JOIDES Downhole Measurements Panel

29 February - 2 March, 1996 meeting, Tsukuba, Japan

draft minutes

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

In addition to normal agenda items, the Spring 1996 DMP meeting addressed two special topics:

(1) downhole measurements opportunities in OD21 were discussed in a joint DMP/OD21 afternoon meeting, in response to specific requests from OD21 and PCOM and a general request (96-1-15) from EXCOM. The resulting recommendations are included in Appendix 2 of these minutes.

(2) the scope of ODP Phase 3 downhole measurements was discussed in detail, in response to EXCOM requests for priorities for downhole-measurement innovations and reductions (96-1-14) and for suggestions on the scope of the upcoming WLS RFP (96-1-13). DMP was fortunately positioned to consider these issues efficiently, because last year's DMP theme was review of Wireline Logging Services; most of the groundwork information gathering had already been completed. DMP Recommendation 96-1-2 and subsequent consensus items and recommendations resulted from this discussion, and the rationale for these conclusions is summarized in these minutes.

DMP consensus: The Davis-Villinger tool performed well on Leg 164, and DMP has no reservations concerning its scheduling for Leg 169.

DMP consensus: The Fisseler water sampler should be further tested, in mechanically different sediments, to permit evaluation of whether or not additional development efforts are warranted. Comparison of this tool's performance to adjacent WSTP sampling is recommended.

DMP consensus: DMP will compile summaries of all active downhole tool developments, including their status and plans, then consult with other panels on priorities and scientific usefulness of these tools.

DMP consensus: DMP endorses the concept of duplicate snapshot databases at LDEO and TAMU, as a first step toward the longer-term goal of a fully distributed database.

DMP consensus: DMP commends the LDEO Borehole Research Group for their on-line database initiative, which will provide an impressive advance in both access to log data and ease of combining core and log data.

DMP consensus: The proposal for a Schlumberger-based ship-to-shore satellite link offers the potential for a substantial increase in the shipboard usefulness of logs, and DMP looks forward to seeing the results of the current trial.

DMP consensus: DMP endorses the Wohlenberg proposal for a 1-year trial of providing lithology logs for *Initial Reports* volumes. The trial would only be undertaken for legs in which approval as shore-based science is obtained, and DMP encourages cochiefs to grant this approval.

DMP Recommendation 96-1-1 to PCOM: DMP recommends that the 1998 drydock include the following two improvements: (1) renovation and expansion of the Downhole Measurements Lab, aimed partially at fostering interactions between loggers and other shipboard scientists, and (2) improvements in the pressure recording systems for packer measurements.

DMP Recommendation 96-1-2 to PCOM: DMP recommends that the following be considered essential services that must be provided by WLS, and that the Scope of Work statement include these responsibilities:

- Manage WLS and its subcontracts
- Standard geophysical logs (the previous description of "electrical, nuclear, and acoustic" logs is adequate), including data acquisition and quality control
- Logging support equipment (incl. winch, cable, heave compensator, and side-entry sub)
- Specialty logging tools (e.g., temperature, sediment magnetometer, dual laterolog, and VSP, but the SOW probably does not need to mention specific tools)
- Shipboard and shorebased log analysis facilities
- Log processing, analysis, and interpretation
- Education
- ODP logging database (incl. filling data requests, CD-ROMs in *Initial Reports*, and Internet access to log data)
- Support services for third-party logging
- Imaging logging (e.g., routine FMS)
- Logging While Drilling (specialty)

DMP recommends that the following be considered essential services that must be provided by ODP-TAMU:

- Fluid sampling, discrete temperature measurements (e.g., ADARA or WSTP), and core orienting
- Packer (specialty)
- CORKs (specialty)

DMP recommends that the following be considered high-priority services, capable of achieving critical ODP scientific needs, to be provided by WLS to the extent that funding constraints permit. DMP does not make a recommendation concerning whether or not they should be included as Optional Tasks in the SOW statement of a WLS RFP.

- Geochemical logging (specialty)
- High-temperature logging (specialty)
- Core/log integration
- Engineering development center

DMP Consensus: DMP recommends that the next WLS Scope of Work statement, like the current one, refrain from descriptions that compel selection of Schlumberger

as provider of logging tools. Encouragement of alternative providers will benefit the program, by increasing competition and cost pressure on whoever is chosen to provide routine logging. The LWD provider need not be the same as the provider of downhole logging.

DMP Recommendation 96-1-3 to PCOM: DMP recommends that the geochemical tool string be redefined as an ODP specialty tool rather than a standard tool. DMP recognizes that this change in status implies reduced use and reduced cost of future geochemical logging and processing. [motion passed with 9 in favor, 2 opposed, and 1 abstention]

DMP consensus: DMP is concerned that the long-spaced sonic tool does not satisfy ODP needs for routine velocity logging. DMP asks BRG to investigate the financial implications of providing an improved velocity tool.

DMP consensus: Logging While Drilling should now be considered an essential downhole measurement in some environments.

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Chair:	Richard Jarrard	US
Panel Members:	Bobb Carson	US
	Arthur Cheng	US
	Andrew Green	UK
	David Herrick	US
	Peter Lysne	US
	Daniel Moos	US
	Philip Nelson	US
	Karen Romine	Australia-Canada
	Richard Wendlandt	US
	Jurgen Wohlenberg	Germany
	John Woodside	ESF
	Makoto Yamano	Japan
Liaisons/Guests:	Cristina Broglia	LDEO-BRG
	Paul Dauphin	NSF
	David Goldberg	LDEO-BRG
	Adam Klaus	ODP-TAMU
	Gregory Moore	PCOM liaison
Apologies:	Dan Arnold	US
	Gilles Dubuisson	France

1. WELCOME AND INTRODUCTION

The first meeting of the JOIDES Downhole Measurements Panel (DMP) for 1996 was called to order at 0900, Thursday, 29 February at the Geological Survey of Japan, Tsukuba, Japan.

Chair Richard Jarrard noted recent changes in panel membership. Henry Salisch (Aus/Can), Karen Van Damm (U.S.), and Steven Hickman (U.S.) had rotated off the panel. Their replacements bring new expertise to the panel: Karen Romine (Australian Geological Survey) works with seismic stratigraphy and its links to logs, Dan Moos (Stanford) uses downhole measurements for studies of stress and ocean crust, and Bobb Carson (Lehigh) does long-term monitoring of ODP holes, especially accretionary prisms. Liaisons were introduced, then all participants briefly introduced themselves. Gilles Dubuisson and Dan Arnold were unable to attend this meeting.

DMP thanked its hosts for the opportunity to meet at the Geological Survey of Japan. Dr. Kuramoto of the Geological Survey of Japan welcomed DMP, then DMP host Makoto Yamano commented on meeting logistics.

Jarrard reviewed agenda plans. He noted that DMP was continuing the tradition of an annual theme, and in particular a Spring meeting theme, and that the theme of this meeting is long-range planning of downhole measurements. This emphasis is manifest in agenda item 4, the joint DMP/OD21 meeting on downhole measurements opportunities in OD21 (at PCOM, OD21, and EXCOM request), and in item 7, the scope of future ODP downhole measurements (at EXCOM request via the PCOM Chair). Shorter-term topics would be reduced in time, to permit comprehensive considerations of these two subjects. A call for proposed agenda changes elicited no changes.

Jarrard then asked members and liaisons to look at the agenda from the standpoint of conflict of interest. He reviewed ODP policy on conflict of interest, noting the two areas of particular concern in this meeting:

(1) proponents of drilling proposals would need to leave the room during discussions (if any) of those proposals. Jarrard noted that he and Goldberg were proponents of Costa Rica/Barbados logging while drilling (LWD), and he asked if any other attendees were proponents. Moos responded that he is a proponent of returning to 504B.

(2) Wireline Logging Services (WLS) and ODP-TAMU liaisons would need to leave the room during discussions of item 7, scope of future ODP downhole measurements, because one purpose of that discussion is to suggest the statement of work for an upcoming RFP for WLS.

A call for changes to the draft minutes of the September 1995 DMP meeting elicited one suggested change. Jarrard asked that the first sentence of paragraph 5 on page 22 be changed from "Jarrard noted that a primary purpose of Costa Rica is to better define the material balance and the behavior of fluids in the decollement" to "Jarrard noted that a primary purpose of accretionary prism legs is to better define the material balance and the behavior of fluids." He had avoided talking specifically about Costa Rica because he is a proponent, and he had emphasized the interest in fluids throughout the prism, not just in the decollement. No other changes to the minutes were suggested, and the slightly amended minutes were accepted as a fair representation of proceedings at the College Station meeting.

2. LIAISON REPORTS

A) NSF

Paul Dauphin summarized the January 1996 recommendations of the Mid Term Review: (1) continuation of the program beyond the current phase, (2) an additional vessel, possibly a Japanese riser-equipped drill ship, beginning in 2003, (3) collaboration with other programs, (4) longer-term drilling for some objectives, (5) immediate initiation of planning for post-2002 drilling, (6) strengthened scientific leadership, and (7) better communication and broader public support. In response to questions about the commitment to OD21, Dauphin said that the program strongly endorses riser drilling, endorses OD21 in principle, and recognizes the long lead time in bringing riser drilling on-line, but the program has not formally committed to a specific drill ship.

Dauphin then summarized current ODP-related NSF grants. Several of these concentrated on downhole measurements: Leg 169 seismic monitoring, Barbados CORKs, OSN-1 pilot experiment, Legs 168 & 169 CORKs, and development of a high-resolution gamma-ray tool. Lysne noted that NSF funds downhole measurement projects long before DMP is asked to decide whether to recommend their ODP deployment. He asked whether greater coordination between DMP and NSF is possible to avoid efforts and expenditures on projects that are unlikely to obtain DMP approval. The panel agreed that proponents are welcome but not required to obtain DMP endorsement prior to submitting a proposal, and no improvement of the present system could be identified. In response to a question on ODP budget projections, Dauphin responded that the budget is effectively flat until FY98.

B) PCOM & EXCOM

PCOM liaison Greg Moore summarized resolutions and consensus items by both PCOM and EXCOM that were of potential interest to the panel. EXCOM had strongly endorsed the Long Range Plan (LRP) and emphasized that future drilling and other ODP judgements must be in the context of the LRP. The panel expressed a desire to receive personal copies of the LRP; only the previous and current DMP Chairs had seen even drafts of this document. Moore reported that the combination of initiatives in a flat-funding environment meant that EXCOM

expected retention of any existing components (e.g., downhole measurements) to be justified, not assumed, by panels.

PCOM recommendations and decisions included the following: a call for multileg and/or multiplatform drilling proposals, approval of a VSP for Leg 166 (pending identification of a proponent and funding), approval of LWD on Costa Rica if funding can be found, and priorities for the program at Hole 735B. Moore also summarized the selections for FY97 legs.

3. ODP-TAMU REPORT

Adam Klaus distributed the Semiannual Report of the Science Operator, calling the panel's attention to the ship schedule within it. Klaus then summarized ODP-TAMU downhole measurement plans for upcoming legs. He informed the panel that leg preliminary reports and prospectuses are available on the World Wide Web.

Klaus discussed the results and implications of deployments of new and modified tools on Leg 164 (Gas Hydrates). The pressure core sampler (PCS), which had undergone recent modifications (particularly of cutting shoes), was run 46 times, and its round-the-clock use required two on-board engineers. The success rate, though far below 100%, was greatly improved over previous legs. The PCS is used mainly for gas samples; its design does not maintain pressure during removal of core. The PCS is now an on-line tool, available for future legs (assuming that an appropriate engineer is aboard); no new modifications are scheduled.

The Davis-Villinger temperature tool was also used on Leg 164. This tool is a modification of the Water Sampler Temperature Pressure (WSTP) design, currently focusing only on temperature. It was brought aboard by small boat, then run 4-5 times. It appears to work well, is easy to handle, and needs only minor software revision. It has an accelerometer for identification of tool movement, and future enhancements may include addition of pressure measurement and merging with the Fisseler water sampler. The tool has not been turned over to ODP-TAMU yet. Lysne asked for, and received, assurance that ODP-TAMU will assume responsibility for its support. Yamano, DMP watchdog for the tool, reported that he had reviewed the comprehensive supporting documentation provided by the tool's proponents, and that he was satisfied with both this information and tool performance.

> *DMP consensus:* The Davis-Villinger tool performed well on Leg 164, and DMP has no reservations concerning its scheduling for Leg 169.

The Fisseler water sampler, a new modification of the WSTP aimed at improved water sampling through more controlled fluid draw-in, was run 5 times on Leg 164. Its mechanical functioning was satisfactory, but it obtained no useful samples; formation properties were clearly incompatible. The tool is not planned for any future legs, and ODP-TAMU has no budget for tool improvements. Shipboard Measurements Panel is acting as watchdog for this tool. In-situ fluid sampling is also within the DMP mandate, so the panel appointed Bobb Carson as DMP watchdog of the Fisseler water sampler. In view of the well established major deficiencies of WSTP water sampling, DMP concluded that investigation of the potential of the Fisseler water sampler should not be shelved.

> *DMP consensus:* The Fisseler water sampler should be further tested, in mechanically different sediments, to permit evaluation of whether or not additional development efforts are warranted. Comparison of this tool's performance to adjacent WSTP sampling is recommended.

Based on the discussions of these three Leg 164 tools, Lysne and Carson raised two related questions that the panel explored:

(1) is DMP receiving adequate feedback from shipboard scientists on how well the development tools fulfill their needs? Furthermore, because there are no so many LDEO, TAMU, and third-party development tools, is DMP sufficiently aware of their technical and scientific status to prioritize them? Carson suggested the following DMP action.

> *DMP consensus:* DMP will compile summaries of all active downhole tool developments, including their status and plans, then consult with other panels on priorities and scientific usefulness of these tools.

Watchdogs were asked to write draft tool summaries within the next two months, so that panel distribution and revisions could be completed in time to make this document an agenda item at the next meeting.

(2) are the needs of immediately upcoming legs causing longer-term developments to be shelved, so that both ODP-TAMU engineering and the panels are always in a panic fire-fighting mode? Have engineering personnel been reduced too much, precluding even the small effort required to maintain an orderly progress for some technology developments?

Klaus continued the ODP-TAMU report by providing a JANUS update. Several portions of the database are being tested already on the ship. Some portions needed greater effort than had been anticipated, so some lower-priority aspects may be dropped. On Legs 168 and 169, the previous database will be retired.

The flat '94-'97 total budget, with some portions necessarily exhibiting an inflation increase, will require ODP-TAMU cutbacks. Where the cuts will occur is a question to be answered next week by BCOM. Possibilities with downhole measurements implications include reduction in support personnel such as shipboard engineers and deferring of construction of a DCS land-test facility. Another possible cutback is a reduction in ODP-TAMU liaison travel to panel meetings. Jarrard responded that DMP would be very disappointed by such a liaison cutback, because DMP's effectiveness is dependent on close interaction with both ODP-TAMU and BRG liaisons.

Klaus reported that planning for a '98-99 drydock was beginning. Sedco has agreed to avoid increasing the day rate until 2002 (presumably except for cost-of-living increases), if up to five million dollars in improvements are undertaken at the drydock. Klaus brought a memo from Jeff Fox to JOIDES panel chairs, soliciting panel input on high-priority improvements. Jarrard suggested that the panel think about this topic and return formally to it later, as a new agenda item following the WLS report.

4. JOINT DMP/OD21 MEETING ON DOWNHOLE MEASUREMENTS OPPORTUNITIES IN OD21

The entire afternoon (~1330-1800) of February 29 was devoted to a joint DMP/OD21 meeting. Present were all of the DMP meeting attendees (both members and liaisons), as well as 20 other scientists and engineers. This was an open meeting, announced both within Japan and to attendees at the Eighth International Conference on Continental Scientific Drilling (also held in Tsukuba, on the three days immediately preceding this meeting). These proceedings and their conclusions are reported in Appendix 2.

5. WIRELINE LOGGING SERVICES REPORT

A) Logging Database

Cristina Broglia described the status and plans for the WLS database and data distribution; both are WLS services which she now manages.

WLS is currently implementing its third major innovation in data distribution. Prior to 1990, data were distributed primarily as Log Industry Standard (LIS) tapes, but many potential users were discouraged by difficulty in reading these binary files, particularly with changing Schlumberger formats. In 1990 (Leg 130), WLS started routine data distribution as ASCII files. Though less compact, these files could be read by anyone and imported to their preferred graphics program; they could also be distributed on floppy or by Internet instead of on tapes. Beginning in 1993, logging and some other data were also provided digitally in *Initial Reports* volumes, on CD-ROM.

The third innovation, occurring now, is development of an on-line database. Unlike the previous Internet data-request and data-distribution option, the on-line database will permit users to browse data availability and grab data on their own. WLS will use an ORACLE database, linked to the World Wide Web (WWW), and users can access data from either. The plans presented by Broglia were a major improvement over those heard by DMP from the ODP-TAMU and WLS representatives at the previous DMP meeting. At that time, DMP was informed that logging data would be completely excluded from the JANUS postcruise database; logging data would remain at the LDEO Borehole Research Group (BRG), and flags within the JANUS database would inform users of the existence of these separately obtainable data. In response, DMP's recommendation 95-1 was that BRG and ODP-TAMU should work together to integrate all ODP data, including logging data, in a common database. This recommendation is now being implemented by BRG and ODP-TAMU, with a thoroughness and pace that surpass DMP hopes.

Broglia reported that a recent meeting of database representatives from ODP-TAMU and BRG had resulted in the abandonment of independent database options. Their preferred replacement was the following:

(1) duplicate logging databases at TAMU and BRG, with BRG providing periodic updates to ODP-TAMU for inclusion in the overall database.

BRG subsequently developed an alternative plan, which they intend to propose at a follow-up meeting next week:

(2) keeping "snapshots" of the entire database at both TAMU and BRG.

DMP discussed advantages and disadvantages of both approaches, concluding that both were good but the second appeared to be preferable.

> *DMP consensus:* DMP endorses the concept of duplicate snapshot databases at LDEO and TAMU, as a first step toward the longer-term goal of a fully distributed database.

Broglia reported that the transformation to a complete on-line database will occur in three phases:

(1) phase 1 includes development of an on-line data catalog, where one can search for data in various ways (e.g., initially by leg or by site, later by map), then select a data request form, later receiving the data electronically. Acronyms are avoided. The logging brochure is already on-line, furnishing details of individual tools and their applications.

(2) phase 2 is development and testing of a database structure suitable for WWW access. WLS intends to start testing a WWW interface in April, using Leg 155 data, and to start an analogous shipboard system for on-board data on Leg 168.

(3) phase 3 is "data migration", the transfer of the 224 previously logged ODP holes into the database. This transfer will begin with legs (Leg 130 to present) for which BRG has already prepared ASCII files of processed logs. The transfer will not be completed until 3/31/98, because most earlier logs have not been processed to the post-130 standard, so some reprocessing as well as reformatting is required. Data migration will be confined to the standard geophysical logs, which are the most requested logs. Sonic waveforms, borehole televiewer, and Formation MicroScanner (FMS) data are lower priority, because of fewer requests, very large datafile sizes, and lack of a universally useful format.

Other details of the plan remain to be worked out. For example, Moos emphasized that the query pathways must be seamless, for easy grabbing and comparison of core and log data. Several panel members emphasized that a multiplicity of possible query paths would greatly increase the scientific power of the logging/coring database. Cheng asked if any mechanism was being implemented for browsing data before requesting them; Broglia responded that there were no such plans, and log figures are available only in *Initial Reports* (or soon in the CD-ROMs rather than within the volumes). BRG keeps a catalog of data requests, and Moos asked if this catalog could be put on-line, so that individuals could identify other users of the same datasets, thereby fostering collaboration and avoiding duplication of efforts. Goldberg and Dauphin responded that they would need to check policies concerning privacy, and Broglia mentioned that their WWW home page has a bibliography of all logging papers published within ODP volumes. Wohlenberg agreed to act as DMP watchdog of the ongoing database project, including JANUS and the WLS efforts.

Cheng asked if other loggers' derived logs (e.g., waveform-based sonic logs) would be included in the database. Wohlenberg suggested that derived-lithology logs could also be included, and other panel members commented on the full range of third-party logs that would be much more easily obtained from a common database than from those who acquired the data. The panel, however, felt that BRG could not be responsible for the quality of these data and that the data should not be included in the database. Instead, flags should indicate existence of these additional data.

Broglia concluded by mentioning several other database developments. All original data tapes (both ODP and DSDP) are being copied to DAT tapes, to prevent loss of data due to tape degradation. VSP data are being converted to SEG-Y format for easier use. Temperature data are being processed. DSDP data are already on CD-ROM, along with data access software, and reformatting them for the on-line database is prohibitively time-consuming.

DMP consensus: DMP commends the LDEO Borehole Research Group for their on-line database initiative, which will provide an impressive advance in both access to log data and ease of combining core and log data.

B) Results and Implications of Recent Logging Operations

David Goldberg began his report on recent logging operations by providing long-term statistics on which logging tools are run at logged sites. The percentages of logged sites with individual tool types run is as follows: 100% for the quad combo or its predecessors, 69% for FMS (starting with Leg 126), 70% for temperature, 48% for the geochemical string, 28% for the sediment magnetometer (GHMT, since Leg 154), and 5.5% for a Schlumberger VSP tool (since Leg 111).

Some recent logging operations were quickly summarized:

Leg 162: 4 holes logged; wireline heave compensator upgraded; latest version of core/log integration software used (for core-core integration only).

Leg 163: no logging.

Leg 164: 3 holes logged with quad combo, FMS, and geochemical tools; VSPs including offset seismic experiments; first deployment of the BRG shear sonic tool; wireline heave compensator tested.

Leg 165: 4 holes logged with quad combo, FMS, geochemical, and sediment magnetometer; magnetometer software tested.

Goldberg showed examples of log-based scientific results from Legs 162 and 164. On Leg 162, both gamma-ray and magnetic-susceptibility comparisons of downhole and continuous-core records exhibited excellent character match, providing an impressive example of the potential of core/log integration. On Leg 164, logs detected a 200-m-thick zone rich in gas hydrates, and postcruise log analyses are expected to provide approximate concentration profiles of gas hydrates. The logs partially detected, and the VSP clearly delineated, free gas beneath the bottom-simulating reflector.

The BRG shear-source tool was run for the first time on Leg 164, and data were obtained at all three logged holes, with only a modest investment of ship time. The data have not been processed yet. The panel asked both Goldberg and DMP watchdog Cheng to report back on results at the next DMP meeting. The tool has not been requested or scheduled for upcoming legs.

The Woods Hole VSP tool was run to give vertical seismic profiles at three holes, with oblique seismic experiments at two of the holes. These experiments consumed 45, 49, and 27 hours at the three holes. Such experiments are inherently more time-consuming than standard logging, but these were further slowed by several factors. Problems included a parted wire, cable damage because arms did not fully close, a cable kink, and clamping problems due to oversize hole. The necessity of changing between the Schlumberger and Gearhart-Owen cablehead at each site also consumed some time.

Goldberg noted that the cablehead conversion problem is common to all third-party tools, and he reported that BRG intends to end this time-consuming task by providing a general-purpose crossover from the Schlumberger cablehead. Other tool developers can then modify their cableheads to fit this crossover. Ralph Stephen, owner of the WHOI VSP tool, had provided written comments that excessive cable torquing was the reason for the first two VSP failures, and that ODP logging in general might benefit from using a Schlumberger swivel head. Jarrard commented that torquing is worst when the side-entry sub is used, as in the three VSP deployments, and that he thought ODP had used the swivel for several legs but abandoned it because it often shorted out. Goldberg agreed to research the swivel option and report back at the next DMP.

In response to a question about availability of Schlumberger VSP tools for this leg, Goldberg replied that only a 1-component tool was on board, and Jarrard noted that the proponents could have used it as a backup, by paying for its lease costs out of their existing NSF grant. Goldberg added that the current leg (Leg 166) does have a Schlumberger 1-component VSP scheduled, with funding from USSAC. He said that Schlumberger VSPs are potentially fundable from the WLS contract, if BCOM approves and if they are scheduled early enough for inclusion in the next year's specialty-tool portion of the Schlumberger subcontract.

Green asked if there is any issue with using non-Schlumberger commercial tools, and Goldberg responded that the only obstacles are the same compatibility ones (e.g., cablehead, data transfer, and availability of a shipboard logger) that are routinely dealt with successfully by third-party loggers. Moos asked if commercial tools from other vendors are considered third-

party, requiring full DMP third-party approval process. Jarrard said yes, in theory, but he expressed the hope that DMP could streamline the process for these well-tested tools.

DMP watchdog Green said that the WHOI team had been very cooperative in providing information and had agreed to add a precruise field test. He suggested that DMP should withhold conclusions concerning the Leg 164 VSP until he, the WHOI scientists, and the panel could look at the results in more detail. The panel agreed to table further discussion on the WHOI VSP tool until the next meeting. The panel briefly discussed the scientific value of a VSP in an upcoming return to Hole 735B, the need for a proponent, and the feasibility of inserting a Schlumberger VSP-tool use into next year's WLS budget, but DMP felt that conclusions on this issue could be deferred until their next meeting.

Moos pointed out that the BRG shear-source and VSP experiences raise a broader question: does a third party tool need to be an improvement on a tool already provided by Schlumberger? Jarrard responded that DMP cannot insist that a tool be the best in the world; other factors such as cost and proponents' familiarity with a tool's response also influence choice of tool. Moos added that an extensive VSP, after a suite of standard logs, taxes even a Schlumberger engineer's endurance; an intermission for another logger to run a tool may be prudent. The panel agreed that ODP needs to consider the cost of a tool to the program as a whole, not the cost to the proponent; ODP and DMP are acutely aware that ship time is expensive.

Goldberg also reported that a major upgrade of the wireline heave compensator had just been completed, and that its performance can now be tested periodically. A performance test on Leg 164 showed substantial residual heave due to a phase lag between accelerometer and heave cylinder, and fine tuning is underway to remove this phase lag. Future software tuning is likely, and plans also include a comparison of downhole to uphole accelerometer results. Goldberg was asked whether the BRG developers of wireline-heave-compensator improvements were communicating with developers of the DCS secondary heave compensator; he responded affirmatively.

C) Upcoming Operations

Goldberg said that the current leg (Leg 166) includes two tests that could initiate major improvements in shipboard operations: real-time Internet communications and an improved Schlumberger neutron-porosity tool.

A feasibility test is being conducted of using the MAXIS logging unit and a Schlumberger satellite for real-time Internet communications. If inexpensive transfer of logging data between the ship and the BRG processing center were available, BRG could process and return data to the ship in time for use during the leg. Top priorities for this processing are depth shifting, geochemical-log processing, sediment-magnetometer processing, borehole corrections, and Schlumberger VSP processing. Asked whether the geochemical logs would be sent to Leicester for processing, Goldberg replied that Leicester would not process logs for this test, and indeed long-term geochemical-log processing could be given to Schlumberger instead of to Leicester. Jarrard responded that this task was taken away from Schlumberger early in ODP because in-house processing was cheaper and superior. The panel was not persuaded that removing this responsibility from Leicester is warranted.

Access to the Schlumberger satellite system is fixed-cost regardless of amount of use, so it also could replace all current Marisat email traffic by ODP. Already it appears to be cost-effective, and the current email expenses are accelerating. Problems remain to be resolved, however; in particular, "firewalls" would be needed, to prevent unauthorized access to Schlumberger systems.

DMP consensus: The proposal for a Schlumberger-based ship-to-shore satellite link offers the potential for a substantial increase in the shipboard usefulness of logs, and DMP looks forward to seeing the results of the current trial.

Goldberg then yielded the floor to Jurgen Wohlenberg, who had a proposal akin to the current topic of near-real-time transfer of processed data to the ship. Wohlenberg proposed a 1-year feasibility study, to be financed from German ODP funds, of determining lithology from logs and providing the results to shipboard scientists shortly after logging. The technique to be used is electrofacies analysis, in which all available logs are compared to core-based ground truth, to provide transforms from log responses to "electrofacies units". The technique is well established in oil-industry sediments, and Wohlenberg had shown examples of applying the method to the German Continental Drilling Program (KTB) at the previous DMP meeting. Wohlenberg stated that success of the feasibility study might lead to a later proposal to provide a long-term service. He noted, however, that current ODP policy specified a one-year moratorium for release of ODP data to individuals outside the shipboard scientific party.

Asked about the turnaround time, Wohlenberg replied that it would probably take 1-4 weeks, so the results might not be of value on-board but could be included in the *Initial Reports*. Lysne suggested that feasibility could be demonstrated immediately by using older logs, while awaiting outcome of the evaluation of real-time ship-to-shore data transfer. Woodside recommended having a JOIDES logger do the electrofacies analysis, for improved communication of results to the shipboard scientific party. Wohlenberg replied that he might ultimately provide software for shipboard electrofacies analysis. Jarrard expressed reservations about giving a primary core/log-integration task of the JOIDES logger to a non-shipboard scientist. Carson reminded the panel that a mechanism for the feasibility study already exists: scientists can apply to the cochiefs for permission to do shorebased studies.

DMP consensus: DMP endorses the Wohlenberg proposal for a 1-year trial of providing lithology logs for *Initial Reports* volumes. The trial would only be undertaken for legs in which approval as shore-based science is obtained, and DMP encourages cochiefs to grant this approval.

Goldberg continued his report with the news that a new Schlumberger neutron tool, the Integrated Porosity Lithology Tool, will be run on Leg 166 for the first time in ODP. It uses a minitron source rather than the conventional radioactive-chemical source. Unlike the neutron-porosity tool normally used in ODP, which is seriously biased by hole standoff (the gap between tool and formation) and borehole effects, the new tool is much less sensitive to borehole effects. The tool string will also use a higher-temperature (up to 175°C) spectral-gamma-ray tool.

Goldberg reported that two of the standard tool strings, the quad combo and FMS, are being changed, by moving the sonic tool from the quad combo to the FMS. This change shortens the extremely long quad combo. More important, it consolidates tools that work best in a centralized configuration (sonic and FMS) into the same string, and tools that require or favor eccentralization (density and neutron) in a different string (now called the triple combo instead of the quad combo).

Goldberg informed the panel that he had received an NSF grant to construct a high-resolution gamma-ray tool that is attachable to standard Schlumberger strings. The tool is intended to provide a factor of four increase in vertical resolution, fulfilling an objective of the Long Range Plan: higher-resolution logging for improved core/log integration. A switch tool permits logging with the Schlumberger string or with the gamma-ray tool. Thus, the Schlumberger and gamma-ray logging occurs on separate uphole passes, the advantage of the switch capability being the savings of round-trip time between the rig floor and sea floor. Other

sensors by third parties could potentially be substituted for the gamma-ray tool, using the same switch. Panel members noted that it would be useful to have Schlumberger guidelines on what specifications Schlumberger would expect third-party tools to fulfill before allowing them on the Schlumberger toolstring. The timetable for tool development includes presentation to DMP of land-test results in Fall '97 and availability of an approved tool for ODP use in early '98.

Goldberg said that a special session on core/log/seismic integration at the December AGU meeting had been successful, and 13-15 resulting articles were in review for a special section of *Geophysical Research Letters*. Lysne stated that special sessions like these are not effective for wide advertising, and Goldberg responded that they are useful but not intended as a substitute for including log-based results in standard scientific sessions. Goldberg also announced that BRG is developing a Seismic/Log Integration Package, partly in response to the current lack of routine shipboard generation of synthetic seismograms. Cheng and Romine doubted the need for developing such a package, given the abundance of inexpensive commercial and even public-domain packages, and Goldberg assured the panel that very little BRG time would be devoted to this project. Goldberg also reported that Diamage, a Schlumberger Geoframe image analysis package, is being tried at Lamont. It displays and manipulates side-by-side core photos and FMS data. ODP currently lacks whole-core scanning capability and seldom has whole cores appropriate for such scanning, but Klaus announced that digital split-core scanning is a high-priority for future ODP-TAMU upgrades.

Goldberg then summarized downhole measurement plans for upcoming legs. Legs 167 and 168 will use mostly standard logging; the sediment magnetometer will also be run on Leg 167 because of the leg's paleoceanographic objectives. Leg 169 will examine hydrothermal circulation and therefore will have several high-T temperature tools aboard: the pressure/temperature memory tool, LDEO tool, and French tool. All three had already received tentative DMP approval, but not use, for TAG.

For FY97, Goldberg highlighted as the major innovations tentative use of Logging While Drilling (LWD) on Legs 170, 171B, and 174A, as well as a CORK at 174B. He summarized the results of considerable negotiation with Schlumberger concerning LWD: the standard "1st-generation" LWD suite (density, neutron, gamma ray, and resistivity) is now available for a full leg without paying a substantial premium for the period in which the equipment is aboard but not used. Consequently, LWD can become part of a normal leg rather than requiring an LWD minileg plus extra portcall like Leg 156. This increased availability results from the fact that Schlumberger's greatest LWD demand has now moved on to 2nd and 3rd-generation LWD tools. The 1st-generation measurement suite is comparable to those on the triple combo tool string for standard open-hole logging. Goldberg announced that he was proposing the following LWD plans in the submitted FY97 WLS budget:

Leg	# LWD holes	# LWD days	cost
(Costa Rica alone:	4	14	$335K)
(Barbados alone:	4	12	$250K)
both:	8	26	$500K ($85K saved)
New Jersey:	3	4	$170K
total proposed:			$670K

Goldberg announced that this Schlumberger contract increase, if approved, would permit a negotiated reduction in the FY97 costs for geochemical logging. Rather than paying a day rate for the geochemical string throughout FY97 as in the past, geochemical logging could be treated as a special tool: it would be kept on the ship, but WLS would only be charged for the two legs (Legs 173 and 176) on which he proposed to use it, at about $60K/leg. The panel asked if this meant a savings of $240K for the four legs on which the tool would not be used, and Goldberg responded that there would be a savings of unspecified magnitude. It was noted that the decreased geochemical data acquisition also implied a reduction in the Leicester

processing effort and budget. The proposed special-tool budget, including both geochemical logging and sediment magnetometer, is about $200K for FY97, up from $100K in FY96.

DMP regarded these FY97 WLS proposals regarding LWD and geochemical logging as information items, and the panel made no recommendations. DMP had previously recommended LWD at Costa Rica (DMP Recommendation 95-5).

Goldberg also proposed addition of perhaps a day to FY97 Leg 174B (Engineering/CORK), to test a circumferential resistivity-at-bit tool at MARK. This 2nd-generation LWD tool, which is somewhat analogous to a full-coverage FMS but with lower resolution (6"), could image large-scale porosity (e.g., pillow porosity) of young oceanic crust. He emphasized that poor penetration and core recovery are not the only disappointments of previous drilling in young oceanic crust; a total of only one site has been logged on the previous TAG, MARK, and Hess Deep legs. Cost of using this LWD tool is not yet known. Moore asked what WLS would give up to free sufficient funds to enable leasing this tool, and Goldberg responded that it would be funded -- if at all -- only by end-of-year surplus or by an external proponent. DMP was intrigued by the idea, but unwilling to let it detract from other downhole-measurement plans. DMP concluded that it had insufficient information, particularly on ship-time and costs, for an endorsement at this time. Carson suggested that an alternative approach would be to wait until the next young-crust science leg rather than inserting it into an engineering leg.

Goldberg provided an update of Schlumberger tools available but not currently used in ODP. He listed tools compatible with MAXIS and noted that most are too large to fit through the ODP bottomhole assemblies. He introduced the Platform Express, a tool string that runs faster, is higher resolution, and is much shorter than the Triple Combo (which is about to be used in ODP). The obstacles to ODP use of the Platform Express, however, are uncertain cost and too-large diameter for the density tool.

The WLS report concluded by returning to Jeff Fox's 2/26/96 written request for panel input on potential drydock improvements. Goldberg stated that a Downhole Measurement Lab renovation had been designed for the last drydock but was not undertaken because of insufficient funds. The former price quote was $400K, which would permit a tripling of the size of this lab. The panel responded that a cosmetic change would not be warranted, but the renovation could provide an opportunity to reduce the geographical separation and associated lack of communication between loggers and other shipboard scientists. Panel members also questioned the need for such a large space increase solely for logging. Carson suggested that a much lower-cost drydock change, with substantial scientific impact, would be upgrade of the pump-pressure recording systems, used in packer experiments.

DMP Recommendation 96-1-1 to PCOM: DMP recommends that the 1998 drydock include the following two improvements: (1) renovation and expansion of the Downhole Measurements Lab, aimed partially at fostering interactions between loggers and other shipboard scientists, and (2) improvements in the pressure recording systems for packer measurements.

6. CONTINENTAL DRILLING UPDATES

A) Results of the VIIIth International Symposium on the Observation of the Continental Crust Through Drilling

Lysne summarized results of the continental drilling symposium that had been held in Tsukuba immediately prior to this DMP meeting. He briefly described the variety of previous national drilling programs and strategies, ranging from the German approach of one deep 9-km hole plus pilot hole at KTB, to the U.S. approach of funding a large number of relatively inexpensive and shallow drilling programs. He announced that a memorandum of

understanding for a new International Continental Drilling Program (ICDP) had been signed by Germany, the United States, and China at the meeting. Program coordination will be centered at Potsdam. For this year, the ICDP budget is $1.6M, and meeting participants were optimistic about a rapid increase in the number of ICDP members. ICDP budgets are aimed at drilling costs; science costs are to be funded separately by member nations.

B) Japanese Ultradeep Drilling and Geoscientific Experiments (JUDGE)

Teruki Miyazaki joined the DMP meeting briefly to report on the JUDGE project. The goal of this ambitious project, which is now in the feasibility-study stage, is to drill a 10-km land-based hole south of Tokyo, penetrating the decollement of the underthrusting Philippine Sea plate. In contrast to ODP shallow drilling into accretionary prisms such as Nankai, this much deeper hole would sample the seismogenic portion of a subducting-plate boundary. The scientific and social incentive for this program is the hope that long-term monitoring within this seismogenic zone could improve earthquake prediction. Technological challenges faced by JUDGE include expected 400°C temperatures and the likelihood of unstable holes. Estimated costs of several hundred million dollars are also an obstacle. DMP expressed interest in hearing updates if the project moves beyond the feasibility-study stage.

C) Antarctic Continental Drilling

Jarrard summarized plans for the Cape Roberts Project (CRP), a scientific-drilling program jointly funded by New Zealand, Italy, United States (NSF Office of Polar Programs), Germany, and United Kingdom. CRP seeks to understand the Early Tertiary and Cretaceous relationships among climate, sea level, and glaciers (if any) in the Antarctic. No sediments of these ages outcrop on land in the Antarctic, so CRP will drill sediments just offshore, by setting the drilling platform on fast ice. CRP will use an offset-drilling strategy much like ODP employed in Prydz Bay: four 500-m holes will be drilled through dipping reflectors. Drilling will occur in late '96 and late '97. The diamond-coring holes will require slimhole logging tools, and logistics preclude use of a major logging company.

7. SCOPE OF FUTURE ODP DOWNHOLE MEASUREMENTS

Jarrard provided the background for including this item in the agenda. January 1996 EXCOM motion 96-1-13 "requests JOI and PCOM to provide by June 1996 recommendations on specific services, and their related costs, that are currently provided for Wireline Logging Services" in order to assist in framing the scope of the WLS RFP. EXCOM motion 96-1-14 asks that "JOI, in consultation with PCOM & BCOM, examines the important new innovations in the program (Borehole Utilization, legacy holes, *inter alia*) and detail their costs. PCOM & BCOM should advise JOI on what existing components (publications, logging, indeed all components) might be dropped or reduced to accommodate these new initiatives and clearly label the costs, benefits, and losses." Both motions focussed on ODP Phase 3, 1998 to 2003. Jarrard said that he had sought and received confirmation from the PCOM Chair that PCOM did want DMP to undertake this task at our Spring meeting. Chair Robert Kidd had added, "Please ensure that your WLS liaison is not part of this panel discussion because of conflict of interest issues." Jarrard announced that since our discussion would deal with all downhole measurements, not just WLS services, he would ask BRG liaison Goldberg, BRG guest Broglia, and ODP-TAMU liaison Klaus to leave the room following an initial presentation by Goldberg.

Jarrard noted that DMP was well positioned to respond to this EXCOM request, because last year's DMP theme was review of Wireline Logging Services. He summarized preparatory steps at previous meetings:

1. Fall '94: DMP asked BRG to provide information on the geochemical and FMS tool strings; DMP particularly sought illustrations of the tools' scientific impact and the budgetary consequences of deleting each tool.

2. Spring '95 (at Leicester): representatives from the Leicester and Marseille nodes presented examples of ODP scientific discoveries attributable to the geochemical and FMS tools. Goldberg (who was not present) responded to the budgetary request by providing a histogram separated only into categories of Schlumberger, LDEO base, total subcontracts, and special operating expenses, plus a written statement that "I would anticipate negligible effect on this portion of our budget by removal of the Geochemical Logging Tool (GLT), for example, from the *JOIDES Resolution.*" DMP deferred conclusions for two reasons: some panel members thought they still had inadequate information on scientific impact of the tools, and PCOM liaison Brian Lewis discouraged DMP from considering priorities or contractual issues. Instead, DMP chose to expand their forward and backward looks at these issues, as follows: DMP asked the JOIDES Office for next year's prospectus, DMP invited guests at the Fall '95 meeting to comment on logging impact on their legs, and DMP distributed a questionnaire on logging impact to cochiefs and JOIDES loggers.

3. Fall '95: JOIDES Logger Woodside and cochief Shipley reported on logging results and recommendations from their legs, but the prospectus was not sent to DMP, and replies to the questionnaire were disgracefully few.

Jarrard concluded that the information gathering phase of DMP's evaluation was almost over. True, some panel members probably still felt uncomfortable with their knowledge of the ODP scientific value of some tools, but the panel as a whole did possess that needed perspective. Jarrard proposed that we conclude the data gathering by having Goldberg provide a briefing on WLS components and costs, then Jarrard would summarize downhole measurements needed for Phase 3 of the Long Range Plan (LRP). Then the panel could list current downhole measurement services, both of WLS and ODP-TAMU, both innovations and standard, and classify them as essential, high-priority, or low-priority. The panel agreed to this approach.

Asked to provide the WLS briefing, Goldberg began by objecting to Jarrard's planned exclusion of the WLS liaison from the meeting during decision-making. He suggested as an alternative that he be allowed to attend the session but not speak except to respond to questions from the Chair. The panel weighed pros and cons of this exclusion at considerable length. They noted that it was not even firmly decided that an RFP would be issued; if issued, conceivably someone on the panel might later decide to bid, gaining a competitive advantage by having influenced the DMP recommendations. Jarrard responded that although he preferred excluding liaisons to avoid even the suspicion of possible conflict-of-interest, the decision should be made by the panel rather than by the Chair. A straw vote demonstrated that, by a strong majority, the panel chose the option of letting the liaisons remain and speak only in response to questions. The panel recognized that this decision probably was incompatible with Kidd's instruction to "ensure that your WLS liaison is not part of this panel discussion". *[Note: in the discussions that followed Goldberg's presentation, the panel did have abundant questions for Goldberg and one question for Klaus, and the informal panel consensus appeared to be that the liaisons provided very useful data without advocacy]*

Goldberg began his briefing with a pie chart of the $4.8M WLS FY96 budget (the FY97 budget was unavailable because it is still in negotiation): 49% Schlumberger, 13% subcontracts, 13% BRG personnel, 12% other BRG, and 11% BRG indirect costs. FY98 is the last year of this phase of ODP. He emphasized the steadily increasing gap between the original BRG 5-year proposal for WLS budgets and the nearly flat FY95-98 actual budgets. The original proposal had assumed a steady, modest 3% growth rate. Flat budgets accompanied by inflation of some components has meant, and will continue to mean, inability to incorporate technology improvements, as well as fewer specialty-tool deployments (in spite of the high scientific leverage of such deployments). The FY97 budget is still in negotiation, but possible cuts include reduced use of geochemical tools (as discussed previously) and reduced processing.

Goldberg reviewed the current Scope of Work statement for WLS, noting that the most variable component is third-party support.

Jarrard announced that EXCOM expected all Phase 3 planning to be undertaken in the context of the Long Range Plan (LRP). He regretted that the panel had not had an opportunity to see the LRP; it had only recently been approved by EXCOM and was, presumably, now in press. He asked DMP to proceed with this agenda item nevertheless, because only immediate DMP action could meet the EXCOM expectation of receiving responses via PCOM by June 1996. To provide the LRP context, he began with the three LRP initiatives: (1) paleoenvironment and paleoclimate, primarily a phase 3 initiative, (2) observatories for long-term monitoring, an initiative for both phases 3 and 4, and (3) deeper penetration of rifted margins, convergent margins, and oceanic crust, primarily a phase 4 initiative but with shallower-penetration attacks on these objectives during phase 3.

Jarrard then showed a transparency listing the five LRP scientific themes (climate change; sea-level change; sediments, fluids, and bacteria; transfer of heat and materials to/from mantle; deformation of lithosphere and earthquake processes), and tentatively listing the overall importance for the achievement of each theme of each of several downhole-measurement tools: quad combo, geochemical string, FMS, specialty tools (e.g., temperature, sediment magnetometer, dual laterolog, borehole televiewer, VSP), packer, CORK or seismometer deployment, LWD, and high-temperature tools. The panel discussed and modified these judgements, and the resulting overview of downhole tool needs for LRP objectives is shown in Appendix 1. Subsequent decision-making on priorities for individual components of ODP downhole measurements were based in part on these judgements concerning needs for LRP objectives.

Jarrard displayed a transparency listing the specific tools previously discussed (both WLS and ODP-TAMU), as well as all services listed in the current WLS Scope of Work statement. This listing provided a framework for subsequent discussions, aimed at distinguishing essential services from high-priority and low-priority services. A guiding premise in these discussions was the statement by PCOM liaison Moore that everything must be put on the table and justified; DMP must not assume that any component should remain just because it has always been there. Repeatedly, the Chair asked, "Is this component dispensable, or is it essential, and why?"

Before detailing the discussions leading to the final DMP recommendations, their conclusion is shown in the following recommendation to PCOM. We distinguish between routine measurements, which are undertaken at virtually every logged hole, and specialty measurements, which are employed only occasionally to achieve a specific site objective.

DMP Recommendation 96-1-2 to PCOM: DMP recommends that the following be considered essential services that must be provided by WLS, and that the Scope of Work statement include these responsibilities:

- Manage WLS and its subcontracts
- Standard geophysical logs (the previous description of "electrical, nuclear, and acoustic" logs is adequate), including data acquisition and quality control
- Logging support equipment (incl. winch, cable, heave compensator, and side-entry sub)
- Specialty logging tools (e.g., temperature, sediment magnetometer, dual laterolog, and VSP, but the SOW probably does not need to mention specific tools)
- Shipboard and shorebased log analysis facilities
- Log processing, analysis, and interpretation
- Education
- ODP logging database (incl. filling data requests, CD-ROMs in *Initial Reports*, and Internet access to log data)
- Support services for third-party logging

Imaging logging (e.g., routine FMS)
Logging While Drilling (specialty)

DMP recommends that the following be considered essential services that must be provided by ODP-TAMU:

Fluid sampling, discrete temperature measurements (e.g., ADARA or WSTP), and core orienting
Packer (specialty)
CORKs (specialty)

DMP recommends that the following be considered high-priority services, capable of achieving critical ODP scientific needs, to be provided by WLS to the extent that funding constraints permit. DMP does not make a recommendation concerning whether or not they should be included as Optional Tasks in the SOW statement of a WLS RFP.

Geochemical logging (specialty)
High-temperature logging (specialty)
Core/log integration
Engineering development center

Schlumberger subcontract:

In some previous meetings, DMP had been frustrated by inability to find out details of the Schlumberger subcontract, currently 49% of the total WLS budget. The FY97 Schlumberger subcontract is proprietary, pending conclusion of negotiations. Jarrard showed a transparency of the FY96 subcontract, received from JOI, and provided an overview of cost elements, including very rough estimates of the portion of the Schlumberger budget attributable to geochemical and FMS logging.

In light of the high cost of the Schlumberger subcontract, the panel explored the question of whether ODP is locked to Schlumberger. The conclusion was no; neither the existing WLS Scope of Work statement, nor the need for standard logs, nor the demand for LWD necessarily require Schlumberger for success. If, however, geochemical logging were judged to be essential for ODP, that decision would necessitate selection of Schlumberger. Schlumberger has a reputation for being very good but expensive. The petroleum industry tends to use Schlumberger most for frontier drilling and least for stepout wells, and all ODP sites are frontier drilling by industry standards. The panel was quite satisfied with the quality of service that Schlumberger has delivered, but they noted several second-order problems: obtaining sonic waveforms, changing formats, and unwillingness to provide documentation on tool responses. Herrick pointed out that industry, including Schlumberger, is now exhibiting a change of attitude to a more cooperative sharing of information.

DMP Consensus: DMP recommends that the next WLS Scope of Work statement, like the current one, refrain from descriptions that compel selection of Schlumberger as provider of logging tools. Encouragement of alternative providers will benefit the program, by increasing competition and cost pressure on whoever is chosen to provide routine logging. The LWD provider need not be the same as the provider of downhole logging.

Support services for third-party logging:

Third-party logging is, and has always been, a strong ODP scientific asset with minimal cost to commingled funds (primarily ship time). To assure quality control and maximize the dependability of this asset, DMP has devoted substantial effort to developing third-party tool requirements. Lysne said that ODP must be willing to back up these requirements by having WLS devote some engineering support (<1 FTE) to assuring that third-party tools fulfill these

requirements. Jarrard commented that perhaps more essential than policies is the need for WLS to consult with third-party tool developers, to examine their plans and advise them on compatibility with the ODP operational setup, and to provide a test hole and logging truck in which data acquisition mimics as much as possible the drillship operational environment. The panel did not define these support services as including design or construction of parts of third-party tools, but the support could include recommending design changes and supplying equipment such as the Schlumberger-head crossover (described earlier in these minutes).

The panel had no firm guidelines on amount of funding or scope of this effort. Some is essential, and likely funding levels are within the range where any increase in WLS funding will be a cost-effective investment.

Engineering Development Center:

The panel had little discussion on this topic, recognizing that the $100-300K/year cost of a serious engineering development center was too great to permit it to be considered as an essential service. Tool development was part of the original WLS contract. For the near term, however, ODP may have to rely on third parties, using non-commingled funds, for major downhole tool developments.

Cheng asked whether the WLS contractor should also be a third-party tool developer. The panel saw both advantages and disadvantages of such a combination. One advantage is that having a separately funded engineering effort increases the pool of engineering expertise available to WLS. One disadvantage is conflict of interest: the WLS contractor has a privileged advisory position within the panel structure that can easily become advocacy. DMP concluded that ODP should neither require nor discourage third-party tool developments by the WLS contractor, and that both DMP and the WLS contractor should remain alert to associated conflict of interest.

Geochemical logging:

Probably the biggest surprise of these DMP recommendations is that the status of geochemical logging be changed from routine to specialty. This recommendation in no way implies a loss of enthusiasm for the tool; it is instead a response to the EXCOM request to specify where costs can be reduced to permit innovations (such as LWD and CORKs). The panel was cognizant of a statistic that Goldberg had provided: even when considered as a required standard log, the geochemical tool has only been run at half the logged sites. Some panel members questioned whether geochemical logs are used enough to justify the costs. In part, this is a consequence of processing delays; shipboard scientists do not normally even see the processed geochemical logs until the *Initial Reports* come out. BRG's proposed combination of satellite data transmission and sending processed geochemical data back to the ship, if implemented, would undoubtedly increase the use of geochemical logs by shipboard scientists.

DMP was unable to obtain an accurate estimate of the cost savings that will result from changing the status of the geochemical tool from routine to specialty. Prior to hearing Goldberg's estimate that keeping the tool on board and using it for two legs per year would cost $60K/leg for those legs on which it is used, Jarrard had roughly estimated the total annual cost of the tool as ~$430K±100K (based on the assumption that its share of total equipment day rates is 20%, and its share of processing costs is 25% of total non-Schlumberger subcontract costs). Goldberg responded that this estimate is too high. The panel much preferred the option of using the tool for perhaps two legs per year, rather than removing it from the ship.

DMP Recommendation 96-1-3 to PCOM: DMP recommends that the geochemical tool string be redefined as an ODP specialty tool rather than a standard tool. DMP

recognizes that this change in status implies reduced use and reduced cost of future geochemical logging and processing. [motion passed with 9 in favor, 2 opposed, and 1 abstention]

Standard logging:

Cheng suggested that the definition of standard logging may need redefinition, and Carson suggested that DMP should take a hard look at the possibility of a radical redefinition of the standard string. Jarrard responded that such a discussion might best be deferred until the next meeting.

Cheng cited sonic logging as an area of immediate concern. He described the Schlumberger long-spaced sonic tool, which is the tool used for virtually all ODP logging, as providing unreliable data. He posed the question of whether the Schlumberger Dipole Shear Sonic Imager (DSI) may be a necessity rather than an option. Moos responded that a more sophisticated sonic tool should indeed be a priority, but not necessarily the DSI; other logging companies have better sonic tools too. Panel members agreed that use of the DSI is highly desirable even without considering its shear-wave capability. During his earlier presentation, Goldberg had mentioned the DSI as a tool that had been successfully tried in ODP but then taken off the ship because it was too expensive. He now added that the first-generation DSI generated questions about the reliability of both its P and S determinations at very low velocity (such as is commonly encountered in shallow portions of ODP holes).

DMP consensus: DMP is concerned that the long-spaced sonic tool does not satisfy ODP needs for routine velocity logging. DMP asks BRG to investigate the financial implications of providing an improved velocity tool.

Education:

The current WLS Scope of Work statement specifies that the "subcontractor will provide education of scientific applications of well logs through logging schools held approximately one per year, the distribution of an extensive logging manual, and the production of an ODP logging brochure." Kidd's letter to Jarrard directing the panel to investigate this agenda item asked "what might be dispensed with (the educational workshops - still needed, for example??)" The panel asked Goldberg whether these services are still being provided. He replied that the brochure and schools had already been cut; symposia (esp. special AGU sessions) were fulfilling some of the role previously played by logging schools.

Panel members had mixed feelings about the impact of the symposia, but they agreed that logging education is essential within ODP. Few universities offer courses in downhole measurements, yet many of the shipboard scientific party (particularly stratigraphers, physical properties scientists, and geophysicists) are potential users of logging data. Consequently, education directly translates into increased scientific production from logs. The panel recognized that the optimum type of education is debatable and dynamic (e.g., on-line tutorials?), so an RFP SOW should specify the need for educational services without restricting what those services might be. Some logging education is essential, and education expenditures are already minimal.

Internet access to log data:

DMP began its consideration of this component by noticing that Internet access to log data was listed as an optional task, not currently funded, within the present WLS Scope of Work statement. The panel had already discussed and strongly endorsed a major initiative on this topic earlier in the meeting; Jarrard noted that this initiative is projected to be complete by the

time Phase 3 begins. The panel agreed that the incremental cost of maintaining and updating it during Phase 3 is trivial compared to its scientific impact through increased use of log data. DMP concluded that Internet access to log data should be added to the database responsibilities listed in the WLS Scope of Work statement.

Formation MicroScanner:

That FMS is an essential ODP logging tool was quickly agreed by the panel, presumably because evaluation of FMS scientific impact was a topic at the 1995 DMP meetings. The panel had already concluded that FMS is much used by the community. Indeed, it is the only type of logging data used by many stratigraphers and structural geologists. In keeping with the DMP recommendation that a Scope of Work statement not compel the use of Schlumberger, Jarrard suggested that the statement specify "imaging logging (e.g., FMS)" or just "imaging logging".

Logging While Drilling:

- LWD also was quickly agreed by the panel to be an essential logging component for some legs. Little justification was provided, because the topic had been explored in detail in several previous meetings (see, for example, topics 8 and 14 in the Fall 1995 DMP minutes).

The panel recognized that even the first-generation LWD tools, which provide the same types of measurements as the Triple Combo, are expensive. The $670K LWD budget proposed by WLS for FY97 may be an anomaly, however, resulting from the sudden Barbados-inspired recognition within the scientific community that LWD permits successful logging in previously unloggable environments. A better estimate of the longer-term costs of LWD, assuming that ODP does not insist on state-of-the-art for this rapidly evolving technology, may be about $200-400K/yr.

DMP consensus: Logging While Drilling should now be considered an essential downhole measurement in some environments.

High-temperature logging:

High-temperature logging is an area of innovation that DMP considers to be essential to the achievement of some scientific objectives, particularly those in young crust. Fewer high-T legs are anticipated for Phase 3 than ODP had projected 5 years ago, when DMP devoted much more attention to this topic. One panel member asked what we mean by high-T logging, and the consensus answer was "any tool, existing or being developed, with higher temperature tolerance than the normally available tools." Like other special environments, high-temperature ones will sometimes warrant high-T specialty tool expenditures. Such expenditures would need to be considered on a case-by-case basis: major tool-development efforts are unlikely to be affordable by ODP given the projected level of Phase 3 high-T drilling, but future leasing of high-T tools may be very cost-effective.

Conclusions:

DMP concluded this analysis of the scope of future ODP downhole measurements with several more general comments:

- Lysne reminded the panel that these evaluations represent the current status only; they are not cast in concrete. DMP responds to new developments and will certainly continue to do so in the future, so the list of priorities will change.

- WLS is seen as having an important liaison role outside the ODP structure (e.g., potential liaison to the International Continental Drilling Program), but it is probably not appropriate to specify that role in the Scope of Work statement.

- A radical change in the WLS RFP process is worth considering. JOI could seek and obtain bids from various potential logging companies, as well as obtaining bids from more than one Schlumberger branch, rather than requiring that the bidder do so. RFP responders would not be required to use the JOI numbers; they would be free to obtain their own bids. The advantage of this approach is that JOI has greater negotiating leverage than an individual scientist has.

8. WRAPUP

A) DMP Consensus Items and Recommendations to PCOM

Jarrard asked that this brief topic be inserted into the agenda, and the panel agreed. Jarrard read his interpretations of what the panel had agreed to during the meeting, in order to permit panel members to make immediate corrections and potentially to change "consensus" to "majority view". Corrections were few, but panel members did remind Jarrard that DMP conclusions on a couple of topics should be added to the DMP Consensus category.

B) Next Meeting

The Fall 1996 meeting had been tentatively scheduled to be held in San Diego at the mid-October port call, so that newer members could visit the ship. Jarrard announced that he would have to be in Antarctica at that time, and he asked the panel's forbearance until Spring 1997 to visit the ship, at the Charleston, South Carolina portcall. Jarrard offered to host the Fall 1996 meeting in Salt Lake City, Utah. Panel members agreed to hold the next DMP meeting in Salt Lake City on September 30 to October 2, 1996.

C) Adjournment

Panel members thanked our hosts, Makoto Yamano and the Geological Survey of Japan, for their thoughtful support both before and throughout the meeting.

The formal proceedings of the JOIDES Downhole Measurements Panel were concluded at 12:30 on Saturday, March 2, 1996.

Appendix 1: figure not included electronically

Appendix 2

Joint DMP/OD21 Meeting on Downhole Measurements Opportunities in OD21

1 March, 1996 Tsukuba, Japan

Chairs:	Richard Jarrard (DMP) and Hajimu Kinoshita (JAMSTEC)	
Attending from DMP:	Bobb Carson	Lehigh Univ.
	Arthur Cheng	Massachusetts Institute of Technology
	Andrew Green	CSM Associates, UK
	David Herrick	independent consultant
	Peter Lysne	Sandia National Labs
	Daniel Moos	Stanford Univ.

	Philip Nelson	US Geological Survey
	Karen Romine	Australian Geological Survey Org.
	Richard Wendlandt	Colorado School of Mines
	Jurgen Wohlenberg	Angewandte Geophysik, Germany
	John Woodside	Vrije Universiteit
	Makoto Yamano	Earthquake Research Institute, U. Tokyo
	Cristina Broglia	LDEO-BRG liaison
	Paul Dauphin	NSF liaison
	David Goldberg	LDEO-BRG liaison
	Adam Klaus	ODP-TAMU liaison
	Gregory Moore	PCOM liaison, Univ. of Hawaii

Non-DMP participants:

Mamoru Enami	JAMSTEC
Tatsuki Endo	Schlumberger
Hiromi Fujimoto	Ocean Research Institute, U. Tokyo
Kantaro Fujioka	JAMSTEC
Adel Guindy	Schlumberger
Norikazu Hashimoto	Geophysical Surveying & Consulting
Yuka Kaiho	JAMSTEC
Hideaki Kakuma	Akashi Corp.
Shin' ichi Kuramoto	Geological Survey of Japan
Makoto Miyairi	JAPEX Research Center
Jiro Naka	JAMSTEC
Hajime Nakamura	JAPEX
Masatoshi Nakamura	JAMSTEC
Takeichiro Ohhashi	Oyo Corp.
Paul Robinson	Dalhousie University
Shin' ichi Takagawa	JAMSTEC
Takashi Uchida	JAPEX Research Center
Shigehito Uetake	JAMSTEC
Tetsuro Urabe	Geological Survey of Japan

OPERATIONAL AND SCIENTIFIC OVERVIEWS

Co-chair Richard Jarrard welcomed participants to this joint meeting.

Co-chair Hajimu Kinoshita provided an overview of OD21. The program is expected to be wider in scope than the current ODP, with deeper holes, seismic observatories, and ability to drill in areas containing hydrocarbons. The initial target is a 2.0-2.5 km riser system. The OD21 organizational aim is now to be fully international rather than an entirely Japanese initiative. Program administration and management are uncertain, but they are likely to be similar in many ways to the current ODP structure (including roles like those currently undertaken by JOI and ODP-TAMU). Drill-ship construction needs to start in late 1998, so construction-planning decisions are imminent and recommendations are welcomed. A COSOD-type meeting in late 1997 is likely. A driving social force for this program is the need for improved earthquake predictions. Therefore, a high-priority drilling target will be a hole into the shallow prism thrusts, because they trigger earthquakes that propagate as far as the sea floor, causing tsunamis.

Shin' ichi Takagawa provided a briefing on OD21 riser plans. The use of risers creates several opportunities: (1) multiple, nested casing strings, stepping down in diameter with increasing subbottom depth, (2) larger-diameter logging tools, (3) deeper penetration, (4)

blowout preventers, enabling drilling where hydrocarbons may be present, and (5) higher core recovery. One tradeoff is the choice between a large-diameter or slimline riser: larger-diameter risers permit deeper penetration (via more casing strings), whereas slimline risers are less affected by currents and, because they are lighter and require less shipboard storage volume, potentially much longer. OD21 is currently planning to use 16" riser, but 9.5" slimline riser is also being considered.

Rotary drilling and drill-in casing will be standard. Penetration will depend on the formation: perhaps 3500 m subbottom for 16"-riser drilling in stable formations, but less in unstable formations. Dynamic navigation will use differential GPS, but DGPS still has some regional gaps in coverage. The ship will be ~175 m in length, with 150 people. Additional capabilities include quick separation between the blowout preventer and riser, drill string motion compensation, coring, and riserless drilling to 7 km. A typical year of operations might cost $80-120M and consist perhaps of 6 months of riser drilling, 4 months of non-riser drilling, and 2 months at dock. A 3.5-km hole is expected to take about 4 months to drill and core.

Kantaro Fujioka summarized Japanese plans for long-term monitoring of OD21 holes. Ideally, instrumentation of selected holes would permit monitoring of changes in the following: seismicity, porosity, density, temperature, plate motion, tsunami generation, and geochemistry. Some of these variables are already being monitored at the Mid Atlantic Ridge. Data telemetry could use the existing network of sea-floor cables, although not all of the best drilling areas have abundant cables.

David Goldberg briefly described some differences in downhole-measurement opportunities for OD21, compared to present ODP. The larger diameters of OD21 holes permit use of a wider suite of logging tools (e.g., imaging and high-temperature tools). Also, the possibility of employing different drilling strategies (e.g., deviated holes) permits new approaches to long-standing scientific problems.

Co-chair Richard Jarrard commented on the fortunate timing of this joint meeting: it was originally planned in response to requests from OD21 and PCOM for recommendations on possible OD21 downhole measurement plans, then the February 1996 EXCOM asked for PCOM and OD21 science planners to organize a series of discussions on scientific research in Phase IV (post-2003) of ODP. Jarrard briefly summarized some of the Phase IV scientific objectives as detailed in the Long Range Plan, noting their strong thematic links to the June 1994 OD21 report "Ocean Drilling in the Twenty-First Century".

SUBCOMMITTEES

The detailed examination of individual topics was undertaken by dividing the group into three subcommittees, which met for one hour, then reorganizing into three more subcommittees, which also met for one hour. The subcommittee mandates and moderators were as follows:

Scientific objectives addressable by OD21:

- Processes at convergent plate margins (Carson)
- Oceanic crust (Robinson)
- Passive margins: tectonics and sea level (Romine)

Technology-limited science:

- Long-term monitoring (Carson)
- Borehole seismic observatories and earthquake prediction (Green)
- Cooperative development of new technologies (Lysne)

The subcommittees recognized both gaps and overlaps resulting from this simple six-part division of OD21 downhole-measurement opportunities. They concluded, nevertheless, that these topics did address many of the most critical and unique of the initial opportunities provided by Phase IV riser drilling. Longer-term scientific objectives (e.g., deep drilling into

"zero-age" crust) and goals achievable without riser drilling (e.g., many paleoceanographic objectives) were not considered.

Following the second set of subcommittee meetings, the entire group reconvened for brief presentations by moderators on the conclusions of individual subcommittees.

PROCESSES AT CONVERGENT PLATE MARGINS

Objective: determine decollement characteristics. How do stress, pore pressures, fluid flux, and sediment strength interact at the decollement? What determines the position of the decollement, and why does it change (e.g., strain hardening, cementation?) as subduction progresses? Understanding the characteristics and processes at an active decollement will require a combination of downhole measurements, seismic surveys, and analyses of structural geometry.

Downhole measurements needed: stress/strain, temperature (both background and transient), fluid flow (including pressure, permeability, and storativity, as well as their dynamic ranges), seismicity, seismic anisotropy, *in-situ* fluid sampling, and physical properties (including their relationship to geochemistry, temperature and the pressure field).

Objective: mass budget of a subduction zone. What are the volumes of offscraped sediments, subducted materials, and underplated materials? What properties of the rocks and subduction environment control this partitioning? What causes underplating?

Downhole measurements needed: porosity and lithology logging, physical-property logs, links to seismic (synthetic seismograms and VSPs).

Objective: fluid budget of a subduction zone. What are the origins of fluids expelled from accretionary prisms? How are fluids of the subducting plate partitioned into subducted vs. expelled fluids? Within a prism, what is the relative importance of concentrated vs. disseminated flow?

Downhole measurements needed: fluid flow parameters (including pressure, permeability, and storativity), *in-situ* fluid sampling, imaging of fracture and faulting patterns, temperature transients.

Objective: carbon cycle at convergent margins. What is the flux of hydrocarbons (esp. methane)? How much carbon is sequestered as gas hydrates or carbonate? What is the role of the microbial community in affecting this carbon cycle?

Downhole measurements needed: in-situ fluid sampling, geochemical logging, VSPs.

Objective: episodicity of subduction processes. We recognize that spot measurements often are not representative of cumulative geologic results (e.g., daily sediment movement vs. storm transport), but we have meager data on the temporal variability of subduction processes. How do fracture permeability, pressure, and fluid flow change over a period of years? Do lateral seismic changes (e.g., polarity of the decollement) detect these temporal changes, and is 4-D seismic (repetition of VSPs, cross-hole seismic, or 3-D seismic experiments) capable of detecting the episodicity?

Downhole measurements needed: long-term monitoring of boreholes (as described by another subcommittee), calibration of 4D seismic data with physical conditions in the

borehole (e.g., Vp, Vs, VSPs, pore pressure), vertical arrays of high-frequency seismometers for active seismic experiments (e.g., VSPs and cross-hole experiments).

OCEANIC CRUST

Objective: igneous stratigraphy, composition, and physical properties of normal oceanic crust. What aspects of the crustal generation process (e.g., spreading rate, magma supply) control the stratigraphy and physical properties of ocean crust? How do magmatic and tectonic processes interact? To what extent are the composition and physical properties modified by hydrothermal circulation? To what extent can we infer igneous stratigraphy or metamorphic fronts from seismic stratigraphy? DSDP and especially ODP progress on these questions has been sometimes stunning and sometimes frustrating. The OD21 prospect -- devoting both the time and technology needed for 3500m-penetration holes into oceanic crust -- is a leap beyond the previous investigations of shallow crust.

Downhole measurements needed: geophysical logs (for calibration of surface geophysical data), permeability, fluid flow (both natural and resulting from drilling a hole), imaging of fracturing and flow/pillow/dike morphology, long-term monitoring. Larger holes will permit use of many tools (e.g., high-T tools) that are too large for current ODP use.

Technological limitations: If OD21 is initially limited to 2500-m water depths by the decision to use a large-diameter riser, then this primary crustal objective -- normal oceanic crust -- is not addressable. This goal will need at least a 3500-m riser system, and the subcommittee recommends that lengthening the riser capability be a high priority (perhaps via a smaller-diameter riser?).

Objective: igneous stratigraphy, composition, and physical properties of shallow-water crustal exposures. Many intriguing crustal environments are either exposed in relatively shallow water or are covered by a sufficient thickness of sediments to permit drilling with a 2500-m riser system: seamounts, large igneous provinces, transverse ridges (e.g., Hole 735B), some backarc basins, and Red Sea. How do lithospheric dynamics and the crustal generation process of such regions differ from that of normal oceanic crust, and what are the consequences for crustal stratigraphy, composition, and physical properties?

Downhole measurements needed: same as above.

PASSIVE MARGINS: TECTONICS AND SEA LEVEL

Objective: tectonics of passive margins. What are the dynamics and structural consequences of extensional deformation of continental lithosphere? What are the dynamics and structural consequences of the embryonic stage of oceanic lithosphere development? Passive margins provide a unique record of both, but we need deep-penetration capability to reach the earliest part of the sedimentary record at passive margins.

Downhole measurements needed for 1-D objectives: porosity logs (crucial for decompaction and passive-margin geohistory), log-based lithology and identification of fining-upward and coarsening-upward patterns.

Downhole measurements needed for 2-D objectives: velocity & density logs (for synthetic-seismogram links from 1-D biostratigraphy & lithology to 2-D seismic) and VSPs or check-shots, log-based calibration of lateral seismic lithology interpretations, log-based interwell correlation (for determining lateral variations in lithology, porosity,

and grain size and thereby establishing the 2-D geometry and stacking patterns of stratigraphic sequences).

Special downhole-measurement priorities: Log calibration and interdisciplinary log analysis will be crucial for obtaining these objectives. The necessity of merging high vertical-resolution deep-borehole data with 2-D and 3-D seismic data requires increased emphasis on VSPs, check shots, shear-velocity logging, and perhaps cross-hole tomography.

Objective: sea-level change. What is the impact of eustatic sea-level change on the stratigraphy of continental margins, and what are the contributions of uplift and subsidence? Because the accommodation history of basins -- and resulting geometry and stacking patterns of stratigraphy -- depends on both tectonics and sea level, this objective and the preceding one cannot be isolated. What are the interrelationships among sea level, climate, and oceanographic conditions, as revealed by the signatures of all three within the sediments of passive margins? Previous scientific drilling has had to avoid some of the best localities for investigating these questions, because of either hydrocarbon risk or excessive sediment thickness.

Downhole measurements needed: same as above.

LONG-TERM MONITORING

As riser capability moves scientific drilling toward fewer, deeper, more expensive holes, instrumenting these holes for long-term monitoring may become the norm rather than a rare event.

Objective: temporal variations of subseafloor processes. What are the episodicities and magnitudes of changes in downhole temperature, fluid composition, fluid flow, seismic activity, and stress/strain in a variety of tectonically active (e.g., accretionary prisms, spreading centers) and "inactive" (e.g., passive margins) environments?

Downhole measurements needed for a passive-monitoring approach to this objective: temperature, osmotic fluid samplers (which require periodic removal and/or replacement) or newly developed sensors, flowmeters (thermal or mechanical), determination of Darcian flow (from a combination of initial permeability tests and long-term monitoring of borehole pressure), borehole seismometers, and tiltmeters (esp. for comparison to seismic activity).

Downhole measurement tactics for an active-experiment approach to this objective: Active post-drillship hydrogeological tests to study fluid flow require submersible or ROV hydraulic connection to the borehole, determination of in-hole pressure and fluid volume expelled or injected, and pumping to stress the formation. Seismic tomography of paired boreholes may detect changes associated with episodic fluid flow, pressure changes, or gas hydrate stability. Paired boreholes also permit interwell hydrogeologic tracer studies.

Broader technology development needs: Most passive and active experiments require not just an instrumented borehole but also telemetry and -- in most cases -- a sealed borehole. Downhole systems will evolve, so easy exchange of systems is a priority. Both strategies might be appreciably enhanced by OD21 development of capability for either directional drilling or *in-situ* perforation of casing (for hydrogeology experiments and sensor placement).

Note: This subcommittee did not consider power or telemetry requirements for long-term observatories. Those elements and other aspects of borehole and sea-floor observatories are discussed in detail in the following:

Dziewonski, A., and Lancelot, Y. (Convenors), 1995, Multidisciplinary Observatories on the Deep Seafloor, Report of the ION International Workshop, Marseille, France, 229 pp.

Carson, B., Becker, K., Purdy, M., Wilkens, R., Gieskes, J., and Hildebrand, J. (Convenors), 1996, BOREHOLE: A Plan to Advance Post-Drilling, Sub-Seafloor Science, Report of a JOI/USSAC Workshop, Miami, FL, 83 pp.

BOREHOLE SEISMIC OBSERVATORIES AND EARTHQUAKE PREDICTION

Objective: earthquake prediction. Can we improve short-term earthquake prediction by getting close to the seismogenic zone and monitoring geophysical and hydrologic properties (esp. small-scale seismic activity)? The subcommittee consensus was that borehole seismic observatories will improve our understanding of fault zones. There was no consensus, however, on whether this understanding is likely to lead to improved, timely earthquake prediction. The uncertain chance of success needs to be considered in the context of a potentially immense benefit-to-cost ratio.

Advantages of borehole seismic observatories: Going downhole moves the seismic monitoring closer to the seismogenic zone (whether at a spreading center or subduction zone). This will provide improved location of earthquake foci, detection of smaller earthquakes, and -- in combination with other observatories -- better fault-plane solutions. While some of these zones can be monitored with land drilling, they are usually at shallower depth offshore. Going downhole provides a seismically quieter environment and places the seismometers below the highly attenuating surface sediments, thereby providing lower detection threshold and higher frequency content.

Downhole-measurement needs and challenges: The seismic observatories will need broad-band seismometers (up to at least 100 Hz) and long-term deployments (years). Technological problems will include data-transmission cables, corrosion (esp. near spreading centers), temperature (even 100°C over prolonged periods damages most electronics, and 250-300°C capability is desirable in some environments), tool size, and long-term coupling of the tool to the formation.

Objective: filling critical gaps in the global seismic network. Properly located borehole seismic observatories can improve resolution of mantle tomography, thereby linking mantle dynamics to lithosphere creation, subduction, and intraplate volcanic processes.

Advantages of borehole seismic observatories: primarily optimized seismometer locations, unconstrained by locations of land, but also: improved determination of earthquake foci, better fault-plane solutions, and a seismically quieter environment.

Downhole-measurement needs and challenges: mostly same as above.

Note: Although our meeting considered seismic observatories and other long-term monitoring in separate brief subcommittees, the two share so many scientific applications and technological challenges that a combined, more detailed analysis would have been preferable. The subject of earthquake prediction, in particular, demands consideration of seismic plus other monitoring, in a much longer meeting than was possible here.

COOPERATIVE DEVELOPMENT OF NEW TECHNOLOGIES

Objective: providing downhole measurement technologies needed for OD21 science. In contrast to the other subcommittees' identification of downhole measurements needs, this subcommittee concentrated on means to reconcile technological needs with development resources, both monetary and intellectual.

The downhole-measurement technology needs anticipated for OD21 have many similarities to those of other existing scientific-drilling programs (e.g., ODP, ICDP), and the subcommittee underscores the value of interaction among these geoscience programs. None of these groups can rely on the oil-and-gas industry, the traditional provider of new drilling and logging technologies, to fund the needed technology developments. Successful scientific applications can be used to advertise and promulgate measurements for industrial purposes, and this tie should be exploited in discussions with industry.

Although technology needs of the various scientific drilling programs are similar, no systematic coordination of technology developments among the scientific drilling programs has been implemented. A coordination center for these global activities will be needed, like those already established for ODP at TAMU, US Continental Scientific Drilling Program (CSDP) at TAMU, and ICDP at Potsdam. ODP and the US CSDP already share an engineer at TAMU.

Recommendations: Formal liaisons should be established between the various scientific drilling programs -- in particular between ODP, OD21, and ICDP -- to identify areas of technical collaboration. These liaisons should meet and formally report their findings, perhaps through the JOIDES Journal. Perhaps the charter of the joint ODP/US CSDP engineering office at TAMU can be expanded, to allow access by the worldwide scientific drilling community. The intent of this expansion is to provide a clearing house for general information, not technical detail.

Downhole measurement technology developments have long lead times. By starting now to arrange collaborative funding and construction of the highest-priority downhole-measurement innovations, OD21 can be poised to deploy them in 2003.

After a closing statement by Hajimu Kinoshita, this joint meeting was adjourned.