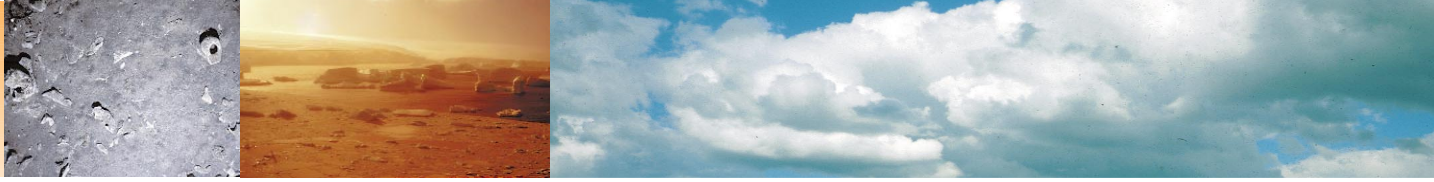
OCEAN DRILLING PROGRAM



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JOIDES journal

Joint Oceanographic Institutions for Deep Earth Sampling

A Letter from the Chair

On May 10, 1999 JOIDES became 35 years old. Not many people realize that JOIDES pre-dates both the Deep Sea Drilling Project and the Ocean Drilling Program. It had its origins in a consideration of what might be learned about the history of the oceans from a series of shorter holes sampling the sediments rather than the single deep hole to penetrate ocean crust to the Mohorovicic Discontinuity (the MOHOLE) that had been proposed in the late 1950's.

Two individuals questioned the strategy of drilling a single hole – Maurice Ewing of Columbia University's Lamont Geological Observatory and Cesare Emiliani of the University of Miami's Institute of Marine Science. Both argued that much could be learned about the history of the Earth from the sediments overlying the oceanic basement. It must be remembered that in the 1960's most geologists thought that the ocean basins were ancient and permanent features and that a thick sediment column would include all of the Phanerozoic and most of the Precambrian. The fact that seismic surveys carried out by Ewing's group indicated that the average thickness of sediments in the ocean basins was only about 500m was an unexplained peculiarity. Drilling the sediments should reveal why so little material had accumulated over such a long time.

The impetus for drilling and coring at many sites in the ocean was focused in a proposal by Cesare Emiliani of the University of Miami to the US National Science Foundation for "Project LOCO (Long Cores)", submitted in 1962. Cesare's interest was primarily in the Cenozoic history of the oceans – to learn more about the cooling of deep ocean waters and inception of glaciation. He formed a LOCO advisory group of scientists from major US oceanographic institutions to help guide the program.

The JOIDES Office 2000: Warner Brueckmann, Jeffrey Schuffert, Bill Hay, Emanuel Soeding, and Bettina Rohr (from left to right).

Enthusiasm for the idea of learning about the history of the ocean basins from its sediments was such that four of the major oceanographic institutions, Miami, Lamont, Scripps and Woods Hole, agreed to disband the LOCO committee and form an advisory group which took the name "JOIDES = Joint Oceanographic Institutions for Deep Earth Sampling," coined by Roger Revelle, to develop an ocean drilling program. The directors of the four institutions were the members of the Executive Committee and one scientist from each institution formed the Planning Committee. The Executive Committee selected Lamont as the first operator institution and the Institute of Marine Sciences in Miami as the first core repository. The first series of sites (the "JOIDES holes") were drilled by the DV CALDRILL in 1965 on a transect across the Blake Plateau off Jacksonville, Florida, funded by the National Science Foundation. The tradition of a party of shipboard scientists from a variety of institutions was born during this project. The University of Washington's School of Oceanography joined JOIDES in 1968. The results of the drilling off Florida were that successful and exciting that JOIDES selected Scripps Institution of Oceanography as the operating institution and core repository for a second project, titled "The Deep Sea Drilling Project" intended to last 18 months, starting in August 1968.

This mode of operation, with JOIDES providing scientific advice, Scripps managing the operations, and NSF funding and monitoring the project was modified in 1974 with expansion of the membership of JOIDES to include organizations in other countries as well as other US institutions. International funding was coordinated through the National Science Foundation and JOI, Inc. was established as a corporate entity to offer liability protection to the members of JOIDES.

For accounts of the fascinating early history of the ocean drilling program see:

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Shor, E. N. (1985): A chronology from Mohole to JOIDES In: *Geologists and ideas; a history of North American geology*. Editors: Drake, E. T., Jordan, W. M. In the collection: Centennial special volume. Geol. Soc. Amer., Boulder, CO, pp. 391-399.

Winterer, E. L. (2000): Scientific Ocean Drilling, from ASOC to COMPOST; In: *50 Years of Ocean Discovery*, National Academy Press, Washington D.C., pp. 117-127.

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Technology

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Scheduled Legs until March 2002

LEG	TITLE	DATES	DATES
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192	Ontong Java	Guam	09/13/00 – 11/12/00
193	Manus Basin	Guam	11/12/00 – 01/09/01
194	Marion Plateau	Townsville	01/09/01 – 03/05/01
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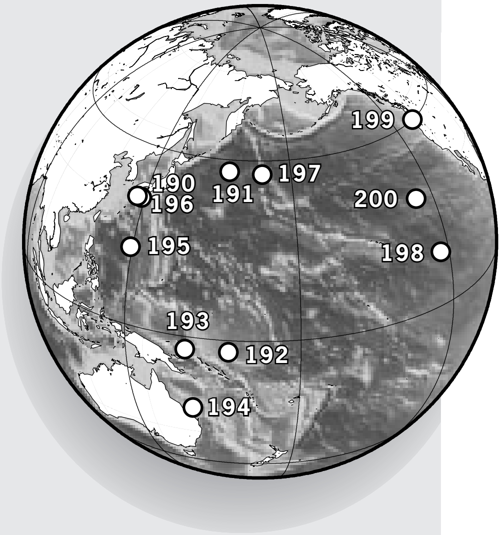
198	Paleogene	Honolulu	08/10/01 – 10/09/01
199	Gas Hydrates	Victoria	10/09/01 – 12/06/01
200	H2O	San Francisco	12/06/01 – 01/13/02
201	SE Paleoceanography	Panama City	01/13/02 – 03/10/02



Cool-water 'Reefs', possible Hydrogen Sulphide/Methane Clathrates, and Brine Circulation – Preliminary Results of Leg 182 Drilling in the Great Australian Bight

by David Feary[1], Al Hine[2], Mitch Malone[3], and the Leg 182 Scientific Party

Leg 182 sailed from Wellington in early December 1998 with a broad range of scientific objectives — the first scientific drilling expedition in the waters south of Australia provided a great opportunity to increase understanding of the depositional dynamics of cool-water carbonate environments. The priority objectives to be addressed at 10 sites in the western Great Australian Bight (Fig. 1) were:

- To gain an increased understanding of the evolution of the Southern Ocean. The location of the Great Australian Bight, facing the evolving Southern Ocean throughout the Cenozoic, made this area a prime site to determine the timing and paleoceanographic effects of the Tasman Gateway opening.
- To develop a greater understanding of the factors controlling cool-water carbonate sedimentation on one of the earth's largest and longest lived cool-water carbonate platforms. The tectonic stability and absence of riverine sediment input provided the opportunity to analyze a depositional system controlled almost entirely by oceanographic factors.
- To record a sea-level history for this part of the Southern Ocean, as a component of the global latitudinal sea-level transect. In addition, an important objective was to determine how sea-level fluctuations controlled cool-water carbonate ramp deposition.
- To determine the characteristics of fluid circulation within a carbonate platform adjacent to a vast inland karst with sluggish water circulation; and to understand the nature of early burial diagenesis (lithification and dolomitization) in a cold, seawater-dominated system.

As with most drilling legs, some of the questions were immediately answered by drilling results, whereas others must await the painstaking process of post-cruise analysis. In this brief review of results, we will concentrate on those areas where shipboard and early post-cruise analysis provided immediate spectacular results, but recognising that the long-term scientific legacy of Leg 182 will be much broader.

OVERVIEW

The shelf-edge to upper slope in the Great Australian Bight is distinguished by a spectacular succession of prograding clinoforms forming an unusually thick sediment wedge that was found to be of

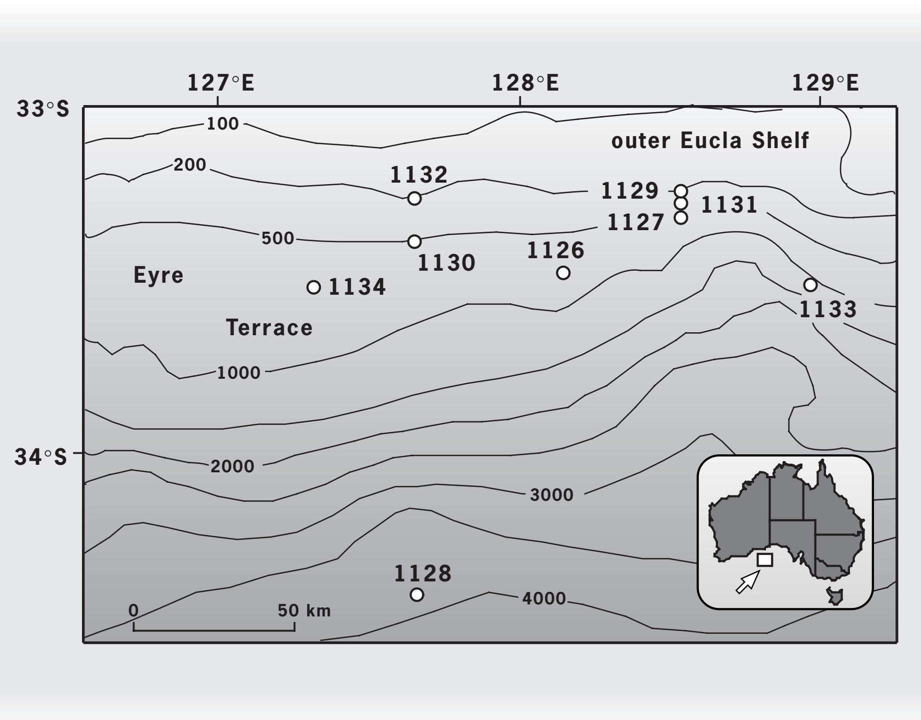


FIGURE 1 *ODP Leg 182 drill sites in the western Great Australian Bight. Most sites are located on the upper slope to shelf edge, together with a single deep water site (1128).*

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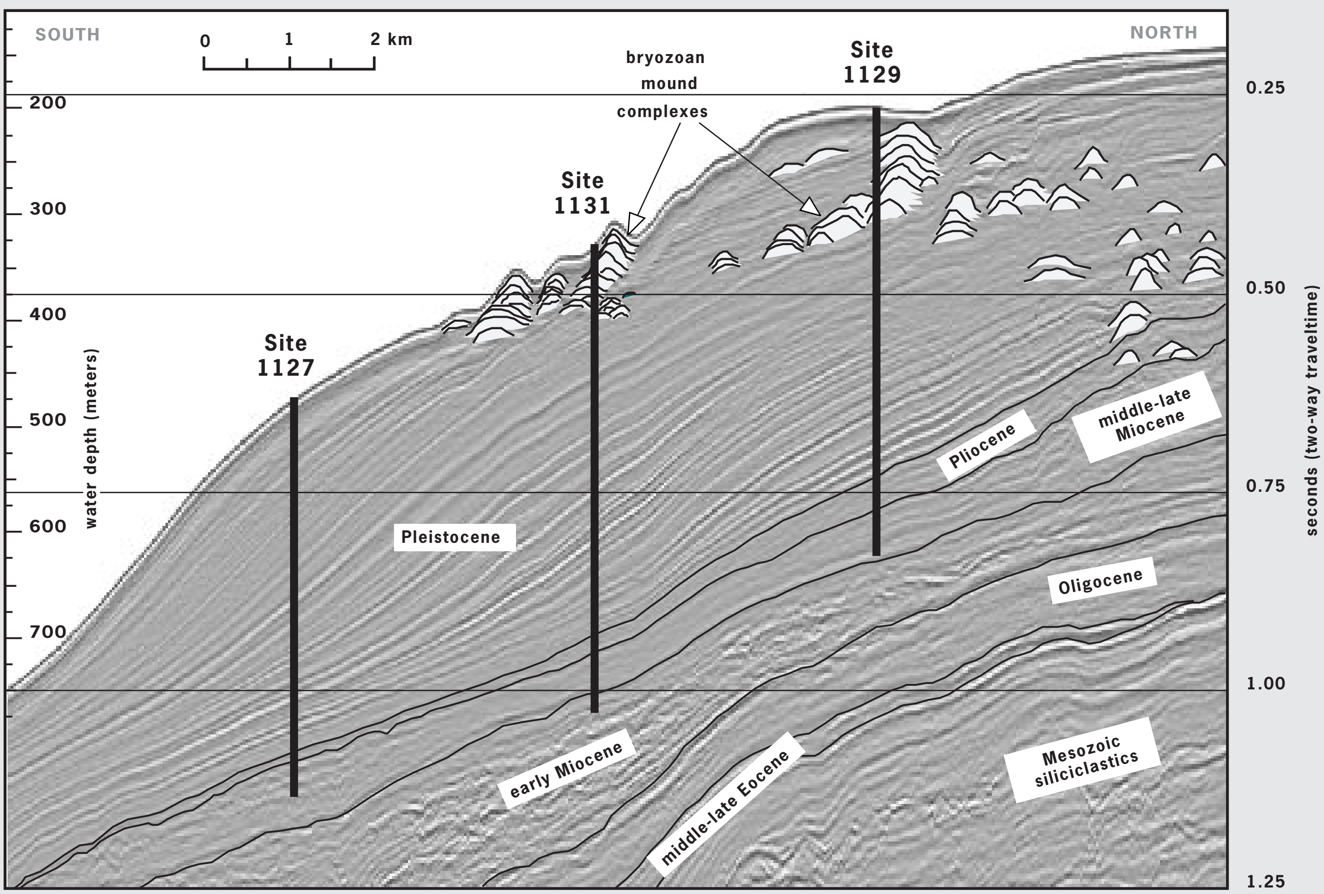

FIGURE 2 *Seismic image showing the thick Pleistocene wedge underlying the outermost shelf and upper slope. Bryozoan mounds are visible as individual mounds and as mound complexes immediately below the sea-floor seaward of the shelf-edge, and also buried within the sediment wedge.*

mostly Quaternary age (Fig. 2), overlying a pronounced sequence boundary representing a hiatus of up to 12 m.y. Sites 1127, 1129, and 1131 form a closely-spaced depth transect across this wedge. The Pleistocene thickness exceeded 550 m, indicating average accumulation rates of over 300 m/my through this time period. For shorter periods of time, accumulation rates exceeded 40 cm/ky, which rival the fastest rates known in shallow-water tropical carbonate depositional systems (James, 1997). Sediments constituting this slope wedge are bioturbated muds and very fine, sand-sized skeletal grains, with the unexpectedly high sedimentation rates representing episodes of organic growth followed by wave-driven erosion on the adjacent broad 'shaved' shelf (James et al., 1994). Seismic imagery, downhole logging, and mineralogic data suggest that the wedge is packaged in cycles, most likely responding to astronomically-forced sea-level fluctuations.

The underlying Eocene shallow-water terrigenous sands and carbonates deepen upwards into Oligocene and early-middle Miocene pelagic ooze and chalk, characterized by stained hardgrounds and numerous omission surfaces. These ramp sequences were poorly recovered at most sites, as a result of thin beds and lenses of chert resulting from selective silicification.

BRYOZOAN MOUNDS – COOL-WATER CARBONATE 'REEFS'

Seismic reflection imagery along the western Great Australian Bight showed enigmatic mounded features within the Cenozoic succession beneath the shelf and upper slope (Feary and James, 1995; 1998). High resolution seismic data collected for the Leg 182 site surveys (Fig. 2) confirmed the three-dimensional geometry of these mounded reflectors (Feary, 1997), but were unable to resolve whether these features were of biogenic or current origin. Drilling at Sites 1129 and 1131 confirmed that these are bryozoan mounds, and they are the first modern analogues for features that have been described from onshore exposures

(e. g., Surlyk, 1997) and from many parts of the geological record. The mounds cored in the Great Australian Bight are similar in geometry, scale, and general composition to the ancient bryozoan-dominated structures, and the late Quaternary buildups are the first examples of these long-lived reefs to be found in their present original depositional setting. Seismic data show that these build-ups have been present, throughout most of the Pleistocene, as a zone of linear mounds up to 65 m high lying immediately seaward of the shelf-edge (200–350 m below sea-level) and extending more than 300 km across the western Great Australian Bight. Individual mounds are up to 720 m wide, and extend up to 10 km along slope.

Cores from these mounds show that they are composed of branching bryozoan fronds and molluscs surrounded by mud, and that individual mounds within mound complexes are separated by mud layers. The model presently being developed is of alternating mound growth and quiescence phases, with upwelling along the margin during sea-level lowstands contributing to mound growth, followed by cessation of mound growth and covering by mud during sea-level highstands. If this model is correct, it raises the interesting possibility of a global alternation in the location of reef/mound growth, with tropical reefs growing most strongly during interglacials, and bryozoan mounds developing during glacial periods.

HYDROGEN SULPHIDE AND METHANE GAS – FLUID CIRCULATION AND CLATHRATES

Although fluid flow through the margin was identified as a leg objective, there was little expectation prior to drilling that the results of fluid circulation within the succession immediately underlying the outer shelf and upper slope would prove to be so dramatic. A 'tongue' of high salinity fluid (up to 106 ‰) interacted with high organic carbon concentrations within the Pleistocene sediment wedge at the modern outer edge of the continental shelf to produce spectacularly high concentrations of methane (>700,000 ppm) and hydrogen sulphide (>150,000 ppm) gas. The recovery of such high concentrations of poisonous gas imposed severe restrictions on core processing activities, and required the wearing of unwieldy breathing apparatus on the rig floor and catwalk (Fig. 3).

The organic carbon to feed this bacterial sulphate reduction process (Malone et al., 1999) was deposited when storms repeatedly removed organisms growing on the vast Great Australian Bight continental shelf and piled the material at the shelf edge. The high-salinity brine is presumed to have formed during times when sea level was low, and large evaporative lakes produced hypersaline fluids which drained into underlying sediments.

Unusual Na+/Cl– ratios greater than unity in brines within the thickest part of the Pleistocene shelf-edge wedge present the interesting possibility that they may reflect the formation of mixed methane and hydrogen sulphide clathrates (frozen gas) within the upper part of the succession (Swart et al., 1999). Although the relatively warm water temperatures and shallow depth would rule out the presence of pure methane clathrates, the addition of hydrogen sulphide places at least part of the Pleistocene sediment wedge within the H_2S/CH_4 clathrate stability zone.

In contrast to the mineralogically stable environment predicted prior to drilling, the oxidation of organic matter at these sites caused accelerated diagenesis. The high hydrogen sulphide content resulted

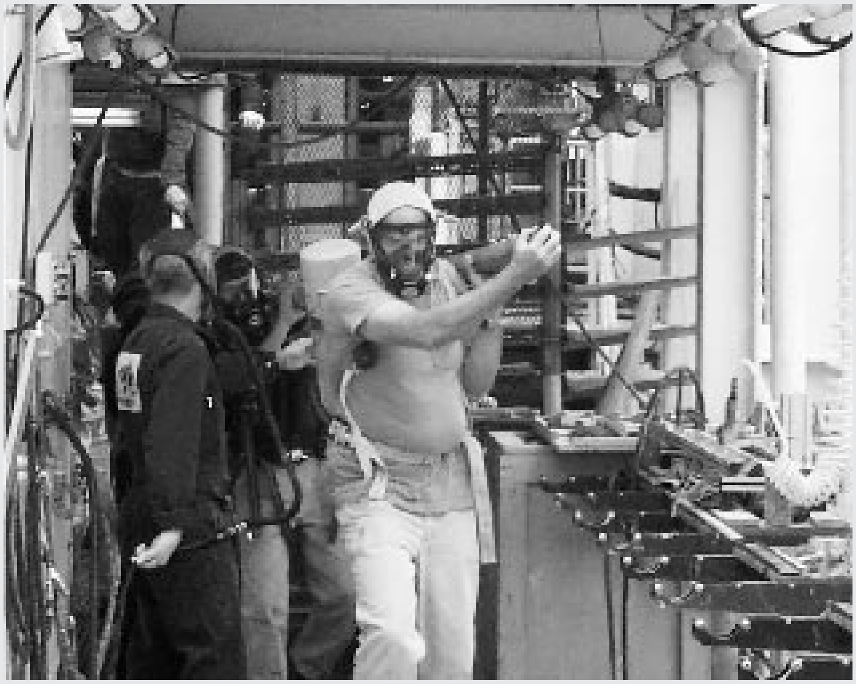

FIGURE 3 *Recovering core on the rig floor and cutting/splitting core on the catwalk were difficult because of the high concentrations of poisonous hydrogen sulphide gas.*

in decreased pH of pore fluids causing dissolution of the least stable carbonate minerals, and the increased alkalinity resulting from sulphate reduction created a thermodynamic regime favorable for the formation of dolomite.

SOUTHERN OCEAN EVOLUTION

The sedimentary succession drilled at the toe of slope (Site 1128 in ~3800 m water depth), chronicles the change from early Paleogene time, when a humid onshore climate flushed large amounts of terrigenous clastic sediment into the deep sea, to Neogene time when increasing continental aridity promoted mostly marine carbonate deposition. Green Eocene siliciclastic sands and silts that accumulated largely below the CCD in a poorly oxygenated, bathyal setting, become finer grained upward with much of the deep-water late Eocene represented by clay deposition. Initiation of the contemporary Southern Ocean circulation system, and thus the modern global ocean, is signalled by a gradual change to early Oligocene brown clay and carbonate, as this part of the seafloor became ventilated and the CCD deepened. The deep-water Neogene record is one of pink pelagic carbonate ooze punctuated by white planktonic foraminiferal turbidites. Early-middle Miocene time is represented by a major hiatus and sediment gravity flow deposits.

LEG 182 SHIPBOARD SCIENTIFIC PARTY

David Feary and Al Hine, Co-Chief Scientists; Mitch Malone, Staff Scientist; Miriam Andres, Christian Betzler, Gregg Brooks, Charlotte Brunner, Michael Fuller, Ann Holbourn, Mads Huuse, Alexandra Isern, Noel James, Bryan Ladner, Qianyu Li, Hideaki Machiyama, David Mallinson, Hiroki Matsuda, Richard Mitterer, Roberto Molina-Garza, Cecile Robin, Joellen Russell, Samir Shafik, Toni Simo, Peter Smart, Guy Spence, Finn Surlyk, Peter Swart, and Ulrich Wortmann.

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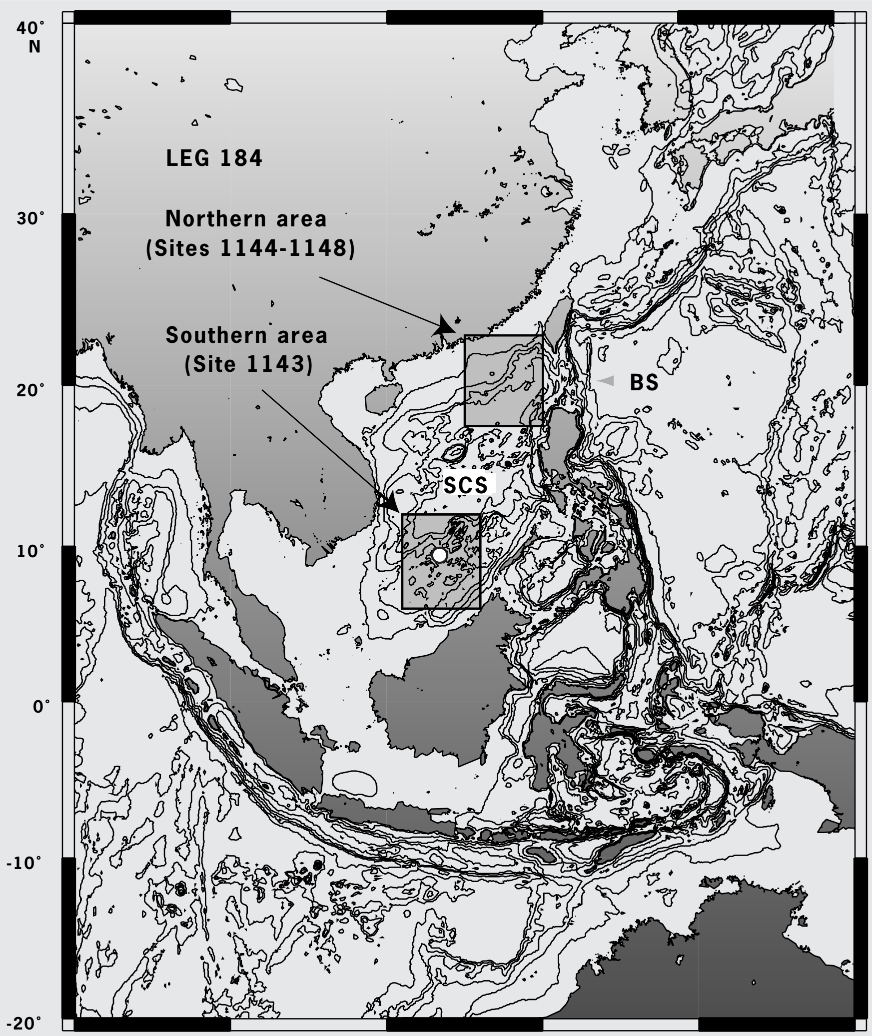
Exploring the Asian Monsoon through Drilling in the South China Sea

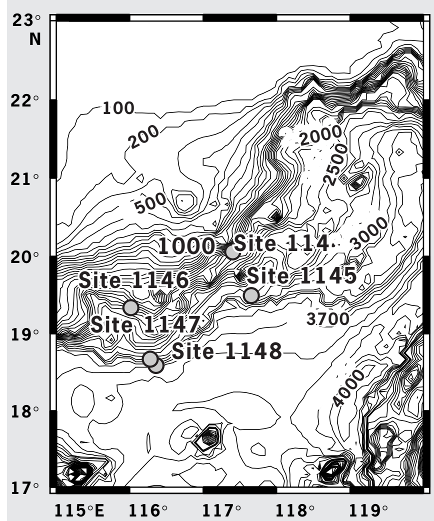
Pinxian Wang[1], Warren Prell[2], Peter Blum[3] and the Leg 184 Scientific Party

The Asian monsoon system is a major component of both regional and global climate, and understanding of its evolution and variations is a major theme in paleoclimatology. Up to now, the monsoon-related paleoceanographic studies have been dominated by those on the Indian monsoon (e. g., ODP Leg 117 to the Oman margin), whereas the East Asian paleo-monsoon studies have been mainly restricted to land-based works, commonly with monsoon information from the Chinese loess. The South China Sea (SCS) with its high sedimentation rates of carbonate-rich hemipelagic sediments offers a unique opportunity to study the variability of the East Asian monsoon in the Western Pacific region. Its location between East Asia and the "Maritime Continent" is ideal to document the paleoceanographic response to both winter and summer monsoons. On the other hand, both evolution of the Asian monsoon system and the Cenozoic global cooling are thought to be closely linked to the Himalayan-Tibetan orogen (Prell and Kutzbach, 1997). The sediments of the SCS therefore record the erosion and weathering of tectonic orogens as well as changes global and regional climate.

Leg 184, the first deep-sea drilling leg to visit the seas off China, was designed to recover sediment sections in the SCS to study the climate changes on a variety of time scales. The broad scientific themes of Leg 184 were (1) to document the Cenozoic history of the SCS, including its biostratigraphy, lithostratigraphy, chronology, paleoclimatology, and paleoceano-

FIGURE 1 *Locations of Leg 184 drill sites in the South China Sea. Figure at right is a close-up of the "northern area" sites.*





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graphy; (2) to reconstruct the evolution and variability of the East Asian monsoon during the late Cenozoic on millennial, orbital and tectonic time scales; and (3) to identify and better understand the links among tectonic uplift, erosion and weathering, hemipelagic deposition, and climate change, including the co-evolution of the Asian monsoon and Neogene global cooling.

Our expedition to the South China Sea had all the ingredients of a good spy novel, including exotic ports (Fremantle and Hong Kong), international intrigue (permission to drill), a solar eclipse, threats of piracy, the Chinese New Year (year of the Rabbit), a volcanic eruption (Anak Krakatoa = child of Krakatoa) while transiting the Sunda Strait, dangerous shoals, an Equator crossing, and treasures from the sea floor. All this and exciting science too!

DRILLING RESULTS

The Leg 184 shipboard party cored 17 holes at 6 sites in the northern and southern parts of the SCS (Figs. 1, 2) and recovered 5463 m of sediment. The drilling of hemipelagic sediments was exceptionally successful, with core recovery averaging 83%–101%. Because the drilling progressed rapidly and only trace amounts of hydrocarbons were detected, the target depth was deepened at three sites (with approval from our trusty ODP-TAMU Director), and the original drilling objectives were exceeded. Drilling at the first site, Site 1143 in the Nansha or Spratley Islands area, was complicated by several diplomatic and safety questions: a broken radar, multiple claims to the region by several political entities, poorly charted waters of the “Dangerous Grounds” area, and the threat of piracy in the region. All the obstacles were overcome in time and the sediments recovered from the site have provided a complete record of 10 million years history of the area within the modern “Western Pacific Warm Pool”.

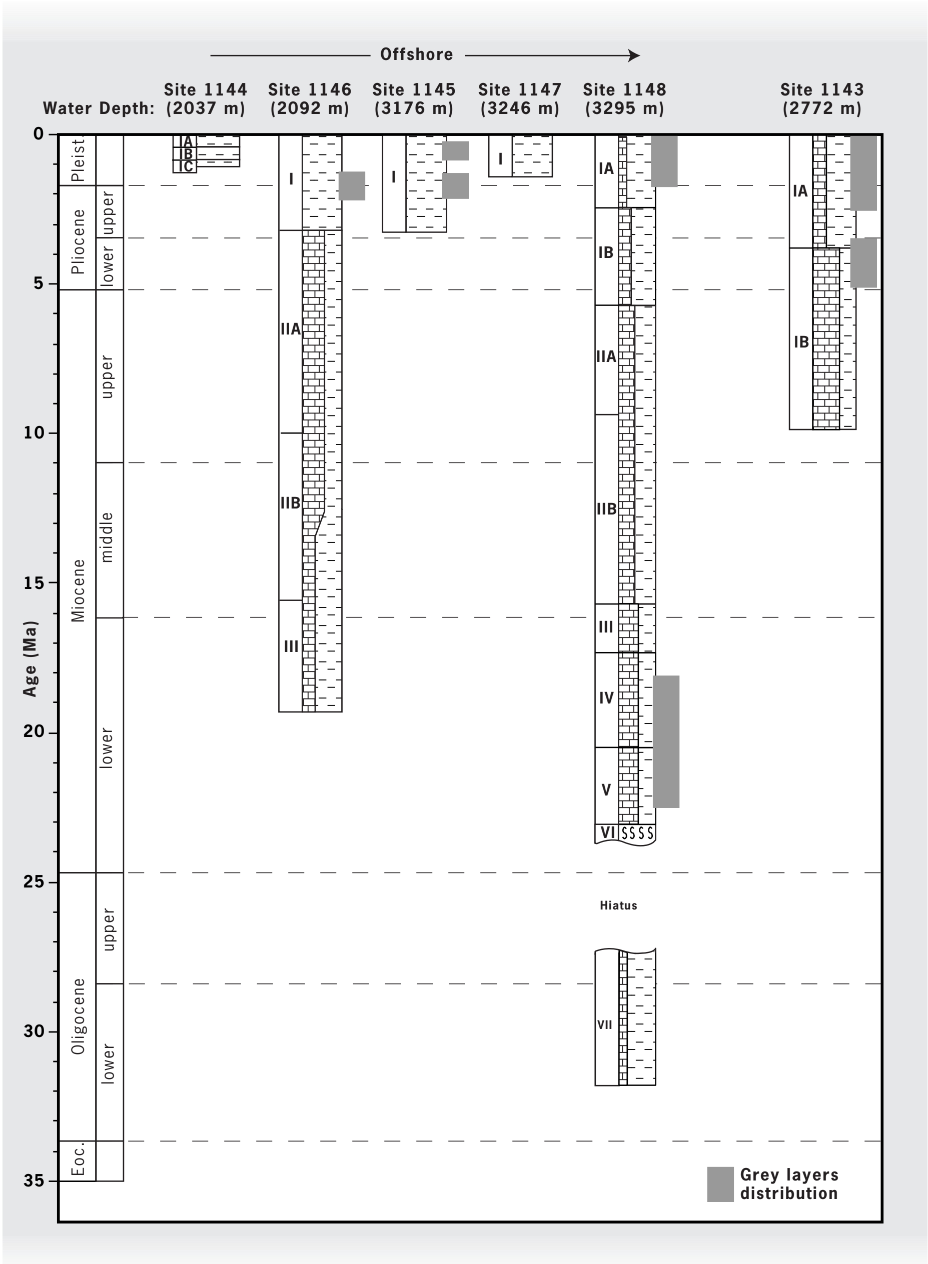


FIGURE 2 *Summary diagram of Leg 184 coring results as a function of age. Horizontal line patterns are clay and silt; brick pattern represents nannofossil ooze with foraminifers or chalk. The Roman numerals denote lithologic units.*

The northern sites on the continental margin of China span a great variation in sedimentation rates (Fig. 3), but the hemipelagic sediments at all sites are rich in calcareous microfossils, enabling the application of stable isotopes and faunal analyses in paleo-monsoon studies. Site 1144, for example, is distinguished by its very high linear sedimentation rates (LSRs, 300–1100 m/m.y.) and mass accumulation rates (MARs, 25–140 g/cm^2/k.y.) (Fig. 3B). The over 500-m long section from this site is expected to provide high-resolution records for the last 1 m.y., as the site is located on a sediment drift where a nearby sediment core has yielded proxy records of monsoon variations on millennial and centennial time scales

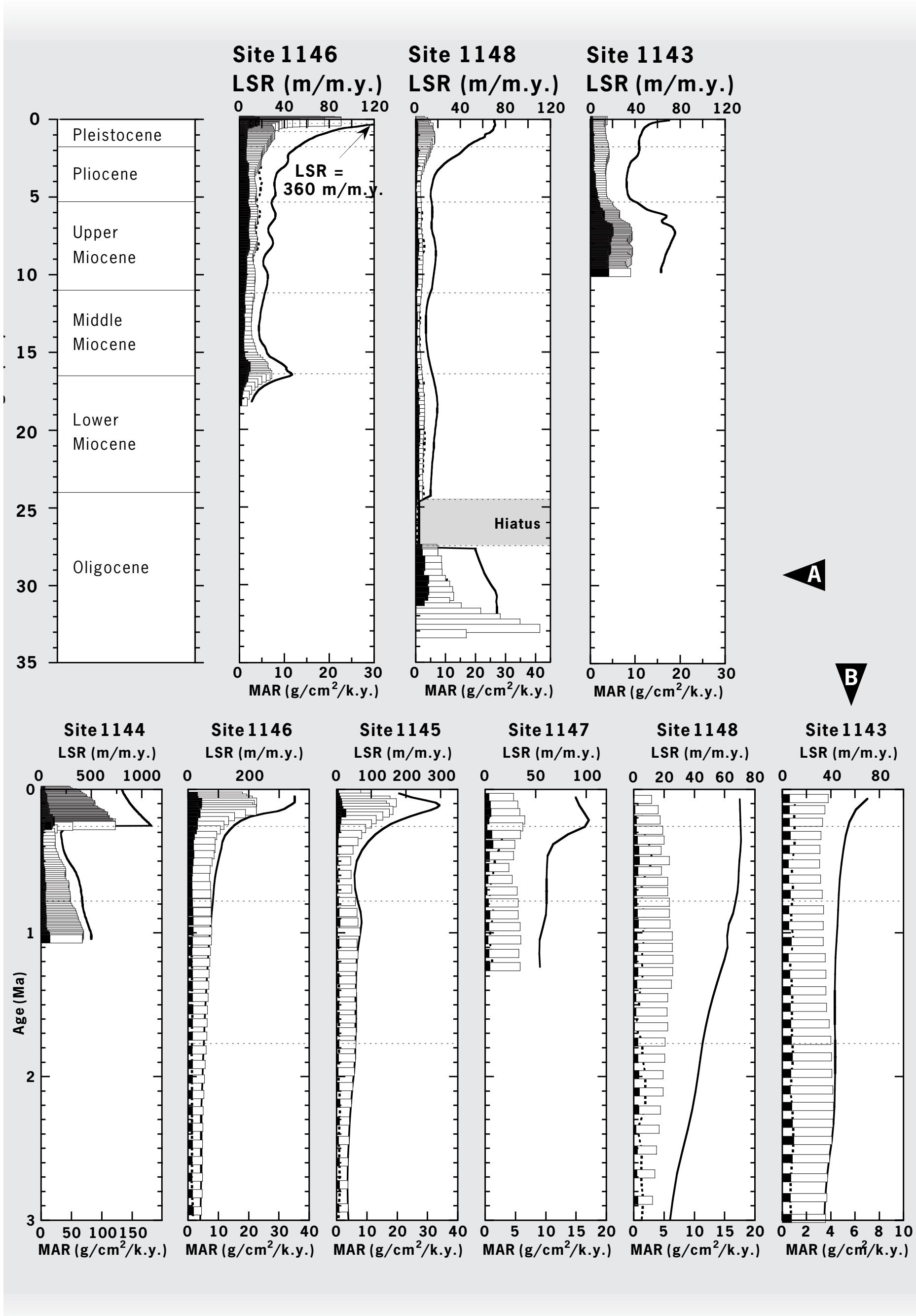


FIGURE 3 *Total (stippled histograms) and carbonate (solid histograms) mass accumulation rates, and linear sedimentation rates (solid line), vs. age. A) Complete section for the three deepest sites. B. Close-up for the last 3 m.y. at all Leg 184 sites.*

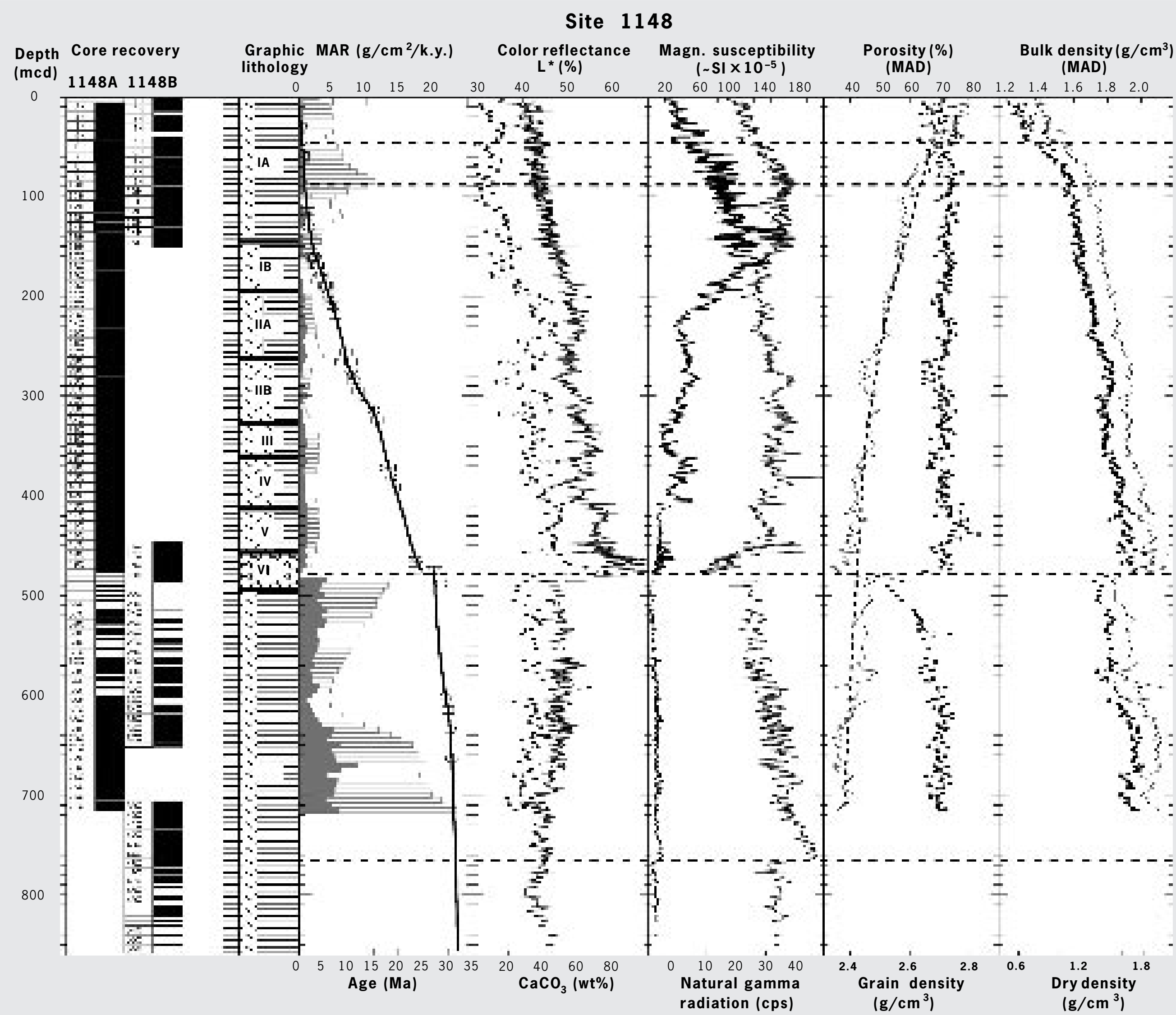
(Wang et al., 1999). Site 1146 (water depth 2092 m), also from the northern slope of the SCS, recovered an over 600 m long section representing a 19-m.y. record. This long-term record at orbital-scale resolution (2 k.y.) will allow comparison of East Asian monsoon variability with orbital forcing, glacial forcing, and internal feedback within the climate system. In addition the record will provide a new set of constraints of the possible relationship between Tibetan Plateau uplift, monsoon evolution, and global cooling. The paleo-monsoon record at Site 1146 will provide an appropriate counterpart to Site 1143 (water depth 2772 m, bottom age 11 Ma) from the southern SCS (Fig. 3A) and Site 722 (water depth 2028 m, bottom age 15 Ma) from the Arabian Sea. The comparison of these cores should help to identify potential sources of common causality for the Asian monsoon evolution. Site 1148 on the lowermost northern slope of the SCS (water depth 3295 m) recovered the longest section of the entire leg. Its 850-m long sequence represents a 32-m.y. record, which could be used to evaluate models of the SCS continental margin evolution and the impact of Himalayan-Tibetan uplift on monsoon onset and intensification.

ENVIRONMENTAL HISTORY

The 32-m.y. sequence of deep-sea sediments recovered during Leg 184 covers almost the entire environmental history of the SCS since its opening. Judging from magnetic anomaly (C 11–C 5c) patterns, the sea-floor spreading phase of the SCS took place between 32 and 16 Ma (Briais et al., 1993). The deep-water nature of the microfauna from the lower and middle Oligocene deposits (Site 1148, 32-27 Ma, 850-480 mcd) and the lithology suggest that when sea-floor spreading began, the basin was already fairly deep, most probably an upper bathyal environment formed during the rifting stage in the early Paleogene. The extremely high MAR (18.8 g/cm^2/k.y.) in the early Oligocene implies a focusing of sediment flux into the newly opened narrow basin. This is in contrast to the Sea of Japan where initial spreading at ~28 Ma was accompanied by widespread non-marine and “Green Tuff” deposition, and bathyal water depth was reached only after 23 Ma (Ingle, 1992).

The latest stage of the Oligocene produced drastic changes in sediment deposition at Site 1148 (Fig. 4). The absence of nannofossil zone NP 25 and some planktonic foraminifer markers indicates a deposition hiatus of ~3 m.y. (Figs. 2, 3A,

FIGURE 4 *Summary diagram of coring results at Site 1148, at the meters composite depth (mcd) scale. Maximum penetration measured with the drill pipe is 853 meters below sea floor (mbsf). The core recovery column is a graphic presentation of the cored and recovered intervals for each hole; larger gaps are the result of coring problems (<100% nominal recovery), smaller gaps (typically 0.5–2 m), revealed by hole-to-hole correlation, occur even when nominal core recovery is 100% or more. The graphic lithology column presents the major sediment types: horizontal line patterns are clay and silt, diagonal dash patterns are nannofossil ooze with foraminifers; lithologic units are denoted with Roman numerals. Mass accumulation rate (MAR) were calculated for total sediment (light gray histograms) and carbonate only (solid gray histograms) from 5 m interval sampling of the smoothed depth-age model, dry density, and carbonate concentration; the smoothed depth-age curve (line) is overlain with control points from nannofossil (squares) and foraminifer (circles) biostratigraphy and magnetostratigraphy (crosses). Color reflectance lightness (L*) parameter (solid line) was measured every 2–4 cm and smoothed with a 20-point moving average for this figure, and carbonate concentration expressed as wt% calcite (dots with dashed line) was measured every ~3.5 m. Magnetic susceptibility (thicker line) and natural gamma radiation (thinner line) were measured every 2–5 cm and the records presented here are smoothed with a 20-point moving average. Porosity (solid line) and grain density (dots with dashed line) were calculated from moisture and density measurements on samples taken every 1.5–3 m. Bulk density (solid line) and dry density (dots with dashed line) were calculated from moisture and density measurements on samples taken every 1.5–3 m.*



4). This hiatus near the Oligocene/Miocene boundary started at ~27 Ma, the time that the spreading ridge of the SCS basin is thought to have jumped southward (Briais et al., 1993). The Oligocene-Miocene transition represents one of the most significant Cenozoic changes in the tectonic and environmental history of the SCS (Wang, 1990). During this period, the sedimentary basins of the northern SCS shelf are thought to have experienced a transition from the rifting stage to one of broad subsidence (Ru et al., 1994).

The early Miocene (16.5–23.7 Ma) at Sites 1146 and 1148 is represented by a calcareous clay with an average carbonate content of ~35 wt%. The total MARs for this interval were three times lower than in the Oligocene (Fig. 3A). During the second stage of sea-floor spreading (27-16 Ma), the SCS basin became much broader than in the Oligocene (Briais et al., 1993). The early Miocene was also characterized by an expansion of reef facies in the shallow waters of the western Pacific, including the Pearl River Mouth Basin (Wang, 1990). The relatively low carbonate accumulation rate but high carbonate content may be attributed to the more pelagic environment of the larger SCS basin, the lack of sediment focusing, and the wide distribution of reef facies on the shelves.

The seafloor spreading phase of the SCS basin stopped at magnetic Anomaly C5c, or ~16 Ma, which is close to the early/middle Miocene boundary. The middle Miocene section (~16–11 Ma) from the northern continental margin (Sites 1148 and 1146) has relatively high carbonate content (>30 wt%), only slightly lower than the early Miocene but much higher than the modern values (<5% and ~20% at Sites 1148 and 1146, respectively). Total accumulation rates during the middle Miocene were 1.91 g/cm^2/k.y. at Site 1148, slightly lower than in the early Miocene and much lower than at Site 1146 (~4.34 g/cm^2/k.y.) (Fig. 3A). Additional postcruise biostratigraphic control is needed to establish whether the slower accumulation rates are related to a change in tectonics or to depositional hiatuses observed on the northern shelf.

Upper Miocene sediments were recovered in the northern (Sites 1146, 1148) and southern SCS (Site 1143). One third to one half of the mass of sediments from northern and southern sites above the modern lysocline (Sites 1146 and 1143) is composed of carbonates (Fig. 3A). Site 1146 shows a significant increase in carbonate accumulation rate from 1.35g/cm^2/k.y. in the middle Miocene to 1.88 g/cm^2/k.y in the late Miocene, while total accumulation rates decreased slightly. At Site 1148, the increase in carbonate accumulation from 0.52 to 0.72 g/cm^2/k.y. during that interval is also reflected in the total accumulation rate. The larger concentration in terrigenous sediment as well as the poor preservation of planktonic foraminifers at Site 1148 indicate a different development compared to Site 1146 in shallower water depth.

Despite the similar carbonate concentrations in upper Miocene sediments, the accumulation rate at the southern Site 1143 is twice as high (~3.8 g/cm^2/k.y.) than at the northern Site 1146 (~1.9 g/cm^2/k.y.). The high carbonate accumulation at tropical Site 1143 might be related to the late Miocene to early Pliocene "biogenic bloom" in the equatorial Pacific (Berger et al., 1993; Farrell et al., 1995) but also seems partly related to redeposition of adjacent sediments as evidenced by the frequent turbidites and slumped sediments in the lower section. The high carbonate percentages in the Miocene deposits from the northern sites imply a low supply of terrigenous material from the land that may be related to rising sea levels during this interval. In general, the high carbonate sediments throughout the Miocene and the similarity between the northern and southern sites suggest a much more stable environment than during the Pliocene-Pleistocene.

Leg 184 recovered Pliocene deposits at four sites (1143, 1145, 1146, and 1148) and Pleistocene sediments at all six sites, although with substantially different accumulation rates (Fig. 3B). At the southern Site 1143, both carbonate and non-carbonate accumulation rates decreased from the late Miocene to Pliocene (Fig. 3): carbonate from 2–4 to ~1 g/cm^2/k.y., and non-carbonate from 3-4 to ~2 g/cm^2/k.y.. The decreasing trend continued to the Pleistocene for carbonate, whereas the non-carbonate rate increased again after ~3 Ma, indicating some increased supply of terrigenous material. On the northern continental margin, Pliocene accumulation rates remain at the late Miocene level at Sites 1146 and 1148 but with slightly lower rates in the deeper Site 1148. Both sites exhibit a rapid increase in LSR and non-carbonate deposition that started at ~3 Ma. Site 1145 records only the past 3 m.y., but the non-carbonate accumulation increases after 2.5 Ma. This apparently regional increase in non-carbonate accumulation may be evidence for an intensification of erosion that is related to climate, sea-level, and/or tectonic events. For example, Chinese geologists report evidence for significant uplift of the Tibetan Plateau at ~3 Ma (e.g., Li et al., 1996), and the widespread accumulation of loess in central China started at ~2.4 Ma (e.g., Liu et al., 1985). However, sea-level changes associated with increased global glaciation may have also contributed to transporting sediments to these continental margin sites. Moreover, all the northern sites show an increase in MAR in the late Pleistocene, especially the last 0.26 m.y. (Fig. 3B). The higher MAR is mainly the result of increased supply of terrigenous material, which might again be related to sea level changes, as the northern shelf and the coastal plains have recorded only the late Pleistocene marine transgression.

SUMMARY

Leg 184 recovered a sequence of hemipelagic sediments that records the past 32 m.y. of environmental history of the SCS. For the first time in the lower latitude western Pacific, these cores provide a high-resolution continuous record of relatively carbonate-rich fine-grained sediments and a possibility of sea-land correlation of the upper Cenozoic stratigraphy for the region. The lithologies, microfossils, and physical properties of the hemipelagic sequence reveal significant trends, abrupt changes and clear cyclicities, which exhibit orbital-scale and finer fluctuations in monsoon climate.

The Oligocene/Miocene boundary in the northern SCS is marked by sedimentary deformation, abrupt lithologic changes, and a stratigraphic hiatus. These related features will help resolve the nature and timing of one of the most significant Cenozoic tectonic and climate changes of the region.

Cores from all sites, both the northern and southern SCS, have high carbonate content during the Miocene and lower Pliocene. The low terrigenous input and partly high carbonate production resulted in a sedimentary environment on the northern slope similar to that near the reef areas in the southern part of the sea in the Miocene; accumulation rates, however, are significantly different in the northern and southern SCS after the Miocene.

A general increase of non-carbonate sediment accumulation after 2–3 Ma was found at all drill sites; for the northern sites, the increase has become even more significant in the latter part of the last million years. A site with exceptionally high rates of hemipelagic fine-grained sedimentation (Site 1144, ~500 m of sediment for the last 1 m.y.) offers a unique opportunity for high-resolution paleoenvironmental studies at decadal scale.

LEG 184 SHIPBOARD SCIENTIFIC PARTY

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Drilling the Input to the Subduction Factory: ODP Leg 185

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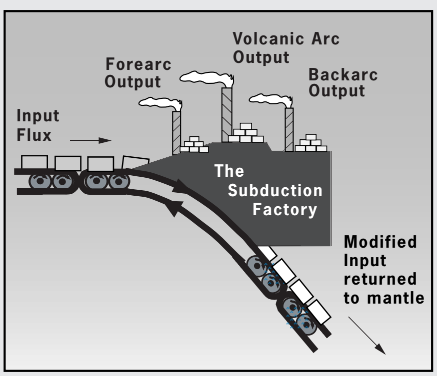
Seafloor formed at ridge axes, altered by interaction with hydrothermal fluids and cold sea-water and covered by a blanket of sediments, is fed into subduction zones at convergent margins. Here it is mixed with mantle, and transformed into volcanic, fluid and gas products on the overriding plate. The term "Subduction Factory" has recently been coined to describe this recycling process (Fig. 1). Direct observation is difficult, but various geochemical tracers allow us to infer the processes that take place in the factory. By mass balancing the tracers, and measuring chemical fractionation that occurs between them, we can begin to understand how the factory works and affects Earth's evolution. The Mariana-Izu-Bonin margin has a lot to offer in tracer recycling studies. The volcanics are well studied; sediment subduction is virtually complete; the upper plate is oceanic and therefore largely transparent to magma assimilation; there is a wide aperture of output products on the upper plate, from serpentine seamounts in the fore-arc to zero-age basalts in the back-arc. The missing component to the recycling equation, however, has been the sedimentary and basaltic input on the incoming Pacific plate. The aim of Leg 185 of the Ocean Drilling Program was to core two sites in Mesozoic crust in the western Pacific, and so determine inputs into the western Pacific subduction factory (Fig. 2). In order to characterise these geochemical fluxes, detailed geochemical data are required on the cored samples. These data must be integrated with logging information to reconstruct the entire drilled section of crust, and with seismic data to extend the fluxes regionally.

FIGURE 1 *Input to and output from "The Subduction Factory".*



In terms of the Subduction Factory initiative, Leg 185 results bear directly on the problem of the forcing functions on factory output, and the volatile cycle through the factory. Forcing functions include convergence vectors, thickness of the upper plate, slab temperature, and sediment transport to depth. The Izu-Mariana margin is an excellent area to examine these functions because of the large geochemical signal along-strike in the volcanic arc. These are illustrated in Figure 3, where significant differences in Ba/Na are observed in the basalts formed in the Izu-Bonin and the Marainas systems. Similarly Pb-isotope variations are strikingly different and probably controlled by the sediment input to the system. Leg 185 results will also provide critical new data for the volatile cycle. The volatile emissions (H_2O, CO_2, SO_2 and Cl) from arc volcanics derive from the basaltic portion of the downgoing plate and the subducted sediments, yet this volatile input is virtually unknown for any convergent margin. Results from Leg 185 will demonstrate how alteration zones and carbonate veins are organized in ancient fast-spreading crust, and so enable the first estimates for volatiles in the upper oceanic crust and sediments near a subduction zone with which to compare directly to volcanic and fore-arc volatile outputs.

The oldest oceanic crust on Earth is subducting into the Izu-Mariana arc system, and in addition to providing geochemical data to input into the subduction equation, the two sites studied provide important constraints on the nature and history of Mesozoic ocean crust. Site 801 is in the Pigafetta Basin (Fig. 2), which is in the Jurassic Quiet Zone (JQZ) and is dated as ~170 Ma (Pringle, 1992). It is the oldest crust drilled by ODP or the Deep Sea Drilling Project (DSDP). The second site, Site 1149 in the Nadezhda Basin (Fig. 2), is on the same flow line as Site 801 but is on magnetic Anomaly M11 and, as such, has an estimated age of ~135 Ma. Both sites originated at spreading centers in the Southern Hemisphere and then migrated northward, but at different times and durations. Thus, in addition to the "Subduction Factory experiment", Leg 185 scientists had an unparalleled opportunity to (1) assess the paleoequatorial sedimentation history of the Pacific Ocean since Meso-

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zoic time, (2) place limits on the ages of the oldest magnetic anomalies in the ocean basins, and (3) study the nature of the JQZ.

DRILLING RESULTS

Lithological columns for the sites drilled during Leg 185 are overlain on a perspective map of the West Pacific basin in Figure 4. Leg 185 re-occupied Hole 801C off the Marianas, which was first drilled during Leg 129 (Lancelot, Larson et al., 1990). The most characteristic feature of the sedimentary section is ~200 m of volcaniclastic turbidites which were shed from the numerous intraplate seamounts surrounding the site. Such turbidites are not present in the sedimentary assemblage overlying basement at Site 1149, where volcaniclastic sediments are ash deposits derived from the adjacent Izu-Bonin arc. These fundamental differences in the sedimentary column must play a role in the differences in the chemical signatures of the two arc-systems. Leg 129 penetrated basement which included a sequence of Cretaceous alkali basalt sills, about 50m of Jurassic ocean-floor basalts, and a hydrothermal deposit formed at ~170 Ma. Formed at fast spreading rates (as high as 16 km/m.y.), Site 801C is a valuable Mesozoic analog to the modern East Pacific Rise. During Leg 185, the hole was deepened to nearly 500 m into basement with ~50% recovery. Most of the drill-hole was logged. An important aspect of the Leg is the use of the logging information to quantify the relative volumes of the different basement lithologies (flows, breccia, hydrothermal deposits etc.) which control the chemical budgets.

The main objective at ODP Site 1149, was to penetrate through the sedimentary section and > 50 m into the Early Cretaceous crust entering the Izu-Bonin trench (Fig. 2), and so provide the first samples of the crustal inputs to the Izu-Bonin subduction zone. More than seven previous attempts in the Nadezhda Basin, a 1000 x 1000 km region west of the Japan and the Izu-Bonin islands, had failed to penetrate through the resistant cherts at 50–150 m below seafloor (mbsf). Leg 185 was successful in drilling through a thick section of chert and porcellanite (~250 m), as well as >130 m into volcanic basement, at some of the greatest water depths and total drill string lengths (>6300 m) attempted by deep sea drilling. Although recovery of the chert section was low (<15%), geochemical logging of the section was successful in providing the first complete profile of the sedimentary section being subducted at the Izu-Bonin trench.

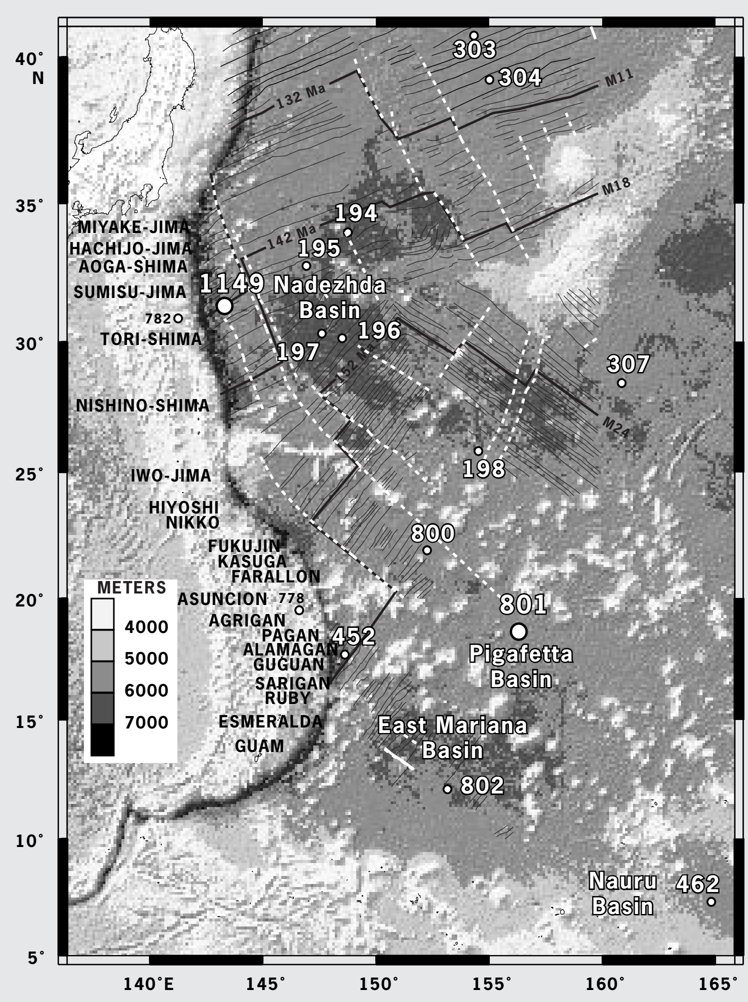


FIGURE 2 *Predicted topography of the northwest Pacific (Smith and Sandwell, 1997) and magnetic lineations of the western Pacific compiled from Nakanishi et al. (1989) and the PLATES Project (1998). Ages of selected lineations (solid black lines) are given using the time scale of Channell et al. (1995). Open circles show locations of selected DSDP/ODP sites. Site 1149 is located 2200 km northwest of Site 801 along a fracture zone bounded flow line spanning ~388 m.y. White dashed lines = locations of fracture zones (GMT software, Wessel and Smith 1995).*

SAMPLING STRATEGY FOR GEOCHEMICAL MASS-BALANCE STUDIES

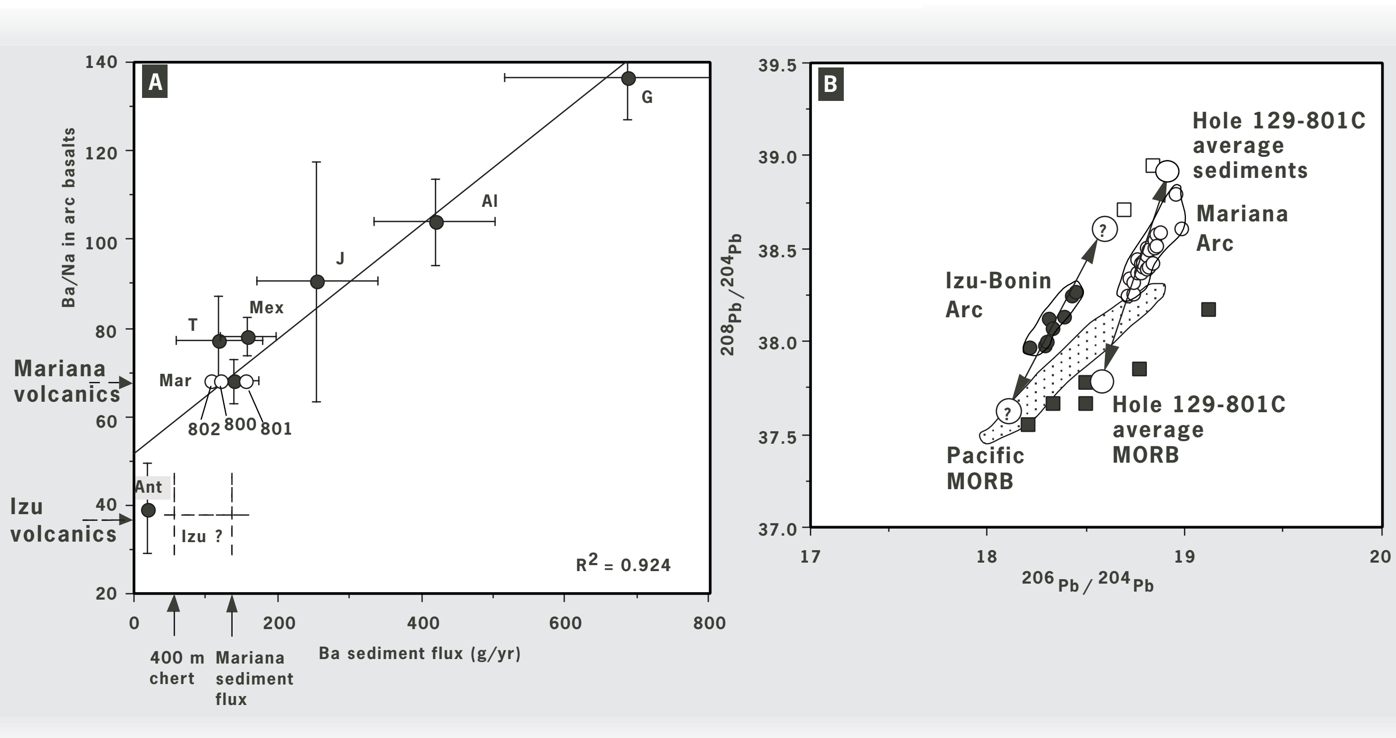
Integration of the logging information and the geochemical data is essential to reconstructing the chemical fluxes controlled by the altered upper oceanic crust and overlying sediments. As the two sites represent the first deep basement penetration near a subduction zone they provide an unparalleled opportunity to evaluate geochemical fluxes to the Subduction Factory. For example, Figure 5 shows some of the initial results for the basement section in Hole 801C presenting logging results, volume % of vein material, and the main lithological features. Leg 185 was staffed with a large number of geochemists and the success of the Leg can only be evaluated when the data become available. Nonetheless, the sampling strategy was aimed at providing the first comprehensive data suite for altered oceanic basement and involved scientists sharing common samples in order to cover a complete spectrum of analyses. This communal sampling strategy involved over 40 major and trace elements, as well as isotopes of Pb, Nd, Sr, Os, Hf, Li, B, Be, Cl, S, Se, C, N, O and H. Some samples having different degrees of alteration will be mixed to provide "composites" which will serve as geochemical reference samples in the construction of global models for the Geochemical Earth Reference Model (GERM).

In addition to providing the samples and logs required for the Subduction Factory experiment, Leg 185 made the following important discoveries, which are summarised below and developed further in the Initial Reports volume (Plank, Ludden, Escutia, and the Leg 185 Scientific Party).

OPUNCTUATED ALTERATION – A CHARACTERISTIC OF FAST-SPREADING CRUST?

In contrast to the decrease in oxidative alteration that occurs with depth at other

FIGURE 3 *(A) Correlation between Ba flux in subducted sediment and Ba enrichment of arc basalts for various arcs (Ant = Northern Antilles, Mar = Marianas, T= Tonga, Mex = Mexico, J = Java, Al = Aleutians, and G = Guatemala) around the world (after Plank and Langmuir, 1993). Open circles = three different sediment flux estimates for the Marianas, based on the three ODP Sites drilled during Leg 129 (800–802) (Plank and Langmuir, 1993). Note Izu volcanics are lower in Ba/Na than Mariana volcanics by a factor of two. Drilling at Site 1149 will help to test if the low Ba/Na of the Izu volcanics is related to a lower Ba sediment flux. Shown for reference are the average Mariana Ba sediment flux and the flux for a 400-m section of chert (with 125 ppm Ba, similar to the upper radiolarites in Hole 801C; Karl, et al., 1992).*
(B) Contrasting Pb isotopic composition of Mariana (open circle) and Izu-Bonin (solid circle) arc volcanics. Mariana volcanics form a mixing trend (arrow), almost perfectly coincident with mixtures of ODP Hole 801C sediment (open boxes) and basalt (solid boxes) averages. Drilling at Site 1149 will test whether the Izu-Bonin Arc trend (arrow) is consistent with different subducted material than for the Marianas. Modern Pacific MORB data are shown for reference. Data sources: Elliott, et al., 1997; Gill, et al., 1994; Plank and Langmuir, 1998; Castillo et al., 1992.



sites in the oceans, the MORB basement at Site 801C is punctuated by discrete zones of alteration between intervals of minimally altered basalt (see Fig. 5). These discrete zones occur adjacent to ocherous, Fe-Si-rich, low temperature hydrothermal deposits, and near breccia deposits probably related to near-axis faults. Away from these alteration zones, fresh basaltic glass occurs abundantly, demonstrating the spatially heterogeneous nature of seafloor alteration. Hole 801C is the only site to sample a significant portion of Layer 2A in fast-spreading crust, and so this organization of alteration zones near hydrothermal deposits and faults may be the hallmark of fast spreading crust. In order to quantify the visual descriptions, ground-truth the logs, and determine the timing of alteration events, a common set of samples of Site 801C basement lithologies has been taken for all geochemical investigators.

CONTRASTING SEDIMENT INPUT TO THE MARIANA AND IZU SUBDUCTION ZONES

Having cored for the first time through the entire sedimentary section subducting at the Izu-Bonin margin, Leg 185 enables comparison of the inputs to the Mariana and Izu arcs. In contrast to the East Mariana and Pigafetta Basin sediments subducting at the Marianas trench, the Nadezhda Basin sediments lack a mid-Cretaceous volcaniclastic section, and contain more siliceous and carbonate-rich biogenic material due to its longer passage beneath zones of high biological productivity. Shorebased geochemical studies of communal samples will demonstrate the extent to which these different sedimentary histories can be traced to the volcanic output from the two arc systems. For example, does the sedimentary and basaltic input on the in-coming plate provide suitable Pb isotope mixing end-members for the Izu arc volcanics, or are other mantle and upper plate sources required? Does the extensive biogenic section in the lower half of Site 1149, which is highly depleted in alkali elements, contribute to the low alkali content of the Izu arc?

MESOZOIC AND CENOZOIC PELAGIC SEQUENCES

The equatorial paleolatitude history of Site 1149 during the mid-Cretaceous, combined with a predictable subsidence history, is ideal for testing variations in the Cretaceous CCD. Site 1149 sediments also record a well-developed metalliferous sedimentary profile, which

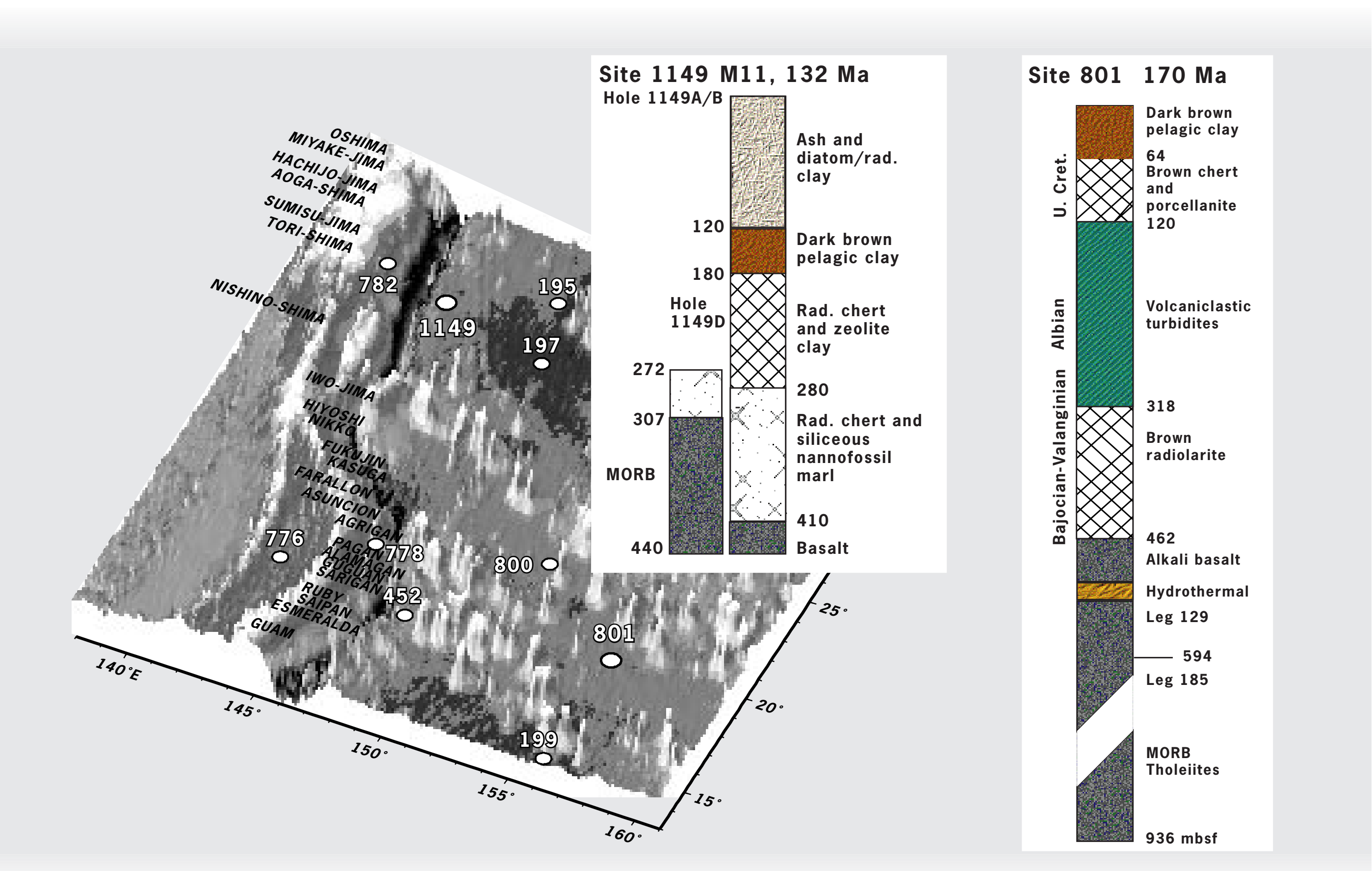
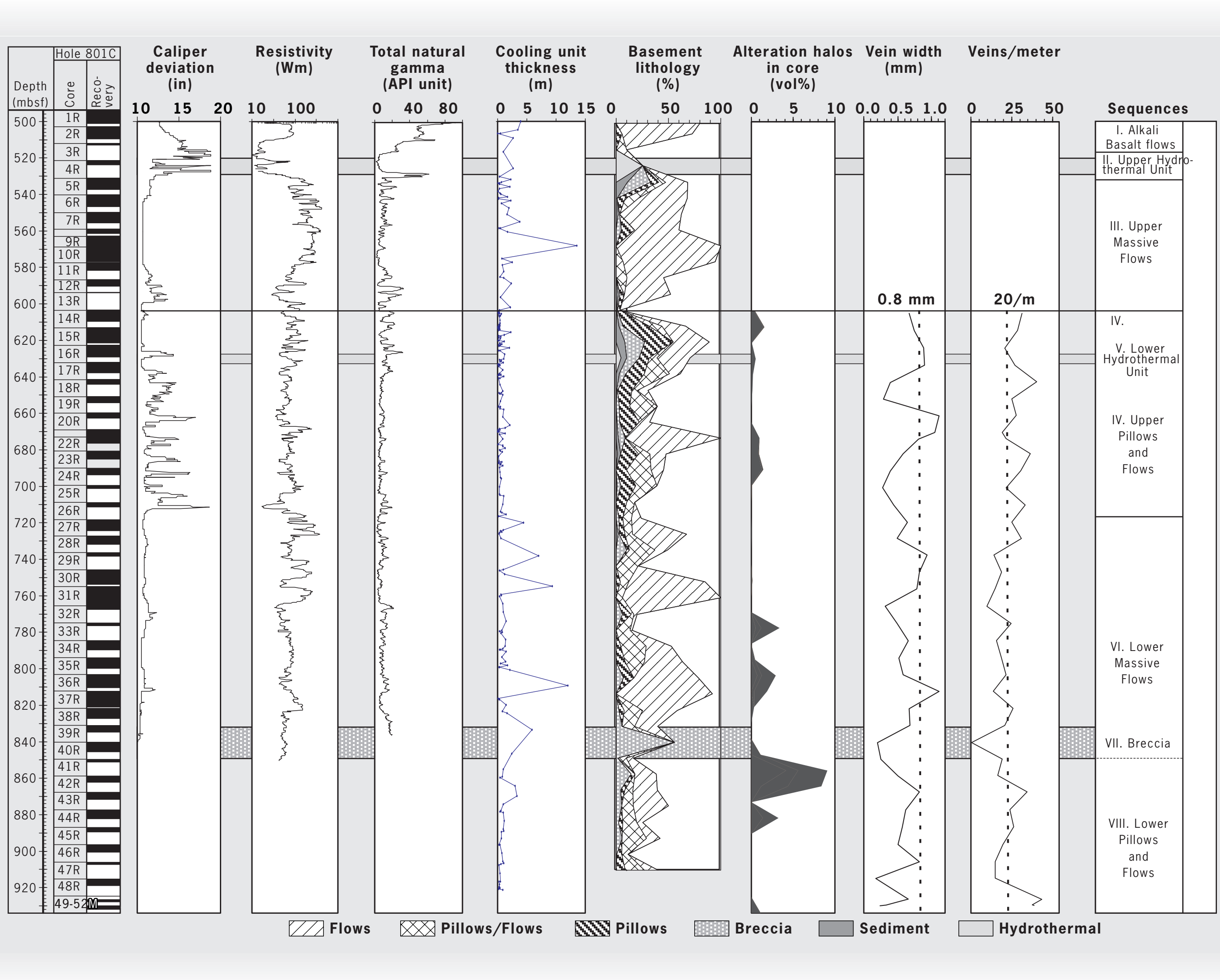


FIGURE 4 *Perspective map of Izu Mariana arcs and Leg 185 drilling sites, Sites 801 and 1149. Predicted bathymetry based on satellite altimetry [Smith and Sandwell (1997)] and GMT software (Smith and Wessel, 1990).*



documents clearly the decreasing influence of hydrothermal plume precipitation with distance from the ridge. Very high sediment accumulation rates (~ 30 m/Ma) and the mineral composition of the youngest sediments suggest that Site 1149 was in the reach of the Asian dust plumes after the early Pleistocene. An extensive Miocene to Pleistocene ash record preserves a history of Izu-Bonin volcanism, and represents a cannibalistic flux to the subduction zone.

MESOZOIC PACIFIC BASALTIC GLASS

Fresh basaltic glass recovered from both Sites 1149 and 801 provide pristine samples of the igneous liquid that forms Mesozoic Pacific crust. These are valuable samples that record mid-ocean ridge processes, mantle composition and mantle temperature at a time preceding the Cretaceous superplume event in the Rapid Polarity Alternations during the Jurassic Magnetic Quiet Zone.

FIGURE 5 *Basement igneous stratigraphy, logging results and alteration features down-core for ODP Site 801C.*

Hole 801C Jurassic basement records up to six geomagnetic reversals. Not only are there several reversals, but some sections preserve gradual changes in the magnetic field direction from one polarity interval to the other. Thus igneous basement at 801C was extruded at a time of rapid polarity alternations of the geomagnetic field. These data may provide an explanation for the Jurassic “Quiet” zone in a series of superposed flows with opposite polarity, essentially canceling out one another. The presence of fresh basaltic glass at depth in 801C will also provide suitable material for paleo-intensity studies, to test the hypothesis that the Jurassic Quiet Zone was a time of low geomagnetic field intensity.

THE DEEP BIOSPHERE

Leg 185 was the first ODP leg to invest a significant effort in equipping a microbiology laboratory carrying out microbial contaminant tests, and establishing techniques for core handling biological samples. The initial results and the strategy are described in Smith et al. (in press and online). Contaminant tests using perfluorocarbon and fluorescent microsphere tracers demonstrated that sediments cored with the APC showed less susceptibility to contamination than RCB coring. In fact, several APC core interiors were entirely free of contaminants, and both APC and RCB core interiors were free of the microsphere tracers. These tests, which demonstrate that biological contamination can be assessed and surmounted, pave the way for establishing ODP as a new platform for microbiological studies. Leg 185 samples are being used to start culturing experiments in various media at both atmospheric and in situ pressure, and to begin shorebased DNA extraction and community characterization.

Several glass samples from Site 801C show textural evidence for microbial alteration and invite the intriguing question of whether there is still microbiological activity in 170 Ma volcanic basement (see Fisk et al., 1999).

For more information see:
http://www-odp.tamu.edu/publications/
http://www.crpg.cnrs-nancy.fr/Science/Leg185/

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Seismogenic Zone Deep Drilling and Measurement Report of the Detailed Planning Group

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INTRODUCTION

Most of the worlds great earthquakes and tsunamis are generated by rupture on the "seismogenic zone" of subduction thrust faults. An important project in future scientific ocean drilling, especially of the OD21 riser ship scientific program, is to drill through and make detailed measurements and recordings in the parts of subduction thrust faults that generate great earthquakes. The objectives are an improved understanding of the physical and chemical processes responsible for earthquakes, and seismic hazard reduction for the very destructive great earthquakes that occur on these faults. Some of the important questions are:

1. What controls the earthquake cycle of elastic strain build-up and sudden rupture: what are the stress, pore pressure and chemical changes?
2. Are there specific changes of stress, pore pressure, pore fluid chemistry or other parameters with time, that define increasing probability of great earthquakes?
3. What controls the parts of subduction thrusts that are seismic and aseismic, especially the seaward updip and landward downdip limits?
4. What is the nature of asperities on the megathrust fault that are inferred to be stronger and generate large earthquake slip compared to areas that may have significant aseismic creep?
5. What is the nature of "tsunami earthquakes"? Why do some large slip events have most stress release in the seismic motion of great earthquakes, whereas others have slower slip that generates only moderate earthquakes but large tsunamis?

The SEIZE (Seismogenic Zone Experiment) Detailed Planning Group (DPG) addressed mainly scientific questions, but also considered the technical capabilities required to meet the scientific objectives and the possible technical limitations to drilling and measurement.

THE RISER DRILLSHIP CAPABILITIES

Several previous workshops and reports dealt with studies of the subduction seismogenic zone in general (1, 3), and scientific riser drilling (2). Important relevant information also is found in the proposal for drilling the San Andreas Fault (4) and results from the German KTB well. This DPG dealt primarily with drilling by the OD 21 riser drill ship in the Japan area, but shallower penetration drilling by the present JOIDES Resolution and future non-riser drill ships was also considered. Transects across subduction zone margins including deep riser holes and shallower non-riser holes near the trench are needed to meet the scientific objectives. A drill ship with a riser that allows return circulation and seals the hole during drilling is necessary both for deep drilling and for extensive downhole measurement and recording Important capabilities in addition to the greater hole depth that will be possible

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THE SEISMOGENIC ZONE DPG

Goal

To define a comprehensive study of an active seismogenic zone that will investigate the physical and chemical processes that control earthquake nucleation and propagation. This will include development of a coordinated drilling plan, and identification of drilling, monitoring, technological, and site survey requirements. This study will be the first project to be undertaken by IODP using the new riser drilling ship.

Mandate

To work with other appropriate international geoscience initiatives to:

- Define the detailed scientific objectives of drilling and monitoring an active seismogenic zone.
- Develop a coordinated drilling strategy to complete the defined objectives that will likely include an integrated program of non-rise and riser drilling.
- Identify potential geographic areas as targets for drilling that are in the vicinity of Japan.
- Determine the site survey requirements both for deep drilling and to maximize the scientific results from seismogenic zone drilling.
- Determine the drilling technologies/facilities, downhole measurements and sampling, and long-term monitoring that will be required.
- Solicit proposals for experiments or investigative strategies that might be included.

with the OD21-ship compared to the JOIDES Resolution are:

1. The increased hole stability made possible by circulation of drilling mud,
2. The balancing of formation pressure with mud weight, especially where overpressured,
3. The blowout preventer permitting drilling in areas that may contain hydrocarbons,
4. The continuous cuttings sample return, and much higher quality core recovery,
5. The much higher quality of downhole geophysical logs made possible by the constant diameter (gauge) hole resulting from stabilization by drilling mud,
6. The access to the hole through large diameter casing permiting use of larger diameter logging tools, instruments and experiments than have been possible using the JOIDES Resolution.

The OD 21 riser drill ship has a planned initial capability of 2,500 m riser length, to be extended in later development phases, and a 10,000 m drill string. The first OD21 drilling is to be in the Japan area; initial study shows that most sites around Japan where the water depths are less than 2,500 m, require over 5 km penetration to the seismogenic zone. Such penetration involves potential technical difficulties and drilling times of several years. However, several sites off SW Japan (Nankai Trough) appear to require less penetration although they may have atypical structure. Careful study is needed to find suitable sites requiring the minimum penetration to reach the seismogenic zone. The search for the best initial site will require additional 2D and 3D multichannel and other seismic data.

SCIENTIFIC REQUIREMENTS FOR SITE SELECTION

The DPG did not review in detail the available site survey and previous studies for the Japan region or other possible sites globally. However, some of the important site needs that were identified are listed here:

1. A subduction zone where the tectonics, structure, thermal regime, and earthquakes are very well studied and well known. Previous shallow drilling of the subduction thrust and on the continental slope in the area of the proposed deep site would be essential. The regions should be structurally simple with an inferred decollement that is fairly stable in position and depth with time.
2. Shallow plate dip and shallow trench such that the subduction thrust fault can be reached by OD21 drilling in a reasonable time, i.e., less than 5 km penetration. This appears to require sites where young oceanic plates are being subducted. It is recognized that young plates also imply high temperatures and thus drilling and measurement difficulties. In addition to the greater drilling time and greater potential for failure, deeper subduction thrusts can be less well characterized because of the decreased resolution of seismic and other signals with depth.
3. Accretionary prism sediments are expected to be readily penetrated by the OD21 drilling. A low temperature gradient (heat flow) is desirable by the OD21 drilling.
4. The subduction thrust should be accessible to non-riser drilling seaward from the main deep riser site that penetrates the seismogenic zone. The 2,500 m water depth limit does not apply to non-riser drilling, but the practical maximum penetration for non-riser drilling is probably less than 2 km. At Nankai Trough (Site 808) penetration of 1,300 m through the décollement into basement was achieved with some difficulty, and there have been considerable drilling difficulties experienced previously for penetration greater than 1 km in accretionary prisms.

   Non-riser drilling of an out-of-sequence thrust fault, connected to the décollement and well imaged with defined reflection polarity, is very desirable.
5. A recent great earthquake within the seismogenic zone that has been well studied is needed to characterize the seismogenic zone. A map of slip displacement in the event is desirable. Shorter earthquake return times should mean a shorter time scale for the changes associated with the great earthquake cycle.
6. The subduction thrust should be well imaged by multichannel seismic data, especially in the area of the seismogenic zone to be drilled. It is critical to know the depth of the decollement, and its thickness and reflection polarity. Also the better the image of the seismogenic zones the more readily can the drilling data results and conclusions be extended laterally and to other regions.
7. The locked part of the seismogenic zone should be defined. This may be achieved by, (a) determining the updip and downdip limits of rupture of past great earthquakes (seismic modelling, aftershock distribution, tsunami modelling), (b) analyzing the distribution of intermediate size and small earthquakes (especially with thrust mechanisms) that define which part of the thrust is seismic, (c) evaluation of geodetic data (interseismic and coseismic), both on land and if possible on the seafloor, that define the locked zone and rupture zone. In a few areas peninsulas allow land geodetic measurements sufficiently far seaward to define the seaward as well as landward limit of the locked zone.

What are Detailed Planning Groups (DPG's)

Detailed Planning Groups (DPGs) are short-lived planning groups that are created by SCICOM for more intensive study of certain aspects of planning that may arise. DPGs are created by SCICOM with individual mandates that may be either scientifically or technologically based. DPGs provide written reports to SCICOM. Example tasks for DPGs include: translating highly-ranked ODP science proposals into concrete drilling plans; advising on regional and site surveys needed for future drilling; preparing drilling prospectuses which synthesize all thematic and site survey input, etc.

Members of DPGs are chosen by SCICOM for their expertise and experience with respect to the assigned DPG mandate. Each full member of ODP has the right of representation. DPGs are disbanded once their task is completed.

HAZARDS

The formation expected to be penetrated off SW Japan is a young clastic accretionary sedimentary prism. The main technical concerns for drilling the subduction thrust and seismogenic zone are:

a. difficult formation conditions, i.e., unconsolidated unstable sediments, high formation pressure, and high temperatures;
b. storms, especially typhoons,
c. strong ocean currents, such as the Kuroshiro current along most of the Nankai Trough region.

Careful engineering design, and planning are needed to deal with the typhoons and strong currents. Additional thermal data and modelling, geotechnical studies etc. are needed to predict and design for the formation conditions in a deep accretionary prism borehole.

LONG TERM MONITORING

Although core and cutting sampling are important to the SEIZE program, the deep drilling should be considered primarily as a method of access to the seismogenic zone, allowing a wide range of measurements and long-term recording. The borehole is to become an observatory. Many of the scientific objectives can be achieved only through a comprehensive and well prepared downhole measurement and recording program.

The most important sampling, measurement, and recording programs include:

1. geophysical and geological site characterization studies,
2. measurements on core and cuttings,
3. analysis of fluid and gas samples,
4. downhole measurements,
5. long-term fault zone monitoring.

MANAGEMENT OF SEIZE DRILLING

The planning and scientific operations for long duration OD 21 programs will be very different from the 2-month drilling leg experience of ODP/DSDP. The DPG recommends that an expert scientific team be set up for each major OD21 program such as SEIZE to develop detailed scientific and operational plans, and to carry through to the scientific program onboard the ship during drilling and measurement. The team should have subgroups for each of the main scientific components, including the required site surveys and studies. The scientific team must work closely with the JAMSTEC drilling engineering and science groups who are responsible for design, construction and operation of the OD21 drill ship. The proposed scientific team needed for a SEIZE drilling and measurement program follows the 5 project elements listed above. It may be appropriate to have an initial competition for the most qualified and most motivated participants based upon proposals for each component of the project. These proponents then would prepare detailed science plans for their part of the scientific program. A small committee with representation from all of the components would provide oversight to the science for the whole SEIZE project. It is desirable for the critical aspects of the project to be funded together, including the most critical site surveys. Independent funding should be only for site surveys, associated science, and those parts of the program that are not essential to the overall success of the project.

Further Information:
Full DPG-Report: http://www.joides.geomar.de/files/seizerept.pdf
SEIZE Website:
http://www.soest.hawaii.edu/margins/SEIZE_sci_plan.html

[1] The Seismogenic Zone Experiment (SEIZE) Workshop, Waikoloa, Hawaii, June 3-6, 1997 (http://www.soest.hawaii.edu/margins/SEIZE.html);

[2] The International Conference on Cooperative Ocean Riser Drilling (CONCORD), Tokyo, Japan, 22-24, 1997 (http://www.jamstec.go.jp/jamstec/OD21/CONCORD/state.html);

3 Costa Rica -–Nicaragua Seismogenic workshop report CriNiSEIZE;

[4] Scientific Drilling into the San Andreas Fault at Parkfield, CA: Project Overview and Operational Plan (http://pangea.Stanford.EDU/FZD/).

Report of Long Term Observatories Program Planning Group

By Becker[1], K. and Suyehiro[2], K. (Co-Chairs), Davis, E., Duckworth, R., Duennebier, F. K., Foucher, J., Kinoshita, M., Lovell, M., Screaton, E. J., Spiess, F., Stakes, D. S., Villinger, H.

INTRODUCTION

In the current ODP Long-Range Plan (LRP), long-term observatories for in-situ monitoring of geological processes are highlighted in two important senses: as a current ODP innovation and as one of three major technological/scientific initiatives to be emphasized in addressing ODP's principal scientific research themes. The LRP emphasis on observatories and in-situ monitoring of geological processes confirms that ODP presently is at the forefront of the growing international movement toward utilizing both seafloor and ocean borehole observatories to monitor active Earth processes in the time domain and greatly enhance our tomographic image of Earth. The initiative for observatory science represents an important future direction for marine sciences; it spans all disciplines of ocean and geosciences and therefore also represents an important incentive for interdisciplinary studies. ODP is uniquely positioned to lead in this effort in three ways: in providing the "legacy holes" that will remain the only means of emplacing long-term sensors, samplers, and instruments to significant depths in the subsurface; in providing the core and log "ground-truth" for the historical record of active earth and ocean processes; and in terms of its established international programmatic organization. And any future scientific ocean drilling program post-2003 should be prepared to carry on this leadership role, as has already been confirmed by the emphasis on borehole observatories in the CONCORD and COMPLEX Reports and the draft IODP science plan.

The LRP initiative for in-situ monitoring of geological processes covers a number of scientific themes centered on active Earth processes spanning a large range of time and space scales, and therefore programmatically link ODP to a range of international and national geoscience initiatives. Like the ODP drillship itself, observatories are tools that can be used to address many independent scientific objectives.

The Long Term Observatories PPG

Overall Goal

To develop a plan for the integration of long-term instrumentation in boreholes with seafloor observatories planned by other global geoscience programs, with the goal of:

- investigating the structure and dynamics of the Earth's interior;
- quantifying the flux of heat and materials to and from the Earth's interior.

Mandate

To work with other appropriate international geoscience initiatives to:

- Devise experiments that incorporate the use of ODP boreholes for long-term measurements at seafloor observatories.
- Recommend mechanisms for the implementation, emplacement, and oversight of borehole-related instrumentation in the context of seafloor observatories planned by other global geoscience initiatives.
- Organize the development of instrumentation/experimental proposals in collaboration with appropriate global geoscience initiatives.
- Recommend ways in which instrumentation in boreholes can be serviced and maintained by, and data retrieved from, platforms other than the JOIDES Resolution.
- Provide advice on site survey data, core measurements, logging requirements, and the completion of boreholes in preparation for instrumentation. planned by other global geoscience initiatives.
- Organize the development of instrumentation/experimental proposals in collaboration with appropriate global geoscience initiatives.
- Recommend ways in which instrumentation in boreholes can be serviced and maintained by, and data retrieved from, platforms other than the JOIDES Resolution.
- Provide advice on site survey data, core measurements, logging requirements, and the completion of boreholes in preparation for instrumentation.

THEMES OF THE LONG TERM OBSERVATORIES PPG

The Long Term Observatories PPG was established to address "instrumentation" as well as broad scientific themes that fall

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within the mandates of both the Interior and the Exterior Science Steering and Evaluation Panels (SSEPs). Given that our advice encompasses both technological issues and scientific themes, it is directed not only to the SSEPs and SCICOM, but in some cases to SciMP, SSP, and OPCOM. The PPG worked with appropriate "global geoscience initiatives" including ION and InterRidge, and national counterparts such as DEOS (Deep Earth Observatories on the Seafloor - US and UK), OSN (Ocean Seismic Network - US), OHP (Ocean Hemisphere Project - Japan), and the various national ridge-crest programs. There are also strong national initiatives with less developed international analogs (e.g., US MARGINS and the fledgling "InterMARGINS") and other initiatives just barely gearing up on scientific themes of enduring interest, for which borehole observatories could be a very important tool, e.g., a new ILP initiative on "Hydrogeology of Oceanic Lithosphere. The PPG membership included strong links to nearly all of these initiatives.

Although the PPG's life was limited to three years some of the specific items in its mandate could not be completed in this short time line. Ongoing effort will be required throughout the lifetime of ODP, particularly as "global geoscience initiatives" interested in seafloor observatories develop their plans.

OBJECTIVES OF LONG TERM OBSERVATORIES

In the past decade there has been a growing movement on the part of many geoscience initiatives towards establishing seafloor observatories, which include borehole instrumentation. The case for seafloor observatories is set out in a host of international and national workshop and committee reports dating from the late 1980's through the 1990's, including the current ODP LRP. The geoscience initiatives involved have separately set out the intellectual justification and technological requirements for seafloor observatories; these generally apply to borehole observatories, with special considerations for the great value and particular configurations of boreholes. We drew heavily on the documents concerning observatories written by other geoscience initiatives, particularly ION (International Ocean Network) and the US planning effort DEOS (Dynamics of Earth and Ocean Systems).

The intellectual justification for seafloor and borehole observatories stems from the premise that Earth is a dynamic system that can only be understood properly if studied in a process-oriented perspective with adequate sampling in both spatial and temporal domains. Given that the oceans cover 70% of the Earth's surface, including the locations of the most active plate boundaries, adequate spatial and temporal sampling of the seafloor and subseafloor formations is critical. Earth processes occur over a wide range of temporal and spatial scales and exhibit considerable covariation and dynamic interlinkages extending to oceanographic and atmospheric processes. While many of these processes are fairly well characterized in the static spatial domain, their temporal behavior is poorly understood. Investigation of the Earth as a dynamic system will require an intellectual reorientation, with increasing emphasis on long time-series measurements to understand processes in the time domain and complement the more traditional focus on spatial mapping and sampling.

Understanding active Earth processes and their importance to society "observatory" science to study properties, parameters, and processes over a variety of time scales, and in some cases to conduct perturbation experiments. Given the range of time/space scales involved, it has been convenient (e. g., in the 1995 ION work-

What are Program Planning Groups (PPG's)

Program Planning Groups (PPG) are small focused planning groups formed by SCICOM when there is a need to develop drilling programs or technological strategies to achieve the goals of the Long Range Plan. PPGs advise upon drilling/technology strategies and proposals for major scientific objectives that are not adequately covered by existing drilling strategies or proposals. Drilling proposals arising from PPG meetings must be submitted to the JOIDES Office by individual proponents or groups of proponents. PPGs also foster communication between the ODP and other major geoscience initiatives. PPGs report to the appropriate panel in the JOIDES Advisory Structure as directed by SCICOM.

Members of PPGs are focused groups of specialists and proponents, chosen by SCICOM through consultation with the SSEPs and community programs. Each full member of ODP has the right of representation. The number of PPGs is determined by SCICOM's need to fulfill the Long Range Plan objectives, subject to budgetary constraints. The normal term length is three years, but can be renewed by SCICOM.

PPG – Final Reports

Since 1997 SCICOM has established nine Program Planning Groups (PPG) and one DPG The PPG's began to present their final reports and recommendations to SCICOM in 1999. In this section summaries of these reports are given. The complete documents are available on the JOIDES-website (http://www.joides.geomar.de) after ratification by SCICOM.

shop report) to consider current and planned efforts on seafloor/borehole observatories in two classes:

1. "Active Process" observatories located where the particular systems are presently most active. The most obvious examples are at plate boundaries: mid-ocean ridges, the settings of possibly the most complex interplay among tectonic, magmatic, hydrothermal and biological processes on Earth; and subduction zones, settings of tectonic and magmatic processes of great destructive impact on society. Given that these plate tectonic boundaries occur almost exclusively beneath the seas, a seafloor/borehole observatory capability is imperative scientifically and societally.

2. "Global Network" observatories (e. g., seismic, geomagnetic), sited to complete the global coverage necessary to image the interior of the Earth utilizing unpredictable natural sources. With 70% of the Earth's surface under the oceans, the global networks will never be complete without seafloor observatories.

This categorization is arbitrary, in that there is a continuum of time scales of Earth processes, all of which are "active" in one sense or another. Nevertheless it may be a useful classification in terms of distinguishing observatories according to whether temporal monitoring of specific processes or better spatial resolution of Earth structure is the key objective.

Although seafloor/borehole observatories may differ in their specific scientific objectives, they share many common technological needs. These are primarily related to the deployment and maintenance of long-term monitoring equipment in the remote and hostile seafloor environment. The primary issues are those of delivering long-term power to seafloor instruments, providing a link for data transmission from the seafloor to land, preferably in near real-time, providing an avenue for remote command and control of seafloor instruments, and facilitating deployment and retrieval of instruments for repair or refurbishment. The LTO-PPG mandate included considering these issues, but it should be emphasized that they are continuing issues that apply to all seafloor observatories and are presently being extensively considered outside of JOIDES. For example, Japan has made major investments in cabled observatories, and the US DEOS planning effort has formulated plans for both cabled and buoyed seafloor observatories; these are both viable options for linking to borehole observatories for power and data transmission and instrument control.

ODP'S CONTRIBUTIONS TO OBSERVATORY SCIENCE

ODP provides three unique and essential contributions that should ensure its continuing leadership role in the growing movement for observatories on and beneath the seafloor:

- "Legacy holes," which represent the only means available for emplacing sensors and instruments deep within subseafloor formations for truly in-situ geological monitoring. This capability is critical in understanding many geological processes; monitoring from the seafloor is often not satisfactory.

- The cores and logs recovered from ODP holes contain the record of active geological processes in the past. The combination of in-situ monitoring at present plus the historical record in the cores and logs can be very powerful in understanding Earth processes.

- In full fruition the initiative for seafloor observatories will be comparable in financial scale and international aspects to the ODP. In coordinating and administering an international seafloor observatory initiative, ODP and JOIDES will be held up as the prime model of a successful, long-term, international scientific program. More important, given its unique scientific contributions, there is a real opportunity for JOIDES, ODP and any post-2003 drilling program to flourish and play an even greater leadership role in international geosciences as seafloor observatory science grows in significance.

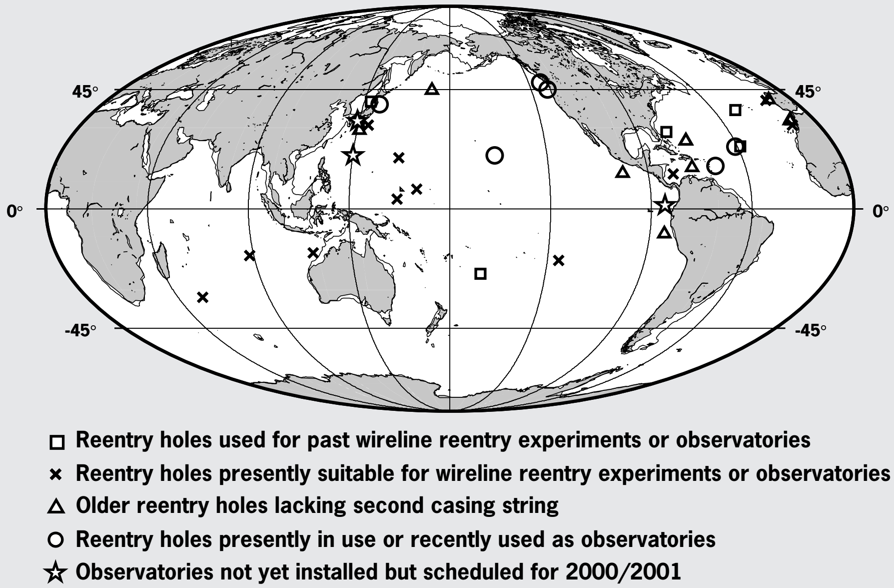
It is no surprise that ODP has been active in implementing borehole observatories for at least a decade. JOIDES support for observatory science can be traced back much earlier, e.g., borehole seismometer deployments during DSDP for periods of months and time-series hydrologic measurements made on DSDP/ODP revisits of legacy holes like 395A and 504B. In the 1990's, ODP has provided strong support for both "global network" and "active processes" observatories, with two prime examples: the legacy holes utilized and/or specifically drilled for the ION/OSN global seismic network and the 13 "CORK" long-term hydrologic observatories installed to date. ODP has recently installed a third kind of observatory designed to monitor processes at intermediate time/space scales: the strainmeter/seisomometer successfully deployed in the Japan Trench during leg 186.

THE IMPORTANCE OF LEGACY HOLES

Legacy holes are stable holes that can be reentered for deepening or for experimental use. These holes include some of those with reentry cones and casing, and could include bare rock holes that can be reentered by a Control Vehicle or ROV. The vast majority of DSDP/ODP holes are non-reenterable single-bit holes; at this time, there are only about 33 useful legacy holes, virtually all of which are traditional reentry holes. A large majority of the best quality reentry holes have been utilized for or proposed for ODP observatories. Eleven of these holes contain CORKs, two contain strainmeter/seismometer installations and six of the holes contain instruments for other experiments that are no longer in use. Interestingly, reentry holes established before 1991 were generally established for deep drilling purposes, but the primary motivation for the majority of reentry holes established since 1991 has been observatory science. The Long Term Observatories PPG noted that the list of suitable legacy holes is very short, and recommends that ODP consider using a significant portion of the remaining drilling program to remediate existing reentry holes and/or drill legacy holes in locations of particular interest for future experiments and observatories.

Legacy holes might include OSN sites, bare rock shallow holes for arrays, hole pairs for cross-hole studies, and other possibilities not envisioned at present. Several existing holes that are presently blocked by experiments that are no longer operating could be cleaned and improved at relatively little expense to make them into valuable legacy holes. The LTO-PPG requests that the ODP consider such cleaning operations whenever logistics present opportunities.

The great majority of legacy holes are located in international waters where they cannot be legally controlled. Present JOIDES policy recognizes this, and merely requests notification of JOIDES when legacy holes are to be utilized. However, the value of these resources to the international geosciences community makes it strongly advisable that their use for experiments be monitored and coordinated by an international group under JOIDES auspices. To date, serious conflicts have not occurred and an oversight group has not been required, but JOIDES should consider establishing an oversight mechanism.



RECOMMENDATIONS FOR THE JOIDES ADVISORY PROCESS

These recommendations include:

1. Establishment of a clear process specific to observatory proposals, including early review of technological aspects. Clear guidelines for early review will be especially important as new types of ODP observatories are proposed by new proponents.
2. Establishment of an oversight group for legacy holes, possibly falling to a subset of SciMP (Scientific Measurements Panel).
3. Seeding of appropriate PPG's with scientists with observatory expertise. The Long Term Observatories PPG sees strong observatory prospects for the themes of at least three of the PPG's active in 1998–2000: the Deep Hot Biosphere PPG, the Architecture of Oceanic Lithosphere PPG, and the Gas Hydrates PPG.
4. The Long Term Observatories PPG membership included strong representation of hydrogeological expertise, as hydrological observatories have been a prominent ODP success since 1991. While the overall goal of the Long Term Observatories PPG mandate included “quantifying the flux of heat and materials to and from the Earth’s interior,” the group did not feel sufficiently qualified to develop a global drilling/observatory strategy to address the wide range of hydrogeological problems in seafloor environments. The Long Term Observatories PPG welcomed the formation of a Hydrogeology PPG by SCICOM in Fall 1999 and recommended that it includes strong observatory representation.

CONCLUSIONS

In maintaining a strong commitment to borehole observatories ODP (and IODP) has an opportunity to strengthen its leadership role in the growing global initiative for seafloor observatory science. The price for JOIDES to exercise a leadership role in long-term monitoring is quite reasonable, given that extensive third-party funds are nearly always used for ODP observatory science. Several examples have followed a funding model in which non-JOIDES funds are leveraged to support scientific instrument packages emplaced in ODP observatory sites as well as post-emplacement data recovery. The total costs of these additional contributions are comparable to the contribution from JOIDES. In this sense, observatories represent a very cost-effective way to extend impact of ODP science in a time of level funding for ODP.

Specifically, continuing commitments are required from JOIDES/ODP toward 1. establishing good reentry holes in appropriate locations, and 2. providing the engineering support for emplacement of third-party instruments. The first includes the commitment of costs and drillship time for standard and new types of reentry holes where appropriate. The commitment required from JOIDES also includes engineering development toward hole completion (e.g., development of hammer-in or drill-in casing systems) in difficult drilling environments where active processes are of great scientific interest. The second aspect includes engineering support at ODP for the seafloor and subseafloor hardware required for the third-party instruments. For example, in the initial CORK design used for 1991–1997 deployments, ODP provided the CORK "body" which sealed the reentry cone and from which third-party sensor strings were suspended. For the strainmeters and broad-band seismometers deployed in the Japan Trench during Leg 186, ODP engineered the system for deploying and cementing the instrument package in place.

To summarize, the Long-Term Observatories PPG strongly recommends high priority should be given to the following:

1. Commitment of drillship time and, in most cases, cost of standard reentry cone/casings at appropriate sites that are well-justified in competitively reviewed JOIDES proposals, e.g., ION sites and other potential legacy holes.
2. Continued development of hole-completion technology for difficult drilling environments where active processes will require long-term monitoring.
3. Continued engineering development support for installation of third-party monitoring packages in observatory holes.

Further Reading:
The Full Long Term Observatories PPG Report from March 1999: http://www.joides.geomar.de/panels/LTO_PPG.html
Note: Some sections were updated in this article to cover the recent developments during the last 14 months.

SEIZE DPG Report:
http://www.joides.geomar.de/panels/SEIZE.html

DEOS web site:
http://vertigo.rsmas.miami.edu/deos.html
(includes links to other observatory sites)

Ocean Drilling Report – Drydock Report

By Aaron H. Woods[1]

Since 1985, when the JOIDES Resolution ventured on her first expedition in the Gulf of Mexico, the ship has undergone three drydock periods for refurbishment of both the ship and laboratory equipment. However, never before has more work been accomplished during a drydock than the recent undertaking in Singapore. The 58-day stay at the Keppel Shipyard enabled ODP to improve the safe and efficient working environment of the JOIDES Resolution and upgrade the ship's operational capabilities to better achieve the objectives stated in ODP's 1996 Long Range Science Plan.

The activities that took place during the stay in the Singapore shipyard can be grouped into three categories. The first, and by far the most extensive, includes the repairs and upgrades of the ship and its equipment. These activities were necessary for the five year contract extension through FY2003 and were funded by the National Science Foundation and Overseas Drilling Limited (ODL), the ship's operator. The second group of activities were the repairs and upgrades to the scientific infrastructure on board the ship and these projects were supported by the co-mingled funds of the Ocean Drilling Program. The two major projects in this category were the addition of the new 7th level and the modification of the core handling and description area on the 6th level. The third group of activities were three major projects that were scheduled during the Singapore yard period because they represented complex and demanding installations that could be best accommodated during an extended period of time when the ship was out of service. Two of the projects, the Active Heave Compensation (AHC) system and Rig Instrumentation, were carried out by ODP. The goal of these two projects was to enhance our ability to make hole and recover better sections of core through the utilization of new drilling technologies. The third project, the installation of a synchronous generator, was carried out by ODL. It is anticipated that this system will significantly reduce fuel consumption because the ship will operate more efficiently.

One of the primary reasons this extensive drydock succeeded was the dedicated efforts of the many ODP staff members that worked long and hard dismantling and reassembling the JOIDES Resolution. The ODP science community is truly fortunate to have the dedicated technicians, engineers and administrative staff that so successfully worked together to complete this challenging mission.

SHIP SAFETY, MAINTENANCE AND UPGRADE ACTIVITY

The first, and by far the most extensive, drydock activities included repairs and upgrades of the ship and its equipment to ensure continued safety and maximum performance during the upcoming ODP expeditions. Some of these projects included the following:

- Refurbishment to the ship's hull, thrusters, thruster wells, tanks, propulsion gear box, and rudder;
- Replacement of all sanitary piping within the accommodations;
- Thoroughly inspection of the drilling equipment;
- Installation of a new data management system (DMS) to better regulate the ship's power, ultimately reducing fuel costs;
- Installation of a new automatic station keeping (ASK) system providing a dual redundancy for maintaining station under a greater range of environmental conditions; and
- Installation of a new breathing system in the core lab, the core handling catwalk area and the drill floor to facilitate safe handling of H_2S-laden cores;

All of these projects were successfully completed during the drydock period and have greatly enhanced the ability of the JOIDES Resolution to continue operating safely and efficiently in the high seas through 2003.

SHIPBOARD LABORATORY ENHANCEMENTS

One of the new science initiatives identified in ODP's Long Range Science Plan was the establishment of microbiology research during ODP cruises. Prior to Leg 184, a temporary microbiology van was installed aboard the ship and this facility was used extensively during Leg 185. Because of the success of Leg 185 and on the recommendations of the JOIDES advisory community, a new laboratory facility was installed on the 7th level that includes wet and dry laboratories, a new conference room, and enhancement to the downhole measurements facility. This additional space will allow the Program to establish a permanent microbiology facility in the lab stack, as well as to significantly enhance the Program's ability to implement the new generation of downhole experiments.

[1] Texas A&M-Ocean Drilling Program
1000 Discovery Dr. College Station,
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In addition, the 6th floor core laboratory was redesigned to better manage core handling and flow, and to more effectively mitigate the affects of noxious gases by installing a better venting system in the core splitting area. Other equipment that was refurbished during drydock included the sonar dome, fantail winches and lab-stack foundation. All of these projects will serve to increase safety and ensure superior service delivered aboard the ship.

TECHNOLOGY UPGRADES

During the dry dock period, the Program took the opportunity to install an active heave compensation (AHC) system. Active heave will more efficiently de-couple ship's heave from the drill string. With reduced heave, variability in weight-on-bit can also be reduced. It is well known that good control of weight-on-bit results in enhanced core quality, longer bit life and greater control when landing equipment on the bottom or in the hole.

Another new technological capability installed was a rig instrumentation system called Fusion. This system represented a conversion of the 25-year old analogue instruments that displayed salient drilling parameters (e.g. hook load, rate of penetration, torque, revolutions per minute depth, depth below seafloor) on charts and/or dials in the operations shack to a digital system. This permits more accurate readings and a continuous data stream that is displayed at key locations throughout the ship and recorded for later analysis and integration into drilling results. Both of these projects were considered a high priority by TEDCOM because of the enhancement to drilling operations and the potential to improve core recovery.

The Singapore shipyard period represented the largest project undertaken by the Program since the ship was converted for ODP 16 years ago. Most of the projects were completed and commissioned before the ship arrived in Fremantle to begin Leg 187, but it has taken a few legs to bring closure to some of the projects and to "shake-down" some of the new systems. The "shake down" period was particularly challenging because Legs 187 and Leg 188 took us to the remote Southern Ocean where environmental conditions and logistic isolation made it difficult to respond to problems. Nevertheless, now all systems are up and running and only two tasks are outstanding:

- the ASK system has not been accepted for shallow water conditions (<50m) and ODP is awaiting new shallow water beacons from the manufacturer before a shallow water test can be carried out; and
- the AHC system needs to be fine-tuned for a range of sea states before it will function in a most optimal fashion and this will take time. Moreover, one of the ODL drilling crews has not yet been trained with the AHC and this is scheduled to take place during the first few weeks of Leg 190. The AHC is presently in operation on Leg 189.

Overall, the JOIDES Resolution is a much more capable vessel, with extended water depth capabilities, improved operational efficiency, and the capability to routinely conduct microbiological research, conductdownhole tool instrumentation and carry out gas hydrate research.

JOIDES Activities during 1999

The JOIDES **Executive Committee** met January 13 -14, 1999, at the Rosenstiel School of Marine and Atmospheric Sciences of the University of Miami on Virginia Key in Miami, Florida. The major items of discussion concerned the nature of membership of countries and consortia that make a less-than-full contribution to the program, the scientific program for 2000, and the development of a special subcommittee of the Science Committee to plan for the future Integrated Ocean Drilling Program (IPSC = IODP Planning Subcommittee). IPSC is a subcommittee of SCICOM and reports through SCICOM to EXCOM and to the International Working Group (IWG) for the IODP. The summer meeting of EXCOM was held 29-30 June, 1999, in Sydney, Australia. The major items included acceptance of the FY 2000 Program Plan, and endorsement of IPSC's plan to form working groups for science planning, industry liaison, and technology.

The JOIDES **Science Committee** (SCICOM) and the Operations Committee (OPCOM) met March 24-27, 1999, in Freiburg in Breisgau, Germany. It reviewed reports from the Panels and decided that in the future the Program Planning Groups (PPGs) would report through the appropriate Science Steering and Evaluation Panel (SSEP), but that SCICOM would receive the final reports from the PPGs. Keir Becker presented the final report of the Longterm Observatories PPG. SCICOM discussed activities to be carried out on future legs, and expressed its pleasure that the microbiology experiments performed on Leg 185 had been carried out successfully. It proposed establishment of a PPG to investigate the possibilities for drilling in the Arctic Ocean. The summer meetings of SCICOM and OPCOM were held August

16–19, 1999 on the campus of the University of California at Santa Cruz. It is during the summer meeting that SCICOM ranks the proposals forwarded to it by the Science Steering and Evaluation Panels. This year there were 24 proposals to consider for six legs of drilling. Members of SCICOM make presentations on the proposals in their area of expertise, and then those members who do not have a conflict of interest rank the proposals following the procedure outlined in the "Guide to the Ocean Drilling Program." This year we did something new: OPCOM took the ranked list and developed three alternative ship tracks, each comprising sets of highly ranked legs using data on drilling and logging times, distances, and weather conditions developed by the ODP Operator at Texas A & M and by the Borehole Research Group at Lamont. These tracks were then brought back to SCICOM on the last day of the meeting, and a final track and preliminary schedule were constructed.

The **Technology and Engineering Development Committee** (TEDCOM) met twice during the year, first in Vancouver, Canada, during the COMPLEX Conference, and then December 1–2, 1999 at ODP TAMU headquarters in College Station, Texas. TEDCOM members were very interested to hear what scientists at COMPLEX wanted to do. This was valuable input in considering the development of new methods and techniques in drilling and coring. At its December meeting, the TEDCOM reviewed all of the engineering development projects currently underway at ODP.

The busiest JOIDES group was undoubtedly the **IODP Planning Subcommittee** (IPSC). Its Chair, Ted Moore of the University of Michigan, was selected by EXCOM in January, and its potential membership was explored and approved by SCICOM in March. The Subcommittee started off as an ad hoc working group in order to have an organizational meeting in Tokyo, Japan on April 22–23. Its first formal meeting was after the COMPLEX Conference in Vancouver on May 29–31, with subsequent meetings in Copenhagen, Denmark (October 22–23), and San Francisco (December 18–19). IPSC organized and appointed a science planning working group which met in Zürich, Switzerland early in November, and by the end of the year had largely completed the task of taking the CONCORD report, the draft COMPLEX report, and other documents to produce a draft science plan for IODP. IPSC also established a working group on technology, which is investigating platforms, and a working group on liaison with industry.

The **Science Steering and Evaluation Panels, Interior** (ISSEP) and Environment (ESSEP), met twice during the year, May 23–25 in Seattle, Washington, and November 1–3 in Udine, Italy. They considered ways in which the active proposals in the system can be improved and brought to the level of maturity so that they can be forwarded to SCICOM for consideration for scheduling. To understand the level of activity in the SSEPs it is important to realize that the JOIDES Office received 33 new proposals in 1999, and at the end of the year there are about 80 active proposals in the system.

The **Scientific Measurements Panel** (SCIMP) met twice during the year, January 19-20 in Houston, Texas, and June 28-30 in Boulder, Colorado. In addition to considering the many aspects of shipboard and shore-based measurements and data handling, they helped IPSC consider scientific equipment that will be need for operations in the IODP.

The **Site Survey Panel** (SSP) met February 9–11 in Fremantle, Australia and July 19–21 at the SSP Office in Lamont-Doherty Earth Observatory in Palisades, New York. The Panel checks the adequacy of site survey data for planning the drilling programs. SSP has experienced an increasingly heavy load of work as the number of proposals forwarded to SCICOM grows larger.

The **Pollution Prevention and Safety Panel** (PPSP) met twice, April 12–14 in San Antonio, Texas, and December 9–10 in San Francisco, California. The Panel reviewed the drilling planned for forthcoming legs through early 2001.

Many of the **Program Planning Groups** (PPGs) were completing their work in 1999, preparing final reports that will be reviewed by the SSEPs before being forwarded on to SCICOM for acceptance.

The Extreme Climates and Environments of the Paleogene and Cretaceous PPG met in Burkheim, Germany March 25–27 and in Santa Cruz California December 10–11. It has been developing a focussed program for investigating extreme conditions on the Earth prior to the Miocene. The Gas Hydrates PPG met at the Technical University in Berlin where it was able to discuss development of the HYACE (HYdrate Autoclave Coring Equipment), intended to be used on future gas hydrate legs.

The Scientific Drilling of Shallow Water Systems PPG met September 24–25 in Aix-en-Provence, France, just before the Conference on Paleoceanology of Reefs and Carbonate Platforms: Miocene to Modern.

The Deep Biosphere PPG met December 18–19 in San Francisco, and will be recommending ways of ensuring ongoing investigations of the microbiology of the sediments and rocks beneath the sea floor.

The Seismogenic Zone Detailed Planning Group met twice, March 17–18 in Tokyo and May 24–25 in Victoria, British Columbia, Canada to complete its report on investigation of the seismogenic zone in active margins via drilling. Its deliberations will be especially important for the early phases of the IODP.

IWG SUPPORT OFFICE ESTABLISHED

The International Working Group Support Office (IWGSO) was established on November 30, 1999 by the Japan Marine Science and Technology Center (JAMSTEC) and Joint Oceanographic Institutions, Inc. (JOI) under the guidance of the Science and Technology Agency (STA) and the National Science Foundation (NSF).

The Support Office is an interim office that was created to provide administrative, clerical, and financial support for the Integrated Ocean Drilling Program (IODP) which is scheduled to begin in 2003. John Farrell and Masanori Shinanois are the Management Representatives from JOI and JAMSTEC.

For more information on the status of IODP planning activities please visit the new IODP website:
http://www.iodp.org

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EUROPEAN OCEAN DRILLING FORUM 10–11 APRIL 2000, LA GRANDE MOTTE, FRANCE

This was the third in the series of biennial conference organised by the European Ocean Drilling Community. The event involved more than 150 scientists and included 75 posters and 25 oral presentations. The conference concentrated on four themes:

Earth's changing climate
(Warm climates, sea-level change, climate tectonic interactions).

Lithosphere factories and mantle dynamics
(Creation of oceanic crust, hydrothermal Systems, large igneous events, core-mantle dynamics, the subduction factory).

The deep bioshere
(Studies of the biomass beneath the ocean-floor).

Understanding continental margins
(Fluid flow, gas hydrates, seismic hazards and resource potential).

The European Contribution to IODP
(Alternate platforms, shallow-water drilling, Arctic drilling; enabling technologies, shore-based laboratories).

These four scientific themes reflected the general scientific goals of the IPSC science plan and the speakers were asked to emphasise the European dimension in their research. In particular climate studies in the Arctic, high-resolution sampling for climate change, methane hydrates, and the hidden biosphere featured in the ongoing and proposed research. The potential of the Mediterranean region for seismogenic-zone studies, for example in the Gulf of Corinth, and the study of erosion and transport into the Indian ocean and in sedimentary fans in the Mediterranean were discussed. Two presentations, one from Elf-Total-Fina and another from Shell International, underlined the need for collaborative research between industry and the understanding of facies models in deep-water depositional environments.

The presentations included a summary of the IPSC's activities, including plans for the Japanese Riser vessel and a US-sponsored JR-replacement vessel. The session on the European Contribution to IODP discussed recommendations of the European Science and Technology Advisory Group on Ocean Drilling, including:

- refining scientific issues for IODP in respect to Europe
- pursuing a technological model for European contribution to IODP
- approaching EU funding for tasks (sub-committees and technology)
- recommendation to European / national funding agencies how they should be involved with IODP.

The ECOD consortium will host the next European Ocean Drilling Forum.

John Ludden, ODP-France

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A new JOIDES Directory is available online from the JOIDES website. This is a document compiled on demand from our database. It contains contact information for member-country offices and panel members. The directory can be edited and printed.
Download at
www.joides.geomar.de/directories

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