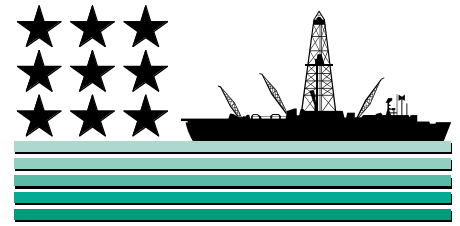


# JOI/USSAC NEWSLETTER



NOVEMBER 1996

VOLUME 9, NUMBER 3

## Post-2003 talk about ODP is on the rise

*contributed by Dale Sawyer*

**M**ajor scientific advances in the Ocean Drilling Program are often rooted in technological innovations, and if recent discussions are any indication, the next great leap forward may be riser drilling. This technology – not well understood by most ODP scientists – can be simply described as a drilling system that uses enclosed circulation of viscous mud to enhance drillhole stabilization and to drill deeper. Riser drilling was considered an integral part of the 1990 ODP Long Range Plan (LRP), the report of the U.S. COMMITTEE on POST 98 Drilling (COMPOST), and the new 1996 ODP LRP, and this technology remains essential to meet ODP's ambitious goals to drill deeply into thick sedimentary sequences and into oceanic crust.

Despite the potential of this technology, a drillship equipped with a riser system has never been used by the scientific ocean drilling community. Riser drilling requires a quantum increase in cost, operating time, and technical complexity and its use must be balanced against the scientific return. Nevertheless, and perhaps fortuitously so, two options have recently arisen for acquiring riser drilling capability. The principal option has been put forward by the Japanese Science and Technology Agency (STA/JAMSTEC) and is known as "Ocean Drilling in the 21st Century." This option seeks Japanese funds to build a large (190 m, 30,000 ton) research drilling vessel capable of riser operations in 2.5 km of water by the year 2003 and eventually in 4 km of water. This vessel, and a *JOIDES Resolution*-type ship, would form the backbone of a new international scientific ocean drilling program that would extend beyond 2003. This preference is at the core of ODP's new LRP.

An alternative to the "two-ship" option, is a major refit of the *JOIDES Resolution* in 2003 that would include stretching the vessel to make room for a riser system. Discussion and consideration of these options are ongoing, but the time is ripe to provide the community with an article about this technology which also touches briefly on some of the anticipated scientific payoffs.

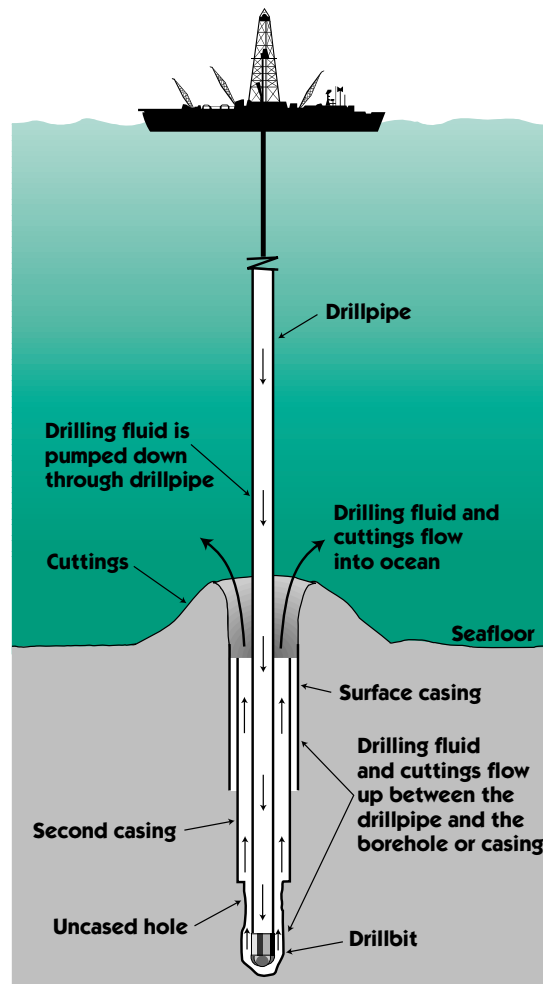


Fig. 1: Drilling without a riser.

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**Dale Sawyer is Associate Professor of Geology and Geophysics at Rice University in Houston, Texas. He sailed on Leg 149 to the Iberia Abyssal Plain where a six kilometer riser would have come in quite handy.**

## What is a riser?

A riser is a metal tube (pipe) that extends up from the seafloor to a drilling platform, such as a drillship's rig floor. Its inner diameter is large enough to let pass the drillstring, the drillbit, logging tools, additional casing strings, and any other devices that scientists may want to place into the hole. ODP scientists and engineers have been considering risers with outer diameters ranging from 5 to 5-1/2 in. (for the Diamond Coring System), to 9-5/8 to 10-3/4 in. (for a *JOIDES Resolution* slimline riser), to 16 to 21 in. (oil industry standard). The top end of the riser must be attached to the drillship and it must bear the total weight of the device. A riser has to be compensated for heave, the wave-induced vertical movement of the drillship. The riser heave compensating equipment, or "riser tensioner system," was removed from the *JOIDES Resolution* when it was converted for the ODP. This riser heave compensation system is distinct from the drillstring heave compensator that is currently, and routinely, used on the *JOIDES Resolution*.

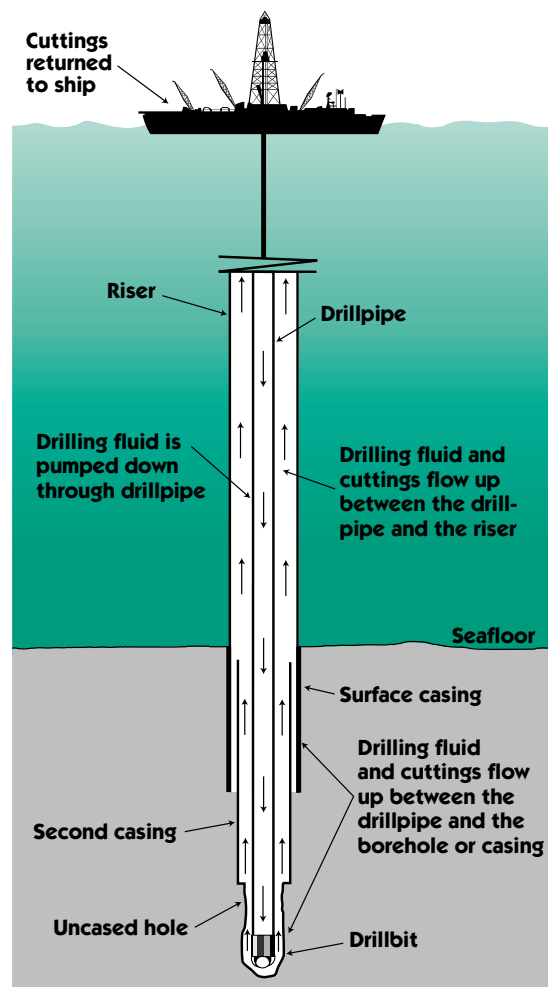


Fig. 2: Drilling with a riser.

## What is a casing string?

The bottom end of the riser must be firmly attached to the top of the drillhole in the seafloor. Such a connection is provided by a casing string which is cemented into the seafloor. A casing string is like a riser in that it too is a metal tube large enough to pass the drillbit, drillstring, logging tools, additional casing strings, and other items destined for the drillhole. The *JOIDES Resolution* is presently capable of setting casing and does so whenever reentry cones are used. The shallowest or surface casing string, usually 20-60 m long, is "jetted-in" to unconsolidated sediments or "drilled-in" to rock. Jetting-in consists of lowering the casing string to the bottom and pumping water through it while lowering it into the sediment. When the casing is jetted-in, the sediment settles back around the casing and anchors it. Drilling-in consists of drilling a hole large enough to contain the casing, lowering the casing into the hole, and then pumping cement down through the casing and up the space between the outside of the casing and the wall of the hole (Figure 1). This anchors the casing solidly to the rocks on the side of the hole. After the casing is set, the riser is lowered to the casing and the two tubes are locked together by a riser connector. A "blow-out preventer" (see below) is placed at the seafloor between the casing and the riser.

## What can a riser do?

The riser provides a way to return drilling fluid and cuttings, the ground up bits of rock, from the drillhole to the drillship (Figure 2). Because most of the drilling fluid can be reused, it is possible to use drilling mud rather than seawater as the primary drilling fluid. The potential advantages of using mud are the most compelling reasons for ODP to consider using a riser.

When the *JOIDES Resolution* drills now, most of the penetration is accomplished with seawater which is pumped down through the drillpipe, out the bit, and into the bottom of the hole (Figure 1). The seawater cleans and cools the bit and then flows up the space between the outside of the drillpipe and the borehole wall entraining, or lifting, the cuttings up and out of the hole. Removing cuttings from the hole is essential if drilling is to continue. The mixture of seawater and cuttings are expelled from the hole

into the ocean at the seafloor and the cuttings pile up in a cone around the hole.

Seawater is a reasonable drilling fluid, but drilling mud is much better, largely because of its greater density and viscosity. The *JOIDES Resolution* drillers recognize the advantages of drilling mud, and when certain drilling problems arise, such as slow penetration, hole instability, or a buildup of heavy cuttings, they will pump a mud “pill” or “sweep” (1100–1925 gallons of drilling mud) into the hole to try to solve the problem. They use a mud pill rather than continuously pumping mud because this costly material is lost into the ocean upon expulsion from the hole. In contrast, when drilling with a riser, the mud along with the entrained cuttings are returned to the ship. The mixture of mud and cuttings flows up the space between the drillpipe and the riser. The cuttings are removed from the used drilling mud and the mud is returned to a tank for reuse.

### **What is a blow-out preventer and how does it work?**

A riser system uses several pressure control devices, such as a “blow-out preventer” (BOP) that sits on the seafloor between the riser and the casing, or a “diverter,” which is positioned at the top of the riser, below the rig floor. A BOP is designed to protect the drillship and the ocean environment from well “blow-out,” which can occur if drilling penetrates a rock formation that contains fluids (or gases) at pressures that are higher than those in the borehole. When this happens in the absence of a riser, the formation fluid/gas flows up the borehole and out into the ocean. Such flow can damage the environment, and if it occurs while drilling in shallow water, the flow can become a hazard to the ship itself. If a blow-out occurs and a riser is being used, but without a BOP, the formation fluid flows up the borehole, through the riser, and out onto the rig floor, which could result in a catastrophe. Blow outs are particularly dangerous when they result from drilling into natural gas, which expands tremendously as it rises, due to pressure release. Some type of blow-out protection is essential when there is a chance of encountering oil or natural gas. ODP has avoided the need for this technology by being extraordinarily careful in

## **What is drilling mud?**

Drilling mud is a combination of water and various clays and chemicals. There is a significant body of engineering knowledge devoted to the properties of drilling mud; there are even so-called “Mud-Engineers.” When your mother told you to stop making mud pies as a child, she may have discouraged you from pursuing a potentially lucrative career! An important property of mud is its density because the mud exerts pressure on the borehole that is proportional to the mud’s density and the height of the mud column (all the way up to the ship). The density is controlled by the amount of solids (bentonite, barite and cuttings) added to the water. The density of mixtures ranges from 1.0 g/cc (pure water) to more than 2.6 g/cc (a heavy mud). The mud-induced pressure is the first line of defense in protecting the drillship and the environment from blow outs (the uncontrolled release of oil or natural gas from a well). The pressure of the drilling mud has some ability to push against the walls of the borehole, which potentially reduces “caving,” the collapse of the wall rocks into the hole. The pressure also causes some of the water in the drilling fluid to penetrate the permeable rock formations of the borehole wall. This water, referred to as “filtrate,” is driven deeply into the wall rocks, while the solid component of the drilling fluid is filtered out, and build up what is known as a “mudcake” on the borehole wall. The depth to which the filtrate penetrates can be observed using electrical logs and is often taken as a measure of the permeability of sedimentary formations. The mudcake tends to prevent caving by holding together softer sedimentary rocks. The mudcake often forms an impermeable layer that seals the formation so that drilling fluid is not lost by flowing into the formation, which is a particular problem in highly fractured formations.

A second important property of drilling mud is its viscosity, which is controlled by the amount of sepiolite mud that is added to the water. Drilling mud can lift cuttings much more effectively than seawater because mud is more viscous. Seawater is nearly incapable of lifting cuttings of relatively dense igneous rocks from open holes that are deeper than approximately 2 km; indeed this fundamental limit may have been reached in ODP Hole 504B. Lifting cuttings of unusually dense rocks like metal sulfides can be difficult even in shallow holes. The use of sepiolite can extend these limits substantially. One scientific drawback of using drilling muds is that they contaminate cores. The drilling mud is pumped past the core barrel just before passing out through the bit into the hole. The core will inevitably be exposed to the drilling mud at the bit. The significance of this contamination will vary according to what information is sought from the cores. Pore water chemistry is almost certainly compromised.

The cuttings are removed from the used drilling mud on the drilling platform by a vibrating screen device known as a “shale-shaker” and by centrifugal sand and silt cleaners. After being processed, the mud is transferred to tanks for reuse. The cuttings are valuable because they may include samples of rocks that were not recovered as cores, and would have otherwise remained unknown to the scientists.

*continued on page 19*

## SPECIAL REPORT

*Mike Purdy is  
Director, Division of  
Ocean Sciences for the  
National Science  
Foundation.*

# Korea joins the Ocean Drilling Program

*Dr. G.M. Purdy gave the following speech at a reception held at the Canadian Embassy on October 8, 1996, welcoming Korea as ODP's newest member. The JOI Staff enjoyed listening to this inspiring speech, and thus would like to share it with you.*

**T**oo infrequently today, given the budgetary climate in Washington, does a Federal bureaucrat like myself get the opportunity to participate in such an unquestionably positive event as this, as I on behalf of the U.S. National Science Foundation welcome the Republic of Korea into the Australian-Canadian Consortium and look forward to their constructive participation in the International Ocean Drilling Program. Perhaps it would be useful for me to say a few words about this Program, which some of us here understand so intimately and others know so little about.

The Ocean Drilling Program is frequently misunderstood by many to be little more than a facility, a tool to be used by other projects to reach their goals. It is true that, necessarily, the program is centered around a tool — a unique tool — the drilling vessel *JOIDES Resolution* — but it is so much more than this. The Ocean Drilling Program is a science program, a major earth and ocean sciences research program in its own right — it has its own clearly definable intellectual rationale driven by the participation of a great international community of marine geoscientists from 19 different countries. It is universally regarded, and has been for many years, as the most superb example of the effectiveness of international cooperation in basic research.


But the greatness of this program and the key to its longevity and success lies not in the spectacular engineering feat that is drilling in the deep ocean — and I must not belittle this achievement — drilling a hole in the ocean floor is equivalent to me trying to drill the embassy floor with a piece of thread 0.5 mm in diameter that is 4 meters long — twice my height. If you have that scale picture in your mind (and remember that the ship returns and actually reenters previously drilled holes), spectacular as it is, this is not the true greatness of ODP. The source of this greatness is the community of researchers and scientists that drive the Program. There is no power-crazed bureaucracy that shackles the Program to conservative or outdated ideas. The science planning and science operations of ODP are controlled by the

researchers themselves. That is why the Program is as fresh as it is today, tackling research problems as topical and as close to the cutting edge as it was more than 20 years ago.

What kind of research problems am I talking about? For those of you from outside the science, I think it is important for me to explain what can be so interesting on the ocean floor to justify such effort and resources to recover samples. Let me quickly give you two broad examples. The ocean floor is the only place on Earth where we can find an undisturbed record of past climate on our planet that extends back thousands, tens of thousands, millions and tens of millions of years. The skeletal remains of past life in the oceans, fallen to the seafloor and today forming the sedimentary cover of the ocean floor, that in some places can be thousands of meters thick, is an incredible natural and well preserved archive of information. The chemical and isotopic signatures that modern techniques can extract from these skeletons allow researchers to reconstruct past climate and ocean circulation patterns. We are learning of profound adjustments to the Earth's climate system, some of which occurred with catastrophic rapidity over a few decades or centuries. Only with *JOIDES Resolution* can we probe the deepest sediment piles and recover the most precise and complete record of past climate changes and so provide the essential framework from within which we can understand humankind's impact on our planet.

Secondly, the Earth's crust is about one fifth as thick beneath the deep ocean as it is beneath the continents. This crustal skin covers the earth's mantle. It is the temperature variations within this uppermost mantle the distribution and transportation of heat within the uppermost mantle, that drives continental drift that drives plate tectonics, and is responsible for all earthquake and volcanic activity around the globe. If we want to understand how the mantle works there is no better place to study these rocks than beneath the deep ocean where the crust is thin and young and simple.

The more than 18,000 tons of steel and alloy that is the drillship is the catalyst that brings together researchers from wide-ranging disciplines, cultures and nations to tackle together some of these most fundamental scientific questions. But it is the people involved in ODP that make it great.


With the addition of our colleagues from the Republic of Korea we bring new expertise to the program — we bring fresh perspectives and we increase the intellectual resources upon which the program is built. There is nothing more valuable than that. We welcome you. 

## Investigating climate intervals of extreme warmth

contributed by Lisa Sloan

One of the primary goals of the Marine Aspects of Earth System History (MESH) program plan is to study and understand climate intervals of extreme warmth, especially those that existed between the early Eocene and the latest Pliocene. To address this program element, a workshop was held at the University of California, Santa Cruz, on July 11-13, 1996, cosponsored by the JOI/USSSP and the MESH planning office. The conveners were Lisa Sloan (UCSC) and Nick Pisias (OSU). The main goal of the workshop was to define drilling objectives that would further the study and understanding of warm climates in Earth history through identification of the key questions regarding the nature of warm time intervals, and identification of regions where marine data might be recovered to answer such questions. Specific drilling targets were identified at the workshop and scientists were selected to develop those targets, in order to foster the long-term development of drilling proposals. To make progress toward the goal of better describing and understanding the processes associated with the evolution of warm past climates, the conveners brought together both data-oriented paleoceanographers and modeling specialists, with the hope that combining the two perspectives and encouraging collaborative studies would produce new and innovative approaches to the problem.

Throughout the three-day workshop, attendees: heard plenary talks addressing drilling logistical issues, records of extreme Cenozoic warmth (Figure 1), and modeling studies of extreme-warmth paleoclimate; participated in working groups which approached drilling goals from question-, process-, and temporal perspectives; and took part in discussion sessions involving the entire workshop group. The workshop

culminated in the identification of drilling targets, and identification of workshop participants who would foster the development of drilling proposals, and would lead the efforts to expand scientific participation for the drilling initiatives. Drilling targets identified at the workshop included: Bay of Biscay/ Newfoundland Ridge (leaders: L. Stott, R. Norris, K. Miller), Western Tropical Pacific (leaders: J. Zachos, T. Bralower, T. Moore), Western Indian Ocean (leader: A. Droxler), Western Boundary Current, Pacific Ocean (leader: T. Crowley), South and Central Atlantic Ocean (leader: K. Miller), and the Bering Sea. Additionally, at this time, the MESH Warm Intervals Workshop attendees voted unanimously to endorse several drilling programs already in progress, including the Prydz Bay, Ross Sea, Weddell Sea transects, and the Paleogene Pacific transect. 

### USSSP/ MESH Workshop Report

Lisa Sloan is  
Assistant Professor  
of Earth Sciences,  
University of  
California,  
Santa Cruz.

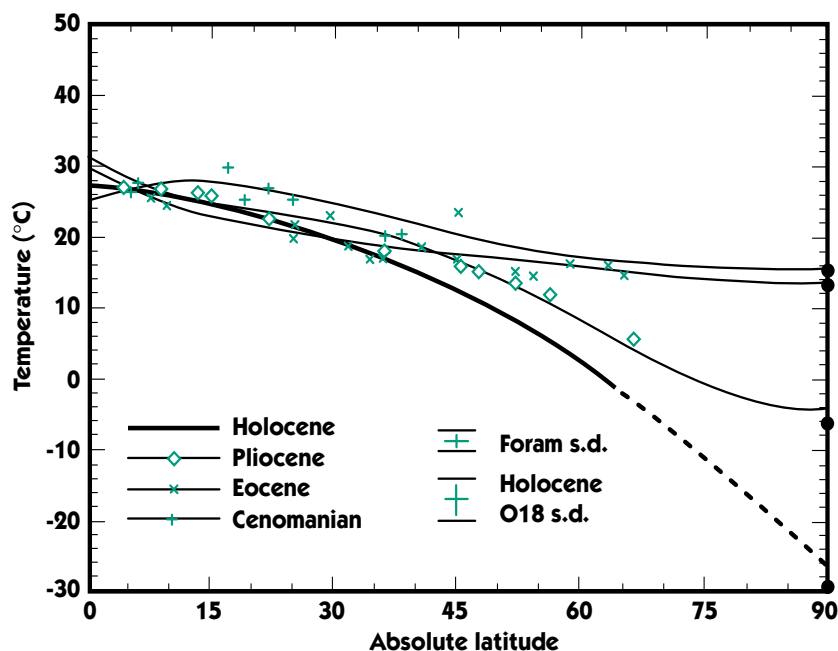


Fig. 1: Zonal profiles of latitudinal surface temperature gradients reconstructed for warm intervals of geologic time. From Crowley, T. and Kim, Comparison of long-term greenhouse projections with the geologic record, *Geophys. Res. Ltrs.* 22(8), 993-936, 1995.

# Drill Bits



## Janus update

*Now, by two-headed Janus,  
Nature hath framed strange fellows in her time.  
- William Shakespeare, Merchant of Venice*

Blast off! January 8, 1997 is the scheduled launch date for Janus — ODP's new, relational database management system. The project is in high gear and much has been accomplished since our last report. Modules that will be deployed on Leg 171B include those up to, and including chemistry and a preliminary means for capturing visual core descriptions. See the Janus homepage for details: <http://www-odp.tamu.edu/janus/>. A full report on Janus will be presented in the next newsletter.

## ODP Public Affairs activities

In August, a public relations committee, including members from the University of Victoria, in British Columbia, Canada, highlighted the two-day ODP "subleg" (Leg 169S) in nearby Saanich Inlet. The committee orchestrated a series of public events including a lecture series, a press conference, and tours of the *JOIDES Resolution* that included over 1,400 visitors. The public and press were briefed on the scientific objectives of this mini-cruise, which included obtaining a detailed record of the past 10,000 years of climate change, earthquake frequency, and the role of bacteria in sedimentary processes. A highlight of the port call was a ceremonial welcome performed onboard the *JOIDES Resolution* by Coastal Saanich natives, Tseycum Chief Vern Jacks and Tsartlip Chief Simon Smith.

One of the highlights of the Victoria press conference was the announcement that Korea would be joining ODP as a new member of the Australia-Canada Consortium. This event was later celebrated with the diplomatic community and ODP officials on October 8 in Washington, D.C. at a reception hosted by the Embassies of Canada and Australia and by JOI with the support of NSF (see Dr. Mike Purdy's speech on page 4).

The subsequent expedition, Leg 169, became remarkably newsworthy when drilling reactivated an ancient hydrothermal system in Middle Valley, on the Juan de Fuca Ridge. ODP's exciting accomplishments were

heralded in press releases from the ODP and NSF, in a snippet in *Science* magazine's "Random Samples" section (October 18th issue, page 349), and during a press briefing at the San Diego port call in mid-October. The results of our publicity efforts included a feature newspaper article in the *San Diego Union-Tribune* and comprehensive local television coverage. Scripps Institution of Oceanography coordinated ship tours for officials and university students and staff, as well as a lovely reception at the Martin Johnson House on the Scripps campus. *P. Baker-Masson, ODP Public Affairs Director*

## New multimedia CD ROM

JOI is pleased to announce that the NSF recently granted additional funds to USSSP enabling us to begin a second educational, multimedia CD ROM. This one will focus on the initiation of northern hemisphere glaciation (~2.6 million years ago) and the factors that may have contributed to this, such as plate tectonics (Isthmus of Panama closure), a modal change in orbital insolation, and a large-scale increase in global volcanism. These factors will be examined by studying the geologic record preserved in ODP cores and downhole logs. The new CD ROM will enable the user to gather data from a series of interactive laboratory exercises to test hypotheses about the causes and consequences of glaciation. This is similar to the format used in JOI's CD ROM, "ODP: From Mountains to Monsoons," which is currently available from JOI, free of charge. A virtual "Co-Chief Scientist" will help the user collect and synthesize the data from each laboratory, determine what additional data are needed, and ultimately combine the results and draw some conclusions. JOI will once again be working with Electronic Learning Facilitators, Inc. on this multimedia project. We anticipate the new CD ROM will be ready for release in mid-1998.

## Sampling and curation workshop

On November 18 and 19, JOI will host an ODP Sampling and Curation Workshop in Washington DC that will review, and as necessary, recommend to JOI any changes to current ODP policies regarding core sampling, curation, and repositories. These recommendations will subsequently be reviewed by PCOM/SciCom for comment and endorsement. This review is considered

imperative in light of recent advances in shipboard laboratories and scientific approaches, as well as in ODP procedures (e.g., the new publication policy and changes in the JOIDES advisory structure) and thematic directions (e.g., the 1996 ODP Long Range Plan). Participants in this workshop will include members of the JOIDES Information Handling Panel, ODP/TAMU Science Operations and Curation and Repositories, recent ODP participants and curation experts from the scientific community at large, and JOI and NSF.

The primary objective of the meeting is to evaluate existing policies in light of recent program changes and to suggest improvements and updates as necessary. The overall goals of the sampling policy should be to (1) insure maximum accessibility of ODP samples to qualified scientists and educators, (2) encourage analyses of many types, from a wide range of scientific disciplines, (3) promote timely publication of results, and (4) maintain an archive of data and results derived from sample requests.

Discussion will focus on a variety of topics, including: (1) the general sample request policy (including forms) and associated procedures, (2) sampling from “dedicated holes” and “composite depth sections”; (3) “re-curation”, the effort to alleviate core degradation and ameliorate existing collections; (4) curatorial practices in light of the 1996 LRP initiatives; (5) capacity of core repositories; (6) integration of samples from other drilling platforms into the curatorial system; (7) integration of sampling/curation policy and the new publication policy; (8) the connection between sampling/curation and the Janus database management system; and (9) the philosophical debate over sampling vs. archiving core material.

Workshop participants will include: Patty Fryer, Brian Huber, Warner Brueckmann, Kate Moran, Tom Janecek, Kathy Gillis, Jean Valet, Alan Kemp, Kay Emeis, Rick Murray, Damon Teagle, Eve Arnold, Mitch Lyle, Jamie Allan, Russ Merrill, Chris Mato, John Firth, Ellen Kappel, Dave Falvey, John Farrell, and Paul Dauphin. The results of this workshop will be reported in the March newsletter.



## JOIDES Resolution Schedule for Legs 170-176

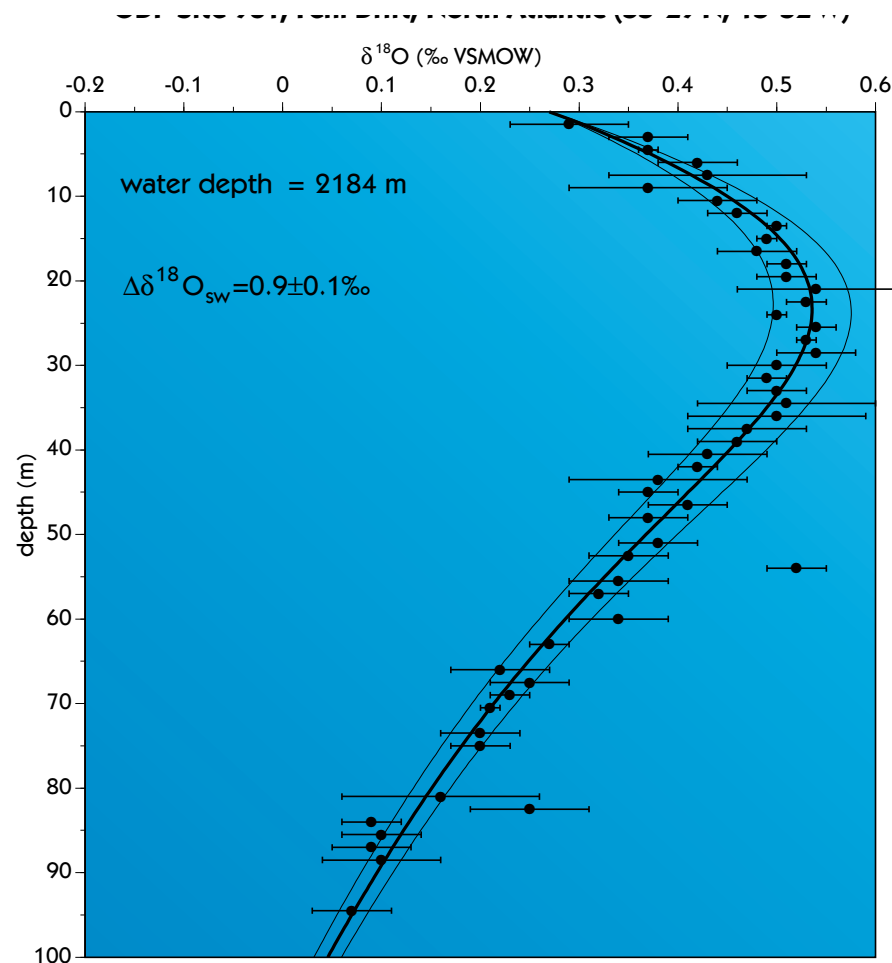
Leg	Region	Co-Chiefs	Dep. Port	Date	Scientific Objectives
170	Costa Rica Accret. Wedge	Kimura Silver	San Diego	10/96	To study the mass- and fluid-flow patterns through the accretionary prism to establish the mechanical and chemical behavior of accretion and under-plating, tectonic erosion, and deformation and dewatering distribution.
Transit to Barbados			Panama	12/96	-----
171A	Barbados LWD	J.C. Moore	Barbados	12/96	To understand the interrelationship of deformation, fluid flow, seismic imaging, and physical properties.
171B	Blake Nose	Norris Kroon	Barbados	1/97	To reconstruct ocean chemistry and circulation during the Cretaceous and early Cenozoic, to examine the sediment record following the bolide K/T impact, the hydrographic structure of the low-latitude Cretaceous ocean, and the evolution and biostratigraphy of Cretaceous microfossils.
172	NW Atlantic Sed. Drifts	Keigwin Rio	Charleston	2/97	To analyze geochemical proxies for nutrient content, temperature, and salinity in order to reconstruct a high-resolution, deep- to intermediate-depth hydrographic reconstruction for the western subtropical North Atlantic during the last glacial maximum.
173	Iberia Margin	Beslier Whitmarsh	Lisbon	4/97	To better understand the history of this non-volcanic rifted margin, including the timing and nature of melt generation during breakup and the earliest generation of “normal” oceanic crust.
174A	New Jersey Shelf	Austin Christie-Blick	Halifax	6/97	To investigate the Oligocene-Holocene history of sea-level change by determining the geometry and age of the Oligocene-to-Miocene depositional sequences.
174B	CORK/ Engineering	Becker Pettigrew	New York	7/97	To CORK Hole 395A and to conduct engineering tests.
175	Benguela Current	Berger Wefer	Las Palmas	8/97	To reconstruct the history of the Benguela current and coastal upwelling of the region between 5° and 32°S.
176	Return to 735B	Dick Natland	Cape Town	10/97	To deepen hole 735B and investigate the nature of magmatic, hydrothermal, and tectonic processes in the lower ocean crust at a slow-spreading ocean ridge.

## Ice age ocean temperatures inferred from ODP pore waters

**Daniel P. Schrag**

*Department of Geosciences, Princeton University*

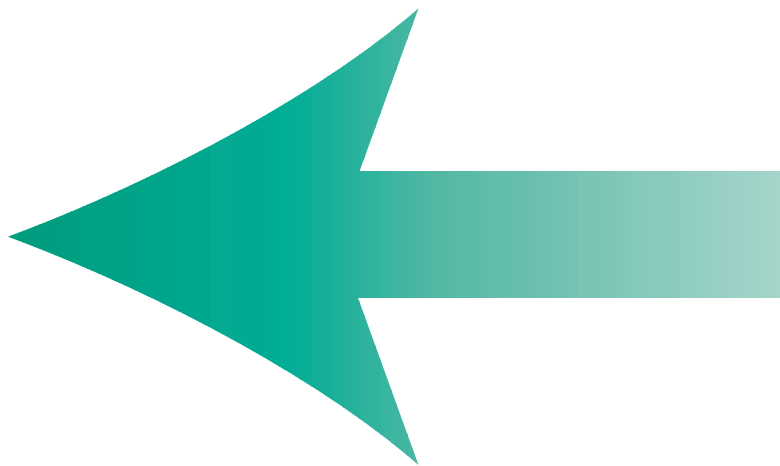
In efforts to reconstruct past climates and to improve our understanding of climate dynamics, paleoceanographers have focused on key parameters such as ocean temperature and the size of continental ice sheets. To estimate temporal fluctuations in these two, scientists have historically relied upon downcore measurements of the ratio of oxygen isotopes  $^{16}\text{O}$  and  $^{18}\text{O}$  (i.e.,  $\delta^{18}\text{O}$ ) in calcareous foraminiferal microfossils. The difficulty of this approach is that foraminiferal  $\delta^{18}\text{O}$  monitors changes in both temperature and seawater  $\delta^{18}\text{O}$ , the latter of which is primarily due to variations in ice sheet size. Up to now, the challenge has been to disentangle the two signals from the one foraminiferal data set. A new approach — measuring the  $\delta^{18}\text{O}$  of pore waters squeezed from ODP cores — may resolve the degree to which each parameter contributes to the total change in foraminiferal  $\delta^{18}\text{O}$ . The approach is straightforward. Seawater diffuses into the seafloor leaving a profile of  $\delta^{18}\text{O}$  versus depth in the sediment column that records the  $\delta^{18}\text{O}$  history of the overlying seawater, independent of temperature [Schrag and DePaolo, 1993]. The depth to which the signal penetrates is determined by the diffusivity of water through the pore spaces. Detailed measurements of pore water  $\delta^{18}\text{O}$  from the upper 50 m of ODP Site 925 (Leg 154), in the tropical Atlantic, enabled us to reconstruct seawater  $\delta^{18}\text{O}$  during the last ice age [Schrag *et al.*, 1996]. These data suggest that continental ice growth increased the mean  $\delta^{18}\text{O}$  of seawater by only  $1.0\text{‰}$ ,  $0.3\text{‰}$  less than previous estimates. New data on North Atlantic samples from Leg 162 (in collaboration with D. Hodell and K. MacIntyre) yield a similar change of  $0.9 \pm 0.1\text{‰}$  (see figure). By subtracting these pore water values from the larger foraminiferal values we have isolated the temperature component of the isotopic signal. Our data suggest that the deep ocean was  $\sim 3^\circ\text{C}$  colder during the ice age and the tropical surface ocean was  $2\text{--}5^\circ\text{C}$  colder. These results support the argument that the ice age world was colder than some paleoclimatologists previously thought. Detailed sampling of pore waters on future drilling legs will tell us how seawater temperature and  $\delta^{18}\text{O}$  in the deep ocean varied within and between ocean basins.



ODP Site 981, Feni Drift, North Atlantic ( $55^\circ 29'\text{N}$ ,  $15^\circ 52'\text{W}$ )

### References:

- Schrag, D.P. and D.J. DePaolo, Determination of  $\delta^{18}\text{O}$  of seawater in the deep ocean during the last glacial maximum, *Paleoceanography*, 8, 1-6, 1993.
- Schrag, D.P., G. Hampt, D.W. Murray, The temperature and oxygen isotopic composition of the glacial ocean, *Science*, 272, 1930-1932, 1996.



**It's not too late to submit your abstract(s) for the "ODP's Greatest Hits" abstract collection. This full-color volume of outstanding ODP scientific results will be used to aid in U.S. ODP renewal efforts. A SAMPLE ABSTRACT IS ON THE FACING PAGE. For more information on submitting an abstract contact Ellen Kappel at [ekappel@brook.edu](mailto:ekappel@brook.edu).**

## **Dynamic fault-zone permeability in the Barbados accretionary prism**

ODP Leg 156 was designed to evaluate hydrogeologic and tectonic processes within the Barbados accretionary prism, focusing on the major thrust fault which marks the boundary between the North American and Caribbean plates. Indirect evidence suggests that this décollement zone is the locus of focused fluid flow and locally elevated pore fluid pressures. Given the extremely fine-grained character of the accretionary prism materials (predominantly clay and claystone) how can the décollement zone act as a conduit for fluid flow? One potential mechanism involves locally increasing permeability as a function of decreasing effective stress (increasing pore fluid pressure).

My fellowship research focuses on the degree of pressure-dependence of permeability within the décollement zone as determined from field and laboratory experiments. Permeability measurements conducted on samples from whole-round cores in a triaxial cell under varying conditions of effective stress yield values which are extremely low. Permeability was determined from a series of low pressure gradient, constant-rate flow tests at each stress increment. Core-scale permeability decreases one to several orders of magnitude, as pore pressure is decreased from near lithostatic towards hydrostatic values.

Work with Andy Fisher during Leg 156 provided the opportunity to participate in field measurements of permeability. *In situ* testing at Sites 948 and 949 was designed to estimate formation-scale permeability values. An inflatable drillstring packer was used to isolate a 40 m section of screened borehole. The test interval included all of the structurally defined décollement zone at both sites. We ran a series of pulse and flow tests, and monitored the pressure response of the isolated section. Analyses of the resulting pressure-time records indicate that background pore fluid pressure increased during testing and that this pressure rise was associated with increasing formation-scale permeability. These permeability values were several orders of magnitude greater than core-scale measurements.

Both core-scale and formation-scale permeability exhibit similar degrees of pressure dependence. One potential explanation for why formation-scale permeability values exceed core-scale permeability is the effects of sampling. Core samples may not contain larger-scale structural features, such as networks of microfractures or scaly fabric, which provide dynamic, pressure-dependent and perhaps transient pathways for fluid flow.

## **fellowship** *profile*

### **Gretchen Zwart**

**Ph.D. Student:  
UC Santa Cruz**

**Faculty Advisor:  
J. Casey Moore**

## SCIENCE RESULTS

# ODP recovers "live" volcanic rocks

Contributed by Martin Fisk, Stephen Giovannoni, and Ingunn Thorseth

*Martin Fisk is Associate Professor of Marine Geology at Oregon State University. In addition to studying oceanic volcanic rocks, he contemplates life on Mars, hortas, and accepts donations of "live" oceanic basalts. Favorite saying: "The truth is out there."*

*Stephen Giovannoni is Associate Professor of Microbiology at Oregon State University. He surfs when he's not developing microbes for the cheese industry, or identifying unculturable microbes in the oceans, lakes, and Earth's crust.*

*Ingunn Thorseth is Norwegian Research Council Postdoctoral Fellow to Oregon State University. While conducting her Ph.D. work, she single-handedly convinced most of us that microbes "eat" rocks. Now she is trying to make a living.*

Life, as we know it, requires water, carbon, nutrients, and energy, and appears to be limited to temperatures of about  $-10^{\circ}$  to  $120^{\circ}\text{C}$ . Before chemosynthetic communities were discovered in hot springs, energy from the sun was presumed to be the driving force of the biosphere that exists in the atmosphere, the hydrosphere, and the top few tens of meters of Earth's solid surface. Despite this heliogenic view of the biosphere, some suspected that life could exist in the Earth as long as organic carbon was available for energy and temperatures were not far above  $120^{\circ}\text{C}$ .

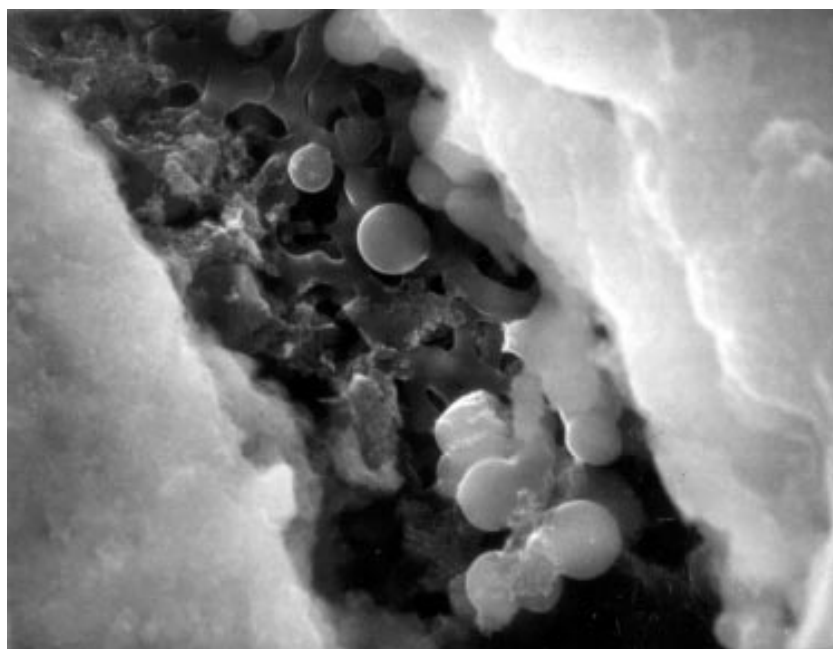
Now, based on scientific research conducted on Ocean Drilling Program samples, it is clear that there is enough carbon to support microbial life in the upper few *hundreds* of meters of the ocean crust. Parkes and others [1994] found about a billion cells per  $\text{cm}^3$  in surface sediments and about ten million cells per  $\text{cm}^3$  at depths of more than 500 m in ODP cores from the Pacific. Using these numbers, they estimated that life in deep-sea sediments constitutes 10% of the living carbon of the surface biosphere. It has been assumed, however, that the crystalline part

of the deep subsurface does not contain enough organic carbon to maintain microbial life. Is this view still correct?

Microbes are successful opportunists. Where there is an inadequate supply of energy from the sun or from organic compounds, certain creatures are capable of using other energy sources, as long as there is also a sufficient supply of water, carbon and nutrients and if the temperatures are tolerable. These microbes act as catalysts by promoting chemical reactions that enable them to extract energy for their own purposes. For example, some bacteria survive by oxidizing sulfide, sulfur, hydrogen, reduced iron and manganese, as well as other inorganic compounds.

Abundant chemical energy is available for metabolic activity in deep-sea hydrothermal springs due to the high flow of reduced compounds into oxygenated ocean bottom water. In the deep subsurface, however, such flow is likely to be low. Nevertheless, even if the supply of chemical energy is low, and the organic carbon content of the surrounding rocks and sediments are minimal, bacteria are still capable of surviving by means of their abilities to oxidize inorganic compounds.

Bioetching of silicate minerals has been known for some time. It is now recognized that microorganisms are capable of breaking down volcanic silicate glass [Thorseth et al., 1995], although the reason(s) for this remain unclear. It is not known whether the microbial attack on glass is a consequence of metabolic by-products,

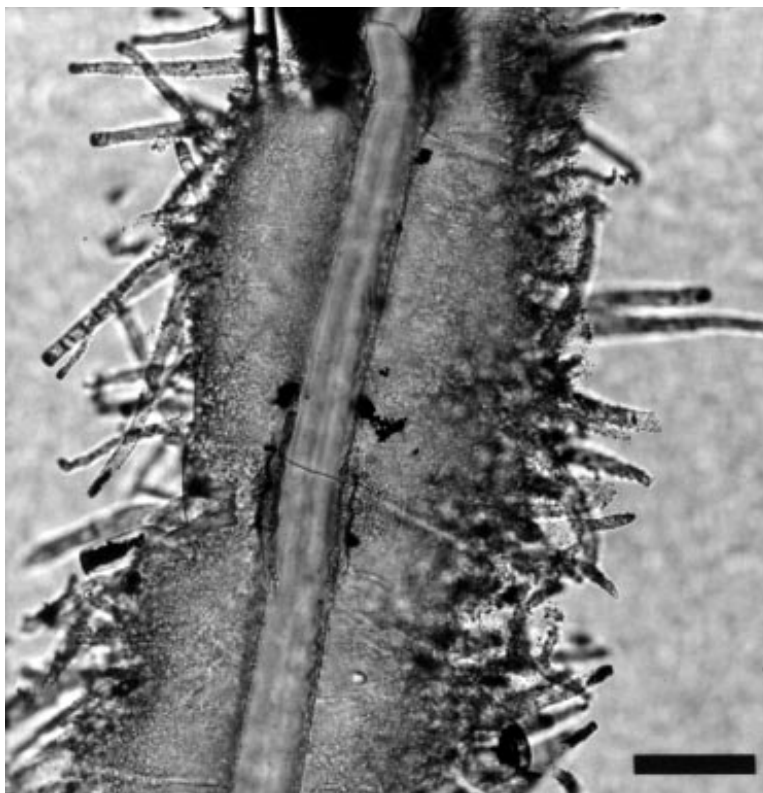


**Fig. 1:** SEM photograph of a clay particle from  $64^{\circ}\text{C}$  sub-bottom water collected with the water-sampler-temperature-probe at ODP Hole 1026B. Spheres up to  $2\ \mu\text{m}$  in the fracture in the grain appear to be connected by a web of material. The filter was stored in alcohol and then dried in air, so cell shapes are not well preserved.

whether the microbes extract energy or nutrients from the glass, or if bacteria create burrows to escape predation. If microbes are capable of extracting energy from silicates, then temperature and not energy, is the limiting condition for life deep in the Earth. If this is the case, life may exist as deep as 15 km in areas of low geothermal gradients. Salinity is an unlikely barrier to microbial life because halophylic bacteria can thrive in brines consisting of 20 to 30% salt.

Microbial life in the volcanic crust of the oceans has also been hypothesized, based on hydrothermal vent water that is charged with bacterial fragments. These may be the dead remnants of cells that lived within subsurface aquifers before being heated to vent temperatures (typically greater than 120°, but commonly 200°–300° C). This hypothesis is supported by sub-bottom water samples collected on Leg 168 near the Juan de Fuca Ridge in August 1996. Clay particles, filtered from 64° C water that was collected *in situ* with a remote sampling tool from Hole 1026B, contain cells that appear to be growing in fractures (Figure 1). The composition of the clays suggests that they were not introduced by drilling, but the identity of the cells must still be determined.

Additional evidence for the existence of microbes in the oceanic crust has been found in the volcanic rocks of ODP Hole 896A [Giovannoni *et al.*, 1996; Furnes *et al.*, 1996]. At about 300 m below the seafloor, including about 150 m of overlying sediment, basalt glass was found to contain clay-filled fractures that once were conduits for circulating fluids (Figure 2). Alteration products of the volcanic glass surround such fractures. The photo also shows hollow channels that extend from the clay into the glass. The channels are 1 to 2 µm in diameter and up to 20 µm long, although wider and longer channels were found elsewhere in Hole 896A. Alumino-silicates fill the channels, but the ends are stained brown and analyses show elevated levels of carbon, nitrogen, phosphorus, and potassium, indicating the presence of organic matter. Studies using fluorescent dyes suggest that DNA is present at the tips of the channels. Reduced iron could be the source of metabolic energy capable of sustaining microbial life in this basaltic glass. Iron, as FeO, makes up about 9 weight percent of the glass at Hole 896A, so there is an abundant



**Fig. 2: Transmitted light photograph of a fracture through glass from a basalt 300 m below the seafloor from ODP Hole 896A (northeast of the Galapagos Islands). The fracture (about 7 µm wide) runs from the top to the bottom of the photograph, and is filled and surrounded by clay. Channels extend from clay into fresh glass (right and left sides of the photo). The scale bar is 10 µm.**

supply for oxidation. For such oxidation to occur, however, there would have to be free oxygen — which is not the case now, but probably was so before the surface was sealed by sediment. Thus, the channels may be fossil evidence of microbial activity.

Although we interpret the presence of the channels and the distribution of C, N, P, K, and DNA in the channels as evidence of microbial activity, biological cells have not been found in the channels. There are several potential explanations for this. The cells may not have survived being transferred from below the seafloor to the surface of the ocean, and onto the ship (60° C to 25° C and 300 bars to 1 bar). Sample handling could have destroyed the cells because the samples were dried under heat lamps and exposed to atmospheric oxygen. The microbes may have died and disintegrated because of changing sub-bottom conditions before the samples were collected. Finally, damaged cells may be unrecognizable. Improved methods for sampling and handling material from the deep biosphere may be needed to preserve cells.


## References:

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- Thorseth, I.H., H. Furnes, and O. Tumyr, Textural and chemical effects of bacterial activity on basaltic glass: an experimental approach, *Chem. Geol.*, 119, 139-160, 1995.

Even when "live" rocks are recovered from the ocean floor, scientists will question the origin of the living microbes found in the rocks. Obtaining samples that are free from drilling contamination is difficult even in relatively shallow, easily drilled sedimentary rock on land. Oceans sediments can be collected with hydraulic piston cores and subsampled in clean environments that minimize contamination, but fractured rocks are likely to be contaminated by seawater and drilling mud. Rapid, high-resolution techniques for comparing DNA extracted from basalts and from potential contaminants will likely resolve this problem.

We now believe that vast amounts of unexplored biological diversity is present in the Earth and that this biodiversity is a resource that may provide society with unique enzymes and antibiotics. Novel enzymes for industrial processes and bioremediation may be obtained from organisms that live in ecosystems at the extreme temperature,

pressure, and salinity limits of life. Enzymes from thermophilic bacteria from the deep biosphere may withstand the high temperatures that are optimal for industrial processes. The enzymes that perform PCR (polymerase chain reaction) are derived from such extreme environments. PCR is the technique that is widely used for copying DNA in all areas of biotechnology, including forensics, medical diagnostics, and basic research.

Microbes in volcanic crust are not likely to contribute significantly to the global carbon budget, but they may be important as catalysts for chemical change. In this role they could regulate the cycling of elements between seawater and the ocean crust. Microbes that derive their energy from inorganic chemical reactions suggests that life may thrive in previously unsuspected places. The presence of life on Mars and Europa are certainly possible under these expanded conditions for life. 

## ODP/ InterRidge/ IAVCEI Workshop Report

**Henry Dick is Senior Scientist in the Department of Geology and Geophysics and Van Allen Clark Chair for Excellence in Oceanography at the Woods Hole Oceanographic Institution.**

## The ocean lithosphere: Into the 21st century

*contributed by Henry Dick*

Over the last decade, the Ocean Drilling Program has tested hard rock drilling in young basalts in ocean rift valleys, in sill complexes at continental margins, in oceanic plateaus, and in deep crustal and mantle rocks in tectonic windows. These legs have provided earth scientists with a large body of information about where and how to drill the oceanic lithosphere. In addition, they have provided the first direct sampling of the oceanic lithosphere down to below seismic Layer 2, and reference sections for seismic Layer 3 and the mantle.

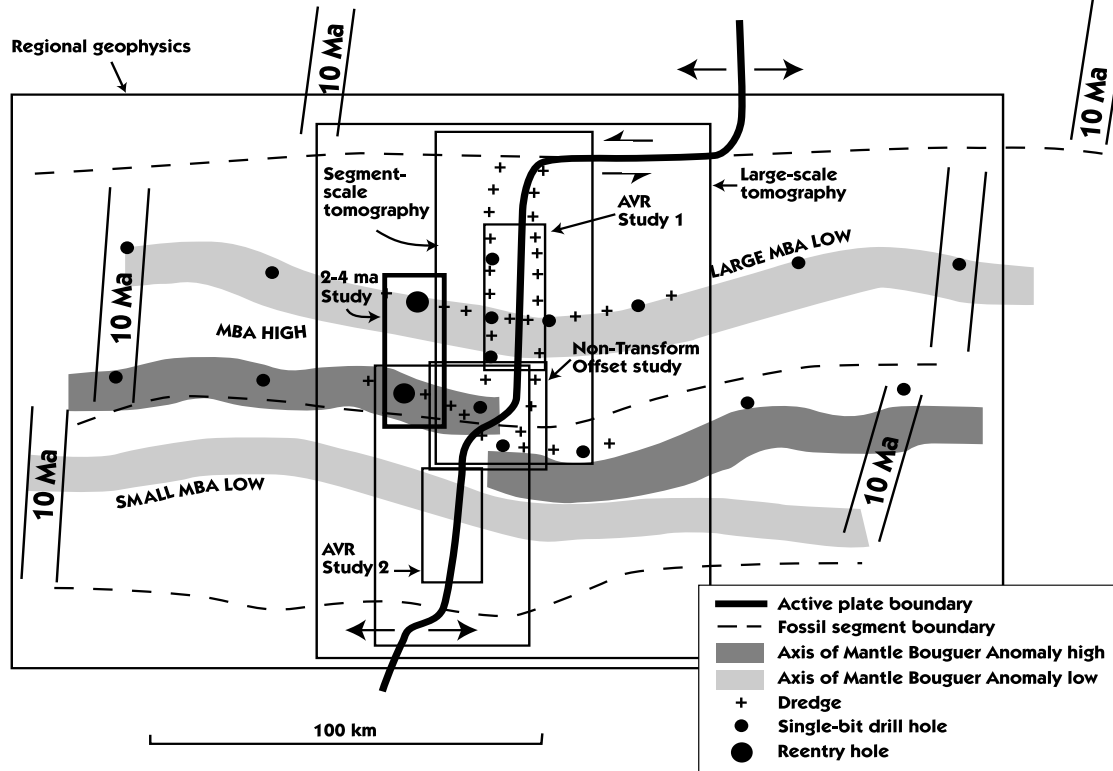
It can be said then that oceanic lithosphere drilling has past beyond the test phase, and that now is the time for a staged, comprehensive and practical plan to explore it. Such a plan can provide a historic advance in our knowledge of the planet by producing the first generalized picture of the oceanic lithosphere based on direct observation. This means that within ODP Phase III (1998-2003) we need to get the best possible composite sections of oceanic crust formed at fast- and slow-spreading rates, to truly

test the limits of the *JOIDES Resolution's* deep drilling capacity, and to obtain a first order picture of the lateral variability of representative end-member oceanic large igneous provinces (LIPs). Moreover, Phase III drilling should provide a base to build a new program for Phase IV (post-2003), to finally provide a comprehensive quantitative ocean lithosphere model.

It was for this purpose that the ODP, InterRidge, and the IAVCEI Commission on Large Basaltic Provinces jointly sponsored a workshop: The Ocean Lithosphere and Scientific Drilling into the 21st Century in Woods Hole May 26-29, 1996. The workshop was convened by Henry Dick (U.S.) and Catherine Mevel (France). There were approximately 110 participants representing all ODP member countries.

Although much of the first day of the conference was used to establish common ground among the diverse scientific disciplines and interests represented by the ocean lithosphere community, the majority of the three

days was spent divided into working groups, which periodically reconvened in general sessions to report on progress and to come to a consensus by the end of the meeting. Although the list of proposed legs was long, recognizing the great demands on the drillship by other scientific programs, considerable effort was put into defining a realistic minimum program to address the major goals of InterRidge and LIPs during Phase III.



### InterRidge "4-D Architecture" slow-spreading experiment

Workshop recommendations cover three areas: major scientific questions which can only be addressed by drilling; the technological requirements; and the planning which must occur to insure that the recommended program happens in an orderly and timely manner. In particular, testing the limit of the *Resolution's* deep drilling capabilities was seen as a necessary precursor to planning a future deep drilling program. Moreover, if the scientific community is to be ready to begin very deep holes early in Phase IV, then the present ship must drill pilot holes at selected target sites.

Given the complex, laterally heterogeneous composition of the oceanic crust at all scales, the members of the workshop stressed the importance of making the maximum possible use of the current drillship, and then endorsed the critical scientific need for a two-ship program for ocean lithosphere drilling beyond the year 2003. A full understanding of the nature of the oceanic crust cannot be had without total crustal penetration at several locations in the ocean basins representing end-members for spreading at ocean ridges, and the formation of large igneous provinces. Successfully extrapolating from these few holes, which will likely take years to drill, will require series of carefully placed offset drill holes in key tectonic windows into the

lower crust and mantle, and across the major large igneous provinces.

In all, the workshop identified some 14 legs of drilling required to meet its highest priority objectives within the scope of the ODP. Not all of these legs are technologically feasible at this time, but might be before the end of Phase III. In addition, the workshop noted that the two arc environment legs should be considered in the broader context of active margins drilling. Thus, the workshop proposal provides a prioritized framework for planning drilling for Phase III and into Phase IV, identifies the highest priorities among these, and provides a contingency plan for drilling.

Finally, the meeting considered that the existence of a significant biomass within seafloor rocks represents a most exciting opportunity for science, which should be pursued with vigor. It recommends the immediate formation of a JOIDES Detailed Planning Group to prepare for installation of a microbiological laboratory on the *JOIDES Resolution* and the formation of a Working Group on Biology. The meeting noted that InterRidge already has its own Biology Working Group (Chair D. Desbruyères, IFREMER) which would be well-placed to assist the ODP in setting up its own.

*Direct support for running the meeting was provided by the JOI/U.S. Science Support Program, with additional support provided by InterRidge. Travel for the participants was funded by the national InterRidge and ODP programs.*

# A N N O U N

## JOIDES OFFICE RELOCATION

The JOIDES Office rotated from Cardiff to WHOI, effective October 1, 1996.

The new JOIDES Office staff includes:

**Planning Committee Chair:**

**Dr. Susan E. Humphris**

**Science Coordinator:**

**Dr. Katherine K. Ellins**

**International Liaison:**

**Dr. Maria Mutti**

**Staff Assistant:**

**Ms. Shirley J. Waskilewicz**

**JOIDES Office**

**Geology and Geophysics Department  
Woods Hole Oceanographic Institution  
MS #22**

**Woods Hole, MA 02543 USA**

**Phone: (508) 289-3481**

**Fax: (508) 457-2187**

**E-mail: joides@whoi.edu**

**Home Page: www.whoi.edu/joides**

## Looking for your October 1996 JOIDES Journal?

The October 1996 issue will not be printed. If you would like an electronic copy, please visit the JOI home page at <http://www.joi-odp.org> (look under "What's New"). The next issue of the *JOIDES Journal* will likely be printed and distributed in Spring 1997.

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## JOI/USSSP SUPPORTED SHIPBOARD PARTICIPANTS

### LEG 170: Costa Rica Accret. Wedge

**U.S. Co-Chief:** E. Silver, UCSC

**ODP Staff Scientist:** P. Blum

**LDEO Logger:** S. Saito

**J. Griffin, U of NE, Lincoln**

**B. Housen, U of MN, Minneapolis**

**M. Kastner, SIO**

**N. Lindsley-Griffin, U of NE, Lincoln**

**K. McIntosh, UT Austin**

**J. Morris, Washington U**

**J. Muza, FSU**

**D. Scholl, Stanford U**

**H. Tobin, Stanford U**

**L. White, San Francisco State U**

### LEG 171A: Barbados LWD

**U.S. Co-Chief:** J.C. Moore, UCSC

**ODP Staff Scientist:** A. Klaus

**LDEO Loggers:**

**D. Goldberg**

**C. Major**

**M. Reagan**

**N. Bangs, UT Austin**

**B. Bekins, USGS**

**S. Erickson, U of UT**

**G.F. Moore, U of HI at Manoa**

**E. Screaton, U of CO at Boulder**

**P.H. Stauffer, UCSC (USSAC Fellow)**

**P. Teas, UCSC**

### LEG 171B: Blake Nose

**U.S. Co-Chief:** R. Norris, WHOI

**ODP Staff Scientist:** A. Klaus

**C. Barker, USGS**

**C.D. Blome, USGS**

**K. Faul, UCSC**

**M.A. Holmes, U of NE, Lincoln**

**B. Huber, Smithsonian Inst.**

**M. Katz, LDEO**

**K. MacLeod, U of Washington**

**J. Ogg, Purdue U**

**D. Pak, UCSB**

**J.M. Self-Trail, U of NE, Lincoln**

**W. Ussler, U of NC**

**D. Watkins, U of NE, Lincoln**

## Now accepting nominations for JOIDES SciCom and JOI/USSAC

Joint Oceanographic Institutions is seeking nominations for U.S. positions on the JOIDES Scientific Committee (SciCom) that is currently being formed and the JOI/U.S. Science Advisory Committee (JOI/USSAC) for the Ocean Drilling Program.

The JOI Board of Governors anticipates appointing a minimum of three new members to SciCom in early 1997, replacing part of the current JOIDES Planning Committee (PCOM) membership. Membership term is three years.

Four new members of USSAC will be appointed by the JOI Board of Governors in the spring, with their three-year term beginning October 1, 1997.

If you are interested in serving on one of these important committees, please send a CV (no more than two pages), and a letter of interest to Dr. David Falvey, Ocean Drilling Program Director, Joint Oceanographic Institutions, 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102. Scientific leadership and a keen interest in Ocean Drilling Program science and related activities must be demonstrated.

For more information on SciCom duties and responsibilities, please contact Dr. Susan Humphris, Planning Committee Chair (see address above). For more information on USSAC duties and responsibilities, please contact Dr. Roger Larson, USSAC Chair (see page 27).

## VISIT THE ODP SUPER BOOTH AT AGU

**Booths 211-213-215**

# CEMENT S

NOW AVAILABLE FROM JOI/USSSP

## *Recycling processes and material fluxes at subduction zones*

**Proceedings of a JOI/USSSP workshop  
held at Avalon, California, June 12-17, 1994**

**Convened by:**

**D.W. Scholl (USGS), T. Plank (U of KS, Lawrence),  
J. Morris (Washington U), R. von Huene (GEOMAR),  
and M.J. Mottl (U of Hawaii)**

**Available on the JOI web site:**

**<http://www.joi-odp.org> (see "What's New")**

**Or, to request a hard copy, contact:**

**JOI/USSSP, Joint Oceanographic Institutions, 1755  
Massachusetts Avenue, NW, Suite 800, Washington,  
DC 20036-2102, fax: (202) 232-8203, e-mail:  
[joi@brook.edu](mailto:joi@brook.edu)**

## *fellowship* OPPORTUNITIES

JOI/USSAC is seeking doctoral candidates of unusual promise and ability who are enrolled in U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both one- and two-year fellowships are available. The award is \$20,000 per year to be used for stipend, tuition, benefits, research costs, and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward the objectives of a specific leg or to broader themes.

### **PROPOSAL DEADLINES FOR**

**Shipboard Work (Legs 176-181) 4/15/97**  
**Shorebased Work (regardless of leg) 4/15/97 & 11/15/97**

For more information and/or to receive an application packet please contact Andrea Johnson at:

JOI/USSAC Ocean Drilling Fellowship Program  
Joint Oceanographic Institutions  
1755 Massachusetts Ave., NW, Suite 800  
Washington, DC 20036-2102; Tel: (202) 232-3900 x213;  
Fax: (202) 232-8203; Internet: [ajohnson@brook.edu](mailto:ajohnson@brook.edu)

## **Leg 169S: Saanich Inlet Post-Cruise Science Proposals**

**JOI/USSSP proposals for post-cruise science support for the  
Saanich subleg (Leg 169S) must be received by JOI no later than  
December 20.**

**For more information contact John Farrell at [jfarrell@brook.edu](mailto:jfarrell@brook.edu)  
or at (202) 232-3900 x211.**

## **Request for proposals**

Joint Oceanographic Institutions is pleased to announce the availability of Requests for Proposals for:

- **Wireline Logging  
Services Operator  
for the Ocean  
Drilling Program**
- **Site Survey Data  
Bank Services  
for the Ocean  
Drilling Program**

If you would like a copy of either of the RFP's, please contact:

Ms. Patricia Williams  
Joint Oceanographic Institutions  
1755 Massachusetts Ave., NW,  
Suite 800  
Washington, DC 20036-2102  
(202) 232-3900 x237  
or at [pwilliams@brook.edu](mailto:pwilliams@brook.edu)

## **SUBSURFACE BIOSPHERE WORKSHOP**

**Date:** March 1997 (tentative)

**Location:** Washington, DC

**Convenors:** K. Juniper,  
J. Baross, and M. Lilley

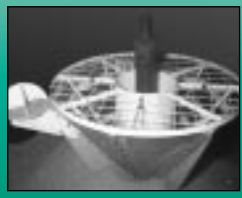
**Sponsors:** JOI/USSSP, RIDGE,  
NOAA VENTS Program, and  
U. of WA Volcano Center

**For more information:**

Dr. Marvin Lilley at  
[lilley@ocean.washington.edu](mailto:lilley@ocean.washington.edu)

Several lines of evidence have converged in recent years to bring the concept of a deep biosphere to the forefront as an exciting scientific question in both ridge crest and off-axis environments. An invited speaker/panel format will be used at this workshop in an attempt to fully evaluate our current state of knowledge and to provide a broad-based dialog on the existing data and plans for further investigation of this topic.

## BOREHOLE REPORT



# Post-drilling experiments and observations of a hydrothermal system

contributed by Robert Zierenberg, Keir Becker, Earl Davis, and the Leg 169 Scientific Party

ODP Legs 139 and 169 laid the ground work for a series of post-drilling experiments to study the causes and consequences of hydrothermal circulation at a sediment-covered spreading center in the northeast Pacific Ocean. Hydrothermal circulation of seawater through the oceanic crust is one of the most important mechanisms for transferring heat and mass between the lithosphere and the hydrosphere. On a global scale, circulation through oceanic spreading centers alters the original composition of the upper crust, which in turn affects the final composition of materials that are recycled at subduction zones. Seawater chemistry is also affected by hydrothermal circulation because of the chemical reactions and ionic exchanges that occur as seawater interacts with the crust through which it flows. On a local scale, ridge crest circulation supports chemosynthetic biologic communities and forms massive sulfide deposits that provide us with metals like copper and zinc.

Hydrothermal circulation is controlled by the temperature regime and physical properties

of the surrounding sediments and rocks. To understand the interplay of these factors, we have to drill into the system to take samples or measurements, but the act of drilling disturbs the system and alters the *in situ* conditions we seek to measure. *In situ* temperature measurements are perturbed by the cool surface ocean waters that are flushed down the drillstring and out of the drillbit during normal drilling operations. Physical properties, such as porosity, permeability, and thermal conductivity, can be measured on recovered core samples, providing important constraints on the factors that control fluid flow. However, the core samples themselves may not be representative of the *in situ* conditions because of drilling-induced disturbance and post-drilling decompression.

Physical properties measurements of sediments and rock can also be taken within boreholes, immediately after drilling has ceased, using instruments such as packers and flowmeters [Becker *et al.*, 1994]. Packers “pack off,” or isolate, a section of the

drillhole while fluid is pumped into the surrounding rocks. Records within a packer or flowmeter measure the fluid pressure changes within the isolated section of borehole, providing a measure of the surrounding rock formation's permeability. These downhole instruments enable scientists to measure physical properties over a larger area than a laboratory sample, thus providing data that are more representative of the properties that control hydrothermal flow. Nevertheless, even these measurements provide information from only the immediate vicinity of the borehole.

Evidence from a variety of seafloor and land-based observations and measurements suggests that hydrothermal circulation occurs on the scale of kilometers, both vertically and horizontally. Thus, laboratory

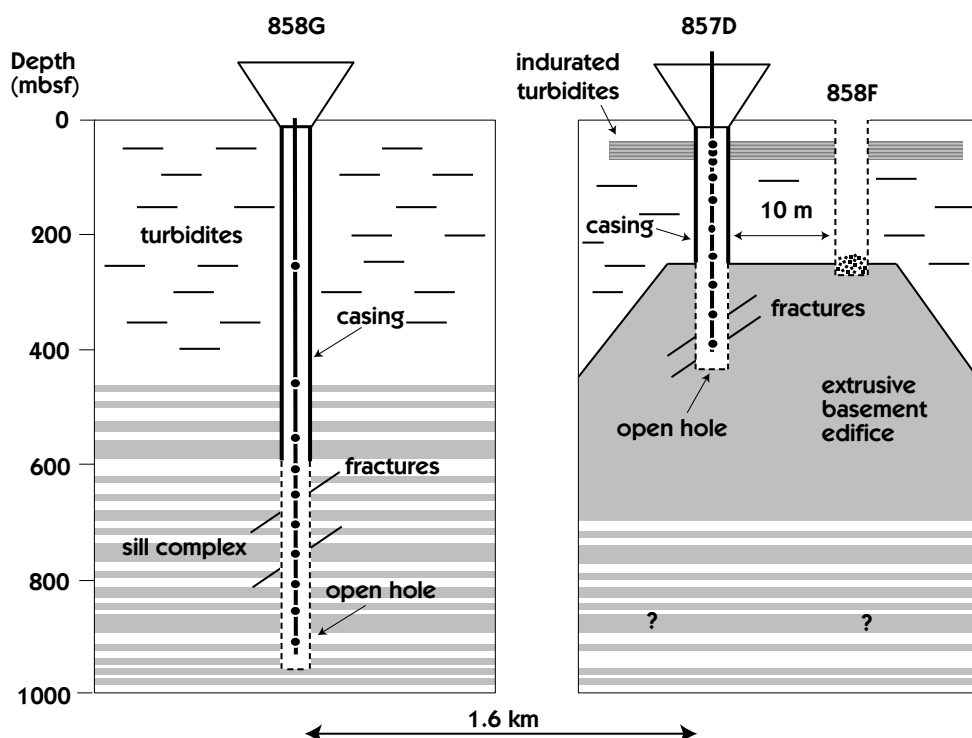


Fig. 1: Depth to the basement in the two holes that have been reinstrumented with CORKs. Basement (shaded) at Site 857 is defined as the top of a sill-sediment complex at 470 mbsf. Basement under Site 858 rises to 250 mbsf and is extrusive basalt [Davis and Becker, 1994]. Lines and circles at the center of the hole represent the temperature string and the position of the thermistors (black circles).

work on core samples and short-term packer/flowmeter experiments that measure physical properties in the area immediately surrounding the borehole, may not provide all of the essential data to understand kilometer-scale hydrothermal flow. What is necessary to constrain models of the entire circulation system, then, is to isolate the borehole from cold seawater and monitor the return to thermal equilibrium following drilling, which may take months. To this end, ODP has developed specialized borehole seals, or “CORKs,” from which instrument strings can be hung downhole and left to record for years after drilling [Davis *et al.*, 1992a]. Instruments that are currently being used in ODP holes are capable of measuring *in situ* temperatures and pressures, and of taking fluid samples osmotically for chemical measurements that can be made back in the laboratory, after the data have been retrieved from the borehole instruments by a submersible or a ship. We report here the design and initial results of ODP experiments to constrain the properties that control hydrothermal circulation in the Pacific’s Middle Valley hydrothermal field.

### Middle Valley experiments

The first two CORK borehole seals were deployed by ODP during Leg 139 in 1991 in two reentry holes (ODP Holes 857D and 858G) in Middle Valley, Juan de Fuca Ridge [Davis *et al.*, 1992a]. These CORKed holes were instrumented with pressure transducers and thermistors strings to monitor the recovery of drillhole conditions from the thermal disturbance induced by circulation of surface seawater during drilling. The initial results from these simple seafloor observatories provided important constraints on the physical properties of the upper oceanic crust and the overlying sediment, including the thermal structure and *in situ* pore pressure [Davis and Becker, 1994]. These experiments were highly successful, and scientists quickly sought to reinstrument these drillholes with new CORKs because the old seals eventually failed and because new thermistor strings had been developed.

Leg 169 returned to Middle Valley during the summer of 1996 to: (1) replace the instrument strings in these two holes (Figure 1) and; (2) conduct the first ever active borehole hydrological experiments on the scale of the large circulation cells that control hydrothermal venting. Packer and flowmeter



**Fig. 2:** Photograph taken from the Alvin submersible in 1993 showing a bacterial mat covering the data logger, which was bathed in hydrothermal fluid leaking from the bottom of the Hole 858G reentry cone. Subsequent observation of the hole with the drillstring TV camera prior to reCORKing on Leg 169 showed that the bacterial mat had disappeared and that hydrothermal venting had ceased sometime between 1993 and 1996.

experiments conducted during Leg 139 indicate high permeability near the boreholes that is concentrated in discrete zones, probably reflecting the presence of fracture or fault zones. Other observations suggest that the entire basement beneath the sediment cover is highly permeable and that rapid hydrothermal circulation is occurring within the upper oceanic crust at this site.

One of the fascinating results of Leg 139 was the huge flow of seawater, in excess of 10,000 liters per minute, into the Middle Valley basement once drilling created a pathway through the impermeable sediment cover [Davis *et al.*, 1992b; Becker *et al.*, 1994]. The basement’s *in situ* hydrostatic pressure is apparently much less than that exerted by an equivalent column of overlying cold seawater because of its nearly isothermal temperatures, inferred to be near 300°C. The Leg 139 CORK in Hole 857D monitored the initial recovery of the thermal structure in the borehole, after drilling ceased. The CORK data indicate that formation pressures were in equilibrium with the hot hydrostatic gradient defined by local geothermal conditions, such that opening the hole to cold hydrostatic drilling fluids would produce a differential pressure of 1 MPa. Thus, we believed that the downhole flow of cold seawater would resume once we removed the existing CORK and circulated drilling fluids in the hole. It was this positive pres-

**Robert Zierenberg** is a researcher at the U.S. Geological Survey and has recently joined the faculty at the University of California, Davis.

**Keir Becker** is Professor of Marine Geology and Geophysics at the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami.

**Earl Davis** is a senior researcher at the Pacific Geoscience Centre, Geological Survey of Canada.

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- Davis, E.E. and Becker, K., Formation temperatures and pressures in a sedimented rift hydrothermal system: 10 months of CORK observations, Hole 857D and 858G, *Proc. ODP, Sci. Results*, 139, 649-666, 1994.

sure pulse, which ended 4 days later when the hole was resealed with a new CORK, that was utilized as the signal in the active CORK-to-CORK experiment described above.

To test the large-scale hydraulic conductivity within this basement, we hope to record in Hole 858G the arrival time and magnitude of the pressure pulse induced by unCORKing Hole 857D, located 1.6 km away. The arrival time of the pressure pulse depends primarily on the permeability (hydraulic transmissivity) of the basement. The pulse's amplitude is attenuated by the permeability and the storage capacity of the reservoir. Given the high permeabilities measured in Hole 857D ( $> 10^{-13} \text{ m}^2$ ) we would expect an induced pressure pulse to travel the 1.6 km to Hole 858G in approximately three days. We will find out the results of this experiment when the data loggers from these CORKed holes are "read" next summer.

Ocean bottom seismometers (OBSs) are another tool that can use this pressure pulse to explore the deeper parts of the hydrothermal system. The pulse initiated at Hole 857D should increase pore pressures, which may induce faulting and hydrofracturing in the rocks near the ridge axis, because they are assumed to be in a tensional state near failure. This movement can be detected by OBSs. NSF funding allowed Spahr Webb of Scripps Institution of Oceanography to deploy an array of six OBSs around Hole 857D and four around Hole 858G prior to

drilling. These devices will be recovered next spring and will provide data on the extent, nature, and depth of drilling-induced seismicity, as well as on the deep plumbing system of the Dead Dog vent field.

Prior to inducing the pressure pulse in Hole 857D, we replaced the second CORK and thermistor string in Hole 858G, which is located in the middle of the Dead Dog vent field approximately 30 m away from a hydrothermal chimney. Fluids from this chimney were sampled by the *Alvin* submersible in 1990 and temperatures as high as 276°C were measured. When *Alvin* returned to collect data from this CORK in 1993, its seals were found to have failed, and hydrothermal fluid was venting around the data logger. Although the data logger was covered with a bacterial mat (Figure 2), it continued to function. The final portion of the 17 month-long pressure record (Figure 3) indicates that pressures had risen to over 50 kPa above hydrostatic before the seals failed. When we recovered the old CORK, we found that its interior was heavily encrusted with hydrothermally precipitated anhydrite, pyrrhotite, and pyrite, and with lesser amounts of sphalerite, chalcopyrite, and galena. This artificial "chimney" contains significantly more sulfide than the naturally occurring chimneys in the Dead Dog field, which are primarily composed of anhydrite and only minor amounts of sulfide [Ames *et al.*, 1993].

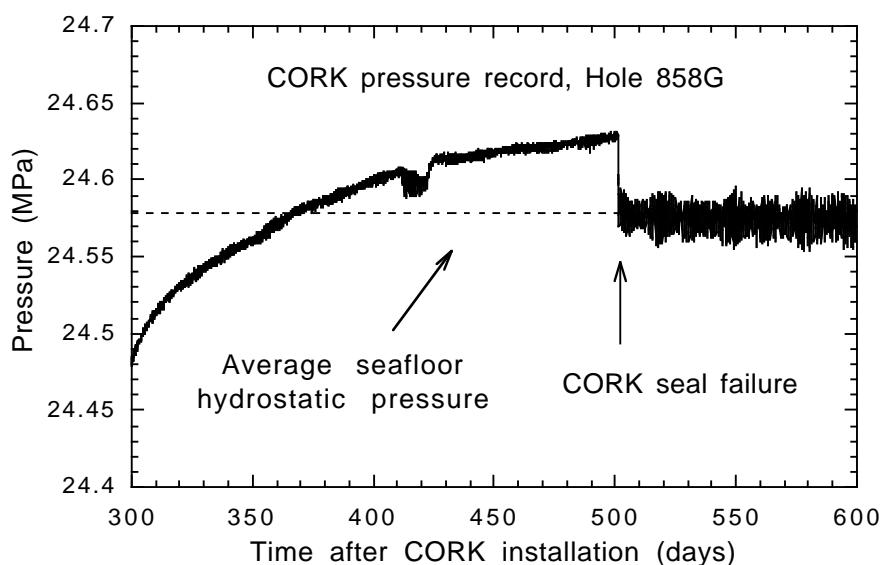



Fig. 3: Pressure record from Hole 858G showing the recovery of pore pressures beneath the vent field to values above the local hydrostat followed by a pressure drop that marks the failure of the CORK. The attenuated tidal signal within the borehole returns to the full seafloor amplitude after the seals failed.

Data from the CORK contained a detailed record of the relative temperature changes in the hole during the recording period, but a problem with the integrity of the insulation in the thermistor housing prevented an accurate determination of the subseafloor temperature profile. After we removed the borehole seal, we deployed the Ultra High Temperature Multi Sensor Memory temperature tool and collected a detailed profile of the downhole temperature. This tool was recently developed by industry sources through NSF funding to Keir Becker. Although the drillstring video camera showed no venting from the borehole, before or after removing the old CORK, high-temperature fluid ( $> 240^\circ\text{C}$ ) was encountered at shallow depths in the borehole. Below 85 mbsf, the fluids were isothermal at  $272^\circ\text{C}$ . Samples of the borehole fluid were found to be similar in composition to those from nearby hydrothermal vents, after correction for seawater contamination. We had hoped to only

minimally disturb the thermal structure in Hole 858G in order maximize the opportunity to observe the pressure pulse generated in Hole 857D. Unfortunately, an obstruction in Hole 858G that prevented installation of the new thermistor cable required us to drill, which circulated surface seawater in the hole. A wash core recovered after drilling through the obstruction consisted mostly of fine-grained pyrrhotite and pyrite.

The results of our borehole experiments will not be known until the OBSs have been recovered and the CORK pressure and temperature data are retrieved next year. The core samples recovered on Legs 139 and 169 provide us with an integrated record of

the fluid-rock interactions occurring in ocean ridge hydrothermal systems. However, long-term monitoring of these dynamic systems is necessary to gain a greater understanding of the factors that control hydrothermal fluid flow. The installation of CORKs is an important step forward in utilizing the *JOIDES Resolution* as an experimental (as opposed to strictly observational) platform to investigate hydrothermal systems. Our efforts represent an initial phase of development of seafloor observatories. These observatories will continue to provide important scientific data well after the drillship has moved on to new challenges in other parts of the world's oceans. 

## Riser drilling continued from page 3

drillsite selection and by vigilantly monitoring for indicators of migrated thermogenic oil or gas in the drill cores.

The “annular and ram” type of BOP that is used in the oil industry offers the greatest protection during drilling. This system is designed to allow several levels of response to an impending blow out and to provide the maximum chance for the driller to regain control of the hole, and continue drilling safely through a high pressure formation. During normal drilling operations, the BOP acts as an open valve which allows the drillpipe and the drillbit to move freely, and enables normal circulation of drilling fluids and cuttings.

In the course of drilling, the driller may recognize a potential blow out if the volume of fluid returning to the drillship via the riser exceeds that being pumped down the drillstring. Generally, the driller's first action is to activate the annular BOP, which closes a rubber packer around the drillstring, in an attempt to shut off the upward flow of drilling fluid and cuttings. After activating the rubber packer, the driller may attempt to balance the high pressure from the formation fluids by pumping a denser mud down the drillstring and into the hole. In many cases, the circulation of denser mud will control the pressure and the rubber packer can be released. The driller may then case off the high pressure formation and continue drilling deeper. If activation of the rubber

packer and circulation of denser mud failed to stop the upward flow, the driller would then signal the BOP to close the first of two sets of hydraulic pipe rams that would tightly grab the drillstring and seal the annular space through which formation fluids, mud, and cuttings, were rising. If this approach stopped the upward flow, the driller would again try to control the hole with heavy mud injected into the hole through the drillstring. If this fails, and in what would have now become a real emergency, the driller would signal the BOP to close the shear ram which would sever the drillstring and seal the hole.

Access to move mud in or out of the hole would now be possible only if the riser and BOP are equipped with “choke and kill lines” (or an auxiliary stab-in kill port). The choke and kill lines are 4-inch high pressure pipes that run alongside the riser from the ship to the seafloor BOP. With the drillstring severed and the hole otherwise sealed, drilling in the hole is certainly finished, and the choke and kill lines may be used to pump cement into the hole to permanently plug it before it is abandoned.

A simpler type of seafloor BOP could be designed and used by ODP if we did not want or need to case-off and drill through highly pressured formations. In this type of operation, we would not need as many response options (such as annular packers and pipe/shear rams, and choke and kill

lines) and we would plan to plug and abandon any hole in which we encountered dangerously high pressures.

A “diverter” is an even less robust type of BOP that can be placed within the riser, below the rig floor. The primary purpose of a diverter is to keep formation fluids/gases that may get into the riser above the seafloor BOP from venting on the rig floor during a blow out. The diverter may be able to stop the upward flow, but if it cannot, it vents the dangerous fluids away from the ship. While a diverter might prevent immediate and catastrophic loss of the drillship during a small blow out, it would allow few viable options for controlling, plugging, and abandoning the hole. A riser would not be safe to use without some form of seafloor BOP.

### **What kinds of risers are being discussed?**

The Japanese are considering designing and deploying an oil industry-style riser that will be capable of drilling in water depths of up to 2.5 km on the drillship they plan to build. They intend to extend its capability to 4 km in the future. Their system would probably use a 21 in. diameter riser and a BOP with parallel 4 in. diameter choke and kill lines. This riser will likely require expensive and bulky flotation modules to make it easier to deploy and to prevent it from breaking under its own weight. A riser and industry BOP system like this should enable exploration in sedimentary basins where the dangers of oil or natural gas encounters are likely and which previously precluded scientific drilling. Many holes in which we now must stop drilling, or fail to log due to hole collapse, might be drilled further and logged successfully with an industry-style riser system.

The JOIDES Technology and Engineering Development Committee and ODP/TAMU have considered designing a 4 km water depth “slimline” riser for use on either the Japanese drillship or the *JOIDES Resolution*. A slimline riser would probably be about half the diameter of an industry-style riser and would not be intended for well control or have choke and kill lines. It is envisioned that the slimline riser would initially be operated with a diverter and no seafloor BOP. A minimal seafloor BOP could be added to the system later, for emergency well control. A slimline riser would probably not require flotation collars. Such a riser, par-

ticularly before the development of a seafloor BOP, would not allow drilling in any new or riskier environments, such as places where oil or natural gas encounters are likely. The key advantage of a slimline riser over an industry-style riser is that the former will sooner provide the advantages of continuous drilling with mud circulation in water depths below 2 km.

The riser proposals from both the Japanese and ODP/TAMU push the envelope of the current knowledge of riser design. Either system will be expensive to design, build, test, and operate. Neither will operate in the entire range of water depths in which we are accustomed to working. However, both offer the opportunity to use drilling mud, with all its potential advantages for hole stabilization and cutting removal.

ODP is about to join a consortium of oil and drilling technology companies to explore the possibilities of designing a riserless mud circulation system. In this system, drilling mud would still be pumped down the drillpipe, out the bit, and into the hole. Instead of returning to the drillship through the a riser, drilling fluid and cuttings would be returned through a large, perhaps 11 inches, flexible umbilical extending from the drillship to the seafloor. This system may be easier to deploy than a riser and might avoid some of the complicated problems associated with long risers.

### **How would ODP benefit from a riser?**

Many of the hole-stability problems encountered in a variety of ODP drilling environments can be overcome with a new drilling system that uses mud circulation. Drilling would be easier and core recovery would be better. Numerous ODP legs have suffered hole-stability problems that caused drilling to be stopped, prevented continuous logging, or inhibited other scientific activities (see facing page). These have been most common in holes being drilled to address scientific questions focusing on tectonic and lithospheric objectives. Specific examples include trying to penetrate the detachment at the base of the accretionary wedge in Barbados, and attempting to obtain better core recovery of rifted margin sediments and basement rocks in the Iberia Abyssal Plain and Layer 2 of the oceanic crust at Hole 504B. The 1996 ODP LRP calls for more drilling in these types

# Passive margin transects: Sea level studies

contributed by James Austin, Jr. \*, Gregory Mountain \*, and Craig Fulthorpe \*

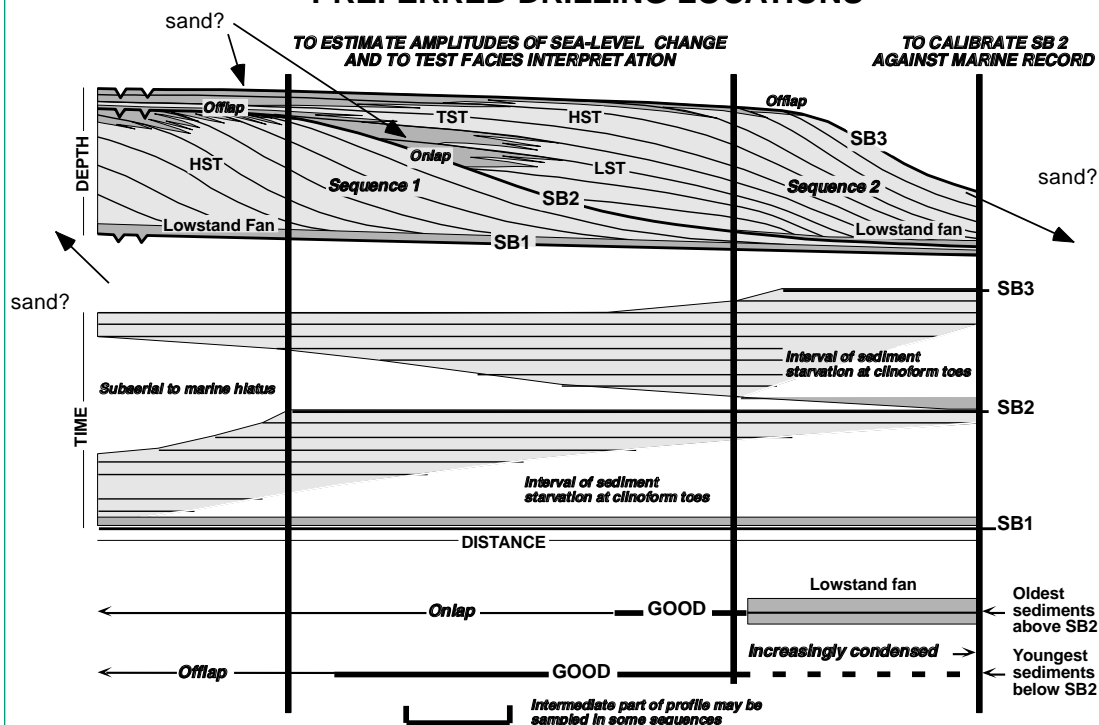
Riser drilling will be particularly useful for penetrating thick sediment prisms along continental edges containing un- or under-consolidated sands. Since the beginning of DSDP, drilling through and completely sampling such sediments with standard rotary drilling techniques and open-hole, water-based drilling fluids has simply been beyond our capacity. Sand-prone sections have proven difficult to recover in adequate quantities, have led to unstable holes and lost equipment, and have frequently prevented reaching the desired target depths.

Nonetheless, in continuing the Mid-Atlantic Transect for the study of sea level (a central theme of the LRP; see results of ODP Leg 150/150X), Leg 174A will provide ODP with the operational baseline for riserless drilling in shallow-water. This expedition will drill, core, and log at least two sites on the New Jersey shelf, and to meet the objectives, complete core recovery, stable hole conditions, and excellent logs are critically important. Depositional

clinoforms (topset-foreset deltaic wedges) indicating intervals of rapid margin progradation during the Miocene and the passage of Earth's climate into the modern, glacially dominated regime will be targeted. Nearby commercial wells show that sands are a prominent part of topset strata and are occasionally, a major component of the foresets. The age and depositional environment of these sands must be determined to understand both sea-level history and how changing sea level is preserved in the geologic record. Although Leg 174A will offset expected recovery losses inherent in coring sands by using Logging-While-Drilling, logs cannot completely compensate for a lack of core. ONLY riser drilling can optimize core recovery in such sand-prone sections. Understanding the history and stratigraphic impact of global sea-level fluctuations depends upon the development and application of riser technology.

\*The University of Texas Institute for Geophysics  
\*Lamont-Doherty Earth Observatory

## PREFERRED DRILLING LOCATIONS



of environments in which mud circulation could be helpful in overcoming difficult drilling conditions.

### Drilling problems and riser solutions

**Problem:** Drilling through a fault zone. Pieces of fractured rock fall from the borehole sides and jam up the core barrel and or the bit.

**Solution:** Drilling with mud may prevent this because the mudcake may hold the fractured rock together.

**Problem:** Drilling in dense basement rocks. Seawater circulation is not adequate to lift the cuttings which settle and refill the hole or jam the bit when pumping stops.

**Solution:** High viscosity drilling mud can be pumped through the hole to lift the cuttings and clear the hole. Continuous use of mud may prevent this problem.

**Problem:** Drilling through sandy turbidite sediments. Unconsolidated sand flows into the hole, filling it up each time drilling stops.

**Solution:** Drilling with mud will probably help. The density of the mud will be closer to that of the sand/water mixture making flow-in less likely. The pressure of the column of drilling mud can be adjusted to balance the flow-in pressure. A mudcake may build up which binds the flowing sand. The mud circulation will keep the sand from falling down into the hole. However, note that drilling will be in the non-circulation mode for the first 800-1000 m before casing will be held for a riser/BOP. Thereafter, circulation will depend on the formation allowing it until the next casing is set.

**Problem:** Drilling in a hydrothermal system. The drillbit encounters a low-pressure formation that sucks seawater in from the drillhole. There is no water circulating up the hole to lift the cuttings.

**Solution:** Drilling mud might clog up the low-pressure formation with mudcake, forming an impermeable seal. Fluid circulation and cutting removal would resume.


### Where can we drill safely using a riser?

I envision that an oil industry-style riser and BOP system would permit us to conduct limited scientific ocean drilling in deep water sedimentary basin sites now considered off

limits because of safety and pollution concerns. This riser system might also allow us to continue drilling safely after encountering signs of migrated hydrocarbons, which would now immediately shut us down. On the other hand, I expect that ODP/TAMU and JOIDES Pollution Prevention and Safety Panel (PPSP) would still require that we avoid drilling into structural traps or in places where encountering accumulated oil or thermogenic gas is likely. Even with this system, there would still be safety concerns about drilling in very shallow water.

Using a slimline riser with a diverter (without a seafloor BOP) would be only marginally safer than current ODP drilling practice. The minimal improvement would come from the use of drilling mud to control unstable formations. With such a system, I doubt that the ODP/TAMU and PPSP would allow drilling in situations much riskier than they currently permit. Deployment of a slimline riser with seafloor BOP would probably fall somewhere between these two cases. I expect that we would be allowed to drill in a broader variety of sedimentary basin sites, but by no means "anywhere we would like."

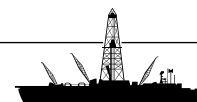
### Costs/benefits of a riser

There are significant technical challenges, costs, and risks associated with developing a riser system for use with either a Japanese drillship or a modified *JOIDES Resolution*. Offsetting these are the potential for recovering better and more complete core in areas where hole stability has been a problem, and for drilling and logging in scientifically interesting but presently off-limits areas. I firmly believe that scientists should take a more active role in weighing the potential for scientific benefit of a riser system against its costs. We must learn what a riser can do for our science. We must let our NSF program managers know whether we want riser capabilities. We must not let the decisions be made solely on the basis of politics or poorly founded assumptions about what the scientific community wants. 

*We gratefully acknowledge Brian Jonasson, Gene Pollard, Alister Skinner, and Jamie Austin for their thoughtful reviews of this article.*

# ODP publications – a vision for the future

**A**s reported in the July 1996 JOI/USSAC Newsletter, JOI, ODP/TAMU, and PCOM have spent considerable time during the last year developing a future vision for ODP publications. The deliberations surrounding ODP publication strategy are ongoing, and the strategy and volume design will no doubt evolve as new hardware and software are introduced and people become more familiar and comfortable with using electronic journals. In the box below we provide a summary of the current ODP publications plan, which was endorsed by the JOIDES Executive and Planning Committees this fall. Please note that a shift to all-electronic publishing will proceed only when JOI receives (1) a positive recommendation from the JOI Publications Steering Committee which is currently being formed, and (2) endorsement by the JOIDES Scientific Committee (SciCom).



## Ocean Drilling Program

### The essentials

#### INITIAL REPORTS

##### VOLUMES 169-175:

- Book:
  - scientific overview
  - site chapters (including site summaries, operations reports)
  - guide to usage of material on CD
- CD:
  - prime data (core-description forms, core photographs, thin-section descriptions, and smear-slide descriptions)
  - large tables
  - logging figures
  - large data sets (including GRAPE, index property, magnetic susceptibility, and natural gamma data)
  - viewable/printable copy of book material

##### VOLUMES 176 AND BEYOND:

- Book: none
- CD:
  - scientific overview
  - site chapters (including site summaries, operations reports)
  - prime data (core-description forms, core photographs, thin-section descriptions, and smear-slide descriptions)
  - large tables
  - logging figures
  - large data sets (including GRAPE, index property, magnetic susceptibility, and natural gamma data)
  - viewable/printable copy of book material
- World Wide Web version of CD material (viewable, downloadable, printable)

#### SCIENTIFIC RESULTS

##### VOLUMES 152-168:

- Book: Contains peer-reviewed papers
- NOTE: Beginning with Volume 160 publication obligation may be met by publishing in the outside literature after one-year post-cruise
- NOTE: Beginning with Volume 161 the SR volumes will be limited to 500 pages; reprints no longer published in book
- CD: Viewable volume and data sets (if provided by author)

##### VOLUMES 169 AND BEYOND:

- Book: none
- CD: Entire publication published on CD
- World Wide Web version of CD material (viewable, downloadable, printable)

#### NEW SCIENTIFIC RESULTS SCHEDULE

##### SECOND POST-CRUISE MEETING:

- Scheduled 12-24 months post-cruise

##### MANUSCRIPT SUBMISSION SCHEDULE (Leg 164 and beyond):

- Specialty initial submission: 28 months post-cruise
- Specialty revised submission: 33.5 months post-cruise
- Synthesis initial submission: 34.5 months post-cruise
- Synthesis revised submission: 39 months post-cruise

##### PUBLICATION OF SCIENTIFIC RESULTS VOLUME:

- Approximately 48 months post-cruise

## ODP renewal effort warms up

*Contributed by J. Paul Dauphin, Associate Program Director, NSF/ODP*

**F**irst a piece of good news. For the first time in a long time the NSF started the fiscal year with a budget. In late September the spending bill which contains the NSF's budget was signed by the President. The new budget provides a total appropriation of \$3.270 billion reflecting a 5.1 % increase for research and related activities. How this new budget translates into funding levels for the Division of Ocean Sciences and in particular ODP has not been fully worked out yet, but we will report on it in the next issue.

In a previous column we reported that the U.S. Science Support Program (USSSP) to ODP is required to go through periodic review and renewal within the National Science Foundation because of the program's large size. Renewal approval is granted by the National Science Board (NSB), the governing body of the NSF. We are presently in the middle of this process. A panel of qualified reviewers was convened and they have produced a report with their recommendations. This report will be included with the materials we will present to the NSB when we make our request for renewal. Based on the positive recommendations of the review panel, and the strong performance of the USSSP, I am confident that in the next issue of the newsletter I will be able to report that the Program was approved for another three-year period.

On the subject of renewal, I thought I would review some of the important milestones facing the Ocean Drilling Program as it races towards its scheduled termination at the end of fiscal year 2003. Some of you may recall that the NSB renewed ODP in 1993 for a period of ten years with funding authority for a period of five years, through FY 1998. In mid-1997 we will review the Program and request authority from the NSB to continue funding the Program for an additional four years, through fiscal year 2002. The Ocean Drilling Program is scheduled to end on September 30, 2003. The 1996 ODP Long Range Plan defines in some detail the third and final phase of the Program (FY 1999 - FY 2003) and refers to a Phase IV (FY 2004 - ?). Phase IV represents the beginning of a new program of scientific ocean drilling that

envisions a two-platform operation; one with riser capabilities and one with capabilities similar to the present *JOIDES Resolution*. If the Phase IV plans are to be implemented, the first step will be to send a clear, strong, and compelling request to the NSF from the U.S. Geosciences community.

In order to successfully argue for a new, expanded program of scientific ocean drilling to the NSB, and defend it in an extremely competitive environment filled with numerous strong initiatives, NSF directors/personnel will require a forceful, clear and unambiguous request from the geosciences community. Mike Purdy, Division Director Ocean Sciences at the NSF, has requested that USSAC undertake an assessment of the U.S. community's overall desire, needs and commitment to such a program and particularly the scientific demand for riser-type drilling capabilities. Numerous activities, workshops, and conferences which touch upon this issue have occurred or are planned. These will provide USSAC with some of the input it will need to meet this challenging task. Among these activities is a riser drilling engineering workshop in Japan, which is occurring as this article is being written, and is examining the technical feasibility of riser drilling as designed to meet the scientific objectives of a future drilling program. Our Japanese colleagues, who are hosting this meeting, are proposing to build, and pay the capital cost for, the riser drilling vessel for use by the international scientific community. Also, in early December, at the request of the NSF, a representative cross section of the geosciences community has been invited to meet in Oregon to discuss the future directions of marine geosciences and the facilities that such a future might require. This workshop should provide a broader perspective on the requirements and role of a future ocean drilling program.


As Roger Larson reports in his editorial elsewhere in this newsletter, USSAC has asked Jamie Austin and Nick Pisias to assemble and co-chair a committee comprised of USSAC and non-USSAC members to respond to the request made by the NSF.

The committee is to submit a report by March 1997 that updates and amplifies on the earlier COMPOST Report (which is available on the JOI WWW homepage at <http://www.joi-odp.org> — “What’s New”).

An international workshop, the CONference on COordinated Riser Drilling (CONCORD), is planned tentatively for late July 1997 in Japan for the purpose of identifying and formulating with greater precision the scientific questions which require riser drilling (see box below). The results of this workshop are intended to complement the 1996 ODP Long Range Plan which focuses primarily on drilling with a *JOIDES Resolution*-type vessel.

Discussions of the post-2003 future of scientific ocean drilling at the NSF with the

NSB will probably begin next year, when funding renewal for 1998-2002 is being considered. A detailed and mature position will have to be developed by the time the NSF makes its funding request to the NSB for the last year of the Program in 2002. To a large extent, community response will determine the nature of this request.

These issues do not necessarily address the additional questions of management, operations and logistics presented by a new and enhanced drilling program. If there is to be a scientific ocean drilling program in the 21<sup>st</sup> century, then all of these issues will have to be resolved and strong international participation will be required. Your input and participation in the process is essential. 

## CONCORD: CONFERENCE ON COOPERATIVE OCEAN RISER DRILLING

**Dates: July 1997**

**Place: Japan**

This workshop represents the continuation of ongoing international deliberations aimed at establishing a program of scientific ocean drilling utilizing two drillships operating globally. One of these vessels will have riser-type drilling capabilities for well control permitting deep drilling in areas such as continental margins, oceanic crust, oceanic plateaus, and the seismogenic zones in areas of plate subduction. The other drillship will have capabilities similar to the *JOIDES Resolution*.

The purpose of the July workshop will be to formulate the main scientific objectives outlined in the ODP Long Range Plan that require riser drilling as part of the project plan, and to define the strategies and technology needed to achieve these goals. The workshop report will summarize and document the main problems and goals but will not specify the research-implementation plan which will be proposal-driven as in the current ODP. The workshop report will also: provide the final scientific background and documentation for the OD21 proposal to the Japanese government due in August 1997; dem-

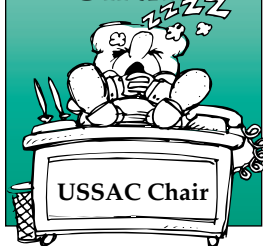
onstrate the global scientific community’s commitment to OD21 as part of a new era of ocean drilling; and generate momentum for timely planning of pre-drilling investigations within research topics and regions of high priority.

### **Working Groups (tentative):**

- 1) Climate and sea-level changes
- 2) Architecture of the oceanic lithosphere
- 3) Continental rifting and LIPs
- 4) Subduction and earthquake processes
- 5) Drilling & tool technology development
- 6) Borehole and seafloor observatories

Approximately 25 members of the U.S. scientific community will be invited to this conference, representative of all of the disciplines cited above. Expenses will be supported by the U.S. Scientific Support Program of ODP. Expressions of interest should be sent by 1 February 1997 to one of the two Co-Chairs: Hans-Christian Larsen, Danish Lithosphere Center, Oester Voldgade 10, 1350 Copenhagen K, DENMARK ([larsenhc@dlc.ku.dk](mailto:larsenhc@dlc.ku.dk)) or Dr. Ikuo Kushiro, Director, Institute for Study of the Earth’s Interior, Okayama University, JAPAN ([kushiro@misasa.okayama-u.ac.jp](mailto:kushiro@misasa.okayama-u.ac.jp)).

## A letter from the Chair



*Dr. Roger Larson is Professor of Marine Geophysics, Graduate School of Oceanography, University of Rhode Island.*

## Long-term U.S. interests in scientific ocean drilling

The watchword in science funding these days seems to be "plan ahead," and that is just what NSF is trying to do for the long-term future of scientific ocean drilling. ODP as a program is mandated to end on September 30, 2003, and NSF Ocean Sciences Director Mike Purdy has asked USSAC to assess the type and level of U.S. interest in scientific ocean drilling beyond 2003. In plain language, NSF wants to know what kind of science we would like to do, what it will take to do it in terms of facilities and money, and how broad that interest is within the U.S. scientific community. While this assessment will be ongoing and will hopefully become more focused as more information on advanced drilling systems becomes available, Mike would like us to give him a preliminary report by March, 1997. Clearly, this initial report will help NSF frame a U.S. response to the Japanese initiative to build and operate a riser drillship sometime soon after 2003. An international meeting to focus mainly on riser drilling science and technology is now planned to be held in late July, 1997 (see page 25). For those of you who might be wondering what a riser is, and what it might be good for, see Dale Sawyer's article elsewhere in this newsletter.

In typical committee fashion, USSAC initially formed a subcommittee to plan a strategy for responding to NSF's charge. They have summarized previous planning documents, such as the 1993-vintage COMPOST (COMmittee on POST-1998 drilling), and USSAC has helped sponsor several workshops on various aspects of the question, such as the workshop on lithospheric drilling held in Woods Hole last May (see the summary on page 12) and the workshop on intervals of extreme warmth held in Califor-

nia in July (see summary on page 5). At our last meeting at the end of September, USSAC reformatted that subcommittee and expanded it to include members beyond USSAC in a deliberate attempt to assess the broadest possible level of interest in these issues.

The Co-Chairs are:

- Jamie Austin, University of Texas, and
- Nick Pisias, Oregon State University.

Other committee members are:

- Mike Arthur, Penn State University;
- Keir Becker, University of Miami;
- Bobb Carson, Lehigh University;
- Missy Feeley, EXXON Prod. Res.;
- Dennis Kent, Columbia University;
- Jim Natland, University of Miami;
- Dale Sawyer, Rice University; and
- Mark Zoback, Stanford University.

This committee will be working over the winter to do the job NSF has set for us. Other long-term planning meetings are also in the works that will encompass or have an impact on these efforts, notably the NSF-sponsored FUMAGES (Future of Marine Geosciences) meeting scheduled for early December. Besides such formal input, we'd love to hear from you as individuals. After all, you are the community we are supposed to represent. So if you have interests in the long-term future of scientific ocean drilling, send your views to Jamie at [jamie@utig.ig.utexas.edu](mailto:jamie@utig.ig.utexas.edu), Nick at [pisias@oce.orst.edu](mailto:pisias@oce.orst.edu), or to any of the other committee members. NSF has made it very clear that the competition for new resources will be tough and in order to be successful, we must have broad support for ocean drilling. Thus, we look forward to your help in this ongoing adventure.

A handwritten signature in black ink, appearing to read "Roger".

Roger L. Larson  
Chairman, USSAC

**Want to review the  
1993 COMPOST document?**

**Refresh your memory as to what it said?**

**Visit JOI's web page at <http://www.joi-odp.org>  
Look under "What's New"**

**Dr. Michael Arthur\***  
Department of Geosciences  
Pennsylvania State University  
503 Deike Building  
University Park, PA 16802  
tele: (814) 863-6054  
fax: (814) 863-7823  
arthur@geosc.psu.edu

**Dr. James A. Austin, Jr.**  
Institute for Geophysics  
University of Texas at Austin  
8701 North Mopac Expressway  
Austin, TX 78759-8397  
tele: (512) 471-0450  
fax: (512) 471-8844  
jamie@utig.ig.utexas.edu

**Dr. John Barron**  
U.S. Geological Survey, MS 915  
345 Middlefield Road  
Menlo Park, CA 94025  
tele: (415) 329-4971  
fax: (415) 329-5203  
jbarron@isdmnl.wr.usgs.gov

**Dr. Rodey Batiza**  
Dept. of Geology & Geophysics  
University of Hawaii  
2525 Correa Road  
Honolulu, HI 96822  
tele: (808) 956-5036  
fax: (808) 956-2538  
rbatiza@mano.soest.hawaii.edu

**Dr. William Curry**  
Dept. of Geology & Geophysics  
Woods Hole Oceanographic Inst.  
Woods Hole, MA 02543  
tele: (508) 457-2000 x2591  
fax: (508) 457-2187  
wcurry@whoi.edu

**Dr. Margaret Delaney**  
Earth Sciences Department  
University of California, Santa Cruz  
Earth and Marine Sciences Bldg.  
Santa Cruz, CA 95064  
tele: (408) 459-4736  
fax: (408) 459-3074  
delaney@cats.ucsc.edu

**Dr. Robert Dunbar**  
Dept. of Geology & Geophysics  
Rice University  
PO Box 1892  
Houston, TX 77251  
tele: (713) 527-4883  
fax: (713) 285-5214  
dunbar@rice.edu

**Ms. Mary Feeley**  
Exxon Exploration Company  
PO Box 4778  
Houston, TX 77252-4778  
tele: (713) 423-5334  
fax: (713) 423-5891  
mary.feeley@exxon.sprint.com

**Dr. Tim Herbert**  
Dept. of Geological Sciences  
Brown University  
Providence, RI 02919  
tele: (401) 863-1207  
fax: (401) 863-2058  
timothy\_herbert@brown.edu

**Dr. Roger Larson, Chair\***  
Grad. School of Oceanography  
University of Rhode Island  
Narragansett, RI 02882  
tele: (401) 874-6165  
fax: (401) 874-6811  
rlar@gsosun1.gso.uri.edu

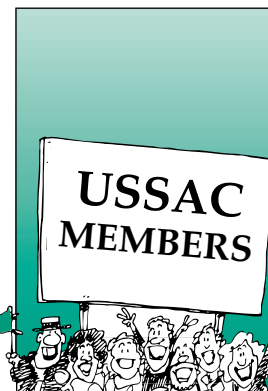
**Dr. Marvin Lilley**  
Box 357940  
School of Oceanography  
University of Washington  
Seattle, WA 98195  
tele: (206) 543-0859  
fax: (206) 543-0275  
lilley@ocean.washington.edu

**Dr. Carolyn Mutter**  
Geoscience 103  
Lamont-Doherty Earth Observatory  
Palisades, NY 10964  
tele: (914) 359-2900 x628  
fax: (914) 365-3181  
czm@ldeo.columbia.edu

**Dr. James Ogg**  
Dept. of Earth & Atmos. Sciences  
Purdue University  
West Lafayette, IN 47907  
tele: (317) 494-8681  
fax: (317) 494-1210  
jogg@vm.cc.purdue.edu

**Dr. Terry Plank\***  
Department of Geology  
University of Kansas  
120 Lindley Hall  
Laurence, KS 66045  
tele: (913) 864-2725  
fax: (913) 864-5276  
tplank@kuhub.cc.ukans.edu

**Dr. Bernd Simoneit**  
Col. of Oceanic and Atmos. Sci.  
Oregon State University  
Oceanography Building 104  
Corvallis, OR 97331-5503  
tele: (503) 737-2155  
fax: (503) 737-2064  
bmcvicar@oce.orst.edu



**\*USSAC Executive Committee**

**Membership term is three years.**

## LIAISONS

**Dr. J. Paul Dauphin**  
Associate Program Director  
Ocean Drilling Program  
National Science Foundation  
4201 Wilson Boulevard, Rm. 725  
Arlington, VA 22230  
tele: (703) 306-1581  
fax: (703) 306-0390  
jdauphin@nsf.gov

**Dr. Ellen S. Kappel**  
Program Director, JOI/USSSP  
Joint Oceanographic Inst., Inc.  
1755 Massachusetts Ave., NW  
Suite 800  
Washington, DC 20036-2102  
tele: (202) 232-3900 x216  
fax: (202) 232-8203  
ekappel@brook.edu

**Dr. James Allan**  
Asst. Manager, Science Operations  
Ocean Drilling Program  
Texas A&M University  
1000 Discovery Drive  
College Station, TX 77845-9547  
tele: (409) 845-9297  
fax: (409) 845-0876  
james\_allan@odp.tamu.edu



The JOI/USSAC Newsletter is issued three times a year by Joint Oceanographic Institutions, Inc. (JOI) and is available free of charge. JOI manages the international Ocean Drilling Program (ODP) and the U.S. Science Support Program (USSSP) which supports U.S. participation in ODP. Funding for JOI/USSSP is provided through a cooperative agreement with the National Science Foundation (NSF).

**Editors: Ellen Kappel and John Farrell**  
**Layout and Design: Johanna Adams**

Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of NSF or JOI. Please contact the editors for more information or to subscribe:  
JOI/USSAC Newsletter, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, NW, Suite 800, Washington, DC 20036-2102;  
tele: (202) 232-3900; fax: (202) 232-8203; Internet: joi@brook.edu

## *D*ISTINGUISHED LECTURER SERIES 1997-98 JOI/USSAC

The JOI/USSAC Distinguished Lecturer Series began in 1991 with the goal of bringing the results of ODP research to students at both the undergraduate and graduate levels and to the earth science community in general. A flyer/application for the 1997/98 Series will be available in January 1997. Applications will be accepted from U.S. institutions (colleges, universities, and nonprofit organizations) interested in hosting a talk by one of the lecturers listed below. To receive an application contact the JOI/USSAC Distinguished Lecturer Series, 1755 Massachusetts Avenue, NW, Suite 800, Washington, DC 20036-2102; tele: (202) 232-3900; fax: (202) 232-8203; e-mail: joi@brook.edu.

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ODP's inaugural expedition to the  
New Jersey continental shelf**

*Dr. Margaret Delaney (University of California, Santa Cruz)*

**Nutrients and ocean history:  
A focus on phosphorus**

*Dr. Gregor Eberli (University of Miami)*

**Sea-level changes: The pulses of sedimenta-  
tion on carbonate platform margins**

*Dr. Deborah Kelley (University of Washington)*

**Volatile-fluid evolution in submarine  
magma-hydrothermal systems**

*Dr. Larry Peterson (University of Miami)*

**Climate change in the tropical Atlantic:  
Clues to patterns and processes  
from the Cariaco Basin**

*Dr. Haraldur Sigurdsson (University of Rhode Island)*

**Global episodes of explosive volcanism:  
Evidence from ODP Leg 165**