JOI/USSAC
NEWSLETTER
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From the Paleocene to today's El Niño and beyond: Selling ancient warming in the 21st Century

contributed by Timothy J. Bralower

The question had been rephrased for a third time. "So you're saying there's not the slightest chance that an event like the late Paleocene thermal maximum can happen in the future, given El Niño and global warming?" Try as hard as he could, the reporter couldn't get me to predict doom in the future of the planet. But I knew what he was thinking in the awkward silence that ensued. If such an event will not happen again in the near future, why was I so interested in studying it, and why should we be spending tax dollars funding research on it?

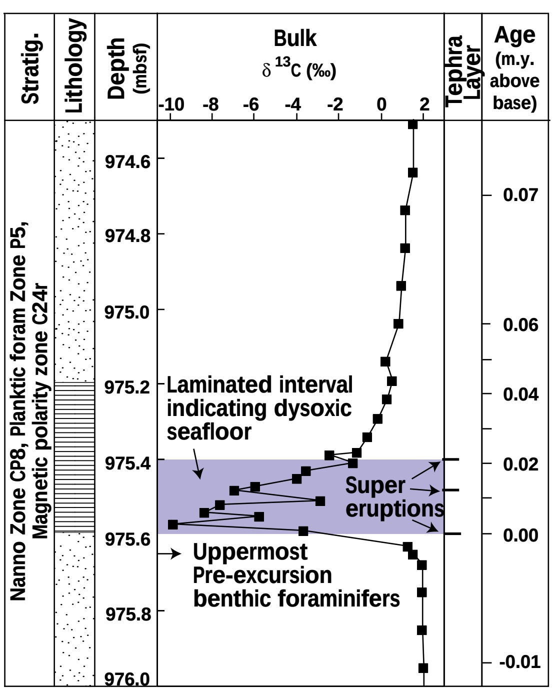

Fig. 1: Environmental changes in LPTM at Site 999 (Colombian Basin). Shown from left are bio- and magnetostratigraphy, lithology showing position of claystone, depth (meters below seafloor), bulk carbonate $\delta^{13}C$ values, positions of tephra/ash layers and age. Note the supereruption between the uppermost pre-excursion and lowermost $\delta^{13}C$ excursion values. The level of benthic foraminiferal extinction has been obscured by dissolution. All data are described in Bralower et al. [1997].

The late Paleocene thermal maximum event (LPTM) is one of the most abrupt and dramatic global warming events documented in the geologic record. This time interval saw the seas off Antarctica and the deep oceans warm to a balmy 18°C [*Kennett and Stott,* 1991], eradicating any significant latitudinal and vertical thermal gradients. Abyssal warming led directly to the largest extinction event in the deep sea in the last 90 million years [*Thomas,* 1990], to a burst of evolution in the surface oceans [*Kelly et al.,* 1996], and to rapid migration of mammals on land [*Gingerich et al.,* 1980]. These oceanographic and biotic changes were accompanied by a transformation in global carbon cycling, evidenced by a short-lived negative excursion in $\delta^{13}C$ in marine and terrestrial fossils [*Kennett and Stott,* 1991; *Koch et al.,* 1992]. Even more intriguing is that the LPTM lasted only a geologic heartbeat, occurring within 50,000 years. We speculate [*Bralower et al.,* 1997] that a catastrophic volcanic eruption in the Caribbean was at its start (Figure 1).

In fact, the causes of the LPTM are probably extremely complex. The changes in Earth's atmosphere, biosphere and hydrosphere were so rapid that they are difficult to constrain, continually clashing with our understanding of geological processes and chemical cycling. It was such a dilemma that led Dickens et al. [1995] to postulate a largely untested scenario for the origin of the carbon isotopic excursion, thermal dissociation of methane hydrate as a consequence of the warming of the deep ocean. The methane hydrate hypothesis has two major advantages over any conventional mechanism of carbon cycling: the reservoir of hydrate is enormous and its carbon isotopic values are extremely light (about -60 per mil). In addition, as Dickens et al. [1997] later pointed out, methane and its oxidant CO_2 have the potential to explain at least some of the LPTM atmospheric warming. Today, most methane hydrate remains

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buried tens to hundreds of meters below the seafloor on the continental slope. The big question is what caused the hydrate to dissociate and escape the sediment column.

We speculate [*Bralower et al.,* 1997] that a combination of factors, superimposed on a warm, equable late Paleocene Earth, enabled a Caribbean volcanic eruption to trigger the LPTM. An explosive eruption occurred just before or at the onset of the LPTM, as indicated by ash horizons in two Caribbean sites drilled during ODP Leg 165 in early 1996 (Figure 2). The volcanic eruption occurred amid an extended episode of volcanism in the Caribbean (Figure 3). This episode overlaps with long-term volcanism that led to the formation of the North Atlantic Igneous Province Large Igneous Province (LIP). Others [*Rea et al.,* 1990; *Eldholm and Thomas,* 1993] have suggested that this effusive volcanism, through the emission of CO_2, was responsible for the late Paleocene warming that began prior to the LPTM and was concentrated at high latitudes. The Caribbean volcanism may have slowed the rate of warming in low-latitude areas, and briefly switched the source of deep water formation from high- to low-latitude areas as originally proposed by Kennett and Stott [1991] (Figure 4). The ensuing gas hydrate dissociation had the potential to fuel the LPTM warming through a complex positive feedback.

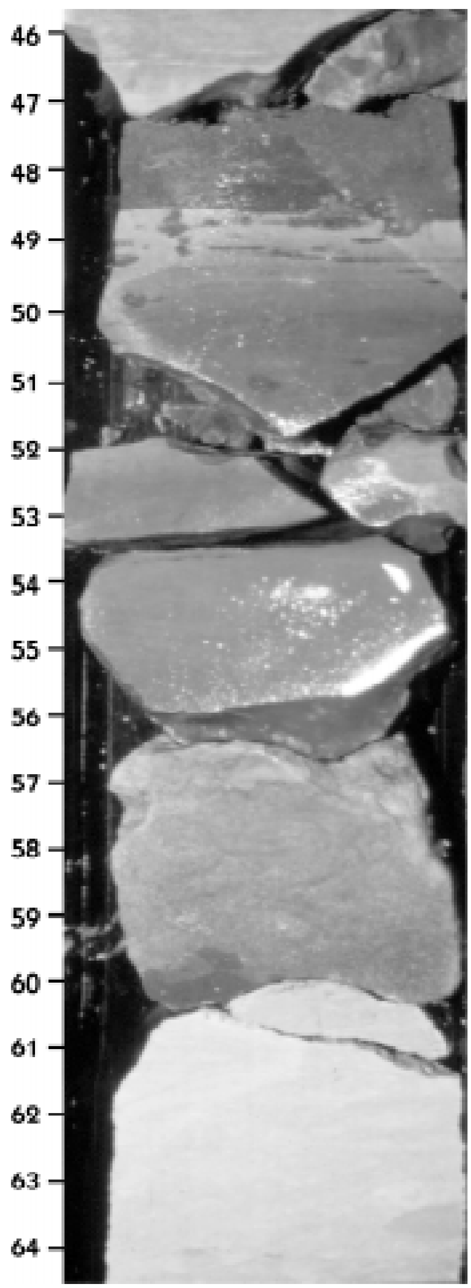

Fig. 2: Prominent blue-grey ash (57-61 cm) directly beneath LPTM claystone (49-57 cm) at Site 1001 (lower Nicaraguan Rise). Note red-brown ash level above claystone at 47-49 cm.

This is not the first time that volcanism has been suggested as a trigger for ancient climate change. Kennett and Thunell [1975] noted a significant increase in ash layers in upper Pliocene Deep Sea Drilling Project cores from the Pacific, and suggested that cooling from circum-Pacific explosive eruptions led to the onset of Northern Hemisphere glaciation. At the other end of the climate spectrum, effusive eruptions involved in the construction of LIPs such as the Ontong Java Plateau in the Pacific are thought to have played a role, through warming, in the deposition of organic-rich sediments in Cretaceous Oceanic Anoxic Events [e.g., *Arthur et al.,* 1991; *Larson,* 1991]. But the role of volcanism in forcing ancient climate change over periods longer than a few years has been questioned by many researchers based on modern climatological data.

Explosive volcanism typically leads to cooling due to the emission of stratospheric sulfate aerosols, but in historic eruptions, the effect is minor and short lived. The most climatologically studied modern eruption, the 1991 eruption of Mount Pinatubo, caused only a 0.2ºC global cooling that lasted 2-3 years. Larger eruptions such as the 1815 eruption of Tambora caused more significant cooling (0.5ºC), but the effects lasted only several years. Furthermore, experts disagree about the potential climatic effects of even larger eruptions, such as the 75 ka “supereruption” of Toba, an event that dwarfed any in historic time. Because the Toba supereruption occurred in the midst of glacial cooling, its climatic effects must be inferred. Estimates of sulfate aerosol loading suggest that the Toba supereruption may have initially caused 3-4ºC of global temperature decrease, with cooling persisting for a century or more, a true volcanic winter [e.g., *Rampino et al.,* 1988; *Zielinski et al.,* 1996]. Theoretically, however, large loadings of SO_2 lead to condensation and coagulation, generating larger particles that fall out of the stratosphere faster, reducing the potential climatic effects. Regardless of the magnitude of the Toba cooling, how could any short-term cooling resulting from explosive volcanism cause a longer-term climatic event such as the LPTM? Because deep sea LPTM sections are temporally condensed, it is impossible to investigate sub-millenial climatic changes, thus a precise answer to this question may never be known. The climatic effects of effusive volcanism have also been challenged. For such eruptions, particularly those that occur underwater, the CO_2 may never accumulate in the atmosphere in an undersaturated ocean [e.g., *Varekamp et al.,* 1992].

Because of these uncertainties, the evidence for a volcanic trigger to the LPTM stared at us for two years before we drew a connection between a prominent ash layer directly underlying the LPTM claystone at Site 1001 (Figure 2). In our defense, this core was badly fractured. We had not seen the wispy 1.5 mm ash layer at Site 999 which proved that the timing was exact. Once the distinctive feldspar phenocrysts from this layer appeared in a washed sample, the coincidence was too perfect to overlook, and we started considering possible causal scenarios. Clearly, the scale of the Caribbean eruptions was enormous. From the thickness of the ash horizons at Site 1001 and the distance from possible arcs, these eruptions were similar in magnitude to the Toba supereruption.

We cannot rule out the possibility that the Caribbean "supereruption" played no role in the LPTM, but was merely an "innocent bystander." It is possible that warming from the North Atlantic Igneous Province volcanism reached a threshold point, reversing circulation patterns at the same instant at which the supereruption occurred. Or as we proposed, the Caribbean supereruption may have amplified the effects of the North Atlantic volcanism by decreasing the rate of warming in the tropics. Perhaps the effects of several Caribbean supereruptions coalesced. Or maybe extrapolations of the climatic effects of supereruptions from observations of small historic eruptions are entirely inaccurate. The ancient record suggests that we need to keep the door open to the possibility that major eruptions can initiate longer-term climate change. If such a relationship exists between volcanism and longer-term climate change, then perhaps there are other LPTM events, ancient El Niños, hidden in the rock record of warm climate intervals. Sampling strategies have concentrated on long-term (several hundred thousand to millions of year) climate changes [e.g., *Zachos et al.,* 1993] and would not detect such abrupt events. We need to probe the Cretaceous and Paleogene record for these mini-LPTMs.

Our paper was published shortly before the Kyoto Summit on global warming and at a time when the press was reporting the daily repercussions of El Niño. The timing couldn't have been better from a publicity viewpoint. As I dealt with more reporters, I learned to delicately promote the lessons of the LPTM for global warming without implying the possibility of a 21st Century meltdown.

Future global warming would probably never cause double-digit polar temperatures that would melt the world's ice sheets and drown coastal cities. However, having ice today puts us in a far more precarious position than at the time of the LPTM. Natural perturbations such as volcanism and gas hydrates appear to be intimately related to the LPTM, yet we have a poor understanding of their effects and potential interactions with other perturbations. The polar oceans are far too cold (and dense) for an LPTM-style switch in the source of deep waters that could release extensive hydrates by thermal dissociation. But locally, smaller quantities of hydrate may be susceptible to thermal dissociation by minor bottom-water temperature fluctuations [e.g., *MacDonald et al.,* 1994]. Hydrates could be released in large quantities through sediment failure and sea-level change [*Paull et al.,* 1991]. Unfortunately for science, but fortunately for humans, Earth has not recently experienced volcanism of the magnitude of the Caribbean supereruptions.

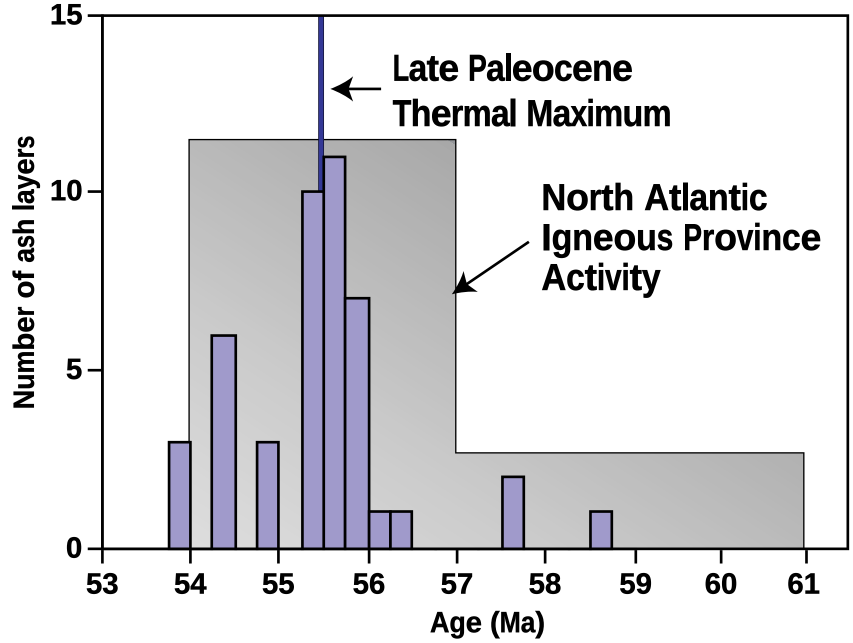

Fig. 3: Timing of Caribbean volcanism (plotted as number of ash layers per 0.25 m.y.), North Atlantic Igneous Province [from *Storey et al.,* 1996], and LPTM.

The deep oceans will not in the near future fill with warm water causing the scale of extinction of many deep sea inhabitants that occurred during the LPTM. Nor will we witness the evolution of new species or the migration of fierce predators due to climate change. However, many marine and terrestrial species are already stressed due to anthropogenic activities, and minor perturbations caused by natural processes may have a profound effect. The collapse of fisheries in El Niños, Tambora crop failures, and the steady northward march of fire ants and killer bees offer their own warnings for the future.

Climate and oceanographic models which are largely constructed based on modern circulation patterns have a difficult time recreating an LPTM world with minimal thermal gradients [e.g., *Sloan and Thomas,* 1997]. There are problems either with the models or with the boundary conditions, specifically the interpretation of oxygen isotopic data in terms of

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temperature. Further work on intervals such as the LPTM will help refine the application of models to warm climate intervals and, at the same time, fine-tune our interpretation of climate proxies.

We are in the midst of what appears to be one of the largest El Niño events yet recorded, certainly the most investigated climatic event, modern or ancient. Last year was the hottest year since climate records have been kept, and even skeptics are beginning to invoke global warming. These modern events offer a lesson in their complexity to the study of ancient climate intervals. But with public awareness of El Niño and global warming at an all time high, now is an ideal time to sell the lessons that ancient climate can provide to our understanding of the modern Earth.

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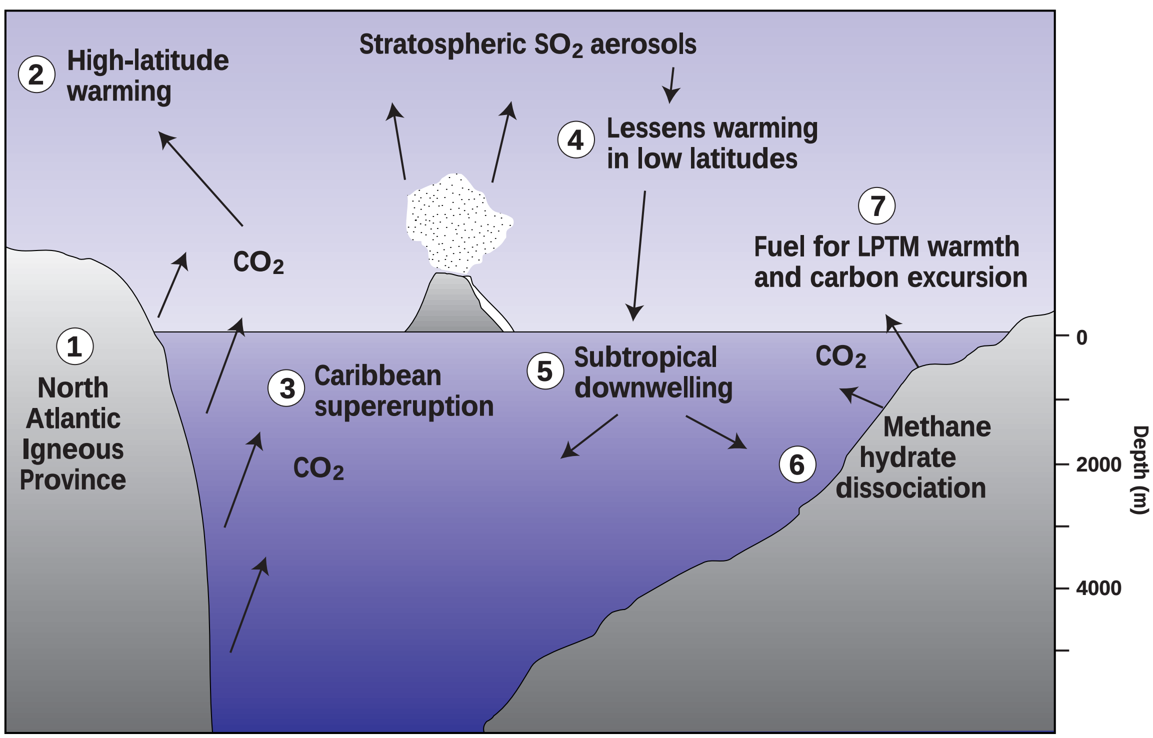

Fig. 4: Simplified model for the origin of the LPTM.

Pleistocene atmospheric variations and the nitrogen isotope dynamics of the Southern Ocean

The JOI/USSAC Ocean Drilling Fellowship Program funded my investigation of nitrogen isotopes as a paleoceanographic proxy of nutrient status in the Southern Ocean. This work involved both the development and application of N isotopes as a paleoceanographic tool. Using the sediment cores collected during ODP Leg 120, I employed this tool to reconstruct the history of nitrate utilization in the Antarctic.

By studying the link between nitrate utilization and the N isotopic composition of nitrate, I developed a precise, high-throughput method to measure the N isotopic composition of oceanic nitrate [*Sigman et al.*, 1997]. I then applied this method to latitudinal transects of water column depth profiles and surface samples from the Indian and Pacific sectors of the Southern Ocean. The results demonstrate distinct regimes of N isotope dynamics in the Antarctic and Subantarctic Zones (south and north of the Polar Frontal Zone, respectively). The Antarctic data indicate a relatively simple link between the degree of nitrate utilization by phytoplankton and the isotopic composition of nitrate (Figure 1). While several uncertainties remain, the findings validate the use of the N isotopes as a proxy for nitrate utilization in the Antarctic.

I investigated the isotopic composition of diatom microfossil-bound N to assess and overcome problems associated with the diagenesis of bulk sedimentary N in paleoceanographic studies. The results suggest that diatom-bound N is native to the diatoms and insensitive to early diagenesis. In addition, geographic variations indicate that it tracks the isotopic composition of the sinking flux. These results imply a promising role for diatom-bound organic matter as a paleoceanographic tool.

Using the isotopic composition of diatom-bound N, I reconstructed the glacial/interglacial history of nitrate utilization in the Antarctic. The $\delta^{15}N$ of diatom-bound N is 3-4‰ higher in the last glacial's sediments than in Holocene sediments. These results support the hypothesis, previously based on bulk sediment N isotope data, that nitrate utilization in the surface Antarctic was higher during the last ice age. The inferred range of utilization changes can explain the entire ~80 ppm amplitude of the observed glacial/interglacial variations in atmospheric CO_2.

Longer time scale work on sediment cores from ODP Sites 748 and 751 is ongoing, the fundamental question being the timing with which the Cenozoic Southern Ocean developed into a nitrate-rich environment.

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Fellowship Profile

Daniel Sigman

Ph.D. Institution: WHOI/MIT

Faculty Advisor: Dan McCorkle

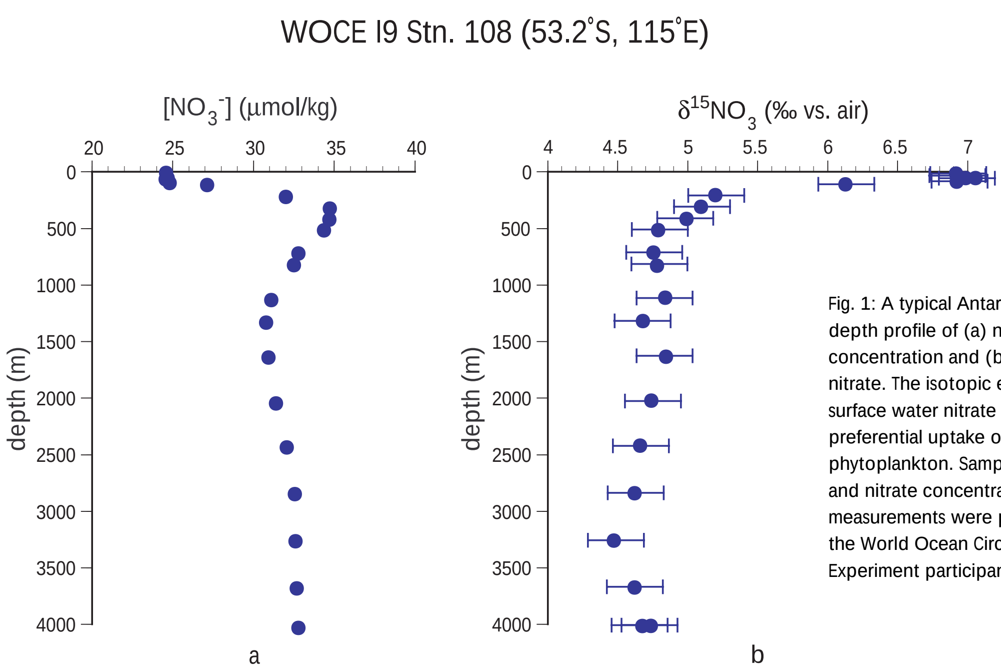
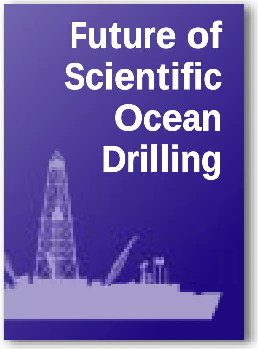


Fig. 1: A typical Antarctic water depth profile of (a) nitrate concentration and (b) the $\delta^{15}N$ of nitrate. The isotopic enrichment of surface water nitrate is due to preferential uptake of ^{14}N-nitrate by phytoplankton. Sample collection and nitrate concentration measurements were performed by the World Ocean Circulation Experiment participants.



Nick Pisias is Professor of Oceanic and Atmospheric Sciences at Oregon State University and Interim Director of the Ocean Drilling Program at Joint Oceanographic Institutions.

The drilling program beyond 2003 – Let the planning begin

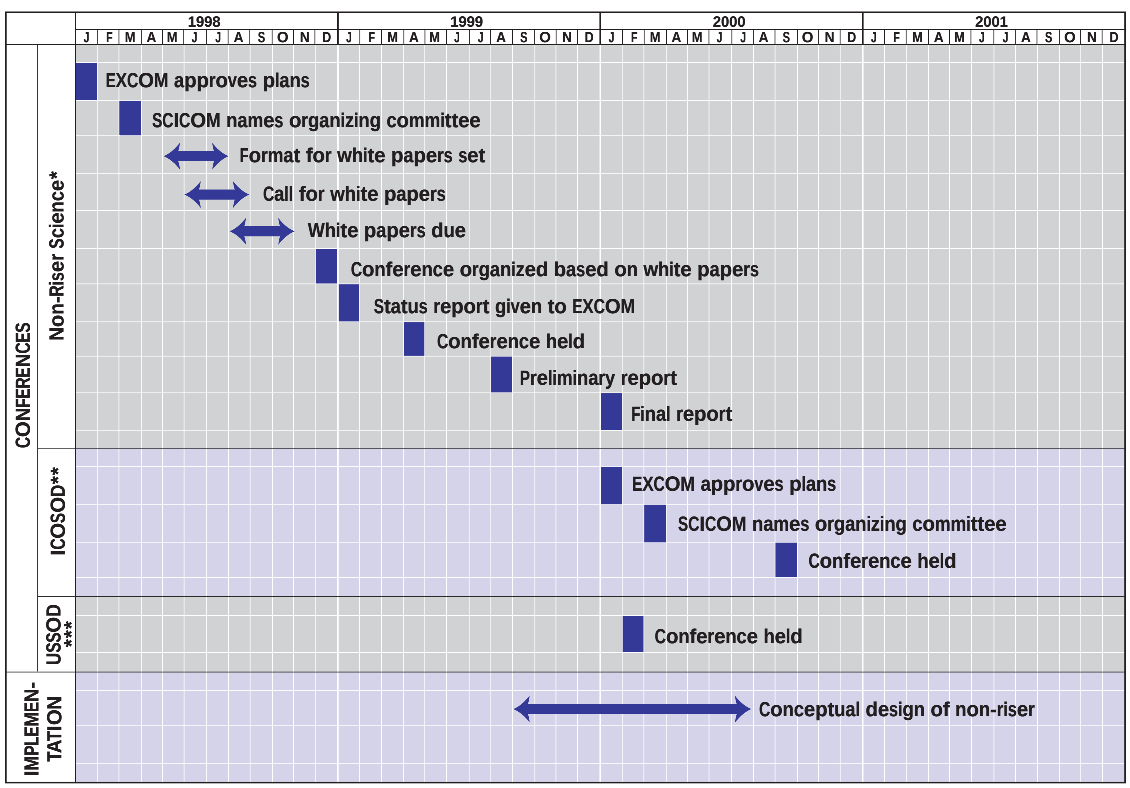
contributed by Nicklas Pisias

The National Science Foundation has formally approved the Ocean Drilling Program (ODP) through 2002. In 2002, formal approval will be requested from the National Science Board for the last phase of ODP. But what happens beyond 2003? When I was asked to be Interim Director of ODP at JOI, the primary question was: Is there a scientific need for an ocean drilling program beyond ODP? So far, when I ask this question the answer has been an unqualified "yes!" So, what are the fundamental questions to be addressed by drilling in the 21st Century? How do we develop the scientific arguments for a new program? How do we integrate these questions into plans for the riser ship being proposed by the Japanese STA/JAMSTEC agencies? How will a new, multi-platform program be structured? These, and many other questions, need to be addressed.

To start answering these questions, the JOIDES Executive Committee has endorsed a planning schedule. A modified version of this schedule is shown below. Two international conferences are planned. The first, in spring 1999, will primarily focus on articulating the scientific goals for non-riser drilling. This conference will be structured around an open call for white papers from the broad international community. This strategy is designed to engage bright and, especially, young scientists to build a consensus from the best ideas and develop a scientific plan accordingly. The non-riser conference will complement the Conference on Cooperative Ocean Riser Drilling (CONCORD), held last summer, which defined scientific objectives for riser drilling.

The report from the spring 1999 conference will be used to formulate a request for proposals (RFP) for a conceptual design of the second drilling platform of the new program. A design phase is planned for late 1999 and the first half of 2000. During this time, JOIDES will be planning a second international conference to integrate the scientific objectives of CONCORD and the non-riser conference. It is anticipated that this conference — tentatively named the Integrated Conference on Scientific Ocean Drilling or ICOSOD — will be a smaller meeting charged with developing the first long range plan for the new drilling program.

PLANNING FOR POST-2003 SCIENTIFIC OCEAN DRILLING



*The Conference to Define Science for Non-Riser Drilling in the 21st Century **The Integrated Conference on Scientific Ocean Drilling ***The U.S. Conference on Scientific Ocean Drilling

So where does a U.S. conference on scientific ocean drilling fit in? Critical to the success of the new program is a well organized and active U.S. community and a well formulated document to be used during the review of the new program. The U.S. Conference on Scientific Ocean Drilling (USSOD) is tentatively scheduled in January 2000 to assure that the new program is ready for U.S. review.

We are entering a new phase of ocean drilling with a multi-platform program first scientifically envisioned in the report of the U.S. Committee on Post-1998 Scientific Ocean Drilling (COMPOST-I) convened by USSAC in 1993 and subsequently endorsed in the 1996 ODP Long Range Plan. If the vision articulated in these documents is to be realized, it is critical that the community step forward and take ownership of the program. I encourage all to become active players in this process.

Advanced CORKs for the 21st Century

contributed by Keir Becker and Earl Davis

Workshop Report

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

A JOI/USSSP-supported workshop was convened on December 15 and 16, 1997, at Scripps Institution of Oceanography, to outline the scientific objectives and general technical requirements for the next generation of Ocean Drilling Program (ODP) instrumented borehole seals or "CORKs." These experiments were initially developed for long-term thermal and physical characterization of subseafloor hydrology, but there is great interest in their potential for sampling of subsurface fluids and microbiology. The workshop was attended by 25 earth scientists representing a broad spectrum of disciplines, ranging among hydrogeology, seismology, geochemistry, microbiology, paleoceanography, and engineering. Reviews of existing CORK technology and recent scientific results were followed by discussions of directions for future CORK science. Specific needs for future CORKs were then discussed in the context of two generic hydrolithologic sections representative of subduction complexes and oceanic crust. Discussions were restricted to those sections most appropriate for CORK installations, that is, where hydrologically active formations or structures can be intersected below naturally low-permeability sediments through which casing can be set.

Two key requirements were common to the relatively diverse but interrelated disciplinary objectives. Of particular importance was the need for accessing multiple formation zones that are hydrologically isolated from one another. Current CORK technology allows monitoring of only the average conditions represented by the full interval of open hole below casing or a single screened interval in a fully cased hole. Multilevel monitoring and sampling capabilities will open many new opportunities in all geologic settings, and will make much better use of the selected ODP holes drilled for CORK experiments. The second advance, considered critical for future CORK instrumentation, was the capability for wireline servicing and possibly deployment, which would reduce demands and dependency on the ODP drillship and provide increased flexibility for CORK science. Conceptual designs were presented and discussed for multilevel packer/sensor/sampler systems that could be deployed by either wireline or the drillship, the former for holes established in stable formations, and the latter for either stable or potentially unstable sections.

It was recognized that while most CORK efforts in the future will focus on specific hydrologic drilling experiments (as they have in the past), it will also be important to consider possible future CORK objectives during the planning of reentry holes drilled for other purposes. This will provide the opportunity for CORK installations to thermally and hydrologically characterize in a wide range of ocean basin settings. It was also recognized that some ODP CORK sites would be appropriate for installation of complementary instrumentation nearby, on the seafloor and/or in small holes drilled or cored from platforms other than the ODP drillship.

Determining the best technical ways to meet the objectives discussed during the workshop was the focus of a second followup meeting involving ODP engineers and a small number of scientists in late February 1998. This group was charged with outlining the most reliable and efficient means of hole completion, casing installation, and emplacing multi-level packer/sensor/sampling strings that will also provide flexibility for post-emplacement servicing and opportunities for installation of additional instrumentation.

Workshop Report

Report on a workshop on volcanic rifted margins

contributed by Bob Duncan

Bob Duncan is Professor of Oceanic and Atmospheric Sciences at Oregon State University.

The origin, character and development of Volcanic Rifted Margins (VRMs) were the subjects of a four-day workshop hosted the GeoForschungsZentrum (GFZ), Potsdam, from November 10-14, 1997. The International Lithosphere Project (ILP), GFZ , BGR Germany, and JOI/USSSP sponsored the meeting. Its purpose was to share the results of recent field, analytical and modeling programs, identify gaps in knowledge, and make general recommendations about future research in VRMs. The workshop was the continuation of a series on continental margins initiated by ILP's project team on the continent-ocean lithosphere boundary. Previous workshops were held in Majorca, Spain (non-volcanic rifted margins), and in Sendai, Japan (convergent margins). Conveners of this third meeting were Manik Talwani, Joerg Erzinger, Bob Duncan, Mike Coffin and Karl Hinz. Sixty persons attended, of whom fifteen were students.

The workshop was organized into four sessions:

1) Keynote talks;
2) Volcanic margins – geophysical observations;
3) Interplay between magmatism and tectonics; and
4) Models and modeling for generation and emplacement of volcanic margins.

The keynote talks introduced various themes for the workshop. Karl Hinz described the distribution and scale of Atlantic volcanic margins and he emphasized the episodic nature of intensive production of the oceanic crust. Bob Duncan summarized work on the time scales of volcanism and rifting at continental margins associated with the onset of mantle plume activity. Mike Coffin reviewed models for emplacement of large igneous provinces in the oceans and on continents. Dan Bernoulli attempted the difficult task of identifying margin volcanism in the geologic record in continental suture zones.

In the session on geophysical imaging, Steve Holbrook described the results of recent seismic studies on the East Greenland rifted margin. Sverre Planke discussed seismic interpretation of volcanic stratigraphy at a number of rifted margins. Victor Abreu presented a comparison of the geological evolution of the Pelotas Basin offshore Brazil and its counterpart on the African side, from seismic profiles and industry wells. Carlos Cramez emphasized the importance of studies of volcanic margins in conjunction with oil and gas exploration, especially as commercial exploration proceeds towards deep water areas.

The third session discussed the interplay between magmatism and tectonics. Andy Saunders addressed the connection between the Iceland plume and Paleocene rifting in the North Atlantic. Julian Marsh reviewed the structure, timing and tectonic setting of the Karoo and Etendeka flood basalt provinces in southern Africa and the adjacent continental margins. Chip Lesher emphasized how the thermal structure of the sub-lithospheric mantle can be inferred from the quantity of melt in the Tertiary North Atlantic igneous provinces, and Martin Menzies described the timing and composition of magmatism with respect to tectonism in the southern Red Sea (Afar-Yemen) volcanic margin. Chris Hawkesworth attacked the general question of the association of continental flood basalts with continental breakup.

In the last session, on models and modeling, Phil Symonds discussed emplacement of volcanic margins with reference to the Western Australian Margin. Cindy Ebinger considered the extensive Cenozoic magmatism in Africa under the slogan of "One plume goes a long way." Dennis Harry and Charlotte Keen described progress in numerical modeling experiments in mantle flow and melting beneath rifting margins. Posters on various topics related to the themes of the sessions were also on display throughout the meeting.

The most significant new observations are:

- About 70% of the Atlantic margins are volcanic. This percentage is much larger than previously recognized. In fact, the "typical" margin may be volcanic rather than non-volcanic. Some of these margins have an obvious plume association, others do not.
- The total period of volcanic activity preceding, attending and following rifting may be variable, but the main pulse of magma production occurs over a very short interval (1-2 m.y.).
- Significant environmental effects may result from the sudden production of large volumes of volcanic material, either subaerially or submarine.

continued on page 20

Workshop on the Costa Rica-Nicaragua seismogenic zone

contributed by Eli Silver

Workshop Report

The seismogenic zone of convergent margins generates Earth's greatest earthquakes. Geological processes within this zone affect geochemical and mass cycling and significantly impact margin volcanism. The hazard implications are profound for the inhabitants in these areas.

Marino Protti, Universidad Nacional, Heridia, and Eli Silver, University of California, Santa Cruz, convened a workshop to review the Costa Rica-Nicaragua Seismogenic Zone (CRiNiSEIZE) in San Francisco on December 7, 1997. The workshop was sponsored by JOI/USSSP, NSF International programs, and MARGINS, and was attended by 55 experts representing a variety of scientific disciplines. The meeting was built upon three previous international workshops which stressed the importance of understanding the mechanics of the seismogenic zone in subduction environments. One meeting, the Seismogenic Zone Experiment (SEIZE), identified the Costa Rica-Nicaragua seismogenic zone as one of the two highest priority regions for focused studies.

Specific CRiNiSEIZE workshop goals were: to better define the nature of the seismogenic zone, to prioritize potential scientific studies, and to organize international teams to focus on different aspects of the zone's structure and behavior. These teams are expected to generate research proposals that ultimately lead to drilling in the active seismogenic zone. The workshop produced a multidisciplinary strategy to prepare for riser drilling on the Central American margin. As a first step, the workshop participants proposed passive seismic experiments to map and define the seismogenic zone. A plan was developed to deploy about 30 three-component ocean bottom seismometers (OBS) and 20 land recorders. The well studied Nicoya seismic gap (Costa Rica) was identified as the prime site for investigation.

Workshop participants also proposed regional multichannel seismic and OBS refraction studies of the Nicaragua margin to obtain crustal structure information compatible with existing data for Costa Rica. The first studies would involve 2D seismic reflection, although any site recommended for riser drilling would likely require 3D work as well. 3D seismic data is currently available for Costa Rica. Because riser drilling to the seismogenic zone is costly and time consuming, only the most effective imaging tools should be used. These may involve experiments using 4D seismics—that is, time variability in reflectivity characteristics associated with fluid flow and mechanical changes.

Heat flow data are also required from the Nicaragua margin, for comparison with the Costa Rican data. One cruise to swath map and collect heat flow data may be sufficient to characterize structural changes along the margin. Additional submersible observations would provide a time-series understanding of the intensity and chemistry of fluid venting along faults and mud volcanoes.

As part of the overall strategy, the workshop also recommended four to six locations off the Nicoya peninsula for marine geodesy studies. Expansion and densification of the Nicoya and surrounding Global Positioning System (GPS) arrays, expansion of GPS studies into Nicaragua, and the addition of more continuous stations were recommended. Other offshore geophysical experiments could monitor long-term vertical motions.

ODP non-riser drilling is an important way to characterize the incoming crust. A desirable goal would be to penetrate the Tsunamigenic zone off Nicaragua and monitor fluid pressure and flow over time. CORK holes through the Costa Rica décollement could monitor fluid variations and chemical behavior associated with forearc strain and seismicity. Finally, by using drill-in casing ODP may be able to penetrate the deformed Costa Rica prism. Data from ODP Leg 170 suggest this prism is related to onshore geology, not to incoming Cocos plate material. A program that monitors fluid and chemical behavior should be carried out simultaneously at several active flow horizons within a hole.

Geochemical studies of the arc volcanoes may reveal the degree to which materials flow through the seismogenic zone. Furthermore, modeling and laboratory studies should be included in the planning and synthesis stages of all components. An integrated program to study the Central American margin promises a fuller understanding of the seismogenic process, and joint efforts will minimize the cost/benefit ratio of conducting a large scientific endeavor.

Eli Silver is a Professor at the Earth Science Department and Institute of Tectonics of the University of California, Santa Cruz.

ANNOUN

SUBDUCTION FACTORY

International Workshop
June 7-9, 1998 • La Jolla, CA

Subduction, magmatism and chemical recycling at convergent margins have profound scientific and societal consequences. The National Science Foundation, JOI/U.S. Science Support Program, and MARGINS Initiative are sponsoring a small (<50 participants) interdisciplinary workshop to discuss the most important science to be tackled at convergent margins, to identify the optimal place(s) for a focused, interdisciplinary experiment, and to plan proposals to the NSF and ODP. Workshop participants will cover the entire spectrum of subduction zone expertise, including: theoretical, experimental, analytical and field-oriented geophysics, petrology, low- and high-temperature geochemistry and volcanology. Space is available at this workshop; full consideration will be given to applications received by April 1, 1998. U.S. participants may obtain partial travel funding. Further information on application procedures and the workshop are available on the web at http://epsc.wustl.edu/admin/people/morris/factory.html. Inquiries may be addressed to Julie Morris by e-mail (factory@ levee.wustl.edu), phone (314/ 935-6926), fax (314/935-7361), or at: Julie Morris, One Brookings Dr., CB 1169, St. Louis, MO 63130-4899, U.S.A.

POSITION AVAILABLE

U.S. REPRESENTATIVE to the JOIDES OFFICE

The JOI/U.S. Science Support Program (USSSP, www. joi-odp.org) is seeking applications from U.S. scientists for a 2-year position as the U.S. representative in the JOIDES Scientific Planning Office, beginning January 1, 1999. The JOIDES Office, currently in Woods Hole, Massachusetts (www.whoi.edu/joides/) will move to GEOMAR (www.geomar.de/), in Kiel, Germany, for the period 1999 through 2000. The successful applicant will provide high-level executive support to the Chair of the JOIDES Science Committee. Duties may include managing drilling proposals submitted to JOIDES, liaison to one or more panels within the advisory structure, editing the *JOIDES Journal,* and assisting the Science Committee Chair in preparation of meeting agendas, agenda books, and meeting minutes. The position requires excellent communication skills and international travel.

A Ph.D. in earth sciences or related fields and previous involvement with the Ocean Drilling Program (www. joi-odp.org) are desirable. Salary, benefits, and relocation costs will be negotiated. Qualified applicants should submit a curriculum vitae and three references to Ms. Denise Lloyd, JEX, JOI/U.S. Science Support Program, Joint Oceanographic Institutions, 1755 Massachusetts Avenue, NW, Suite 800, Washington, DC 20036-2102. JOI will begin reviewing applications immediately, and will continue until an appointment is made. EOE.

WINTER 1998 JOI/USSAC OCEAN DRILLING FELLOW

ONE-YEAR, SHOREBASED FELLOWSHIP

Michael Wara
University of California, Santa Cruz

Boron isotopes in foraminifera as tracers of ocean pH: ODP Site 803D

JOI/USSAC OCEAN DRILLING FELLOWSHIP PROGRAM

JOI/USSAC is seeking graduate students 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 up to $22,000 per year to be used for stipend, tuition, benefits, research costs, and incidental travel, if any. Masters and doctoral degree candidates 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

Shipboard work (Legs 182-187): 4/15/98
Shorebased work (regardless of leg): 4/15/98 and 11/15/98

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; E-mail: ajohnson@brook.edu

CEMENTS

JOIDES Resolution schedule for Legs 178-187

LEG	REGION	CO-CHIEFS	DEP. PORT	DATE	SCIENTIFIC OBJECTIVES
178	Antarctic Peninsula	Barker Camerlenghi	Punta Arenas	2/98	To explore Antarctic glacial history and sea-level change and to investigate the paleoproductivity in the Antarctic coastal ocean.
179	NERO/Hammer Drilling	Casey	Cape Town	4/98	To install a broadband ocean seismometer and instrument package which will fill a gap in the Global Seismic Network and permit study of Indian Plate dynamics.
180	Woodlark Basin	Taylor Huchon	Darwin	6/98	To investigate lithosphere extension, specifically the nature of low-angle faulting, continental breakup, and the evolution of conjugate rifted margins.
181	SW Pacific Gateway	Carter McCave	Townsville	8/98	To reconstruct the stratigraphy, paleohydrology, and dynamics of the Pacific's Deep Western Boundary Current and related water masses since the early Miocene.
182	Great Australian Bight	Feary Hine	Wellington	10/98	To document this carbonate platform's evolution since 65 Ma in response to oceanographic and biotic change and to study global sea-level fluctuations, physical and chemical paleocean dynamics, biotic evolution, hydrology and diagenesis.
183	Kerguelen Plateau	Coffin Frey	Fremantle	12/98	To investigate the origin, growth, compositional variation, and subsidence history of the Large Igneous Province (LIP) formed by the Kerguelen Plateau and Broken Ridge.
184	E Asia Monsoon	TBN	Fremantle	2/99	To study the evolutionary development and variability of the East Asian monsoon.
185	Izu-Mariana	Ludden Plank	Hong Kong	4/99	To determine the net crustal fluxes being recycled into the deep mantle by mass balance of the inputs and outputs at the Mariana-Izu subduction zone.
186	W Pac Seismic Net/Japan Trench	TBN	Tokyo	6/99	To establish long-term borehole geophysical observatories at three key areas in the western Pacific to understand the effect of plate subduction on active plate boundary processes.
---	Dry dock	----------	----------	8/99	----------
187	Aus-Ant Discordance	TBN	TBN	10/99	To unravel the dynamic history of the Australian-Antarctic Discordance by a planned program of off-axis sampling.

JOI/USSSP Supported Shipboard Participants

LEG 178: ANTARCTIC PENINSULA
ODP Staff Scientist: Gary Acton
Stefanie Brachfeld, U of MN, Minneapolis
Ellen Cowan, Appalachian State U
Carlota Escutia, USGS
Yohan Guyodo, U of Florida, Gainesville
Frank Kyte, UC Los Angeles
Lisa Osterman, USGS
Jeffrey Schuffert, Brown U
Amy Weinheimer, Scripps
Diane Winter, Florida State U

LEG 179: Ninety East Ridge Observ.
U.S. Co-Chief: John Casey, U of Houston
ODP Staff Scientist: D. Jay Miller
LDEO Logging Scientist: Greg Myers
LDEO Logging Trainee: Remi Boissonas
Robert Busby, Channel Z. Seismometry, Inc. (no USSSP support)
Zhongping Guo, U of Houston
Hartley Hoskins, WHOI
Peter Thy, UC Davis

NEW! ODP data at your fingertips

ODP's new relational database, Janus, has now been launched on the WWW. The new data management system was first deployed on the *JOIDES Resolution* in January 1997, during Leg 171, and it has been successfully operational since then. ODP science data are proprietary for one year after a drilling leg. February 1998 marks the end of the moratorium for the first Janus leg (171) and the public release of data over the internet using JanusWeb (www-odp.tamu.edu/database). ODP data not specific to any one scientific discipline are not proprietary. These data include the drill hole and core depth information for all of the ODP and DSDP sites (over 1000 in the global ocean) and are currently available over JanusWeb. Data that were collected prior to Leg 171 are available from Misty Thomson, the ODP/TAMU Data Librarian (database@odp.tamu.edu) and will eventually be available on JanusWeb as efforts to migrate the data proceed.

CORK reveals huge fluxes in off-axis hydrologic circulation

contributed by Keir Becker and Earl Davis

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

Introduction and background

During the summer of 1997, the Ocean Drilling Program (ODP) deployed its thirteenth instrumented borehole seal, or CORK, in Hole 395A. This CORK, and four of the six CORKs installed during summer 1996 in the "Flank Flux" area near the Juan de Fuca Ridge, were deployed for long-term monitoring of hydrologic processes in off-axis hydrothermal systems. In contrast, the first six CORKs had been deployed during 1991-1994 in divergent and convergent plate boundaries to study axial hydrothermal processes and fluid flow associated with accretionary tectonics, respectively. The ridge flank CORKs represent deployments in a third type of subsurface fluid flow environment with great significance for the ocean basins — off-axis hydrothermal systems. Despite the spectacular nature of axial hydrothermal venting and associated biota, it is now well accepted that off-axis systems account for the majority of hydrothermal heat and chemical fluxes in the oceanic crust and are a major factor in the chemical and physical evolution of the crust. It is also suspected that off-axis hydrothermal systems may harbor a very significant subsurface microbiological population. Off-axis circulation occurs at lower temperatures and slower rates over large areas of the ocean basins, out to crustal ages of tens of millions of years. It only rarely produces identifiable vents, and is therefore more difficult to study with measurements at the seafloor. To date, much of our understanding of off-axis circulation is based on deductions from patterns in seafloor heat flow, analyses of pore waters in the sediments overlying oceanic basement, the alteration history recorded in cores from off-axis sites, and on numerical simulations. The five CORKs now active in off-axis systems represent the first continuous monitoring of *in situ* conditions and processes in such systems.

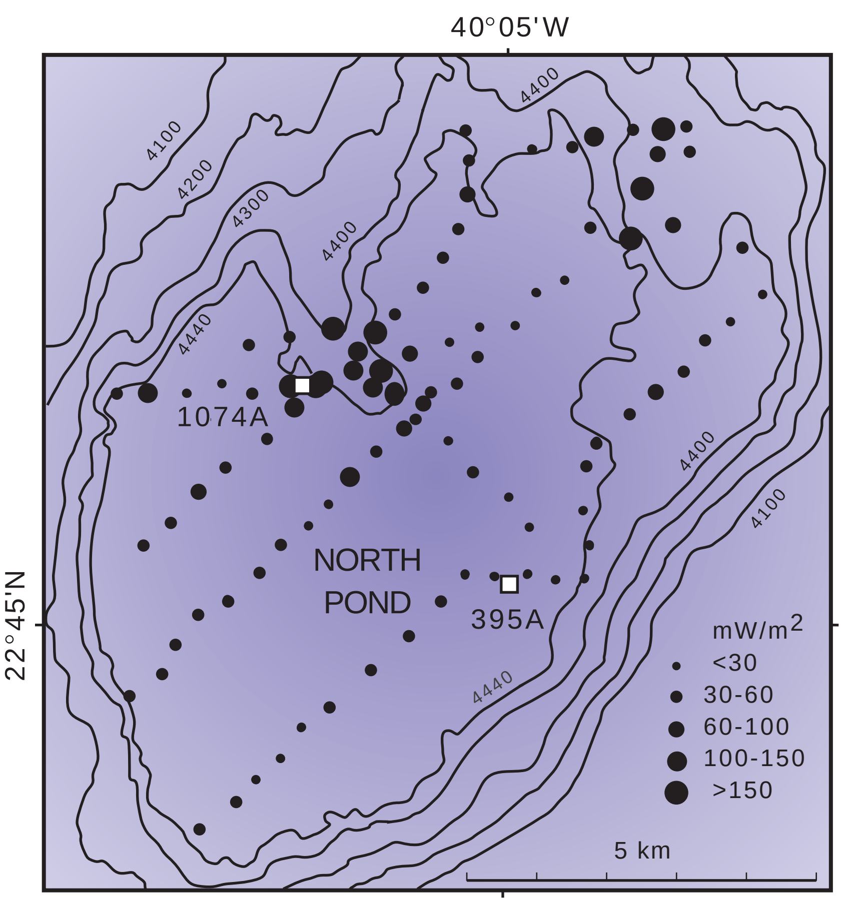


Fig. 1: Location of Hole 395A in North Pond, showing the heat flow survey of Langseth et al. [1992]. Bathymetry is shown in meters, with contour interval of 100 m except for the deepest contour at 4440 m.

During two NSF-funded submersible expeditions in late 1997 and early 1998, we recovered the first data from all five off-axis CORKs, all of which will continue to monitor for several more years. Using DSV *Alvin* in October 1997, we recovered the first 13 to 14 months of downhole pressure and temperature data from the four Flank Flux CORKs. Using DSV *Nautile* in January 1998, we recovered the first half-year of temperature/pressure data from Hole 395A.

Davis and Becker [in press] describe the results from the Flank Flux CORKs in some detail, so we emphasize the preliminary results from Hole 395A in this report. Nevertheless, several main conclusions from the Flank Flux sites are pertinent and bear repeating here. First, the Leg 168 drilling results indicate unexpectedly large distances (many tens of kms) and rates for off-axis fluid circulation in young oceanic crust beneath a sediment cover [*Davis, Fisher, Firth, et al.,* 1997]. Second, the older pair of Flank Flux CORKs, located at an adjacent basement ridge and trough fully buried by sediments (1026B and 1027C, respectively, approximately 3 km apart and 3 m.y. in age), showed significant lateral gradients in fluid pressure in the uppermost crust. Underpressures were registered in the basement trough site, while overpressures were registered in the ridge site. In fact, the ridge site produced 65°C fluids at about 100 L/min before being sealed with a CORK [*Fisher et al.,* 1997] and

5 L/min when the hydrologic access valve on its CORK was opened after 13 months of sealing. J. Cowen and H.P. Johnson installed a long-term NSF-funded experiment to sample these fluids for evidence of subsurface microbiological activity. Third, the younger pair of Flank Flux CORKs were located about 9 km apart in 0.9 and 1.3 m.y.-old crust under about 150 and 100 m sediment, respectively, where all Leg 168 results indicate efficient lateral transport in highly permeable upper basement of low-temperature fluids that probably originate in the widely exposed basement in younger crust nearer the Endeavor Ridge axis. These CORKs showed essentially hydrostatic pressures, with no resolvable lateral gradient between them. While this result may not be immediately intuitive, it is to be expected in a freely flowing system with high basement permeability and little resistance to flow, such that only negligible pressure losses are experienced along the flow path.

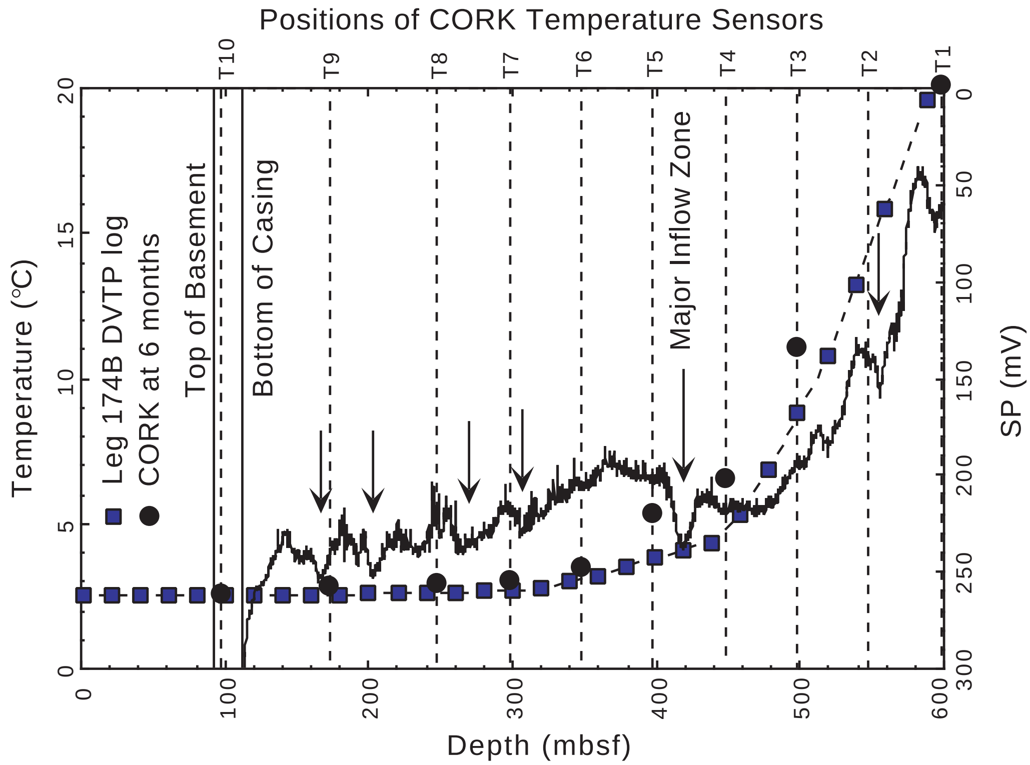


Fig. 2: Leg 174B temperature (purple squares) and spontaneous potential (SP) logs in Hole 395A, with CORK temperatures (black circles) as recorded six months after CORK deployment.

Ridge-flank circulation under isolated sediment ponds: Hole 395A

Drilled in 1975-1976 [*Melson, Rabinowitz, et al.,* 1979], Hole 395A was one of the earliest successful reentry holes in oceanic crust, and it remains one of the most important reference holes for young crust. The hole penetrates 92 m of sediments and over 500 m of predominantly extrusive basalts. It is located in an isolated sediment pond ("North Pond") about 8 x 15 km in size (Figure 1), in 7-m.y.-old crust west of the axis of the mid-Atlantic Ridge. Oceanic crust formed at slow spreading rates typically exhibits much greater bathymetric relief than crust formed at fast rates, so this kind of environment is typical for off-axis circulation in the Atlantic and Indian Oceans.

Hole 395A is also one of the best examples of a phenomenon which dramatically illustrates the need for experiments like CORKs to understand such off-axis circulation. In the 21 years it was left open after initial drilling, repeat temperature logs, fluid samples, and flowmeter logs clearly demonstrated that ocean bottom water was flowing down the hole at consistent rates of 1000 L/hr [e.g., *Becker et al.,* 1984; *Morin et al.,* 1992]. Figure 2 shows the downhole temperature log taken on Leg 174B a few days before the CORK was installed, illustrating the virtually isothermal profile in the upper 300-400 m characteristic of this downhole flow. This figure also shows the Leg 174B log of spontaneous potential (SP), which is quite sensitive to fluid flow; this log suggests that the primary zone accepting downhole flow was at about 420 mbsf, with several other shallower zones and possibly a deeper zone accepting lesser amounts of the flux.

Several DSDP/ODP holes drilled through sediment cover into young oceanic crust display similar downhole flow, and one or two counter-examples drilled into sediment-covered basement highs demonstrate uphole flow. In either case, leaving the hole open and allowing free communication between formation and ocean bottom water amounts to hydrologic "contamination" that precludes fully understanding the driving forces for the natural fluid flow in the formation, flow that occurred before drilling. In simplest terms, the purposes of the CORK experiment are first to seal an ODP hole, preventing such hydrologic "contamination," and second to allow long-term monitoring of conditions in the sealed hole as they return to the natural state unperturbed by drilling.

Digressing a moment to consider the drilling disturbance in more detail, downhole flow in an open hole requires both sufficient formation permeability and a pressure differential to drive the flow. The latter probably results from some combination of two effects: true formation underpressures resulting from natural fluid circulation (which we're really interested in) and a drilling-induced artifact resulting from the density differential between cold drilling fluids and warmer formation fluids. In most well-documented cases of downhole flow in crustal holes, the formation temperatures are indeed warmer than the drilling fluid, so the drilling-induced artifact must be significant and virtually precludes determining the true formation state. The higher the formation transmissivity, the lower the differential pressure required to drive downhole flow.

Hole 395A is important among examples of downhole flow, in that it was drilled into an area of low heat flow; thus, the density difference between drilling fluids and formation fluids was small, and a predominantly natural driving force is probably responsible for the prolonged downhole flow. Important clues to the nature of the natural fluid flow system are provided by the detailed heat flow survey conducted long after drilling by Langseth et al. [1992], which indicate a general increase of heat flow from southeast to northwest across North Pond (Figure 1). Even where the heat flow is high, pore pressure measurements show negative gradients in the sediments, suggesting recharge everywhere in the sediment pond. These observations corroborate the model put forth by Langseth et al. [1984] (Figure 3) for one-pass lateral fluid flow in permeable upper basement beneath North Pond, running from southeast to northwest. In this model, permeability of uppermost basement is quite high and interconnected throughout the sediment pond, and the lateral flow is vigorous enough to keep temperatures at the basement contact nearly isothermal, increasing only slightly along the flow path beneath North Pond. In this case, heat flow in North Pond would be predicted to be directly related to distance from the basement exposures to the southeast and inversely related to sediment thickness just as observed by Langseth et al. [1992]. The CORK experiment in Hole 395A was designed to monitor true formation pressures and temperatures in the upper basement the zone of large-scale lateral flow in order to elucidate the causes and patterns of this flow and to further test the model of Langseth et al. [1984] for off-axis circulation in sediment ponds on the flanks of slow-spreading ridges.

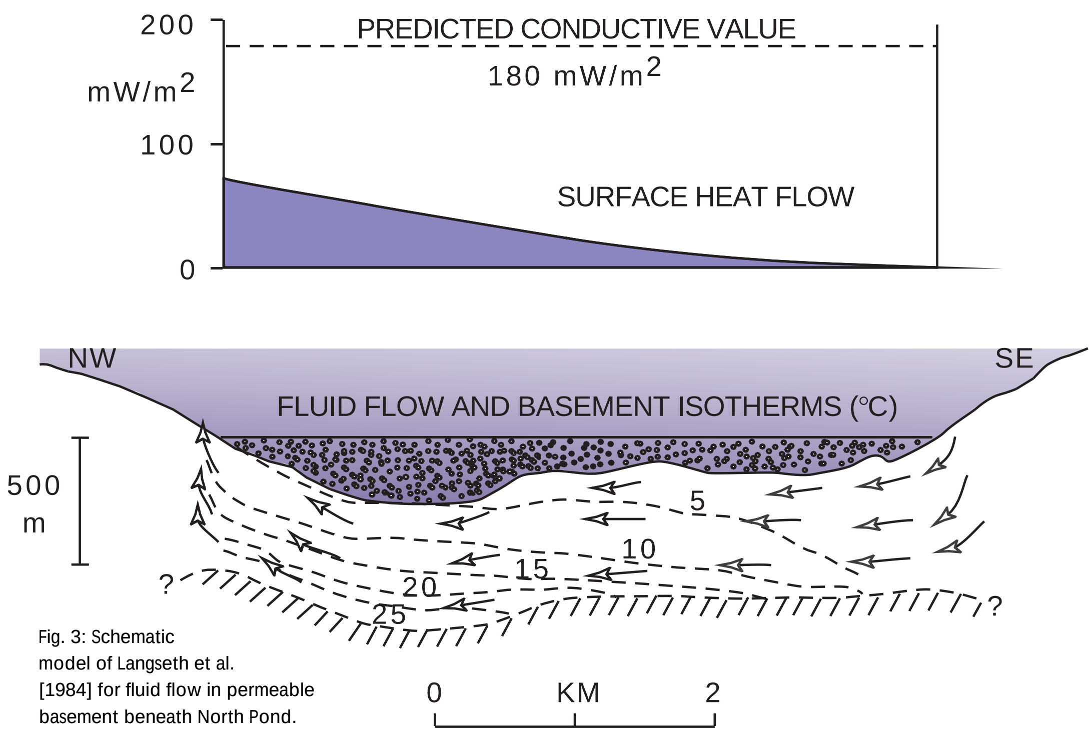


Fig. 3: Schematic model of Langseth et al. [1984] for fluid flow in permeable basement beneath North Pond.

Preliminary CORK results from Hole 395A

The six months of CORK data successfully recovered from Hole 395A will require very careful processing, as they show evidence of an unexpected contact resistance where the downhole sensor signals are brought into the CORK data logger. This resulted in variable offsets of apparent CORK temperatures up to 0.5° C in magnitude and an interruption in the delivery of pressure data for the second through fifth months of recording. Nevertheless, the best data clearly show a very slow recovery of temperatures and pressures in the hole (Figure 4). Full recovery will certainly take much longer than six months, given the 21 years of unabated downhole flow immediately before the installation of the CORK. Until the recovery is complete, we can

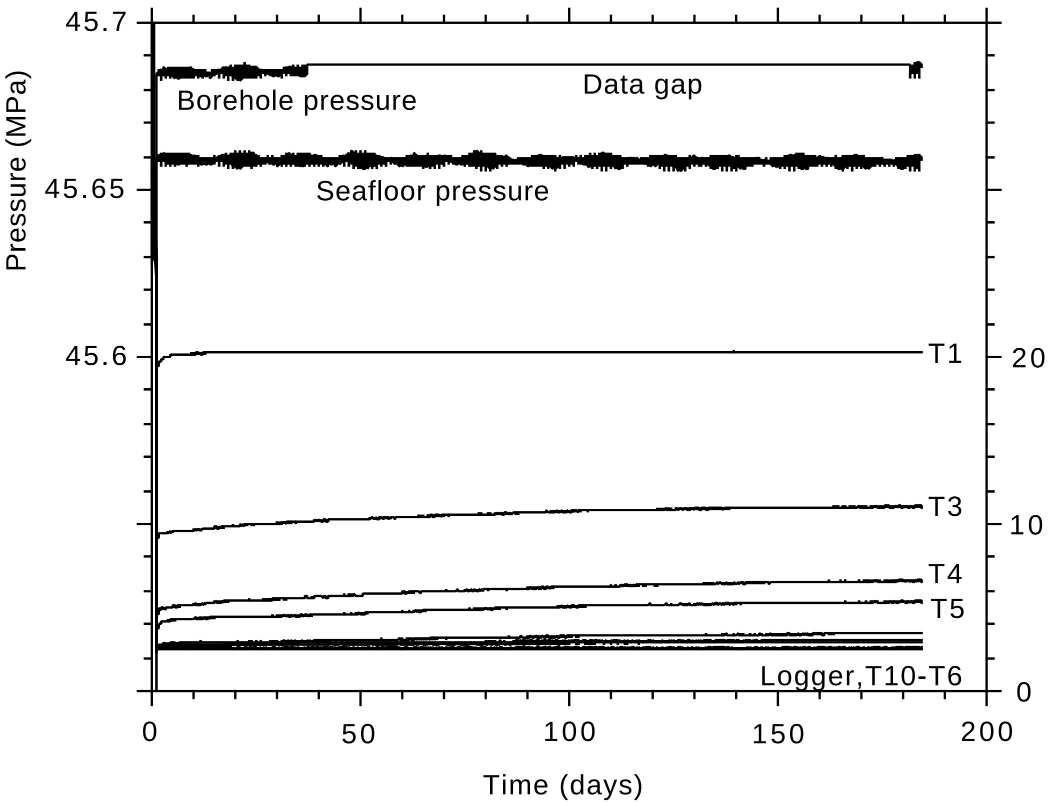


Fig. 4: Pressures and temperatures recorded during the first six months of operation of the CORK in Hole 395A. The data was recovered on January 30, 1998 using DSV *Nautile* with NSF support.

present only lower bounds to *in situ* temperatures and pressures — but these preliminary results are themselves quite illuminating.

First, although temperatures clearly show signs of recovery throughout the first six month recording period, they are still not much warmer than the profile characteristic of downhole flow (Figure 2). Second, *in situ* pressures appear quite close to hydrostatic under local geothermal conditions and the attenuation of the tidal signal seen in the sealed hole is small (Figure 4). Thus, there appears not to have been a strong formation underpressure "sucking" the pre-CORKing downhole flow into a basement reservoir; instead, it appears that the upper basement beneath North Pond is very well connected in a hydrologic sense to the ocean bottom water via the basement exposures that surround North Pond. These results clearly support the Langseth model, in that they indicate that much of the uppermost basement beneath the sediment pond is indeed very permeable and kept quite cool by vigorous lateral flow of fluids close to bottom-water temperature. Basement permeability and transmissivity underneath the sediment pond must be high enough that there is virtually no resistance to flow, nor pressure losses along the flow path. In this context, the disturbance generated by the 21 years of downhole flow before CORKing a total of over 100,000,000 L of seawater flowing down the hole and into the formation was just a relatively minor perturbation to the natural flow system! More important, these preliminary results, like those at the younger pair of Leg 168 CORKs on the flank of the Endeavor Ridge [*Davis and Becker,* in press], strongly support other inferences that there are huge fluxes of low-temperature fluids in very transmissive upper basement in thinly sedimented young oceanic crust.

References:

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In praise of remarkable people

Ellen Kappel is leaving JOI/ODP! That news should come as no surprise to most of you. When first known a couple of months ago, word spread through the ODP community as quickly as the APC plunges through nannofossil ooze. Yes, Ellen is departing, but in doing so she also leaves us with a legacy of significant accomplishments for the good of the order. The success of our science should not have to depend on the extraordinary efforts of a single person but often it does. Ellen was one of these people. Sure, many of us contribute, but without the energies of a few highly effective individuals, our contributions would never be molded into a successful venture. We rarely think about how valuable an individual is to us until after they are no longer there. So here I am, after the fact, providing you with a brief retrospective of the things Ellen accomplished through her work at JOI. Please understand that the following was written with great reverence, although it does not even begin to convey the positive impact that Ellen has had.

Ellen Kappel came to JOI nearly 12 years ago (July 1986). She was appointed initially as a Staff Science Associate, but soon began "running" USSSP, and was converted to Program Director for JOI/USSSP, then Associate Director of ODP. When Ellen arrived at JOI, USSSP primarily covered costs of JOIDES program travel, science support, data syntheses and workshops. Under Ellen's guidance, a number of other activities were undertaken. For example, she initiated publication and dissemination of the *JOI/USSAC Newsletter.* In addition, she helped implement the very successful JOI/USSAC Ocean Drilling Fellowship Program and JOI/USSAC Distinguished Lecturer Series. Post-cruise funding for U.S. scientists also grew, in part due to her advocacy. She helped to ensure that these post-cruise science proposals received adequate and fair review, and tried to allow as much flexibility as possible in the use of these funds by investigators. She also initiated the Site Augmentation Program, another important mechanism for increasing the scientific impact of ODP drilling.

It is clear to most of us that, throughout her tenure at JOI, Ellen always kept the best interests of the ODP community at heart. Her contributions range from the concrete to the intangible. For example, she often recognized the significance of, and found funding for, potentially important innovations to ODP, such as the Wireline Reentry System. Arguably, what she has done best is to extoll the virtues of ODP's scientific accomplishments through innovative educational and promotional vehicles. For example, the *Oceanus* volume (Winter, 1993-94) celebrating 25 years of Ocean Drilling was Ellen's brainchild; this volume was widely read and resulted in spin-offs, including an educational slide set. Educational CD ROMS were yet another of Ellen's original ideas for getting the word out about ODP. The prototype CD "From Mountains to Monsoons" was highly successful. Over 3000 copies were distributed worldwide, and the effort was met with positive reviews in such places as the *Journal of Geoscience Education.* Ellen's most recent gem was the production of *ODP's Greatest Hits* which was discussed in my last column. And who hasn't seen a smiling and convivial Ellen promoting ODP through the JOI/USSSP exhibit at one of many scientific meetings?

Ellen's work for the ODP community has not ceased. Over the next year she will be completing a number of projects, including: production of another CD ROM with Bob Duncan tentatively titled "Gateways to Glaciation;" work on a proposal for an Ocean Sciences Exhibit at EPCOT Center, to prominently feature ODP; and a proposal for an ODP article in *Discover Magazine*. In addition, she continues to contribute to SeaNet, a telecommunications project (bringing internet and high-speed data communications to sea) for which she co-wrote a successful ONR proposal and served as Principal Investigator while at JOI.

Over time, I am certain that you will hear of many kudos given to Ellen. The august body, JOIDES EXCOM, was among the first to acknowledge her formally following the announcement that she would be leaving JOI/ODP: "*By consensus, EXCOM wishes to record its sincere thanks and appreciation to Ellen Kappel for her dedication, energy and considerable effort in support of the Ocean Drilling Program. The preparation of the* Greatest Hits *compilation for the 1997 New York Port Call was only one of her many contributions made over many years. Recognizing that Ellen herself has been a 'great hit' within the global ODP community, we extend our best wishes for her future career."* Ellen is on "professional development leave" through December, 1998. During this time, she will be examining new career prospects for the future, as well as continuing on efforts to promote ocean sciences outlined above. If you want to contact Ellen she can be reached by e-mail (ekappel@brook.edu) or phone (301/229-2709).

Dr. John Farrell has assumed Ellen's duties as Associate Director of ODP and Program Director of JOI/USSSP. John is a fine scientist and effective advocate of scientific ocean drilling in his own right. His considerable energies are even now being bent to the task of keeping USSSP running smoothly. Although we know that it will be difficult to have to work out from under the huge shadow cast by his predecessor, we have great expectations of John now and for the future. All of us on USSAC are pleased to have the opportunity to work with him.

I cannot end this without welcoming another exceptional colleague, Dr. Nick Pisias, who has stepped in as Interim Director of ODP at JOI. What possible reward is there for him to do such a thing? The praise and adulation of the community? Hmmmm! Well, Nick is there, for the moment, and I, for one, am relieved that he has sacrificed time with family, time for thinking deep thoughts, writing manuscripts, his soccer coaching career, and all the rest to shepherd the interests of ODP through JOI at a critical time. He deserves hearty thanks from all of us for his willingness to work for the scientific ocean drilling community in this way. We are fortunate to have someone of his caliber and dedication in that position.

Michael A. Arthur
Chair, USSAC

The future of scientific ocean drilling is now

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

NSF Report

Planning for the support of scientific ocean drilling beyond the year 2003 continues to command increasing attention within NSF. It is complemented by efforts in the U.S. and international scientific communities which seek to articulate the compelling scientific issues which can only be addressed by an enhanced drilling program. Numerous activities over the past several years, as well as ongoing efforts, are refining the nature of a such a program and defining the facilities needed to adequately address these scientific issues.

In early 1997, the Division of Ocean Sciences, at NSF, requested that USSAC assess the degree of U.S. commitment to scientific ocean drilling beyond 2003. USSAC formed the U.S. Committee for Post-2003 Scientific Ocean Drilling (COMPOST-II). The committee developed a report that has been delivered to NSF. A full copy of the report can be seen on the JOI web site at: http://www.joi-odp.org/joi/USSSP/USSSPpubs.html. Comments are encouraged and welcomed. The intent of the committee is to publish an abbreviated version of the report along with its recommendations in an upcoming issue of *Eos* with comments from NSF. At a recent meeting with the COMPOST-II co-chairs, NSF endorsed the committee's recommendations and enlisted USSAC's help in defining the manner in which the U.S. scientific community could most effectively participate in a future drilling program. The aim is to seek a balance between the needs of individual scientific efforts and those of major coordinated earth science initiatives. A time frame for Integrated Ocean Drilling Program development activities was also discussed at this meeting (see the article and schedule on page 6 in this issue).

On another note, 1998 field programs being supported by the NSF-ODP Grants activity include:

1) A detailed mapping and sampling program in the vicinity of site 735B in the Indian Ocean under the direction of Henry Dick (WHOI) with Canadian and British colleagues.
2) A near bottom gravity study of sites drilled in Middle Valley off the Washington coast led by Marc Zumberge (SIO).
3) Deployment of seismometers at the Ocean Seismic Network (OSN) site near Hawaii by Ralph Stephen (WHOI) and John Orcutt (SIO).
4) High-resolution seismic studies along the New Jersey transect by Greg Mountain (LDEO).
5) Two programs under the direction of Keir Becker (RSMAS) to service existing CORK sites in Middle Valley and at Barbados in collaboration with Canadian and French colleagues.
6) Initiation of experiments at Oregon margin CORK sites to study formation of gas hydrates by Bobb Carson (Lehigh) and Miriam Kastner (SIO).
7) A U.S. Japan collaborative program involving (3-D) seismic reflection, active refraction and passive

ocean bottom seismicity in the Nankai Trough region off Japan. This effort will be led by Nathan Bangs and Tom Shipley (UTIG), Greg Moore and Julia Morgan (UH), and J. Casey Moore (UC Santa Cruz) along with Japanese colleagues.

Recently, NSF staff from the Divisions of Ocean Sciences and Earth Sciences (OCE) met with the steering committee of the MARGINS initiative, a bold new program to "understand the complex interplay of processes that govern the evolution of continental margins." NSF intends to begin funding this initiative in FY 1998 with support from the Ocean Drilling Program and Marine Geology and Geophysics Program in OCE and the Continental Dynamics Program in the Earth Sciences Division. A planning office has been established at the University of Hawaii under the direction of Brian Taylor, Chair of the MARGINS steering committee. More information can be found at the MARGINS web site: http://www.soest.hawaii.edu/margins/.

I cannot end this report without mentioning Ellen Kappel's departure from her duties as Program Director of USSSP and Associate Director of ODP at JOI. I miss her frequent, early morning phone calls to discuss the most recent or pressing ODP and USSSP issues for which she was responsible. Ellen has consistently worked very hard, and with a great deal of energy and enthusiasm, on ways to improve the Ocean Drilling Program, help the ODP community, and increase the visibility of the program. Science education is one of Ellen's favorite topics. She has developed a very impressive and effective suite of educational programs within USSSP that target students at all levels. In fact, while on professional development leave, Ellen is enjoying the opportunity to devote time which she did not have before to a number of her favorite educational projects. She will be missed. Best of luck and happiness Ellen.

NSF would like to take this opportunity to welcome Dr. John Farrell as Ellen's successor at JOI. John will have a "tough act to follow" as they say but all indications are that he is up to the task. We wish him well.

Also, we are pleased to welcome Dr. Jamie Allan to the NSF Ocean Drilling Program. Jamie comes to us from Texas A&M University where he was Interim Manager of Science Services at ODP. He will be filling the rotator position that was recently vacated by Sandy Shor.

GEOLOGICAL SOCIETY OF AMERICA PENROSE CONFERENCE

OPHIOLITES AND OCEANIC CRUST WORKSHOP

NEW INSIGHTS FROM FIELD STUDIES AND THE OCEAN DRILLING PROGRAM

A Geological Society of America Penrose Conference, "Ophiolites and Oceanic Crust: New Insights from Field Studies and the Ocean Drilling Program," will be held September 13-17, 1998, at Marconi Center, Tamales Bay, California. The co-conveners are Yildirim Dilek, Don Elthon, Eldridge M. Moores, and Adolphe Nicolas. For details see www.geosociety.org/admin/penrose.htm#ophiolites.

The main themes of the conference are: (1) Structure/tectonics of ophiolites and ophiolite-ocean crust analogy; (2) Structural and magmatic processes at spreading centers; (3) Hydrothermal alteration, serpentinization & mineralization; (4) Petrology and geochemistry of ophiolites and oceanic crust; (5) Sedimentation and sedimentary cover of ophiolites and oceanic crust; (6) Fracture zone tectonics in ophiolite/ocean crust geology; (7) Ophiolite emplacement, mélange problem, and metamorphic soles; and (8) Outstanding problems and future studies in ophiolite/ocean crust geology, and drilling into oceanic crust in the 21st Century. Thematic sessions will include short lecture(s), poster presentations, and group discussions; poster presentations will be a significant component of the conference to facilitate interactions and group discussions. A one-day field trip to the California Coast Ranges will explore the Late Jurassic Coast Range Ophiolite and its sedimentary cover, the Franciscan mélange, and the structural relations between the ophiolite, mélange, and forearc basin (Great Valley Sequence).

Participation in the conference will be limited to 80 people. Participants will be selected to include broad representation of different relevant disciplines, particularly from scientists that have participated in projects of the Ocean Drilling Program, and researchers from the marine geology/geophysics and ophiolite geology communities. Graduate students are encouraged to apply; a partial subsidy will be available to some graduate students. The registration fee, which will cover lodging, meals, field trips, and ground transportation during the meeting, is not expected to exceed $700.

Full consideration will be given to applications received before April 1, 1998. Formal invitation to participants will be mailed by May 1, 1998. Potential participants should send a letter of application to Yildirim Dilek at Department of Geology, Miami University, tel: (513) 529-2212; Fax: (513) 529-1542; E-mail: dileky@muohio.edu. Applicants should include a brief statement indicating their area of interest, the relevance of their recent work to the themes of the meeting, and the subject of their presentation at this conference.

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Volcanic rifted margins, continued from page 8...

Discussion revealed an appreciation of two fundamentally differing styles of Earth dynamics that can be read in the geologic record of VRMs. One is uniformitarian, manifested by steady-state seafloor spreading following continental breakup. The other is catastrophic, occurring for only a brief period of time (a few million years at most) coinciding with breakup, and at widely spaced intervals in the geologic record. To understand the full story of heat and material exchange between Earth's interior and surface, we need to pay as much attention to the catastrophic events as we do to the much more commonly studied and continuous phenomenon of seafloor spreading.

The presentations at the workshop, and the discussions, raised a number of important scientific questions. Among these are:

- How might the composition and distribution of seaward dipping reflectors (which are a large component of igneous activity on the margins) provide constraints on mantle rheology and melt segregation?
- How might plumes be related to seaward dipping reflectors and to the evolution of volcanic rifted margins? What clues might these relationships provide to convection in the mantle?
- What is the effect of lithospheric structure and deformation history on the development of volcanic rifted margins?
- What is the relationship between the timing of magmatism and extension and how does it vary among volcanic rifted margins?
- How does aesthenospheric temperature evolve through time in a rifting margin, and how does it control magmatic volume? What is the relationship between mantle thermal structure and lithospheric architecture, before and after rifting? What are the important controlling factors?

The workshop then raised the issue of what we need to measure better. A number of geophysical experiments, geologic studies and geochemical analyses were suggested. By and large, these studies were directed at resolving the structure and composition of the margin, lithosphere, and aesthenosphere, and its evolution through time. The central role of drilling to develop and test models for both volcanic and non-volcanic margins was recognized. A significant part of future efforts should be devoted to models and modeling studies; it was quite evident that more realistic and finer-scale modeling studies are essential to help choose between different evolution scenarios for the volcanic margins.

The conveners are currently preparing a full summary of the meeting proceedings and recommendations, including abstracts of the presentations and posters. In addition, many of the presentations have been extended to articles and, along with additional studies of VRMs, will be published in a special issue of *Marine Geophysical Letters* this year.

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