (persons)				
10	**Water Maker**				
	Type				
	Capacity (m^3/day)				
11	**Storage Capacities**				
	Fuel (m^3)				
	Lube oil (m^3)				
	Drill water (m^3)				
	Ballast (m^3)				
	Potable water (m^3)				
12	**Heliport**				
	dimensions (m)				
	capacity (tonnes)				
13	**Heave Compensation**				
	Type (active/passive)				
	Lift capacity (active/locked) (tonnes)				
	Max. operating condition (vessel heave, period) (m, sec)				
	Total stroke (m)				

14	**Derrick**				
	Height (m)				
	Base dimensions (m)				
	Rating (static/dynamic) (tonnes)				
15	**Drawworks**				
	Power (HP)				
	Brake torque, max (kN.m)				
	Rated hook load (tonnes)				
16	**Rotary table**				
	Size (cm)				
	Continuous torque (kN.m)				
	Max speed (rpm)				
17	**Top drive**				
	Manufacturer, model				
	Load rating (tonnes)				
	Continuous torque (kN.m)				
	Intermittent torque (kN.m)				
	Breakout torque (kN.m)				
	Max. speed (rpm)				
18	**Pipe racker**				
	Manufacturer				
	Main features				
	Capacity				
19	**Normal Complement of Tubulars**				
	5 inch drillpipe (m)				
	5.5 inch drillpipe (m)				
	6.625 inch drillpipe (m)				
	3.5 inch drillpipe (m)				
20	**Mud handling**				
	Mud pumps (no.)				
	Pump power/pressure (HP/kPa)				
	Active pit volume (m^3)				
	Reserve pit volume (m^3)				
	Bulk storage capacity (m^3)				
	Sack storage (no. sacks)				

PART B

This part need only be completed if the vessel has a rated drilling depth (combined water depth plus penetration) of 7,600 m (25,000 ft.) when drilling in non-riser mode, AND the vessel is currently equipped with a dynamic positioning system.

1. Please provide a General Arrangement drawing of the vessel.

2. Considering food, fuel, fresh water, and the like, how long can the vessel remain on location without resupply? What is the limiting factor?

3. As outlined in the introductory letter, the Conceptual Design Committee has identified 1,800 m^2 of laboratory space forward of the derrick as a design requirement. To achieve laboratory space on the *JOIDES Resolution*, the volume used for riser storage was converted. Recalling that this vessel will also drill without a riser, please conceptually indicate how laboratory space could be created on this vessel. Please support the response with appropriate sketches. (Hand drawn sketches are perfectly adequate.)

4. The Conceptual Design Committee has identified that in some situations it would be desirable to deploy a subsea BOP. Could this be accommodated? What would be the maximum water depth in which the BOP could be deployed? What modifications, if any, would be required to do so?

5. Using standard drill pipe, to what depth (combined water column plus penetration) could the vessel drill if a minimum of 4.125 inch ID is required of the drill pipe?

6. Are there any regions of the world in which the vessel cannot operate (such as high latitudes) or cannot operate due to political or jurisdictional considerations?

7. If the vessel is not equipped for anchoring, what is the feasibility of adding anchoring capability for work in waters less than 500 m deep?

8. Can triple stands of drillpipe be run in using the top drive? When the top drive is fully elevated, what is the vertical clearance above the drill floor?

9. In its present configuration, can the vessel transit the Panama Canal? Are there any major ports in which the vessel cannot berth?

10. What are the major communications and navigation systems installed on the vessel?

11. Given your understanding of the conceptual design requirements, do you consider it to be technically feasible to modify the vessel to meet them? If so, generally how long would you anticipate that these modifications would require, including design time? (This question is only being asked to establish the lead time required for the RFP.)

12. Given present contractual obligations and commitments, when do you expect that the vessel will be available?

13. Please indicate the range in which the day rate for the vessel would fall (excluding fuel, lubes, port costs and the like) if it were to be taken under chart for a 10 year term in its present configuration. The Conceptual Design Committee appreciates the confidential nature of pricing information, and therefore understands if you decline to answer this question.