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Leg 174B Revisits Hole 395A: Logging and Long-Term Monitoring of Off-Axis Hydrothermal Processes in Young Oceanic Crust

by Keir Becker, the Leg 174B Scientific Party, and Earl E. Davis

It is now well accepted that off-axis hydrothermal systems account for the majority of hydrothermal heat and chemical fluxes in the oceanic crust and are a primary factor in the chemical and physical evolution of the crust. Relative to on-axis hydrothermal systems, off-axis circulation occurs at lower temperatures and slower rates over larger areas of the ocean basins, commonly out to crustal ages of tens of millions of years. To date, much of our understanding of off-axis circulation has been based on deductions from patterns in seafloor heat flow, analyses of pore waters in the sediments overlying oceanic basement, numerical simulations, and drilling results in a few well-studied, well-sedimented off-axis areas.

In mid-summer of 1997, Leg 174B briefly revisited Hole 395A, a classic legacy hole in young crust near the Mid-Atlantic Ridge, for a 5-day program of logging and installation of the thirteenth ODP CORK (Circulation Obviation Retrofit Kit, or instrumented borehole seal) for long-term hydrological monitoring. The primary purpose of this work was to further elucidate the formation properties and driving forces controlling the vigorous off-axis, low-temperature hydrothermal circulation inferred to be active in the region from previous reentries of the hole and geothermal surveys. With four CORKs deployed during Leg 168 on the flank of the Endeavour Ridge (Davis, Fisher, et al., 1997; Davis and Becker, submitted), and the CORK deployed in Hole 395A during Leg 174B, there are now five active CORKs providing the first continuous monitoring of *in situ* conditions and processes in off-axis hydrothermal systems.

Ridge-Flank Circulation in a Sediment Pond Near the Mid-Atlantic Ridge: Hole 395A

Drilled in 1975-1976 (Melson, Rabinowitz, et al., 1979), Hole 395A was one of the earliest successful reentry holes in oceanic crust, penetrating 93 m of sediments and over 500 m of predominantly extrusive basalts. It remains one of the deepest penetrations of young, upper oceanic crust formed at a slow-spreading mid-ocean ridge and is thus a very important reference site. It is located in 7 m.y.-old crust about 70 km west of the axis of the Mid-Atlantic Ridge in an isolated sediment pond ("North Pond") about 8 x 15 km in size and completely surrounded by exposed basement with topographic relief up to a km (Fig. 1). Oceanic crust formed at slow spreading rates typically exhibits much greater bathymetric relief than that formed at fast rates, so this kind of environment is typical for off-axis circulation in the Atlantic and Indian Oceans.

Hole 395A was also one of the earliest and best examples of a phenomenon that is fairly common in holes drilled into young oceanic crust — that of ocean bottom water flowing down the hole. In the 21+ years since initial drilling, Hole 395A has been re-entered 4 times: first during Leg 78B, again during Leg 109, later using the French wireline reentry system during the DIANAUT expedition, and most recently, during Leg 174B. Each time, repeat temperature logs, fluid samples, and flowmeter logs clearly demonstrated that ocean bottom water was flowing down the hole at consistent rates of about 1000 liters / hr (e.g., Becker et al., 1984; Morin et al., 1992). Downhole flow in an open hole requires both a pressure differential to drive the flow and sufficient formation transmissivity to accept the flux. The higher the formation transmissivity, the lower the differential pressure required to drive downhole flow. The pressure differential probably results from a combination of two effects: true formation underpressures resulting from natural fluid circulation, and a drilling-induced artifact resulting from the density

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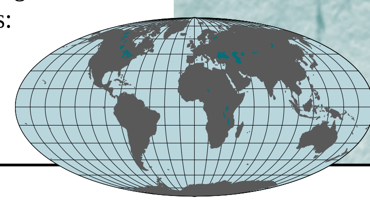

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differential between cold drilling fluids and warmer formation fluids. Resolving the former is obviously of greatest interest.

In most cases of downhole flow in crustal holes, however, the formation temperatures are indeed warmer than the drilling fluid, so the drilling-induced artifact must be significant thereby precluding determination of the true formation state if the hole is left open.

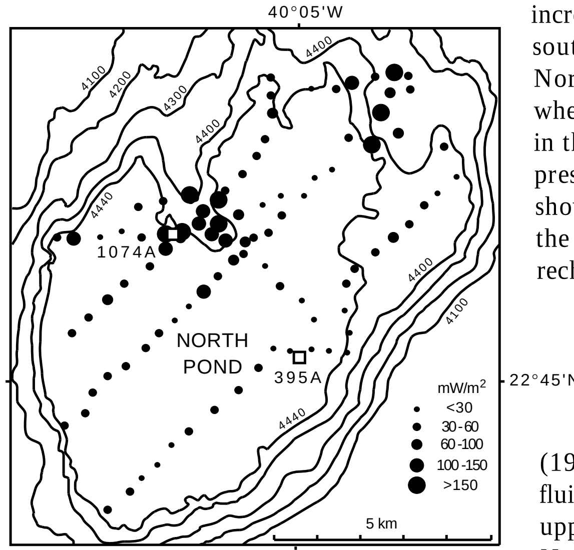

Figure 1. Location of Hole 395A in North Pond, showing the heat flow survey of Langseth et al. (1992). Bathymetry is shown in m, with contour interval of 100m except for the deepest contour at 4440m.

Hole 395A is important among examples of downhole flow because 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.

Early indications of the nature of the subsurface fluid flow system at North Pond were provided both by downhole measurements during prior re-entries and, in particular, by the detailed heat flow survey conducted by Langseth et al. (1992) long after drilling of Hole 395A. Prior downhole measurements indicate that the upper 300-400 m of basement in Hole 395A is permeable enough to support a vigorous fluid flow system, if there is lateral continuity of such permeability in the crust underlying North Pond. The heat flow survey revealed values considerably less than those expected for conductive cooling of 7-m.y.-old crust (≈180 mW / m^2), with a general increase of heat flow from southeast to northwest across North Pond (Fig. 1). Even where the heat flow was high in the northwest, pore pressure measurements showed negative gradients in the sediments, suggesting recharge everywhere in the sediment pond. These observations corroborated the model put forth earlier by Langseth et al. (1984) for one-pass lateral fluid flow in permeable upper basement beneath North Pond (Fig. 2), with the flow generally 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. Hence, 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).

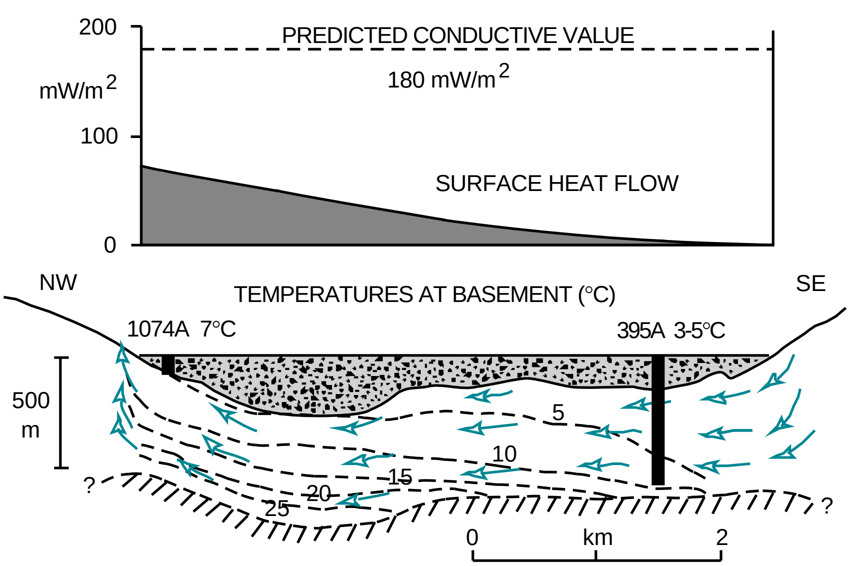

Figure 2. Schematic model of Langseth et al. (1984) for fluid flow in permeable basement beneath North Pond, showing approximate relative locations of Holes 395A and 1074A.

Logging Results for Hole 395A

About two days were devoted to logging in Hole 395A, with the overall purpose of documenting the *in situ* physical properties of the upper oceanic crust at the site, particularly insofar as they relate to the hydrologic properties. The hole had been logged reasonably well during Legs 78B and 109, so Leg 174B focused on deploying improved tools more recently available to ODP. These included temperature, FMS, and density-porosity-resistivity logs, as well as two new tools deployed in oceanic crust for the first time: an azimuthal resistivity imager (ARI) and a digital shear imager (DSI). These logs provided an overwhelming amount of high-quality data, and only preliminary analyses have been attempted so far.

Fig. 3 shows the downhole temperature log taken when Leg 174B first reentered Hole 395A. This is very similar to past temperature logs in the hole, and illustrates the virtually isothermal profile in the upper 300-400 m characteristic of downhole flow of ocean bottom water. Fig. 3 also shows the Leg 174B log of spontaneous potential (SP), which is quite sensitive to fluid flow. The SP 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. The resistivity log, not shown, indicates that the inflow zones are associated with low resistivities between cyclic zones of high resistivity. Hyndman and Salisbury (1984) and Moos (1990) reported this cyclicity in earlier logging data from the hole, and suggested that it represents eruptive cycles. If so, the temperature and SP logs suggest that most of the considerable permeability in basement at Site 395 is concentrated in the zones between eruptive cycles.

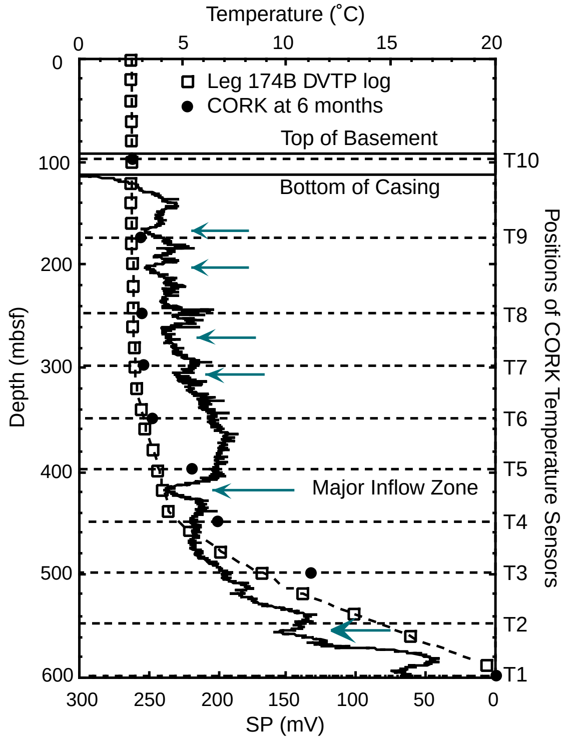

Figure 3. Leg 174B temperature (open squares) and spontaneous potential (SP) logs (solid line) in Hole 395A, with CORK temperatures (solid circles) as recorded six months after CORK deployment. Arrows indicate possible zones accepting downhole flow.

Coring the Sediment Pond: Results from Site 1074

The logging and CORK installation in Hole 395A were completed ahead of schedule on Leg 174B, allowing time to offset the ship and core the sediments of North Pond. These sediments had not been properly cored during the original drilling leg, which occurred before the advent of the hydraulic piston corer. The ship was offset 4.5 km to the northwest of Hole 395A, to the zone of highest measured heat flow in North Pond.

A 64 m-thick section of sediments and underlying 0.6 m of basalt were recovered using the APC / XCB assembly at Hole 1074A (Fig. 1). The sediments are predominantly nannofossil ooze, with 2 m of red clay overlying the basalts. Sediment temperatures were measured with the Adara shoe, and pore water chemistry was analyzed throughout the core. The temperature profile is conductive and the pore water profile is diffusive, with no evidence for advection through the sediments associated with the relatively high heat flow in North Pond. The temperature profile extrapolates to a value of about 7°C at the top of basement near the western edge of North Pond — very close to the value predicted by the Langseth et al. (1984) model (Fig. 2). This result, and the lack of evidence for advection through the sediments at the site, provide further corroboration for the Langseth et al. (1984) model of fluid flow confined to basement beneath North Pond.

Preliminary CORK Results from Hole 395A: Post Leg 174B

Six months after the CORK deployment on Leg 174B, the first half-year of temperature / pressure data was recovered from Hole 395A on January 30, 1998, using DSV *Nautile*. Preliminary interpretation of the data suggests a very slow recovery of temperatures and pressures in the hole. Full recovery which will certainly take much longer than six months, given the 21+ years of unabated downhole flow before the installation of the CORK. Until the recovery is complete, we can present only lower bounds to *in situ* temperatures and pressures.

Although temperatures clearly show signs of recovery throughout the first six month recording period, they are not much warmer than the profile characteristic of downhole flow (Fig. 3). In addition, *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. Thus, there appears not to have been a strong formation underpressure “sucking” the pre-CORKing downhole flow into a basement reservoir; rather, 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 sufficiently high 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 liters 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

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Miocene to Pleistocene Sand-Rich Sequences and Sea-Level Changes at the New Jersey Outer Shelf: Results from Leg 174A

by James A. Austin, Jr., Nicholas Christie-Blick, Mitchell Malone, Gregory S. Mountain and the Leg 174A Shipboard Party

The emergence of seismic / sequence stratigraphy since the late 1970s has led to a revolution in stratigraphy and a renewed interest in the stratigraphic response to eustasy / global sea-level change (e.g., Vail et al., 1977; Haq et al., 1987; Christie-Blick et al., 1990). Two observations that were advanced to support the eustatic interpretation are 1) widespread seismic evidence of regional unconformities (sequence boundaries) characterized by apparently abrupt basinward shifts in onlap, thought to imply rapid falls of sea level with amplitudes of over one hundred meters; and 2) the purported worldwide synchroneity of those unconformities. Evidence for eustatic forcing has not been universally accepted for a number of reasons, but emerging correlations between upper middle Eocene to Holocene stratigraphy at the New Jersey margin and oxygen-isotopic variations in deep-ocean sediments are consistent with the long-hypothesized glacial-eustatic forcing of observed sedimentary cyclicity during this span of continental glaciation (Miller et al., 1996a).

Leg 174A was a continuation of the New Jersey Mid-Atlantic Sea-level Transect (MAT), the first coordinated effort to evaluate the effects of glacial-eustatic change at a passive continental margin dominated by siliciclastic sedimentation (Figure 1; Mountain and Miller, 1997). Focused on the outer continental shelf and upper slope, Leg 174A followed successful sampling of the slope and rise (Leg 150; Mountain et al., 1994), and continuing drilling of the New Jersey Coastal Plain (Legs 150X and 174AX; Miller et al., 1994; Miller et al., 1996b, and in press).

The Miocene-Pleistocene succession beneath the New Jersey shelf is divided into at least 18 unconformity-bounded sequences. These are lozenge-shaped features in dip section, each sequence thinning both landward and seaward from a depocenter located immediately outboard of the "rollover" or "breakpoint" in the underlying sequence boundary (the position at which this surface steepens basinward into a clinoform). Sequence boundaries are defined in the vicinity of

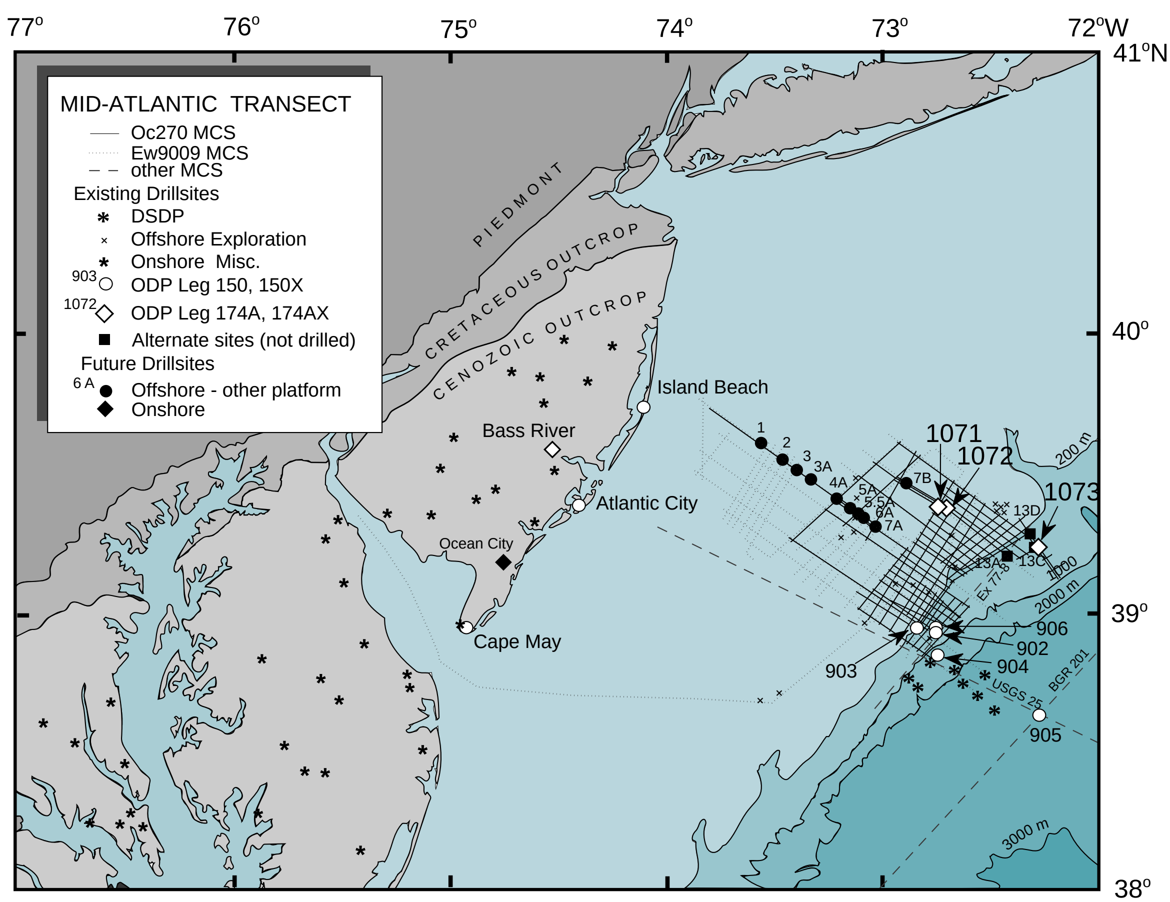

Figure 1. Locations of Leg 174A sites on the outer shelf (Sites 1071 and 1072) and uppermost slope (Site 1073). Other components of the onshore/offshore Mid-Atlantic Sea-Level Transect (MAT) are also shown, along with locations of multichannel seismic (MCS) coverage (bold lines) used for site selection.

these rollovers / breakpoints by the termination of seismic reflections (and strata) against overlying (offlap) and underlying (onlap) surfaces, respectively. Offlap tends to be subtle, but is nevertheless an important indication that depositional base level was significantly lower when the sequence boundary was formed. The degree of offlap at sequence boundaries also increases significantly from the lower and middle Miocene to the Pliocene-Pleistocene, presumably as a result of increasing amplitudes of associated glacial-eustatic change.

The main contribution of Leg 174A was to acquire core and downhole logs from four upper middle Miocene to Pleistocene unconformity-bounded sequences. Each drill location was carefully selected close to sequence boundary rollovers / breakpoints, where sedimentary facies are sensitive to variations in paleowater depth and hence can provide constraints on amplitudes of sea-level change (Figure 2). Downhole geophysical data proved to be critical in the interpretation of incompletely recovered stratigraphy, in correlating stratigraphy with seismically determined stratal geometry, and in locating specific surfaces in boreholes (Figure 3). Age constraints for surfaces penetrated at Sites 1071 and 1072 on the outer continental shelf are shown in Figure 2 (mostly on the basis of dinocysts, with support from planktonic foraminifers, nannofossils, and paleomagnetic evidence for the Bruhnes / Matuyama polarity boundary). Sampling across the same surfaces at Site 1073 on the continental slope suggests that pp3(s) is probably younger than 0.46 Ma and that pp4(s) is younger than 4.5 Ma (based on nannofossils). Surface m0.5(s) is older than 7.4 Ma and probably older than 8.6 Ma. Surface m1(s) (penetrated only at Hole 1071F, 1.1 km east of Holes 1071A-E and not shown in Figure 2) is older than 11.4 Ma and probably older than 12.5 Ma (based on planktonic foraminifers). A large hiatus was encountered at the level of m0.5(s) and m1(s) at Site 1073. Each of the surfaces illustrated in Figure 2 is interpreted as a sequence boundary, except for pp5(s), which correlates with an interval of upward deepening and is late Miocene in age (not Pliocene-Pleistocene as originally thought).

The succession consists largely of sands, silts and clays, with recovery predominantly from fine-grained sediments. The distribution of sediment types within unconformity-bounded units proved to be unusual and at variance with the interpretation of Greenlee et al. (1992) using industry seismic and well data. At the level of surfaces m0.5(s), pp4(s) and pp3(s), the lower part of each sequence is comparatively sandy, thins seaward (seismic geometry), and appears to have accumulated in shallower water than the finer-grained sediments above. Progradational (highstand) sediments expected beneath sequence boundaries are poorly developed or absent at Site 1071. We

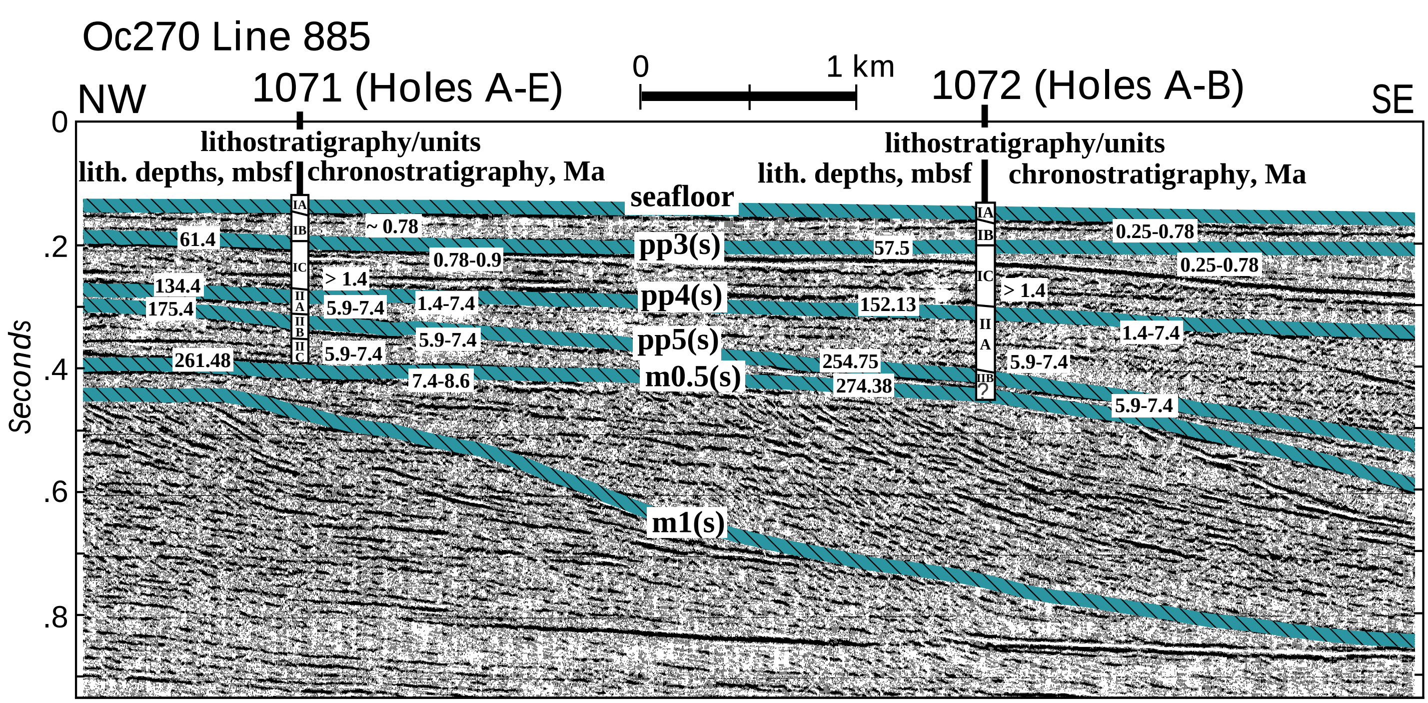

Figure 2. Comparison of results at Sites 1071 and 1072, superimposed on MCS profile Oc270-885 collected to prepare for Leg 174A (see Figure 1). Depths to the left of lithostratigraphic columns refer to lithic boundaries close to but not necessarily coincident with sequence boundaries. Ages refer to intervals bounded by sequence boundaries - pp3(s), pp4(s), m0.5(s) and m1(s) - and by pp5(s), now reinterpreted as an interval of upward deepening which is late Miocene in age. Surface m1(s) was penetrated only at Hole 1071F, located 1.1 km east of Holes 1071A-E and not shown here.

hypothesize that during times of sea-level rise, the sediment supply was sufficient to fill any available accommodation (a "keep-up" situation). Highstand progradation was possible only seaward of the rollover / breakpoint in the underlying sequence boundary, consistent with the many tens of meters of sand encountered below surface m0.5(s) at Site 1072 (Figure 2).

Observations at Site 1071 place constraints on the amplitudes of water-depth changes within sequences. Maximum water depths inferred for the late Miocene on the basis of benthic foraminifers are ~ 50-100 m. The minimum water depth is inferred for an unusual facies observed in Hole 1071F close to, but most likely a few meters above, sequence boundary m0.5(s), and no more than 3 km landward of the rollover / breakpoint for this surface. The facies consists of laminated silty clay that lacks bioturbation and is virtually barren of planktonic foraminifers and dinocysts, and instead contains abundant organic detritus, pollen and fungal spores. Taken together, these observations imply a lagoonal or estuarine environment of deposition. Therefore, during the development of sequence boundary m0.5(s), the shallow shelf must have become subaerially exposed to a point within 3 km landward of its rollover / breakpoint. Water-depth changes within the overlying sequence were on the order of 50-100 m. This is larger than had been expected for the late Miocene (~8.6 Ma), but consistent with the recent discovery of middle Miocene ice-rafted detritus in the northern Atlantic (ODP Leg 151; Myrhe, Thiede, and Firth et al., 1995) that indicates an onset of northern hemisphere glaciation earlier than formerly thought.

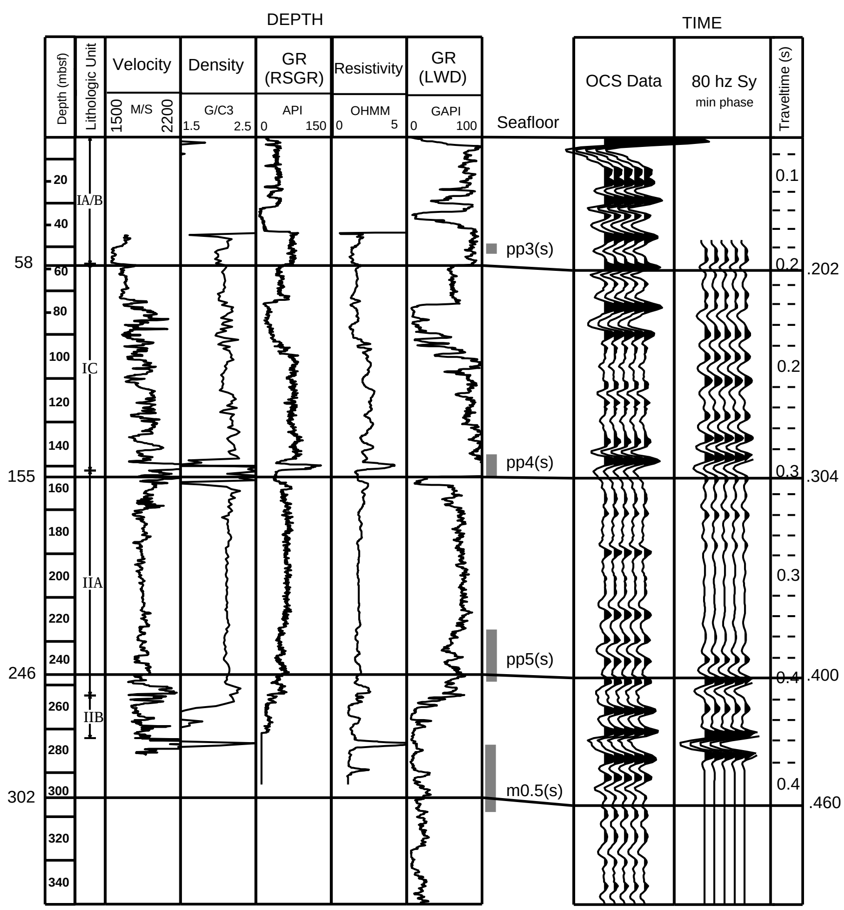

Figure 3. Lithostratigraphic units and downhole logging measurements from Site 1072 (left), a seismic trace collected at the site with synthetic seismogram (right), and four seismically identified sequence boundaries matched to these data (middle) by converting each from travel-time to depth using velocities derived from "checkshot" data and semblance velocities from Oc270 MCS data (gray boxes). Downhole logging data permit refinement of the sequence stratigraphic interpretation with respect to borehole stratigraphy.

The main operational limitation for Leg 174A was the ubiquitous presence of thick, unconsolidated sands. These proved difficult to recover with technology available on the *JOIDES Resolution*, and they led to unstable hole conditions that prevented sampling of the Miocene section as deeply as planned beneath the shelf. However, the drillship maintained station successfully in water depths of 88-98 m, and the sampled shelf sections proved to be virtually devoid of hydrocarbon accumulations. These operational considerations will guide future thinking on shallow shelf drilling, particularly as regards offshore completion of the MAT.

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Benguela Current and Angola-Benguela Upwelling Systems: Preliminary Results from Leg 175

by Wolfgang H. Berger, Gerold Wefer, Carl Richter and the Leg 175 Scientific Party

Understanding the role of the ocean in climate change through heat transport and control of carbon dioxide is critical in determining the mechanisms of climate change. The Benguela Current plays a key role in the heat transfer from South Atlantic to North Atlantic, which in turn dominates climate developments in the northern hemisphere in the late Neogene (see articles in Wefer et al., 1996a). The associated Angola / Namibia upwelling system is one of the few great upwelling regions of the world that are thought to be of major importance in controlling short-term fluctuations in atmospheric CO_2. It exhibits productivity values ≥180 gC / m² / yr, and extends over a considerable portion of the western margin of South Africa. Like the systems off Peru and California which have been studied during recent ODP legs, the Angola / Namibia regime is characterized by organic-rich sediments that contain an excellent record of productivity history which is closely tied to the regional dynamic of circulation, mixing and upwelling. In addition, this environment provides a prime setting for "natural experiments" in diagenesis, primarily concerning the genesis of economically important petroleum and phosphate resources.

The major objectives of the "Benguela Leg" (ODP Leg 175) were (1) to reconstruct the late Neogene history of the Benguela Current and the associated upwelling regimes between 5° and 32°S; (2) to determine whether changes in the surface current and upwelling regimes are related to changes in the climates of western South Africa; and (3) to study early diagenetic processes in environments with very high organic carbon and opal contents.

Forty holes at thirteen sites were drilled in a series of transects off the coasts of the Congo, Angola, Namibia and South Africa (Fig. 1). Selection of sites was based on high-resolution airgun profiles collected during two 4-month expeditions mounted for this purpose (Sonne Expedition SO86 in 1993; Meteor Expedition 34 / 1 in 1996). These preparatory expeditions were carried out by the GEO Group at Bremen University; processing was done at the Alfred-Wegener Institut in Bremerhaven.

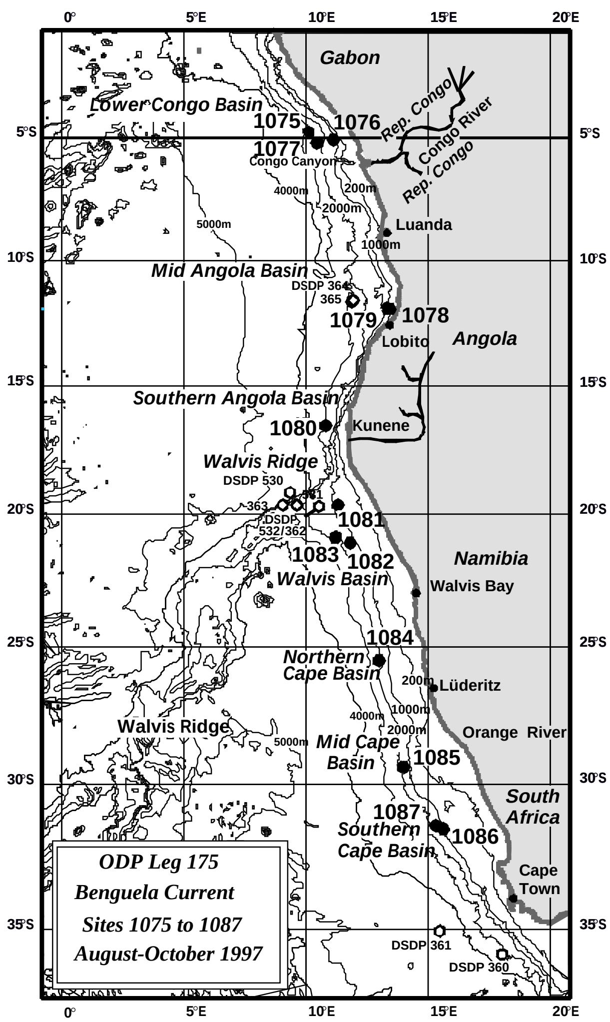

Figure 1. Locations of sites drilled along the African margin during ODP Leg 175.

Most of the sites have high sedimentation rates (~100 m / my) and provide continuous records which offer the opportunity to develop detailed paleoceanographic records with a resolution near 1000 yr. The individual transects reflected a compromise between geographic coverage, accessibility, and time constraints. Drilling at the six sites off the Congo River and off Angola, where active exploration for offshore hydrocarbons is taking place, was limited to a maximum penetration depth of 200 mbsf (meters below sea floor) for safety reasons. On Walvis Ridge, off Namibia, and off South Africa, two sites were drilled to APC refusal, and five sites were drilled to between 400 and 600 mbsf. This overall drilling strategy resulted in the recovery of Quaternary records north of Walvis

Ridge, and late Neogene records on the Walvis Ridge and at the sites to the south. Several sites included upper Miocene sediments, one site (Site 1087) recovered upper Eocene sediments (but the record was not continuous in the lower section).

A total of 8003 m of sediment cores were collected during Leg 175, a record for ODP. The high gas contents of the sediments prevented rapid compaction of the sediments, thus resulting in fast drilling operations. However, the high gas contents also resulted in sediment expansion that created voids and cracks, thus providing difficulties in handling and measuring physical properties. Logging data, therefore, became particularly important in reconciling the depth scales between the different holes. A total of six sites were logged during Leg 175 (Sites 1077, 1081, 1082, 1084, 1085, and 1087), with a variety of different measurements, including gamma ray, porosity, density, acoustic velocity, electrical resistivity, and magnetic susceptibility. Stratigraphic continuity of the retrieved record relied on drilling multiple holes and on correlating the records using splicing. The most reliable records for splicing proved to be magnetic susceptibility and spectral reflectance.

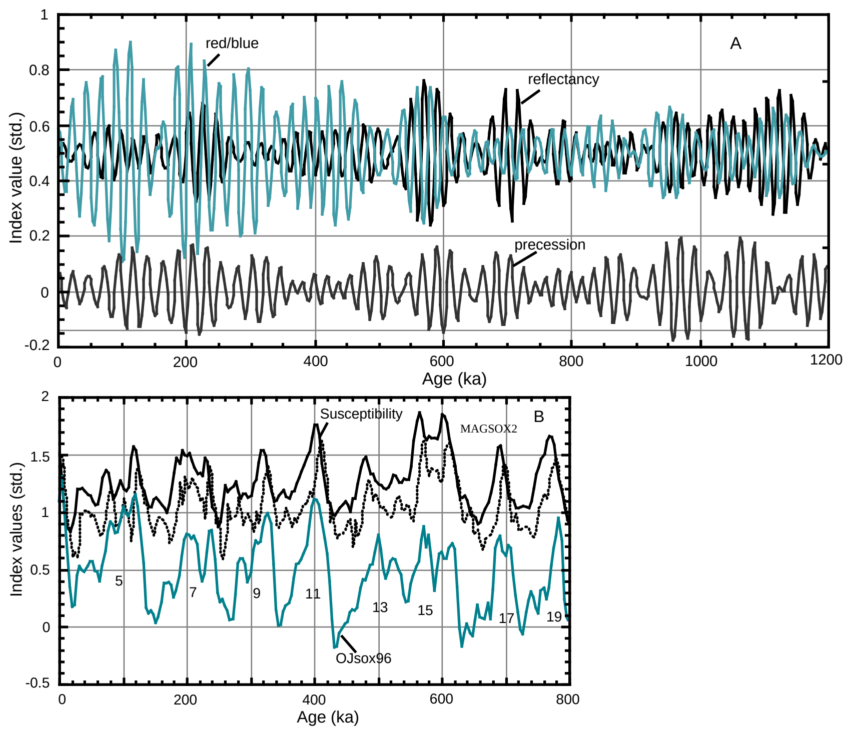

Figure 2. Evidence that orbital forcing dominates cyclic sedimentation off the Congo River. a) Precessional signal within the color and reflectance records. b) Magnetic susceptibility and the Ontong Java oxygen isotope record (OJsox96, as given in Berger et al., 1996). Correlations are constrained by paleomagnetic reversals determined on board.

Productivity Fluctuations and Climate Periodicities

Variations in productivity are generated in different ways within different geographic settings (off the Congo, near the Angola Dome, at Walvis Ridge, in the upwelling cells south of the Ridge). Much detailed work will be necessary to document fluctuations in productivity in these various settings, and to tie the fluctuations in oceanic conditions to the corresponding changes in climate on the adjacent continent.

Preliminary results indicate that the productivity systems are indeed extremely sensitive to climatic change on several time scales. The northernmost sites (Sites 1075, 1076, and 1077) contain the record of sediment supply by the Congo River, intercalated with the oceanic record. The hemipelagic sediments are dominated by diatomaceous clays, in part carbonate-bearing. Total organic carbon contents are 2.3-2.6%, which is high for ocean margin areas and reflects a history of elevated primary production in this area. Pollen, freshwater diatoms, phytoliths, and clay minerals provide clues to climatic change in the drainage basin of the Congo. First indications are that all major Milankovitch cycles are represented within the apparently continuous Quaternary record, but with different spectral power depending on the type of record. Color variations measured on board the *JOIDES Resolution* show a pronounced precessional influence (Figure 2a), while magnetic susceptibility closely tracks sea level, as seen in the standard oxygen isotope record (Figure 2b). This transect of sites will contribute greatly to our understanding of the changing conditions of sedimentation in this area. Depositional patterns are expected to reflect climatically-driven changes in the supply of riverine materials, upwelling export, and open-ocean contributions.

Two sites (1078, 1079) were located outside the Bight of Angola to provide information on “pelagic background” sedimentation for the latest Neogene, as they are situated between the high productivity regions to the north and south. Sediments from this region indicate lower primary productivity in overlying waters; thus, the influence of open ocean is more pronounced and will provide a tie-in of coastal ocean history to the record of the pelagic environment. Sites 1078 and 1079 include sections with extremely high sedimentation rates (up to 600 m / my), and the sediments form one lithostratigraphic unit composed dominantly of silty clays with varying amounts of nannofossils and foraminifers. These high accumulation rates are thought to be the result of vigorous erosion along the coast of Lobito supplying silt to this region.

Long-term, large-scale changes in productivity are evident from major variations in diatom abundance throughout the late Neogene, as is especially evident on Walvis Ridge and in Walvis Basin (Sites 1081, 1082, 1083). These sites consist of calcareous clays, with the upper Pliocene and lower Quaternary sections rich in diatoms. At the end of the early Pliocene, diatom abundance increased very rapidly. Abundances stayed high (with fluctuations) until the end of the early Pleistocene, when they decreased towards present moderate values. This phenomenon had been noted earlier (Dean and Gardner, 1985; Hay and Brock, 1994) but is not yet clearly understood. The step increase in opal deposition about 3 m.y. ago is likely due to increased upwelling accompanying increased flow of the Benguela Current, but the cause of the late Quaternary decrease of diatom productivity is unclear. Presumably, the quality of upwelled water changed during the transition from polar climate forcing (41-k.y. cycles) to global forcing (100-k.y. cycles) about a million years ago. A decoupling of opal production from organic matter production is known, for example, for the 100-k.y. cycle in the western equatorial Pacific (Lange and Berger, 1993).

Site 1084 was situated close to the most active upwelling cell along southwest Africa in Lüderitz Bay. The high sedimentation rates (from 100-270 m / my) for the sedimentary record recovered at this site will allow high-resolution documentation of the variability in coastal upwelling for the last 4.7 million years. The sediments at this site are notably rich in marine organic matter, and well-developed light-dark sediment color cycles in which organic carbon varies between 1.2% and 18% record fluctuations in the elevated marine production associated with the Benguela Current.

A north-south transect of three sites in the southern part of the Cape Basin (1085, 1086, 1087) was drilled to document the history of the Benguela Current near its point of origin. The carbonate-rich sediments contain a record of the influence of warm water from the Indian Ocean, brought by the Agulhas Current. In addition, they provide evidence for incursions of cold Antarctic waters, which apparently reached a maximum near the Pliocene-Pleistocene boundary.

Diagenetic Effects

Considerable diagenetic activity was evident at all sites, but especially at those with high organic matter content. Gas contents in the hemipelagic sediments were high, and based on headspace measurements, biogenic methane and carbon dioxide are roughly equally important at most sites. Interstitial water chemistry profiles at Site 1084 off Lüderitz at the margin of the major Namibian upwelling region, indicated some of the most extreme conditions of sediment diagenesis ever recovered by DSDP or ODP. Maximum values of alkalinity (172 mM) and ammonium (50 mM) were observed, with sulfate being completely depleted within 5 mbsf. A large portion of the excess alkalinity (over seawater values) is the result of bacterial reduction of sulfate and replacement of this strong anion with bicarbonate (from abundant bacterial CO_2 production). Bacterial activity (down to at least 200 mbsf) is responsible for the extreme ammonium values.

One of the more unexpected discoveries of Leg 175 was the presence of numerous dolomitic layers at several of the sites. Some were recovered in the cores; these and additional layers were identified from the logging data by their high velocity, resistivity and density (Figure 3). These layers likely form as the result of the very high alkalinities at these sites. The widespread occurrence of dolomite layers in upper Neogene sediments bears on the interpretation of dolomites exposed on land, such as the ones in the Monterey Formation (Garrison et al., 1984).

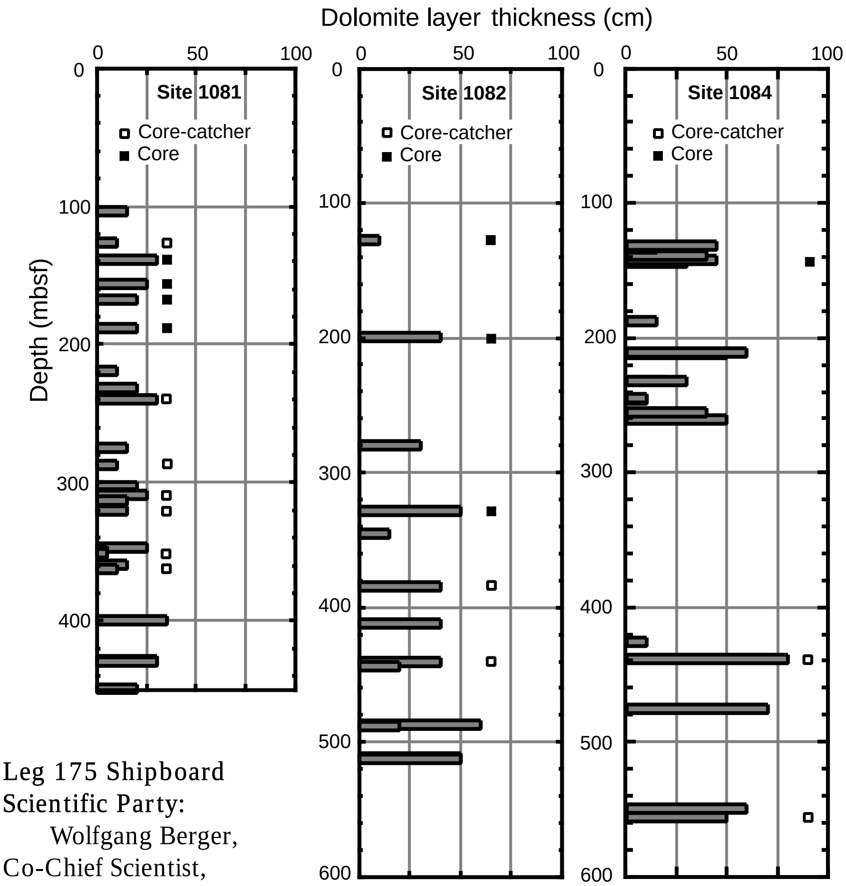

Figure 3. Distribution and thickness of dolomitic layers (and related lithified layers), at Sites 1081, 1082, and 1084. Where present in cores, the dolomite was mainly recovered in the core catcher samples, as it impeded coring.

Leg 175 Shipboard Scientific Party:

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In keeping with ODP's commitment to actively seek collaboration and communication with other global geoscience initiatives, the JOIDES Journal is highlighting in each issue one or two of these programs in order to inform the ODP community of their goals and objectives.

Focus on International Geoscience Initiatives

IMAGES: The International Marine Global Change Study

by Laurent Labeyrie

Understanding and predicting changes in climate and the environment on human time scales represents one of the major challenges of our generation. The relations between climate forcing and responses are complex, and are linked to the non-linear dynamics of the interactions between ice sheets, the atmosphere, ocean circulation, and the continental surface. A wide variety of studies and models aimed at reconstructing the glacial / interglacial history of the last million years have revealed the need to increase the temporal resolution of the proxy data in order to decipher the interrelationships between the different components influencing the climatic system. For example, understanding the evolution of the ocean's thermohaline circulation or the extent of continental ice sheets requires a minimum of a century-scale resolution. Such resolution may be obtained in areas with high sedimentation rates (>10-20 cm / kyr); however, long sediment sections (several tens to few hundred of meters) are required to cover the key periods of fundamental climate change (from the time scales of the Milankovitch and ice sheet oscillations to those of the conveyor belt).

Methods used in the analysis of paleoclimatic proxies extracted from ocean sediments have improved considerably in recent years, allowing the production of quasi-continuous data series for the major climatological and hydrological parameters in the large oceanic basins. Proxy data may be generated over several hundred thousand to millions of years with a temporal resolution of one to a few centuries. Accurate palaeoclimatic interpretation of these records can only be achieved by integration with data on sedimentary properties. The immense economic demands of these studies, as well as the need for efficient exchange of knowledge, require close interdisciplinary and international scientific collaborations and coordinated research programs.

IMAGES (International Marine Global Change Study), whose scientific goals are outlined in its "Science and Implementation Plan", was created by PAGES-IGBP and SCOR to foster international coordination of marine global change studies. The major objectives of IMAGES are (1) to quantify climatic and chemical variability of the ocean on time scales of oceanic and cryospheric processes, (2) to determine the sensitivity of the oceans to internal and external forcing parameters, and (3) to specify the ocean's role in controlling atmospheric CO_2. IMAGES encompasses all the research activities that fall within its goals done by scientists from the different IGBP and SCOR member countries.

IMAGES and the Giant Piston Coring Program

In order to define the variability of surface and deep ocean physical and chemical characteristics during key periods of recent Earth history, modeling of climatic mechanisms must be based on high quality data and must be carried out on a global scale. Some of the necessary high resolution sedimentary records will be obtained within the framework of ODP since there is an important need for drilling to depths of 100 to 300 mbsf in key areas. However, at least 30 dedicated oceanographic expeditions are needed within the next decade in high sedimentation rate areas to collect several hundred cored and drilled sediment sections longer than 30 meters, and the necessary supporting data. These records, obtained through giant piston coring, would serve to (1) improve the resolution of the climatic record, (2) increase the number of locations at which the time period under study can be extended back to 200,000 - 500,000 years (or longer), and (3) act as local reference points for correlations of climatic variability on a regional scale. Pursuing such an objective within the realities of available resources requires efficient international coordination of sampling and analysis of the sediment cores, as well as sharing analytical tools and acquired data.

International giant piston coring cruises are being conducted using the French Polar Institute (IFRTP) vessel *Marion Dufresne*. Three cruises have already demonstrated the feasibility of large scale international collaborations for specific paleoceanographic objectives in different areas: North Atlantic (June 95), South Africa (Oct. 96), Southern Ocean-South West Pacific (June 97). A fourth cruise is planned for June 1998 near Indonesia and the Philippines. The recovered samples are reserved for study by the shipboard party for the first two years, but thereafter will be accessible to the entire IMAGES community.

Working Groups, Workshops and Conferences Sponsored by IMAGES

IMAGES is funded through contributions from participating countries and associations of institutions. Multi-year funding starting in 1996, 1997 or 1998 has been pledged by: USA (NSF MESH program), France (CNRS-INSU), Consortium of German institutions (Univ. of Bremen, Univ. of Kiel, GEOMAR-Kiel, AWI-Bremerhaven), Consortium of Canadian institutions (coordinated by Univ. of New Brunswick), Consortium of Universities from China, Taiwan, Great Britain (NERC), Consortium from New Zealand-Australia, Norway, Sweden, Iceland, Denmark, Portugal, Holland, Spain, Russia, Japan, South Africa and Tunisia. Contacts have been made and discussions are in progress in Mexico, India and Indonesia. These funds enable IMAGES to sponsor working groups and conferences addressing its scientific objectives. In addition, financial support has also been provided to scientists for participation in the AGU Fall Meeting in San Francisco (1996, 1997), to the European Geological Congress in Strasbourg, France (April 1997), and to the upcoming paleoceanography meeting in Lisbon, Portugal (Aug. 1998). Operational support is sought from national and international scientific agencies through proposal submission.

IMAGES has formed the following working groups in order to address geographically specific climatic conditions and its variability:

- WG 1 (Chair: E. Jansen, Bergen): This WG is preparing for a North Atlantic ultra-high resolution study of the Holocene and the last glacial period in the North Atlantic and Norwegian Sea, using the French vessel *Marion Dufresne* for recovery of about 40 cores of more than 35 m in length. The cruise is planned for Summer 1999; proposals are currently under review.
- WG 2 (Chair: M.-T. Chen, Taiwan): Project WEPAMA - WEstern PAcific MArgins heat fluxes. This WG focuses on high resolution studies of the variability of heat transfer along the western boundary currents of the North Pacific.
- WG3, with SCOR (Chair: W. Pixian, China): This WG focuses on the determining the evolution of the Indian and Asian monsoon from marine records, and will have its first meeting in Shanghai from 30 April - 3 May.
- WG4, with PAGES (Chair: T. Pedersen, Canada and A. Mix, USA): This WG addresses the inter-hemispheric and continent-ocean relationships along the western margins of America (Alaska to Chile).
- WG 5, EPILOG (Chair: E. Bard, France and A. Mix, USA): This WG plans a global reevaluation of the ocean surface and deep water hydrology at the Last Glacial Maximum.

Besides these operational working groups, the IMAGES Scientific Committee has established standing groups for examination of specific aspects of marine data acquisition or management of interest to IMAGES objectives :

- Data Advisory Committee; Chair: D. Anderson (dma@paleosun.ngdc.noaa.gov).
- New technologies for Sediment Imaging; Chair: F. Rack (frack@brook.edu).

Information

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Internet: http://www.images.cnrs-gif.fr❖

The Nansen Arctic Drilling Program

by Leonard Johnson

The international Ocean Drilling Program (ODP) currently samples all the world's oceans except the Arctic. ODP has drilled at about 80˚N in the Fram Strait, the "Gateway to the Arctic", but the Arctic Ocean proper remains to be explored (Myhre et al., 1995). The lack of drilling in this ocean is the result of two factors. First, until recently, scientific drilling platforms were not capable of working in a completely ice-covered ocean. Second, site survey techniques required for the preparation of ocean drilling sites are only now being adapted to Arctic operations (e.g., U.S. SCICEX program; Langseth and Coakley, 1996). However, the profound influence of the Arctic Ocean on the global environment, the rapid variability of the Arctic ice cover and its consequences for global change, as well as the unresolved geology of the basement under the Arctic Ocean and its rims, have led to a growing interest in drilling as a means to address these issues. The exciting scientific opportunities in the Arctic Ocean galvanized a small group of international scientists and government officials to meet in 1989 at the International Geological Congress and to initiate the Nansen Arctic Drilling program (NAD).

NAD is an international research effort designed to study the Arctic's geological evolution and past environmental change to better predict the future of the Arctic basin and its effect on global processes. Two major research themes are identified in the NAD Implementation Plan (1997; see also Johnson, 1997). The first is the effect of the Arctic on global environmental dynamics, and its role in the Earth's changing climate on short (decadal) and longer (millennium) time scales. The second is the lithosphere dynamics of the Arctic, for which studies will focus on structural features, such as Lomonosov and Alpha-Mendeleev Ridges, and the gateways to the Arctic — the Fram and Bering Straits. Additional research topics address physical characteristics of the Arctic, specifically permafrost and hydrate dynamics. These themes are similar to those outlined in ODP's Long Range Plan (1996); however, the emphasis of NAD is on scientific issues unique to the Arctic. These include: (1) When and how did the Arctic become a major component of global change? (2) What is the role of Arctic tectonics in global change? (3) What is the nature of the major structural features of the Arctic Ocean basin and how did they evolve?

Drilling strategies to investigate the paleoceanographic and tectonic history of the Arctic Ocean will first focus on continental shelves (e.g. the Laptev Sea) and on topographic highs (e.g. Lomonosov Ridge). Shelf sequences are characterized by higher sedimentation rates and are most sensitive to sea-level changes and variations in fluvial supply. Carefully selected sites on circumpolar continental margins and adjacent marginal plateaus present opportunities to target key time intervals for high resolution studies. These include processes such as:

- fluxes of sediment, water, and ice to and across the Arctic shelves;
- sea-level changes and their effects on the continental margins;
- extent of ice sheets and permafrost conditions;
- paleoceanography of an early Glacial and pre-Glacial polar ocean; and
- evolution of polar pelagic and benthic marine biota.

To study the longer-term history of the Arctic Ocean paleoenvironment, a Giant Piston Coring program (Arctic IMAGES) (Pisias et al., 1994) has been recommended as Phase 1, followed by a drilling program as Phase 2.

On 1 January 1998, NAD reorganized its structure to include Regional Planning Groups (RPGs) to facilitate implementation of the goals of the program. Each RPG consists of a Chairperson, three scientists (including a geophysicist), and a technical expert. This organizes NAD on a project-by-project basis to be funded from different sources depending on the project site.

NAD has established formal linkages with ODP, Past Global Changes (PAGES), the Arctic Ocean Sciences Board (AOSB), Working Group VIII of the U.S. / Russia Bilateral Agreement on the Environment, and the IASC. Informal linkages exist with the Cape Roberts Project, the International Continental Drilling Program and ARCSS / OAII. A very close association with ODP will be particularly beneficial as it will enable NAD to take full advantage of the established policies and programs for support services developed by ODP.

Regional Planning Groups	
Margin	***Basin***
Laptev	Lomonosov
Mackenzie	Alpha
Yermak	
Morris Jesup	
Chukchi	
Bering "land brige"	

The ODP Site Survey Panel, the Technology and Engineering Development Committee, and the Pollution Prevention and Safety Panel provide an opportunity for NAD to receive the guidance and advice of world-class experts and to adhere to — and support — the standards which have proven successful throughout the life of the ODP.

NAD membership now includes Canada, France, Germany, Japan, Norway, Sweden, the United Kingdom, USA, and Russia. Denmark, the Netherlands, Finland and Iceland have participated in the program as observers. Invitations to join have been sent to International Arctic Science Committee (IASC) members China, Italy, Poland, and Switzerland.

NAD maintains a formal Secretariat (funded by participating countries) at Joint Oceanographic Institutions Inc., Washington, D.C. The Secretariat coordinates NAD's funding, communications, special projects, and produces a newsletter, *The Nansen Icebreaker*. Copies of the NAD Science Plan (1992), Implementation Plan (1997) and the semi-annual newsletter can be obtained from JOI, Inc. Additional information is available on the world wide web at http://www.joi-odp.org.

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Leg 174B – continued from page 3

pair of Leg 168 CORKs on the flank of the Endeavour Ridge (Davis and Becker, submitted), strongly support other inferences that there are huge fluxes of low-temperature fluids in very transmissive upper basement in thinly sedimented young oceanic crust, regardless of whether the sediment cover is continuous or patchy and regardless of spreading rate.

Leg 174B Shipboard Scientific Party:

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Borehole Electrical Images: Recent Advances in ODP

by Carlos Pirmez & Tim S. Brewer

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Since its introduction during ODP Leg 126, the Formation MicroScanner (FMS™) has been extensively used to provide detailed images of ODP boreholes in sedimentary, volcanic and, in a few cases, metamorphic basement rocks. The FMS creates a picture of the borehole wall by scanning its electrical conductivity through an array of 64 button electrodes. Current variations in each button are sampled every 2.5 mm with a vertical resolution on the order of 1 cm. Tool position is derived from triaxial acceleration measurements, and tool orientation is determined with a triaxial magnetometer. The conductivity measurements are then converted to color or gray-scale images for display. Changes in borehole wall electrical conductivity represent variations in pore geometry, pore fluid conductivity and cation exchange due to clays and other minerals; hence, variations in color intensity seen on FMS images represent the tool response to changes in fluid content (porosity) and type, mineralogy, grain size, degree of consolidation and cementation, pore structure and perhaps permeability (Bourke et al., 1989; Serra, 1989).

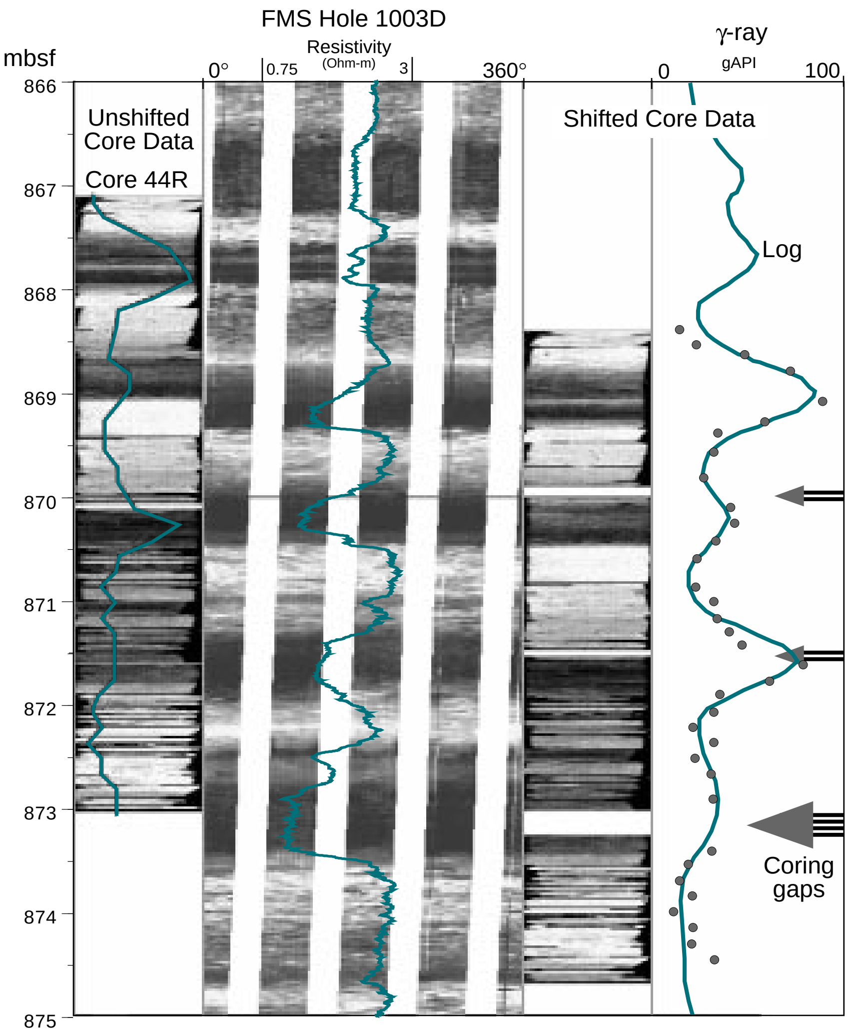

Figure 1. Example of high-resolution core-log depth matching in the middle Miocene carbonates from Site 1003, Great Bahama Bank (ODP Leg 166). On the left side the core photograph and gamma-ray measurements are shown at the original, curatorial depths. Superimposed on the FMS image is the average of the 64 button conductivity traces scaled to absolute resistivity (using the spherically-focused log). On the right panel, the core photos are shifted to match the FMS images, with corresponding depth shifts applied to core gamma-ray measurements (dots). Note fine-scale match at sharp color boundaries and corresponding boundaries in the FMS image. The best match was achieved by lowering the core top by ~1.5 m and further shifting individual core pieces separately (not necessarily at section breaks), revealing recovery gaps within the core, particularly within the darker (and softer) sediments. Good match between core and log gamma-ray measurements serves to independently confirm the depth match.

The oriented resistivity images generated by the FMS tool are akin to core images, and this has been one of the key factors in the dramatic increase in the use of these logs in the past several years, both in ODP and industry. The processing and interpretation of FMS images, with particular emphasis on industry data, is discussed extensively by Serra (1989). Examples of scientific applications of well logs, including FMS images, have been recently reviewed by Goldberg (1997). Here we focus on recent applications of FMS images from sedimentary and volcanic environments. These data illustrate the potential of continuous electrical borehole images in estimating lithology, physical properties, and sedimentary cyclicity in various seafloor environments.

Sedimentary Rocks

Sedimentary sequences offer a high-resolution record of climatic fluctuations, sea-level changes, and tectonic processes occurring at continental margins and in ocean basins. Unraveling this sedimentary record requires continuous information on the sediments, either directly through cores (or outcrops), or through remote sensing methods, including downhole measurements.

During ODP Leg 166, a series of boreholes were drilled and logged in a transect across the Great Bahama Bank, where rapid sealevel fluctuations during the Neogene led to marked variations in the geometry and stratal patterns seen on seismic profiles. Middle Miocene carbonates from the Great Bahama Bank slope display cyclic alternation of light and dark sediment layers (Figure 1; Eberli et al., 1997; Williams and Pirmez, in press). The well cemented, electrically more resistive intervals are represented by light colors in both core and FMS images. The light intervals consist of well cemented, moderately burrowed wackestones containing planktonic and benthic foraminifers, as well as bioclastic fragments of shallow water origin. The dark intervals represent less lithified, intensely burrowed bio-wackestones, with abundant planktonic foraminifers and minor amounts of organic carbon and clay (5–7%). Dark intervals show evidence of dissolution, with development of moldic porosity and flattening of burrows during early compaction.

The illustration in Figure 1 is an example of precise core-depth matching using two different visual correlation techniques: 1) scanned core photographs versus FMS images, and 2) natural gamma-ray profiles measured on core versus downhole gamma-ray measurements (Major et al., in press). The image correlation is based on different types of measurements — borehole wall electrical conductivity measured in the FMS log versus light reflectance recorded in the core photograph. The excellent correlation between the two parameter in these carbonates indicates that electrical conductivity (a measure of fluid and clay content) and color are intrinsically related. The gamma-ray data correlation on the other hand, is based on the same physical measurement (natural radioactivity) and, although of lower vertical resolution, it helps eliminate uncertainties in the correlation through gamma-ray peak to trough amplitude matching.

The high-resolution core-log depth matching in these rocks demonstrates that core tops often are located at a position lower than that assumed during core curation, indicating that the drilling process washes sediment out before it enters the core barrel. Furthermore, in formations with alternating soft and hard sediment layers such as in these cyclic carbonates, the softer material often is not fully recovered, leading to gaps within the core. Precise positioning of core pieces is critical for the determination of sedimentation rates, for the interpretation of depositional history, and for correlating data between adjacent drill holes or with seismic reflection profiles. Core-log depth matching is also critical in evaluating intervals of no core recovery using downhole log data.

Core-log integration studies can benefit from the availability of the very high vertical resolution FMS conductivity log. In Figures 1 and 2, a log curve is constructed from the average conductivity measured by the 64 electrodes of the FMS tool (16 in each pad). Because the electrical current flowing through the electrodes is not focused (unlike other resistivity tools), the raw conductivity measurements derived from the FMS are not calibrated directly into absolute resistivity values. However, an empirical calibration can be performed by scaling the FMS measurements to another resistivity curve, such as the spherically-focused resistivity log. Integration and calibration of the high-resolution resistivity curve against other logs and core measurements (sonic velocity, density, gamma-ray, etc.) offers the potential to derive physical properties at a resolution higher than can be obtained by standard methods of core analysis.

The FMS log can also be used as a proxy for sediment cyclicity analyses, where the cyclic expression is reflected through conductivity changes. This is well demonstrated in the data from the Mio-Pliocene drift deposits at ODP Site 1006. Thin beds resulting from oscillations in bottom-current activity, sea-level changes, and associated variable input of bank-derived carbonates (light cycles) and pelagic carbonates and clays (dark cycles) could not be entirely distinguished using standard logs. Using biostratigraphic ages, spectral analysis indicates that the main variability seen in the resistivity log (dark / light couplets) occurs in the Milankovitch precession bands (19-23 ka). By defining the thickness of every cycle in

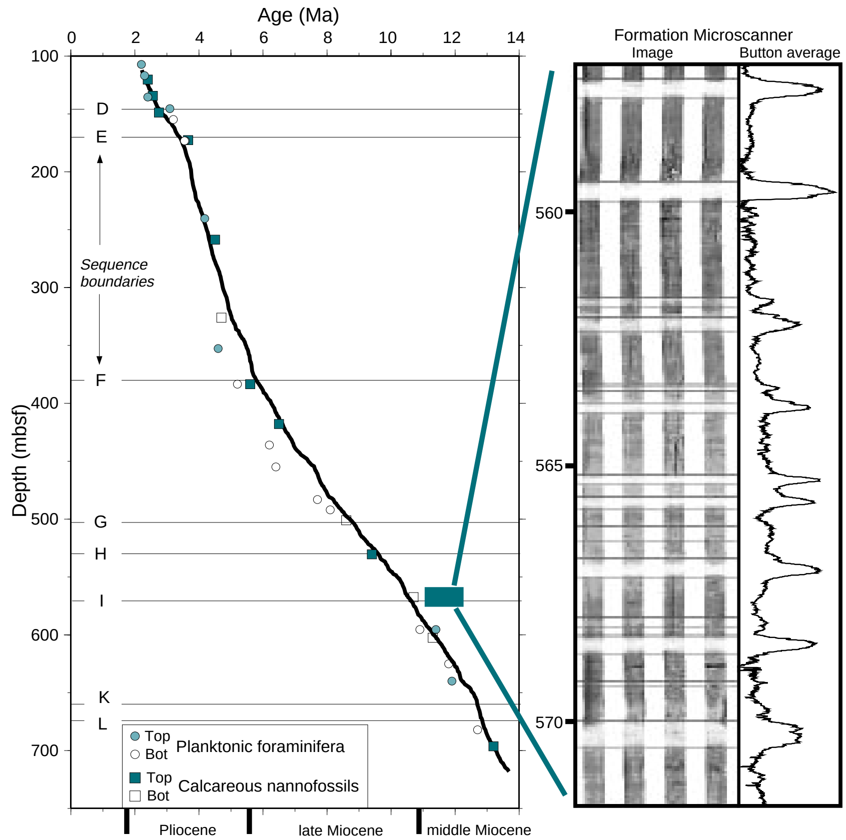

Figure 2. Analysis of cycles from the Miocene-Pliocene drift deposits in the Florida Straits, Site 1006 (ODP Leg 166). The image on the right shows sedimentary cycles composed of resistive (light)-conductive couplets. Guided by the image and button-electrode average conductivity (button-average trace) we defined the thickness of each cycle from the tops of resistive intervals. Spectral analysis and bio-stratigraphy suggest a precessional periodicity. An age-depth curve was then constructed by adding the thickness of each cycle and assuming a cycle duration of 21 ky. Note good match to biostratigraphy (preliminary shipboard picks). Further refinement of the stratigraphy at this site is still required before new ages based on cycle number can be assigned to biostratigraphic data. Compare the relatively thin resistive part of the cycle at this more distal site with Site 1003 (Fig. 1), which is closer to the shallow portion of the carbonate platform.

the interval logged and assuming an average duration of 21 ka, a detailed age versus depth curve can be constructed for the site (Figure 2). An integrated analysis of the FMS-based stratigraphy with bio- and magneto-stratigraphy at this site is in progress. Because FMS logs — hole conditions permitting — can be acquired continuously, cyclostratigraphic studies based on the high-resolution images are a powerful tool in the arsenal of techniques for precise global stratigraphic correlations.

Oceanic Crust

Construction of ocean crust is one of the most fundamental processes on Earth. Volcanism has been operating for at least 2.0 Ga in its present form and probably in a similar or slightly modified fashion since our earliest history. Until the mid 1970s, the inaccessibility of the ocean floor limited models for the structure of ocean crust to a simple layered stratigraphy, as inferred from extensive studies on ophiolite complexes. The stratigraphy of the ocean crust is important since it is a function of (a) the distribution of volcanism within the neovolcanic zone (rift valley), (b) fluid circulation, and (c) secondary alteration, including associated chemical fluxes.

Important information on the construction of the volcanic stratigraphy is provided by core samples through scientific ocean drilling (DSDP and ODP), but is limited by the poor and biased core recovery which generally characterizes basement holes (less than 25% on average). The core record is also often biased toward the rheologically more competent units, such as pillow interiors and massive units, which are more easily recovered. This can lead to large errors in the derived crustal lithostratigraphy (Brewer et al. 1995). However, downhole logging can provide nearly continuous and high-resolution records of the physical and / or chemical properties of the borehole. By integrating analyses of the core with downhole logging measurements, the potential exists to determine the 3-D geometry of the crust and to evaluate how magmatic and secondary (e.g., alteration) processes relate to the observed lithological variations.

Several studies have now demonstrated the potential use of FMS images to discriminate between different volcanic lithologies in ocean basement holes (Davis, Mottl, et al., 1992; Langseth and Becker, 1994; Brewer et al., 1995, and in press). An advantage of FMS images is that they may be viewed as resistivity maps of partial sections of the borehole wall (~25% coverage in a 12 in. diameter hole). Based on the conductivity contrast between basaltic clasts or pillows and the breccia matrix or the interpillow material (Figure 3), the internal structure of brecciated units and pillow lavas, lithological boundaries, and the distribution of secondary low temperature vein arrays can be determined. The key distinguishing features between breccias, pillows and flows revealed through these borehole images are:

- Flows: images dominated by largely uniform resistivity. Individual flows truncated by discrete fractures (conductive clay infills) of variable orientations (Figure 3a);
- Pillow lavas: elliptical shaped sacks of resistive basalt, with variably-sized conductive intercalations of interpillow material (Figure 3b);
- Breccias: generally mottled images with both veined and unveined clasts (Figure 3c). Rapid variations in resistivity reflect size, shape and distribution of clasts, and the composition of the matrix material.

One key question in studying ocean basement is: does the style of volcanism change with spreading rates? Geophysical data and submersible observations of the seafloor have indicated that, at

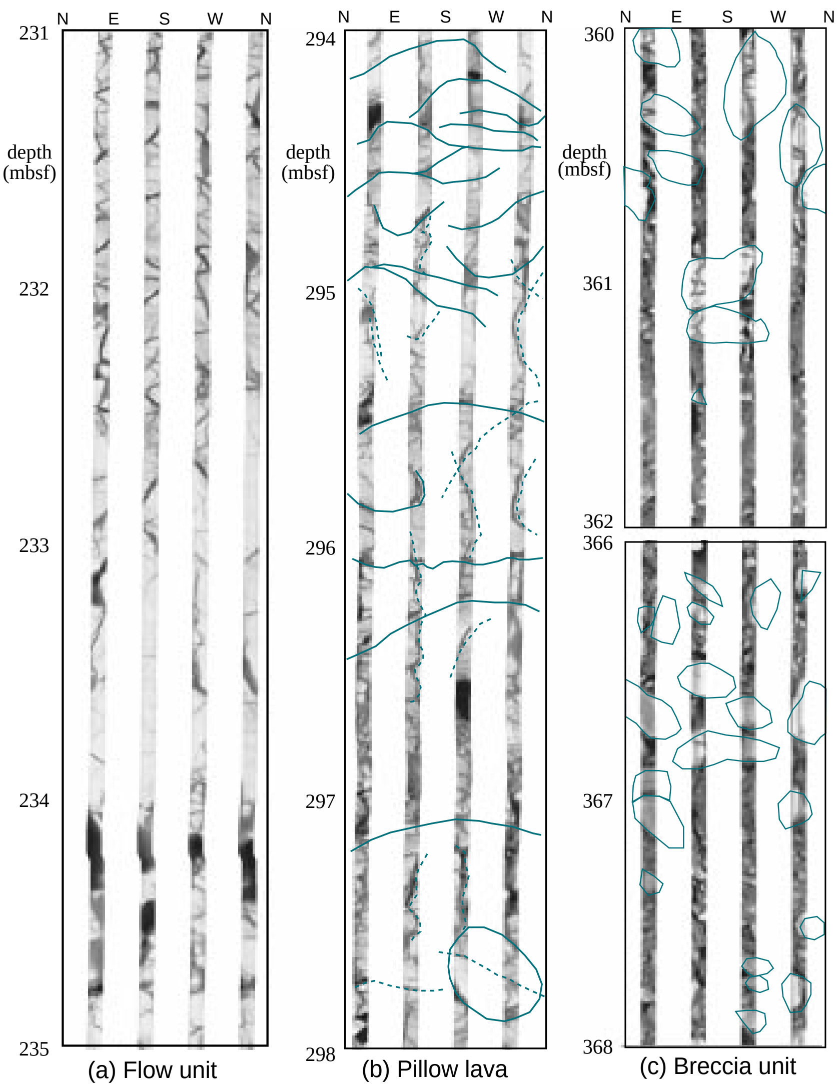

Figure 3. Formation MicroScanner images with typical examples of oceanic crust rock types. Individual portions of pillows are highlighted in (b) and larger blocks are highlighted in the breccia in (c). Light tones are more resistive, data from Hole 896A, located about 200 km south of Costa Rica rift, in crust about 6.1 my old.

least on the surface, the proportions of flows increase and pillow lavas decrease with increased spreading rate (e.g. Smith and Cann, 1992). However, drilling provides another important dimension — time. An initial comparison between slow (Hole 395A) and intermediate (Holes 896A and 504B) spreading-rate systems indicates that this relation is also observed downhole (Figure 4a). This variation probably reflects enhanced effusion rates, consequently allowing more axially-focused sheet flows to develop in the faster spreading rate ridges. It is also evident from Hole 896A that pillow lavas are more abundant in the upper parts of the stratigraphic column (youngest volcanism, Figure 4b), suggesting a change in volcanic style within the neovolcanic zone. This change in the style of volcanism probably reflects small volumes of magma, perhaps with small discrete magma chambers, and lower effusion rates in an off-axis setting which would favor pillow lava eruptions.

Conclusions

The potential of high-resolution FMS electrical borehole images is still being developed within ODP, although it is clear that they provide new, fundamental information for the marine geologist. Borehole images are now available for sites drilled and logged during nearly fifty ODP legs. Information on these data can be obtained through our web site and full online availability is planned for the near future.

The above examples illustrate how integration of core data together with borehole images can be used for precise, centimeter-scale core-log depth matching, evaluation of physical property variations through a high-resolution conductivity trace, detailed evaluation of lithology and core-recovery bias in ocean crustal sites, and cyclostratigraphic studies in intervals of relatively low sedimentation rate. Once detailed depth matching is achieved, borehole images can be used to spatially orient core features. This then allows detailed analysis of structural and magnetic measurements recorded in unoriented cores to be integrated with oriented seafloor measurements and placed within a tectonic and stratigraphic framework (ODP Legs 173 and 176, Shipboard Scientific Party). Such applications will ultimately provide an orientated three-dimensional picture around the drill hole for use in detailed modeling of the processes which operate at various spatial scales.

The interpretations discussed here have been made possible by software tools capable of handling the image data easily, by increased computational power (FMS data files are ~1 Mb / meter), as well as by the efforts of ODP to deploy downhole tools at most drill sites. Image quality is highly dependent on borehole conditions, and our experience indicates that the best results often are achieved where devoted holes are drilled for logging (e.g., Hole 1003D, Fig. 1), thereby diminishing hole deterioration effects associated with long delays between drilling and logging in cored holes. Integrated interpretation of cores, FMS images and other downhole measurements will help ODP achieve its long-range objectives, particularly as we tackle challenging environments such as deep drill holes in continental margins and crustal sites, where continuous core recovery is likely to be difficult.

Note: Additional information on the FMS and other logging tools can be found at the web site of the Borehole Research Group at Lamont-Doherty Earth Observatory (*www.ldeo.columbia.edu/BRG*).

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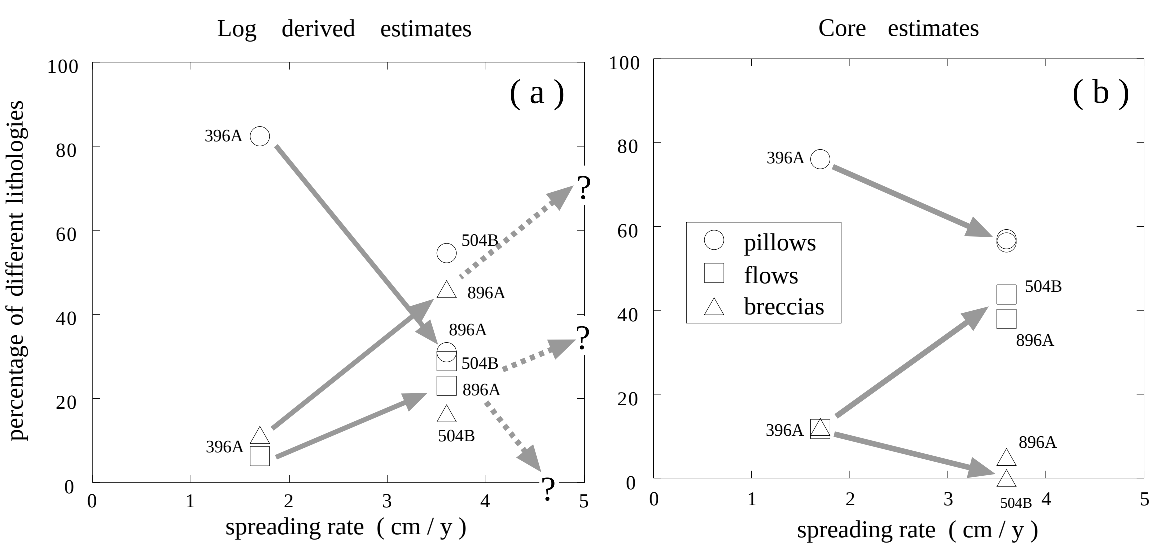

Figure 4. Comparison of (a) log-derived and (b) core-derived estimates of flows, pillow lavas and breccias in crust formed at a slow spreading center (Hole 395A) and at intermediate spreading centers (Holes 504B and 896A). The dashed arrows indicate the extrapolation of trends obtained from log data to a fast spreading center.

Coring Improvements: A Supplement to the Article "Platforms for Shallow Water Drilling" (JOIDES Journal, Vol 23, No 2., pp 15-17).

by Alister Skinner

Alister Skinner is at the British Geological Survey in Edinburgh, UK, and has many years of experience in drilling. He also serves as the Chair of the JOIDES Technology and Development Committee (TEDCOM), and readily offers his help and assistance concerning the availability and use of coring systems.

The technology summary by Mountain and Driscoll of the Marine CAM Shallow Water Drilling Workshop reported in JOIDES Journal, Vol. 23, No 2 (pp. 15-17) fails to highlight improvements in coring, and the availability of new methods, many of which have been in use since the late 1980s. The developments have improved core quality, water depth range and below seabed penetration, and many of the tools have been operated worldwide, both scientifically and commercially, with good results at competitive prices for several years.

It is invariably difficult to get technology details published and thus disseminated, even as a statement in scientific papers detailing how the cores were collected. Usually the information is contained only in conference proceedings, some of which are referenced below. The aim of this article is to show the range of developments available to science thus providing additional information to the reader wishing and needing to pursue them.

- Large gravity / piston corers continue to give excellent results for high resolution climate work. In sediments that are soft enough for this type of coring, cores up to 50 m in length have been recovered by French and German groups.
- Electric vibracoring, correctly identified as being difficult in stiff clays and sands, can operate to at least 2000 m water depth (the British Geological Survey (BGS) have operated to 2,200 m), and units with penetration recording and core barrel retraction prior to lifting from the seabed have increased the core quality to fully acceptable geotechnical standards (Ardus et al, 1982). Although 6 m penetration is the present limit of the BGS system, it allows cores to be taken where none have been available before because the material has been too stiff or too dense to be sampled by non-powered corers.
- There is also at least one rock drill which can operate to the same water depths and has been doing so since 1985 (Pheasant, 1984).
- There are combination tools which can vibracore or rock drill or can vibracore and take Cone Penetration Tests (CPT's), being operated by the British and Danish Geological Surveys respectively (see Geodrilling Magazine, December 1997). Cone Penetrometers as individual tools are commonly used by the geotechnical industry onshore and offshore to obtain high quality *in-situ* physical properties of soils and can be used in conjunction with wireline coring to obtain such parameters in relevant materials throughout the length of a borehole. Cone tip resistance and sleeve friction indicate lithologies and shear strengths while the addition of a pietzocone gives information on porosity and permeability. Their use in conjunction with seabed coring allows for direct calibration with lithologies and integration of other engineering (CPT) data where no cores may exit. Offset coring, based on good geophysical data, over a wide area further increases the scientific value of such tools.
- A hammer drill developed by a European Union consortium has the potential to take cores up to 30 m in length, with an electro-hydraulic system providing the motive power. Presently available cables limit operations to 350 m water depth, but the system has been designed to operate in up to 5000 m water depth (Smith & Tronstad, 1994).
- A hydrostatic corer, the Selcore, has been developed by Bergen University, Norway, with assistance from both an engineering and an oil company. It has so far successfully cored some stiff clays and sandy sediments to 11 m below seabed and, as it operates in a similar manner to a gravity corer, has a water depth limit dictated only by the cable length.
- Push / percussion and rotary coring are routinely used in shallow waters from a variety of platforms and their coring capability can be extended by using vibracoring techniques downhole in a percussion-style borehole. Incidentally, this also works well on land and was the means used in a major UK Scientific Programme, LOIS, to obtain high quality cores from coastal sections and estuaries in a study of Holocene transgressions.
- Wireline coring similar to ODP (in core recovery and coring operations – not in laboratory facilities) has been around since 1975. BGS has drilled more than 600 boreholes by this method. Using small dynamic-positioning vessels and aluminum drillstrings, we now have the capability of operating a 2000 m drillstring. Unlike ODP, however, these small vessels do not have a problem with operations in shallow water where they can use a taut wire while, in deep water, they routinely use Differential GPS to hold station. The vessels can use a wide variety of scientific coring equipment, and

integration of some Russian equipment into various drillstring configurations over the past three years now allows even more versatility in the types of core that can be retrieved.

- A UK company, Seacore, has developed a number of portable marine drills which can be used on suitable vessels of opportunity. Presently they have a water depth capability of at least 2500 m with steel pipe, and this may be increased to 3000 m in the near future.

The price ranges quoted for the operations in Mountain and Driscoll's Table 1 are probably reasonable for one-offs, but are rather high if a number of projects were to be put back-to-back so that one mobilization and demobilization would be necessary and a longer period day rate could be negotiated. In addition, the seasonal occupancy of some vessels allows for good rates to be negotiated when commercial activity is low but the potential for productive work still remains. Following the examples of the oil industry and pooling together resources, which are expensive to both develop and run, there is tremendous opportunity to blend available technology and scientific knowledge to improve the scientific productivity, despite constantly reducing budgets.

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Reply to the Previous Comment

by Gregory Mountain & Neal Driscoll

We thank Alister Skinner for his well-documented update and expansion to our brief overview of technology available for coring at margins. We emphasize that our small gathering of scientists and technical experts focused on the desire to recover sediments (or their in situ properties) from water depths too shallow to be collected by the JOIDES Resolution. Hence, we limited our examination to coring/monitoring devices appropriate for continental shelves and carbonate platforms, especially in 75 m of water, or less. Continuous cores and logs of unconsolidated sediments in shallow water environments are needed to understand many societally relevant earth processes, and widespread knowledge of the tools at hand is crucial.

Alister has also provided valuable perspective by outlining tools that can be deployed from other platforms, many operating in deeper water and designed to recover hard rocks exposed at the seafloor. We look forward to continued dissemination of the type of information that Alister has supplied.

Leg 174A – continued from page 6

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A Message from the Chair —

With the dust settling after the implementation of the new JOIDES Advisory Structure, it is time to start planning for the future. As you know, the Ocean Drilling Program will end in 2003, and hence we must start building an international community consensus for a new program for scientific ocean drilling. The ODP Long Range Plan, published in 1996, called for a two-ship program as the next phase of scientific ocean drilling. This approach was strongly endorsed by the US community in a recent document: COMPOST-II — "A New Vision for Scientific Ocean Drilling".

International planning efforts took a major step forward last July when the Conference on Cooperative Ocean Riser Drilling (CONCORD) defined the scientific initiatives that can be addressed through use of a riser-equipped drilling vessel, which will be one of two major vessels in a new multi-platform program. That meeting targeted a comprehensive study of a seismogenic zone at a convergent margin as the first project for this vessel to begin in the early part of the 21st Century.

The International Working Group (IWG), which consists of representatives from funding agencies in countries and communities interested in participating in a future ocean drilling program, has now requested the help of the JOIDES Advisory Structure in planning for a new Integrated Ocean Drilling Program (IODP). If any of you can think of a better name, please let me know!! In response to this, SCICOM has implemented three activities that are aimed at developing a compelling, new scientific vision for IODP, planning for the first leg of the riser drilling vessel, and determining how best to obtain advice on the technical and operational infrastucture of a multi-platform program.

Of particular interest to the broad Earth Sciences community is a plan to hold an international conference in the spring of 1999 to define the scientific objectives for future ocean drilling intended to complement those already enunciated for riser drilling by CONCORD. In this JOIDES Journal, you will find an advertisement requesting your input to this meeting. **If we are to have a drilling program to follow ODP, it is critical that you respond!** We must demonstrate that there is a groundswell of support for scientific ocean drilling, and we must come together to build a consensus on the key scientific objectives for a new, and more technologically advanced, program. Can you imagine Earth Sciences without an ocean drilling program? This is your chance to have a voice in the future directions of scientific ocean drilling — do it now!

More detailed planning for the seismogenic zone study using the riser drilling ship has also been initiated. Rather than set up a fully staffed Detailed Planning Group (DPG) at the outset, SCICOM decided to send out a Request for Proposals (RFP) for experiments or investigative strategies that might be included in a comprehensive study of a seismogenic zone near Japan. As you will see from the notice in this JOIDES Journal, a special deadline of 1 August has been established for these RFPs. The five DPG members already selected by SCICOM to initiate this process will then be joined by others based on the proposals submitted. They will then begin defining the scientific objectives of a seismogenic zone experiment, developing a coordinated drilling strategy that will likely include an integrated program of non-riser and riser drilling, and identifying the site survey data that will be required prior to drilling.

Obtaining advice on the technical and operational infrastructure of a multi-platform program is one area where the JOIDES Advisory Structure has very limited expertise. In fact, at this point, it is difficult to define the questions we should be asking!! Consequently, SCICOM decided to begin to tackle this by holding a 1-2 day Workshop in the fall to which we would invite experts from industry, both from within and outside the JOIDES Advisory Structure, to discuss our vision of an ocean drilling program and to ask for advice on the most effective mechanisms to determine the technical requirements and infrastructure of IODP. Based on the results of that meeting, we might then be able to more clearly define the path that we should follow to develop the operational infrastructure in step with the development of our scientific ideas.

This time of rapid change in ODP has also been accompanied by changes in the faces we see in senior positions at both JOI and TAMU. Dave Falvey left JOI to assume a position as Director of the British Geological Survey. While with ODP, Dave worked hard to increase international participation in the program, and put into place new project management practices. Tim Francis also departed from ODP to return to a Professorship at TAMU after many years of involvement in a variety of capacities in DSDP and ODP! Finally, Ellen Kappel has taken a year's development leave after many years of dedicated service to ODP. I know you join me in thanking them all for their contributions to ODP, and in wishing them well in their new endeavors.

On the brighter side, we are very fortunate to have Nick Pisias — a long-time friend of ODP — step into the position of Interim Director of ODP at JOI while the search for Dave's replacement is underway. John Farrell has stepped up to bat as Associate Director for ODP at JOI, and is working hard and learning fast. We owe both these individuals our thanks, and our support in their efforts. Finally, I am delighted to announce that Germany has been selected to host the JOIDES Office, starting on 1 January 1999, when Helmut Beiersdorf will become Chair of EXCOM, and Bill Hay will become Chair of SCICOM. The Program will be in good hands with their strong leadership!

Susan E. Humphris

A Message from the Interim Director of ODP —

It is now five months since I restarted my direct involvement in ODP, and the first time I have had the opportunity to address all of the ODP community. As noted by Susan Humphris, ODP is experiencing a time of major transition — a changing panel structure, planning a new program beyond 2003, and significant changes in the management team.

From the Interim Director's office, I see three major challenges in this transition. Clearly, the most important task of a new Director of ODP is facilitating the processes necessary for the establishment of a new scientific drilling program. There is much to be done in defining the structure, establishing new partnerships for funding and support of the program, and coordinating community involvement.

The second challenge is management of the present program. We are completing the Program Plan for 1999 this month and it will be within budget. We have four more years of planning and program ahead, but we are also seeing limited growth in the ODP budget. Because of this limited growth, I asked that JOIDES begin a process of defining what are the essential services that ODP needs to provide the scientific community to achieve the scientific goals outlined in the Long Range Plan. This list of services and the priorities of the Long Range Plan is essential to making good management decisions for ODP.

The final challenge is finding a new Director to lead ODP in Phase III and beyond. There are really two challenges here. First, we must find the right person who not only can manage the program, but also has the skills to focus the community towards the consensus necessary for building a new program. The second challenge is for the community to come together and support the new Director. The Board of Governors of JOI Inc. have been talking with a few very strong candidates. Although some of these individuals are not from the ODP community, they bring important new strengths that are essential at this time of transition. I have greatly appreciated the overwhelming support and encouragement I have received in taking this interim position, and I trust the community will provide this strong support to the next Director.

On a personal note, I took the position of Interim Director as a service to the community — a community that has many outstanding scientists to whom the drilling program is absolutely critical in addressing important problems in geoscience. Before accepting the position, I asked myself whether there were still outstanding problems that demanded a drilling program beyond 2003? I have asked this question many times in the last few months and I have always received the same answer — YES. So, I hope that my short time as Interim Director may have helped in achieving that goal.

Nick Pisias
Interim Director of ODP at JOI, Inc.

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ODP Science Plan: Legs 184 – 188

by Katherine Ellins

The schedule for Legs 184 - 188 was developed in August 1997 by SCICOM in conjunction with its subcommittee, OPCOM. Under the ODP Long Range Plan core theme, *Dynamics of Earth's Environment*, Leg 184 (The East Asia Monsoon) and Leg 188 (Antarctic Glacial History) address objectives contained in the sub-themes, *Understanding Earth's Changing Climate* and *Causes and Effects of Sea Level Change*, respectively. Under *Dynamics of Earth's Interior*, Leg 185 (Mariana-Izu Mass Balance) and Leg 187 (Mantle Reservoirs and Migration: Australia-Antarctic Discordance) address objectives in the sub-theme, *Exploring the Transfer of Heat and Material To and From the Earth's Interior*, and Leg 186 (W. Pacific Seismic Network: Japan Trench) tackles objectives in the sub-theme, *Investigating Deformation of the Lithosphere and Earthquake Processes.*

Leg 184: East Asian Monsoon History

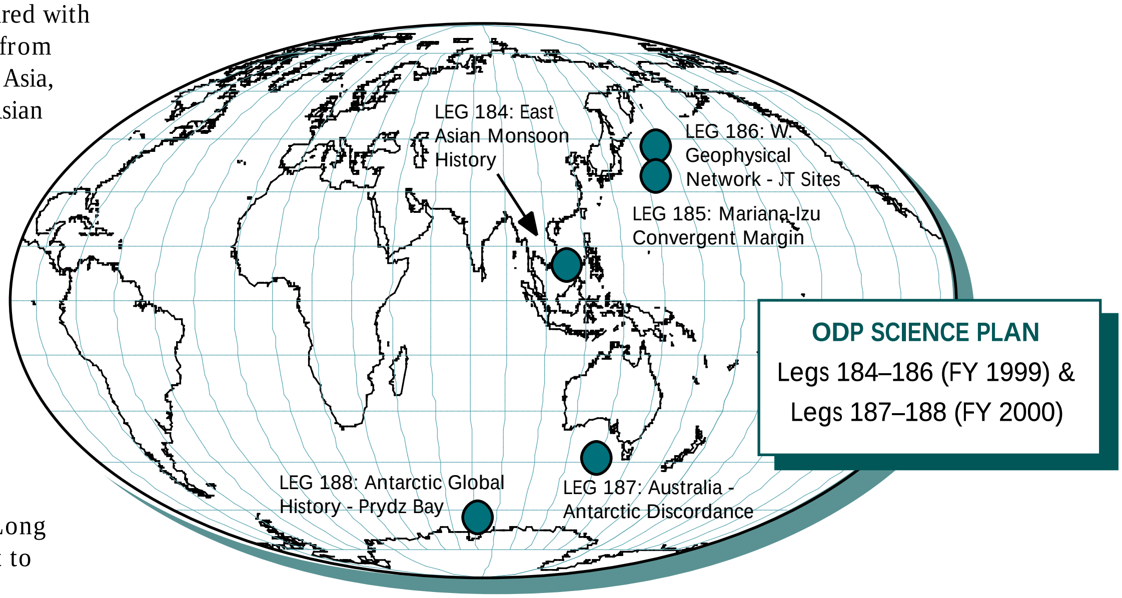
The Asian monsoon is responsible for a significant portion of inter-hemispheric mass and energy transport, and dominates oceanic and atmospheric interaction in the tropics; it is a primary component of the global climate system. The Asian monsoon system consists of two closely interrelated sub-systems: the South Asian (or Indian) monsoon and the East Asian monsoon. Leg 184 will drill seven sites in the South China Sea to document the evolutionary development and variability of the East Asian monsoon to better understand the relationship between the uplift of the Himalayan / Tibetan system, monsoon evolution, and global cooling. Drilling will provide a continuous marine record of climate history in East Asia which can be compared with terrestrial monsoonal records from China and other parts of East Asia, and the record of the South Asian (Indian) monsoon system obtained on Leg 117.

Understanding the interaction between climate and tectonics is fundamental to understanding earth's changing climate, the causes and effects of sea-level changes, and studies of global tectonics, all of which have been identified as high-priority scientific objectives in the 1996 ODP Long Range Plan and are of interest to IMAGES. The importance of this program is further underscored by the creation of an ODP Program Planning Group (PPG) by SCICOM to develop drilling strategies specifically aimed at investigating the interaction between climate and tectonics.

Leg 185: Mariana-Izu Convergent Margin

Leg 185 will investigate the solid Earth geochemical cycle by determining the net fluxes of material at the Mariana-Izu subduction zone by mass balance of the inputs (sediment and basaltic portions of the incoming plate) and outputs (sediment and fluid fluxes to the fore-arc crust and mantle, and crustal components recycled to the volcanic arc and back-arc). Previous drilling has already provided information about many parts of the crustal flux equation at the Izu and Mariana margins. Leg 125 drilled fore-arc sites, permitting the study of fluid outflow, and sedimentary components being subducted at the Mariana trench were sampled by Leg 129. In addition, the volcanic arcs and back-arcs are among the best characterized from intra-oceanic convergent margins. The missing part of the flux equation is the input. To provide this information, Leg 185 will deepen ODP Hole 801C to sample the altered oceanic crust input to the Mariana trench, and drill at Site BON-8A to characterize the sedimentary and crustal section being subducted at the Izu-Bonin trench.

Understanding physical and chemical processes during crustal formation and destruction at convergent margins is fundamental to studies of



global tectonics, magmatism and geochemistry. In particular, the quantification of global geochemical cycles and mass balances at subduction zones, is recognized as being of first-order importance to the scientific communities represented by geoscience programs such as the MARGINS Initiative.

Leg 186: Western Pacific Geophysical Network (Japan Trench)

The Western Pacific is the best suited region on earth to address the dynamics of the subducting plates, their relation to mantle convection, and associated earthquake events. Although an expanding land-based geophysical network exists in the western Pacific region, and Japan is densely networked with seismic stations, up to 75% of the Pacific plate motion in the Japan trench subduction zone is attributed to earthquakes not recorded on normal seismographs located on land. To obtain crucial field data about these subduction zone earthquakes, particularly tsumanigenic and slow earthquakes, and to better understand plate subduction from the trench to the deep mantle, Leg 186 will drill two boreholes in the accretionary wedge near the Japan trench to serve as long-term geophysical observatories. These boreholes will be instrumented with broadband seismographs and strainmeters which will be installed after the drilling by Japanese scientists. Permanent undersea fiber optic cables have already been laid between Japan and the proposed drill sites to permit real-time data recovery, to supply power, and for constant monitoring of the instrument functions.

Leg 186 is of great societal relevance because the Japan trench is close to major population centers that are threatened by both tsunamis and earthquakes. In addition, this program is directly relevant to two special initiatives of the 1996 ODP Long Range Plan, “In situ Monitoring of Geologic Processes” and “Exploring the Deep Structure of Continental Margins”, and to several other geoscience initiatives, including ION, OSN, SEIZE, VENUS and DEOS.

Leg 187: Mantle Reservoirs and Migration — the Australia-Antarctic Discordance

Leg 187 will investigate relationships among ocean crustal composition, mantle composition, spreading and magma supply rates at the Australian Antarctic Discordance (AAD). The AAD, located on the Southeast Indian Ridge, is an anomalous deep (4-5 km) region within the global mid-ocean ridge spreading system that coincides with an isotopic and geochemical boundary. Leg 187 aims to (1) precisely delineate this isotopic boundary and determine its configuration out to at least 30 Ma, and (2) investigate the mantle dynamics of the region, and their relation to the anomalous processes within the AAD. Identification of the off-axis position of the isotope boundary will permit the refinement of the 3-D mantle flow models. Leg 187 will drill approximately eight to ten holes 50-100 meters into basement from among eighteen potential sites. As each hole is sampled, chemical analyses will be carried out on a DCP plasma spectrometer and an AA instrument in order to determine, within a few hours, whether recovered basalts are of ‘Indian’ or ‘Pacific’ mantle origin. This reactive drilling strategy will guide the selection of sites to be drilled during the cruise. The array of drill sites has been designed to cover possible configurations of the isotopic boundary and to distinguish between the competing hypotheses concerning the nature and extent of mantle migration.

The fundamental problems of global mantle dynamics and mantle composition are identified as high priority themes of the ODP Long Range Plan and of relevance to the InterRIDGE program, which has targeted the Southeast and Southwest Indian Ridges (SEIR / SWIR) for special study.

Leg 188: Antarctic Glacial History — Prydz Bay

The Antarctic ice sheet is a key component of the world’s climatic system and has a major influence on global sea levels. At present, knowledge of the history of the Antarctic ice sheet is fragmentary making it impossible to predict whether the present ice sheet will grow or diminish with global warming. In order to gain a better understanding of the role of the Antarctic ice sheet in global climate change and to test models of ice sheet behavior, ODP plans to conduct a series of Antarctic drilling legs. Leg 188, the second leg in this multi-leg approach, will drill Cenozoic sedimentary sequences in Prydz Bay and on the adjacent continental slope and rise to obtain a detailed history of ice sheet growth and decay, and Southern Ocean climate variability. Several initiatives including ANTOSTRAT, IMAGES and the Cape Roberts Project are also underway to study the history of the Antarctic ice sheet.

ODP will proceed with Leg 188 only if the results of Leg 178, the first Antarctic drilling program, demonstrate that the strategy of drilling sediment drifts and progradational wedges yields the records necessary for studying the history of Antarctic glaciation, and if funding to cover part of the cost of an ice support vessel can be found from sources other than ODP.❖

NEXT ODP PROPOSAL DEADLINE:

1 October 1998!

Proposals should be aimed at furthering the goals of ODP outlined in the Long Range Plan. Detailed information on the process and requirements for proposal submission can be found at: <www.whoi.edu/joides>.

JOIDES Resolution Operations Schedule: 1998 - 2000

Leg	Destination	Cruise Dates	Port of Origin Port Dates[*]	Total Days	Transit	On Site
178	Antarctic Peninsula	14 Feb.-11 Apr. 1998	Punta Arenas: 9-13 Feb.	56	18	38
179	NERO/Hammer Drilling	16 Apr.-8 June 1998	Cape Town: 11-15 Apr.	53	27	26
180	Woodlark Basin	13 June-11 Aug. 1998	Darwin: 8-12 June	59	11	48
181	SW Pacific Gateways	16 Aug.-8 Oct. 1998	Sydney: 11-15 Aug.	53	12	41
182	Great Australian Bight	13 Oct.-8 Dec. 1998	Wellington: 8-12 Oct.	56	13	43
183	Kerguelen Plateau	13 Dec.-11 Feb. 1999	Fremantle: 8-12 Dec.	60	22	38
184	East Asian Monsoon	16 Feb.-13 Apr. 1999	Fremantle: 11-15 Feb.	56	14	42
185	Izu-Mariana	18 Apr.-13 June 1999	Hong Kong: 13-17 Apr.	56	14	42
186	West Pacific Seismic Net Japan Trench	18 June-13 Aug. 1999	Tokyo: 13-17 June	56		
	Dry Dock[1] / Transit	Aug. - Oct. 1999				
187	Australian-Antarctic Discordance	Oct. - Dec. 1999	?	56		
188	Prydz Bay[2]	Dec. - Feb. 2000	Fremantle	65		

[*]Although 5 day port calls are generally scheduled, the ship sails when ready.
[1]The location of the dry dock will not be known until late in 1998.
[2]Subject to additional finances being found for an ice support vessel and SCICOM endorsement of outstanding scientific issues.

Scientists who wish to participate in an ODP Leg are encouraged to submit an application via the internet at the web site given below or contact Dr. Tom Davies, Manager of Science Services at ODP TAMU, 1000 Discovery Drive, College Station, TX 77845 (email: tom_davies@odp.tamu.edu). Staffing decisions are made in consultation with the co-chief scientists and take into account nominations from partner countries; final responsibility for staffing rests with ODP at Texas A&M University.

Web site: http://www-odp.tamu.edu/sciops/cruise_application_info.html

STOP PRESS!!

WELCOME!!

The **People's Republic of China** has joined ODP as the first Associate Member of the Ocean Drilling Program!

JOIDES Office is moving!

Beginning **January 1999** the JOIDES Office will be at:

Research Center Marine Geosciences
Wischhofstr. 1 – 3, Building 4
24148 Kiel, Germany
E-mail: joides@geomar.de
Web site: http://www.geomar.de

SCIENTIFIC OCEAN DRILLING NEEDS YOU!

NOTICE: To all members of the earth sciences community.

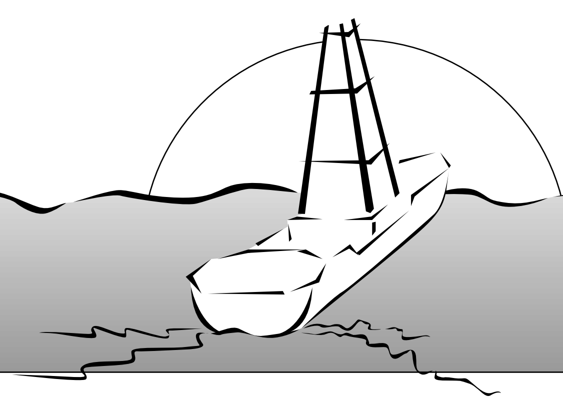
The Ocean Drilling Program will end on October 1, 2003. International scientific cooperative efforts for deep-earth sampling in the marine environment will cease unless our community comes together now to plan a new program for scientific ocean drilling. We've done it before (ODP is the successor to the 1968-1983 Deep Sea Drilling Project) — we can do it again.

INTERNATIONAL CONFERENCE: To be held on May 26-29, 1999, at the University of British Columbia in Vancouver, Canada, to define the scientific objectives for a future, multi-platform ocean drilling program with two major vessels. This Conference will target the scientific goals of non-riser drilling and will complement the recent Conference for Cooperative Ocean Riser Drilling. CONCORD defined the scientific initiatives for use of a riser-equipped drilling vessel (the CONCORD report is available at http://mstip1.jamstec.go.jp/jamstec/OD21/CONCORD/result.html).

WANTED: Brief (~1-page) statements of interest that describe a scientific objective, its importance, and the necessity for drilling. Technical details are not necessary. These statements will be used to organize the Conference. This is your opportunity to influence the scientific direction of the new program and to show your support for future scientific ocean drilling.

DEADLINE: September 1, 1998.

SUBMIT TO: JOIDES Office, Department of Geology & Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA; (508) 289-3481; joides@whoi.edu.



RESPOND TODAY! THE FUTURE OF SCIENTIFIC OCEAN DRILLING IS IN YOUR HANDS

Planning for Seismogenic Zone Drilling –

CALL FOR PRELIMINARY PROPOSALS

Planning is underway for a new drilling program to follow the Ocean Drilling Program which ends in 2003. A riser-equipped drilling vessel is envisaged to be one component of this new program and, in July 1997, the Conference on Cooperative Ocean Riser Drilling (CONCORD) in Tokyo, Japan, defined the scientific initiatives that can be addressed with such a capability. That meeting targeted a comprehensive study of a seismogenic zone at a convergent margin as the first project for this vessel to begin in the early part of the 21st Century. Meeting recommendations are available at: http://www.jamstec.go.jp/jamstec/OD21/CONCORD/result.html; requests for a copy of the report can also be made at that site.

ODP encourages the submission of *Letters of Interest* for experiments or investigative strategies that might be included in a seismogenic zone experiment at a convergent margin. These Letters of Interest will be used to select the Detailed Planning Group that will formalize the strategies to investigate the seismogenic zone. Letters of Interest can include drilling (both riser and non-riser) and coring strategies, downhole measurements or experiments, and long-term monitoring studies. Note that riser drilling operations are limited to a maximum water depth of 2500-3000 m. As the first project of a new vessel, this experiment will take place at a seismogenic zone close to Japan.

Background information, including a workshop report and a science plan for the study of a seismogenic zone is available at http://www.soest.hawaii.edu/margins/Documents.html.

A special deadline of **1 August 1998** has been these letters of interest. They should be 3 (but no more than 5) pages long, and should include a brief description of the proposed project and its overall scientific goals, and the types of drilling, data collection, shipboard or downhole measurements necessary. Additional information is available at the JOIDES Office web site (http://www/whoi.edu/joides) or by contacting the JOIDES Office, Geology & Geophysicis Dept., Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA. E-mail: joides@whoi.edu; tel: 508-289-3481; fax: 508-457-2187.

DSDP/ODP COLLECTIONS:
Radiolarian and Calcareous Nannofossils

Eight sets of of DSDP/ODP calcareous nannoplankton smear slides have been prepared from more than 4,000 core samples chosen from Legs 1 - 35 of the Deep Sea Drilling Project and Legs 132 - 152 of the Ocean Drilling Program. In addition eight sets of DSDP/ODP strewn slides have been prepared from about 3,000 core samples chosen for radiolaria from important sites drilled during the Deep Sea Drilling Project. The prepared sets have been made available to the scientific community at Micropaleontological Reference Centers (MRCs) and satellite institutions that have been geographically selected for world coverage.

To further increase the usage, ODP proposes to offer on loan one set of each to an institution that can show an expertise in the relevant field of study. Institutions requesting either the radiolarian or the calcareous nannofossil collection must demonstrate a willingness to curate and make available this collection to specialists from the scientific community and should provide space, microscopes, a computer, and a collection of DSDP/ODP volumes for the visitors to use. They should also suggest contributions that they can make towards the general improvement of the MRC collections. Possible contributions include: (1) play an active role in selecting additional samples to improve the coverage of the collections; (2) play an active role in development of image database(s) under the guidance of the Scientific Measurements Panel; and (3) contribute toward the preparation of the MRC samples.

CONTACT: Brian T. Huber, Smithsonian Institution, MRC 121, Washington, D.C. 20560 • Phone: (202) 786-2658 • Fax: (202)786-2832 • E-mail: huber.brian@nmnh.si.edu

• HELP WANTED •

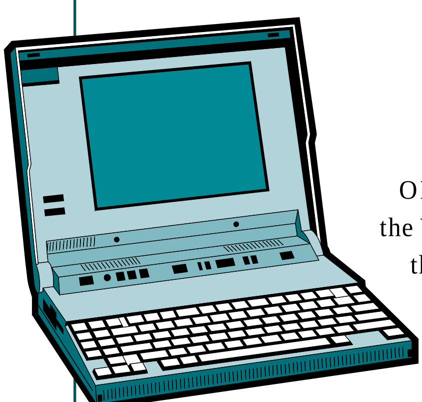
Assistant Research Scientist/Staff Scientist

The Ocean Drilling Programm at Texas A & M University invites applications for the position of Assistant Research Scientist / Staff Scientist with the Department of Science Services. This is a temporary 2-year position, with the possibility of continuing appintment. A Ph.D. in geological science or a related field, and a minimum of three years extensive training in the geological sciences is required. Applicants must have a demonstrated fluency in written and spoken English. Experience as a seagoing scientist is preferred. We are particularly interested in candidates with a background in micropaleontology, paleoceanography or organic geochemistry, although other areas of specialization will be considered since our objective is to recruit the best qualified candidate.

The successful applicant will be expected to sail as a staff scientific representative on an ODP cruise approximately once per year, and will serve as Leg Project Manager to coordinate precruise planning and preparation, and post-cruise scientific research and publication of cruise results. Individual research, as well as collaboration with colleagues in the Texas A & M University Departments of Geology and Geophysics, and Oceanography, and elsewhere is encouraged. Applicants must be able to cooperate and work harmoniously with others. The successful applicant will be required to pass a new employee physical exam and annual seagoing physical exams.

Salary will be commensurate with qualifications and experience of the applicant. We will begin reviewing applications on April 15, 1998, but will continue to accept applications until the position is filled. Applicants should forward a curriculum vita, list of authored / published papers, statement of research interests, and names and addresses of three referees to:

Personnel Supervisor
Ocean Drilling Program
Texas A & M University
College Station, TX 77845
Equal Opportunity / Affirmative Action
Employer Committed to Diversity



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. 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.

• MEETINGS •

• MEETINGS •

* Gordon Research Conference "**Interior of the Earth**", New England College — Henniker, New Hampshire, 28 June - 3 July 1998. The meeting will focus on topics such as the connection between mantle processes and geological / geochemical observations, magmatism and mantle processes, etc. **Contact**: Gordon Research Conferences, University of Rhode Island, P.O. Box 984, West Kingston, RI 02892-0984, USA. • Phone: +1 401 783-4011 • Fax: +1 401 783-7644 • **Information**: http: / / www.lgs.jussieu.fr / ~intridge / 021898.htm

* Gordon Research Conference "**Organic Geochemistry**", Holderness School, Holderness, New Hampshire, USA, 9 - 14 August 1998. The meeting offers sessions on organic matter preservation, hydrothermal ecosystems, chemostratigraphy, etc. **Contact**: Kenneth E. Peters • Phone: +1-214-951-3272 • E-mail: ken_peters@email.mobil.com • **Detailed information**: http: / / www.lgs.jussieu.fr / ~intridge / 021898.htm

* The Sixth International Conference on Paleoceanography (ICP VI), Lisbon, Portugal, 23 - 28 August 1998. The theme of the conference is "**Reconstructing Ocean History — A Window Into the Future.**" **Contact**: Olga Vaia Viagens, Abreu S.A. (Congress Department), Avenida 25 de Abril, 2-Edificio Abreu, 2795 Linda-a-Velha, Portugal. • Phone: 351-1-416-7200 / 7337, • Fax: 351-1-414-3058 / 3042, • E-mail: ovaia@abreu.pt

Visit the ODP booth! For more information, please contact JOI: joi@brook.edu

* Geological Society of America Penrose Conference "**Ophiolites and Oceanic Crust — New Insights from Field Studies and Ocean Drilling Program**", Marconi Center, Tamales Bay, California, 13 - 17 September 1998. The goal of this conference is to re-evaluate the existing models on ophiolite formation and oceanic crust generation, and to explore the possibility of reaching a new consensus on the nature and significance of ophiolites and oceanic crust for present plate tectonic processes and for processes in the geological past. **Contact**: Yildirim Dilek, Department of Geology, Miami University, Oxford, OH 45056, USA. • Phone: +1-(513) 529-2212 • Fax: +1-(513) 529-1542 • E-mail: dileky@muohio.edu • **Information**: http: / / www.lgs.jussieu.fr / ~intridge / 021898.htm

* **European Ocean Drilling Forum**, Edinburgh, U.K., 18 – 22 September l998. The programme for the meeting is available at the web site given below. **Contact**: Alastair Robertson in Edinburgh • Phone: +131650-8546, • Fax +131-668-3184, • E-mail: Alastair.Robertson@glg.ed.ac.uk • **Information**: http: / / www.soest.hawaii.edu / margins / Meetings.html

* **29th Underwater Mining Institute Conference**, Day's Inn, downtown Toronto, 21 - 24 October 1998. Special sessions on "Marine Research Meets Land Exploration: The Contributions of Ocean Drilling and other Seabed Research to Land-Based Mineral Exploration." **Contact**: Karynne Chong Morgan, UMI Conference Coordinator, 811 Olomehani Street, Honolulu, Hawaii 96813-5513, USA. • Phone: (808) 587-5320, • Fax: (808) 587-5325, • E-mail: mmtcuh@aol.com. • **Information**: http: / / www.geology.utoronto.ca / ODP / UMI

* AGU Fall Meeting, 6 – 10 December 1998, San Francisco, Calif., U.S.A. **Contact**: AGU Meetings Department, 2000 Florida, Avenue, NW, Washington, DC 20009 • Phone: +1-202-462-6900; • Fax: +1-202-328-0566; • E-mail: meetinginfo@kosmos.agu.org; • **Information**: www.agu.org / meetings; **Abstract Deadline**: August 26, 1998

* Conference of the European Clay Groups Association (**EUROCLAY '99**) in Krakow, Poland, 4 - 10 September 1999. Contributions from all fields of clay science are welcome. **Information**: http: / / www.ing-pan.krakow.pl

After the conference a workshop entitled "**Clays in the Environment**" will be offered in Banska Stiavnica, Slovakia, and will be combined with visits to several Slovakian clay deposits and acid mine sites. **Contact**: Aka Srodon, Euroclay 1999, Institute of Geological Sciences PAN, Senacka 1, 31-002 Krakow, Poland. • Fax: 48-12-4221609, • E-mail: ndsrodon@cyf-kr.edu.pl

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joides@whoi.edu

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odp@ldeo.columbia.edu

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Palisades, NY 10964, USA
Tel. (914) 365-8672 • Fax (914) 365-3182
borehole@ldeo.columbia.edu

Bremen Core Repository
- Sample Information
- Availability of Residues and Thin Sections (from ODP Leg 151 onward)

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The last world exposition of this century "EXPO '98", April 22 – September 30, Lisbon, Portugal, will have its central theme "Oceans, A Heritage for the Future" with the overall objective of alerting public opinion to the growing importance of the oceans as critical resources for sustainable development. Detailed information is available at: http://www.expo98.pt/en/default.html

Note: The Canadian Pavilion will be hosting an ODP interactive game – Please visit us!!!

1998 — The International Year Of The Ocean

In recognition of the importance of the ocean, of the marine environment and its life-giving resources, the United Nations has declared 1998 as the International Year of the Ocean (YOTO). In 1993, the Intergovernmental Oceanographic Commission of the United Nations Education Science and Cultural Organization (UNESCO) passed a resolution calling for an International Year of the Ocean, and the U.N. General Assembly formally adopted the proposal through its Resolution A/RES/49/13 in December 1994. YOTO provides an opportunity for governments, organizations and individuals to celebrate the role the ocean plays in our lives, and to initiate changes needed to sustain the marine resources on which we depend.

Information: http://www.yoto.com

The year will be filled with special events, including a major International World's Fair, Oceans 98 in Lisbon, Portugal, as well as a series of special events in the United States.

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WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

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