JOIDES Journal

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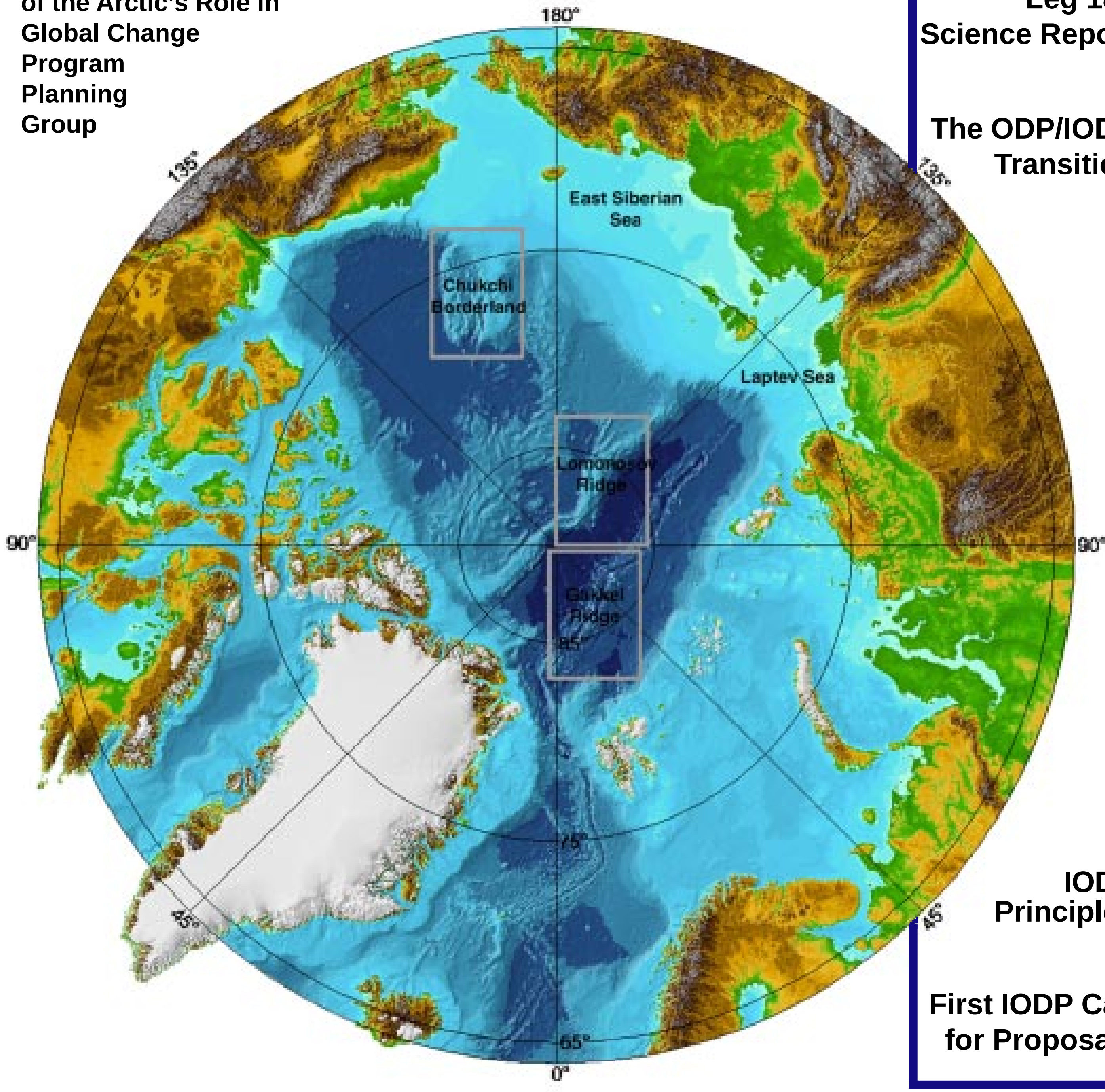
Spring 2001

Joint Oceanographic Institutions
for Deep Earth Sampling

In this issue:

The High-Arctic Drilling Challenge: Excerpts from the Final Report of the Arctic's Role in Global Change Program Planning Group



In this issue from pages 7 - 20:

Panel Report:
Excerpts from the Final Report of the Arctic's Role in Global Change Program Planning Group

Figure Caption for the Front Cover Illustration:

Figure 1. *Regions in the Arctic Ocean targeted for ocean drilling are superimposed on the new IBCAO (International Bathymetric Chart of the Arctic Ocean; Jakobsson et al., 2000) map.*

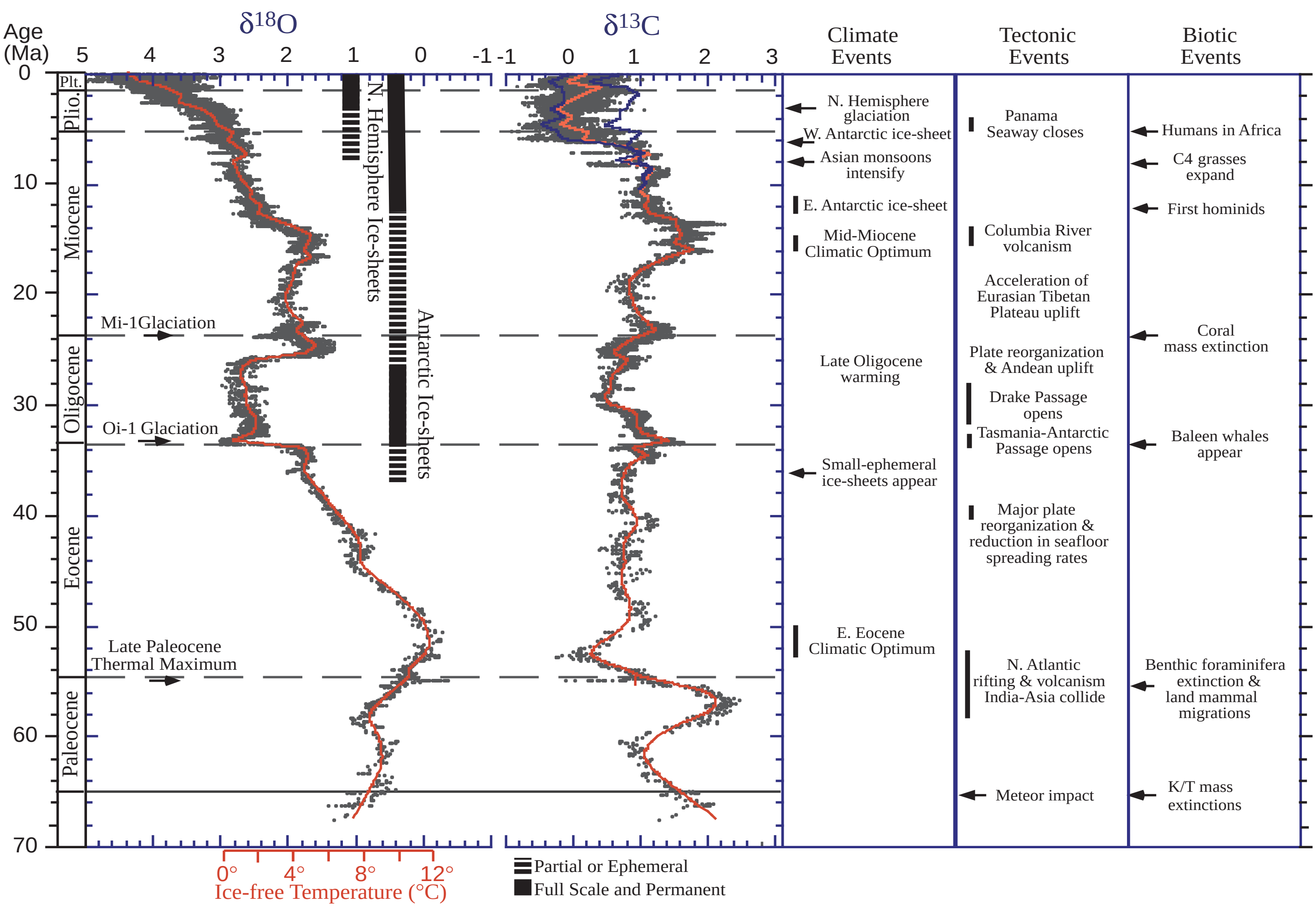


Figure 2*. A global compilation of deep-sea isotope records (Cibicidoides and Nuttallides). The records are based on benthic foraminifera isotope data from 50 DSDP and ODP sites. The raw data were smoothed using a 5 point running mean. The curve fits are locally weighted means. For the carbon isotope record, separate curve fits are presented for the Atlantic and Pacific to show the effects of basin-to-basin fractionation after 15 Ma. Also shown are the major tectonic, climatic, and biotic events of the Cenozoic (Zachos et al. submitted).*

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JOIDES Resolution Operations Schedule: January 2001 - November 2002

Leg	Destination	Port (Origin)	Dates[1]	Total Days (Port/Sea)	Co-Chief Scientists	TAMU Contact
194	Marion Plateau	Townsville	6 January - 5 March	58 (5/53)	F. Anselmetti, A. Isern	P. Blum
195	Mariana/W. Pacific Ion	Guam	5 March - 3 May	59 (5/54)	M. Salisbury, M. Shinohara	C. Richter
196	Nankai II	Keelung	3 May - 2 July	60 (5/55)	K. Becker, H. Mikada, & C. Moore	A. Klaus
197	Hotspots	Yokohama	2 July - 28 August	57 (5/52)	R. Duncan, J. Tarduno	G. Acton
198	Shatsky Rise	Yokohama	28 August - 24 October	57 (5/52)	T. Bralower, I. Premoli Silva	M. Malone
199	Paleogene Pacific	Honolulu	24 October - 17 December	54 (5/49)	M. Lyle, P. Wilson	C. Escutia
200	H_20 Observatory	Honolulu	17 December - 31 January '02	45 (5/40)	R. Stephen, J. Kasahara	P. Wallace
201	Peru Biosphere	Mazatlan	31 January - 2 April	61 (5/56)	S. D'Hondt, B. Jorgensen	J. Miller
202	SE Paleoceanography	Valparaiso	2 April - 1 June	60 (5/55)	A. Mix, R. Tiedemann	P. Blum
203	Costa Rica	Panama City	1 June - 31 July	60 (5/55)	J. Morris, H. Villinger	A. Klaus
204	Gas Hydrates[2]	San Francisco	31 July - 28 September	59 (5/54)	G. Bohrmann, A. Trehu	C. Richter
205	Eq. Pacific Ion[3]	San Francisco	28 September - 3 November	36 (5/31)	J. Orcutt, A. Schultz	G. Acton

[1] Port calls are scheduled for 5 days at the beginning of the listed dates. However, the ship sails when ready.
[2] A mid-leg port call will occur for Leg 196 and may occur for Leg 204.
[3] Leg 205 is tentatively scheduled to end in Panama City, Panama.

14 May 2001

WELCOME

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A Message from the Director of the Miami JOIDES Office

Keir Becker

2001 is a year of tremendous transitions in the scientific planning for ocean drilling. A primary focus of this issue of the JOIDES Journal is to clarify these transitions for you, the ocean drilling community. Almost as soon as the JOIDES Office rotated (probably for the last time) to the University of Miami on January 1, plans gelled to establish an interim Science Advisory Structure (iSAS) for the Integrated Ocean Drilling Program (IODP) served by an iSAS Office in Japan. These IODP support mechanisms, described briefly in this issue, are very much in parallel to the JOIDES Advisory Structure and the JOIDES Office for the Ocean Drilling Program (ODP). As the photo demonstrates, we are working hard to ensure close coordination at all levels.

The JOIDES Office at the University of Miami welcomes special guest Minoru Yamakawa, Administrator for the iSAS Office (left). Chris Harrison, EXCOM Chair, is second from left, followed by Keir Becker, Director and SCICOM Chair; Henny Gröschel, JOIDES Journal Editor; Elspeth Urquhart, International Liaison; and Aleksandra Janik, Science Coordinator. Maya Becker, Executive Assistant, rounds out the group.

At the same time, the JOIDES sub-committee charged with planning for IODP, IPSC (or IODP Planning Sub-Committee), has achieved a truly major milestone, publication of the Initial Science Plan (ISP) for IODP in early May. The ISP builds on the ODP legacy, the ODP Long-Range Plan, and the CONCORD and COMPLEX reports to lay out the scientific foci for the first ten years of the Integrated Ocean Drilling Program. IPSC and its Science Planning Working Group did a superb job in assembling the ISP, which received outstanding reviews by blue-ribbon panels in its near-final stages. An electronic version of the ISP is available at the IODP website, http://www.iodp.org. Paper copies can be requested from national ODP member offices and from the iSAS Office.

If a formal IODP planning structure will phase in during 2001, what will JOIDES be doing through the end of ODP drilling in 2003? First, the final year of ODP drilling with the *JOIDES Resolution* remains to be scheduled at the August 2001 SCICOM/OPCOM meetings. We are fortunate that the drilling community and JOIDES Advisory Structure have nurtured an exceptionally strong group of proposals for the final year of ODP drilling. We can schedule only a small number of the current proposals, but again we are fortunate, in that a new program is developing to which proposals unscheduled by ODP can be transferred for further consideration. The process by which proposals will be transferred also is described in this issue.

After August, 2001, when most JOIDES decisions relating to the *JOIDES Resolution* schedule will have been made, JOIDES and the JOIDES Office will increasingly focus on documenting the ODP legacy - one which will not become fully known until well after all ODP drilling is concluded. We have already started focusing on this important endeavor, and, following a motion at the August, 2000, SCICOM meeting, we are currently developing the content for a special issue of the JOIDES Journal later this year entitled *Achievements and Opportunities of Scientific Ocean Drilling*.

ODP Leg 187: Mantle Reservoirs and Mantle Migration in the Australian-Antarctic Discordance

David M. Christie [1], Rolf-Birger Pederson [2], D. Jay Miller [3], and the Leg 187 Scientific Party

INTRODUCTION

The Indian and Pacific Ocean Mantle Isotopic Provinces

Mid-ocean ridge basalt (MORB) lavas erupted at Indian Ocean spreading centers are isotopically distinct from those of the Pacific Ocean, indicating a fundamental difference in the composition of the underlying upper mantle. Indian Ocean and Pacific Ocean mantle isotopic provinces are separated along the Southeast Indian Ridge (SEIR) by a uniquely sharp boundary that lies within the Australian-Antarctic Discordance (AAD). This boundary, recognized by Klein et al. (1988), was located within 25 km by Pyle et al. (1992). Subsequent off-axis dredge sampling has shown that the Pacific mantle has migrated rapidly westward into the eastern AAD during at least the last 4 m.y. (Christie et al., 1998). The principal objective of Leg 187 was to delineate this boundary further off-axis, and allow us to infer its history over the last 30 m.y.

The Australian Antarctic Discordance (AAD)

The AAD (Fig. 1; next page), at depths of 4 to 5 km, encompasses one of the deepest regions of the global mid-oceanic spreading system. Its anomalous depth reflects the presence of unusually cold underlying mantle and, consequently, of thin crust. The region east of the AAD, Zone A (Fig. 1), is characterized by an axial ridge with smooth off-axis topography (characteristics usually associated with fast-spreading centers), while the AAD is characterized by deep axial valleys with rough off-axis topography (characteristics usually associated with slow spreading centers). These morphological contrasts are paralleled by distinct contrasts in the nature and variability of basaltic lava compositions. They reflect fundamental contrasts in the thermal regime of the spreading center.

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Mantle Flow and the Isotopic Boundary

The AAD is the focus of converging asthenospheric mantle flows, suggested by multiple episodes of ridge propagation from both east and west toward the AAD. Numerical models suggest that convergent, subaxial mantle flow is an inevitable consequence of gradients in axial depth and upper mantle temperature around the AAD (West, 1997).

Within 20 to 30 km of the ~126°E transform in Segment B5, the easternmost AAD segment (Fig. 1), a distinct discontinuity in the Sr, Nd, and Pb isotopic signatures of axial lavas marks the boundary between Indian Ocean and Pacific Ocean mantle provinces. The boundary is remarkably sharp, although lavas with transitional characteristics occur within 50-100 km of the boundary. This boundary has migrated westward across Segment B5 during the last 3 to 4 m.y. (Pyle et al., 1992; Christie et al., 1998).

Understanding the long-term relationship of this uniquely sharp boundary between ocean-scale upper mantle isotopic domains to the remarkable geophysical, morphological, and petrological features of the AAD was the principal objective of Leg 187. The defining characteristic of the AAD is its long-lived, unusually deep bathymetry. The AAD is observed as a depth anomaly that forms a shallow west-pointing V-shape, extending from the Australian to the Antarctic continental margin, and cutting across the major fracture zones that define the eastern AAD segments (Fig. 1). This V-shape implies that the depth anomaly has migrated westward at a long-term rate of ~15 mm/yr, much slower than both the recent migration of the isotopic boundary and the majority of SEIR propagating rifts. Together with the relatively rapid northward absolute motion of the SEIR, this V-shape requires that the cold mantle source of the depth anomaly be linear and oriented approximately north-south. Recently, Gurnis et al. (1998) have suggested that the source of this cold linear anomaly lies in a band of subducted material that accumulated at the 660 km mantle discontinuity beneath a long-lived western Pacific subduction zone prior to ~100 Ma.

History of the Isotopic Boundary

Prior to Leg 187, hypotheses on the long-term relationships between the isotopic boundary and the morphologically defined AAD fell into two classes, schematically illustrated in Figure 1. In the first case, the recent (0 to 4 Ma) isotopic boundary migration reflects a localized (~100 km) perturbation of a geochemical feature permanently associated with the eastern boundary of the AAD since the basin opened. The boundary could be related either to the depth anomaly (boomerang shape) or to the eastern bounding transform (linear N-S), but not, in the long term, to both. In the second case, the recent migration is the culmination of a long-lived phenomenon that only recently brought Pacific mantle beneath the AAD. The boundary should define a west-pointing V-

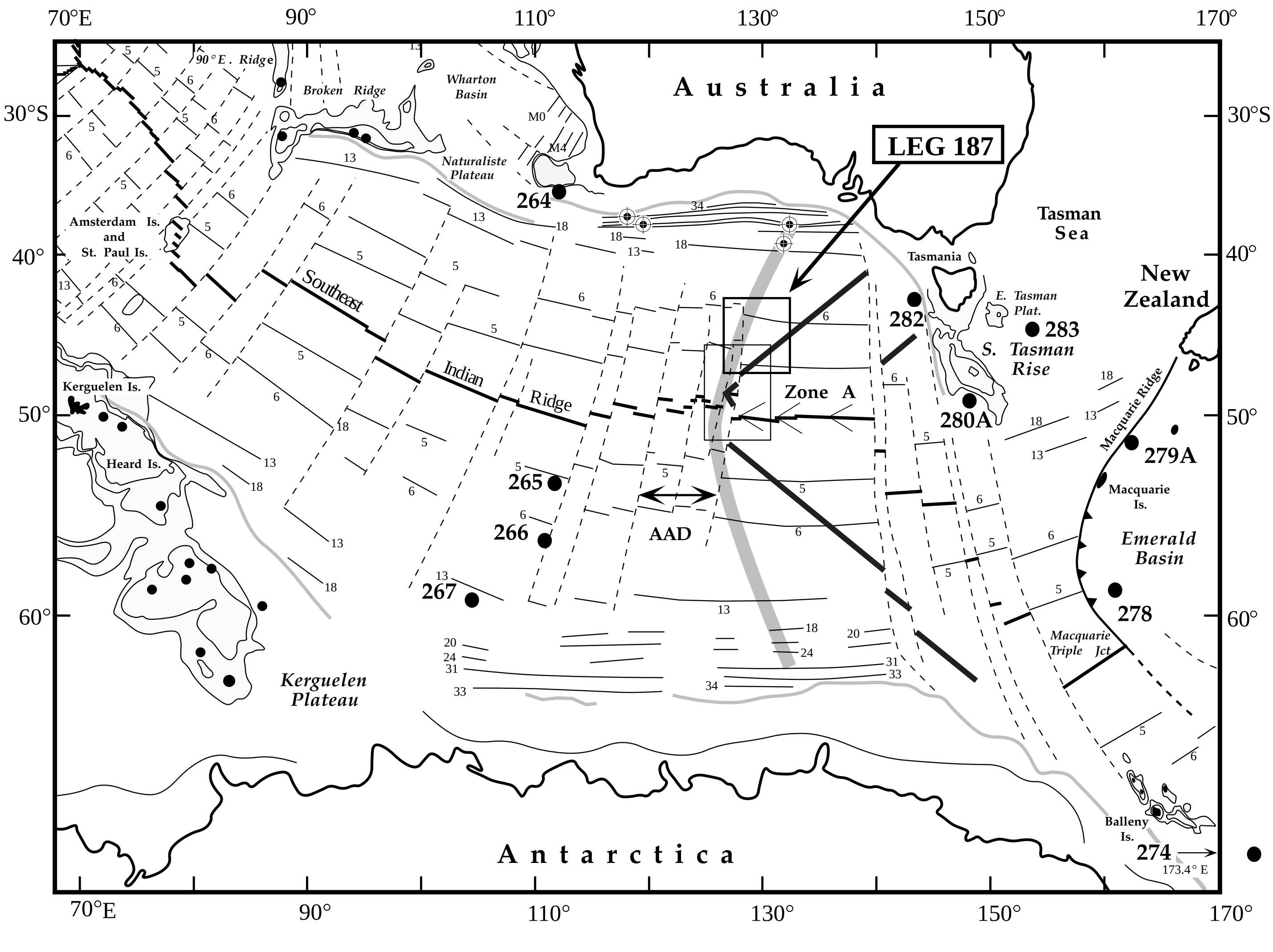

Figure 1: Regional map of the Southeast Indian Ocean (from Pyle et al., 1995) showing magnetic lineations, the Australian-Antarctic Discordance (AAD), and DSDP sites that sampled basement (large, numbered bullseye symbols). Thin, dark V east of the AAD is the predicted trace of a hypothetical isotopic boundary migrating at ~40 mm/yr. Broader gray V is the approximate trace of the regional depth anomaly. Small bullseye symbols south of Australia indicate approximate positions of dredges by Lanyon et al. (1995).

shape at a smaller angle than the depth anomaly. For a migration rate of 40 mm/yr, comparable to Zone A rift propagation rates, this hypothesis is consistent with the onset of Pacific mantle migration 40 to 50 m.y. ago, when the South Tasman Rise first separated from Antarctica. This type of migration received limited geochemical support from the Indian and transitional isotopic signatures of altered ~38- and ~45-Ma basalts dredged to the north and east of the AAD by Lanyon et al. (1995), and from 60 to 69 Ma Deep Sea Drilling Project (DSDP) basalts that were drilled close to Tasmania (Pyle et al., 1995). However, neither sample set is definitive. The dredged samples are from sites within or west of the residual depth anomaly and therefore support two of the three possible configurations. The DSDP samples lie far to the east of the depth anomaly, but very close to the continental margin. Their apparent Indian affinity is suspect because their mantle source may have been contaminated by nearby subcontinental lithosphere.

Subsurface Biosphere

Recent findings have extended the biosphere to include microbial life in deep subsurface volcanic regions of the ocean floor. Microorganisms seem to play an important role in the degradation of ocean-floor basaltic glass, and microbes have recently been documented to inhabit internal fracture surfaces of basaltic glass that specifically were sampled for microbiological studies during MIR submersible dives to the Knipovich Ridge (Thorseth et al., 1999). Dissolution textures directly beneath and manganese and iron precipitates adjacent to many individual microbes suggest that microbial activity plays an active role in the low-temperature alteration of ocean-floor basalts. Traces of a deep biosphere have been documented to several hundred meters depth in the crust by means of glass alteration/dissolution textures, DNA-staining, and carbon isotope ratios from various ODP holes (Thorseth et al., 1995; Torsvik et al.,1998).

So far, little is known about the nature of these organisms. An objective of Leg 187 therefore was to characterize and study microbes present in the volcanic sequence of the crust and to study the diagenetic effects of the microbial activity.

DEVELOPMENT OF A RESPONSIVE DRILLING STRATEGY

We developed a responsive drilling strategy during the cruise since the possible locations of the isotopic boundary in the 10 to 30 Ma seafloor age range targeted for drilling covered a very wide area. Sites were selected from a pre-approved suite on the basis of rapid (12 to 24 hour) turnaround of shipboard geochemical analyses. At several key points in the leg, geochemical data were available prior to departure from a site. These data were used to decide the location of the next site.

Two factors were critical to the success of this responsive strategy, which resulted in the recovery of core from 23 holes at 13 sites with an average water depth of almost 5 km. (In the process, a record 140 km of drill string passed through the drill floor.) The first factor was identification of an element that would serve as a reliable proxy for the Pb isotopic ratios that distinguish the Indian and Pacific mantle isotopic domains. The second was ensuring the onboard availability of reliable, rapid geochemical analyses.

Available data from 0 to 7 Ma dredged samples revealed clear overall differences in both major and trace elements between the lava populations of the two provinces. Few elements can be relied on to accurately determine the affinity of any individual lava. Two elemental plots that reliably assigned >90% of our 0 to 7 Ma archival collection are Ba vs. Zr/Ba and MgO vs. Na2O/TiO2. The latter proved not to be a useful discriminant for drilled samples.

Reliable measurement of these elements on the *JOIDES Resolution* required the installation of an Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES) instrument. This installation, already in the planning stages, was accelerated through the heroic efforts of Rick Murray and the cooperation of several ODP-TAMU and JOI staff. The instrument performed well throughout the leg.

RESULTS

Locating the Isotopic Mantle Province Boundary

Shipboard analytical data were used to determine the configuration of the Indian-Pacific mantle isotopic boundary north of the AAD from 10 to 30 Ma. A Ba vs. Zr/Ba plot for shipboard samples that was used to discriminate between Indian and Pacific mantle domains is shown in Figure 2 (see color plate inside the back cover). Shipboard results have been confirmed by onshore isotopic analyses (Fig. 3; see color plate inside the back cover). The migration of a discrete isotopic boundary across the easternmost AAD over the last 3 to 4 Ma appears to be a transient phenomenon. We believe we have identified at least one similar migration event in western Zone A at about 19 Ma (Site 1158). Over the long term, the Indian-Pacific boundary coincides with the eastern side of the regional depth anomaly, and a transitional region within the depth appears to be dominated by Indian-type mantle with common, discrete occurrences of transitional lavas. Along the eastern boundary of the depth anomaly in western Zone A, Pacific- and Indian-type mantle domains appear to alternate on a time and spatial scale that is comparable to present-day migration in Segment B5 (Fig. 3). In at least one case, this alternation appears to represent a short-lived incursion of Pacific mantle into the depth anomaly coinciding with the arrival of a westward propagating rift.

Characterizing the Biosphere of Deep Oceanic Crust

Microbial enrichment cultures, chemical analysis of metabolic products and 16S-r DNA sequencing of samples recovered from Leg 187 basalts have shown the presence of iron- and manganese-oxidizing and reducing bacteria, methanotrophic bacteria and methanogenic Archaea. The microorganisms found in the basalt samples are different from microorganisms found in sediment and water samples. Leg 187 was therefore a successful first step in the process of characterizing the deep biosphere of the oceanic crust.

LEG 187 SCIENTIFIC PARTY

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The High-Arctic Drilling Challenge: Excerpts from the Final Report of the Arctic's Role in Global Change Program Planning Group (APPG)

Martin Hovland (Chair) [1], *Jan Backman* [2], *Bernard Coakley* [3], *Timothy Collett* [4], *Dennis Darby* [5], *Jean Paul Foucher* [6], *Tim Francis* [7], *Mikhail Gelfgat* [8], *Anatoly Gorshkovsky* [9], *Wilfred Jokat* [10], *Michael Kaminski* [11], *Yngve Kristoffersen* [12], *Kozo Takahashi* [13], *Jörn Thiede* [14], *Chris Wiley* [15], *and James Zachos* [16]

EXCECUTIVE SUMMARY

Global climate models demonstrate the sensitivity of the polar areas to changes in forcing of the ocean/climate system. The presence or absence of snow and ice influences global heat distribution through its effect on the albedo, and the polar oceans are the source of dense, cold bottom waters which influence thermohaline circulation in the world oceans. In spite of the critical role of the Arctic Ocean in climate evolution, only very little material from the Cenozoic is represented in available high-latitude core material. This lack of data represents one of the largest information gaps in modern Earth Science.

Key scientific questions to be addressed by dedicated Arctic scientific drilling include:

- The response of the Arctic during periods of extreme polar warmth;
- Variations in the physical and chemical characteristics of the water mass in an evolving polar deep ocean basin, and the oceanographic response to opening of gateways;
- The history of marine polar biota and fertility;
- The history of Arctic sea ice;
- Ice rafting and the history of local vs. regional ice sheet developments;
- Processes of methane release of destabilized permafrost associated gas hydrate accumulations;
- The history of emplacement of Large Igneous Provinces (LIPs) in the Arctic Ocean and their environmental impact.

The Arctic's Role in Global Change Program Planning Group (APPG) concludes that:

- Scientific drilling can be carried out in permanently ice-covered areas of the Arctic Ocean without harm to the environment. In the short-term (3 to 5 years), this can be achieved with present technology, and the potential for scientific rewards are high.
- An Arctic scientific drilling campaign should start as soon as possible to begin a long-term program in a climatically important, but largely unknown, ocean.
- In preparation for a long-term drilling program in the high Arctic, new geophysical drill site selection data are needed urgently. Site survey data for the definition of drilling targets in the short (3 to 5 years) time frame exist from sections of the Yermak Plateau, Lomonosov Ridge and the Chukchi Plateau (Fig. 1; see front cover).

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[14] Alfred Wegener Institut (Germany)
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[16] University of California (Santa Cruz, CA USA)

- Stationary marine operations in drifting sea-ice require careful ice management, which combines modelling icebreaker performance, ice reconnaissance studies (weather forecasting, radar imaging, and ice floe tracking), and icebreaker operations.

- Proven systems for drilling single-bit holes should be utilized in the short-term. As operational experience is gained, the system capability can be expanded to include re-entry and multi-cased boreholes with instrumentation.

- A long-term drilling commitment in the central deep Arctic, where drilling targets of high scientific priority are located, will ideally require a large icebreaker with deep-water drilling capability. A feasibility study for such a vessel is recommended.

MANDATE AND OVERALL GOALS SET BY SCICOM IN 1999

Motion 99-1-6 of the JOIDES Science Committee (SCICOM) defines the following mandate and overall goal for the APPG:

Mandate

1. Design a scientific drilling strategy to investigate the role of the Arctic in influencing the global climate system. Besides climatic and paleoceanographic studies, this strategy may also address those aspects of the Arctic's tectonic development and magmatic history that may have significantly affected global climate or that may otherwise relate to globally important problems.

2. Summarize the technical needs, opportunities, and limitations of drilling in the Arctic.

3. Encourage and nurture the development of drilling proposals.

Overall Goal

The overall objective of the APPG was to develop a mature science plan concerning those aspects of Arctic drilling that bear on global problems, particularly with respect to the climate system on time scales from decades to millions of years. The panel consisted partly of Nansen Arctic Drilling (NAD) scientists, and used the existing NAD Implementation Plan as a basis for the AAPG plan.

In order to meet this goal and fulfill its mandate, the APPG had three meetings, in Stavanger, Norway (March 2000); Calgary, Canada (June 2000); and Stockholm, Sweden (January 2001). This report contains contributions by the APPG members and others, and was completed in March 2001.

SCIENTIFIC OBJECTIVES

Introduction

Earth's climate has undergone a significant and complex evolution, the finer details of which are just becoming evident through investigations of deep-sea sediment cores (Fig. 2; see color plate inside the front cover). This evolution includes gradual trends of warming and cooling driven by tectonic processes on time scales of 10^5-10^7 year, rhythmic or periodic cycles driven by orbital processes with 10^4-10^6 year cyclicity, and rare rapid aberrant shifts and extreme climate transients with durations of 10^3-10^5 years. This history has been determined largely through investigations of cores recovered from the world's oceans by the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP). Cores from the high latitude southern oceans, where signals of climatic change tend to be amplified, were particularly useful.

Very little is known about signals of climatic change in the Arctic Ocean. This represents a major and unacceptable gap in the global paleoclimatic database. What little information is available on Arctic paleoclimates comes from a few piston cores, exploration wells, and land-based marine outcrops. While these provide glimpses of climate signals for a few brief intervals, the lack of continuous sediment records severely limits efforts to establish a chronologic sequence of climate and environmental change for this important region. In essence, the history of Arctic climate and Arctic Ocean circulation is so poorly known that we view the recovery of any material as a major advance that will, by definition, increase our knowledge and understanding of this critical region.

Paleoclimate and Paleoceanography Questions

A number of specific questions must be addressed in order to understand the influence of the Arctic on global climate change on all time scales, from tectonic to millennial. In summary, these questions are:

- What is the history of Arctic sea ice? When did perennial sea ice first appear in the Arctic? Has it appeared and then disappeared on more than one occasion? Under what circumstances did this pack-ice form or disappear?
- When did the first circum-Arctic ice-sheets appear? Once established, what was the history of growth and decay of these cyclic ice-sheets?
- How has the circulation and stratification of Arctic water masses evolved over the Cenozoic? How have changes in Arctic water mass characteristics influenced global thermohaline circulation (intermediate or deep water)?
- What was the nature of the Arctic environment during periods of extreme global warmth?
- Have there been major changes in the biogeochemical cycles of the Arctic, particularly those affecting methane hydrates?
- What is the history of marine polar biota and fertility?
- How has the tectonic evolution of the basin influenced regional and global climate?

The Search for Answers: Arctic and Global Climate

The Arctic Ocean plays a fundamental role in the global ocean/climate system as the primary heat sink of the northern hemisphere. It is a source of cold, dense intermediate and bottom waters to most of the world's oceans. The permanent sea-ice cover has a tremendous influence on Earth's albedo, atmospheric circulation, and distribution of fresh water. Its variation both seasonally and over longer time periods thus has a direct effect on global heat distribution, climate, nutrients, biota, and sediments. Whether the Arctic Ocean influences changes in global climate, or how it responds to these changes, is unclear.

Perennial Sea-Ice History

The factors that control sea-ice thickness and extent are poorly understood. However, their influences are manifested through 1) changes in albedo, 2) water-column stability and bottom-water formation, 3) ocean/atmosphere heat and evaporative exchange, and 4) bioproductivity and carbon sinks. The distribution of perennial sea-ice is tied to several global boundary conditions including temperature, salinity, and atmospheric and oceanic circulation. We know that this pack-ice cover is sensitive to at least some of these conditions on decadal time scales (Cavaleri et al., 1997; Proshutinsky and Johnson, 1997). Establishing the initiation of Arctic perennial ice cover would permit correlation to global climate changes and thus a clearer understanding of the climate system. In this regard, when did perennial sea-ice cover develop? Under what boundary conditions did it develop, and disappear? Are fluctuations in sea-ice cover linked to growth and decay of continental ice? What is the climatic feedback from an evolving ice pack in amplifying polar cooling by increasing albedo and restricting ocean-atmosphere heat transfer?

To accomplish this objective, the ridges in the central Arctic Ocean need to be cored, especially in areas where sedimentation rates may be high (>1 cm/kyr). While seasonal ice would occur in the periphery of the Arctic Ocean, only the central Arctic would record perennial pack-ice.

Circum-Arctic Ice-sheet Evolution

The evolution of Northern Hemisphere glaciation is complex. There is little doubt about the scale and timing of the major glacial cycles of the Pleistocene, which are well constrained from both direct and indirect evidence (i.e., oxygen isotopes). In addition, the pre-Pleistocene evolution of the Greenland ice-sheets is known from the results of ODP exploration in the Nordic seas. What remains unclear is the pre-Pliocene evolution of small-scale ice-sheets. For example, when did the first ice-sheets form, and what was their extent? Were they ephemeral?

Several major ice-sheets calved icebergs into the Arctic Ocean, as evidenced by the ice-rafted detritus (IRD) record (Polyak et al., 1995; Bischof and Darby, 1997; Phillips and Grantz, 1997). The timing, causes, and consequences of the repeated growth and decay of these ice-sheets throughout their history must be closely linked to global climate. For example, are the growth and decay of the ice-sheets synchronous with sub-polar ice-sheets such as the Laurentide ice-sheet that collapsed periodically to produce Heinrich events in the North Atlantic?

In order to expand the late Pleistocene record of the Arctic ice-sheet evolution, we recommend drilling the continental slopes offshore of the known margins of these ice-sheets. For example, the slope off McClure Straits should contain a complete record of that portion of the Laurentide ice-sheet that calved into the Arctic Ocean. Similar areas offshore of the Innuitian and Barents Sea ice-sheets also should be targeted. In addition, sections of the Lomonosov Ridge that would intersect drift tracks of icebergs from the Canadian ice-sheets should be a prime target for obtaining the history of these ice-sheets.

Circulation/Stratification of the Arctic Ocean

The series of interconnected basins comprising the Nordic Seas contain about 0.7% of the volume of the World Ocean, excluding the Amerasian Basin of the Arctic Ocean. Despite the small volume of these areas, they act as a primary source of a large portion of deep, ventilated waters in the World Ocean. Also, the export of ventilated deep waters to the Atlantic via the Fram Strait is compensated by a corresponding import of relatively warm and saline surface waters of Atlantic origin (Aagaard et al., 1985). The Arctic Ocean is hence commonly described as one of the lungs of the deep global ocean, the other being the Weddell Sea. The tectonic development and opening of the Fram Strait has determined the history of water mass exchange between the Arctic Ocean and the World Ocean, as the strait is the only deep connection between the Arctic and all other oceans. The initial opening of the Fram Strait may have occurred as early as late Eocene, some 35 million years ago.

An understanding of the exchange of water masses between the Arctic Ocean and the world ocean is an essential element in modelling the change in global oceanographic conditions over the past ~40 Myr. Such models require knowledge about, for example, when bottom water formation began in the Arctic, how chemical and physical characteristics of this water mass varied through time, and which cause and effect relationships governed the development of the Arctic water masses.

Extreme Warmth and the Arctic

Another important challenge in paleoclimatology/paleoceanography is to develop a quantitative understanding of the mechanisms responsible for maintaining the extreme polar warmth observed for the Eocene and older and younger intervals. Seven key time intervals of extreme warmth can be examined in the Arctic: The Aptian-Albian, early Eocene, middle Miocene, early Pliocene, MIS 11, Cenomanian, and late Paleocene. What was the climate of the Arctic during these periods? Studies of terrestrial floras suggest mean annual temperatures as high as 13°C during the Cenomanian greenhouse conditions (Spicer et al., 1999). What was the circulation and fertility of this open basin? Was there sea-ice during the Neogene warm intervals? Perhaps the most extreme greenhouse interval is the late Paleocene Thermal Maximum (LPTM). This event, which could have been driven by the release and oxidation of methane from clathrates, is characterized by as much as 8°C of warming in the high southern latitudes. What was the response of the Arctic to this warming?

At present, the existing climate proxy data for the Arctic are at odds with paleoclimate simulations (e.g., General Circulation Models, or GCMs) that produce polar regions characterized by sub-freezing temperatures and significant seasonality. Yet the fossil record suggests mild climates characterized by winters with rare sub-freezing conditions. The reasons for the GCM/data discrepancies are not known. In terms of the dynamics of maintaining extreme polar warmth, climatologists have focused on heat transport processes as well as the effects of greenhouse gases (Lyle, 1997). Simulations made to test the effects of increased oceanic heat transport on high latitude climates have found this to be inadequate for sustaining polar warmth. The presence of a large body of water with its attendant heat capacity should have a major influence on daily and seasonal high latitude temperatures, although the impact of this quantity requires additional testing. One potential solution to the high-latitude warmth paradigm may involve the generation of polar-stratospheric clouds, which tend to insulate the poles, by methane.

The Search for Answers: Evolution of Polar Biota

What little we know about the composition of the Arctic floras and faunas is largely derived from isolated studies of the shallow-marine assemblages in the onshore sediments of Arctic Canada, Spitsbergen, the Pechora Basin, Western Siberia, and a few piston cores on the Alpha Ridge. Mesozoic microfossils (mostly foraminifera and palynomorphs) have been studied from Siberia (Azbel et al., 1991), Canada (Hedinger, 1993), and Spitsbergen. Cenozoic foraminifera and palynological assemblages have been studied in offshore exploration wells in the Beaufort-MacKenzie Basin (McNeil, 1989; 1997). These data provide at least some insight into the nature of Arctic marine faunas.

A number of questions remain to be answered. What is the taxonomic composition of polar marine faunas and floras? Is there any evidence for the bipolarity of polar faunas? Can we establish a workable microfossil biochronology for the Arctic that can be used for correlation purposes? Given the endemic nature of floras and faunas reported from the Arctic, to what extent has the Arctic fauna and flora evolved in isolation from the world ocean? Has the Arctic served as a refugium for species that suffered extinction elsewhere? Can we use the microfossil record of the Arctic as a proxy of water mass properties and productivity, or do we need to develop new proxies? Can we use fauna and flora to interpret the circulation history of the Arctic basins? What role has the Arctic Ocean played in the origin of cosmopolitan oceanic faunas and floras, and terrestrial biota? To what extent is the evolution of polar marine faunas and floras influenced by the evolution of the cryosphere? To what extent can we use the siliceous faunas and floras to interpret the history of sea-ice formation in the Arctic?

The Search for Answers: Arctic Gateways and Basin Evolution

The tectonic environment of the Arctic Ocean changed dramatically during the Mesozoic-Cenozoic. The Cenozoic opening of sea-gateways, especially Fram Strait, favored the formation of continental ice-sheets and sea-ice cover in the Arctic. The opening of these gateways may have played a key role in allowing a substantial decrease in the mean average temperature to that of the present day. Knowledge of this history can only be obtained by sampling the rocks and sediment of the Arctic gateways.

For most of the Mesozoic, the Arctic Ocean consisted of an isolated deep-sea area with no major deep-water connection to the other oceans. Current models suggest that the oldest Arctic deep-sea basin (Canada Basin) opened in the Cretaceous (Vogt et al., 1979). Although this model is widely accepted, details of the Mesozoic evolution of the Arctic are very sketchy. Cenozoic spreading at Gakkel Ridge explains the opening of the Eurasian Basin and its relationship to the Lomonosov Ridge, whereas the nature of the Alpha-Mendeleev Ridge in the Amerasian Basin, as well as the age of the surrounding deep-sea basins, are not known. The most important question to be addressed for the Cenozoic history is "when did the Arctic gateways open?" A number of key areas need to be investigated to unravel the geological history of the high Arctic.

The Alpha-Mendeleev Ridge is the single largest submarine feature in the Arctic Ocean. One model suggests the ridge complex may represent a Cretaceous LIP, and there is some supporting evidence in the form of terrestrial Cretaceous continental flood basalts exposed along part of the Arctic Ocean margins. Recent geological and geophysical investigations support this idea, and the few dredged lavas have strong affinities to continental tholeiites (Muehe and Jokat, 1999). Seismic investigations show that Alpha Ridge is mostly covered by a sedimentary sequence up to 1 km thick (Hall, 1979; Jackson, 1985; Jokat et al., 1999). Shallow cores confirmed that Cretaceous sediments are present (Clark et al., 1986). This area represents a unique opportunity to obtain a complete record of the post-Paleozoic history of the high-Arctic Ocean.

It has been suggested that the Lomonosov Ridge is a continental fragment rifted from the Barents-Kara Sea margin. Seismic reflection data across the ridge show a continuous cover of flat-lying pelagic sediments on the ridge top, underlain by sediment-filled half grabens and diverging reflections (Jokat et al., 1992). The sediments beneath the Cenozoic pelagic section represent the only preserved Mesozoic record from this margin, which comprises one bondary of the Amerasian Basin. Drilling through the unconformity will constrain the development of this passive margin and provide age constraints for rifting of the Eurasian Basin.

The Gakkel Ridge is unique among ocean ridges for its very slow spreading rate. The lavas, their periodotitic melt residues, and the direct interaction of mantle rocks with seawater all hold important information that can add significantly to our understanding of global mid-ocean ridge spreading systems (Hellebrand et al., in press; Muehe et al., 1997). The drilling objectives here are to obtain relatively fresh basement samples from beneath the sediment-covered central and eastern portions of the ridge, and to establish the depth and extent of crust/mantle-seawater chemical and thermal interactions on the ridge. Geophysical data suggest that the Morris Jesup Rise and the northern section of the Yermak Plateau represent an oceanic LIP which once formed an Iceland-like massif at the junction of the North American/Greenland and European plates. These features are presumably underlain by oceanic crust. Knowledge of the origin of these plateaus is essential for understanding the opening of the Fram Strait, and also for reconstructing the opening history of the Eurasian Basin.

The Amerasian Basin probably formed when Arctic Alaska rotated away from Arctic Canada during the Mesozoic, and the Chukchi Borderland is thought to be of continental origin (Grantz et al., 1999). However, the limited geological and geophysical data from these margins and the Canada Basin is insufficient to test this hypothesis. Furthermore, this simplistic model fails to explain either Alpha Ridge or the Chukchi Cap region.

Marine connections between the Arctic and other oceans during the Cretaceous were maintained through the Western Interior Seaway. During the early Paleogene, in contrast, the connections with the Tethys via Turgai Strait in Western Siberia were intermittent. The two modern Arctic gateways, Fram Strait and Bering Strait, developed as a result of later plate motions, and have since been influenced by vertical motions, volcanism, and sea-level changes. The development of these gateways has had a profound impact on global oceanic circulation, and it is clear that an understanding of their tectonic evolution urgently requires further dredging, geophysical investigation, and drilling.

Potential for High Resolution Coring in the Arctic Ocean

The paleoclimate studies dealing with rapid climate change and short-lived climatic events require cores from areas with high sedimentation rates in the Arctic Ocean. In order to resolve changes such as Dansgaard-Oeschger events on the 1.5 kyr frequency, deposition rates of at least several cm/yr are needed, and rates >10 cm/yr are highly desirable. Many processes other than paleoclimate are unique to the Arctic, such as sea ice-rafting from shelf to shelf across thousands of kilometers of ocean

(Bischof and Darby, 1997). Such records also could be useful for investigations of biogenic and nutrient paleo-fluxes in the Arctic Ocean, especially those from the shelves to the basins. Other aspects to investigate with high-resolution records are the ventilation of the deep Arctic Ocean, the impact of fresh water fluxes, and the effect of sea ice formation on the stability of the Arctic pack-ice. Potential locations for high-resolution sediment records in the Arctic Ocean are reviewed below.

Continental Slopes

The most promising areas for both high sedimentation marine records and adequate amounts of biogenic proxies are the continental slopes in certain areas. The margins of the Arctic Ocean have the thinnest pack-ice and probably the shortest intervals of low productivity in the past. Aside from the problem of downslope transport from the shallow shelf or terrigenous sources swamping the marine signal, these locations offer the potential for a compromise between continuous deposition above 10 cm/kyr and adequate amounts of biogenic proxies. Most of these slopes have contour currents that could generate drift deposits with high sedimentation rates. Many canyons cut these slopes and high rates of downslope sediment transport and deposition should occur in fans or deltas associated with these canyons. While these may have a high proportion of terrigenous input, they do provide high resolution.

Not all continental slopes are equally promising. Slopes with good potential for high resolution cores with abundant proxies are the slopes off the Laptev, Chukchi, and Kara Seas (especially in and around the Santa Anna Trough). The Laptev Sea continental slope should contain a record of the western Russian Arctic Ocean, as well as a signal from the Lena, Ob and Yenisey Rivers and other important Russian rivers (Kassens et al., 1999; Stein and Fahl, 2000; Stein, in press). The Kara and Barents Sea slopes leading into the depths of the eastern Arctic Ocean should contain an excellent detailed record of former ice-sheets on these shelf areas (Stein et al., 1994). These fluvial signals are important to both paleoclimatology and paleoceanography. The Chukchi Sea continental slope should provide a marine record of the western Amerasian Arctic Ocean as well as the Bering Strait influx from the north Pacific. The Kara Sea continental slope should provide a marine record for the eastern Arctic Ocean and the influx of North Atlantic water that enters the Arctic Ocean via the Barents Sea. This later location could be critical for understanding the North Atlantic Oscillation and its potential relationship with Arctic paleoclimate changes.

Central Arctic Ocean Ridges

Three sub-parallel ridge systems of different age, origin, and morphology in the central Arctic Ocean are the Alpha-Mendeleev, the Lomonosov, and the Gakkel Ridges. Abundant graben features on each of these ridge systems should support conditions for ponded sediment and higher sedimentation rates. In addition, locations exist where contour currents or geostrophic currents such as the North Atlantic Intermediate Water spill over these ridges in less than 1000 meters water depth. These afford the opportunity for drift deposits and thus high sedimentation rates. Seismic evidence on the Lomonosov Ridge suggests a two-fold thickening of the Tertiary sediment package in some areas (Jokat, 1999; Jokat et al., 1999). In addition, the Northwind Ridge/ Chukchi Plateau area offers potential coring sites close to open water or favorable ice conditions in most summers Because of the generally thicker pack-ice conditions in the Amerasian half of the Arctic Ocean, the Alpha-Mendeleev Ridge and, to a large extent, the Lomonosov Ridge have a lower potential for good biogenic proxy accumulations. Parts of the Gakkel Ridge should not be as severely affected by pack-ice and thus could have a much better proxy record than the other two ridges (Stein et al., 1994).

Deep Arctic Basins

While normal pelagic deposition occurs in the deep Arctic basins (e.g., core 94BC20; Darby et al., 1997), these basins are dominated by turbidite sequences (Campbell and Clark, 1977; Darby et al., 1989). The deposition rates for the normal pelagic sediment in these basins is usually no higher than on adjacent ridges (Darby et al., 1997). There are some exceptions where sedimentation rates of normal pelagic sediments were found to be up to 3.2 cm/kyr in the Canada Basin (Grantz et al., 1999). Turbidite sequences have sedimentation rates of 145 cm/kyr; however, these areas should have a low priority for high resolution coring unless a method to interpret turbidite sequences for paleoclimatic or paleoceanographic problems can be developed. Turbidite sequences do preserve a good record of the sporadic flux of sediment off the shelves or from large rivers (e.g., the Mackenzie fan). The main problems are the sporadic nature of turbidite deposition, and establishing a good stratigraphy without having to date nearly every turbidite layer.

Gas Hydrates in the Arctic

The distribution of gas hydrate in marine Arctic environments is poorly documented. Conditions exist for gas hydrate to occur with permafrost on submerged continental shelves of the circum-Arctic sedimentary basin, much like their terrestrial counterparts (Kvenvolden and Grantz, 1990; Max and Lowrie, 1992). Gas hydrate also may be present in deep marine Arctic basins, as suggested by recent observations of bottom-simulating reflectors (BSR) on seismic lines through the Alpha and Lomonosov Ridges (Jokat, 1999). The amount of methane trapped in gas hydrate is perhaps 3,000 times the amount contained in the atmosphere. A large portion of this methane reservoir is associated with permafrost and located on the Arctic continental shelf.

Of particular relevance to global climatic change is whether large quantities of methane could be released to the water column, and ultimately to the atmosphere, as a consequence of destabilization of gas hydrate present in seafloor sediments. The exact link between global warming and gas hydrate dissociation still is debated. The Arctic continental shelf is a unique site to document the ongoing process of methane release from gas hydrate dissociation. Methane release to the atmosphere may have been active on the extensive Arctic continental shelf since the end of Pleistocene glaciation, when submergence of the shelf considerably increased the temperature at the sediment surface. This would have produced progressive warming of shelf sediment, gas hydrate destabilization, and methane release.

The processes leading to permafrost and gas hydrate destabilization on the Arctic continental shelf have received little attention. Scientific drilling of destabilized permafrost and gas hydrate accumulations would greatly benefit characterization of the distribution of gas hydrate in the Arctic shelf sediments and the thermal and hydrogeological processes that control methane release. Boreholes would provide vital clues to the interplay between permafrost-associated gas hydrate in Arctic shelf sediments and global climatic change.

The APPG recommends drilling a suite of 3 to 4 holes across the Arctic shelf into a destabilized permafrost-associated gas hydrate accumulation to characterize active processes of methane release. The boreholes would extend from an outer position at the former limit of permafrost to an inner position where permafrost has been virtually preserved (e.g., a possible on-land reference site). Drilling objectives would include investigations of:

1. The distribution of permafrost, solid gas hydrate and free gas;

2. The nature of the thermal regime;

3. Active gas transport processes and fluxes, and

4. Development of models of methane release from destabilized permafrost-associated gas hydrate accumulations.

Other biogeochemical cycles, such as the silica cycle, also should be investigated in the context of regional and global climate change. Little is known about these elements and their record of nutrient flux in the Arctic Ocean (Aagaard et al., 1999).

STRATEGIES FOR SUCCESSFUL SCIENTIFIC DRILLING IN THE ARCTIC

Context

In the context of the Integrated Ocean Drilling Program (IODP), scientific drilling in the

Arctic can be accomplished only by an alternate, mission specific platform. Neither the present ODP drillship *JOIDES Resolution* nor the riser and the non-riser vessels proposed for the IODP will ever penetrate into the permanently ice-covered areas of the deep polar basin. Furthermore, since operations will be restricted to summer months and because of the wealth of scientific problems that need to be addressed in the Arctic Ocean, a dedicated effort over 10 to 20 years is required.

More extensive geophysical site surveys of potential drilling targets are needed urgently. Underway geophysical surveys in the Arctic Ocean carried out from both surface icebreakers and from submarines during the past decade have considerably improved our knowledge of the principal features of the Arctic sea floor. This activity needs to continue in order to provide the detailed geophysical foundation from which the best scientific drilling targets can be selected. These site survey data need to be shared throughout the scientific community. Successful science is thus dependent on a flourishing program of marine geophysical surveys in the Arctic.

Jurisdiction

Five coastal states, Canada, Greenland (Denmark), Norway, the Russian Federation and the United States of America, border the Arctic Ocean. A large portion of the Arctic Ocean lies within the 200 nm jurisdiction of these states.

However, no maritime boundaries have yet been agreed to in the Arctic between adjacent states, and to date only two of the five Arctic coastal states (Norway [1996] and Russia [1997]) have ratified the United Nations Convention on the Law of the Sea (UNCLOS).
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Environmental Issues

The sensitivity of low-temperature environments to oil pollution is recognized in Article 234 of UNCLOS (Taagholt, 1992). In addition to these governmental bodies, environmental non-governmental organizations (NGOs) also are deeply concerned about the Arctic environment. It is clear that any scientific drilling programme in the Arctic Ocean must emphatically state that it has nothing to do with oil exploration and that the environmental impact of riserless scientific drilling is negligible.

Pollution Prevention

For over 30 years, DSDP and ODP have maintained an unblemished record with respect to pollution. No blowouts or accidental releases of hydrocarbons into the sea have occurred from drilled wells.

Since scientific drilling objectives in the Arctic Ocean are mainly paleoceanographic and paleoclimatological, proposed drill sites are likely to be of shallow penetration (<500 mbsf). This reduces the risk of hydrocarbon flows.

Management Issues

Management tasks for high-Arctic drilling operations will include:

- Seek coastal state approvals as necessary.
- Manage budgets and maintain auditable accounts.
- Select contractors for ice management, drilling operations, core handling and curation.
- Negotiate contracts.
- Monitor contracts and pay for work done.
- Invite scientific participants.
- Identify safety issues and develop contingency plans.
- Define operational plans and establish lines of responsibility.
- Organize logistics.
- Arrange insurance policies (Government backing may be needed, as with ODP).
- Submit appropriate reports to funding agencies and to the scientific community.
- Interact with international environmental organizations.

Management will need to include personnel experienced in Arctic ice management, drilling operations, core handling, and project management/contracting to carry out the aforementioned tasks. These tasks cannot be relegated to a transitory committee of experts.

Short-term Strategy

A top-rated science proposal (533) for drilling the Lomonosov Ridge already exists. This proposal will be dealt with further by the recently established Arctic Detailed Planning Group (DPG).

Drilling within the permanently ice-covered regions of the Arctic should continue with operations on the periphery of the Arctic ice pack where some site survey data already exists, but for which drilling proposals have yet to be submitted. The approach adopted for these early legs will be to:

1. Use existing technology and ice management techniques already developed for drilling in ice-covered areas;

2. Ensure that many sites are available, over a considerable geographical area. This will prevent the operation from failing because of difficult ice conditions at just a few sites; and,

3. Ensure that adequate site surveys are available for all, including back-up, sites.

Long-term Strategy

In order to achieve the scientific goals of an Arctic drilling program, at least a decade of drilling is required. This long-term strategy assumes that a long-term funding commitment to Arctic drilling exists.

The long-term strategy will build on the results of the first drilling legs in the Arctic ice pack. Indeed, learning from earlier legs will be essential to the success of the whole program.

TECHNOLOGY FOR ARCTIC DRILLING

The general requirements for a drilling platform capable of operating in Arctic sea-ice areas include:

1. Dynamic positioning (DP);

2. High Arctic ice-class rating;

3. An adequate moon pool with a reinforced deck capable of supporting a drill rig. A dedicated drilling vessel will have an integral derrick and heave-compensated drilling capability. Alternatively, suitable vessels of opportunity can be equipped with portable, heave-compensated marine drilling rigs on a project-by-project basis;

4. The facility needs to be equipped with a suitable coring system, and have sufficient deck space for drilling, coring, logging equipment, and tools;

5. Provision for modular laboratory containers for core curation and safety assessment , as a minimum, and for services (water, fuel, power, etc.). Other modular (containerized) laboratories on a project-by-project basis could include physical properties, geochemistry, micropaleontology, and microbiology;

6. Sufficient accommodation for crew and scientists; and,

7. Helideck and other appropriate navigation and safety features for Arctic work.

Potential Platforms

Platform candidates that meet these requirements include:

1. Drilling vessel or barge: Dynamically positioned ice-class vessel or barge with a moonpool and at least a 100-ton capacity, heave-compensated, drill rig. This vessel will require support by one or more icebreaker(s).

2. Icebreaker-based platform (Fig. 3): A portable, heave-compensated drill rig installed on a dynamically positioned icebreaker with a moon pool.

3. Ice -supported drill rig: A portable drill rig transported by an icebreaker or by air and installed on land-fast (non-moving) ice.

Coring and Logging System

The selection of one of the following coring systems will depend on scientific objectives, water, and borehole depth and the type of drilling platform:

1. ODP system: A unique heavy-duty offshore scientific coring system with abilities to operate from oil field size DP drill vessel (e.g., *JOIDES Resolution*).

2. Geotechnical marine coring systems, including the "Piggy-back" option used on geotechnical DP drill vessels and other platforms (e.g., Bucentaur).

3. Complete Coring System (CCS), designed for Russian deep ocean scientific drilling, that can operate from geotechnical type or oil-field DP vessels.

4. "Baikal"- Nedra coring system, based on ODP and CCS techniques, that has been used from a drilling barge in Lake Baikal.

5. DOSECC/Cape Roberts-style systems: Hybrid, specially-designed mining-style, multi-string systems used in scientific coring.

In the short-term (3 to 5 years), technology should allow high-performance, high-resolution coring using single-bit drilling. Proposed operations include hydraulic piston sampling in ooze and soft clays, hydropercussion sampling in sands or silty clays, and rotary coring. Other coring technology compatible with single-bit operations should be part of the system (e.g., "Piggy-Back"/nested coring system, downhole motor coring, HYACE or PCS sampling). A mining-style system could be operated through the secondary drill string.

A portable wireline logging system compatible with the coring system and anticipated borehole diameter is required. This system should include a winch, cable, and data acquisition unit. The basic logging requirements will be the same as in the ODP program. The logging-while-drilling (LWD) system needs to be considered on a project-by-project basis.

Site Survey Needs

Despite substantial efforts, including the SCICEX program of the U.S. Navy, to collect seismic reflection data in the past decade, the geophysical database for the entire Arctic Ocean is scarce. Exceptions are selected sections of the Yermak Plateau, Lomonosov Ridge, and the Chukchi Plateau (Fig. 1). The use of multiple platforms (surface and submarine) of complementary capabilities should be employed for site and exploratory surveys.

In preparation for a long-term drilling program in the high-Arctic, the APPG urgently recommends acquisition of new geophysical data of adequate extent and depth of penetration to support drillsite definition.

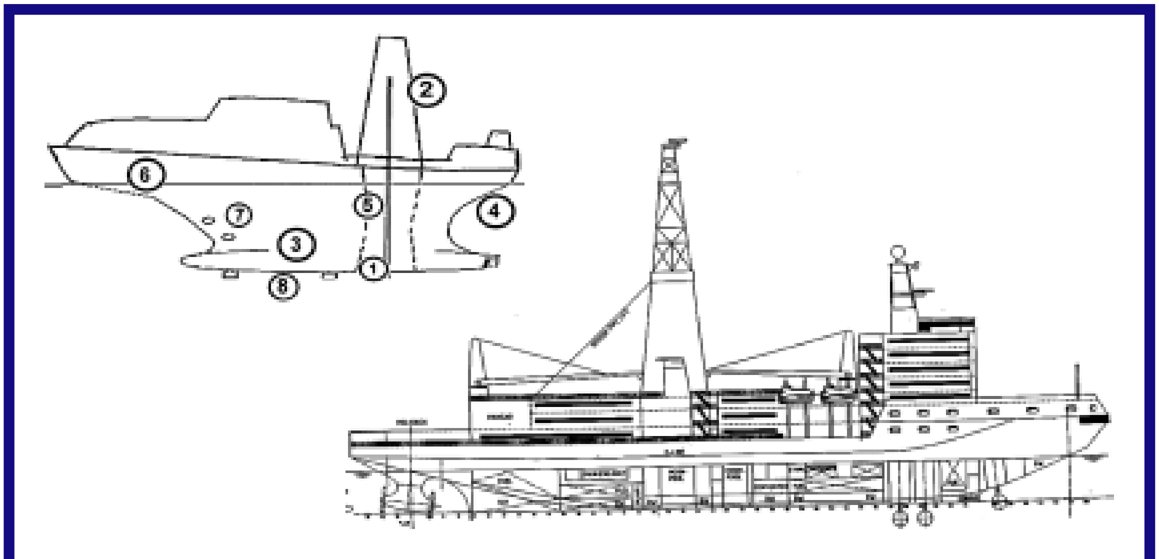

Figure 3. *Conceptual drawings of two icebreakers with drilling rigs. Both have been discussed briefly by the Arctic PPG as potential alternate platforms for ocean drilling in the Arctic Ocean.*

Ice Management

Drilling in drifting ice demands careful planning. Several companies have extensive experience in "Stationary Marine Operations in Drifting Ice" (STAMARDI), particularly in offshore Sakhalin (Okhotsk Sea) and in the Beaufort Sea. One main consideration is the maximum allowable lateral vessel movement. This parameter determines how much time is available for operational decisions to be made (i.e., response time). In order to manage ice during a STAMARDI, at least one primary and one secondary icebreaker are required.

The appropriate ice management system can be modelled by combining icebreaker performance models, ice regime modification models, and ice drift-force models.

Operational Flexibility

The following operational approach would maximize the chances of success:

1. A multi-vessel approach is required for operational flexibility and safety.

2. Arctic operations will require larger than normal fuel capacity (perhaps double).

3. Alternate drill sites should be approved because the primary drill site may not be accessible. It is likely that the sites drilled will be heavily influenced by ice conditions.

4. An appropriate ice management plan.

FUTURE TECHNOLOGICAL DEVELOPMENTS

Although technology exists to perform deepwater drilling in ice-covered regions, there is a need for particular developments for a long-term drilling commitment in the central deep Arctic, where the drilling targets of the highest scientific priorities are located. These developments may comprise several different systems, including remotely operated vehicles and submarines. APPG focused only on a new, conventional, surface vessel system.

Available barges and large icebreakers are either very cumbersome in operation (often lacking proper DP), or are too small for scientific work in difficult ice conditions. Thus a new large research icebreaker with a deepwater drilling capability is needed. In summer, the vessel will provide an alternate platform for Arctic deep drilling, with a derrick and a lab-stack to be mobilized for each season. Such a vessel will guarantee a commitment to a continuous Arctic deep-drilling program, and be a potential contribution to the IODP.

The APPG recommends the establishment of a technical feasibility study for such a vessel, which at present does not exist.

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The Proposal Process During the ODP-IODP Transition

Keir Becker (Director, JOIDES Office) and Ted Moore (Co-Chair, iPC)

One of the greatest strengths of the Ocean Drilling Program (ODP) is the drilling program selection process based on JOIDES panel and peer review of proposals freely submitted by interested geoscientists. A principal function of the JOIDES Office and Advisory Structure is/has been to coordinate the receipt and review of proposals from the community interested in scientific ocean drilling. The Integrated Ocean Drilling Program (IODP) is envisioned to carry on this proposal-driven tradition, with proposal processing and review initially coordinated by the Interim Science Advisory Structure (iSAS) and iSAS Office described later in this issue. Given that the iSAS will phase in during 2001, but JOIDES will continue through 2003, how will the proposal process transition be coordinated?

WHAT HAPPENS TO CURRENT JOIDES PROPOSALS?

The final year of *JOIDES Resolution* ODP operations will be scheduled at the August 2001 SCICOM/OPCOM meetings. Proposals submitted after the October 1, 2000 JOIDES proposal deadline could not fulfill the review process in time for consideration at the August 2001 meetings, so proposal submissions dropped considerably for the March 15, 2001 proposal deadline. But there had been a large upsurge of proposal submissions during 1999/2000, and there are many more strong proposals active than could possibly be scheduled in ODP. Proponents of these proposals will be offered the option to transfer their proposals to the interim IODP planning process, and the JOIDES Office and iSAS Office will work closely to coordinate the transfer of files.

The transfer process for all proposals will be initiated during the summer of 2001, when the iSAS Office is formally opened and the staffing of the iPC and iSSEPs is complete. The exception is the proposal subset that is being forwarded to SCICOM in August 2001 but is not scheduled for the final year of ODP operations. For this group the process will be initiated shortly after the August, 2001 SCICOM meeting. Any transfer must first be approved by the proponents, so the iPC co-chairs and iSAS Office will contact proponents of JOIDES proposals for their permission to transfer the proposal files from the JOIDES Office to the iSAS Office for review by the iSAS. In addition, all proponents will be offered the opportunity to revise or amend

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their proposals in line with the IODP Initial Science Plan and any new guidelines established for IODP proposals.

NEW PROPOSALS FOR THE IODP

It is planned that the publication of the IODP Initial Science Plan (ISP) in May of 2001 will trigger a formal call for IODP proposals in early summer, roughly coincident with the opening of the iSAS Office. Just as active ODP proposals are evaluated in the context of the ODP Long-Range Plan, IODP proposals will be evaluated in the context of the IODP's ISP. Many common scientific themes carry over from the LRP to the ISP, but emphases are different and IODP obviously will involve more drilling platforms than the riserless drill ship that exemplifies nearly all ODP programs.

IODP proposal requirements for programs on the IODP riserless drill ship will probably not be significantly different from current ODP proposal requirements, but IODP proposal requirements for riser drillship programs or mission-specific platforms will need further development in the IODP Call for Proposals. Hence, in many cases, proponents of proposals carried over from ODP will probably want to amend or revise their proposals when transferring them to the iSAS and its Office.

Formation of interim Science Advisory Structure (iSAS) for IODP

To support IODP transition planning during 2001-2003, an interim Science Advisory Structure (iSAS) and iSAS Office are being established in 2001. The iSAS structure parallels the JOIDES Advisory Structure (Table 1), with an interim Planning Committee (iPC) analogous to the JOIDES SCICOM, and interim Science Steering and Evaluation Panels (iSSEPs) analogous to the JOIDES SSEPs. Likewise, there will be an interim Site Survey Panel (iSSP) and interim Scientific Measurements Panel (iSCIMP). Plans are underway for a counterpart to the JOIDES TEDCOM. There will not be an IODP analogue to EXCOM until formation of the IODP SAS in 2003.

The mandates for the iSAS panels have been approved by IWG and are posted at the IODP

Table 1: *Overwhelmed by all these acronyms? Use the guide below to decipher JOI/ODP and iSAS/IODP abbreviations.*

JOIDES/ODP ACRONYMS	
JOI -	Joint Oceanographic Institutions
JOIDES -	Joint Oceanographic Institutions for Deep Earth Sampling
ODP -	Ocean Drilling Program
NSF -	National Science Foundation
JR -	*JOIDES Resolution*
EXCOM -	Executive Committee
SCICOM -	Science Committee
BCOM -	Budget Committee
OPCOM -	Operations Committee
TEDCOM -	Technology & Engineering Development Committee
SSP -	Site Survey Panel
PPSP -	Pollution Prevention & Safety Panel
SCIMP -	Scientific Measurements Panel
ESSEP -	Science Steering & Evaluation Panel - Earth's Environment
ISSEP -	Science Steering & Evaluation Panel - Earth's Interior
PPG -	Program Planning Group
DPG -	Detailed Planning Group
USSSP -	United States Science Support Program

iSAS/IODP ACRONYMS	
CMO -	Central Management Office
iDPG -	interim Detailed Planning Group
IODP -	Integrated Ocean Drilling Program
iPC -	interim Planning Committee
iPPSP -	interim Pollution Prevention & Safety Panel
IPSC -	IODP Planning Sub-Committee
iSAS -	interim Science Advisory Structure
iSCIMP -	interim Scientific Measurements Panel
ISP -	Initial Science Plan for the IODP
iESSEP -	interim Science Steering & Evaluation Panel-Earth's Environment
iISSEP -	interim Science Steering & Evaluation Panel-Earth's Interior
iSSP -	interim Site Survey Panel
IWG -	International Working Group
IWGSO -	International Working Group Support Office
JAMSTEC -	Japan Marine Science & Technology Center
MEXT -	Ministry of Education, Culture, Sports, Science & Technology
MOU -	Memorandum of Understanding
OD21 -	Ocean Drilling in the 21st Century (Japan)
SAS -	Science Advisory Structure (IODP)

web site, www.iodp.org. The timeline for establishing iSAS is presented in Table 2. A key difference between the JOIDES Advisory Structure and iSAS is that iSAS will group and rate IODP proposals, but neither rank them nor finalize the IODP drilling schedule. As of October 1, 2003, when IODP Memoranda of Understanding (MOU) are in place, the iSAS is expected to change into a Science Advisory Structure (SAS) for IODP, which will then build on the work of iSAS to create initial IODP schedules.

iSAS IMPLEMENTATION: 2001 TIMELINE

January	•	Approval of draft iSAS Panel Mandates by International Working Group (IWG)
February - March	•	JOIDES and OD21 advisory structure nominate members for the following committees and panels: 1) interim Planning Committee (iPC); 2) interim Science Steering & Evaluation Panel - Earth's Environment (iESSEP); 3) interim Science Steering & Evaluation Panel - Earth's Interior (iISSEP); 4) interim Site Survey Panel (iSSP)
April	•	iSAS Office established
	•	JOIDES and OD21 consult with IWG regarding iSAS panel and committee membership
May	•	Nominated iSSEP members attend JOIDES SSEP meeting as observers
June	•	Official start of iSAS;
	•	Panel membership established;
	•	Public Call for IODP proposals
July	•	iSSP members attend JOIDES SSP meeting as observers
August	•	First Official Meeting of iPC
	•	iPC members attend JOIDES SCICOM/OPCOM meeting as observers
	•	iPC/iPSC develop mandate for interim Pollution Prevention and Safety Panel (iPPSP) and discuss needs and mandates for new Industry/Technology liaison panel
	•	Nominate iPPSP members
November	•	Joint meeting of iSSEPs and SSEPs
	•	Establish iPPSP, members attend JOIDES PPSP meeting as observers
December	•	iPC establish first riser Interim Drilling Planning Group (iDPG)

Nomination Process for iSAS

Early in 2001, the co-chairs of IWG formally requested that JOIDES and the OD21 Science Advisory Committee work together to "form iSAS as a joint working group representing the two organizations," with a membership reflecting the ideal future contributions to IODP, i.e., approximately 1/3 U.S.A., 1/3 Japan, and 1/3 other countries and consortia.

The response to this request was governed by motion 01-1-5 of the JOIDES Executive Committee (see minutes posted on the JOIDES web site, http://joides.rsmas.miami.edu) and a corresponding, but subtly different, Consensus 01-1-01 of the OD21 Science Advisory Committee. During February to March of 2001, Japanese nominations to iSAS were put forth by the OD21 advisory structure. The EXCOM motion recommended that iSAS nominees be from members of corresponding JOIDES panels wherever possible, and nominations from the U.S.A. and other IWG members were solicited by the JOIDES Office from national ODP committees. Leaders of JOIDES and OD21 worked closely to ensure reasonable balance of expertise among the final list of nominations, which was forwarded to IWG in early May of 2001 for approval at their June 2001 meeting.

Formation of an iSAS Office

Just as the JOIDES Advisory Structure is supported by the JOIDES Office, an iSAS Office has been established to support the IODP planning of iSAS. The iSAS Office, at JAMSTEC headquarters, is under the direction of Dr. Minoru Yamakawa, and assisted by two Science Coordinators (Drs. Nobuhisa Eguchi and Jeffrey Schuffert) and additional staff.

The responsibilities of the iSAS Office are:

- *Support of all iSAS panel activities*, including administrative support to iPC, logistical support for all iSAS meetings, and production of the iSAS web page;
- *Tracking of the IODP proposal review process*, including receiving and tracking of IODP proposals, ensuring timely communications between proponents and iSAS during the review process, developing proposal review forms, and coordinating the anonymous external reviews for proposals forwarded for such review by the iSSEPs;
- *Publishing a newsletter* chronicling IODP planning and development; and
- *Maintaining close communications* among the JOIDES Office, JOI, the IWGSO, and the OD21 Office.

Contact information for the iSAS Office is provided below.

iSAS OFFICE CONTACT INFORMATION

MAILING ADDRESS
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Another staff member to be named

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Call for Proposals: The Integrated Ocean Drilling Program

A new international scientific ocean drilling program will begin in October 2003. Drilling proposals are now being accepted by the interim Science Advisory Structure (iSAS) of the Integrated Ocean Drilling Program (IODP).

Proposals to IODP should address the scientific themes spelled out in the IODP Initial Science Plan (now on the Internet at http://www.iodp.org). Proponents should indicate how the proposed ocean drilling will significantly advance scientific understanding of the Earth processes that comprise these broad themes.

The IODP plans to make the following types of drilling platforms available to proponents in support of the scientific ocean drilling objectives given in the Initial Science Plan:

1. A non-riser, dynamically positioned drillship similar to the *JOIDES Resolution*, but with enhanced laboratory facilities and capable of drilling in nearly all oceanic water depths.

2. A dynamically positioned drill ship with riser well control. Initially this ship will be limited to water depths between about 500 to 2500 m. Drill string length will be approximately 10 km. On-board laboratory facilities will be comparable to those on the non-riser ship (see further description of ship capabilities in the IODP Initial Science Plan).

3. “Mission-specific platforms” will be made available to address scientific problems that cannot be drilled using the two primary drilling platforms. Such missions might include drilling in very shallow waters or in ice-covered areas. Laboratory facilities for such platforms will be considered on a case-by-case basis.

THE IODP PROPOSAL PROCESS AND REQUIRED FORMATS ARE GIVEN AT
http://www.iodp.org under the iSAS link.
Proposals which do not adhere to these format guidelines will be returned to the lead proponent.

Initially, the Drill Site Designation Policy and Site Description Forms used in iSAS proposals will be identical to those used by JOIDES. These guidelines and forms are available at http://joides.rsmas.miami.edu/proposals/.

Deadlines for electronic submission of IODP proposals are 1 October and 15 March.

Proposals should be submitted electronically to the iSAS Office at isasoffice@jamstec.go.jp.
They will be accepted as one PDF file that includes all text, figures and forms.
NOTE: Please specify the software system used to produce the PDF file, and ensure the file will print using Acrobat Reader 4.0 (available at http://www.adobe.com). ***Proposals that cannot be printed at the iSAS Office will be returned to the lead proponent, and may result in the proposal deadline being missed***.

Proponents who are unable to submit proposals electronically may submit ten (10) copies of a paper version (with all figures and forms) by mail to the iSAS Office at the following address. An electronic version of the proposal abstract, in RTF (rich text file) format, also is required. This abstract may be submitted on disk by regular mail or by email to isasoffice@jamstec.go.jp.

iSAS Office
Japan Marine Science and Technology Center
2-15 Natsushima-cho,
Yokosuka-city 237-0061 JAPAN

Deadlines for the submittal of paper-copy IODP proposals are 1 September and 15 February.

Integrated Ocean Drilling Program (IODP) Principles

Approved by the International Working Group (IWG) on 17 January 2001

Final versions of the following IODP principles were accepted at the Southampton, U.K., meeting of the International Working Group (IWG) on 17 January 2001. The Management Structure is a draft version and is not included here.

IODP IMPLEMENTATION PRINCIPLES

Schedule

1. IODP will begin officially on 1 October 2003. Membership and Program implementation will be effective from this date.

2. The first year of the program will be spent in detailed planning activities and preparing for drilling operations (engineering development, detailed site surveys, etc.). Operation of the non-riser vessel will begin in 2005 . Riser vessel operations will begin in 2006.

Interim Science Advisory Structure (iSAS)

1. An interim Science Advisory Structure (iSAS) for IODP will be organized in June 2001 and will exist until 1 October 2003. ISAS will be a joint working group representing JOIDES and the OD21 Science Advisory Committee. The purpose of iSAS is to continue scientific planning for IODP.

2. Membership on iSAS committees will be nominated by JOIDES and the OD21 Science Advisory Committee. Representation on the committees and panels of iSAS is expected to be proportional to the optimal international participation in IODP (1/3 Japan, 1/3 United States, 1/3 other IWG members). JOIDES and the OD21 Science Advisory Committee are expected to confer and consider appropriate disciplinary balance and expertise in making their nominations.

3. An interim Planning Committee (iPC) will serve as the highest level committee and management authority for the iSAS and is expected to oversee and implement iSAS activity. Representation on iPC will be chosen from IWG members who are, in principle, seeking full IODP membership. The iPC will be responsible to the IWG for its guidance and direction and will report to the IWG. IPC will be co-chaired by the chairs of iPSC and the OD21 Science Advisory Committee.

4. IPC will encourage the international community to submit drilling proposals for IODP. The proposals will be examined and reviewed by iSAS, but final evaluation, ranking and scheduling will be conducted by the formal IODP Science Advisory Committee which will be established on 1 October 2003.

5. IWG will request iPSC to provide recommendations on necessary committees and panels for iSAS, a schedule for their creation, and panel mandates by 1 January 2001.

6. ISAS committees are expected to meet in conjunction with their equivalent JOIDES committee.

IODP PROGRAM PRINCIPLES

1. The IODP is a scientific research program with objectives identified in the IODP Science Plan. The results of the Program's scientific and engineering activities will be openly available.

2. The IODP is based on international cooperation and sharing of financial and intellectual resources.

3. Membership in the IODP is available to government and/or national agencies (or their representatives) which have an interest and capability in geoscience research.

4. The IODP will be guided by a science advisory structure, composed of scientists and engineers representing IODP members. The IODP science advisory structure will establish the appropriate panels to provide advice to IODP management on platforms and science operations.

5. The operation of two ocean drilling vessels (riser-capable vessel and non-riser vessel) presently constitutes the core capability of the IODP.

6. The IODP will seek substantive cooperation with other earth and ocean sciences programs and initiatives.

7. Program costs will be determined by the IODP Lead Agencies (presently the National Science Foundation (NSF) and Ministry of Education, Culture, Sports, Science and Technology (MEXT)). The Lead Agencies will contribute equally to Program costs. Program costs are composed of platform operations costs and science operations costs[1]. Platform operations costs of the two primary vessels are to be the responsibility of MEXT and NSF. Mission specific platform operation costs will be the responsibility of the member(s) providing the platform. Members in the IODP (including MEXT and NSF) will contribute financially to support of the science operations costs.

8. Support of scientific research and development costs for shore-based analysis and research on IODP samples and data, and for non-routine downhole measurements, are the responsibility of member countries/ agencies. Support of geophysical and geological research to prepare drilling proposals or identify drilling targets are also the responsibility of member countries/ agencies.

IODP MEMBERSHIP PRINCIPLES

1. Membership in the IODP is available to government and/or national agencies (or their representatives), which have an interest and capability in geoscience research.

2. Membership will be secured through signing of a memorandum of understanding between the government and/or national agency (or representative), MEXT and NSF.

3. Lead Agencies of the IODP, (presently MEXT and NSF), will have equal membership rights and responsibilities. Lead agencies will contribute core capabilities to the Program. Lead agencies will contribute equally to total Program costs.

4. An IODP Council will provide governmental oversight for all IODP activity. All countries, as well as member organizations representing countries, participating in the IODP will be represented on the Council.

5. Members will have the right to: (1) participate in all drilling cruises, (2) be represented on all planning and advisory panels, (3) be represented on IWG or its successor, (4) have access to data, samples, scientific and technical results. (5) Submit proposals to the advisory structure for drilling or engineering developments in support of IODP science, (6) etc.

6. Members will have the responsibility to: (1) actively participate in all aspects of the

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[1] Platform Operations Costs will support the basic operation of the vessel as a drillship, and will include, for example: (1) costs of the drilling and ship's crew, (2) catering services, (3) fuel, vessel supplies and other related consumables, (4) berthage and port call costs, (5) disposal of wastes, (6) crew travel, (7) inspections and insurance, (8) drilling equipment, supplies, and related consumables, (9) administration and management costs of the platform operators.
Science Operation Costs will provide for those activities onboard program platforms necessary to the proper conduct of the scientific research program and those shore-based activities required to properly maintain and distribute samples and data, support seagoing activities, and administer and manage the program. These costs will include, for example: (1) technical services, (2) computer capability, (3) data storage and distribution, (4) description, archiving, and distribution of data and samples, (5) deployment of a standard suite of logging tools, (6) development of new drilling tools and techniques required by IODP research, (7) program publications, (8) costs of consumables (exclusive of those identified under platform operations costs), (9) costs required for administration and management, including the Central Management Office, (10) engineering or geophysical surveys required for hole design or evaluation of drilling safety during final site selection.

IODP, (2) ensure publication and sharing of scientific results, (3) participate in providing data and proposals for planning of drilling programs, (4) etc.

7. Based on present projection of total annual Program costs ($130-140M) for a two drilling vessel program, the financial contribution for membership in the IODP will be $5 million/year. Financial contributions from international partners will be comingled to support science operations costs. This contribution will entitle a member to one participation unit, with one participation unit equivalent to one member per panel and two scientific participants per "cruise leg," or equivalent. More than two participants on a cruise leg may be acceptable as offset by reduced participation in other legs. A member may acquire additional participation units through a corresponding increase in financial contribution, and/or long-term provision of mission specific platforms. It is understood that the Lead Agencies will contribute equally to total Program cost and acquire additional participation units necessary to fully support the program. When the Program is established, associate membership status will be considered.

8. Membership will be based on a 10-year commitment, in principle, to participation in the IODP.

IODP PRINCIPLES ON DRILLING PLATFORMS

1. The operation of two drilling vessels (riser capable vessel and non-riser vessel) presently constitutes the core capability of the IODP. The riser capable platform will be made available by MEXT and will be owned and operated by JAMSTEC, and the non-riser platform by the NSF.

2. Legal and financial responsibility including mobilization and platform operation costs for the riser-capable vessel will reside with Japan, and for the non-riser vessel with the United States.

3. Access to mission specific platforms (beyond the two primary vessels) will be required to meet specific objectives identified by the science advisory structure, but resources to support these activities have not been identified at this time.

4. Legal and financial responsibility, including mobilization and platform operation costs of mission specific platforms, is to reside with the organization(s) or country (ies) which make the decision to offer this additional capability to the Program. Provision of such a capability will not be considered a contribution in lieu of annual IODP membership contribution.

5. IODP comingled program funds will be used to support costs of science operations on IODP drilling platforms.

6. International participation in the science and operations of all IODP drilling platforms will be consistent with IODP program procedures.

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Alternate Drilling Platforms - Europe as the Third Leg of IODP

Andrew Kingdon[1] (on behalf of the ESCOD group)

SUMMARY

The Ocean Drilling Program (ODP) has successfully drilled scientific objectives around the globe with the *JOIDES Resolution* (*JR*) drillship since 1985. Scientists recognize that a substantially refitted *JR*, or a replacement vessel with similar capabilities, cannot achieve every scientific objective identified in the Initial Science Plan (ISP) for the Integrated Ocean Drilling Program (IODP), which succeeds ODP in 2003. Some of these objectives, such as drilling of the seismogenic zone, will be addressed by the Japanese OD21 deep-riser vessel currently under construction. However, geographical, bathymetric, and mechanical limitations will persist with either proposed vessel.

To address these technical challenges, ESCOD, the European Steering Committee on Ocean Drilling hosted a workshop on Alternative Platform Drilling technology in Brussels, Belgium from January 8-9, 2001. Alister Skinner of the British Geological Survey and Jeroen Kenter of the Free University of Amsterdam co-chaired the meeting. Attendees included international marine earth scientists and representatives of the hydrocarbon drilling and service industries, the geotechnical drilling industry, and platform operators.

Industry's key message to the academic community is that almost all of the apparently problematic drilling environments can be cored, provided that the correct vessels, technologies, and planning strategies are used. A clear understanding of scientific priorities and dialogue between drillers and scientists is essential to the development of successful drilling proposals. Improved results can be expected for shallow water drilling and, possibly, deep drilling in hard rock formations at various water depths.

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TECHNICAL CHALLENGES FACING IODP AND INDUSTRY ANSWERS

Presentations of IODP science objectives by scientists were followed by open comment and discussion sessions. Industry representatives suggested how current and future technological and implementation approaches would allow these objectives to be achieved. The importance of continuous coring, unusual in most oilfield operations but common in mining boreholes, was a surprise to many in the oil industry, and helped focus the technical discussions.

Three restrictions on IODP operations not addressed by either a refitted *JR*, a replacement non-riser vessel, or the Japanese OD21 riser vessel, are:

1. **Geographical**: The ice strengthening of the *JR* is adequate for summer operations in some areas of broken ice, but is insufficient to allow drilling in ice-covered high latitude locations such as the Arctic. The highest ranked proposal currently within the ODP proposal system is for drilling along the Lomonosov Ridge in the Arctic Ocean.

2. **Bathymetric**: The *JR* is probably not the most suitable platform for drilling operations in less than 40 to 57 m water depth or in reef areas close to shore; this includes a significant portion of the continental shelves. These areas are vital targets for key ISP objectives of passive margin and climate research.

3. **Mechanical**: The riserless design of the *JR* leads to problems with spudding boreholes into and maintaining borehole condition in hard seafloor substrates (e.g., basalts, hard rock breccias, or coral limestones), sand-rich horizons on margins, and glacial sediments. Only minimal core has been recovered in boreholes that penetrate highly brecciated or unconsolidated material.

Industry representatives' responses to these limitations are summarized as follows:

The Arctic

Arctic Drilling Planning Group representatives remarked that the principal problem presented by the Lomonosov Ridge proposal is the need for a multi-ship program that includes an ice-strengthened and dynamically positioned drilling vessel and two ice breakers. The 25 to 30 day resupply and refuelling cycle for ice support vessels also is problematic. Industry and ODP Canada participants discussed use of existing platforms, and suggested possible drilling strategies and resupply support vessels.

Shallow-Water Drilling: Sandy Substrates and Coral Reefs

The need for scientific drilling through volumes of unconsolidated sands and coral reefs was widely discussed. ODP has repeatedly struggled to maintain stable boreholes where sand crops out at the sea bed, and has had great difficulty achieving significant core recovery. The geotechnical community stressed that these problems, while not simple, are handled routinely in industry by using appropriate technology and planning strategies. The major need, controlled weight on bit, may require a heave-compensated conductor pipe or heave-compensated sea bed reaction template plus ancillary tools, all of which may be better deployed from alternative platforms.

Innovative Drilling/Logging Technologies and Approaches

Innovative technologies of significant potential value to IODP include:

- Aluminum drill strings that allow use of lighter-weight derricks and drilling platforms than conventional steel drill strings;
- Simple, robust technologies, such as sub-sea ice air bags to support the weight of the drill rig and plastic risers to minimise weight, used by the international Cape Roberts drilling program in Antarctica;
- "Piggy-back" drilling, used in the Barents Sea, uses two separate drill strings from a single vessel, one inside the other, as an alternative to conventional risers. The outer drillstring effectively acts as a riser for the inner one which performs the actual drilling;
- Containerized "jack-up" rigs that can be sent anywhere in the world, and assembled on the beach in two days by six people; and,
- Advances in logging tool designs and geophysical log acquisition; NMR logging, LWD (logging-while-drilling), "wireline logging without wirelines", and new slimline logging tool technologies allow even smaller diameter geotechnical bore-holes to be logged to industry standards.

Logistics, Project Management, Industry Data, and Collaboration

Industry participants agreed that a multi-platform program is needed, and advised that the complex logistics would require sophisticated project management. This is routine in industry but is less familiar to the academic sector. BP-Amoco and Shell representatives offered IODP access to industry seismic data to depths of one second, including 3-D data, for use in site surveys and planning. The need for joint industry/academic projects to drive the new program was reiterated.

WHAT NEXT?

A detailed report of the Brussels meeting is being prepared. An inventory of industry drilling equipment, techniques and suitable vessels is being compiled. The inventory will be made available as a planning resource for IODP and the scientific ocean drilling community., and will likely be posted on the Joint European Ocean Drilling Initiative (JEODI) website (www.jeodi.org).

Scientists will be encouraged to write proposals addressing IODP ISP objectives at the Alternate Platform Drilling Conference (APLACON), in Lisbon, Portugal on May 10-12, 2001. This meeting, the successor to the CONCORD (deep-riser drilling) and COMPLEX (non-riser drilling) meetings, will result in drilling pre-proposals to be submitted to iSAS(interim Science Advisory Structure) at the normal 1 October proposal deadline.

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The JOIDES Journal shares the ODP's commitment to actively seek communication and collaboration with other national and international geoscience initiatives. The Journal will highlight these programs in order to inform the ODP community of their goals and objectives.

The MARGINS Research Initiative

http://www.ldeo.columbia.edu/margins

The National Science Foundation's MARGINS research initiative, driven by the Earth Science community, seeks to understand the complex interplay of processes that govern continental margin formation and evolution. Funding is provided by NSF-OCE, NSF-ODP and NSF-EAR. Research projects span onshore and offshore study regions, and address lithospheric deformation, magmatism and mass fluxes, sedimentation, and fluid flow. The goal of the MARGINS program is to provide a focus for the coordinated, interdisciplinary investigation of these processes and is based on four, broad initiatives:

- Seismogenic Zone Experiment
- Subduction Factory
- Rupturing Continental Lithosphere
- Sediment Dynamics and Strata Formation

Each of these initiatives is associated with focus sites, geographic research locations selected by the community to host a complete range of field, experimental and theoretical studies, over the full range of spatial and temporal scales, needed to formulate and address fundamental questions associated with each of the initiatives. Scientific drilling will be used with other tools to help map and define the geological characteristics of the focus sites by providing sediment and basement ages and physical properties, basement fabric, sediment facies, fluid flow regimes, and paleo-environment. ODP and IODP are thus important programs for the successful testing of MARGINS hypotheses.

All four MARGINS initiatives are now positioned to receive proposals. The next MARGINS-NSF deadline is 1 November, 2001. For more information, visit the MARGINS web site: *http://www.ldeo.columbia.edu/margins*.

Joint European Ocean Drilling Initiative (JEODI)

http://www.jeodi.org

JEODI, a thematic network of all European member states involved in scientific ocean drilling, is funded by the European Community. JEODI aims to bring the following to the IODP:

- A European science component to the international objectives for scientific ocean drilling
- Definition of the political structure and funding geometry for a European consortium in ocean drilling
- Technical requirements for a Mission Specific Platform (MSP) program in IODP
- Drilling targets and experiments for scientific ocean drilling using MSPs
- Proposals, cost estimates, and a management structure for shore-based laboratories and facilities in Europe as part of an international program
- A portfolio of drilling targets in Arctic waters
- A technical strategy for deep coring in ice-covered regions
- A report on integration of joint strategies with the International Continental Drilling Program (ICDP)
- Information brochures on the European role in scientific ocean drilling
- An educational outreach program for IODP in Europe

For more information, visit the JEODI website: http://www.jeodi.org

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New Book!

Ophiolites and Oceanic Crust: New Insights from Field Studies and the Ocean Drilling Program

Edited by Yildirim Dilek, Eldridge Moores, Don Elthon, and Adolphe Nicolas

Geological Society of America Special Paper 349, 466 pages, ISBN 0-8137-2349-3

A session (T70) on ophiolites, titled
"Ophiolites as Problem and Solution in the Evolution of Geological Thinking",
will be held at the
Annual Meeting of the Geological Society of America,
November 1-10, 2001
Boston, MA USA

Meeting Announcement!

For more information on the book and the meeting, visit http://www.geosociety.org

EMMM 2002 - Third International Congress on Environmental Micropaleontology, Microbiology and Meiobenthology

September 1-6, 2002 | Vienna, Austria | http://www.isemmm.org

EMMM 2002 is the third in a series of conferences organized by the International Society of Environmental Micropaleontology, Microbiology, and Meiobenthology (ISEMMM), Institute of Paleontology (Vienna, Austria), and the Avalon Institue of Applied Science (Winnipeg, Canada).

Presented papers will be published in a special volume of a newly established peer-reviewed journal, ***Environmental Micropaleontology, Microbiology and Meiobenthology.***

Meeting details will be available at http://www. isemmm.org. To be put on the mailing list, or for more information, please contact:

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Are you organizing a meeting, conference, or workshop of interest to the ocean drilling community? We will include an announcement in the next JOIDES Journal edition if you send us information at least a month in advance of our May 1 and November 1 publication dates.

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GUIDELINES FOR CONTRIBUTIONS TO THE JOIDES JOURNAL

The JOIDES Journal is a forum for news exchange within the international JOIDES community on scientific, technological, and planning developments. Before writing an unsolicited article, please contact the JOIDES Office to discuss whether it is appropriate for that particular issue. Information regarding news or meeting announcements can be sent without prior approval at least one month before the May 1 and November 1 publication dates.

Scientific Contributions (Recent Leg Reports and Post-Cruise Results) should focus on the major highlights of recently completed legs or post-cruise studies. The text should be 1500-2000 words, and contain not more than 10 references and three figures that are clearly relevant to the article.

Technology articles should focus on technological innovations being developed for use within the Ocean Drilling Program and their geological applications. Avoid specialized terminology where possible, or provide brief and clear explanations of specific terms. Content and length requirements are as described for Scientific Contributions.

Planning articles include discussion of JOIDES policies, workshop reports and Steering Committee activities. Text length should be 250-1000 words.

Meeting Announcements should be brief statements, not exceeding 100 words, with the meeting goals, location and dates, and full address of a contact person.

ELECTRONIC SUBMISSION REQUIREMENTS

We will accept electronic submissions if both text and figures are in common formats (e.g., MS Word; Adobe Illustrator, Photoshop, etc.). Send two electronic copies of the text and figures, with your name and complete contact information, to the JOIDES Office and Henny Gröschel at the following email addresses:
joides@rsmas.miami.edu (Tel: 305-361-4668)
hgroschel@rsmas.miami.edu (Tel: 305-361-4903).

Large graphic files may be made available on an anonymous ftp server at your institution, or sent by mail on a CD or Zip disk. In addition, please fax (to (305) 361-4632) or mail a clean black and white laser copy of each figure.

Text files should be saved in two formats: 1) the program in which the article was generated (please specify), and 2) text only, preferably as a rich text format (RTF) file.

Figure formats of choice are Adobe Illustrator EPS and Adobe Photoshop, at a resolution of 300 dpi. If you are using other graphic programs, please save the files in EPS or TIFF format, and specify the program. Contact us if you have questions on file compatibility. Do not send low-resolution GIF files.

Figures should be composed in black and white with one additional color, if desired (0-100% shading is possible). If your graphics program lets you specify PANTONE colors, use PANTONE 2738 CVP as a secondary color. Full color figures on the front and back covers of the JOIDES Journal are now acceptable to JOI, and we will gladly consider CMYK color figures from submitted articles.

Figures should be sized to the two column format adopted by the Miami JOIDES Office. Maximum widths are 7.6 cm (3 in) for one column, or 18.8 cm (7.4 in) for figures that may extend into the outside margin. Submit photographs in either black and white or color, and label clearly with your name and address if you mail the photos.

Where in the World is the JOIDES Office?

Photo, bottom left: *Attendees of the recent SCICOM and OPCOM meetings, held from March 20-23, 2001 at Tongji University in Shanghai, China. Meeting hosts from Tongji University are on the far left, as follows: Prof. Pinxian Wang, front row; Prof. Zuyi Zhou, second row; and Dr. Lei Shao, back row.*

Photo, bottom right: *The ODP and IODP booths traveled to the European Union of Geosciences annual meeting in Strasbourg, France from April 8-12, 2001. Staffers included, from left, Henny Gröschel and Elspeth Urquhart (JOIDES Office), Betsy Fish (IWGSO), and Max Shinano (IWGSO/ JAMSTEC).*

In this issue from pages 3 - 6:

Leg 187 Science Report: Mantle Dynamics and Mantle Migration along the Australian-Antarctic Discordance

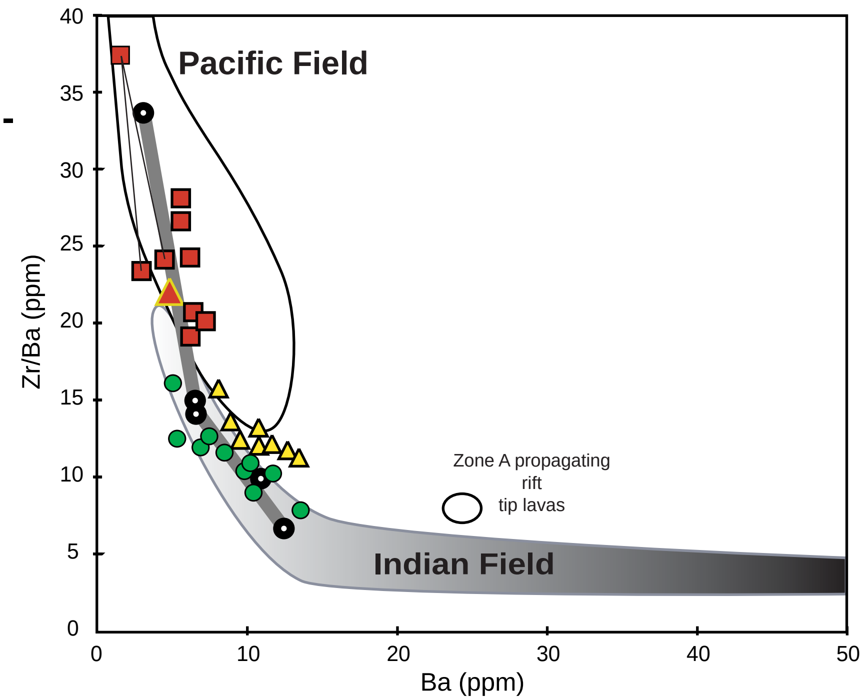

Figure 2. *Ba vs. Zr/Ba plot used to discriminate Indian and Pacific mantle domains onboard JOIDES Resolution. Fields are defined from a 0-7 Ma dredge sample collection. Squares are Pacific-type drilled samples. Lighter circles are Indian-type drilled samples. Triangles are Indian-type samples that plot slightly outside the 0-7 Ma Indian field. These samples were treated separately during the leg and confirmed as Indian by onshore Pb analyses (D. Pyle, unpub. data). Heavy circles are zero-age samples from Segment B5 of the Australian-Antarctic Discordance (AAD).*

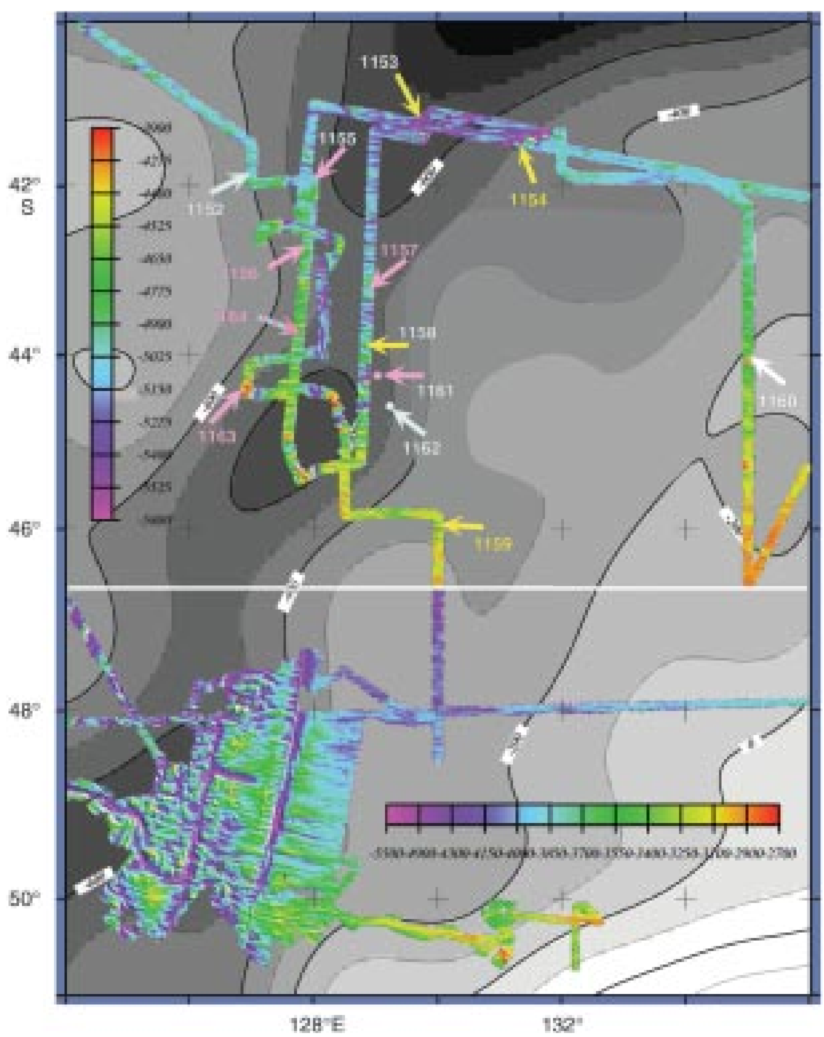

Figure 3. *Site locations in relation to the residual depth anomaly (gray contours) and SeaBeam bathymetry from the Boomerang 05 site survey cruise of R/V Melville. As confirmed by onshore Pb isotopic analyses (D. Pyle, unpub. data), lighter arrows (e.g., Site 1158) indicate sites with Pacific-type isotopic signatures, and darker arrows (e.g., Site 1157) are of Indian type. Site 1153 is transitional (after Christie et al., 1998). DR 11 is a transitional-type dredge from Lanyon et al. (1995).*

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