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JOIDES Resolution returns to the Southern Ocean

contributed by Rainer Gersonde and David Hodell, ODP Leg 177 Co-chief Scientists

INSIDE...

Antarctica and the adjacent Southern Ocean represent one of the most important components of Earth's climate system, yet many questions remain about the region's paleoenvironmental evolution (e.g., [*Kennett and Barron,* 1992]). The main stumbling block in developing detailed paleoclimatic records from this area has been the dearth of high-quality sedimentary sequences. This December, *JOIDES Resolution* will voyage poleward to drill in the southeast Atlantic (ODP Leg 177) and near the Antarctic Peninsula (Leg 178). Here we review the objectives of Leg 177, which will take cores from six sites along a transect from 41° to 53°S (Figure 1). This transect will span the Antarctic Circumpolar Current (ACC), a cold surface water mass that rings Antarctica and contains complex fronts and upwelling/downwelling cells. Because the sites have also been selected along a bathymetric transect, ranging from 2100 to 4600 m, they intersect three deep and bottom water masses: Circumpolar Deep Water (CPW), North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW) (Figure 2). The sediments recovered during Leg 177 will enable us to study the paleoceanographic history of the southeast Atlantic on a variety of time scales, including long-term (10^5 to 10^6 yrs, Cenozoic), orbital (10^4 to 10^5 yrs, Milankovitch), and suborbital (10^2 to 10^3 yrs).

Long-term (Cenozoic) variability

The Antarctic cryosphere contains the largest accumulation of ice on Earth. The development and evolution of the Antarctic ice sheets and sea-ice field has had a profound influence on global sea-level history, Earth's heat budget, atmospheric circulation, surface and deep-water circulation, and the evolution of Antarctic biota. Previous deep-sea drilling in the Southern Ocean provides us with a basic understanding of the paleoceanographic and paleoclimatic evolution of the southern high latitudes during the Cenozoic, which is closely related to paleogeographic changes (i.e., opening of Tasman Seaway and Drake Passage) that permitted the ACC to develop [*Kennett,* 1977]. Isotopic and microfossil evidence suggests that Antarctic ice sheets were established and sea ice expanded during the earliest Oligocene, but little agreement exists on the presence of ice sheets during the Eocene, particularly during the early-middle Eocene. Prior to the growth of large Northern Hemisphere ice sheets during the late Pliocene, the Southern Hemisphere cryosphere is widely considered to have been a major driving force for global climate and sea-level fluctuations. There are significant differences of opinion, however, regarding the details of

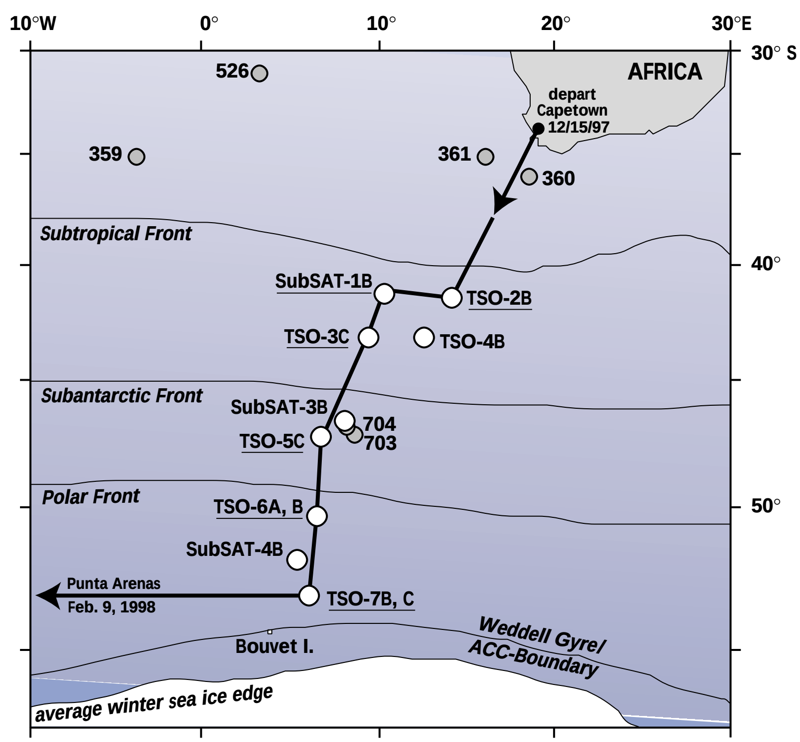

Fig. 1: Location of Leg 177 drilling targets and DSDP/ODP sites (shaded circles) in the South Atlantic relative to major hydrographic fronts. Primary targets are underlined.

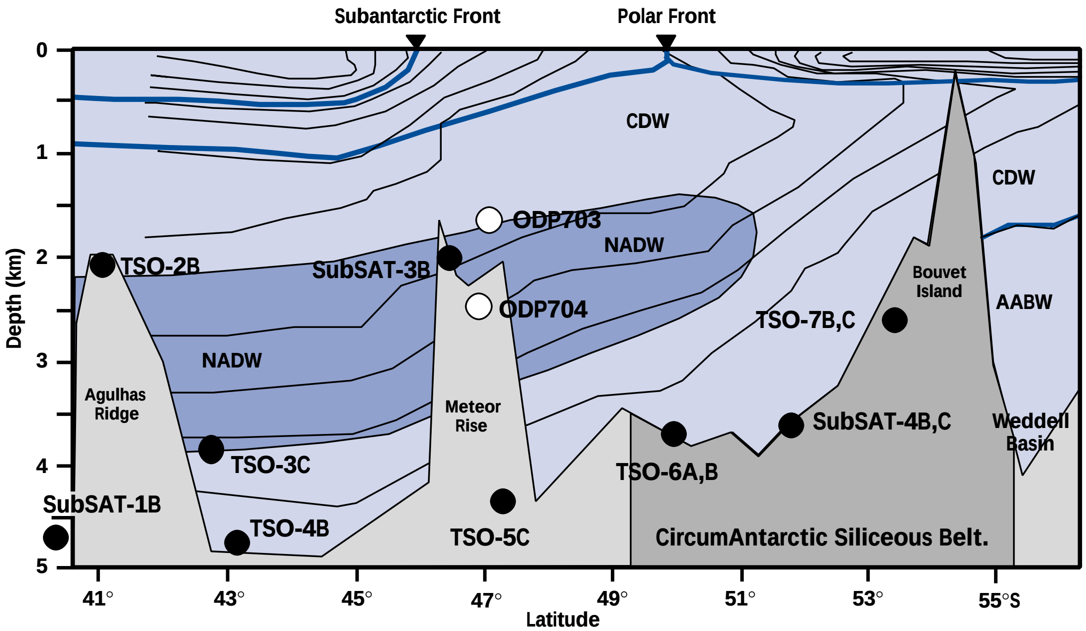

Fig. 2: Vertical distribution of potential temperature on a depth transect in the eastern Atlantic sector of the Southern Ocean relative to the Leg 177 drilling targets.

Rainer Gersonde is a senior researcher at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. He has been involved since 1983 in Antarctic research, and to date has sailed on eight expeditions to the Southern Ocean with the RV *Polarstern;* on four of those cruises he was chief scientist. Dr. Gersonde sailed with ODP previously as a diatom biostratigrapher on Leg 113.

David Hodell is Professor of Geology at the University of Florida, Gainesville. He has participated in ODP Legs 114 and 162 as a sedimentologist and inorganic geochemist, respectively. He also served on the JOIDES Ocean History Panel and currently serves as a member of the new Operations Committee (OPCOM).

Antarctic cryospheric evolution, arising primarily from variations in the interpretation of continental, marine isotope, and sea-level records.

A key objective of Leg 177 will be to augment the paleoclimatic, paleoceanographic, biogeographic, and biostratigraphic history of the Southern Ocean during the Cenozoic, including the evolution and stability of the Antarctic cryosphere. We expect to recover sediments as old as Eocene in two deep holes (TSO-2B, TSO-6A). When combined with previously drilled sites, these holes will form a latitudinal transect that spans the ACC and allows us to study the response of surface water masses in the Southern Ocean to the glacial evolution of Antarctica. Reconstruction of latitudinal isotopic gradients and analysis of the biogeographic distribution and abundance patterns of microfossil assemblages will improve our understanding of the growth and stability of the ice sheets. Leg 177 will also further paleontological and chronostratigraphic objectives by improving southern high-latitude calcareous and siliceous biozonations, and by correlating biostratigraphic events to orbitally-tuned time scales.

Orbital (Milankovitch) scale variability

One of the fundamental tasks in paleoceanography is to reveal the phase relationships between climatic proxies from different oceanographic regions in order to understand the mechanisms by which changes in orbital insolation have forced glacial-to-interglacial climate change during the Neogene. Imbrie et al. [1992] suggested an early response of surface and deep waters in the Southern Ocean relative to proxy data from other regions. This early response has also been observed by other studies during the last climatic cycle [*Charles et al.*, 1996; *Bender et al.*, 1994], suggesting that the Antarctic region may play an important role in driving climate change. The reason for this may be linked to changes in the distribution of sea ice, a fast-responding variable in the climate system. We will study the response of the Southern Ocean to orbital forcing and will determine the phase relationships to climatic changes in other regions.

Leg 177 records will provide spatial and vertical transects needed to improve our understanding of the Neogene response to orbital forcing of surface and deep waters and sea ice in the southern high latitudes. The sites will span the range over which the oceanic fronts and the sea ice limits have advanced and retreated over time within the ACC (Figure 1). We intend to study specific time intervals that have not been well recovered by previous drilling in the Southern Ocean. For example, a particularly interesting time period was the mid-Brunhes, especially marine isotope stage 11 (423 to 363 kyrs), when it appears that climate warmed greatly. This is indicated by a dramatic southward shift of the Polar Front and by the deposition of carbonate microfossils in polar regions that are normally dominated by siliceous plankton, which generally inhabit colder waters. Study of this interval is particularly timely now that the Vostok ice core has been extended to stage 11 [*Petit et al.*, 1997]. The ability to correlate marine sediment records to ice cores significantly improves paleoclimate reconstructions.

Suborbital (millennial) scale variability

Another current focus of paleoclimatic research is the origin of millennial-scale climate variability that was first recognized in ice cores, but now has been found globally [*Broecker*, 1997]. Correlation of Greenland ice-core records to those in sediment cores from the North Atlantic demonstrated that the rapid climatic oscillations observed in ice cores (Dansgaard/Oeschger events) are also preserved in marine records [*Bond et al.*, 1993; *Behl and Kennett*, 1996]. One hypothesis for the origin of these oscillations is based on the strength of the ocean's thermohaline conveyor belt [*Broecker*, 1997]. The South Atlantic sector of the Southern Ocean is especially important in this regard because it represents the entry point of NADW into the ACC. As a result, the South Atlantic sector is highly sensitive to changes in the strength of the NADW conveyor. For example, Charles et al. [1996] reported millennial-scale variability in benthic foraminiferal carbon isotopes in the Southern Ocean that showed a behavior similar to the climate of the North Atlantic (Figure 3). Furthermore, correlation between the Greenland Summit ice core (GISP2) and the Antarctic Vostok ice core suggest that the longer-term millennial variations (circa 2 kyr) observed in GISP2 are manifest as changing temperatures in the Antarctic ice core record [*Bender et al.*, 1994].

To study millennial-scale oscillations and the potential link between the North Atlantic and Southern Ocean, recovery of rapidly deposited, deep-sea sedimentary sequences is required. Two recent ODP legs in the North Atlantic (162 and 172) were highly successful in recovering long sections from sediment drift deposits. To obtain complementary records from the high-latitude Southern Hemisphere, we have targeted sediment drifts and the circumantarctic biogenic silica belt in the South Atlantic. Several of the proposed sites (SubSAT-1B, TSO-6A,B, and TSO-7C,B) have average sedimentation rates exceeding 20 cm/10^3 yrs, which will enable paleoclimatic studies on millennial time scales. For example, SubSAT-1B is located near the site of piston core RC11-83, which contains strong evidence for millennial-scale variability (Figure 3). We anticipate that SubSAT-1B will extend this short piston core record well back into the early Pleistocene.

Summary

Leg 177 is expected to recover an invaluable archive of cores needed to extend our understanding of the Southern Ocean. Improved recovery of cores with high sedimentation rates will permit us to conduct detailed studies of paleoclimate that were previously impossible. We expect that Leg 177 will be the first in a series of legs dedicated to drilling in various sectors of the Southern Ocean using techniques that enable recovery of complete sedimentary sections.

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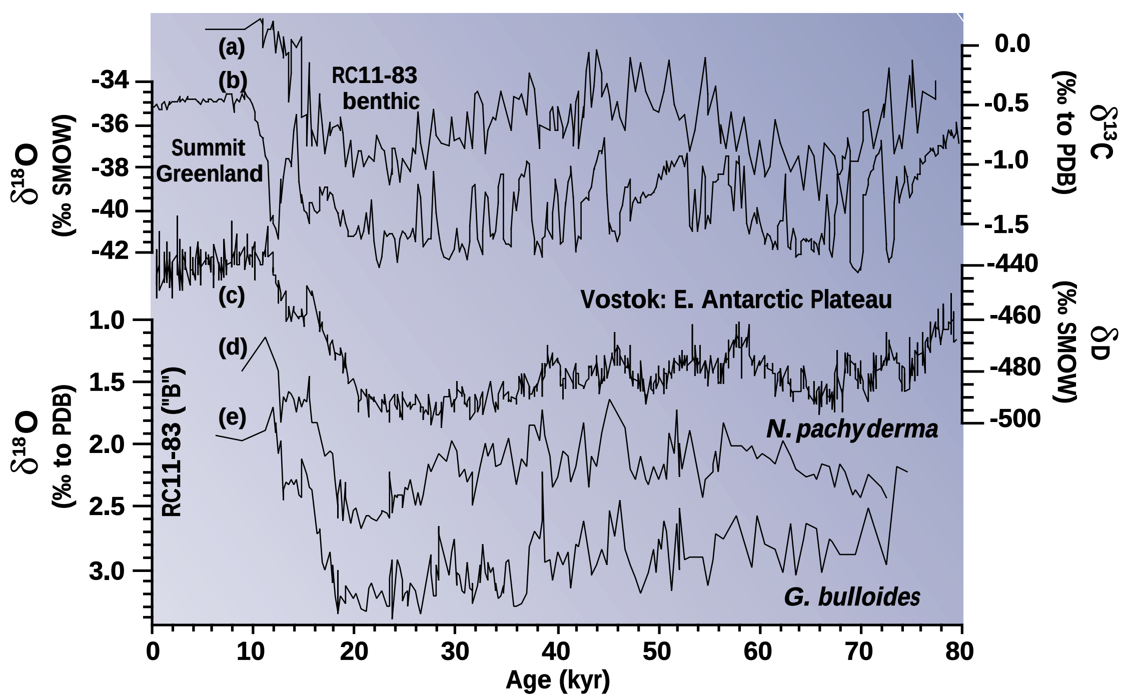

Fig. 3: (a) Benthic foraminiferal carbon isotopic record of Core RC11-83 (located near SubSAT-1B [*Charles et al.*, 1996]) compared to (b) the oxygen isotopic record from the Greenland Summit ice core, (c) the Vostok ice core deuterium record, and the oxygen isotopic records from planktic (d) and benthic (e) foraminiferal species from RC11-83.

Fellowship Profile

Implications of thermohaline circulation for early Pliocene climate change

Katharina Billups

Ph.D. Student: UC Santa Cruz

Faculty Advisors: Ana Christina Ravelo James C. Zachos

Two mechanisms have been invoked to explain high-latitude warmth of the early Pliocene, increased poleward heat transport and elevated atmospheric CO_2 levels. These mechanisms can only be tested by reconstructing the relative strength of thermohaline overturn and the degree of tropical sea surface temperature (SSTs) changes. To this end, I have developed benthic and planktonic stable isotope stratigraphies drilled along a depth transect on Ceara Rise in the western equatorial Atlantic (ODP Leg 154, Sites 925 and 929), and am in the process of generating comparable planktonic stable isotope stratigraphies from the western equatorial Pacific (ODP Leg 130). My intent is to use the Pacific records to assess the heat transport component with respect to global climate variability in the Atlantic surface records.

Reconstructions of deep and surface water hydrography based on the Ceara Rise isotope records indicate that early Pliocene thermohaline circulation was at least comparable to today. Benthic carbon isotope gradients along Ceara Rise are similar to modern, suggesting similar vertical deep-water mass distributions and hence a relatively strong flux of Northern Component Deep-Water [*Billups et al., in press*]. Planktonic oxygen isotope results illustrate that the surface dwelling *Globigerinoides sacculifer* recorded $\delta^{18}O$ values higher than late Holocene, while the thermocline species *Neogloboquadrina dutertrei* recorded values lower than late Holocene (Figure 1). Only the *N. dutertrei* $\delta^{18}O$ values agree with lower mean oceanic $\delta^{18}O$ values due to reduced early Pliocene ice-volume. I interpret the relatively high *Gs. sacculifer* $\delta^{18}O$ values as cooler sea surface temperatures (2-3°C) consistent with relatively strong warm water advection away from the equatorial region. I conclude that a relatively strong thermohaline cell may at least in part explain early Pliocene warmth. Work in progress now comprises completion of planktonic stable isotope records in western equatorial Pacific to separate planktonic stable isotope variability due to local hydrography from global climate change.

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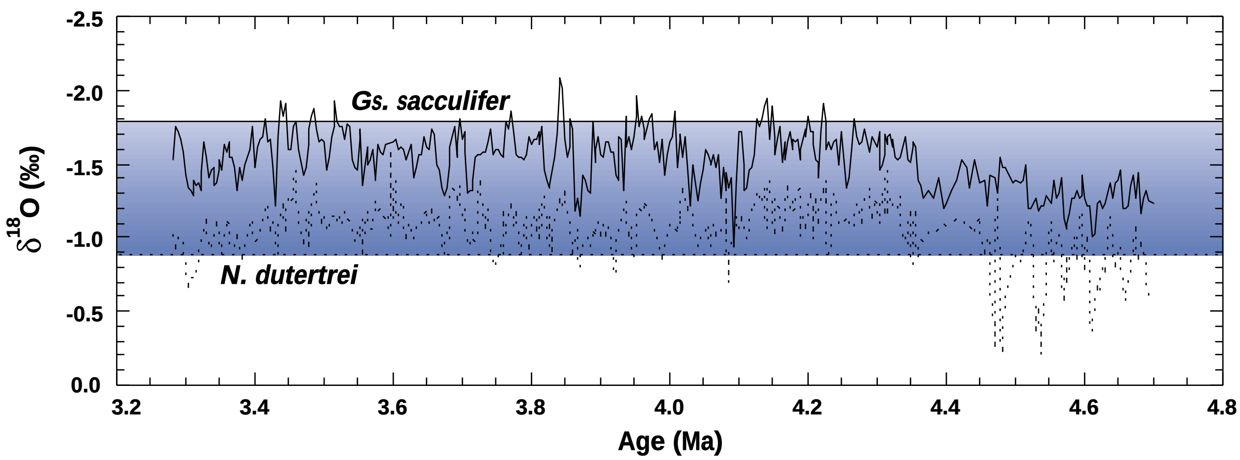


Figure 1: Planktonic (*Globigerinoides sacculifer,* solid line; *Neogloboqudrina dutertrei,* dashed line) oxygen isotope records from Site 925 on Ceara Rise, ODP Leg 154. The horizontal lines represent late Holocene measurements from a nearby core [*Billups and Spero,* 1996]. *Gs. sacculifer* $\delta^{18}O$ values are on average 0.3-0.4 ‰ higher than late Holocene, while *N. dutertrei* $\delta^{18}O$ values are 0.2-0.3 ‰ lower. Only the *N. dutertrei* $\delta^{18}O$ values agree with lower mean oceanic $\delta^{18}O$ values due to reduced early Pliocene ice-volume. I interpret the relatively high *Gs. sacculifer* $\delta^{18}O$ values as cooler sea surface temperatures (2-3°C) consistent with relatively strong warm water advection away from the equatorial region.

Workshop on the subsurface biosphere at mid-ocean ridges

Contributed by Kim Juniper, Marvin Lilley, and John Baross

Workshop Report

A workshop was held in Washington, DC from 17-19 March 1997 to examine the evidence for a subsurface biosphere associated with mid-ocean ridges and to identify the key questions that need to be addressed in order to test the existence of a spatially extensive biosphere that is not dependent on nutrients derived from photosynthesis. More than 100 microbiologists, biologists, geologists, geophysicists, geochemists, biochemists, biotechnologists and engineers attended the workshop. Because of the large group and diversity of topics, the format of the meeting consisted of invited talks and panel discussions on broad ranging topics, as well as contributed posters. The talks and panel discussions focused on the physical, geophysical and geochemical characteristics of the subsurface, the microbial diversity and biogeochemistry issues, and research strategies for sampling and modeling the subsurface.

A diverse body of recent evidence supports the idea of a subsurface microbial biosphere associated with mid-ocean ridges. This includes the detection of microorganisms in drill cores from deep ocean sediments obtained through the Ocean Drilling Program (ODP), the isolation of hyperthermophiles from deep oil wells and diffuse flow fluids from new eruption sites, and the detection of microorganisms in basaltic glass. Many of the talks and panel discussions focused on the geophysical and geochemical characteristics of these environments and the sources and kinds of carbon, nitrogen, phosphorus, and electron acceptors and donors that would be available to support a microbial community. Some of the highlights of the invited talks included: 1) seismic evidence pointing to active cracking and consequently hydrothermal circulation to depths of 5 km along the Endeavour Segment in the NE Pacific Ocean; 2) high porosity of the extrusive layer at mid-ocean ridges; 3) the presence of microorganisms in deep-sea cores that might have extremely slow reproduction rates; 4) the possibility that iron may be the most important electron acceptor and donor for subseafloor bacteria; 5) models for abiotic synthesis of organic compounds under hydrothermal conditions; 6) the possibility that new deep-sea eruption events eject deep subsurface microorganisms; and 7) the implications of a subsurface biosphere associated with hydrothermal activity to life on other planets and moons and to the origin and early evolution of life on Earth. The lively panel discussions focused on subsurface spatial dimensions, the sources and kinds of carbon and other nutrients needed to support life in the subsurface, and the diversity of microorganisms that could exploit these available nutrients.

It was clear from this workshop that many questions exist regarding the physical, chemical and biological nature of the subsurface habitat and that answers to these questions will require interdisciplinary measurements, experiments and models. Some of the key issues to be resolved which were identified at the workshop include: 1) the vertical and horizontal dimensions of the subsurface biosphere; 2) the importance of hydrothermal circulation to the subsurface microbial community; 3) the sources and kinds of carbon, nitrogen, phosphorus and energy sources for subsurface microbial communities; 4) whether or not new eruptive events, including diking episodes, release indigenous subsurface microorganisms; 5) how microorganisms affect the geochemistry of the subsurface; 6) the phylogenetic and physiological diversity of subsurface microbial communities; and 7) the fate of subsurface microbial carbon. The workshop also concluded that rapid response to new seafloor eruptions, time series measurements, and drilling were among the important approaches needed to facilitate further study of the issues listed above.

One of the most rewarding aspects of the workshop was that so many insightful and enthusiastic researchers turned their attention to this subject and promising new collaborations were born.

This workshop was held March 17-19, 1997 in Washington, DC and was sponsored by the RIDGE Program, JOI/USSSP, NOAA VENTS Program, and the University of Washington Volcano Center.

Kim Juniper is at GEOTOP, Université du Quebec à Montréal.

Marvin Lilley is Associate Professor at the School of Oceanography, University of Washington.

John Baross is Professor at the School of Oceanography, University of Washington.

Workshop Report

MarineCAM: A workshop on marine coring at margins

Contributed by Gregory Mountain

This workshop was co-sponsored by JOI/USSSP and the Office of Naval Research.

Gregory Mountain is a Senior Research Scientist at Lamont-Doherty Earth Observatory of Columbia University. Obtaining cores at margins to determine the history and effect of sea-level change has been an elusive goal of his for many years. He estimates that between his first participation on a drilling expedition offshore New Jersey (DSDP Leg 95) and subsequent ODP Legs 150 and 174A, sea level has risen 28 mm. He's anxious to finish the job before the water gets any deeper.

A workshop to foster dialogue between scientific users and technical providers of shallow-water (< 500 m) coring and logging at margins was held May 1 and 2 at Lamont-Doherty Earth Observatory. A total of 28 scientists and 6 representatives from 4 offshore engineering companies attended. This article summarizes workshop findings with the hope that it will help to stimulate scientific exploration into the rich archives of margin sediments.

Science at margins

Scientific breakthroughs await those who can log and core with complete recovery tens to hundreds of meters into shallow water sediments in siliciclastic and carbonate settings, on margins passive or active, on platforms or deltas. Participants outlined several scientific payoffs that can be anticipated: understanding what controls the preservation of short-lived "events" in the geologic record; detailed analyses of pre- and post-failure gravity slides; verification of facies models framed by sequence architecture and the influence of relative sea-level changes; detailed histories of carbonate evolution and sorting out the many factors that affect these systems; paleoceanography in shallow-water settings; and eustatic history. Complete core recovery — especially across centimeter-scale stratal discontinuities — accompanied by *in situ* physical measurements are critically important to all of these missions. Several participants noted that the quality of acoustic surveys has greatly surpassed our ability to ground-truth these data and the geologic inferences drawn from them; all agreed that it is now time to catch up with subbottom sampling at depth scales comparable with these acoustic images. Sampling plans must be global in scope, but locally must allow scientific objectives to govern precise sample location and subbottom depth. The modern shoreline is an arbitrary line dividing the techniques for reaching the subsurface objectives, and we must not forget that scientific rewards can also be found in coastal plain sediments that once were submarine.

Technology at margins

Contractors at the workshop described various shallow-water sediments sampling techniques. Three general approaches were presented: vibra-coring, push/percussive/rotary coring, and *in situ* geotechnical monitoring without coring (Table 1). Vibracoring is accomplished by using a cable to lower a corepipe to the seabed and vibrating it into the sediment with a submerged motor. The pipe and motor assembly is vertically stabilized in one of several ways, and is deployed and retrieved for each core. This technique is weather-sensitive during launch and recovery from a floating vessel, and while usually accomplished from a crane or movable frame over the side, can also be done through a ship's more protected center well, if available. Vibracores can be acquired in virtually any near shore setting, even where it is impractical to work from a floating platform. The deep-water limit is determined by ship stability and by the type of vibrating motor: pneumatic and hydraulic systems are practical to about 75 m water depth, while electric systems can continue to 750 and perhaps to 1500 m. Depth of penetration and degree of core disturbance are controlled in part by the frequency and amplitude of the applied vibrations. Core penetration and quality can be severely limited by thick sand or especially stiff clay. If there is a soft-sediment, fine-grained target below a difficult horizon, techniques can be used to wash down without sampling and resume core recovery when feasible. Nonetheless, practical penetrations for all types of existing vibracores are in the range of 10-20 m subbottom.

Push/percussive/rotary coring spans a large range of operating settings and costs. The basic approach applies a constant load or percussive impulse from above the sea surface that drives a core pipe into the sediment. With increasing induration, operations switch to a top-drive motor that rotates a drill bit and cuts into the formation. With increasing sea state, water depth, and desired depth of penetration, progressively more robust systems can be used to reach thou-

Table 1: MarineCAM options

DOWNHOLE DEVICE	TYPICAL PLATFORM	WD, M	MBSF	COMMENTS	~COSTS[6,7]
pneumatic vibracorer	mid-size ship of opportunity	0-75	10[1,2]		4 - 8
electric vibracorer	mid-size ship of opportunity	0-1500	10[1]		4 - 8
lt-wt electric vibracorer	small ship of opportunity	0-5000	10[1]	Rosscore	2 - 6
lt-wt push/percuss/rot corer	small portable barge	5-30	30[1]	Rosscore; extreme w'ther sensitive	4 - 6
push/percuss/rotary corer	portable barge[5?]	6-30	100	very w'ther sensitive; mbsf limited by barge buoyancy	15 / 250 / 500[a]
"	self-elevating barge	6-100	?1000+	up/down ops very w'ther sens.	30 / 1,200 / 2,000[b]
"	oil field jack-up	20-100	?1000+	"	>> ? 1,000 total
"	anch'd mid-sized ship w/ pool[5]	6-100	650[3]	e.g. Fugro Failing 2000 system[4]	30 / 500 / 1,000[b]
"	DP ship[5]	100+	650[3]	e.g. M/V Bucentaur/Norskald[4]	75 / 1,000 / NA[b,c]
"	oil field semi-submersible[5?]	100+	?1,000+		? 100 + / ? / ?
Terrabor rotary corer	mid-size ship w/ pool or over-the-side	500	50-100	under development; no wireline logs; limited heave comp	?
geotech measurement	anch'd mid-sized ship w/ pool[5]	6-100	70[1]	no samples	30 / 500 / 1,000[b]
"	DP ship w/ pool[5]	100+	70[1]	e.g. M/V Bucentaur; no samples	75 / 1,000 / NA[b,c]

[1] limited by stiff clays + thick sands

[2] "could be increased to 50 mbsf or more" - *K. Moran*

[3] Fugro's Failing 2000 rig + Bucentaur deployable to 650 mbsl (not mbsf)

[4] ? Failing systems + Bucentaur/Norskald can take only push/piston cores (no hard rock diamond core barrel)

[5] need seafloor reaction mass

[6] $K/day vibra-coring includes mob/demob, ~3-6 cores/day

[7] wireline based on 100 mbsf, 30 days on site:

[a] $K/day not incl mob from east coast U.S. / $K east coast U.S. ops / $K west coast U.S. ops

[b] $K/day not incl mob from Gulf of Mexico / $K east coast U.S. ops / $K west coast U.S. ops

[c] west coast U.S. ops only if ship available from SE Asia or China

sands of meters below seafloor (mbsf) in hundreds of meters of water. Several sampling techniques are available (Table 2). The low end of push/percussive/rotary coring begins with a lightweight system typically operated from an anchored platform that because of its weather sensitivity, contractors advised is not usable in more than 30 m water depths. Depending on the substrate, samples can be recovered to 30 m subseafloor. A modular, portable barge system can be assembled on-site; its operating depth is limited by weather sensitivity, and its seafloor penetration is limited by the size/buoyancy of the barge. Typical estimates are up to 30 m water depth and 100 m penetration. Increased seaworthiness and mobility make ships more versatile platforms than floating barges. Mid-sized, anchored vessels with coring through a center well can recover samples to 650 mbsf in as much as 300 m water depths. For more ambitious goals, a dynamically positioned ship can increase the operating water depths to 700 m, again with samples to 650 mbsf. A jack-up platform can be used instead of a ship to lower legs to the seafloor, raise the platform out of the water, and isolate the drill rig from wave motion. These platforms begin with small, towed barges that are recommended in 6-20 m water depths; they can hang enough pipe to core to 500-1000 mbsf. Larger, self-propelled jack-up barges can work to 100 m and core to 1000 mbsf. Oil field jack-ups complete this group of platforms, operating in water depths up to 100 m and penetrating to well over 1000 m. Regardless of size, however, all jack-ups are uniquely weather sensitive during jack-up and jack-down operations.

The Terrabore system is a variation of the above coring technique currently under development by a consortium of Norwegian companies. It is adapted from mining technology and is under review by Antostrat for possible use in overconsolidated glacial tills along the Antarctic continental margin. It uses rotary coring only, is planned for deployment from mid-sized ships of opportunity either over the side or through a center well, and is intended for operating in 500 m of water and to 50-100 mbsf. Thus far, however, and in contrast to the available technologies described previously, Terrabore has limited heave compensation, a function that is vitally important to maximizing core recovery/quality. In further contrast to existing systems, Terrabore at present has no capacity to acquire *in situ* measurements via wireline logs.

The third technique described by contractors is a suite of measurements that yield *in situ* sediment properties but do not recover samples (Table 3). These tools record any of several engineering properties typically used to determine bearing load capacity before placing structures directly on the seafloor. Because of the cm-scale resolution, high reliability, and downhole continuity of these data, workshop participants agreed this information could be a valuable asset to push/percussive/rotary coring. The tools discussed were cone penetrometers, vane shear devices, pressuremeters, and packers. Measurements can be performed in undisturbed sediment 3 m or less ahead of the bottom hole assembly while either continuously pushing the device into the seabed, or in a "measure - advance - measure" mode. Data are stored downhole and downloaded to a top-side computer when the tool is retrieved. Typical properties extracted from these measurements include pore pressure, permeability, shear strength, stress history, and proxies for sediment density and composition. These devices can be used to 3000 m water depths or more. Their subbottom window of applicability is determined by sediment induration; typical applications to 70 mbsf were described. Each can be deployed from the same platform that acquires push/percussive/rotary cores, i.e., a floating barge, ship, or jack-up. Whatever the platform, however, a seafloor "reaction mass" is needed to stabilize the bottom assembly and as much as possible isolate it from platform motion at sea level.

The future at margins

Wide-ranging discussions followed these factual presentations: who will collect cores; when will they do this; and how will it be done? Oil and gas exploration is currently moving into deeper water, providing both a help and a hindrance to scientific concerns. On the positive side, considerable information is being gathered, that if made available, could address many basic scientific issues. The downside, however, is that with such high demand for these technologies, operational costs are high (Table 1).

Table 2: Rotary wireline sampling tools

TOOL	LENGTH, M	SED TYPE	APPLICATION	COMMENTS
split spoon	~1	sand	grain size, composition, paleo	very disturbed sample
Shelby tube (a.k.a. push sampler)	~1	soft to very stiff fine-grained sed	phys props, sedimentology, paleo, pore water, bulk chem, paleomag	sample pushed ahead of drill bit
piston sampler	1 - 3	all sed types	same as above	needs sf reaction mass; piston offsets wall friction during push
diamond core barrel	1.5 - 3	very stiff seds to sed rocks to hard rocks	same as above + petrology	rotation cuts sample

Table 3: Rotary *in situ* wireline tools

TOOL	APPLICATION	COMMENTS
cone penetrometer (CPT, PCPT, seismic)	cont stratig, proxy density, proxy sed type, shear strength, dynamic pore press, pore press decay, stress hist, velocity, optical (under devel)	can be done from wireline or from autonomous seafloor unit (e.g. Seascout, TSP, and others)
vane shear	undrained shear strength, sensitivity, stress-strain	
pressuremeter	shear modulus, stress-strain, lateral stress, shear strength	
packer	permeability, hydraulic fracturing, flow test	
temperature probe	geothermal gradient, bottom water thermal history	
logging-while-drilling	proxy density, -porosity, -grain size, stratigraphy	uncertain fit with pipe diameter; no sonic vel >> 2 km/sec, and even then not generally available

Scientific groups mentioned during the workshop that are likely to pursue efforts for coring at margins included ODP, Antostrat, Strataform, Margins, and Images. ODP attempted its first coring in less than 100 m of water during Leg 174A this summer. Antostrat anticipates a round of pilot study coring efforts off Antarctica in austral summer ’98. Strataform is likely to pursue an ambitious vibracoring program offshore northern California in summer ’98. Images continues to sponsor long piston coring into deep marine sediments, and there is interest in collecting comparable lengths of shallow marine sediments as well. The relatively affordable costs and the large variety of appropriate platforms ensure that vibracoring is within reach of expected scientific budgets. Furthermore, pre-site characterization needed for 10-20 m penetrations are far more modest than for deeper sampling operations.

The jump in cost and operational complexity between vibracoring and push coring poses a significant challenge to meeting a variety of scientific goals. The only route to >20 mbsf samples discussed at the workshop is to hire specialized companies. Daily costs begin at $15K and continue upward to more than $100K (Table 1). Contractors estimated that mobilization costs for these platforms deployed to either the East or West coast of the U.S. would range from $250K to $2M. Obviously, every effort will be needed to reduce these costs by either sharing mobilization with other interests, waiting for a ‘platform of opportunity’ that is transiting through a given study area, or defining scientific programs that are in areas close to where these platforms are already deployed. For any of these strategies to work, the research community needs to be in close communication with platform operators, and at present there seems to be no structure for maintaining such contact.

ODP was mentioned as an organization likely to provide managerial benefit to coring at margins. For example, a Program Planning Group could help to: a) formulate precise scientific objectives; b) maintain a schedule of platforms of opportunity; c) justify the use of the JOIDES Site Survey and Pollution Prevention and Safety Panels for pre-coring site evaluation; and d) ensure proper sample distribution and archiving at one of the ODP core repositories.

Participants left the workshop with renewed confidence that the time had come for coordinated coring at margins. The potential rewards in this virtually untapped geologic archive are very large, but so are the costs for reaching those goals.

Drill Bits

JANUS STEERING COMMITTEE*

Kate Moran (Chair)
Eve Arnold
Steve Hurst

SUBCONTRACTORS:
Glenn Corser
Paul Albright
Mike Ranger

LIAISONS:
Jack Foster
John Farrell

CONCORD

The International CONference on Cooperative Ocean Riser Drilling (CONCORD) was held July 22-24 in Tokyo, Japan. Approximately 150 scientists attended, including more than 30 from the United States. CONCORD considered a diverse range of topics for riser-supported drilling, from sampling the deep biosphere to studying the deep architecture of continental margins and the oceanic lithosphere. CONCORD agreed that riser drilling was "indispensable for the continual development of humankind's understanding of the dynamic processes that shape our planet's surface." Conference participants also decided that the first major goal for the new riser-equipped drillship, to be designed and built by the Japanese Marine Science and Technology Agency (JAMSTEC) in the early years of the 21st century, should be a systematic study of a seismogenic zone within an active subduction system, probably in the western Pacific. Recommendations from the CONCORD report will form the fundamental basis for JAMSTEC's proposal to Japanese government funding sources later this year.

... J. Austin, UT Austin

Staff changes at ODP/TAMU

The ODP at Texas A&M University is pleased to announce three new appointments in the Science Services department:

Dr. Tom Davies, formerly Associate Director of The University of Texas Institute for Geophysics, is the new Manager of Science Services. Tom has served in various positions with the ODP, including Program Associate for the Ocean Drilling Program at NSF, as Chief Scientist at JOI for the Ocean Margin Drilling Program, and as one of the founding architects of USSSP. Tom also has an established record of scholarship, service to the community, and has continued to be involved with ocean drilling since the DSDP. One of Tom's duties is shipboard staffing, so if you are interested in participating on a leg, contact Tom at tom_davies@odp.tamu.edu.

Dr. John Firth has been named ODP Curator and reports to Tom Davies. John sailed as a shipboard participant on Leg 105, and joined ODP/TAMU in 1989 as a staff scientist. Questions regarding core sampling should be directed to John at john_firth@odp.tamu.edu.

Mr. Brad Julson is the new Supervisor of Technical Support. Brad has served many years as a lab officer and technician dating back to the DSDP. With Brad's appointment, applications are now being accepted at ODP/TAMU for a lab officer position.

... A. Woods, ODP/TAMU

Janus project sets sail

Janus project members* are currently sailing on Leg 174B in a concerted effort to complete some key tasks of the first development phase of the new computer database system and to set the stage for phase two. This phase will primarily focus on incorporating digital photographic images of cores into the visual core description applications. The Janus system, which has been up and running successfully since Leg 171B, thanks to the dedicated and hard work of Tracor and TAMU personnel, is maturing with use. Small bugs are being worked out, users are becoming more familiar with the database, and the benefits of a relational database are being realized. The specific tasks for the project members on Leg 174B are to:

1) evaluate and make recommendations on new visual core description (VCD) applications, based on Applecorec, to accurately characterize soft rocks, hard rocks, and structural features. Efforts will include completing standard lithologies and developing VCD output for publication;
2) evaluate the new age model function that will be used to assign ages to depth intervals;
3) review all existing applications (for example, those designed for the multi-sensing track, physical properties, and chemistry) for database editing needs, ease of use, and interface design, among other things;
4) review current procedures for accessing logging data;
5) evaluate designs of the user-interfaces for uploading data from the paleomagnetics lab, the color reflectance instrument, Adara and WSTP tools (temperature data), and the Tensor tool (core orientation data);
6) review web-based access to Janus;
7) develop user requirements for a Janus link to site survey and other seismic data;

... J. Farrell, JOI

Public affairs report

"Blast From the Past"

The Smithsonian's National Museum of Natural History in Washington, D.C. is now highlighting a sediment core from ODP Leg 171B in an exhibit called "Blast From the Past." The exhibit, which will be on display through February 1998 in the Dinosaur Hall, provides dramatic support for the long-standing theory that a large meteorite struck Mexico's Yucatan Peninsula 65 million years ago causing the mass extinction at the Cretaceous/Tertiary (K/T) boundary. As mentioned in the March newsletter, the core was recovered in 130 m of water about 350 miles off the northern Florida coast and provides an extraordinary record of the meteorite's impact and resultant debris that was blasted into the atmosphere. This event led to the extinction of about 70 percent of all species, including the dinosaurs. The ODP core also contains a beautiful record of global repopulation of microorganisms in the oceans after this event.

The exhibit also highlights the research of Dr. Brian Huber, a micropaleontologist in the museum's Department of Paleobiology, and a member of the Leg 171B expedition. Brian studies foraminifera, single-celled organisms that have lived in marine environments for more than 500 million years. More than 90 percent of the free-floating foraminifera species found in the Cretaceous chalk became extinct at the K/T boundary. These species are larger, and far more diverse and ornate, than those found in the overlaying Tertiary layer.

Leg 173 and the Halifax port call

Scientists continue to attract media interest because of recent public affairs activities. Leg 173 petrologist Dr. James Beard, Curator of Earth Sciences at the Virginia Museum of Natural History, responded to questions from individuals logging onto the museum's home page in collaboration with the ODP. More than 200 questions were sent to the ship and answered by Dr. Beard, who was also interviewed for an article in the *Richmond Times-Dispatch* (Richmond, VA).

At the Halifax port call, several news agencies interviewed ODP scientists. Articles appeared in two Halifax newspapers (the *Chronicle Herald* and *Daily News*). A local television show in Halifax, *Breakfast and Television*, broadcasted their program "live" from the ship while in port. Several people were interviewed during the broadcast, including Drs. Jamie Austin, John Farrell, and Kate Moran, Captain Ribbens, Erik Moortgate, and Aaron Woods.

Leg 174A and the New York port call

On Sunday, July 20th, over 400 members and friends of the Ocean Drilling Program scientific community participated in the JOI/USSSP-sponsored "Open Ship Day" in New York City during the *JOIDES Resolution* port call. Visitors from as far away as Virginia and Massachusetts began the day by hearing scientific presentations by Drs. Susan Humphris (WHOI), Jamie Austin (UTIG), Nick Christie-Blick (LDEO), and Peter deMenocal (LDEO). After browsing through several ODP-related displays, visitors toured *JOIDES Resolution* where they also enjoyed brunch. In cooperation with LDEO/BRG, Schlumberger produced a dynamic display highlighting logging technology. The event provided a great opportunity for scientists, families, and students to see firsthand the capabilities of *JOIDES Resolution.*

The New Jersey Margin leg and *JOIDES Resolution's* port call in New York generated a great deal of media interest. Several print and radio journalists, television crews from NHK (Japan) and BBC (UK), and a freelance journalist for CBS TeleNoticias (Miami) boarded the ship during Leg 174A operations to collect film footage for upcoming documentaries and news segments. To date, articles and stories have been featured in *The New York Times*, *USA Today*, *The Washington Post*, Associated Press news wire, and National Public Radio. During the port call, media were invited to visit *JOIDES Resolution* and interview scientists on Saturday, July 19. The CBS TV affiliate in New York City broadcasted a story the same evening and other television and print media have ODP stories scheduled for the future.

... P. Baker-Masson and J. Ramarui, JOI, and A. Woods, ODP/TAMU

ANNOUN

SPRING/SUMMER 1997
JOI/USSAC OCEAN DRILLING FELLOWS

One-year, shorebased fellowships

Stephen Schellenberg, University of Southern California
"Geochemical and faunal analyses of deep-ocean ostracodes during two transient climate extrema of the Paleogene: A test of benthic foram $\delta^{18}O$-based climate reconstructions using ostracode Mg:Ca ratios"

Michael Helgerud, Stanford University
"Experimental measurement and theoretical modeling of the physical properties of sediments containing gas hydrates"

Symposia on ODP results

USSAC would like to encourage individuals, or groups of individuals, to propose ODP results symposia, which culminate in a set of peer-reviewed manuscripts published by a scientific journal. Each symposium should pull together reseach from several ODP legs that are linked by a common scientific objective. USSAC would consider supporting limited editorial assistance for the convenor(s) in addition to travel for U.S. participants to attend the symposium. For more information, contact Ellen Kappel at ekappel@brook.edu or 202-232-3900 ext. 216.

MARINE ASPECTS OF EARTH SYSTEM HISTORY (MESH)

Warm Climate Intervals Workshop Report

Printed copies of the MESH report are now available from JOI. To receive a copy, please send a request to:

JOI/USSSP
Joint Oceanographic Institutions
1755 Massachusetts Avenue, NW, Suite 800
Washington, DC 20036-2102
Phone: (202) 232-3900
Fax: (202) 232-8203
E-mail: joi@brook.edu

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 $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 DEADLINE

Shorebased Work (regardless of leg): 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
E-mail: ajohnson@brook.edu

THE OCEAN LITHOSPHERE & SCIENTIFIC OCEAN DRILLING INTO THE 21ST CENTURY

WOODS HOLE, MA, 26-28 MAY 1996

CONVENORS: Henry Dick (WHOI) & Catherine Mével (CNRS, Paris)

WORKSHOP SPONSORS: IAVCEI, InterRidge, ODP, JOI/USSSSP

The report of this workshop is now available on the JOI web site at www.joi-odp.org/joi/usssp/lithosreport.html.

COMPOST-II

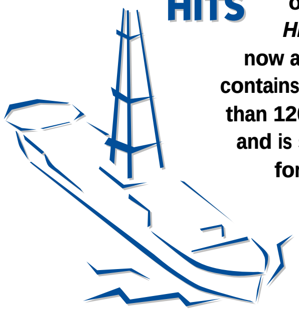
THE U.S. COMMITTEE TO CONSIDER POST-2003 SCIENTIFIC OCEAN DRILLING

Convened by the JOI/U.S. Science Advisory Committee in March 1997

The COMPOST-II report of is now available online. To view or download a copy of the report please visit the JOI web site at www.joi-odp.org/joi/usssp/compost2.html.

C E M E N T S

ODP's GREATEST HITS



The short, brochure version of the *ODP's Greatest Hits* abstract volume is now available. This version contains only 17 of the more than 120 abstracts received, and is specifically intended for port calls and other events where a full *Greatest Hits* abstract volume would not be required.

Visit the JOI web site at www.joi-odp.org or request a copy by e-mail from joi@brook.edu.

Work continues on the full version of *ODP's Greatest Hits.* Many of the abstracts are already up on the JOI web site (www.joi-odp.org) and more are being added every week. A printed version of the full abstract volume will be available by mid-November, in time for NSF's National Science Board review of ODP renewal.

JOI/USSSP SUPPORTED SHIPBOARD PARTICIPANTS

LEG 174A: New Jersey Shelf
U.S. Co-Chief: J. Austin, UTIG
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LDEO Logging Scientist: C. Pirmez
LDEO Logging Scientist: C. Major
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P. Flemings, Penn State U
C. Fulthorpe, UTIG
L. Giosan, SUNY Stony Brook
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C. McHugh, Queens College (CUNY)
G. Mountain, LDEO
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W. Wei, SIO
B. Whiting, College of William & Mary

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LDEO Logging Scientist: D. Goldberg
LDEO Logging Scientist: Y.F. Sun
M. Fuller, U of Hawaii
R. Harris, U of Miami

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L. Davis Anderson, UC Santa Cruz
V. Bruchert, Indiana U
B. Christensen, U of South Carolina
G. Frost, UC Santa Cruz
T. Gorgas, U of Hawaii
C. Lange, SIO
P. Meyers, U of Michigan
R. Murray, Boston U
M. Perez, SIO

JOIDES Resolution Schedule for Legs 174B-183

Leg	Region	Co-Chiefs	Dep. Port	Date	Scientific Objectives
174B	CORK/ Engineering	Becker Pettigrew	New York	7/97	To install a borehole seal (CORK) at 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.
177	S. Ocean Paleocean.	Gersonde Hodell	Cape Town	12/97	To investigate the Cenozoic and Neogene paleoceanographic and climatic history of the southern high latitudes.
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	Singapore	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	Freemantle	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.

The significance of fluid flow through oceanic crust

contributed by Miriam Kastner and Earl E. Davis

Miriam Kastner is Professor, Geosciences Research Division, Scripps Institution of Oceanography. She has been department chair for the last four years and is currently vice-chair. Miriam is also the geology and geochemistry curricular groups student advisor. She has participated in two DSDP and five ODP legs to date.

Fluids are present in almost all Earth environments and play an important role in most crustal and mantle processes. Fluids are present in the pore spaces of sediments and rocks beneath the seafloor; their depth of penetration and rate of flow are controlled by the porosity and permeability of the host formation and by gradients in fluid pressure. Most of the fluid is seawater which has percolated into the rock; in addition, hydrous minerals such as clays, serpentines, and amphiboles have structurally bound water which is released by dehydration reactions at elevated temperatures and pressures. The presence and migration of these fluids influence Earth's heat budget, rock genesis and erosion, dissolution, cementation, and deformation, mineralization, hydrocarbon migration, gas hydrate formation, benthic biology, and magmatism. To better understand the physical and chemical evolution of the oceanic crust and global biogeochemical cycles, it is essential to study fluid-rock reactions and fluid-flow pathways in a variety of oceanic settings. Ocean drilling is critical for these studies.

State of knowledge

Mid-ocean ridges. At mid-ocean ridges, hydrothermally heated and chemically altered seawater circulates rapidly through the oceanic crust at temperatures up to 350° - 400° C, to a depth of a few kilometers. The hot water reacts with and leaches base metals from the sediments and rocks, forming polymetallic sulfide deposits (mostly of Cu, Zn, and Fe) at the seafloor and in the upper oceanic crust. This vigorous convective flow system hydrates the basaltic basement, alters seawater composition (stripping it of its Mg and SO_4, enriching it in major and minor components, i.e., Ca, Li, Si, Mn), and sustains prolific benthic communities. The whole ocean volume circulates through the ridge-crest hydrothermal systems once in a about 10 million years [e.g.: *Stein and Stein,* 1994; *Elderfield and Schultz,* 1996].

Table 1: Comparison of fluid-flow characteristics in different tectonic regimes

TECTONIC ENVIRONMENT	DRIVING FORCE FOR FLUID FLOW	OCEAN VOL. RECYC. TIME	DEPTH OF WATER PENET.
Mid-ocean ridges	Buoyancy and forced	~10 my	a few km
MOR flanks	Buoyancy	~1 my	a few hundred m?
Ocean basins	Forced	unknown	tens to a few hundreds of m
Passive margins	Topography and buoyancy	unknown	a few hundred m?
Subduction zones	Forced (and buoyancy)	300-500 my	tens of km

Buoyancy flows: flow due to fluid buoyancy differences (because of heating or composition, both of which influence fluid density)
Forced flows: flow due to an imposed condition (includes topography with recharge, compaction, diagenesis, and tectonics)

Ridge flanks and ocean basins. At ridge flanks that have been cooled and partially or completely covered by sediments, fluid flow through the upper oceanic crust is less vigorous but pervasive. It is also mostly driven by thermal buoyancy. Fluid advection continues for tens of millions of years, and is responsible for the low conductive heat flow observed in large regions of the ocean [e.g.: *Baker et al.*, 1991; *Langseth et al.*, 1992; and references therein]. This less spectacular but important flow occupies about 60 percent of the ocean floor. As yet it has not received as much attention as the vigorous flow at the ridge crest. It has been the focus of study at DSDP Sites 395 [*Langseth, et al.*, 1992] and 504 [*Langseth et al.*, 1988] and during ODP Leg 168 [*Davis et al.*, 1997]. This type of fluid flow occurs at lower temperatures and therefore has a lesser effect on the composition of seawater; but it profoundly affects the oceanic crust heat budget, continues to hydrate it to an as yet unknown depth (to at least several hundreds of meters) and extent, and diagenetically alters the basal sediment sections above it. The ocean volume may circulate through the ridge flanks system in as little as one million years [*Elderfield and Schultz,* 1996]. In ocean basins, pore fluids are mostly in diffusive communication with bottom seawater. Rates of advection are believed to be thermally and geochemically insignificant, although more work is required in areas of ancient seafloor.

Passive margins. Recent evidence from ODP legs and modeling studies suggest that large scale sea water circulation within carbonate platforms and continental margins is primarily thermally driven. Depending upon the sediment permeability and anisotropy smaller circulation cells may develop nearer the

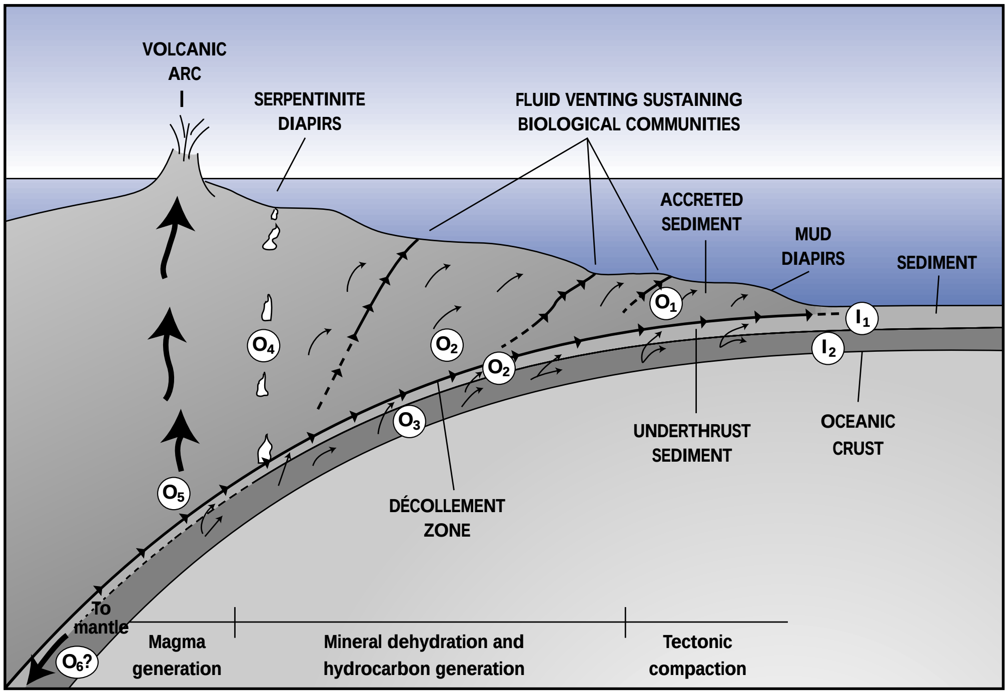

Fig. 1: Illustration of fluids recycling in subduction zones.

sediment surface and water can actually be seen to discharge and recharge in places through the platform sides. Such flow has been documented during the drilling of the Queensland Plateau off Australia (ODP Leg 130) and the Great Bahama Bank (ODP Leg 166). The flow can be recognized by the presence of isothermal and isochemical pore water profiles in the sediments. This fluid circulation has significant implications upon the processes which convert the sediment into limestone and dolomite, and may influence the fluxes of Ca, Mg, and C in the oceans. This circulation also provides a mechanism for electron acceptors to oxidize organic material, and where fluid flow is rapid it provides nutrients that sustain benthic communities [e.g., *Paull et al.*, 1992]. Estimates of topographically driven hydrologic flow from continents through passive margins suggest that these fluxes may also be large [*COSOD II*, 1987].

Subduction zones. Fluids play a critical role in virtually all geologic processes in subduction zones. Tectonic forces cause migration and expulsion of pore fluids by reducing porosity, increasing the sedimentary load and generating fluid by dehydration, transformation, and dissolution of hydrous minerals. These fluids give rise to high pore fluid pressures and may trigger hydro-fracturing. Fresh water from dehydration also dilutes the pore fluids, and thus increases the buoyancy of the deeper, warmer fluids. As indicated by ^{10}Be, these fluids are also involved in arc volcanism [*Tera et al.*, 1986]. The mode of flow varies from the trench to the arc volcanoes, as illustrated in Figure 1. Focused flow rates of 100 m/y in Cascadia [*Carson et al.*, 1990] and 17m/y at Barbados [*Martin et al.*, 1996] through mud volcanoes have been documented. Diffuse flow rates are much lower, but may also be important. Local chemical anomalies, the composition of vein minerals [Labaume et al., 1997] and thermal modeling suggest that focused flow is episodic. The exiting fluids carry into the ocean a multitude of dissolved components, including environmentally important ones (i.e., CO_2, CH_4) that may significantly influence seawater chemistry. Mass balancing will require deep drilling. These fluids sustain benthic biological communities [e.g.: *Kulm et al.*, 1986; *Carson et al.*, 1990; *Le Pichon et al.*, 1990; *Kastner et al.*, 1991]. Preliminary estimates suggest that the whole ocean volume circulates through subduction zones in less than a few hundred (300-500) million years.

Earl Davis is a geophysicist at the Pacific Geoscience Centre, Geological Survey of Canada. He has been studying crustal fluid flow for many years by using seafloor heat-flow measurements to infer rates of flow, and by measuring formation pressures in and pressure gradients between ODP boreholes. Earl was co-chief scientist on Leg 168, which was focused on the physics and chemistry of large-scale fluid flow on mid-ocean ridge flanks. Together with several other anxious colleagues, he is nervously waiting to recover a year's worth of hydrologic data from six sites drilled and instrumented during Legs 168 and 169.

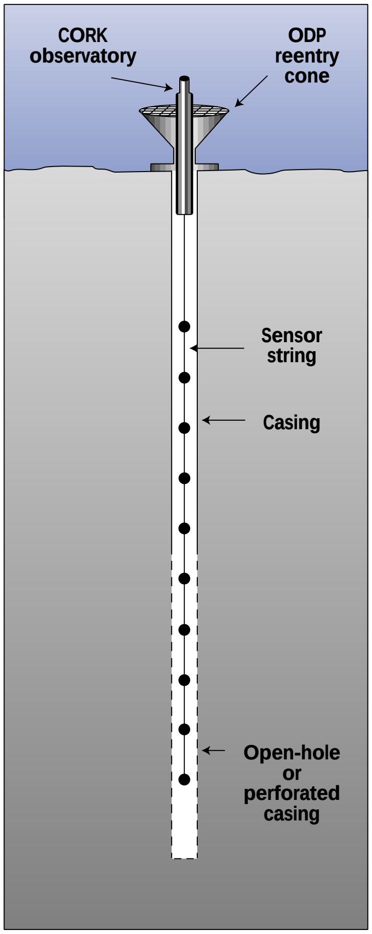

Fig. 2: Illustration of an ODP borehole seal or CORK.

Seawater composition is thus strongly imprinted by its continuous circulation through the various oceanic crustal hydrologic regimes and interaction with the sediments and rocks along the pathways. Characterizing and quantifying the various fluid-rock reactions and hydrologic regimes is therefore most important. For this reason, a new focus is being given to new and innovative field and laboratory experiments for short and long-range monitoring of each of these fluid flow regimes in both boreholes and on the seafloor. A summary of these fluid flow regimes is provided in Table 1.

Short and long-term observations

Most of the information on fluid flow and composition has been derived from seafloor geophysical imaging, heat flow measurements, and chemical profiling of deep cores obtained by the DSDP and the ODP. Much information has been obtained from *in situ* observations and downhole experiments made in ODP boreholes, with emphasis on logging, temperature and pressure measurements, hydrologic experiments, and fluid chemistry. These measurements and experiments are normally conducted immediately after drilling, thus in a somewhat disturbed drilling environment.

With the advent of the ODP borehole seal, or CORK (Circulation Obviation Retrofit Kit; Figure 2), it became possible to instrument holes for long-term monitoring of a multitude of fluid physical, thermal, and chemical properties after dissipation of the drilling-induced disturbances. Recent specialized instruments developed and deployed in CORKs are temperature and pressure sensors, tilt sensors for monitoring tectonic deformation [*Davis and Becker*, 1993/94], and osmotically pumped fluid samplers for continuous monitoring of fluid composition [*Jannasch and Kastner*, 1995; *Jannasch et al.*, 1996] (Figure 3). CORKs have been installed and instrumented in the submarine hydrothermal flow regimes of the Juan de Fuca Ridge, and Ridge flank, on the western flank of the Mid-Atlantic Ridge (Hole 395A), and in two accretionary prisms, at Barbados and Cascadia. Osmotically pumped fluid samplers have been installed in one of the Barbados CORKs (Site 949) and at the Juan de Fuca Ridge; as yet they have not been recovered. Hydrologic experiments were conducted at several of the CORKs, some of which have been visited more than once [*Davis and Becker,* 1993/94; *Davis et al.*, 1995; *Screaton et al.*, 1997; and references therein].

... continued on page 24

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Planning for a new ocean drilling program

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

NSF Report

Planning for scientific ocean drilling post-2003 has increased in intensity in the past few months as the formational meeting of the International Working Group (IWG) of the Integrated Ocean Drilling Program (IODP) took place in Brest, France following the recent Executive Committee and ODP Council meetings. IODP is based on a two-ship program, one of which is a riser drilling vessel and the other is a *JOIDES Resolution*-type vessel. The IWG is comprised of organizations which are potential participants in the IODP. The co-chairs of this working group are Mike Purdy, Director of the Ocean Sciences Division at NSF, and Tsuyoshi Maruyama, Science and Technology Agency, Japan. This was a formative meeting; more substantive discussions are expected when the IWG meets in September in Washington, DC.

As part of the planning process for scientific ocean drilling post-2003, the NSF's Ocean Sciences Division asked USSAC to assess U.S. interest in scientific ocean drilling beyond 2003, the scientific objectives the scientific ocean drilling community wishes to pursue, and what facilities and funds are required to meet those objectives. The report, COMPOST-II, has been delivered to NSF and a copy can be viewed and downloaded from the JOI web site at http://www.joi-odp.org. The report is consistent with the concept of a two drilling vessel program as identified by the IODP. Everyone interested in the future of scientific ocean drilling should read this document and forward their comments to USSAC.

At the June meeting of the ODP Council, all of the existing ODP partners expressed very optimistic intentions to renew their participation for the period 1998 to 2003. A panel was convened by NSF in late June to review the ODP as a step in the process which seeks funding approval from the National Science Board (NSB) for the period 1998 to 2002.

This is an opportune time to remind everyone that the NSF/ODP office is continuing its effort to encourage the development of mature proposals for regional geological and geophysical studies well in advance of drilling from U.S. scientists and institutions. In keeping with the thematic emphasis of the ODP, the NSF will accept proposals for work in any ocean. However, as the international planning effort focuses drilling plans on a particular region, proposals for work in that region will receive special attention.

Proposals are evaluated according to normal NSF merit review criteria, as well as their relation to ODP planning. Thus these proposals should contain a separate section (two or three pages) that specifically addresses the potential of the proposed research to enhance the effectiveness of and scientific return to ODP. This section should discuss both long-term ODP goals (as outlined in the ODP Long Range Plan, or LRP, available from JOI) as well as the specific scientific problems to be addressed. The target dates for submitting proposals to ODP are February 15 and August 15, the same dates as Ocean Sciences Research Programs.

Please note that the NSB has approved new criteria for review of NSF proposals, effective October 1,1997. To view the new criteria go to the NSF on-line Document System at http://www.nsf.gov/cgi-bin/pubsys/browser/odbrowse.pl or order a copy from the NSF Forms and Publications Unit.

Recently funded ODP/NSF field and other programs

A gravity survey to characterize sulfide deposits in the Middle Valley region off the NW coast of the U.S. and test a new towed gravity system. Zumberge (SIO)

A detailed seismic survey of the New Jersey margin to tie results of on-shore and off-shore drilling focused on understanding the history and amplitude of Tertiary sea level change. On-shore drilling has been supported by NSF's divisions of Earth Sciences and the Ocean Drilling Program, off-shore seismics by ONR and ODP, and off-shore drilling by ODP. Mountain (LDEO) and Miller (Rutgers).

Site survey efforts of the South West Indian Ridge area of ODP hole 735B relating previous drilling results to surrounding seafloor geology and provide additional data for future drilling. Dick (WHOI) and Natland (RSMAS). Joint funding with the UK.

Seismometer deployment in early 1998 at the Ocean Seismic Network site south of Hawaii. Orcutt (SIO), Stephen (WHOI).

Carbon flux studies using aerobic and anaerobic chambers connected to the existing borehole seal at Site 892 on the Oregon margin. Carson (Lehigh) and Kastner (SIO).

NSF funding support for an office at the University of Hawaii to provide the organization and planning necessary to achieve the coordinated multidisciplinary research goals of the MARGIN initiative. Taylor (SOEST) Jointly funded by ODP and MG&G, Ocean Sciences Division, and Continental Dynamics, Earth Sciences Division.

The full SEIZE report is available at http://www.soest.hawaii.edu/moore/seize.

Casey Moore is Professor of Earth Sciences at the University of California, Santa Cruz.

Gregory Moore is Professor in the Department of Geology and Geophyisics, University of Hawaii.

SEIZE: The seismogenic zone experiment

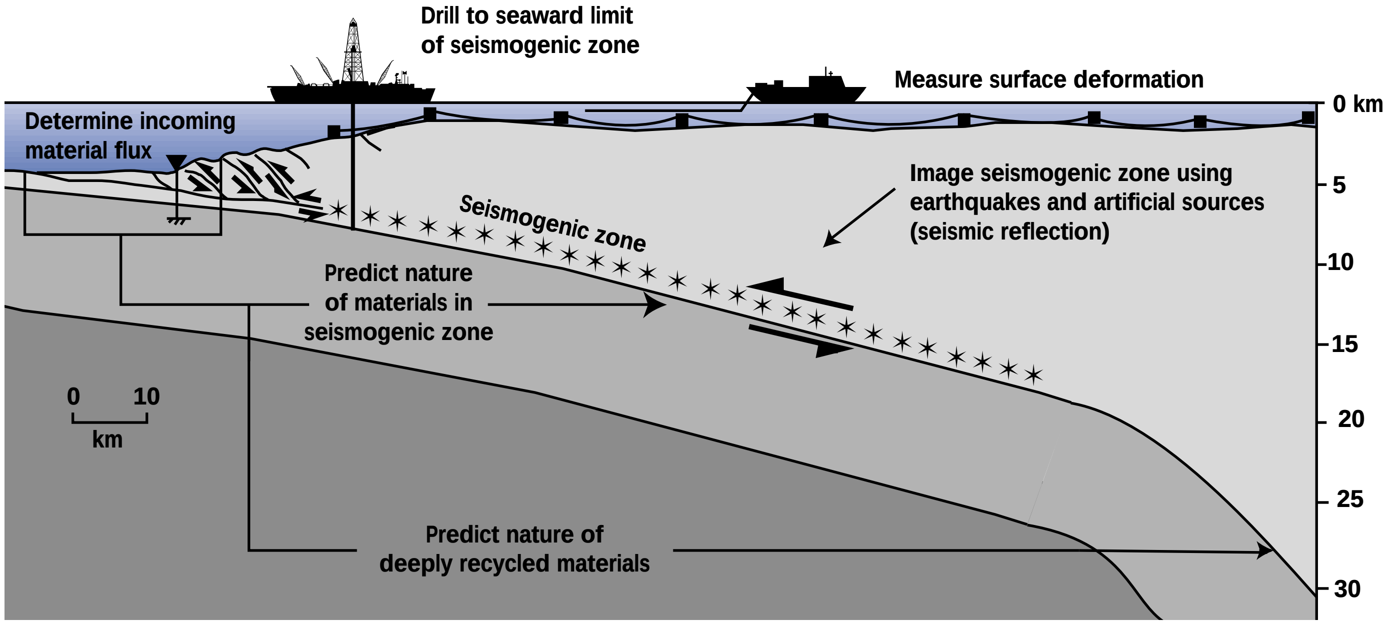
Contributed by Casey Moore and Greg Moore

Most of the world's great earthquakes and tsunamis are initiated in the zone of underthrusting, or seismogenic zone, of subduction zones. Fifty earth scientists (including 18 from outside the U.S.) gathered in Kona, Hawaii during the week of June 2 to discuss approaches to understanding the seismogenic zone. The workshop, sponsored by JOI/USSAC and NSF/MGG, started with an informal evening poster session followed by a day of talks focused on important issues relating to future Seismogenic Zone Experiments. The remaining day and a half consisted of spirited discussions of the key elements of potential SEIZE field study areas.

The workshop built on a 1995 conference on the same topic sponsored by the International Lithosphere Project, and outlined the goals of a seismogenic zone experiment: SEIZE hopes to understand the relationship between earthquakes, deformation, and fluid flow in this environment. SEIZE will address the following questions: 1) What is the nature of asperities? 2) What are the temporal relationships between stress, strain, and fluid composition throughout the earthquake cycle? 3) What controls the up-and downdip limits of the seismogenic zone? 4) What is the nature of tsunamigenic earthquake zone? 5) What is the role of large thrust earthquakes in material mass flux (e.g., accretion vs. sediment subduction vs. tectonic erosion) in subduction zones?

SEIZE will proceed by focused investigations combining earthquake seismology, seismic reflection imaging, and geodetic studies in and around a limited number of seismogenic zones. Sampling the incoming material combined with laboratory experiments and modeling will be used to predict the nature of the fault rock in the seismogenic zone. Waveform models of the seismic images will be used to predict physical properties of the seismogenic zone. Deep riser drilling will be used to test these models, lead to a better understanding of our questions about the seismogenic zone, and calibrate techniques for monitoring changes in fault zones during the earthquake cycle.

Seismogenic zones selected for focused study must have historic earthquake activity, be imagable by seismic reflection, be geographically accessible, and ultimately be penetrable by drilling. At the SEIZE workshop, application of these criteria to candidate localities targeted off the Japanese Islands (Nankai Trough and Japan Trench) and Central American (Costa Rica and Nicaragua) for SEIZE programs. The extraordinary infrastructural investments, the large societal



relevance, the seismic imaging possibilities, and the drilling potential in the Japan area require focus there. Central America, especially Costa Rica, offers exceptional opportunities for seismic and geodetic monitoring, can be imaged and drilled, and contrasts geophysically with the Nankai Trough locality in Japan. Japan Trench and Nicaragua have generated tsunamigenic earthquakes warranting investigation. Investigations in the Nankai Trough in Japan will have direct application to understanding the societally relevant, currently quiescent but paleoseismically active Cascadia seismogenic zone of the Pacific Northwest.

SEIZE is one component of the new U.S. MARGINS initiative at NSF and will be included in future MARGINS funding. The next discussion of SEIZE took place at the CONCORD meeting in Japan.

1997-98 JOI/USSAC Distinguished Lecturer Series underway

JOI is pleased to announce the institutions the 1997-98 distinguished lecturers will visit during the 1997-98 academic year. It was difficult to select the host institutions from the large number of excellent applications received by JOI.

Jamie Austin, University of Texas, Austin
Global sea-level fluctuations: ODP's inaugural expedition to the New Jersey continental shelf

- College of William and Mary, Williamsburg, Virginia
- Five College Coastal and Marine Sciences Program, Northampton, Massachusetts
- Auburn University, Auburn, Alabama
- Vanderbilt University, Nashville, Tennesee
- Trinity University, San Antonio, Texas
- University of Houston, Houston, Texas

Margaret Delaney, University of California, Santa Cruz
A focus on phosphorus

- Ohio University, Athens, Ohio
- Appalachian State University, Boone, North Carolina
- University of Vermont, Burlington, Vermont
- Harvard University, Cambridge, Massachusetts
- Humboldt State University, Arcata, California

Gregor Eberli, University of Miami
Sea-level changes: The pulses of sedimentation on carbonate platform margins

- University of Maine, Orono, Maine
- University of Kentucky, Lexington, Kentucky
- University of Arkansas, Fayetteville, Arkansas
- Williams College, Williamstown, Massachusetts
- University of Georgia, Athens, Georgia

Deborah Kelley, University of Washington
Volatile-fluid evolution in submarine magma-hydrothermal systems

- South Dakota School of Mines and Technology, Rapid City, South Dakota
- Montana Tech. of the University of Montana, Butte, Montana
- Bowling Green State University, Bowling Green, Ohio
- Bloomsburg University of Pennsylvania, Bloomsburg, Pennsylvania
- Scripps Institution of Oceanography, La Jolla, California

Larry Peterson, University of Miami
Climate change in the tropical Atlantic: Clues to patterns and processes from the Cariaco Basin

- University of Pittsburgh, Pittsburgh, Pennsylvania
- Lafayette College, Easton, Pennsylvania
- Michigan State University, East Lansing, Michigan
- University of Wisconsin, Madison, Wisconsin
- University of Florida, Gainesville, Florida

Haraldur Sigurdsson, University of Rhode Island
Global episodes of explosive volcanism: Evidence from ODP Leg 165

- Arizona State University, Tempe, Arizona
- Brigham Young University, Salt Lake City, Utah
- Colorado State University, Fort Collins, Colorado
- Northern Illinois University, DeKalb, Illinois

A letter to the ODP scientific community

Dear Colleague,

The recent decision on ODP publications by EXCOM has caused widespread discussion within the ODP community. In this reply I would like to describe, in more detail, the background and rationale behind the recent EXCOM decisions regarding publications (copies of which are attached for your information), and the steps which are being taken to address some of the concerns many of you have expressed regarding the possible phasing out of publication of a printed IR ["Initial Reports"].

The changes in ODP publication policy have been motivated in part by a desire to cut, or at least contain, costs. ODP has been flat funded for the past five years, which means, in real dollars, the ODP budget is now about 14% less than it was in 1994. Almost all of the international partners in ODP have stated that Phase III renewal is contingent upon a fixed membership fee, i.e. no inflation correction. This means that any increase in funding for ODP over the period 1999-2003 will be dependent on the addition of new members to the Program (an uncertain prospect at best). If current trends continue, by the year 2000 ODP could be operating on a budget that is 20% less in inflation-adjusted dollars than in 1994. And this is in the face of costs in some areas, e.g., drilling supplies and services, that are increasing much faster than the CPI. This has put enormous financial pressure on the Program. ODP's two main subcontractors, TAMU and LDEO, have already been subjected to stringent cost-cutting (with staff reductions and reorganizations), and there is general agreement that any further cost savings will be small, unless existing program services are cut back or eliminated. At the same time, it is clear that continued funding of ODP is dependent on the program pursuing the new initiatives and technical innovation outlined in the ODP Long Range Plan. Any perception that ODP is conducting "business as usual" may very well jeopardize the contributions of some partners, with a resulting domino-effect that could terminate the entire Program. The combination of flat budgets, and the need for new Program initiatives, means that additional cost savings have to be realized to offset the effects of inflation and to fund the new scientific and technological initiatives the community has identified in the ODP Long Range Plan. The ODP publications budget which runs close to $2M/yr has been one of the areas that has been carefully scrutinized in this regard.

Another important motivation for changes in traditional ODP publications, however, stems from a desire to take advantage of the enormous potential of electronic publication and the Internet to distribute data and information in new ways to ODP scientists, and to a much broader community. Indeed, at least two members have made major changes in ODP's publication policy a prerequisite for Phase III renewal. Electronic versions of the Proceedings can potentially allow direct links between the IR, the SR and the ODP JANUS database, as well as to ODP-related publications in the outside literature. This will allow new ways of retrieving and using ODP data that were not previously possible with traditional paper volumes. Another benefit of putting the IR and SR onto CD-ROM and the WWW will be much wider access by a broader scientific community, including industry. Only about 1200 of the printed volumes are currently circulated worldwide. Many universities and research institutions, in both developed and less developed countries, are not receiving the printed IR and SR, but have access to the WWW or CD-ROM-equipped computers. The marginal cost of a CD-ROM version of an IR, or SR (with explanatory notes), is likely to be less than $5, vs more than $60 for the current printed volume. We could envisage circulating perhaps 5,000 copies of the CD-ROM version potentially reaching a much wider audience. Indeed, few people have disputed the potential advantages of electronic publication; the question has really been

EXCOM MOTION 97-2-6

The EXCOM recognizes that the Publications of ODP are an important mechanism by which the principal legacy of the program, its scientific findings, are conveyed to the scientific community, and by which an additional legacy, the scientific samples, are described to the community. We appreciate the concern of the SCICOM for the importance of this communication mechanism. We also appreciate the work that the Publications Committee has done to poll our community about its capability and its continuing commitment to advise us about the access and format of our publications.

The severe fiscal constraints imposed by member contributions anticipated for Phase III of ODP require that we exercise great care in balancing priorities for the ODP activities. First and foremost among those are to foster technological innovation and make progress toward implementing our science plan. Budget projections from our operators indicate that it would be impossible to do so if we accept the extra costs associated with the recommendation of the JOI Publications Steering Committee to continue traditional paper publication of the Initial Reports (IR) for several years.

As a result, the EXCOM reconfirms its 1996 schedule for introducing electronic and CD-ROM publication of the IR and SR volumes and phasing out paper publication. We agree to cap the volume publication budget at the levels indicated in the JOI model for FY 99 and beyond.

We have asked JOI to explore outsourcing publications as an additional option and have also asked that they check obligations for publications in the MOUs and seek relaxation of these obligations if necessary.

"when," or even "if," the printed volumes should be phased out.

Over the past 3 years, the future of ODP publications has been discussed by various committees within the JOIDES advisory structure and a plan has been in place for more than a year to move ODP toward electronic publication of its IR and SR volumes. In December, 1994, a PCOM Publications Steering Committee (PSC) was established to investigate ways of cutting ODP publications costs by up to 30%. In April, 1995 PCOM reviewed and endorsed the recommendations of the PSC which included cutting the IR book to 100 pages of text (with the rest on CD-ROM), reducing the size of the printed core photos by 50%, and reducing the number of pages in the SR volumes by 40%. These recommendations were, however, never fully implemented. In June, 1996, EXCOM was presented with, and approved, a new ODP publications strategy developed by JOI and the PSC. This plan called for the phasing out of both the printed IR and SR volumes over several years and their publication on CD-ROM and the WWW, as well as allowing publication of post-cruise results in the outside literature 12 months post-cruise. In August, 1996, PCOM endorsed this plan with the condition that full electronic publication proceed only when the community was ready. In December, 1996, JOI established a new Publications Steering Committee (PUBCOM) to oversee the transition to electronic publication. This committee met in April, 1997 and recommended that the transition to an electronic/WWW SR proceed as planned but that the IR continue to be produced in print and CD formats for at least another 3-5 years . It was this recommendation, endorsed by SCICOM in April, that was presented to EXCOM in June.

Continuing to produce printed IR volumes in their present form, as recommended by PUBCOM, would cost the program an additional $1.8M over the period FY 98-02. This may seem like a small fraction of the annual $44.4 million ODP budget, but ODP is a program with very high fixed costs. Excluding the SEDCO contract for the drillship, ODP (including TAMU, LDEO and JOI/JOIDES) operate on an annual budget of ~$21 million. Within this figure ODP has a very small "discretionary" budget. In FY 98 this so-called Special Operating Expense (SOE), or X-based budget, will be about $3.7M. It is this budget that supports new engineering development (e.g. development of DCS or active heave compensation for bare rock drilling), CORKS and hard rock guidebases, specialized logging tools (e.g. LWD), iceboats or alternative drilling platforms - i.e. all the costs beyond that of a "standard" drilling leg. Budget projections for FY 99 and beyond indicate this SOE or X-based budget will drop to about $2M/yr. Measured against this, the $400K/yr for publishing the IR books is a significant number. It could be the difference between being able to have an ice support vessel for an Antarctic leg, or LWD and CORKS for drilling an accretionary wedge, or contracting for an alternative drilling platform for the New Jersey margin. It was with this perspective in mind that EXCOM recommended to JOI that the program simply cannot afford to continue to produce, print and distribute 1200 copies of the traditional IR volumes in their present form for another 3-5 years.

EXCOM MOTION 97-2-7

EXCOM asks JOI to provide advice on outsourcing all or part of ODP Publications. This advice should include electronic publications options and consider legal and financial issues. JOI should report their findings at the January 1998 EXCOM Meeting.

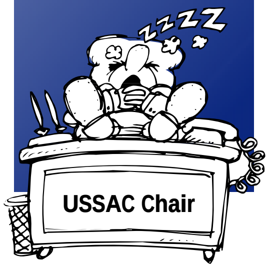
This was not an easy decision. EXCOM was fully aware of the importance that a large segment of the ODP community attach to the printed IR volume. Your messages over the past few weeks have made it very clear that even in the face of these severe fiscal constraints a significant segment of the community would still like to have the option of having a printed IR. In response to these concerns JOI is currently investigating, within the budgetary constraints of EXCOM motion 97-2-6, what options may exist for continuing to provide access (potentially at some cost to users) of some form of a printed version of the IR beyond October, 1998. JOI will report on these options at the earliest practicable date.

This is the first of many difficult choices ODP will have to face as it grapples with the cumulative effect of a budget which has been declining in inflation-adjusted terms for 5 years. If you share EXCOM's concern about the long-term impact of this "flat-funding" policy on ODP, and the Program's ability to implement its Long Range Plan, I encourage you to communicate your concerns to your national funding agency.

Sincerely,

Bob Detrick, EXCOM Chair
on behalf of the entire
Executive Committee

A letter from the Chair



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

How to make tough decisions in tough times

As I write my final editorial as USSAC Chairman, ODP stands at the brink of a potential financial crisis, brought about by the likely renewal of the program from 1998 to 2003, BUT with no increases in funding. As we have had no funding increases since 1994, this potentially will result in a full decade of level funding, in contrast to the ever-increasing costs of basic services for the program, not to mention the needs for engineering development and other special-cost items. In the face of that likely reality, there is no escaping the fact that things will have to be cut, possibly even things that many of us consider to be "basic services." So the questions really are; what do we cut, when, and how do we make those decisions? The current example is the controversy over EXCOM's recent decision to soon eliminate the Initial Reports volume in hard-copy form. That issue is described elsewhere in this volume and currently is being addressed in other forums, so I do not want to add more fuel to that particular fire here. I would rather take a longer view of the problem; namely, how in general should we address these sorts of problems in the future, hopefully to avoid the kind of controversy now raging over the publications issue.

At the risk of sounding like one of your high school sports coaches, we are going to have to start playing more like a team. Casey Stengel once said, "To win the pennant, we're gonna to have to start thinking that we aren't as good as we think we are." That may sound like an oblique way of putting it, but what I mean in this instance is that we are going to have to put our individual egos aside, stop fighting amongst ourselves, and start fighting for the common goal of preserving the most valuable and productive program earth sciences has ever seen. This does not mean to stop examining and arguing the issues that confront us. What it does mean, in my opinion, is that when an important decision must be made on which there apparently is no overall agreement, the group who must make that decision should also ENGAGE other levels within JOIDES in that decision-making process. "Engage" sounds pretty nebulous and it is, because I do not want to prescribe how that is done. It may be simply by more informal discussions between individuals at various levels within JOIDES, or we may need more formal mechanisms. The U.S. Congress has conference committees to work out differences in bills between the House and Senate. We have a Budget Committee made up of joint membership of SCICOM and EXCOM that could be used in the future to deal with such matters at that level. I don't really care how this happens. My point is that we are rapidly reaching a financial situation where we can no longer afford the luxury of simple serial-decision making that goes monotonically up the JOIDES panel and committee structure, because the potential then exists for the sort of current blow up that we now have on our hands. This is obviously going to be even more trouble and effort than decision making is now within JOIDES, but we just have to do it, because we cannot afford to tear the program apart internally. I think that we CAN do this because this is a top-quality program run by top-quality people. But now is the time for us all to realize the effort that will be required in the next few years to preserve scientific ocean drilling well into the 21st Century.

Having said that, I'd like to close by thanking everyone for their support over the last two years while I have chaired USSAC. I especially thank Ellen Kappel, Andrea Johnson, and John Farrell of the JOI Office, who have provided outstanding support, and who are some of the program's most valuable assets. I am pleased to have had the chance to serve.

Roger L. Larson
Chairman, USSAC

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*** USSAC Executive Committee**

Membership term is three years

Fall 1997

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Rick Murray, Boston U
David Naar, USF
Lisa Tauxe, Scripps

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John Barron
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Jim Ogg
Bernd Simoneit

**** Mike Arthur will take over the USSAC Chairmanship from Roger Larson on October 1, 1997.**

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Fluid flow in oceanic crust, continued from page 16

At subduction zones, short-term field experiments at vent sites have been conducted and fluid flow measured. The few short-term measurements of focused fluid discharge rates along prominent faults such as the décollement, but mostly through active vents, are greater by orders of magnitude than the estimated fluid input rates [e.g.: *Carson et al.*, 1990; *Le Pichon et al.*, 1990; *Kastner et al.*, 1991]. These differences imply that the flow is episodic; local pore fluid chemical anomalies, composition of vein minerals, temperature monitoring, and heat flow modeling support this conclusion [e.g.: *Labaume et al.*, 1997; *Le Pichon et al.*, 1990; *Davis et al.*, 1995]. There may be a linkage between the episodicity of flow and earthquake cycles.

Fig. 3: Dr. Kastner attaching the osmo-fluid sampler to the drill string at ODP Hole 949, Barbados.

To determine the fluxes and composition of the expelled fluids in each of the sub-environments, fluid flow rates and composition of both modes of flow, focused and diffuse, must be determined and integrated over time. New seafloor and borehole samplers that will be able to capture both modes of fluid flow in subduction zones and ridge flanks over long times are being designed and developed. To make optimal use of boreholes in the future, the capability to carry out monitoring and sampling at multiple levels is important. Monitoring hydrothermal fluid flow rates and composition at ridge crests is the most challenging future objective because of the very high temperatures and corrosive nature of these fluids, having pH values of ~3.5 and very high H_2S concentrations.

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