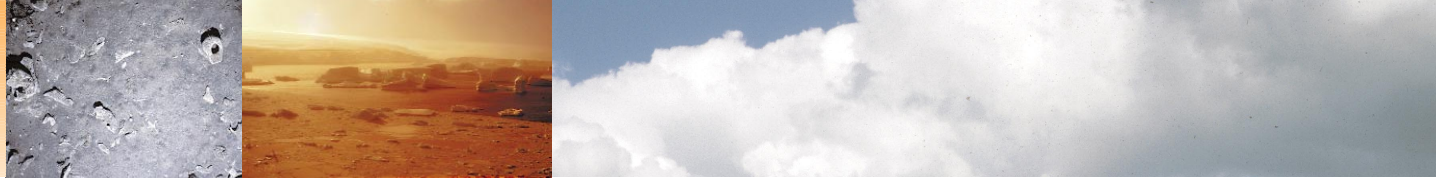
OCEAN DRILLING PROGRAM



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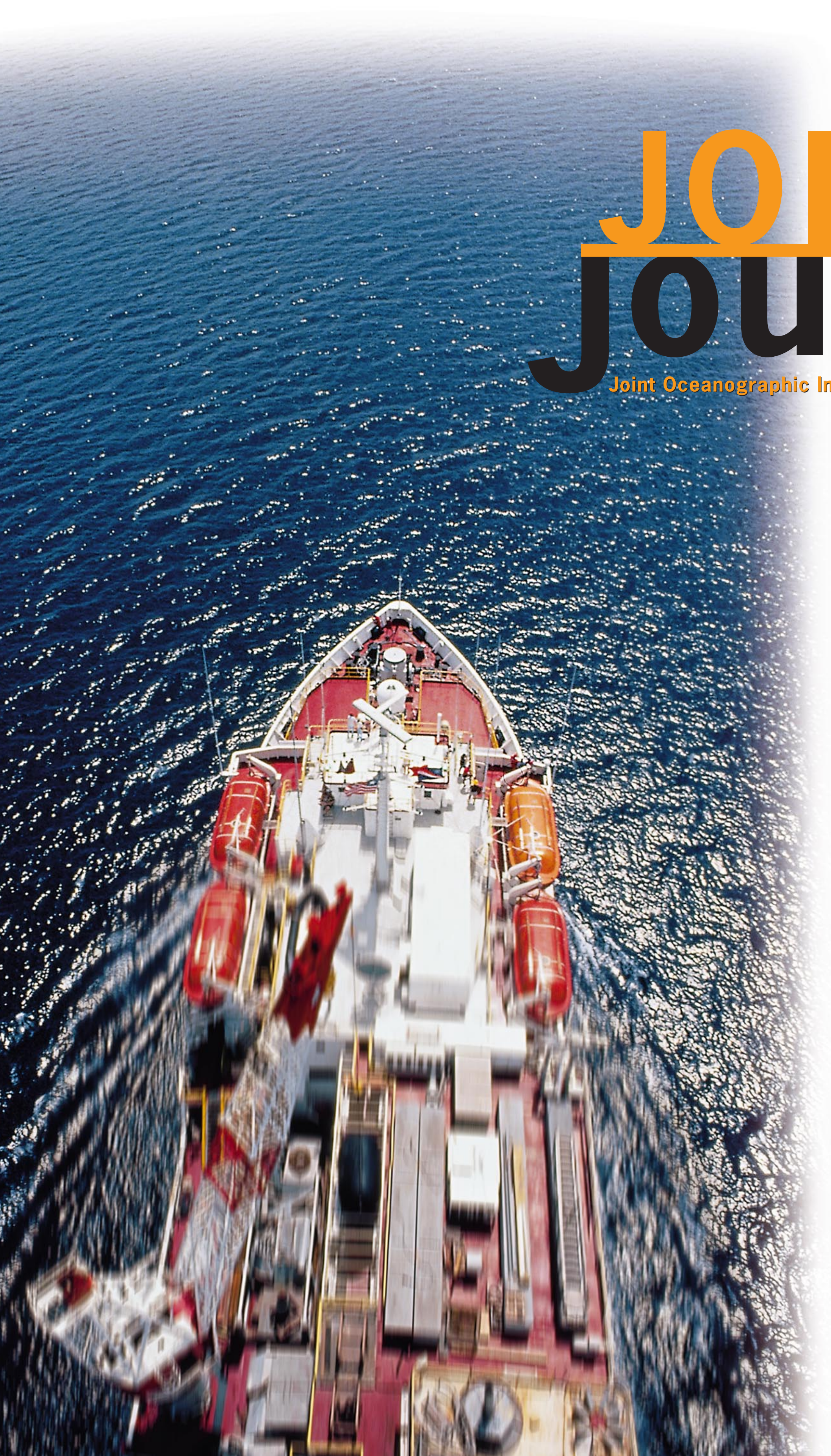


A Letter from the Chair

The JOIDES Office 1999: Warner Brueckmann, Jeffrey Schuffert, Bill Hay, Emanuel Soeding, and Bettina Rohr (from left to right).

The JOIDES office moved to Germany on January 1, 1999, and will be here for two years. The new Chair of the JOIDES Executive Committee is Helmut Beiersdorf of the Bundesanstalt fuer Geowissenschaften und Rohstoffe in Hannover. The JOIDES Office itself, however, is located at GEOMAR in Kiel, on the Baltic Coast of the Jutland Peninsula. GEOMAR is a Marine Geological Research Institute attached to Christian-Albrechts University, perhaps better known as the University of Kiel. Bill Hay is Head of the Office and Chair of the JOIDES Science Committee (SCICOM) and Operations Subcommittee (OPCOM). Warner Brueckmann is the Science Coordinator. He is the liaison between the Office and the Interior Science Steering and Evaluation Panel (ISSEP), and also handles most of the correspondence with proponents. Jeffrey Schuffert is the U. S. Representative in the Office and liaison to the Environmental Science Steering and Evaluation Panel (ESSEP). He is responsible for keeping track of Panel, Program Planning Groups (PPG) and Working Group memberships. Emanuel Soeding is Scientific Assistant and is in charge of developing the JOIDES Website and keeping information on the site up to date. Bettina Rohr is our Administrative Assistant, and keeps the rest of us in line.

These two years will be an exciting time not only for those of us in the office, but for the entire ocean drilling community. The operational phase of the Ocean Drilling Program will come to an end in September 2003. The scheduling of the remaining legs of the program will be done in the next three years; the six legs for 2001 were selected by SCICOM at its meeting in August, 1999, the six for 2002 in August 2000, and the remaining four legs in 2001. At the same time the activities of the present JOIDES Advisory structure will be phased down.

Plans are underway to ensure that scientific ocean drilling will continue well into the next century – as the Integrated Ocean Drilling Program (IODP). As it is envisioned, the IODP will use platforms appropriate to the task in investigating scientific problems. As you will read elsewhere in this issue of the Journal, the OD21 program in Japan has received funding to construct a drilling vessel equipped with a riser.

However, there are many objectives that can be accomplished with an extension of the riserless technology employed by the JOIDES Resolution. To define these objectives, over 300 scientists met at another international conference, COMPLEX, held in Vancouver, British Columbia, Canada, at the end of May, 1999. The COMPLEX Report will document the exciting scientific goals that can be achieved by an ocean drilling vessel without using riser technology, and by alternative platforms that can drill in shallower waters and in ice-covered seas.

The job of integration and planning for the new comprehensive international program of exploration of the sediments and crust beneath the sea is in the able hands of a special group, the IODP Planning Subcommittee (IPSC), headed by Professor Ted Moore of the University of Michigan. The IPSC reports both to JOIDES and to the International Working Group (IWG) composed of representatives of prospective funding agencies.

Other articles in this issue of the Journal provide more detailed information about how the plans for the new program are being developed.

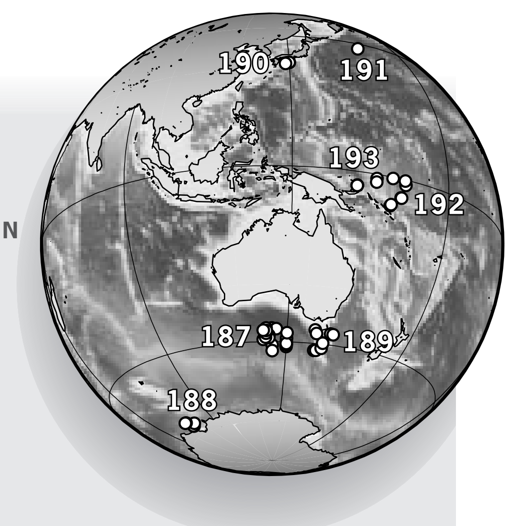
We at the JOIDES office look forward to working with you until the end of our term, December 2000, and hope that we can do as well as the WHOI staff did during last term.

William W. Hay

In this issue

Scheduled Legs until January 2001

LEG	TITLE	DATES	ORIGIN – DESTINATION
187	Australian-Antarctic Discordance	11/15/99 – 01/07/00	Fremantle – Fremantle
188	Prydz Bay	01/13/00 – 03/06/00	Fremantle – Hobart
189	Southern Gateways	03/12/00 – 05/01/00	Hobart – Townsville
190	Nankai Trough	05/22/00 – 07/13/00	Guam – Yokohama
191	West Pacific Seismic Network	07/19/00 – 08/11/00	Yokohama – Majuro
192	Ontong Java Plateau	08/17/00 – 10/05/00	Majuro – Guam
193	Manus Basin	10/11/00 – 12/03/00	Guam – Suva



Continental Rifting, Low-angle Normal Faulting and Deep Biosphere: Results of Leg 180 Drilling in the Woodlark Basin

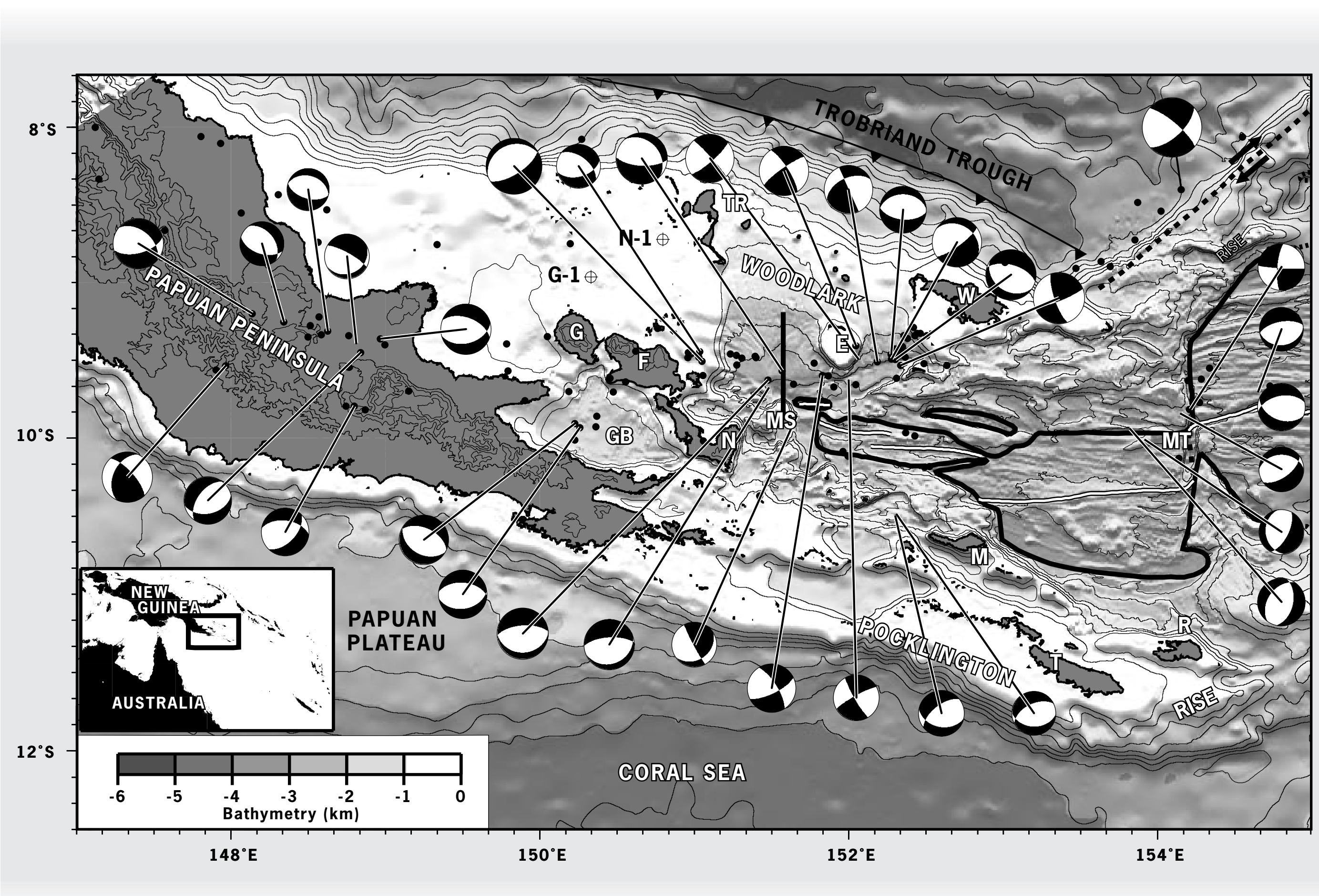
by Brian Taylor[1], Philippe Huchon[2], Adam Klaus[3] and the Leg 180 Scientific Party

OVERVIEW

What makes the largest faults, the ones that sustain most slip, much weaker than existing theories and experiments can explain? To answer this question, Leg 180 targeted drilling of an active fault at the western apex of the Woodlark Basin, where a seafloor spreading center is propagating into rifting Papuan continental crust (Fig. 1). The crust there is being pulled apart at ~3 cm per year. The extension appears to be focused on a normal fault with shallow inclination (25–30° dip down to 9 km) that reaches the sea floor. This makes it ideal for study by vertical drilling but also particularly enigmatic: faults with low dip are locked by gravity and can only slip if unusually weak or well lubricated.

Leg 180 established a high-resolution syn-rift stratigraphy, vertical motion history, and basement petrology of an actively rifting continental margin. The known extent of the deep-sea biosphere was deepened to 842 mbsf – partly as a result of the first use of techniques for uncontaminated sampling of moderately indurated, RCB cores. A bare rock spud-in penetrated the outcropping low-angle normal fault but characterization of the in situ fault properties at depth was thwarted by (a) the presence of trace hydrocarbons at primary Site 1108 and (b) metamorphic talus at alternate Sites 1110–13 closer to the 3 km high fault scarp. Subsequent review by Pollution Prevention and Safety Panel (PPSP) has re-opened the possibility of deepening Site 1108.

FIGURE 1 *Topography of the Papuan Peninsula and bathymetry of the western Woodlark Basin (500 m contour intervals) showing relocated epicenters (black circles) and earthquake focal mechanisms from Abers et al. (1997). The solid line is the landward boundary of oceanic crust and the thin double lines locate the spreading axes (Taylor et al., 1995). The straight line segment at 151°34.5´E locates the Leg 180 drilling transect (see Fig. 2). Inset shows geographical location of the Woodlark Basin.*



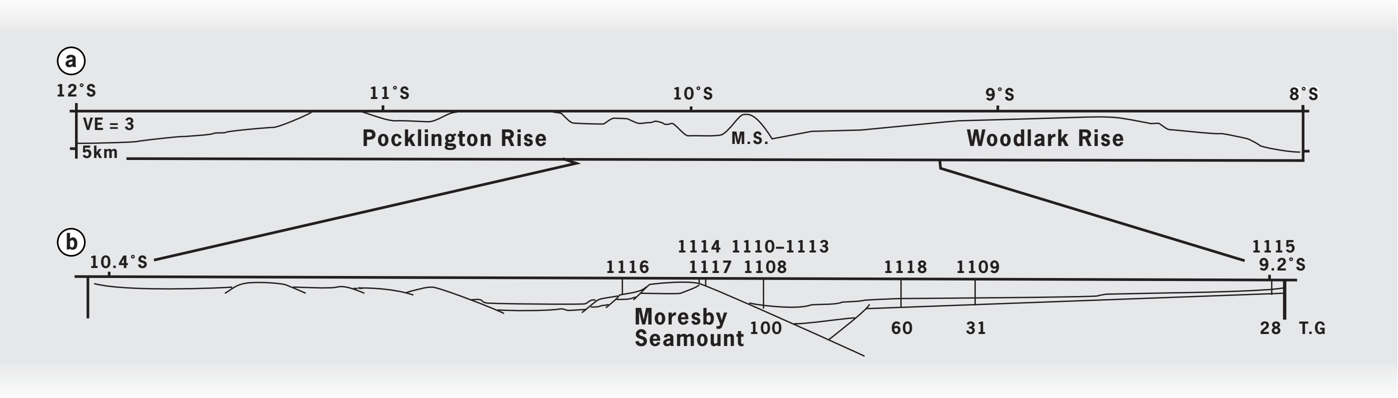


FIGURE 2: *Nested meridional sections at 151°34.5´E showing the (a) regional bathymetry and (b) local structures across the incipient conjugate margins. Leg 180 drill sites are depicted on the b section. T. G.= thermal gradient (°C/km). VE = vertical exaggeration.*

BACKGROUND

The processes by which continental lithosphere accommodates strain during rifting and the initiation of seafloor spreading are the subject of continuing debate. Particularly controversial is the conjecture that much of the strain may be accommodated on areally large normal detachment faults that slip at low dip angles (<30°).

In a departure from previous ocean drilling strategies, Leg 180 drilled an area of active continental break-up, as opposed to conjugate passive margins that are its fossil counterparts. Earthquake source parameters and seismic reflection data indicate that normal faulting is active at depths above 9 km in the region of incipient continental separation, and permit slip on low-angle fault planes (24–35°; Figs. 1–2; Abers, 1991; Taylor et al., 1995, 1999; Mutter et al., 1996; Abers et al., 1997). The asymmetric rift at the western apex of the Woodlark Basin is one of the most seismically active rift systems on Earth (Fig. 1). Current rifting and spreading are confirmed by kinematic measurements using GPS observations (Tregoning et al., 1998).

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STRUCTURE AND STRATIGRAPHY

During Leg 180 we drilled a transect of sites just ahead of the spreading tip: Sites 1109, 1115, and 1118 on the down-flexed northern margin; Sites 1108 and 1110–1113 into the rift basin sediments above the low-angle normal fault zone; and Sites 1114, 1116, and 1117 on the footwall fault block, Moresby Seamount, Site 1114 near the crest, 1116 on the southern flank, and 1117 into the upper fault face (Figs. 1–2).

The northern margin sites (1109, 1115, and 1118), cored to 802, 803, and 927 meters below seafloor (mbsf), respectively, penetrated the syn-rift cover sequence and into pre-rift sections: dolerites at Sites 1109 and 1118, and middle Miocene forearc clastics at Site 1115. A high resolution syn-rift stratigraphy, vertical motion history, and basement petrology was established. In accord with other land and subsurface data, the presence of ophiolitic conglomerates deposited on the rift-onset unconformity at all three northern margin sites, indicates the widespread occurrence of ophiolite forming the basement of the orogenically thickened Papuan Peninsula and Woodlark Rise. Syn-rift sedimentation was initially paralic to inner neritic, followed by successively deeper water Plio-Pleistocene hemipelagic and turbiditic deposits, with discrete inputs of volcanic ash and volcaniclastic turbidites. The detailed record of subsidence that began 6–8 Ma at/above sea level provides primary constraints on models of the continental extension. Seismic profiles and core observations indicate only minor normal faulting of the northern margin, which suggests a long wavelength (flexural) mechanism for the more than 2 km of subsidence observed.

At Site 1114, a south-southwest-facing normal fault offsets the basement by about 2 km near the crest of Moresby seamount (Fig. 2). A 6-m-thick tectonic breccia beneath the 286-m-thick Pliocene-Pleistocene sedimentary section occurs above a basement of metadolerite that was penetrated to 407 mbsf. Basement was not reached beneath the 159 m of coarse rift clastics at Site 1116. Sediments at these two sites document relatively proximal turbiditic and mass-flow deposition from an active arc source with additional metamorphic and ophiolitic components.

There is also evidence for as much as 1 km of erosion, associated with uplift of the footwall following initial subsidence. The most spectacular tectonic structure encountered during Leg 180 is the Moresby detachment fault, dipping at 27°± 3° toward 015° (Fig. 3; Taylor et al., 1999). The apparent fault offset of the basement is 10 km horizontally and 5 km vertically (i. e., 11 km slip at 27° dip). At Site 1117, where the fault plane crops out on the northern flank of Moresby Seamount, we drilled through the ~100-m-thick succession of deformed rocks into a gabbro basement. From bottom to top, the gabbro ranges from undeformed, to brecciated, to foliated cataclasite/mylonite. Epidote and quartz dominate the secondary minerals, indicating syntectonic greenschist facies conditions. Above this, an ultracataclasite fault gouge (5 m was recovered) crops out on the seafloor and represents the most advanced stage of deformation, with evidence for fluid-assisted alteration to produce serpentinite, chlorite, talc, calcite, ankerite, and fibrous amphibole.

A triple casing reentry hole was planned to intersect the low-angle normal fault at 900 mbsf where an estimated 9 km of the 11 km of basement-basement dip-slip offset have occurred. The presence of trace hydrocarbons at Hole 1108B (drilled to 485 mbsf), and the extent of talus proximal to Moresby Seamount where the fault is shallower (Sites 1110–1113, which penetrated 25–174 mbsf), precluded use of the available technology to meet our primary objective. Although the ~100-m-thick low-angle fault zone was cored through at Site 1117, the primary objective of Leg 180 was not met. To understand how an active low-angle normal fault zone slips we need to characterize the in situ properties – stress, permeability, temperature, pressure, physical properties, and fluid pressure – at depth. A return to Site 1108 has been proposed, with the goal of penetrating to/through the fault zone so that these parameters may be measured.

BIOSPHERE

The longest profiles to date of the deep sub-seafloor biosphere were made at Sites 1115 and 1118 (Fig. 4). Bacteria were present in all samples analyzed at the three northern sites drilled to >800 mbsf. Both dividing and divided cells were present to 842 mbsf, although there is an indication that numbers are decreasing more rapidly than the model of Parkes et al. (1994) predicts, resulting in a sigmoidal depth distribution.

Because bacteria play a dominant role in the degradation of organic matter, and consequently drive chemical changes and diagenesis in sediments, their deep subsurface activity is evident in

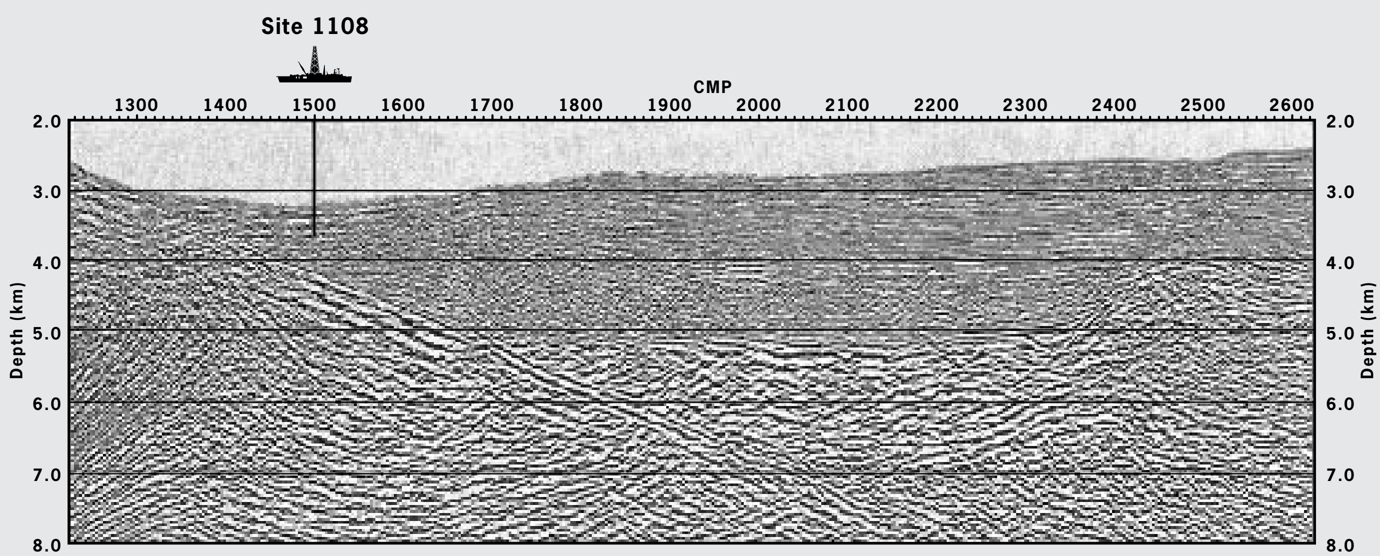

FIGURE 3 *Stacked, migrated and depth converted multichannel seismic line through Site 1108 (modified from Taylor et al., 1999).*

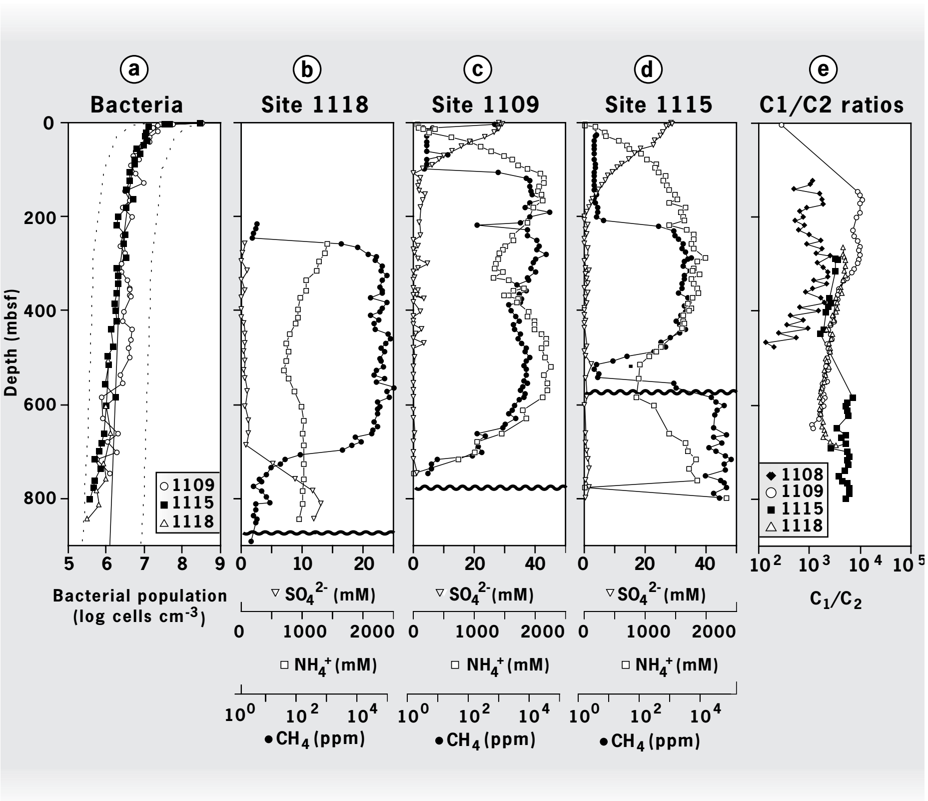

FIGURE 4 *Biogeochemical profiles at Leg 180 sites: a. Total bacterial populations. The solid curve represents a general regression line of bacterial numbers vs. depth in deep-sea sediments (Parkes et al., 1994), with 95% upper and lower prediction limits shown by dashed curves. b–d. Sulfate, ammonia, and methane depth profiles. Wavy line depicts unconformity. e. Methane/ethane ratios.*

geochemical data from these sites (Fig. 4). Pore-water sulfate concentrations are depleted in the uppermost sediments, below which methane concentrations increase rapidly as methanogenic bacteria gain a competitive advantage over sulfate-reducing bacteria for common organic substrates. Biological decomposition of organic matter is also evident from the accumulation of ammonia in the pore waters.

The persistence of microbial life into indurated sedimentary rock adds to a steadily growing body of evidence for a more extensive biosphere than previously imagined. That life is not merely a surface phenomenon has profound implications for the biodiversity of our planet, fossil fuel formation, the origins of life on Earth, and the potential for life on other planets.

For a more complete summary of Leg 180 drilling results, see **www.odp.tamu.edu/publications/prelim/180_prel/180toc.html**

LEG 180 SHIPBOARD SCIENTIFIC PARTY

Philippe Huchon and Brian Taylor, co-chief scientists; Adam Klaus, staff scientist; Sherif Awadallah, Charles Brooks, Bernard Celerier, Eric DeCarlo, Jacqueline Floyd, Gina Frost, Veronique Gardien, Stefania Gerbaudo, Andrew Goodliffe, Jimmy Haumu, Naoto Ishikawa, Garry Karner, Paul Kia, Achim Kopf, Klas Lackschewitz, Robert Laronga, Bernard Le Gall, Ian Mather, Brian Monteleone, Russell Perembo, Johanna Resig, Alastair Robertson, Elizabeth Screaton, Timothy Sharp, William Siesser, Shannon Stover, Kyoma Takahashi, and Peter Wellsbury.

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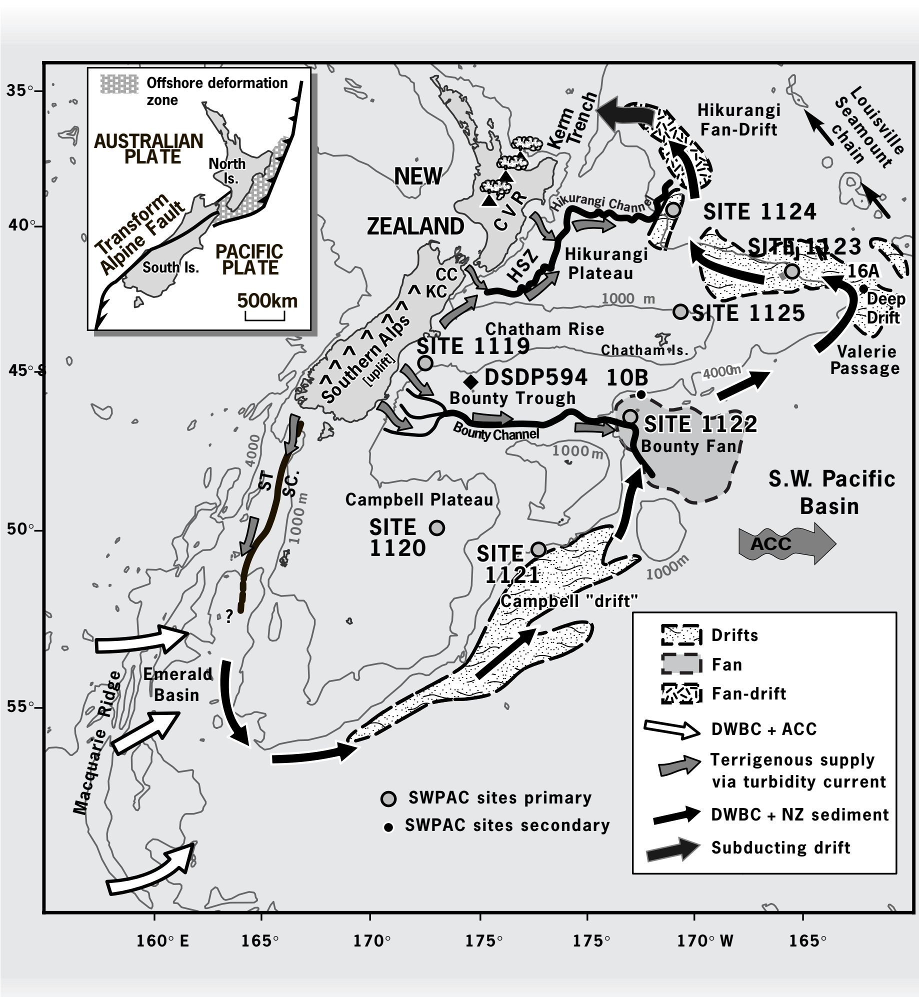
The DWBC sediment drift record from Leg 181: drilling in the Pacific gateway for the global thermohaline circulation

By Robert Carter[1], Lionel Carter[2], Nick McCave[3], and the Leg 181 Shipboard Scientific Party

The global ocean is a major heat reservoir, and therefore a significant determinant of world climate. Two engine rooms drive modern ocean circulation, and thus redistribute this heat. The first is located in the North Atlantic Ocean, where dense saline surface waters sink to form south-flowing North Atlantic Deep Water (NADW). The second lies in the Southern Ocean, where the westerly wind belts force the massive seafloor-to-sea surface Antarctic Circumpolar Current (ACC), within which NADW becomes entrained. As parts of the global thermohaline ocean circulation system (e. g. Schmitz, 1995), these engine rooms are linked by other major current flows, one of which is the Pacific Deep Western Boundary Current (DWBC). The sites drilled on ODP Leg 181 were selected to provide sediment cores, and thus ocean history, from beneath the largest single input of deep, cold water into the modern global ocean, the Pacific DWBC (Fig. 1). The DWBC comprises ca. 20 Sv of northward-flowing water ultimately derived from the Weddell Sea and Adelie Coast regions of Antarctica. The area east of the two islands of New Zealand, between 55°S and 45°S, sees the parting of the ACC and underlying DWBC. In its passage around the Southern Ocean, the ACC passes through gaps in the Macquarie Ridge, to flow around the southeast corner, and then northeast along the eastern margin, of the Campbell Plateau. Just south of the mouth of the Bounty Trough, at 50°S, the ACC veers east to continue its flow across the southern Pacific Ocean. Deep flow at the 5500–2000 m level continues northward along a western boundary delineated by the Chatham Rise, Hikurangi Plateau and Kermadec Ridge, as the DWBC (Fig. 2a,b). The emergent islands of New Zealand are located astride the boundary zone between the Australian and Pacific plates (Fig. 1, inset), and have been created and moulded since the mid-Cenozoic inception of the plate boundary. Remarkably, given its small area of emergence, New Zealand provides ca. 2% of the input of terrigenous sediment into the world ocean from less than 0.2% of the world's land area. This sediment is derived both from the spectacular Southern Alps mountain chain, which is controlled by oblique collision across the Alpine trans-

FIGURE 1 *The Leg 181 operations area within the Eastern New Zealand Oceanic Sedimentary System (ENZOSS), showing the location of the main areas of current scour, sediment supply and drift deposition related to the ACC-DWBC systems.*



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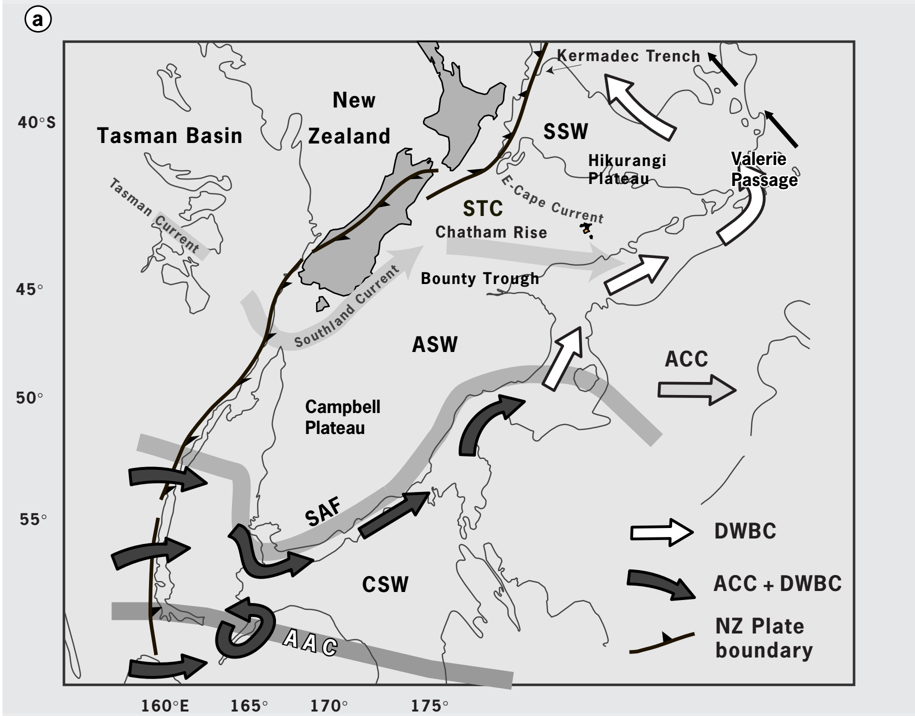
form fault, and from mountains in the North Island, which are controlled to the west by active arc volcanism and further east by uplift of the arc-front accretionary prism above the Hikurangi subduction zone. Rapid tectonic uplift, active volcanism and a vigorous climate ensure the generation and transport of large volumes of sediment from emergent New Zealand to the deep sea. A major part of the terrigenous load is transported east and south to the abyssal Pacific Ocean by turbidity currents flowing along three major submarine channels, the Solander, Bounty and Hikurangi channels (Schuur et al., 1998; Carter and Carter, 1996; Lewis, 1994). These conduits discharge their sediment load directly into the path of the DWBC, where the sediment is then entrained by the DWBC and carried northwards to be deposited in a series of giant sediment drifts (Carter and McCave, 1994). The northernmost drift is presently being consumed at the Hikurangi subduction margin northeast of North Island. Within this Eastern New Zealand Oceanic Sedimentary System (ENZOSS; Carter et al., 1996), the major sediment drifts which formed the target of Leg 181 drilling were anticipated to contain the history of development of current flows into the Pacific through the Southwest Pacific gateway. Only one previous HPC-cored site is located within the ENZOSS area (DSDP 594), and that is above the DWBC (1200 m water depth) and terminated at c. 16 Ma in the middle Miocene. Hence, prior to Leg 181 no oceanic information at all was available regarding the time of inception, or the major phases of development, of the world's largest deep-water cold current.



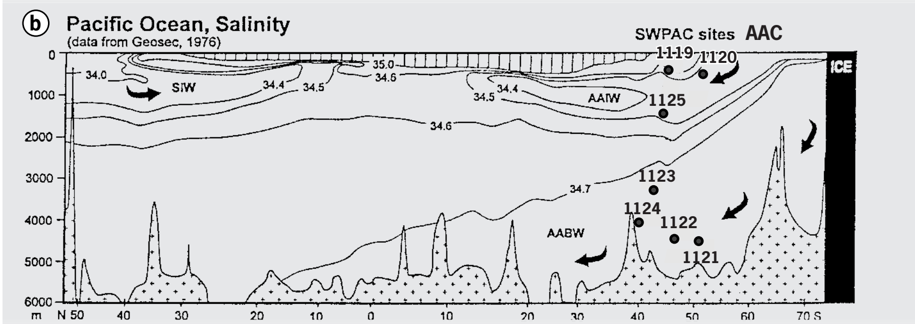


FIGURE 2a *Major water masses fronts and current systems of the Southwest Pacific. ACC = Antarctic Circumpolar Current, DWBC = Deep Western Boundary Current, AAC = Antarctic Convergence, CSW = Circumpolar Subantarctic Water, SAF = Subantarctic Front, ASW = Australasian Subantarctic Water, STC = Subtropical Convergence, SSW = Subtropical Surface Water.*

FIGURE 2b *Meridional salinity cross-section through the Pacific Ocean, with the location of the Leg 181 sites projected onto the plane of the section. AAC = Antarctic Convergence, SIW = Subarctic Intermediate Water, AAIW = Antarctic Intermediate Water, AABW = Antarctic Bottom Water.*

Leg 181 sailed from Sydney, Australia, in mid-August 1998 and drilled seven sites along a roughly southwest to northeast transect on the eastern margin of New Zealand between 39° and 51°S, that incides with the path of the ACC-DWBC. In addition to the primary target of drilling DWBC drifts, individual sites were located to capture the history of a range of water masses (Fig. 3), including Antarctic Intermediate Water (AAIW), and to span the Subtropical Convergence (STC) front (Fig. 2a, b). Leg 181 retrieved 3625 m of core from water depths of 400 m to 4500 m, and established a stratigraphy which ranged from late Cretaceous to Holocene in age. Rather than trying to summarise the entire data set, we focus here on some of the scientific highlights of the leg.

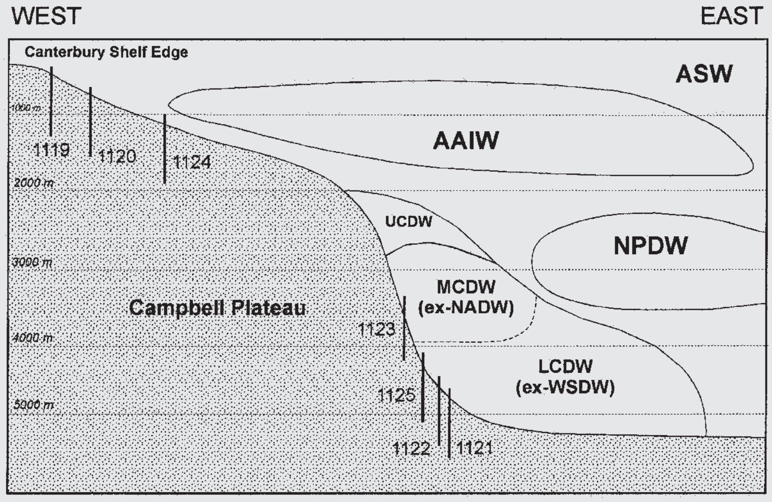


FIGURE 3 *West to east cross-section through the major water masses of the southwest Pacific Ocean at about 45° S, with position of the Leg 181 sites projected onto the plane of the section. ASW = Australasian Subantarctic Water, AAIW = Antarctic Intermediate Water, NPDW = North Pacific Deep Water, UCDW = Upper Circumpolar Deep Water, MCDW = Middle Circumpolar Deep Water, NADW = North Atlantic Deep Water, LCDW = Lower Circumpolar Deep Water, WSDW = Weddell Sea Deep Water.*

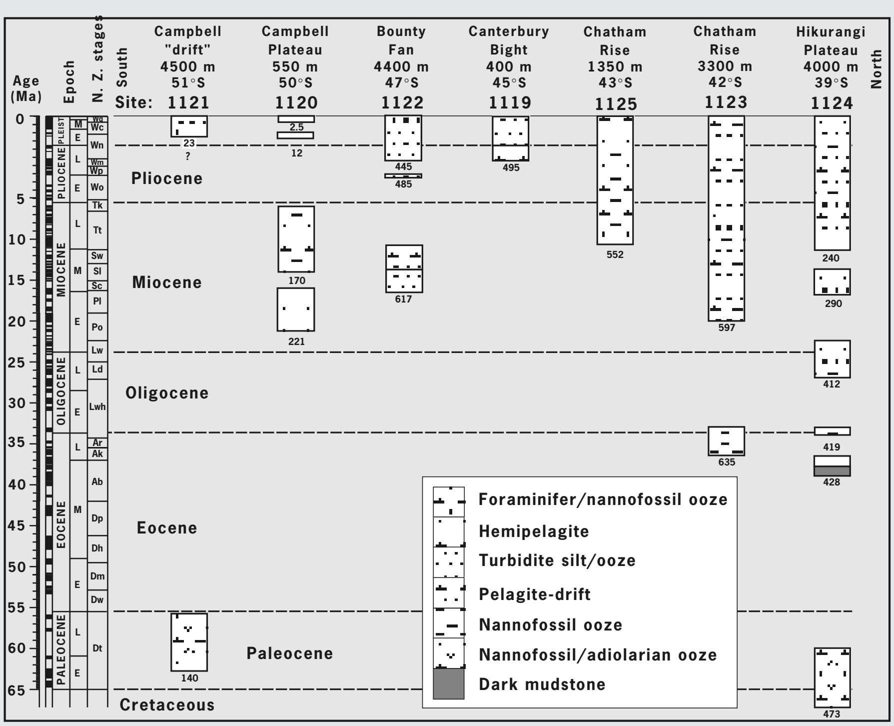


FIGURE 4 *Summary stratigraphy and sediment facies for all sites drilled on Leg 181, aranged broadly in latitudinal order. Small numbers at the base of each section indicates the thickness drilled, in metres, of the overlying section.*

PRINCIPAL RESULTS

The principal shipboard results of Leg 181 drilling can be encapsulated by summary plots of the stratigraphy, sediments and average sedimentation rates at each site (Figs. 4–6). The main scientific target of the leg was the high resolution study of Neogene sediments in the context of ACC-DWBC evolution. However, drilling in the Southwest Pacific is still in a state of reconnaissance, and unsurprisingly Leg 181 sites intersected sediments which range widely in age from late Cretaceous to Holocene. Together with the results of earlier drilling, which transected sediments of early-middle Eocene and early Oligocene age (DSDP Sites 277, 278), a complete deep marine stratigraphic record between the late Cretaceous and Holocene is now available for the Southwest Pacific ocean for the first time. Detailed study of this dataset will lead to significant advances in our understanding of regional stratigraphy, micropaleontology and paleoceanography, as well as helping delineate the origin and evolution of the thermohaline ocean circulation system.

The principal results from ODP Leg 181:

1. In composite, Leg 181 retrieved an almost complete stratigraphic succession of largely deep marine sediment back to the late Eocene (37 Ma), together with two high-quality sites (Sites 1121, 1124) of late Cretaceous to Paleocene (67–56 Ma) age. Sedimentation rates range widely from a low of c. 1.25 cm/ky for Site 1120 on the current-swept, shallow water Campbell Plateau, to a high of 40 cm/ky at Site 1122 on the turbidity-current-sup-

plied levee of the abyssal Bounty Fan. Significant paraconformities, lasting up to many million years occur at several sites, and indicate phases of erosive bottom-water flow within the ACC-DWBC system.

2. Sites 1121 and 1124 contain a stratigraphic record of paleoceanographic events of the early post-rift phase of evolution of the Southwest Pacific Ocean. Sites 1123 and 1124 contain a mid-Oligocene (ca. 34–27 Ma) gap in sedimentation which corresponds to the regional Marshall Paraconformity (Fulthorpe et al., 1996), and to the initiation of the ACC-DWBC system of deep cold water circulation into the world ocean.

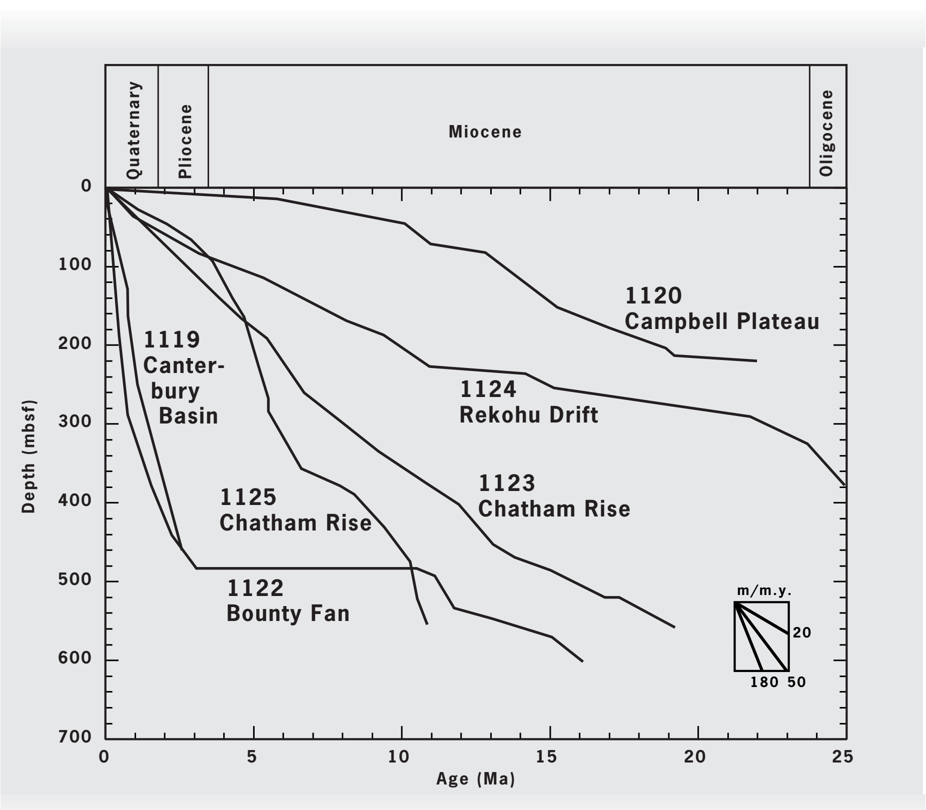
3. Sites 1123 and 1124 are located on DWBC sediment drifts, and contain a high resolution record of climatic cyclicity, and probably also bottom current variability, for the last 20 My. Uniquely in the world ocean, Site 1124 apparently retrieved a complete sedimentary record of uniform sedimentation rate which is richly microfossiliferous and which contains every magnetic reversal since chron C6r of early Miocene (c. 20 Ma) age. Additional correlation control for sites 1123 and 1124 will be provided by the macroscopic airfall tephra that they contain, >50 and >140 tephra, respectively. These tephra (also present at Site 1125) will also delineate an accurate record of explosive volcanicity from the arc volcanoes of central North Island.

4. Site 1125, on the north flank of the Chatham Rise at 1350 m water depth, contains a thick, terrigenous sequence back to ca. 11 Ma, with sedimentation rates as high as 13 cm/ky during the latest Miocene. Situated just north of the Subtropical Convergence (STC), Site 1125 is a counterpart for DSDP Site 594, located south of the Rise in 1200 m water depth. The expanded sedimentation rates will allow high resolution studies of paleoceanographic and paleoproductivity changes at the STC through time, including its positioning with respect to the crest of the Chatham Rise. These sites are also ideally situated for study of the ocean changes which accompanied the late Miocene (ca.6.5 Ma) carbon isotope shift.

5. Site 1122, on the north-bank levee of the Bounty Fan, established that the fan has been built over the last 2 My, during the time of marked glacio-eustatic sea-level fluctuation which accompanied the intensification of polar glaciation during the late Cenozoic. Below a 450 m thick sequence of spectacular fan turbidites, this site contains current winnowed contourites of Miocene age with older reworked siliceous microfossils which contain a record of DWBC and perhaps ACC activity. Thus site 1122 is a vital link between southern Site 1119, where the Neogene record of DWBC activity is largely erosional, and northern Sites 1123 and 1124, which contain the expanded drift record necessary for high resolution paleoceanographic studies.

6. Site 1119, at 395 m water depth on the eastern South Island upper continental slope, penetrated a rhythmic sand-mud, late Pleistocene, shallow water succession, which will help establish the nature of stratigraphic sequences (sensu Exxon) in the environment just seaward of the glacial lowstand shoreline. We achieved excellent core recovery through several lowstand systems tract sedimentary cycles, which are manifested by striking lithological and micropaleontological changes, and bounded by correlative conformities. The deeper parts of Site 1119 cored AAIW-drifts which form part of the Canterbury (upper slope) Drifts, and terminated in the top of a major drift in sediments of late Pliocene (c. 3.0 Ma) age. The base of the same drift can be seen on a seismic line to initiate in basal Otakou Group sediments of early Miocene age (ca. 25 Ma), indicating a longevity of >20 My.

FIGURE 5. *Summary curves of sedimentation rates for all sites drilled on Leg 181.*



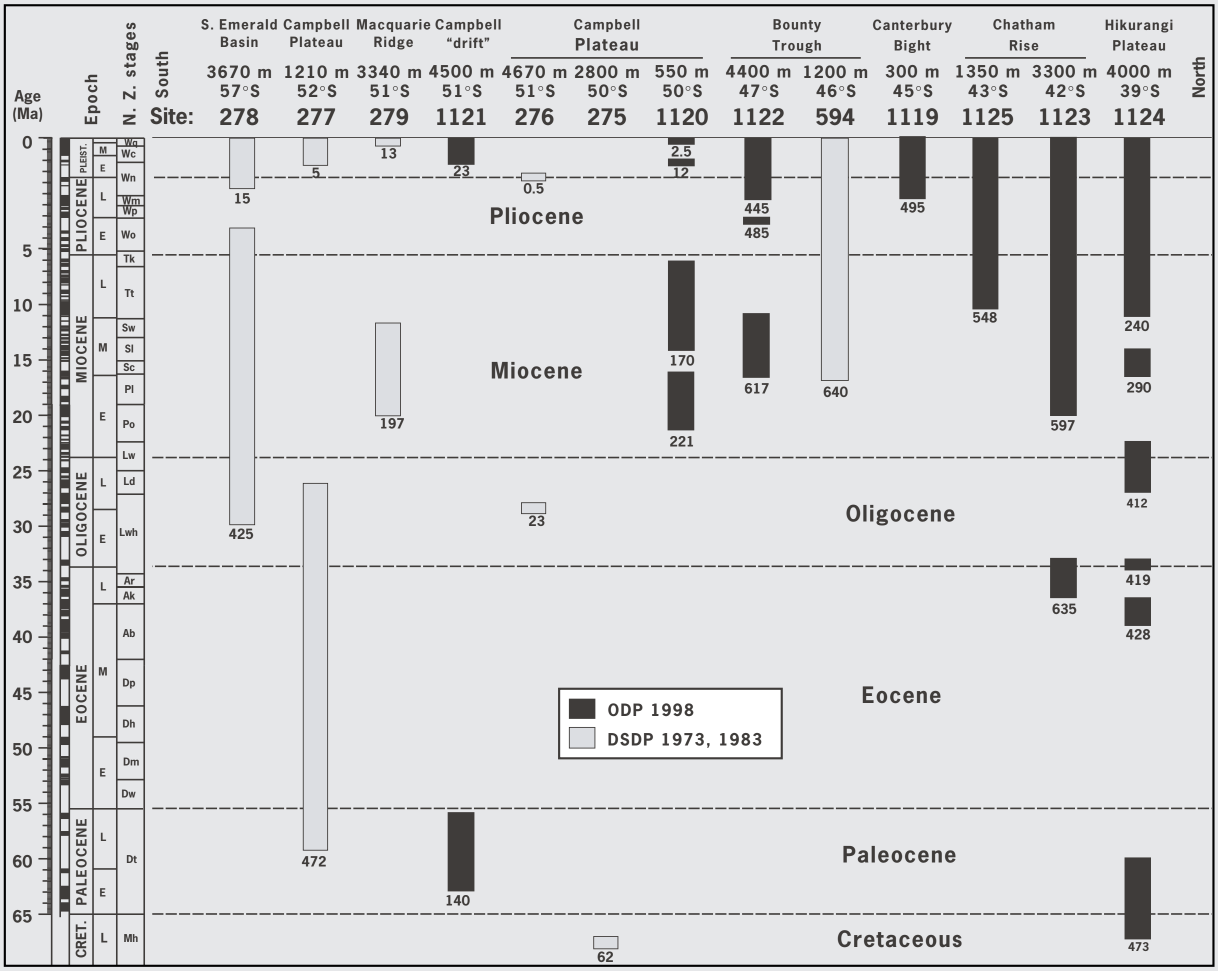


FIGURE 6. *Summary thickness data, including position and duration of significant unconformities, for all available drill-sites in the Southwest Pacific (DSDP Legs 29, 90; ODP Leg 181).*

CONCLUSIONS

All Leg 181 sites are located on the Pacific Plate, and penetrated the typical eastern New Zealand rift-drift or passive margin succession which is exemplified onland by the Canterbury Basin, South Island. However, the results from sites which transected Paleogene sediments (Sites 1121, 1124), and those which are located north of Chatham Rise and contained abundant Miocene and younger ashes (Sites 1123, 1124, 1125), are also strongly relevant to the interpretation of North Island East Coast Basin geology. The Leg 181 Paleogene successions include deep marine siliceous mudstone, brown mudstone and nannochalks which have close counterparts onland. The succession of siliceous shale-black shale-nanno ooze is regionally homotaxial; in the area covered by Leg 181 the succession results from post-rift subsidence under changing oceanographic factors through time (cf., Andrews, 1977). Particular sediment facies may therefore be of different ages offshore and onshore, but in all cases the occurrence of Paleogene facies similar to those of Leg 181 within the North Island allochthon represent the accretion onto the Australian Plate of former Pacific Plate deep marine continental margin sediments. This is an important conclusion, given that there has been a protracted controversy over a shallow versus a deep water origin for the onland East Coast Basin Paleogene sediment facies (e. g., Field et al., 1997). It also points to the potential for future onland studies to add much new paleoceanographic detail and insight to the 181 data set. Finally, study of the ash-rich Miocene and younger sediments from Leg 181 sites will help establish a greatly improved timetable of volcanic and tectonic activity for the Hikurangi plate boundary.

In conclusion, we note that Southwest Pacific Gateways drilling was originally proposed as a minimum 2-leg drilling program. Leg 181 was therefore only a step, albeit a big one, in the direction of understanding more fully the history of deep-water flows into the Pacific Ocean. Inevitably, given the lack of previous drilling in this area, several of the paleoceanographic targets also yielded important stratigraphic results. Of course, the paleoceanographic results are exciting in their own right. For example, the accurate dating of the inception of erosive deep-water flows in the Oligocene at sites 1123, 1124; and the unparalleled completeness of the 20 My long, Milankovitch-driven record of the upper part of site 1123. Just as importantly, however, Leg 181 has established the stratigraphic data base necessary for much tighter targeting of future paleoceanographic drilling in the region. Our knowledge of the oceanic stratigraphy of the Southwest Pacific is now at the level that had been reached for the North Atlantic Basin by the late 1970s. Therefore, we anticipate confidently that the paleoceanographic results from Leg 181, and those from future drilling in this region, will add greatly to our understanding of southern hemisphere climatic cyclicity and global ocean circulation. Recent ODP Legs 177 and 181, together with earlier drilling, make a great start, but the Southern Ocean doubtless has much to teach us yet.

LEG 181 SHIPBOARD SCIENTIFIC PARTY

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Investigating the crustal framework at the NERO Hole 1107A, Leg 179

E. R. Flueh[1], I. Grevemeyer[1] and C. Reichert[2]

In the last decade or so, our knowledge of the Earth's structure has been greatly improved by the development of new generations of global seismological monitoring networks, providing high-quality digital broadband data from earthquakes recorded at teleseismic distances. These data have been fundamental in tomographic imaging of the deep interior of the Earth. The seismological community, however, has recognized that global seismic observations will remain incomplete until instruments are deployed on the ocean floor. Today, existing worldwide networks suffer from uneven coverage. Numerous stations have been placed on the continents, but only a few stations have been installed in oceanic regions, mainly on volcanic islands. Moreover, station coverage is biased towards the Northern Hemisphere. Images of Earth's interior velocity structure suffer from the lack of control from seismic stations in the southern oceans.

The installation of ocean bottom seismic stations, their maintenance, and the recovery of data on a timely and long-term basis represent a formidable technical challenge. However, seismologists pushed forward plans to install long-term stations on the ocean floor (e.g., Suyehiro et al., 1992; Dziewonski et al., 1992; Montagner et al., 1994). In spring of 1998 the *JOIDES Resolution* drilled Hole 1107A on Ninetyeast Ridge, a major hotspot track in the Indian Ocean (Casey et al., 1998). The hole was drilled to be the future host of a long-term seismic station, called the Ninetyeast Ridge Seafloor Observatory (NERO). The location near 88°E/17°S (Fig. 1) was chosen to fill in a gap in global station coverage within the Indian Ocean.

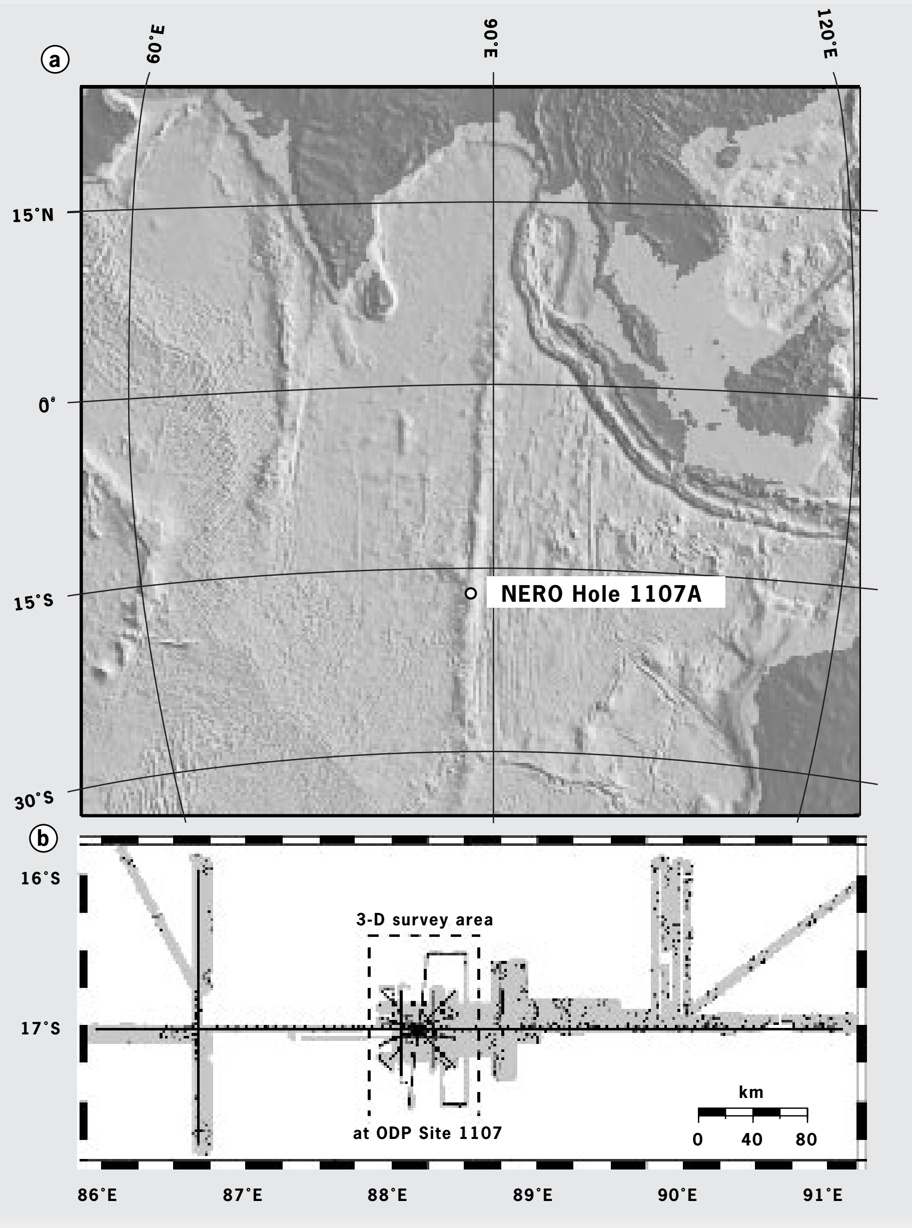

FIGURE 1a *Predicted bathymetry map of the Central Indian Ocean showing ODP Hole 1107A.*
FIGURE 1b *Seismic survey lines and ocean bottom instrument locations (dots) of the RV Sonne Cruise 131.*

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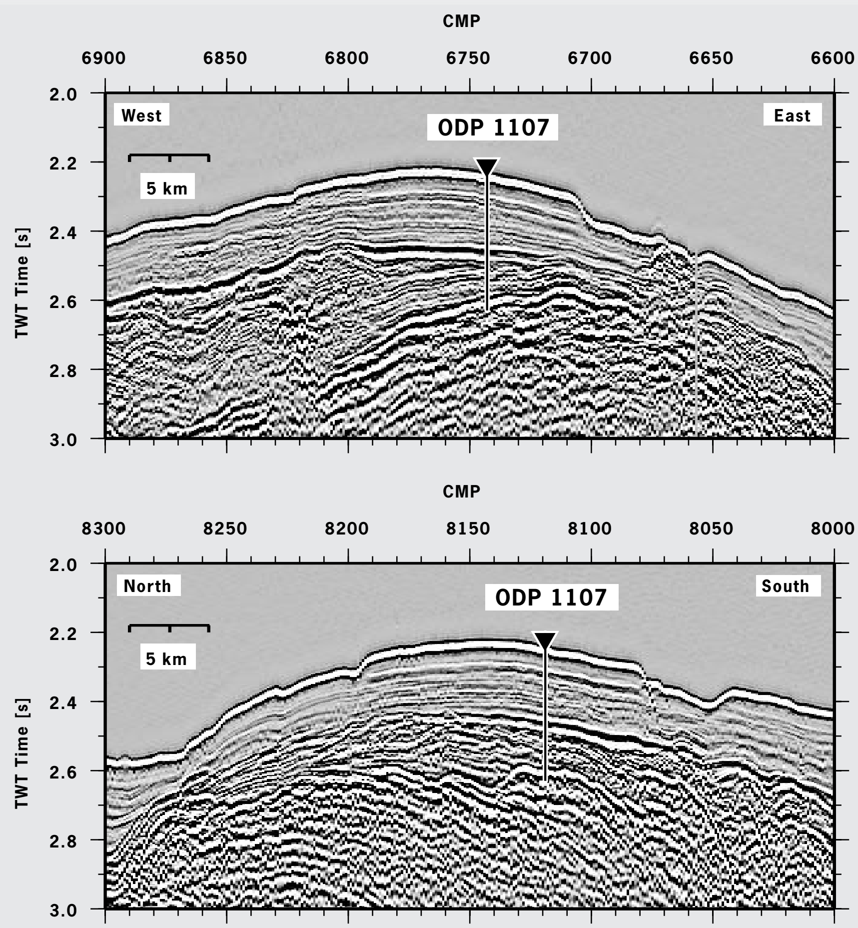
The German *R/V Sonne* joined the *JOIDES Resolution* to gather the necessary information for an effective and reliable operation of NERO by collecting seismic reflection and wide-angle/refraction data to image the local and regional structure of crust and upper mantle of the Ninetyeast Ridge and adjacent ocean basins (Flueh and Reichert, 1998; Flueh et al., 1999). The high quality seismic data will be used to better understand broadband recordings made by NERO. Moreover, the seismic data provided the opportunity to assess the volcanic processes creating the edifice of a hotspot track.

FIGURE 2 *Seismic reflection profiles crossing Hole 1107A.*



SEISMIC DATA ACQUISITION
During *R/V Sonne* Cruise 131 a large ocean bottom seismograph (OBS) and hydrophone (OBH) experiment was conducted on Ninetyeast Ridge. In total about 2500 km of seismic refraction/wide-angle and seismic reflection data were acquired. This activity included the deployment and successful recovery of more than 100 OBH/OBS stations and the use of a 3-channel mini-streamer (Fig. 1). The kernel was a network of profiles in an area approximately 55 by 110 km around ODP Sites 757 and 1107 and a roughly 600 km long east-west transect through its center. The aim was to study the small scale structure at the drill site and the regional structure of the hotspot trail and adjacent ocean basins.

The seismic source was a tuned array of 20 airguns with a total volume of 51.2 liters. The ocean bottom instruments were digital recording systems of GEOMAR (Flueh and Bialas, 1996). In addition, the *JOIDES Resolution* deployed two U.S. Geological Survey (USGS) OBSs to carry out a seismic-while-drilling experiment (Casey et al., 1998). These instruments also recorded four out of the 16 lines of the network for three-dimensional tomographic imaging of the NERO site.

RESULTS The uppermost crustal structure is revealed by the seismic reflection data. We found a clearly stratified section of pelagic sediments covering volcaniclastic deposits created by phreatic eruptions consistent with drilling results from Site 757 drilled during ODP Leg 121 (Peirce et al., 1989). Below this, the seismic reflection data revealed a sequence of westward dipping reflections (Fig. 2) stratigraphically similar to the seaward dipping reflectors discovered at volcanic continental margins (Hinz, 1981). On the continental margins, drilling indicates that the dipping sequences were created by excessive submarine to shallow water volcanism. Both Site 757 and Hole 1107A were drilled into this sequence. Based on ODP Site 642, results from the Vøring volcanic margin (Planke, 1994) the NERO broadband station will likely be located within a cyclic sequence of basaltic lavas and thin tuff layers.

The deeper parts of the ridge were imaged by diving waves recorded on the OBH and OBS stations. To initially assess the seismic velocity structure of crustal rocks at the NERO site we applied a 2-dimensional tomographic inversion method for first-arrival travel times (Parson et al., 1996). The inversion suggests profound differences between the volcanic edifice and the adjacent ocean basins. Westward of the ridge, velocity-depth profiles closely match typical velocity

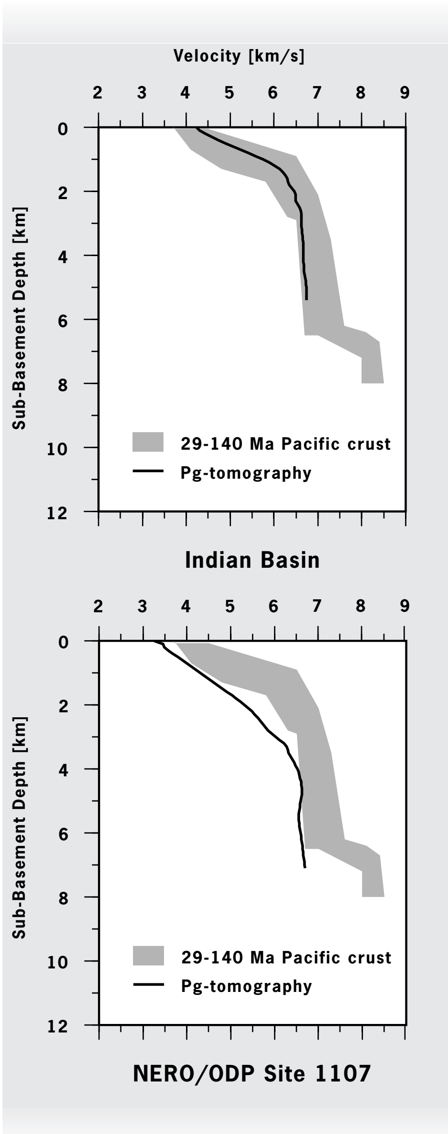


FIGURE 3 *Initial seismic results from tomographic inversion of seismic refraction data.*

bounds on oceanic crust (Fig. 3). On the edifice, the extrusive section of crust (indicated by seismic velocities less than 6.5 km/s) is about two times the thickness of normal oceanic crust (White et al., 1992). The transition to mostly intrusive rocks is similar to other large seamounts and volcanic islands, such as Hawaii (Klein, 1981), the Great Meteor Seamount (Weigel and Grevemeyer, 1999), and Jasper seamount (Hammer et al., 1994).

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Bringing ODP Log Data to the World Wide Web

Mary Reagan[1], Cristina Broglia[1], and Dave Goldberg[1]

Over the last four years an easily accessible, on-line database of the log data collected by the Ocean Drilling Program (ODP) was developed. The ODP Log Database currently contains a majority of the log data collected by ODP, and in future, will provide access to all ODP log data. It can be accessed and searched via the internet, providing a convenient method for downloading large amounts of data, educational materials, and technical information about the log data applications in science. The ODP Log Database can be accessed at **http://www.ldeo.columbia.edu/BRG/ODP/DATABASE**.

USING THE DATABASE

What are the benefits of this on-line log database? For many scientists, the most practical benefit is access to log data 24 hours a day, 7 days a week from any computer in the world. You no longer need to run to the library to find the *Initial Results* volume containing the log data CD or send a request to LDEO-BRG for Pre-CD ROM data.

But the benefits of an on-line log database go well beyond this simple added convenience. The on-line database allows scientists to search the database for information they need. Many of those who have been involved in ODP for a number of years can easily rattle off site locations, tool deployments, and even formations encountered during a particular cruise. The majority of the scientific community, however, is not as familiar with the data. Using the on-line log database, a user has the ability to search by leg, hole, location, ocean/sea, or tool. This means that a scientist can select “Tyrrhenian Sea” from the ocean/sea field and discover that ODP has collected log data in this area during Legs 107 and 161. Alternatively, a student working on a report about Hole 504B can search on that hole and find out that logging operations occurred during Legs 111, 140, and 148.

We will soon be adding a *keyword search* as well. This feature will greatly enhance the search capability of the database. For example, scientists will be able to search for all holes where basement was penetrated, or search for all the holes where fluid processes were an important objective.

The log database is also useful for cruise planning. If a proponent is writing a proposal for drilling in an accretionary prism, for instance, the keyword feature can be used to search for all holes logged in accretionary prisms and determine what tools were used in each. The links to the on-line logging summaries would reveal that the traditional coring and logging techniques used in the early cruises were not very successful. Recent cruises (such as Legs 170 and 171A) that used logging-while-drilling (LWD) techniques, however, delivered very satisfactory results. Links are also available to the *Guide to Logging* where in-depth information on the tools is provided and the *Proponent's Helper* for assistance in completing the required site forms.

While the log database is an important asset to most ODP research, its value is greatly enhanced when the data can be integrated and compared with core data. For this reason, a link is provided from each listing of log data collected in a hole to the corresponding core data (Fig. 1). A simple click on the link connects you to the appropriate Janus database page from which any of the core data files for that hole can be downloaded.

The links between the log database and Janus allow easy switching between requests for various data types. Opening a second window that links directly to the Janus page for the same hole provides the opportunity to see what types of data were collected from both core and log measurements. This also saves time since the core data from the same hole may be downloaded without having to repeat the search procedure in the Janus database.

Links to external databases also help to integrate information from a variety of sources. One of the links currently in place is to the International Continental Drilling Program (ICDP). This tie was established to facilitate the use of ODP data by the continental drilling community, as well as to enable easy searches on a variety of databases. The link between the ODP log database and the ICDP database clearinghouse (http://icdp.gfz-potsdam.de/ch/search/html/search.html) allows searching of the ODP log database alone or in combination with the ICDP data sets. The results of such a search point you back to the originating databases.

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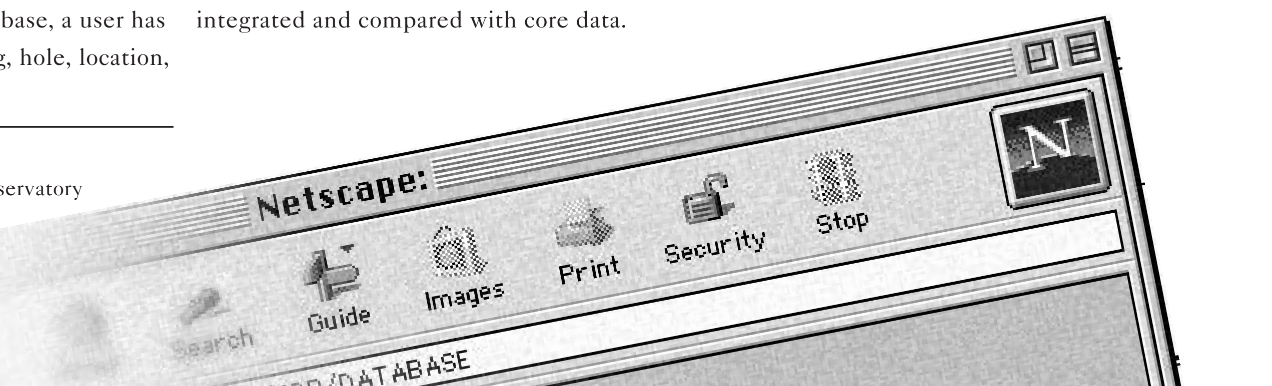
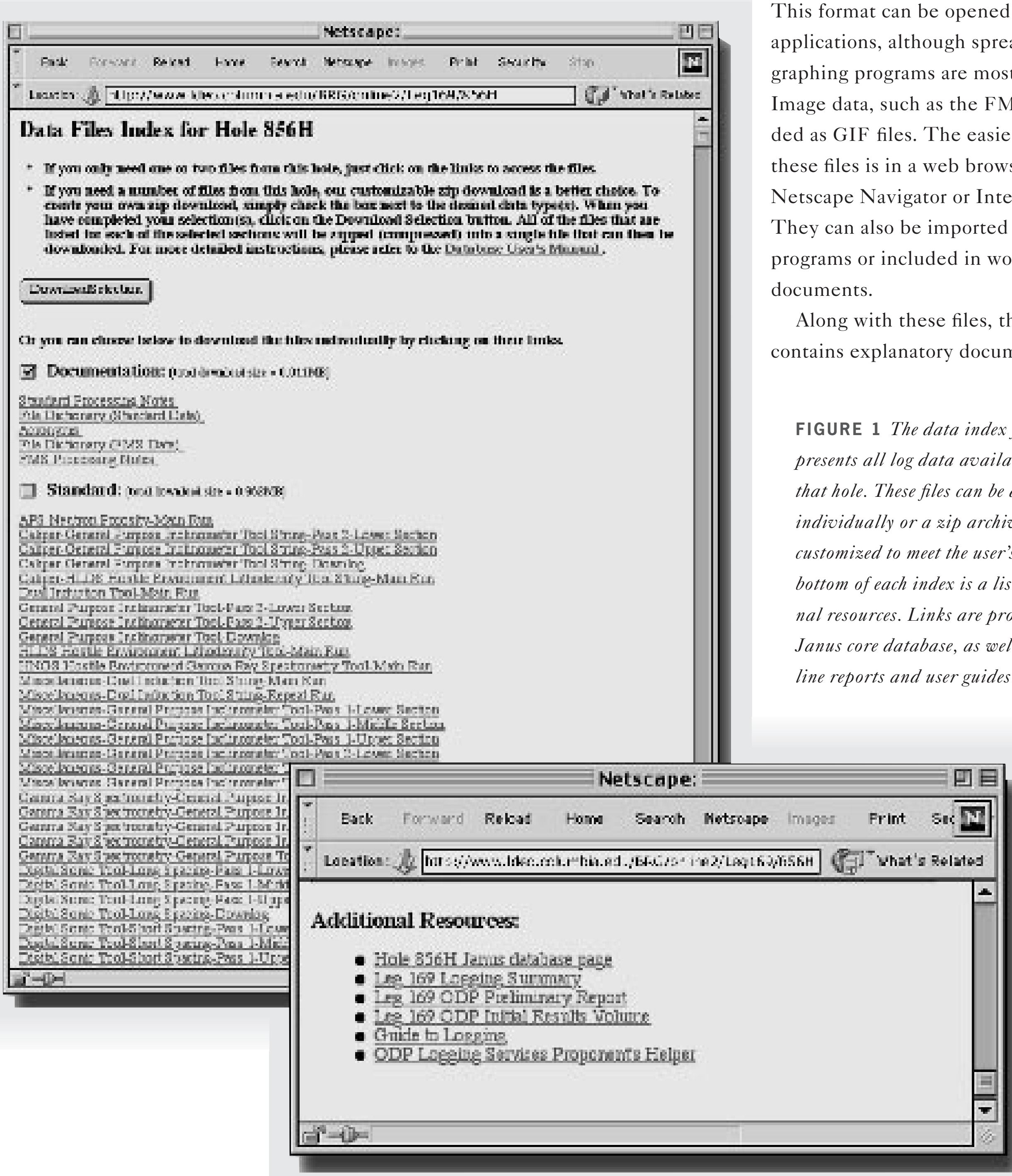


Mirror sites of the log database in Europe and Asia may eventually allow faster access to the data from these parts of the world. The ICDP database is serving as partial test of a mirror site since it is possible to search the log database from within it. However, the user is directed back to the LDEO website for data download.



DATA FORMAT

The ODP log database consists of profiles and images of geophysical measurements – e. g., density, gamma ray, porosity, resistivity, and acoustic properties – recorded as a function of depth in a drill hole. There are two basic data formats currently available on-line: ASCII and GIF. By far, the most common format is ASCII. This format can be opened in a variety of applications, although spreadsheet and graphing programs are most often used. Image data, such as the FMS, are provided as GIF files. The easiest way to view these files is in a web browser such as Netscape Navigator or Internet Explorer. They can also be imported into graphics programs or included in word processing documents.

Along with these files, the log database contains explanatory documentation and

FIGURE 1 *The data index for each hole presents all log data available online for that hole. These files can be downloaded individually or a zip archive can be customized to meet the user's needs. At the bottom of each index is a list of additional resources. Links are provided to the Janus core database, as well as to online reports and user guides.*

log summary plots. The documentation provides an overview of operations for each hole as well as information about processing procedures and quality control. The file dictionaries provide a list of the file names for each hole and the corresponding data type contained within it. For example, the file "948C-hldt-hr.dat" contains high-resolution density data. While it is possible to decipher the contents from the file name, especially if you are familiar with logging tool acronyms, it is much easier to simply download the file dictionaries. The acronym list not only provides a list of tool acronyms, but also lists the data column acronyms and the corresponding measurement units. The log summary plots show various types of log data and core recovery plotted versus depth. They are available only for the more recent legs (Leg 159 and later).

DATA ACCESS

To download log data, you first select the search parameters (e.g., leg, hole, year, location, specialty tool) to create a listing of all the log data collected by ODP that meet the criteria. Clicking on an individual hole provides a listing of all the data files available for that hole (Fig. 1). There are two ways to download the data files identified in the listing. If you need only a few files from the hole, you may download each one individually by simply clicking on the file name. If you need all or most of the data from the hole, you should select the Zip method. Simply click on the box beside each data type you would like. The system collects all of the appropriate files and downloads them in compressed form. There are several programs that can be used to decompress the files. For a Macintosh, StuffIt is most common, WinZip for a PC, and unzip for Unix. Once uncompressed, the files can then be easily opened and manipulated in programs such as Excel, Kaleidagraph, or Canvas. An on-line User's Manual is available with detailed instructions on completing data searches and downloads. An electronic request form is provided for data not available on-line.

Access to recent ODP data is restricted to members of the shipboard scientific party for a period of one year following each cruise. Shortly after each cruise, the ODP Logging Data Services Supervisor informs the scientific party that the data are available on-line and provides each participant with a user name and password. One year following the cruise, this restriction is lifted and the scientific community can freely access the data on-line.

THE FUTURE

Over the next year, we plan to put much of the remaining data on-line (e.g., borehole televiewer data). Our focus will be on enhancing the user experience, expanding links to external sources and databases, and providing new ways for scientists to view and use log data. We also intend to offer more relational searches. Beyond the keyword searches, which have already been discussed, the ability to search for data where a combination of criteria are met may be quite useful. A search for "basement" sites, restricted to holes where the geochemical tool was deployed and located in the Pacific Ocean might have been desired, for example, prior to Leg 185 operations. Down the line, searching the data files themselves could enable a specific numerical test to be made, such as looking for hydrothermal sites where the downhole temperatures exceed 80°C or where porosity values are greater than 10%.

Other enhancements of the log database may include links to ODP-related operations, such as site survey and seismic data. We anticipate such enhancements will increase with time and that use of the log database will continue to grow as new data types and capabilities are added. For more information about log data and the ODP log database, please contact LDEO-BRG at borehole@ldeo.columbia.edu or through the ODP Logging Services website. (**www.ldeo.columbia.edu/BRG/ODP**)

ACKNOWLEDGEMENTS

We wish to note the contribution of the following members of ODP Logging Services to the database development effort: Anthony Martino, Ted Baker, Jim Murray, Trevor Williams, Veronique Louvel, Caroline Philippot, and Pat Fothergill. We also wish to thank the staff at JOI, JOIDES, TAMU, and the Site Survey Databank for their advice and support.

Strategy for scientific drilling of marine gas hydrates

M. Hovland[1], T. J. G. Francis[2], G. E. Claypool[3] and M. M. Ball[4]

INTRODUCTION

Scientific drilling in the deep ocean sometimes requires penetration of an anomalous bottom-simulating seismic reflection (BSR), that is believed to be associated with methane hydrate (Tucholke et al., 1977; Shipley et al., 1979). Conditions for stability of methane hydrate are present throughout the deep oceans where water depths are greater than about 200–500 meters, depending on bottom-water temperatures. However, gas hydrates are only developed where sufficient microbial methane has been generated at shallow depths, or where thermogenic natural gas has migrated up from greater depths. These regions of gas hydrate occurrence are primarily located on continental margins, and are sometimes indicated by the presence of the BSR (Kvenvolden, 1993).

Petroleum exploration is rapidly moving into deep-water (>1000 m) marine environments. The deep-water Gulf of Mexico is the most active U.S. domestic area of petroleum exploration, where gas hydrate occurrences include near-surface thermogenic and biogenic hydrates (Brooks et al., 1984) and deeper BSR-associated features (Hedberg, 1981), inferred to be gas hydrates. Norwegian oil companies and research institutions are currently drilling a series of riserless scientific holes on the Norwegian Continental Slope and the Vøring Plateau in water depths between 1 and 2 km. One of the objectives of this drilling is to penetrate and sample the sediments associated with the BSR. Petroleum exploration in the North Atlantic west of the Shetland Islands will also require drilling of gas hydrates.

The Deep Sea Drilling Project (DSDP) and Ocean Drilling Program (ODP) have a history of shallow penetration drilling in deep-water sediments with high gas concntrations and BSRs. This experience is relevant for future drilling, both scientific and commercial, in deep marine environments.

PREVIOUS DSDP/ODP POLICIES

Following the recovery of petroleum hydrocarbons in cores drilled above salt domes on DSDP Legs 1 and 10, the Pollution Prevention and Safety Panel (PPSP) was formally instituted in 1970 as part of the JOIDES (Joint Oceanographic Institutions for Deep Earth Sampling) advisory structure. Subsequent drilling results in gassy sediments on DSDP Leg 11 (Blake Outer Ridge) brought marine gas hydrate phenomena to the attention of the geoscience community (Lancelot, 1971; Stoll et al., 1971). The JOIDES PPSP adopted a general policy that uncontrolled (riserless) drilling would not be approved beneath gas hydrate BSRs, because the reflector was evidence for gas occurrence, and because the gas hydrate layer was thought to act as a seal for high pressure gas accumulation. This advice remained in place during DSDP and the beginning of ODP, and prevented achievement of some drilling objectives, especially on accretionary margins where deeper tectonic targets frequently were overlain by visible BSRs.

The first intentional departure from this policy occurred in connection with ODP Leg 112 drilling on the Peru margin. A proposed site (later Hole 688) was located where seismic records showed a break in a regional BSR, but where high gas contents in the sediments were expected. Drilling beneath the theoretical base of gas hydrate stability (475 mbsf) at Hole 688 was approved on condition that sediment gas contents did not increase, and that gas hydrates were not recovered in cores immediately above the base of gas hydrate stability. Hole 688 was drilled to a total depth of 770 mbsf, and no anomalous amounts of gas were encountered (Suess, von Huene et al., 1988), even though gas hydrates were recovered at 141 mbsf in Hole 688A (Kvenvolden and Kastner, 1990).

The intentional penetration, without incident, of the base of gas hydrate stability in Hole 688 on Leg 112 suggested that previous PPSP guidelines may have been overly restrictive. A justification for future safety policy was developed, based on a theoretical analysis showing that gas hydrate probably could not act as a seal for high-pressure gas accumulation in marine sediments, as long as excess water is present. This lack of high pressure beneath the base of gas hydrate stability results, because free gas is in equilibrium with the overlying hydrate. That is, the base of gas hydrate stability is a 3-phase (gas, liquid, solid) equilibrium boundary in a 2-component (methane, water) system, in which temperature occupies the available degree of freedom, and pressure is fixed, generally at hydrostatic. Any build-up of gas pressure beneath this boundary would cause additional reaction of gas with excess water, until the pressure was relieved by restoration to the prevailing equilibrium pressure.

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LEG 141

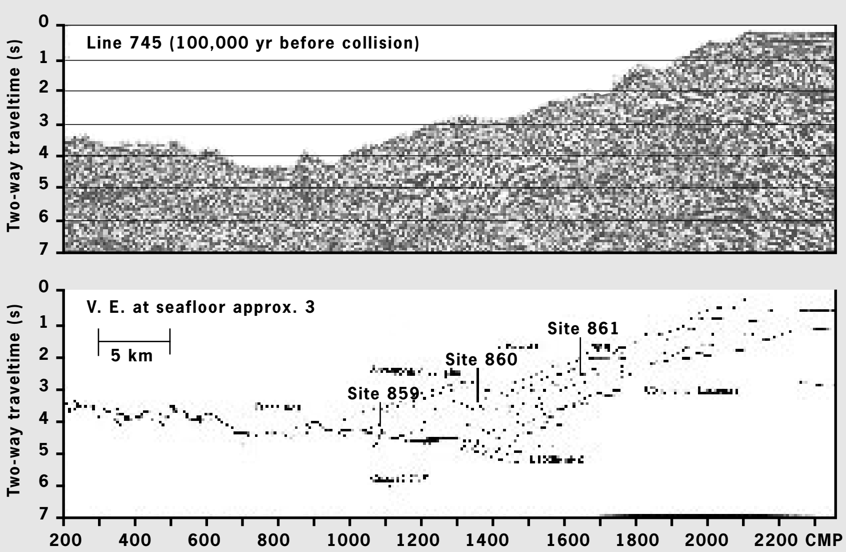
With the experience of Leg 112 drilling, and a possible change in PPSP policy, drilling proposals that involved penetration of BSRs were no longer discouraged. The first application of the new policy was in connection with proposed drilling at the Chile Triple Junction, Leg 141. In offshore Chile prominent BSRs occur at shallow depths of burial due to high geothermal gradients (Fig. 1). Proposed sites were approved contingent on the usual careful gas monitoring, and on a drilling sequence from deeper to shallower water sites.

The results of Leg 141 were disappointing from the standpoint of gas hydrate recovery, but generally confirmed the lack of significant amounts of free gas beneath the BSR and base of gas hydrate stability. Two holes (Sites 859 and 860, in water depths of 2749 and 2200 m, respectively) penetrated the depth of the BSR without any problems. Low chlorinity porewaters suggested the presence of small amounts of disseminated gas hydrates in the sediments above the BSR (Froelich et al., 1995).

In Hole 859, sonic logging confirmed the BSR at a depth of 97±1 mbsf, with a measured temperature of 19.4°C. Hydrostatic pressure at this depth is consistent with equilibrium decomposition pressure predicted by the methane hydrate-seawater (3.5% NaCl salinity) pressure-temperature equilibrium (Brown et al., 1996). Vertical Seismic profiling (Bangs et al., 1995) indicated a low velocity zone between 97 and 105 mbsf, that is consistent with 1–2% free gas beneath the base of gas hydrate stability.

In Hole 859A, there was also a net reduction in the average wet sediment porosity in the six cores above the BSR (44.7% porosity) compared with the six cores beneath the BSR (37% porosity). This observation is the first indication that sediment porosity is reduced below the BSR. Another result from Leg 141, was that the cores recovery went down dramatically both as the BSR was approached and also after penetration. For Hole 859A, core recovery had been 100% in the upper 25m of the hole, but was reduced to only 18% in the 25m above the BSR, and 21% in the first 25 m below the BSR. For Hole 859B, the recovery was even less, at 14% in the last 25 m above the BSR, and no core recovery at all, in the first 25 m below the BSR.

FIGURE 1 *Seismic Line of the Chile Margin (Leg 141) near the Darwin Fracture Zone and it's line-drawing interpretation (from Behrmann et al. 1992).*



LEG 146

Leg 146, on the Cascadia Accretionary Wedge off western North America, was the next ODP Leg where BSR penetration and sampling was proposed. Two sites with prominent BSRs, one in deep water off Vancouver Island (Site 889), and one in shallow water off Oregon (Site 892), were targeted.

The results from Leg 141 had provided some confirmation of the PPSP modified interpretations of the BSR. On Leg 146 the PPSP was asked to approve penetration of a BSR in even shallower water. It was now generally recognized that free gas is required beneath the BSR, but that only small gas quantities (1–4% of pore space) can produce the observed geophysical effects. The strategy recommended for safe drilling on Leg 146 was to first core the BSR in deeper water, and then move to shallow water. Careful gas monitoring and proceeding on a core-by-core basis, with geochemical analyses keeping pace with the coring, was recommended for safety reasons in shallow water.

The results from Leg 146, Hole 889 (water depth of 1315 m) again showed only indirect evidence for gas hydrates, which appeared to be present in lenses and thin zones above the BSR, and which decomposed upon core retrieval. However at Hole 892 (water depth of 674 m) gas hydrates were physically recovered from shallow cores. The gas hydrates were visible as white pellets resembling hailstone (Hovland et al., 1995; Kastner et al., 1995) and clear 2–3 cm nodules found in the upper 19 m of Hole 892A and 892E (Westbrook et al., 1994). Leg 146 thus provided the following observations concerning gas hydrate occurrence:

- The estimated temperature at the depth of the base of the gas hydrate stability zone was about 0.7°C cooler than the temperature predicted from hydrostatic pressure and the CH_4-seawater P-T equilibrium relationship.
- Only small amounts of free gas are present beneath the BSR in overconsolidated and fractured sediments having relatively low water content.
- Sediments that previously contained gas hydrates (which decomposed upon core retrieval) were indicated by low temperature anomalies in the sediments due to endothermal hydrate decomposition, and by chloride depletion of the porewaters in the sediments.

Attempts to retrieve gas hydrate containing cores at in situ pressures using a pressure sampling device on Leg 146 were unsuccessful because of equipment failure and difficult coring conditions. Core recoveries were low (60%) at both Holes 889 and 892, due to tectonic disturbance and fracturing of the dewatered sediment, possibly associated with gas hydrate formation processes.

The results of ODP Leg 146 supported the findings of Leg 141, in that a large and permeable free gas reservoir did not exist, even below a prominent BSR. The amount of free gas in the pore space of sediments beneath the BSR was estimated to be less than 5% by volume (MacKay et al., 1995).

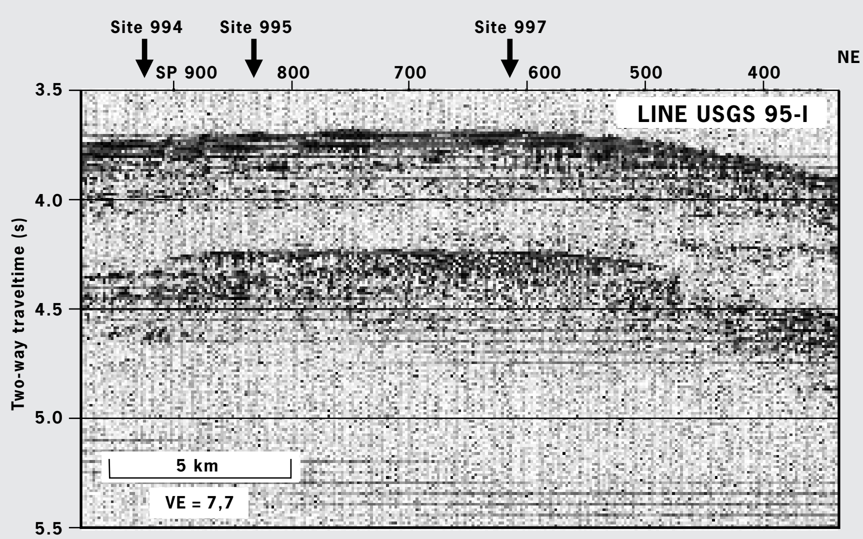
LEG 164

The first ODP Leg dedicated to the study of gas hydrates was 164 in the Blake Ridge-Carolina Continental Rise gas hydrate field. Because the safety rationale for permitting riserless drilling of BSRs was validated by previous drilling on Legs 141 and 146, a more aggressive drilling program was approved for Leg 164. This program included drilling on the crest of the Blake Ridge where the BSR was underlain by a prominent "bright spot", and where the BSR was disrupted by diapirs. The main safety recommendations for Leg 164 were a) to "creep up on the BSR" by drilling first on the flanks of the Blake Ridge where the BSR was absent or less prominent, and b) to monitor hydrocarbons and apparent core gas quantities carefully.

A transect of three sites (Hole 994 without a BSR, and Holes 995 and 997 with prominent BSRs) was drilled across the Blake Ridge to investigate the association between gas hydrates and the BSR (Fig. 2). Nothing recovered in the cores directly indicated a reason for presence or absence of the BSR. The lithology was uniform at the three sites with gas hydrates present in all three holes between 200 and 450 mbsf, and physically recovered from cores in Holes 994 an 997. Although solid gas hydrate layers/nodules up to 15 cm thick were recovered, the majority of the gas hydrate occurrences on Leg 164 were more finely disseminated and decomposed prior to core recovery.

The BSR and base of gas hydrate stability in Hole 997 (water depth of 2770 m) is located at a depth of about 450 mbsf, which is about 50 m shallower than predicted from methane hydrate-seawater P-T equilibrium (Ruppel, 1997). The reason for this difference between the observed and theoretical depth of the base of gas hydrate stability is presently unknown. The temperature at 450 mbsf was estimated to be about 20°C, and hydrostatic pressure is about 32.7 MPa. The estimated equilibrium decomposition pressure at 20°C for the CH_4 hydrate-seawater system is 26.5 MPa (Maekawa et al., 1995). The decomposition temperature for methane hydrate at 32.7 MPa is 22°C. Unless Hole 997 sediments are underpressured by 6.2 MPa (812 psi), or the temperature estimate is too low by 2°C, it appears that other factors (surface tension, gas or water composition) must affect gas hydrate stability in these sediments.

FIGURE 2 *Seismic reflection Profile USGS 95-1 was collected from the Cape Hatteras during ODP Leg 164 (from Paull et al. 1996).*



Successful pressure core samples (PCS) were obtained both within and beneath the gas hydrate stability zone (GHSZ), and provided the first direct measurements of in situ methane quantities in gas hydrate-containing sediments (Dickens et al., 1997). Methane contents in the gas hydrate stability zone ranged from 0.04 to 0.84 moles of methane per liter of porewater, corresponding to a gas hydrate saturation level of 0-9 percent of the pore space. Beneath the gas hydrate stability zone, a measured gas content of about 2 moles per liter of porewater was observed, which gave a calculated gas saturation of about 12 percent of the pore volume.

Other basic observations related to gas hydrates during Leg 164 are summarized as follows:

- Chloride concentrations provided estimates of gas contents consistent with PCS measurements.
- Temperature measurements on cores after recovery on deck were very sensitive to the presence of gas hydrates.
- While resistivity logs show spiking within the 200–450 mbsf depth range, the velocities obtained from the vertical seismic profile are not diagnostic for gas hydrates.
- Core recovery appears to diminish in zones of gas hydrate occurrence; i.e., where chloride content was low (indicating gas hydrate occurrence), the core recovery was low.

RECOMMENDATIONS

Based on these findings, drilling through a BSR does not pose a severe hazard for either blowout or pollution. However, the experience base is still quite limited, with only about a dozen such holes drilled to date. Because the BSR is now confirmed as a reflector associated with small volumes of free gas, generally in sediments of unknown porosity and permeability, similar precautions to those used when drilling in areas with a general gas hazard should be taken. For safety, it is therefore recommended to detect, image and analyze the BSR as best as possible. If no 3D-seismic data are available, 2D-seismic records should be of good quality and high resolution, be subjected to attribute processing for enhancement of BSR-associated features, and be interpreted by experienced and competent investigators. If 3D-seismic data are available, in addition to the 2D-high resolution data, then the 3D-seismic data should also be processed and analyzed for shallow gas hazards as proposed by Heggland et al. (1996) and Roberts et al. (1996).

Riserless scientific drilling through the gas hydrate stability zone should not be permitted if the analysis and interpretation of the seismic data suggest that a large, high permeability gas reservoir is present beneath the BSR.

Future drilling on continental margins will clarify the abundance and distribution of gas hydrates and help develop a better understanding of the relationship between gas hydrates and the nature of the BSR. Based on past experience, the following recommendations may help to achieve better scientific results:

- When coring in gas- and gas hydrate-containing sediments, limit recovered cores to 6 m, to prevent loss of core material due to extrusion associated with gas expansion.
- If possible, sample porewater in undisturbed sediment at ambient pressure ahead of the bit (BAT-sonde or WST-sonde), to determine baseline salinity prior to hydrate decomposition.
- In known or suspected hydrate intervals, increase the sampling frequency for porewaters (chlorinity determinations) and physical properties (porosity and water content), to better characterize the gas hydrate distribution.
- Measure core temperatures immediately upon core recovery, or with temperature probes in specially designed core liners, in order to detect and preserve gas hydrates for analysis.
- Obtain direct estimates of pressure in the sediments, both above and below the BSR, by use of packers and repeat formation testers or similar wireline tools. Direct pressure measurements are critical to test the assumption of hydrostatic pressure at the base of the gas hydrate stability zone.
- Place visible nodules or pieces of gas hydrate in large syringes for degassing with minimal air contamination. Collect and analyze samples of both gas and water as described by Hovland et al. (1995). Gas composition may help resolve whether the gas is locally generated or has migrated from greater depths.

It should be noted that disrupted BSRs may be associated with methane venting on the seafloor, as at ODP Site 892, and that high concentrations of H_2S gas may be associated with shallow gas hydrate occurrences. On such occasions during ODP Legs, special rig floor H_2S procedures were employed due to detectable H_2S gas venting from cores. Vigorously outgassing cores are not to be taken into closed laboratory spaces, but allowed to degas in the open air.

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The Ocean Drilling Stratigraphic Network (www.odsn.de)

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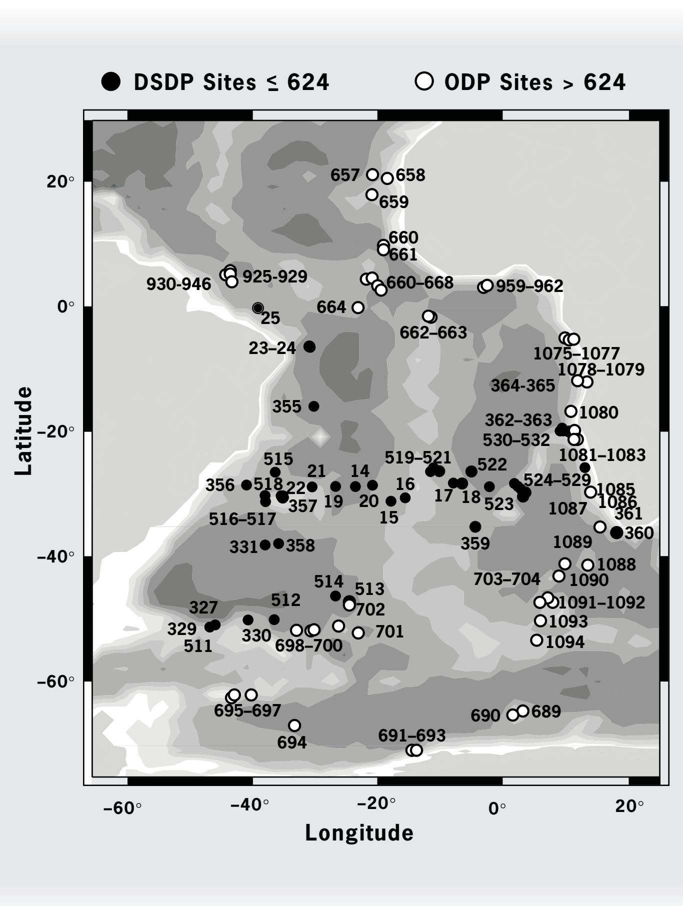
Over the last 3 decades the international drilling programs DSDP and ODP have addressed major problems in Earth Sciences. Interdisciplinary cooperation has grown significantly, and a rich archive of sea floor samples, scientific ideas, and expertise has accumulated. In recent years, electronic communication has revolutionized data archiving and distribution, making possible broader scientific and synthetic studies leading to new initiatives.

The Ocean Drilling Stratigraphic Network (ODSN) is intended to contribute to these efforts by establishing links between scientists, providing an infrastructure for data exchange, analysis and interpretation, and by organising and supporting efforts for syntheses and co-operative studies. There have been major improvements in all fields of stratigraphy, from magnetostratigraphy, biostratigraphy, and isotope stratigraphy through new methods of lithologic characterisation by physical properties and other proxy parameters, to downhole logging and high-resolution seismics. These allow refinement of chronostratigraphy and thus a better understanding of processes in the Earth system.

To make optimum use of available and recently collected stratigraphic material, the ODSN can fill the gaps between shipboard scientific parties and older data, the Janus database at ODP headquarters, and shorebased scientists. It can be used as a global network to disseminate information rapidly and to make the community aware of new data, methods and ideas.

FIGURE 1 *DSDP/ODP Sites in the South Atlantic covered by the Integrated Stratigraphy Project in Bremen.*



In order to develop ODSN, scientists from Bremen, Kiel and Bremerhaven convened an international workshop in Bremen in December 1995. They subsequently developed pilot projects to learn about data use and to establish links and demonstration databases.

MAIN OBJECTIVES

- To provide a communications network for scientists working with DSDP/ODP materials.
- To create a network of databases for stratigraphic information from DSDP/ODP Sites including the JANUS shipboard database and published and unpublished data from shorebased studies.
- To develop integrated chronostratigraphic concepts and models, and improve methods for integration of different datasets.
- To organize biostratigraphic and taxonomic databases for microfossils.
- To make stratigraphic data and models widely available via Internet and through publication of CD-ROMs.
- To assist in preparation of future drilling proposals and legs.
- To initiate and support synthesis projects.

PROJECTS ASSOCIATED WITH THE ODSN

Integrated Stratigraphy in the South Atlantic (University of Bremen) (www.mtu.uni-bremen.de/ odsn/)

The regional focus in the South Atlantic derives from other marine research at the University of Bremen. These include the Special Research Project "The South Atlantic in the late Quaternary", funded by the German Research Foundation (DFG) and recent participation in South Atlantic and Southern Ocean site survey and drilling activities. Fig.1 shows the DSDP/ ODP sites in the South Atlantic covered by the project. Re-examination and improved interpretation of the stratigraphic data from DSDP legs in combination with new information from ODP Leg 175 (Benguela Current) permit development of a higher-resolution, multi-parameter regional stratigraphic framework.

This will help to answer questions about the regional development of sedimentation along the Southwest African continental margin as well as the Neogene paleoceanography of the South Atlantic gyres. A broad spectrum of datasets, ranging from biostratigraphy to downhole logging and seismics, has been collected from different sources and scientists. These include the results of DSDP Legs 71 to 75 and ODP Legs 113, 154 and 175. The data are being used to integrate the different stratigraphies, construct consistent age models and to correlate between different sedimentation regimes. They are available electronically at the Bremen website.

Computer based Evaluation of DSDP/ODP Data (GEOMAR, Christian-Albrechts-University, Kiel) (www.odsn.de)

The goal of the group at GEOMAR is to update and rework stratigraphies of DSDP and ODP holes on a global scale and to maintain a consistent database for this information. It is to include stratigraphic, lithologic, microfossil, isotopic and chemical data.

To begin this big task, the Kiel group began by compiling data which were already available on CD-Roms or in the literature, but not always in an easily usable format. However, these represent only about half of the stratigraphic database published on DSDP/ODP materials.

Much of the most useful stratigraphic work has appeared in subsequent publications in the outside literature. These data are being sought out and added to the database, but this is a slow process. At the GEOMAR Site you will find several datasets and applications available:

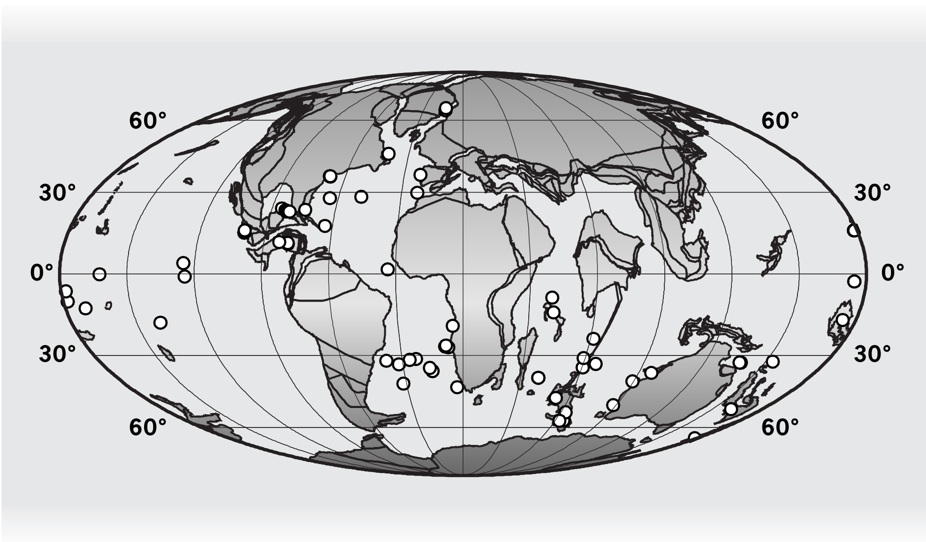
- Distribution and range charts for all major microfossil groups
- Uniformly recalculated age-depth data for fossil datums in many DSDP-holes. These are based on the Berggren et al. (1995) timescale, using the datum ages of the Leg 165 Shipboard Scientific Party.
- Carbon/carbonate data.
- A numerical timescale conversion module for comparison of ages among six different numerical timescales used by DSDP and ODP.
- A program to plot global or regional plate tectonic reconstruction maps for ages <150Ma based on the Hay et al. (1999) model. It is also possible to plot DSDP/ODP sites and to insert your own data into these maps.
- Plot the global occurance of microfossils in DSDP and some ODP holes and insert these into the plate tectonic reconstructions.

All of the data and maps at the GEOMAR site are available for YOU to use in YOUR publications. They can be readily downloaded in various graphic formats or as textfiles prepared to be used with common spreadsheet programs. All we ask is that you ackowledge use of the site. Interestingly enough, biologists and vertebrate paleontologists were among the first to "discover" the site, and judging from the hits so far it is now being used as a teaching aid in general courses in geology and in specialized courses in biogeography.

Biogeography of Benthic Foraminifers (Geological-Paleontological Institute, University of Kiel)

This project is investigating distribution patterns of benthic foraminifers and their temporal variability in the Cretaceous Atlantic in order to understand the role of

FIGURE 2 *The occurence of D. lodoensis in DSDP/ODP-Holes plotted on a 50.0 Ma paleogeographic reconstruction as available online at www.odsn.de.*



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paleoecology and paleogeography as indicators for water mass distributions and carbon accumulation.

Mirror Site of the JANUS Database at the University of Bremen

ODP's JANUS database contains many different kinds of shipboard data. It is one of the major achievements of the program. It now makes ODP data internationally accessible via the internet after the cruises without interaction with database management. To improve performance for European scientists and to allow more efficient work with the data, a mirror site for the JANUS database – an Oracle relational database system – has been set up in Bremen in close co-operation with the ODP operator and the Bremen core repository. Further mirror sites are under construction. A database update is planned every two months after a new drilling leg. It should be noted that for recently collected data a moratorium of one year exists. During this time only the shipboard scientific party is granted access.

Mirror Site of ODP Publications at MARUM/AWI Webserver (Bremen/Bremerhaven)

The paperbased publications of ODP have been replaced by electronic publications. These are available as CD-ROMs and via the internet, opening the information to a wide scientific community. To improve performance, shorten download times, and to prepare for the expected increase in demand, a mirror site for all the ODP publications has been set up within the PANGAEA database network for paleoclimate research (www.pangaea.de). This is jointly operated by MARUM (Institute for Marine Environmental Research at the University of Bremen), and the AWI (Alfred-Wegener-Institute for Polar and Marine Research in Bremerhaven). These mirror sites will also improve opportunities for shorebased sampling, post cruise measurements, and studies at the Bremen core repository.

OTHER PROJECTS USING THE ODSN:

The Microfossil Database at the Basel Micropaleontological Reference Centre (NHM Basel/ETH Zürich)

Groups at the Natural History Museum (NHM) in Basel and the Swiss Federal Institue of Technology (ETH) Zürich are working on the development of a taxonomic database of selected microfossils, concentrating on calcareous nannoplankton and planktonic and benthic foraminifers. The project will make the Neptune database (Lazarus, et al. 1995, www.ngdc.noaa.gov) available in electronic form. Further taxonomic and stratigraphic work and an expansion of the data sets in co-operation with the ODSN is intended.

INVITATION

The ODSN can serve as an archive of primary data and scientific results, making these available to other users via the Internet. Additional projects are welcome to provide or retrieve data and to improve data quality and usage. ODSN is seeking partnership projects and encourages scientists with other databases to join the network.

Another focus of ODSN is the initiation and realisation of complex projects that require broad expertise of large groups of scientists, and the organisation of meetings and workshops related to stratigraphic studies. The projects of the University of Bremen and GEOMAR in Kiel represent pilot studies now entering their final phase. Interested potential partners are invited to contact us with proposal needs and future plans.

Please contact either odsn@geomar.de or a13g@mtu.uni-bremen.de if you would like to participate in the ODSN.

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Planning and Announcements

TOWARD AN INTEGRATED OCEAN DRILLING PROGRAM - IODP – THE CONCORD AND COMPLEX CONFERENCES

On July 22–24, 1997, an international Conference on Cooperative Ocean Riser Drilling (CONCORD) was held in Tokyo to identify science questions that would require the use of a riser equipped drillship to answer. The conference was organized by the Japan Marine Science and Technology Center (JAMSTEC), The Ocean Research Institute of the University of Tokyo (ORI), and Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), with Hans-Christian Larsen of the Danish Lithosphere Center and Ikuo Kushiro of Okayama University, Japan as Chairs of the Steering Committee. It was attended by over 150 leading geoscientists, microbiologists, deep-sea drilling engineers and earth science program executives from 17 countries. CONCORD working groups considered aspects of six broad topics: Climate, Sea Level Change and the Deep Biosphere; Architecture of Ocean Lithosphere; Continental Rifting and Large Igneous Provinces; Subduction and Earthquake Processes; Borehole and Seafloor Observatories; and Drilling and Tool Technology Development. The working groups identified a variety of fundamental scientific questions that can most effectively be addressed by deep ocean riser drilling:

- Understanding the Earthquake Cycle by Direct Long-term Observation of Active Processes in the Seismogenic Zone
- The Deep Biosphere
- A Mesozoic Reference Section
- Tectonics and Monsoon Development
- Water-Rock Reactions and the Evolution of Oceanic Crust
- Ultra-deep Drilling of the Lower Crust and Moho
- Rhythms of the Greenhouse World
- Mantle Dynamics, Global Change, and Rupture of Continental Lithosphere
- Dynamics of Subduction – Earthquakes and Faulting
- Initiation of Subduction, Island Arc Evolution, and Birth of Continents
- Multi-Packer, Multi-Level Multi-Sensor Observatory Development

The CONCORD Report is available from JOI in Washington, D.C. at www.joi-odp.org/JOI/Publications.html.

On May 26–29, 1999, a second international meeting, the Conference on Multiple Platform Exploration of the Ocean (COMPLEX) was held in Vancouver, British Columbia, Canada, to identify high priority science that could be studied without using non-riser drilling platforms. This conference was organized by JOIDES and JOI. Nicholas Pisias of Oregon State University and Asahiko Taira of the Ocean Research Institute of the University of Tokyo organized and led the meeting on behalf of JOIDES.

The COMPLEX meeting was organized around 315 abstracts submitted to the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) (www.oceandrilling.org/ COMPLEX/ abstracts.html). This meeting was divided into fourteen primary scientific sessions and structured to provide opportunity for all to participate in the discussions covering the following themes:

COMPLEX
Conference on Multiple Platform Exploration

- Understanding Extreme Climates
- Documenting Climate Variability
- Constructing the Lithosphere
- Subduction Factory and Convergent Margin Processes
- Geological Processes related to Rifting
- Climate Forcing on long time scales - Tectonics and Climate
- Climate Forcing on short time scales - External and Internal
- Mechanisms Evolution of the Crust and Lithosphere
- Seismogenic Zones
- Basin and Passive Margin Evolution
- Dynamics of the Earth's Interior
- Catastrophic Events
- Understanding the Earth's Biosphere
- Gas Hydrates

A major objective of COMPLEX was to define how a multiple platform strategy might be used to achieve the scientific objectives of the future scientific drilling Program.

The COMPLEX Report is in preparation and will be published as special issue of the JOIDES Journal.

Comparison of the CONCORD and COMPLEX Reports shows that there is a broad consensus in the scientific community concerning the major topics of Earth Science that require deep sea drilling as a critical source of information. It is also evident that the appropriate technologies must be employed in different situations to achieve success in these scientific investigations.

INTEGRATED OCEAN DRILLING PROGRAM PLANNING SUBCOMMITTEE (IPSC)

At its meeting in January, the JOIDES EXCOM approved a plan to establish an IODP Planning group as a small Subcommittee of SCICOM, reporting through SCICOM to EXCOM and to the International Working Group (IWG), which consists of representatives of potential funding agencies.

The tasks assigned to the Integrated Ocean Drilling Program Planning Subcommittee (IPSC) include:

- Coordinate development of the IODP science plan, integrating the CONCORD and COMPLEX reports.
- Develop options for technical and operational capabilities required to meet the science plan with regard to drilling, site surveys, and downhole measurements.
- Develop strategies to address technical and operational issues identified at the Technical and Operations Workshop held November 17–18 1998 in Houston.
- Assess managerial and financial requirements for different operational options.
- Design a new advisory structure utilising input from Conferences, Workshops, JOIDES Committees, Panels, and PPGs.
- Develop a detailed plan for the transition from ODP to IODP.

Subsequent to the EXCOM meeting, Dr. Ted Moore of the University of Michigan was selected to Chair this group. At the JOIDES SCICOM meeting in Freiburg in March a list of potential subcommittee members was developed. Ted Moore then contacted prospective members to make sure that they would be able to devote the time required for the activities of this critically important group. The members of the Integrated Ocean Drilling Program Planning Subcommittee (IPSC) are:

Dr. Ted Moore, University of Michigan, Ann Arbor, Michigan, USA, Chair
Dr. Asahiko Taira, Ocean Research Institute, University of Tokyo, Tokyo, Japan
Dr. Hans Christian Larsen, Danish Lithosphere Center, Copenhagen, Denmark
Dr. James Austin, University of Texas, Austin, Texas, USA
Dr. Jörn Thiede, Alfred Wegener Institute, Bremerhaven, Germany
Dr. Jim Kinoshita, JAMSTEC, Tokyo, Japan
Dr. Dieter Eickelberg, Bentheim, Germany

The group had its first full meeting at the end of May, after the COMPLEX conference in Vancouver. One of the initial tasks of IPSC is to coordinate international comment and advice to the Japan Marine Science and Technology Center (JAMSTEC) and Japans Science and Technology Agency (STA) on the design of the riser vessel. To assist in this, IPSC asked the JOIDES Scientific Measurement Panel (SCIMP) for information concerning laboratory needs on the new vessel.

To facilitate its work, IPSC is establishing three working groups, one concerned with producing an integrated science plan, one concerned with technological developments in industry, and one concerned with possible industrial cooperation in the scientific program. The group plans to meet next in Copenhagen, Denmark, in October, 1999.

NEW PPG'S ESTABLISHED: "THE ARCTIC'S ROLE IN GLOBAL CHANGE" AND "HYDROGEOLOGY"

Program Planning Groups (PPGs) are small groups of scientists formed by the Science Committee (SCICOM) when there is a need to develop drilling programs or technological strategies to address specific scientific goals of the Long Range Plan. These are relatively short-lived groups who report to the appropriate Science Steering and Evaluation Panel (SSEP). They make final presentations of their deliberations to SCICOM. Proposals responding to the theme of the PPG can be initiated by individuals or groups. Currently there exist 6 PPGs (Architecture of the Oceanic Lithosphere, Climate-Tectonics Links, Deep Biosphere, Extreme Climates, Gas Hydrates, Shallow Water Systems). At it's meeting in Freiburg, Germany in March, 1999, Keir Becker informed SCICOM of the deliberations of the Long-Term Observatories PPG. The final report was accepted by SCICOM and the PPG was thanked for their excellent work. The report can be read and downloaded from the JOIDES office webpages at www.joides.geomar.de/ reports/pr_ppg_lto.html.

Recently SCICOM and the SSEPs discussed the need for two new PPGs, one about "The Arctic's Role in Global Change" and another concerned with "Hydrogeology" of deep sea sediments and ocean crust. These PPGs are now being established. Their membership will include scientists nominated by the SSEPs, the various ODP Secretariats, and, for the Arctic Group, the Nansen Arctic Drilling Program.

The Arctic PPG will assess how the role of the Arctic in global change, particularly with respect to Earth's climate, can be evaluated through scientific drilling. The overall goal of this group is to build on the existing Implementation Plan of the Nansen Arctic Drilling (NAD) Program, developing a mature science plan for learning about the role of the Arctic in the global climate system from sediments in the Arctic Ocean basin and its surrounding shelves. Interest in the polar climate system ranges through times scales from decades to millions of years. This PPG will include both NAD scientists and others with a background in Arctic paleoclimate research.

The Hydrogeology PPG is being established to promote the study of hydrogeologic processes in marine subsurface environments through the use of boreholes and other methods. It's overall goals are to summarize current understanding of the processes and effects of fluid flow, to define and prioritize the main problems in submarine hydrogeology in terms of their global significance, and to explain how studies of these environments may relate to those of analogous subaerial formations.

Details with more information on the PPGs, their mandates and membership can be found on the JOIDES office webpages (www.joides.geomar.de) as soon as they are available.

THE OD 21 VESSEL

Shortly after the meeting of the JOIDES EXCOM in Miami in January 1999, the Japan Marine Science and Technology Center (JAMSTEC) and the Japanese Science and Technology Agency (STA) received government approval to begin detailed design and initial construction of their riser drillship. The initial authorization is for $116M in FY 1999. It is anticipated that this will be followed by authorizations of $230M in FY 2000 and a final $150M in 2001. The basic design of the vessel is scheduled to be completed in March 2000, with hull construction to start shortly thereafter. Construction is expected to be finished in 2003. Sea trials will ensue, and the vessel is expected to be fully operational by the end of 2005. The vessel will initially be outfitted with a 1000 m riser, to be extended to 2500 m as the vessel become operational for scientific projects in 2005. The ultimate goal is to be able to drill with return circulation and well control in waters 4000 meters deep, with a total drill string length of perhaps 12 km. (For more information about the capabilities of the vessel, see Takagama, S. 1998. Riser drilling technology for an integrated Ocean Drilling Program. JOIDES Journal, 24/2 pp. 31–33.)

Although different objectives will require specific drilling strategies and different times on site, the ship is likely to be at some of the sites for well over one year. It is clear that no one scientific party is going to staff the ship for such a long period of time; the "JR" model of staffing that most of us are familiar with is unlikely to apply. Given such long on station times, one of the key design questions from a scientific point of view is: "How extensive should the laboratory and technical facilities be?"

There are two extreme viewpoints:

- All that is required is a rather small, perhaps technically oriented scientific party capable of making all measurements that are either ephemeral in nature or are required in order to make sound scientific judgements pertaining to the drilling, coring, and down hole measurements programs. All detailed scientific studies of the recovered cores can be more efficiently and cost effectively made at shorebased laboratories.
- Given the larger ship required to handle the casing and riser technology, and the additional space available to scientists that accrues as a result of such a large ship (perhaps 50% larger than the JR), we should adopt a "floating institute" approach to scientific facilities on the OD21 vessel. We should provide this institute with all the latest technical and scientific measurement equipment that can be reasonably operated at sea, and staff the legs with rotating teams of scientists that work extensively on all the core material and data associated with each riser site.

Parallel shorebased facilities could, and perhaps should, also be available, so that rotating scientific teams can access data bases, cores, and logs there too.

The members of IPSC discussed this issue and came to unanimous agreement that it is most desirable to lean toward the second option (above), but with some modifications:

a) the initial shipboard laboratory capabilities need not be greatly in excess of what will soon be available on the JOIDES Resolution; however, additional space that we already know will be available will allow a less crowded layout;

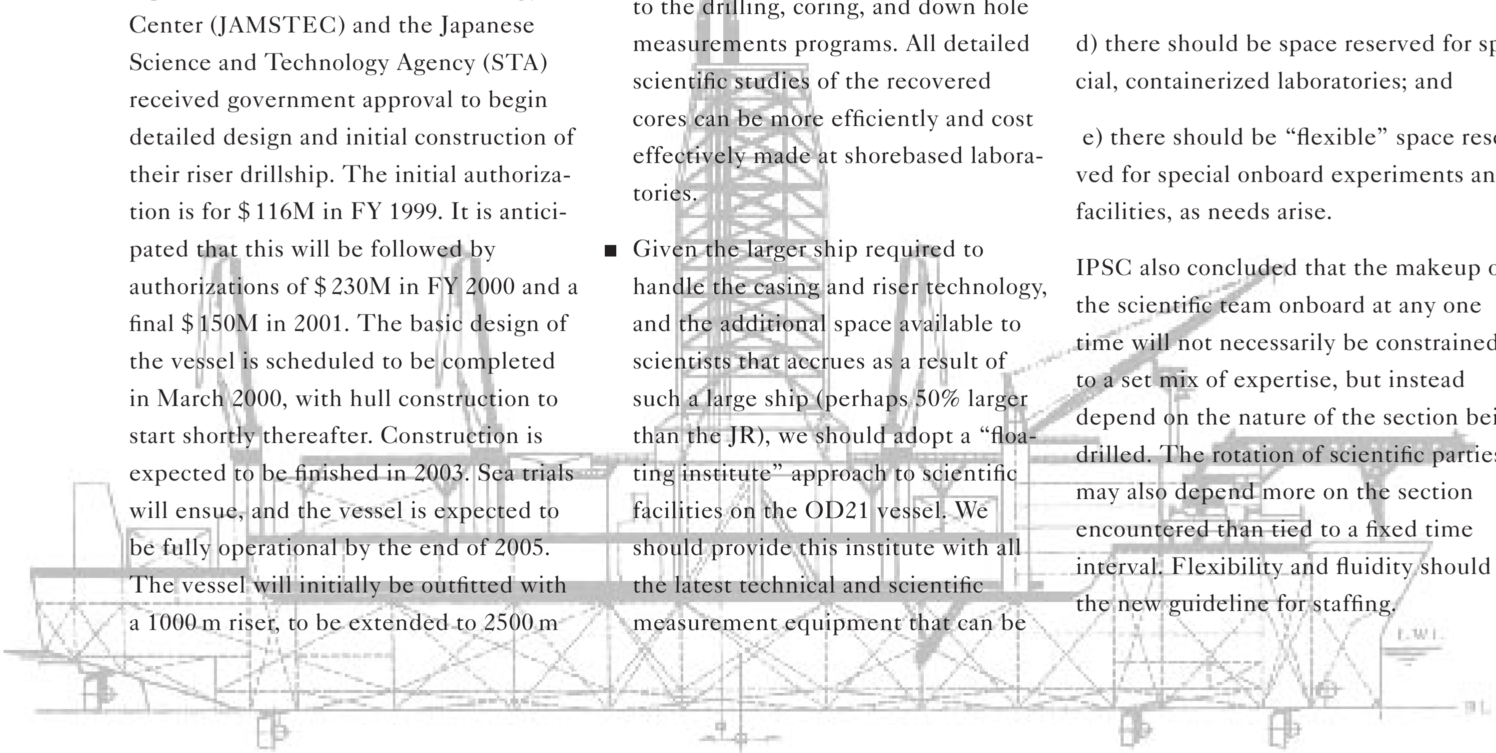
b) additional facilities should include a capability to perform interactive interpretation of 2D and 3D seismic data sets and an integration of core and log data with seismic data;

c) there should be space set aside for laying out and examining as much as a few hundred meters of recovered core material; this lack of observational capability is one of the real limitations of the JR;

d) there should be space reserved for special, containerized laboratories; and

e) there should be "flexible" space reserved for special onboard experiments and facilities, as needs arise.

IPSC also concluded that the makeup of the scientific team onboard at any one time will not necessarily be constrained to a set mix of expertise, but instead depend on the nature of the section being drilled. The rotation of scientific parties may also depend more on the section encountered than tied to a fixed time interval. Flexibility and fluidity should be the new guideline for staffing.



IPSC is interested in learning whether you agree with its positions on these issues, or whether you feel that another approach to the design of shipboard laboratory facilities is more reasonable. If you wish to comment, please respond to JoAnne Reuss (jor@umich.edu) at the IPSC Office at your earliest convenience.

Now that the end of ODP is in sight you might think that it is too late to submit a proposal. This is **not true**. Preliminary proposals submitted by March 15, 2000, and Full Proposals submitted by October 1, 2000 could still be scheduled in the present program. However, these terminal deadlines apply only to the ODP, not to its successor program, the IODP. Good proposals that cannot be drilled during the present program will be carried over for consideration in the IODP. **There will be no break in the proposal submission and evaluation process.**

Submitting proposals – deadlines must be rigidly enforced!

The deadlines for arrival of proposals in the JOIDES office must be rigidly enforced to meet panel schedules.

PRELIMINARY PROPOSALS

Preliminary Proposals may be **no more than 10 pages** (including Abstract, Figures, and References, but not including Site Summary Sheets) and should contain the following:

1. Clearly stated scientific goals, and how they relate to high priority scientific objectives within the Long Range Plan (or how they move beyond the LRP, or open up new fields of study). A description of relationship to other global geoscience programs (if any) should be included.
2. Justification of the need for drilling to accomplish the objectives.
3. Brief description of proposed sites, penetration depths, expected lithologies, etc.
4. Brief description of available site survey data.
5. A well defined drilling and logging/ downhole measurements strategy and explanation as to how it addresses the scientific goals of the project.
6. A description of all anticipated logistical requirements.

For any unusual logistical problems or potential hazards (e.g., currents, sea ice, shallow water, hydrocarbons, special tool requirements, alternate platforms, etc.), proponents must contact the Science Operator before submitting a proposal. Please provide critical information to the ODP Deputy Director, Texas A & M University, 1000 Discovery Drive, College Station TX 77845 USA (Jack_Baldauf@odp.tamu.edu).

FULL PROPOSALS

The submission of a full proposal will be recommended by the Scientific Steering and Evaluation Panel(s) or by SCICOM on the basis of the Preliminary Proposals. Full proposals will be submitted to the JOIDES Office by the 15 March or 1 October deadline. Sources for these proposals will be mainly the proponent(s) of the Preliminary proposal(s), but may include members of a PPG or DPG (for those proposals referred to such Groups), or others that are added to address issues raised by the panels.

Full proposals will be **no more than 25 pages** long and must adhere to the content and format requirements listed below.

Full proposals will be reviewed by the appropriate SSEP(s) to determine whether they meet the criteria necessary to be sent out for external comment.

These criteria are:

1. The proposal addresses a scientific problem that is identified as a high priority in the ODP Long Range Plan (or moves the program beyond the LRP);
2. There is clear justification that drilling is the best way to achieve the scientific objectives being addressed;
3. There is a well defined drilling strategy, the success of which can be assessed on the basis of the geophysical/ geological data as presented in the proposal.

Both preliminary and full proposals must adhere to the following formatting requirements. **Failure to do so or exceeding the page limits will result in the proposals being returned to the proponents:**

Abstract:	400 words
Font size:	12 point, 1 1/2 spacing
Margins:	one inch all around
Binding:	none; proposals must be stapled.
Figures:	black and white. Color figures are discouraged, as JOIDES does not have funds to reproduce them. If color figures are essential, please contact the JOIDES Office for advice. Figures should be page-sized. Do not include large foldouts.

Electronic version is required on disk formatted for Macintosh (WORD or WORDPERFECT).

Ten (10) copies of Proposal/Figures/ Forms are to be sent to the

JOIDES Office
GEOMAR
Wischhofstr. 1-3
D-24148 Kiel
GERMANY

Site Description Forms may be obtained from our FTP site, http://www.joides.geomar.de/proposals/ or a copy may be printed in PDF.

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