Minutes of JOIDES Downhole Measurements Panel Meeting at Lamont-Doherty Geological Observatory Palisades, New York September 20-21, 1984

Panel Members Present	Absent
M. H. Salisbury (Chairman)	R. Jung
R. N. Anderson (ex-officio)	H. Kinoshita
K. Becker	
S. Bell	
F. Duennebier	
D. Georgi	Visitors
J. Hovem	D. Hunt
E. Howell	J. Ladd
A. Jageler	D. Moose
O. Kappelmeyer	C. Moore
R. McDuff (PCOM liason)	R. Newmark
G. Ohloeft	M. Purdy
G. Pascal	D. Roach
A. Timur	J. Schlee
R. Traeger	D. Smith
P. Worthington	A. Sutherland (NSF)
A. Wright (TAMU liason)	M. Zoback

1. Previous Minutes (January 1984) approved.

2. NSF Report (Sutherland)

Since the last meeting, there have been several important developments in the Ocean Drilling Program:

First, SEDCO has been acquired by Schlumberger. The takeover was friendly and no changes in management are anticipated in the first year.

Second, France is expected to join Germany as a full contributing member of the program within a month. Japan will not join this year but will next year. The participation of the U. K., Canada and the European Science Foundation (Norway, Sweden, Switzerland, Holland, Italy, Greece and Spain) remains uncertain because of funding problems. It is important that at least two additional countries join by January, 1985 because the FY 85 budget is predicated on contributions from four full members in addition to the U. S.

Finally, Gary Brass (University of Miami) will be replacing Herm Zimmerman at the NSF.

3. JOI Report (Dan Hunt)

Background: The Joint Oceanographic Institutions, Inc., composed of the U.S. member institutions in JOIDES and based in Washington D.C., is contractually responsible to the NSF for the management of the Ocean Drilling Program. The principal subcontracts managed by JOI include

the contract to TAMU for the operation of the ship and shore-based support facilities, the Lamont logging and Site Survey data base contracts and contracts to U.S. oceanographic institutions for site surveys. JOI submits a monthly report to the NSF which includes reports from its subcontractors and distributes a newsletter on the Ocean Drilling Program to the members of JOIDES. To solve operational and financial problems arising among the various institutions having major operational responsibilities within the ODP, an Interface Working Group (IWG) consisting of the following individuals will meet as problems arise:

IWG Membership:
Phil Rabinowitz, Chairman (TAMU)
Roger Anderson (LDGO)
Roger Larson (PCOM Chairman)
Dan Hunt (JOI)

Report: Since the pre-proposal conference for ship's contractors held by TAMU less than a year ago, the contract has been let to SEDCO for the use of the SEDCO/BP471, the lab stack has been designed and the ship conversion has begun. A conversion cost overrun of about $4.0Mm is projected due to increases in lab space, power requirements and furniture costs. Distributed over two years, the overrun amounts to only $1.5M but this sum will have to be made up budget cuts. In making these cuts, JOI requests that the DMP prioritize its requirements for tool development.

4. TAMU Report (Audrey Wright)

The conversion of the ship began in August and should be completed in early November, after which the laboratory gear will be installed. Approximately $3M in new state of the art equipment will be put on the ship, including 2 VAX's, a new heave compensator built by Western Gear and an array of downhole tools owned by TAMU (see Appendix I, Downhole Tool Report).

TAMU is also developing a bare rock drilling capability for use on Legs 106 and 110 (Mid-Atlantic Ridge) and 111 (East Pacific Rise) based on site specifications outlined by members of the submersible community in consultation with the ODP engineering group (slopes of <20° with random boulders <1 m. high). In addition, TAMU is developing drill-in casing for use on Leg 109 (Barbados Thrust).

The ship is scheduled to leave the yard in late November for the SEDCO shakedown cruise. TAMU will run a second shakedown cruise in December consisting of two 10-day legs with a personnel transfer at sea between legs. If no major problems develop, Leg 101 will depart on January 1, 1985. The first five legs have been scheduled and will spend an average of 56 days at sea, of which 41 days will be spent drilling.

The co-chief scientists for the first three legs have been selected (101: Austin, Schlager; 102: Schlee, Salisbury; 102: Boillot, Winterer) and one of the co-chiefs has been selected for Leg 104 (Eldholm). Staffing for Leg 101 is nearly completed.

Discussion (Wright and Panel members)

Pascal: In order to take full scientific advantage of the boreholes, the French urge that all holes be equipped with re-entry cones. This would make it possible to re-log and instrument interesting holes after the drillship had left the area. The panel recommended that TAMU develop small (or more to the point, cheap) re-entry cones so that they can be deployed on a routine basis (Rec. 4; also see Appendix II and Rec. 16 of January 5-6, 1984 minutes).

5. Planning Committee Report (Russ McDuff)

Since the last DMP meeting, the PCOM has met twice, once to outline the long-term (10 year) ship's track and once to prepare a more detailed track for the first two years of drilling. The long range plan is to circumnavigate the globe during the next 6½ years, leaving 3½ years to be planned in the future. The ship's track, assuming a January 1985 start, is constrained by the following high latitude weather windows:

Area	Window
Norwegian/Labrador Seas	7/85
Weddell Sea	1/87
Kergelen	1/88
NW Pacific	7/89
NE Pacific	7/90

At the May, 1984 PCOM meeting, the targets for the first two years of drilling were selected as follows:

Leg 101 - Bahamas
Leg 102 - ENA-3/417D, 418A, 395A
Leg 103 - Galicia
Leg 104 - Norwegian Sea
Leg 105 - Baffin Bay/Labrador Sea
Leg 106 - Mid-Atlantic Ridge/Kane F.Z.
Leg 107 - Tyrrhenian Sea
Leg 108 - N.W. Africa (Cenozoic)
Leg 109 - Barbados North
Leg 110 - MARK-2
Leg 111 - ?
Leg 112 - ?
Leg 113 - ?
Leg 114 - Weddell Sea

The following targets are being considered for Legs 111-113:
Ionian Sea
N.W. Africa (Mesozoic)
Barbados South
Yucatan Basin
Venezuela Basin
Hole 504B
Costa Rica
EPR-1 (15°N)

Peru Trench
Chile Triple Junction

Of the legs already agreed upon, Legs 102, 106, 109 and 110 would presumably be of most interest to the DMP. If any of the Legs being cosidered for 111-113 are of particular DMP interest, the panel should make its recommendations known to the PCOM.

6. U. S. Science (USSAC) Report (Fred Duennebier)

Background: To complement the national committees in other JOIDES countries, a series of committees (known collectively as the U. S. Scientific Advisory Committee, or USSAC) has been formed in the U.S. to encourage and organize U.S. scientific involvement in the drilling program. USSAC has 24 members (one from each of the 10 U.S. oceanographic institutions plus 14 selected by the JOI board of governors) divided among three panels:

Field Programs (John Orcutt, Chairman)
Mandate: Advise JOI on requirements for U.S. site surveys and field studies in support of the drilling program; assist JOI in the preparation of RFP's.

Downhole Measurements (Fred Duennebier, Chairman
Mandate: Monitor the downhole measurements program and advise JOI on requirements for tool development and modification; provide JOI with technical specifications for RFP's.

Science Support
Mandate: Advise TAMU on matters pertaining to salary support for U.S. scientists participating on the drill ship; administer the distribution of funds for post cruise research by shipboard and shore-based scientists.

In addition, USSAC plans to sponsor workshops and synthesis studies of DSDP and ODP results.

Early in 1984, USSAC prepared a proposal requesting funds for site surveys, downhole tool development, salaries for participating U.S. scientists and post cruise research. It has since been substantially modified and will be submitted to the NSF through JOI for approval by the National Science Board in November.

At the first meeting of the USSAC Downhole Measurements Panel, it was recommended that ~$100K be spent on a synthesis of DSDP logging and physical properties results and that USSAC sponsor workshops on:

1) Long term recording of borehole geophysical data
2) Tools for in situ measurements (including measurements while drilling)

3) High temperature logging (perhaps in conjunction with the continental drilling community). It is estimated that each workshop would cost ∿20K. Both the synthesis study and the workshops would be initiated by RFP's. An additional $100-150K may be available in the first year of the program for the development of new tools. The priorities tentatively established by the panel for the use of these funds (if available) are:

1st: Absolute depth meter
2nd: 4-arm dipmeter
3rd: Borehole gravimeter

Wireline re-entry was also discussed but most panel members felt it should be handled through normal NSF channels since its operation would be independent of the drilling program.

Discussion (Duennebier and panel members)
The panel applauded the intent of USSAC to convene workshops on high temperature tool development, long term recording and in situ measurements but recommended (Rec. 6) that foreign expertise would strengthen many of the discussions and should be solicited. To aid in the preparation of a logging/physical properties synthesis LDGO was urged (Rec. 5) to prepare and maintain an up to date catalog of available DSDP/ODP logs.

7. Logging Report (Roger Anderson)

Since the last DMP meeting, contract negotiations with Schlumberger and JOI have been completed and the contracts have been signed. The basic operation will include contract logging by Schlumberger starting with Leg 101, log analysis and the operation of selected special tools. Two new tools (a state of the art borehole televiewer made in West Germany and a multi-channel sonic tool) were acquired using FY 84 funds but unless several more countries join JOIDES, it won't be possible to acquire any new tools in FY 85 because of budget cuts precipitated by the ship conversion cost overrun.

During the past several months, the group at LDGO moved into its new logging facility, began calibration and field (borehole) testing of its special tools, and wrote a draft logging manual for the ODP. Arrangements were made with Peter Lysne for the calibration of nuclear tools against core samples.

The special tools which LDGO has acquired or plans to acquire early in the program include the following:

Borehole televiewer (Mark Zoback)

During the first few legs, it is planned to use the Simplec tool used during DSDP. In FY 85, however, delivery will be taken on a new digital tool made by Bobica in West Germany, which gives higher quality data and is simpler to use. The tool digitizes both the travel time and amplitude of the

return signal. The data will be processed using VIVICA software purchased in FY 84. Under ideal conditions, the tool gives a high resolution (2 mm) picture of the borehole wall and measures the depth and orientation of breakouts caused by in situ stress. The tool is slow (5'/min), however, and the data is degraded by ship's motion and rough holes which scatter the return signal.

Wireline Packer (Mark Zoback)

LDGO intends to replace the Lynes packer used by DSDP with a TAM wireline packer designed to measure pore pressure and permeability and to take four fluid samples on command from the surface. Sensors in the sample chamber monitor Eh, Ph, resistivity, pressure and temperature so that contaminated sea water can be detected and flushed from the chamber prior to sampling. The tool, which was designed by Al Jageler at AMOCO is still a prototype and is too large for ODP use. AMOCO plans to run bench tests of the tool this spring and to modify it for field use in 1986. To participate in the tests and share in the results, LDGO must contribute ~$10K toward development costs in FY 85. FY 86 funds will be used to build or modify one of the tools for ODP use.

12 Channel Sonic (Dan Moos)

For several years, LDGO has been testing a single source, 12 receiver sonic tool built by Simplec. The tool, which will be capable of continuous logging in about a month, is much more sophisticated than Schlumberger's LSS tool and gives much better data. By employing gathering techniques as the tool is raised up the hole, the data obtained is roughly equivalent to that from a reversed refraction experiment. To overcome coupling problems and allow faster logging (5m/min vs 2.5 m/min for the present tool), hopes to acquire a dual receiver tool for $75K. Another tool which would be very useful would be Mobil's S-wave tool.

(At this point, the panel broke for a tour of the LDGE logging facilities, including the log analysis center, the tool workshop and the logging truck donated by Schlumberger)

Schlumberger Program (Roger Anderson)

Under the present agreement with Schlumberger, three engineers will be assigned to the Project for the next 18 months, and two each of the following tools will be placed on the ship:

NGT	spectral gamma ray (U, Th, K)
CNT-G	thermal/epithermal neutron
LDT	gamma density
DLL, SFL	Dual lateralog, spherically focussed log
DIL	induction log
LSS	long-spaced sonic (Vp, Vs)
WST	vertical component clamped seismometer
HRT	high resolution (±4°F) temperature
Caliper	

In addition, the following tools are available if ordered in advanced:

TET	tracer injection (to determine flow rates)
PFS	pore fluid samples (returns fluid under pressure)

Schlumberger has not made available their borehole televiewer, digital sonic tool or dipmeter (which in any case is oversized and only works for dips up to 40°).

Discussion (Anderson and Panel members)
Several members of the panel pointed out that in rugose holes, the BHC sonic tool gave more quantitative results than the LSS. The panel accordingly recommended (Rec. 7) that instead of 2 LSS tools, the ship should go out with one LSS and one BHC sonic tool.

It was also pointed out by Ohloeft that the Schlumberger tools must be calibrated in hard rock pits if the data is to be used quantitatively. This could be done at the Denver Federal Center or the API pits. The pits in Ottawa are the best for neutron tool calibration. Following this discussion, the panel instructed LDGO to have Schlumberger calibrate its tools in hard rock pits (Rec. 9).

Wireline Heave Compensator (Roger Anderson)

Acting on the DMP requirement (Rec. 1-C-3 of January, 1984 minutes) that the ODP logging data be corrected for ship's heave, LDGO has begun working with Schlumberger to design a wireline heave compensator. Schlumberger proposes to use a piston-mounted sheave to pull up or lower the logging cable in opposition to the heave of the ship as sensed by either a quick response (2 sec.) accelerometer with a 2' sensitivity or an altimeter with 20 cm sensitivity. Both sensors will be provided to insure operational flexibility. The total cost of the system will be ∿$106K.

Discussion: (Anderson and panel members)

Several panel members were doubtful that a heave compensation system using a surface sensor would be effective in reducing the motion at the bottom of an elastic cable 5 km long. Duennebier pointed out that the motion should be considerably reduced because the driving force is removed and Anderson added that the Navy has developed and employs similar methods. Salisbury commented that once built, the effectiveness of the heave compensator could be evaluated quantitatively using the DBMI developed by DSDP.

When asked by Hunt and Anderson to prioritize the wireline heave compensator, the TAM packer and the 12-channel sonic tool for acquisition purposes, the panel made the following recommendations (Rec. 8):

1st priority: Wireline heave compensator.

The panel felt that correction of ship's heave is the most important problem facing the logging program. A wireline heave compensator should reduce the problem considerably and should be built and tested ASAP. Even though it may eventually have to be complemented by an absolute depth sensor fashioned after the DBMI, mechanical compensation is needed to prevent contact tools (WST, dipmeter, TAM packer) from tearing up.

2nd priority: TAM packer

LDGO should monitor (buy in to) AMOCO tests. If these are successful, development (miniaturization) of the tool should be the top priority in FY 86.

3rd priority: 12-channel sonic

LDGO should gain experience with its single source, 12 receiver tool before acquiring a 2-way tool.

Other tools:

3 axis magnetometer: Oscar Kappelmeyer outlined the status of a new 3-axis borehole magnetometer being developed in West Germany. The tool is presently oversize but with 6 weeks notice, could be slimmed down for use on Leg 102. The panel strongly recommended (Rec. 3) that the tool be modified for ODP use and that it be fielded on Leg 102.

Magnetic susceptibility: Gary Ohloeft noted that the USGS magnetic susceptibility tool could probably be modified for ODP use (it just needs a high pressure casing) and that it would be extremely useful in the basement. The panel recommended modification and fielding of the tool on Leg 102 (Rec. 20).

Ultra high resolution temperature: The West Germans have also developed a very high resolution (.001°C) temperature tool using a platinum P-100 resistivity type sensor which can be used to 300°C. Since it can be used for high temperature logging and the detection of aquifers, the panel recommended its use during the ODP (Rec. 3).

HPC heat flow: Dick von Herzen requested that the DMP review the operational status of the HPC heat flow tool and advise how it should be maintained and operated in the future. The panel regards the tool as essential for routine heat flow/temperature gradient measurements and recommends (Rec. 11):

1) that TAMU assume full responsibility for maintenance and operation of the tool;

2) that it be deployed at every HPC site, and

3) that TAMU assign a geophysics staff scientist to

champion its use and development. The panel also requests that Dick von Herzen remain as consultant to TAMU on matters pertaining to the tool.

In addition to these tools, it was suggested (Rec. 1) that the panel should prepare an announcement for EOS and other technical journals summarizing downhole measurement plans and opportunities and soliciting proposals for new experiments and tools.

Shipboard Logging Personnel: (Roger Anderson)

In order to operate the logging equipment and analyze the data on each leg, LDGO requests that a minimum of 3 slots be assigned to logging personnel on each cruise as follows:

1 Schlumberger engineer
1 LDGO logging scientist (to operate special tools and assist in data analysis)
1 log analyst from the scientific/industrial community

On early Legs, LDGO also asks to put a trainee on board.

For Legs 101 through 104, LDGO proposed the following personnel in addition to the Schlumberger engineer.

101: Anderson, Hobart
102: Moos, Broglio
103: Goldberg, Roach
104: Lysne, Moran

Discussion (Anderson and panel members)
After a brief discussion, the panel endorsed the request in full (Rec. 10) and recommended further that the log analyst/scientist selected from the community must be mutually acceptable to LDGO and TAMU.

Concern was expressed regarding the relatively small number of academic scientists versed in log analysis and the difficulty experienced in the past in getting log analysts from industry to participate on the ship. (Industry is reluctant to release analysts for two months at a time and DSDP couldn't afford to pay industry salaries if they were released). Timur suggested and the panel recommended (Rec. 2) that the DMP should secure the cooperation of industry management before TAMU or LDGO approached individuals in industry about participating on specific cruises. Recruiting could also be conducted through trade journals such as The Leading Edge, the Journal of Petroleum Technology and the Oil and Gas Journal.

8. Status of Independent Proposals (Matt Salisbury)

Packers

a) Keir Becker (SIO) has been funded by the NSF for two years to 1) refurbish the Lynes packer or purchase a new TAM straddle packer for pore pressure, permeability and hydrofracture tests; 2) purchase a clean fluid sampler; 3) purchase a low flow rate (100 m/hr or more) flow meter; 4) continue running the large scale resistivity experiment. It is planned to run the equipment on Legs 102, 106, 109, 110 and 111.

b) Ove Stephansson and Gunilla Tornqvist (Lulea University of Technology, Sweden) are submitting a proposal to funding agencies in Sweden to modify a sleeve packer for measuring in situ stress in rocks and unconsolidated sediments. It is hoped to run the unit on Leg 109 (Barbados North).

VSP

c) Paul Stoffa and Joe Phillips (UT/Austin) have submitted a proposal to the NSF for multi-year funding to conduct VSP and walkaway seismic profiling (WSP) plus data processing and analysis on numerous legs as a service (like logging) to the ODP.

d) Ralph Stephen (WHOI) and Larry Meyer (Dalhousie) have submitted a proposal to the NSF to conduct the oblique seismic experiment (OSE) and VSP studies at Sites 417/418 and 603 on Leg 102.

At the present time, the NSF is trying to get the two groups to resubmit with a common budget and divided responsibilities: UT/Austin having responsibility for Legs 101 and 104; WHOI/Dalhousie for Leg 102.

Wireline Re-entry

e) Fred Speiss (SIO) submitted a major equipment proposal the NSF requesting funds for a deep tow vehicle with re-entry capability. He has been instructed to resubmit.

f) Ralph Stephen, et al., (WHOI) have also submitted a proposal to the NSF for a re-entry vehicle. The proposal is still pending.

Downhole Magnetometers

g) Jim Scott (USGS) has a gyro-oriented 3-axis magnetometer which only needs a high pressure (titanium) casing to be rated for ODP use. Funds are being sought within the survey for the conversion.

h) Paul Johnson (UW) is writing an NSF proposal for a 3-axis unit.

i) Wilhelm Bosum and Ewald Meyer (BGR) have an operational 3-axis

magnetometer which would have to be repackaged in a smaller casing for ODP use. Modification has already begun and the tool will be ready for Leg 102.

j) Paul Johnson (UW) is having Schoenstedt build a vertical gradiometer using NSF funds. The tool will have to be strengthened for ODP use.

Magnetic Susceptibility Meter

k) Jim Scott has an operational magnetic susceptibility tool which only needs a high pressure casing for ODP use. Modification has begun and the tool will be deployed on Leg 102.

Pore Water Sampler

l) Ross Barnes (UW) is preparing an NSF proposal to upgrade the sampler used by DSDP and to conduct a comprehensive pore water chemistry program on samples obtained during the ODP.

Complex Resistivity

m) Gary Ohloeft (USGS) has operational equipment which can be used by ODP without modification. No proposal needed.

HPC Heat Flow

n) Dick von Herzen (WHOI) has developed and fielded a self-contained sensor/recording unit which fits in the wall of the HPC cutting shoe. No proposal is needed if TAMU assumes responsibility for the maintenance and operation of the tool (see Rec. 11).

Borehole Seismometers

o) Tom Brocher (WHOI) is preparing a proposal to place a borehole seismometer in the seafloor near the Kerguelen Islands at a site antipodal to the Nevada test site in order to study seismic waves traversing the earth's core.

Geotechnical Studies

p) Jean Briaud (TAMU) is preparing an NSF proposal to deploy downhole geotechnical gear developed by McClelland Engineers on Leg 109 (Barbados North) in order to study sediment shear strength, temperature and pore pressure as a function of depth near the Barbados Thrust.

Proposals are still needed for the conversion of borehole gravimeters, 4-arm dipmeters and neutron activation gear for ODP use, the design and construction of high temperature logging equipment and long term observatories to monitor seismicity, strain, tilt, temperature, flow, pressure and water chemistry.

Other proposals have been received which are of great interest to the panel but which do not directly involve downhole measurements:

q) Bob Whitmarsh (IOS) is preparing a proposal to study strain relief in cores recovered by drilling.

r) Neville Carter (TAMU) has received NSF funding to study deformation in cores recovered by drilling.

It is critical for both that TAMU develop a soft and hard rock oriented coring capability.

9. Leg-Specific Logging/Downhole Experiment Recommendations

To acquaint the panel with the objectives of upcoming legs so that the panel could make leg and site-specific recommendations on logging and downhole experiments, proponents for Legs 101, 102, the bare rock drilling legs and the Barbados legs were asked to give presentations on their respective legs. (Legs 101 AND 102 were selected because they are early in the program; the bare rock and Barbados legs because they present technical problems requiring long lead times to solve).

Leg 101, Bahamas (John Ladd, LDGO)

Leg 101 has three primary objectives: 1) to study the demise of the Mesozoic carbonate platform and its subsequent re-establishment; 2) to study late Tertiary off-bank deposition; and 3) to study the Tertiary history of the Gulf Stream through the Straits of Florida. Site selection is not yet complete but the following target areas and sites are being considered:

Florida Straits. A 1500 m, single-bit hole (BAH-1) is planned to drill into the Mesozoic reef complex and determine the nature of the velocity transition at the base of the section.

Exuma Sound. A series of deep single bit holes (BAH-12A, B, C, D) is being considered to examine shallow water bank deposits similar to those in the Florida Straits. Several shallow HPC holes (BAH-11A, B, C) are being considered to look at offbank deposition.

Little Bahama Bank. An HPC transect (BAH-7, 8, 9) will be cored to look at lateral facies changes. BAH-9 may be deepened by rotary drilling.

In view of the objectives of the drilling program, the DMP recommends (Rec. 12) the following logging/experiments program for Leg 101:

BAH-1 (1500 m hole):

Standard logging - needed for stratigraphic correlation and to calibrate the new logging system in a consolidated carbonate sequence (est. time: 1-1.5d)

VSP - needed to calibrate high resolution seismic stratigraphy obtained during site survey (1d)

Muiltichannel sonic logging (8 hr)

Oriented Coring

HPC Heat Flow (upper section of hole)

Pore Water Sampling - to look for changes in water chemistry accompanying diagenesis.

Other Rotary Sites:

Same program as BAH-1 minus VSP.

HPC Sites:

Standard logging in at least one hole - to calibrate logging system in unconsolidated sediments.

Oriented coring, HPC heat flow, pore water sampling at all sites.

Leg 102, Basement Geophysics, Jurassic Sediments

(John Schlee, Matt Salisbury). Leg 102 has two primary objectives: 1) to recover the Jurassic sediment section underlying the lower continental rise at the eastern end of the New Jersey Transect and ;2) to determine the geophysical nature of old oceanic basement from in situ measurements. Two sites will be examined:

DSDP Site 603

To reach the first objective, a hole will be washed to 1550 m at DSDP Site 603 (the depth cored on Legs 93 and 95) and then continuously cored through the Jurassic sediment section and into the basement to a total depth of about 1900 m.

DSDP Site 418

Hole 418A was drilled on Legs 52 and 53 to a subbasement depth of 550 m through pillow basalts, massive basalts and incipient dikes but the hole was never logged because a tool got stuck in the sediments when logging was initiated. On Leg 102 an attempt will be made to fish the tool. If successful, a comprehensive suite of logs and experiments will be run in the hole.

The panel reviewed and endorsed the following logging/experiment program for Leg 102 (Rec. 13):

Site 603:

Standard logging - needed for stratigraphic correlation with core material and for correlation with results of seismic intercomparison experiment conducted over site (2.8 d).

VSP - for comparison with seismic intercomparison experiment (1 d)

Multichannel sonic logging (1 d.)

Site 418

Standard logging - to obtain baseline suite of logs in old crust (1 d)

3-axis magnetometer - to monitor NRM and inclination vs depth for determination of thickness of magnetic layer (6 hrs)

Large-scale resistivity - to determine large scale porosity of extrusive section (6 hrs)

Multichannel sonic logging - to obtain detailed Vp, Vs structure of old crust (12 hrs)

BHTV - to obtain record of mesoscopic features and determine direction of in situ stress (12 hrs)

VSP - to determine interval velocities, anisotropy and attenuation in old crust (6 d)

Packer tests - to determine pore pressure, permeability and magnitude of in situ stress in old crust (18 hrs)

Flow meter tests - to determine flow regime in old crust (4 hrs)

Water sampling - to determine chemistry of water in equilibrium with basement rocks (4 hrs)

Heat Flow - to constrain flow models derived from packer, flow meter and temperature data (1 hr)

The panel recommended Hole 417D as an alternate to Hole 418A if the tool cannot be fished.

Leg 109, Barbados North (Casey Moore)

Leg 109 has one primary objective - to drill through the thrust plane at the base of the Barbados accretionary prism in order to study the hydraulics of the fault and deformation and changes in physical properties vs depth across the fault. One site will be drilled.

LAF-1. On Leg 78A, thrust faults were observed at several levels in Hole 542 and when the basal thrust was approached, heaving formations were encountered. Water came up the drill pipe, implying that the fault zone is overpressured, but no water samples were taken. On Leg 109 it is planned to drill to the fault, case off the fault zone and drill ahead to basement.

The Barbados thrust provides an unprecedent opportunity to study the hydrogeology of an active thrust fault, deformation occuring in the accretionary prism and dewatering phenomena associated with underthrusting. The DMP recommends (Rec. 14) a major borehole geophysics/hydrogeology program at LAF-1, including:

Standard logging - for stratigraphic correlation and in situ definition of sediment physical properties vs depth (1 d)

Packer tests - TAM packer to determine pore pressure and permeability across the fault; sleeve packer to determine in situ stress (1-2 d).

Flow meter tests - to determine flow rate of water up the fault (4 hr)

Heat flow - to determine mechanisms and magnitude of heat and water transport through the sediment prism (6 hr)

Fluid/pore water sampling - to determine nature and source of fault water and pore water (12 hr)

BHTV - to measure dipping structures and stress direction (8 hr)

Oriented coring

Geotechnical studies - to determine sediment shear strength, temperature and pore pressure vs depth throughout the section (2 d)

Long term Observatory - since drilling will perturb the system, a long term observatory should be installed to measure gradual changes in flow, temperature, pressure and water chemistry. The hole should also be instrumented with tiltmeters, strain gauges and a borehole seismometer.

Leg (future), Barbados South (Casey Moore)

It is hoped in the future to drill a major transect of sites across the southern end of the Lesser Antilles to study the evolution of a modern arc. Four target areas are being considered for drilling.

LAF-4,5. Two deep holes have been proposed study the subduction zone and the eastern deformation front. The site configuration and objectives are similar to those at LAF-1.

LAF-7. Several HPC holes have been proposed to at the toe of the deformation front to determine the age of folds produced by thrusting.

LAF-9,9A. Two sites have been proposed to drill synform basins on the upper slope in order to study continuing deformation of the accretionary prism: a 1 km hole near an active mud volcano (LAF-9); and an 800 m hole (9A) near the edge of the basin to study its age.

LAF-12. A final deep hole is planned to study deformation on the inner deformation front.

The panel recommends the following logging/experiment program:

Subduction zone and eastern deformation zone (Sites LAF-4,5)

Same as LAF-1.

Toe Sites (LAF-7)

Standard logging in at least one hole (½d)

HPC heat flow (1 hr)

Pore water sampling (6 hr)

Oriented coring

Geotechnical studies (8 hr)

Mud volcano site (LAF-9)

Standard logging (1 d)

Packer tests - to determine permeability and pore pressure near or in the vent (½ d)

Flow meter - to determine water flow through the sediments (4 hr)

Fluid sampling - to determine chemistry and source of well water (8 hr)

Heat flow - to determine mechanisms and magnitude of water transport (4 hr)

Geotechnical studies - to determine sediment shear strength, temperature and pore pressure in or near the vent (8 hr)

VSP or check shot survey - to determine interval velocities in over-pressured or fluidized sediments (1 d)

Synform basin site (LAF-9A)

Standard logging (1 d)

HPC heat flow

Pore water sampling (3 hrs)

Inner deformation front (LAF-12A)

Same as at LAF-1

Bare Rock Legs (Mike Purdy)

An extended discussion was held on the problems and requirements for logging and experiments in high temperature holes, but since a quorum of the panel was no longer present, the results will not be presented here.

10. Panel Membership

One of the shortcomings of the new JOIDES panel structure is that several major disciplines, including physical properties, geotechnical properties and organic and inorganic geochemistry are no longer well represented on the panels. To improve the situation in at least one of these area, the DMP recommends (Rec. 17) that a geotechnical properties specialist (soils engineer) be added to the panel. Possible candidates include:

Dick Goodman	(Berkeley)
Ed Hamilton	(NOSC, ret.)
Dick Bennett	(NORDA)
Lowell Babb	(McClelland Engineers)

In view of the many common interests and problems shared with the Lithosphere Panel, the DMP also requests a permanent liaison between the two panels and recommends Keir Becker to the position (Rec. 18).

11. Next Meetings

It has been suggested that the DMP meet jointly with the Lithosphere Panel to assess high temperature logging problems and to help formulate a downhole measurements program for the MARK I, II, EPR and 504B Legs (106, 110, 111-113). Since many of the DMP members are not well versed in high temperature measurements, it was recommended instead (Rec. 16) that a subgroup of the panel, consisting of Dick Traeger, Fred Duennebier, Gary Ohloeft, Al Jageler, Keir Becker and Matt Salisbury attend the next Lithosphere Panel meeting.

The panel recommended (Rec. 19) that the next full DMP meeting coincide with the Leg 102/103 port call in April. This would allow the panel to see the ship and review the first ODP logging results.

102a

DMP

JOIDES DOWNHOLE MEASUREMENTS PANEL
LDGO - SEPTEMBER 20-21, 1984
SUMMARY OF RECOMMENDATIONS

1. DMP should prepare EOS and technical journal announcement summarizing downhole measurement plans and opportunities during ODP and soliciting ideas.

2. DMP should solicit cooperation of industry management before recruiting log analysts for cruises.

3. DMP encourages FRG to proceed with plans to modify three axis magnetometer for use on Leg 102 and high resolution temperature gear for later use (including ultra high temperatures).

4. DMP reiterates need for TAMU to develop smaller, cheaper cones so they can be deployed routinely.

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6. DMP applauds USSAC intent to convene workshops on high temperature tool development, long term recording, in situ measurements. Panel points out that workshops would be strengthened in many areas by foreign expertise.

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8. New tool acquisition priority. DMP recommends:

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   2nd Priority: TAM Packer (acquisition delayed until testing completed by AMOCO).

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9. DMP recommends that Schlumberger tools be calibrated in hard rock pits.

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    1 Schlumberger engineer
    1 LDGO downhole measurements scientist (to run LDGO tools)
    1 Logging scientist/analyst from community
    1 LDGO trainee (when space available).

Logging scientist from community must be mutually acceptable to LDGO and TAMU.

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13. Leg 102 (418A/603). DMP endorses 418A/603 drilling/experiment plan but recommends 270 m basement section open above BHA, bit in 417D as backup for geophysics experiments. (See 9/22/84 letter to Honnorez, Garrison for details).

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16. DMP recommends sending subgroup of DMP (Traeger, Duennebier, Ohloeft, Jageler, Becker, Salisbury) to November Lithosphere Panel meeting to assess high temperature problems and help formulate downhole measurements program for MARK I, II, EPR and 504B Legs (106, 109, 111-113).

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18. DMP requests Lithosphere - DMP liaison. Recommends Keir Becker for PCOM approval.

19. Next full meeting to coincide with Leg 102/103 port call (now scheduled for early April).

Distribution:
Jose Honnorez
Lou Garrison
Audrey Wright
Rogert Anderson
Eoger Larson

APPENDIX I

I. DOWNHOLE TOOL REPORT: ENGINEERING OPERATIONS DEPARTMENT

A. Core Orientation Multi-Shot Compass/Camera

The multi-shot cameras and associated equipment will have to be rented from Eastman-Whipstock or Datadril (with an option to buy). The pressure case and non-magnetic sinker bar assembly equipment on hand can be adapted to use the multi-shot tool in place of the now obsolete Kuster single-shot. Additional sinker bar components will be required which are not currently in the inventory. At least one 30-foot non-magnetic Drill Collar will be required. (See Orientation Outlook Report and D. Huey memos for more details.)

Type of Data Obtained - Magnetic Azimuth and off-vertical inclination orientation data can be obtained for any piston core (APC or VLHPC). Also, hole deviation data can be obtained at any time while using any coring system. If the non-magnetic Drill Collar is not in the BHA, hole deviation can be checked, but the direction of deviation will not be known (usually not required).

Future Plans - Rent and operate a set of multi-shot tools for the first three legs to determine of adequate data can be achieved on piston cores to satisfy the scientific mandate.

Other Considerations - Committed, assigned staffing for operation, data interpretation, and tool maintenance will be necessary (especially on legs with heavy piston coring schedules) to get quality data and to avoid the inadequacies encountered with the old Kuster system. Two or three 30-foot non-magnetic drill collars will be required on board the ship to provide for full orientation capabilities while allowing for downhole losses and for lead time when re-ordering.

Recommendations - Buy at lest one non-magnetic drill collar. Rent the multi-shot equipment as planned. Use on an many piston cores as possible. Evaluate success after Leg 103.

B. Hole Deviation Measurement

Tool status - There is no system for deviation measurement currently on hand. This capability will be regained when a multi-shot system is acquired for APC core orientation. The Eastman Drift Indicator Rental Agreement was cancelled by DSDP with the advent of the Kuster Single Shot System.

Frequency of Use - Approximately each 100 meters on deep penetrations (>400-500m) or more frequently if requested by science.

Type of Data Obtained - Eastman of TATCO Systems provide paper "bullseye" discs, punched to show deviation from vertical (no azimuth capability). Multi-shot provides sequence of photo discs with hole deviation and direction data in addition to core orientation data. If the multi-shot is run without a non-magnetic drill collar, then only the deviation from vertical is meaningful.

Future Plans - The multi-shot system can be deployed on the sandline whenever a deviation reading is desired, regardless of the BHA in use. Data will be needed on future deep penetrations to warn of potential drilling problems associated with "doglegs" and excessive hole angle. The data is also useful in sedimentary structure and paleomagnetic investigations.

Other Considerations - Cost of renting or purchasing the Eastman system used by DSDP is exorbitant. Eastman quoted $25,000 for purchase or $11,000 per year to rent. A TOTCO drift indicator is part of the available instrumentation on SEDCO/BP 471; however, a special pressure case/shock absorber system would have to be designed and fabricated for coring use.

Recommendations - Use the multi-shot system for this purpose.

C. . Drill String Severing Tools

Tool Status - Hardware for the system used by DSDP is intact except for the explosives and the shooting panel which was returned to Schlumberger under the terms of the rental contract. Upgraded systems are under investigation.

Frequency of Use - Anticipated usage is approximately twice per year.

Type of Data Obtained - The severing system is used to minimize the drill string loss when the string becomes irretrievably stuck.

Future Plans - Plans for deeper penetrations without benefit of a circulating mud system and for penetrations into young basalts and thrust zones will almost certainly result in increased incidence of stuck pipe with resulting losses of BHA and lower drill string components.

Other Considerations - A "state of the art" severing system is needed that will provide increased safety, dependability and efficiency over the DSDP system. Class A or B explosives should be avoided if possible because of shipping and port entry restrictions.

Recommendations - Continue investigating the most modern systems available. Purchase a "shooting" power supply panel for the logging winch that is compatible with the downhole system selected. Training for contractor personnel in explosives safety will be required.

Notes - On September 4, 1984, a meeting was held at the TAMU Annex in which Global High Energy Systems presented their new (less than 2 years old) pipe severing system. That system is quite impressive and appears to hold a lot of promise. It utilizes a dual detonator arrangement that sets up a collision of propagating shock waves. Detonation is achieved with standard wireline equipment used by oilwell servicing units.

D. Pressure Core Barrel

Tool Status - Two complete PCB Assemblies (less one accumulator assembly) plus one additional complete ball valve assembly are on hand, along with adequate spares for limited usage. DSDP operations have shown the system to be viable but susceptible to jamming and low core recovery.

Frequency of Use - The system was used on only two or three DSDP legs where the recovery of gas hydrates under pressure was desired. On Leg 76 the system was deployed on 5 occasions recovering hydrate gas on 4 runs under pressures of 1500 to 4700 psi. It should be noted that during Leg 84 (site 565) massive hydrates were recovered with the standard rotary core barrel.

Type of Data Obtained - The system is capable of recovering cores up to 6.8 m long under insitu pressure (up to 5000 psi). The pressure and temperature of the pressure chamber may be measured, and fluids may be withdrawn through a sampling port. Solid material cannot be removed from the core barrel under pressure, however.

Future Plans for Tool Use - The operations department has no knowledge of any plans for the use of the PCB System on voyages presently in the planning stages.

Other Considerations - The PCB is compatible with the standard rotary coring assembly, but a special core bit must be used that decreases core diameter form 62mm to 54mm. An ample supply of these bits is on hand. The PCB is not compatible with the HPC/XCB BHA.

Recommendations - If future use is planned, an additional accumulator assembly should be procured. If extensive or consecutive usage is anticipated, more ball valve assemblies will be needed (long redressing time) as well as more spare parts. Training for contractor personnel will be necessary. Some limited refurbishment and pressure testing of all critical components will be required to ensure tool safety.

E. Drill Bit Motion Indicator (DBMI)

Tool Status - The accelerometer and recording package has been overhauled and bench test indicate the unit is 100% operational. One full set of all sub-assemblies, with some spares, are in current inventory along with a pressure case; however, the end caps probably should be replaced.

Type of Data - The DBMI records actual accelerations at the bit during coring or other selected operations for correlation with IDSS and SMDS inputs to overall drill string dynamic analysis.

Future Plans - Continue deployments of the tool when it can be fitted conveniently into normal operations to increase the quantity and quality of baseline data. This is significant for providing 1) comparison with and verification of drill string computer modeling results, 2) general information about bit behavior during coring, and 3) data to help evaluate heave compensation effectiveness.

Other Considerations - Past history has shown that obtaining usable data from the DBMI requires a lot of pre-planning and patience. Dedicated shipboard programs will be required in the future to gain the full capability of the tool.

Recommendations - Maintain the equipment on shore and deploy at sea when needed as part of an overall drill string and coring technology evaluation program. New end caps for the pressure case should be fabricated and the pressure case should be pressure tested. The accelerometer package should be tested on a dynamic test device with a known input motion to verify that the device provides the correct output.

F. Ship Motion Data System (SMDS)

Tool Status - The vertically stabilized gyro sensor package was recently returned from the manufacturer after refurbishment. The package will be mounted in an appropriate enclosure in the vicinity of the moonpool on the SEDCO/BP 471. Cable requirements running to the Instrument Penthouse have been specified to SEDCO. The data recording equipment is all currently operational.

Type of Data Obtained - Continuous data on roll, pitch, and heave of the ship can be recorded during engineering tests to correlate with IDSS and/or DBMI test runs.

Future Plans - See DBMI and IDSS plans. The SMDS is one part of the overall data gathering system.

Recommendations - The SMDS system is low cost, low maintenance, and its usage does not impact other operations. There is no reason not to maintain it aboard the ship for full time readiness.

G. Core Barrel Instrumentation, Pressure (CBIP)

Tool Status - Four electronic packages are on hand which sample and record data. They were also used on the aborted Gyro Orientation Tool. The current condition of all four is questionable and some redesign and refurbishment would be required before going to sea with this tool. One or two months of ET time could be invested in these tools to improve their ease of operation, maintenance and reliability. The tool was used successfully on Leg 94 and unsuccessfully on Leg 96.

Type of Data Obtained - The CBIP was specifically developed to measure drilling fluid pressures in and around the coring tools during coring operations. The back pressure on the vented sea water in the core liner, the bit back pressure , the pressure above the check ball in the vent subs, and the pressure diverted to the XCB cutting shoe jets are all significant parameters in the technology of core recovery. These pressures need to be measured insitu during actual operations.

Future Plans - The data taken during Leg 94 was the initial step in what should be a thorough data gathering program involving the Rotary Core Barrel (RCB), XCB and PCB. The potential benefit is redesign of the venting and/or cutter jet systems aimed at enhancement of core recovery.

Recommendations - Bring the CBIP equipment up to full operational status. Include CBIP pressure measurement programs in leg plans at some future date to continue design and development of superior coring tools.

H. Instrumented Drill String Sub (IDSS)

Tool Status - The IDSS system is in storage at ODP. The system is comprised of two strain-gaged joints of pipe; a "down hole," self-contained, solid state data recorder; an interface unit for transmitting data from RAM to tape, terminal, or display; and a Kennedy incremented recorder. Several strain gage channels on the drill pipe joint are inoperative; otherwise the system is in working order.

Frequency of Use - The IDSS should be deployed on the order of 4 times every other leg. The deployments require about 1/2 hour of rig time each.

Type of Data Obtained - The IDSS records drill pipe stresses, including bending, tension, and torque. The data will be used to verify analytical computer model predictions of fatigue and stress, and will provide operations with guidelines on safe drill string operating limits.

Future Plans - Modify tool and instrumentation to provide shipboard data as well as tape data for onshore processing. Evaluate design for very long drill strings (25,000-30,000 ft.). Continue measurement program started at DSDP. Program to continue for about 20-30 deployments over a period of 1 to 1 1/2 years.

Other Considerations - time should be formally scheduled for making measurement runs during legs when ET staffing can support deployments. In the absence of formally committed engineering measurements time, past experience indicates many, if not most, of the planned measurements runs were relegated to low priority and consequently did not occur.

Recommendations -

1. Configure instrumentation to provide shipboard stress data as well as tape data for onshore analysis.
2. Continue the stress measurements program.
3. Review instrumentation design and hardware arrangements for improved handling. Improve recorder for lower power consumption and interface with standard microprocessors.

I. Lynes Packer-Fluid Sampler (RFT)

Tool Status - The Lynes retrievable formation tester (RFT) is currently stored at ODP. Dr. Keir Becker at Scripps is presently applying to NSF for grant money to operate the ODP RFT from the SEDCO/BP 471. The tool will require extensive refurbishment as noted below.

Type of Data Obtained - Well bore fluid samples, formation pore pressure, fracture gradient of the formation, general geochemistry and hydrogeology data.

Future Plans - Dr. Keir Becker at Scripps is reported to have been awarded NSF Funding to operate the ODP RFT from the SEDCO/BP 471. Dr. Roger Anderson stated on August 29, 1984 that an attempt to utilize the tool on Leg 101 may be made.

Other Considerations - The RFT will require extensive refurbishment. Pat Thompson and Mike Storms are the only personnel who remember the RFT. The work will require two man weeks to organize, direct, and test at Lynes.

Recommendations - In order to have the unit available for Leg 102, work should be started as soon as possible.

J. Estimated Cost for Tool Operational Readiness

1. CORE ORIENTATION MULTI-SHOT COMPASS/CAMERA

6-month rental	$ 5,000
Non-Mag drill collar	$16,000
Non-Mag sinker bar/accessories	$ 5,000
	$26,000

2. HOLE DEVIATION MEASUREMENT

Included in I above

3.	DRILL STRING SEVERING TOOLS	$30,000
4.	PRESSURE CORE BARREL	$20,000
5.	DRILL BIT MOTION INDICATOR	$12,000
6.	SHIP MOTION DATA SYSTEM	$ -0-
7.	CORE BARREL INSTRUMENTATION, PRESSURE	$10,000
8.	INSTRUMENTED DRILL STRING SUB	$44,000
9.	LYNES PACKER/FLUID SAMPLER	$65,000

II. DOWNHOLE TOOL REPORT: LOGISTICS AND TECHNICAL SUPPORT DEPARTMENT

A. Insitu Pore Water Sampler

Current Inventory -
- 2 ea. Complete tool (includes electronic timer; does not include pressure barrel or sediment probe)
- 6 ea. Sediment probe (various lengths)
- 4 ea. Pressure barrel
- 2 ea. Spare electronic timer
- 1 ea. stainless steel tool shell
- 1 set Miscellaneous valves, fittings, switches, regulators, motors, etc.

Current Status - Both tools require refitting. Estimated time for refit is 4 weeks labor for one person. estimated cost to make tools functional is less than $400.00 if spare parts in stock are used. Refit would include cleaning corrosion off tools, adjusting timers, setting regulators, flushing plumbing, adjusting valves, and pressure testing. Manpower is available to perform necessary refit.

Proposed Upgrades - Build complete new tool using spare SS shell and parts from current stock. Not all parts are on hand to assemble a new tool. Estimated time is 4-6 weeks. Estimated cost is $3500.00. Manpower may not be available for this task until March.

Refit all or some of the tools for hot hole work. Currently, tools can be used in holes up to approx. 70°C. This would require changing all o-rings, wiring harness, motor, timer, and all other electronic parts. Estimated time and cost dependent on availability of parts.

Lengthen tool to increase water collection capacity. This can be done by increasing the size of the SS tool shell and redesigning the temperature measurement package that is run in tandem with the pore water sampler. Temperature package modification only requires fitting Von Herzen piston core temperature recorder and probe in a sub-assembly of the filter block. Temperature package conversion could be completed by January 1. Estimated cost of lengthening tool is unknown. Most practical approach is to build a new tool. Estimated cost of a new tool is $8500.00

Upgrade spare parts stock. Estimated cost is $1000.00.

B. . <u>Temperature Measurement Tool</u>

Current Inventory - UYEDA/IPOD STYLE	4 ea.	Thermistors
	6 ea.	Sediment probes (same as for pore water sampler)
	2 ea.	Electronic recording devices

Current Status - Thermistors and recording packages functional. Thermistors need recalibration, but could be used "as is" if calibration tables are found.

(Von Herzen HPC Style) All recorders and related equipment shipped to Woods Hole from the Glomar Challenger.

Proposed Upgrades - No longer use Uyeda/IPOD style equipment. Modify sediment probes as discussed above with the pore water sampler, to accommodate Von Herzen instrument. Estimated cost is less than $500.00 per tool and conversion could be completed by January 1.

Design electronics for use in hot holes. Current tools designed for temperatures up to 70°C. Requires new electronics and o-rings. Estimated time and cost of conversion unknown at this time.

C. Pressure Measurement Instrument (PMI)

Current Inventory - 2 ea. Pressure transducers
4 ea. Electronic recording instruments

Current Status - Transducers can be plumbed into the pore water sampler and recording instrument can be used in place of temperature recorder. This reduces the capacity of the pore water sample. The pressure recording instrument was interfaced with a Tektronics computer which is no longer functional. Therefore, a new interface must be built. Estimated time to build an interface is 4 weeks.* Estimated cost is $200.00. The recording instrument has not been field tested and may require additional testing.

* ODP electronic techs cannot build interface until next year.

Proposed Upgrades - Lengthen isitu pore water tool so pressure transducers can be permanently installed, without reducing capacity of pore water sample.

Design pressure case for the recording instrument with standardized connectors to all sub-assembly parts.

D. Gyro Orientation Tool

Current Inventory - 1 ea. Pressure case
1 ea. Vertical orientation gyro

Current Status - Direction gyro needs to be replaced at a cost of approx. $5000.00. Modifications to pressure case are needed to plug set screw holes. Recording instrument is same as PMI. Interface must be built. Instrument received from DSDP was a prototype. Deck handling procedures and maintenance are still unknown.

Proposed Upgrades - Before making an attempt to ready this tool, a multi-shot survey tool should be tested and evaluated. The maintenance on the multi-shot will be less and the deck handling will be faster and easier.

Recommendations - To have a downhole tool program by January 1, the following recommendations are proposed:

1. Refit insitu pore water samplers and purchase adequate spare parts.
2. Machine filter block for the sediment probe tips that accommodates the Von Herzen style temperature measurement instrument.

3. Maintain Uyeda/IPOD thermistors for future use in "hot holes." Recalibrate thermistors.

4. Test PMI transducers and recording package. If possible, standardize connectors to all sub-assemblies.

Notes - Cost estimates for electronic modifications and refits are parts only. In-house labor would be provided on a time and priority basis. Machining cost estimates include parts and labor.

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19. Next full meeting to coincide with Leg 102/103 port call (now scheduled for early April).

20. DMP recommends modification of USGS magnetic susceptibility tool for ODP use on Leg 102.

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